ABSTRACT

Title of Dissertation: THE INFLUENCE OF THE RIVER OTTER (*LONTRA CANADENSIS*) ON AQUATIC CONSERVATION IN THE GREATER YELLOWSTONE ECOSYSTEM: A SOCIO-ECOLOGICAL APPROACH TO EVALUATING CONSERVATION FLAGSHIPS

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Large scale habitat loss, unprecedented rates of species extinction, and other biodiversity issues have prompted wildlife conservationists to increasingly apply the "flagship" species concept to guide conservation decision making. Flagships are designated based on their ability to serve a socio-economic role, attracting public attention and financial support to conservation initiatives. Critical to flagships success is selecting an appropriate flagship—one that will be widely supported and will not invoke ill-will among any stakeholders. Thus, determining if the species meets certain pre-established criteria that are known to influence social-psychological processes is a critical step in flagship selection. The river otter (*Lontra canadensis*) is a widely distributed apex predator and possesses various other socio-ecological traits that make it suitable for a flagship species. However, empirical evidence supporting the use of the river otter as a flagship is lacking. In this dissertation, I study the ability of the river otter to serve as a flagship species in the Greater Yellowstone Ecosystem, one of the largest intact temperate-zone ecosystems in the world. I examine visitor attitudes and perceived resource conflicts with river otters and anglers, assess visitor willingness to engage in pro-conservation behaviors to help river otter conservation, and estimate probability of viewing the river otter using camera-traps along the Snake River. In addition to fulfilling certain recommended criteria of a flagship species, such as having a large body size, being charismatic, encompassing a wide-spread geographic range, and being uncommon across the landscape, my results suggest that visitors and anglers have positive attitudes towards the river otter, and that exposure to the river otter increases people's willingness to engage in pro-conservation behaviors to help conserve the river otter and its aquatic habitat. However, pre-existing negative media portrayals as well as low visibility of the species, are potential liabilities of the river otter as a conservation flagship. The studies in this dissertation deepen the understanding of river otter socio-ecology as well as develop and apply elements of a socio-ecological framework that refine the approach of effectively selecting a successful conservation flagship.

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by

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Dedication

To my Poppy and Pap

Acknowledgments

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Chapter 1

Incorporating social-ecological concepts into flagship species selection: a comprehensive framework

Introduction

Large-scale habitat loss, unprecedented rates of species extinction, and other biodiversity issues have prompted biologists to increasingly apply the "surrogate" species concept to guide their conservation decision making. Surrogate species, such as flagship, indicator, keystone, and umbrella, have been frequently used as proxies in conservation biology to represent larger conservation issues such as ecosystem preservation and health. However, flagships differ from other conservation surrogates, which are selected for their ecological roles, because they are designated based on their ability to serve a socio-economic role, attracting public attention and financial support to conservation goals (Leader-Williams and Dublin 2000, Walpole and Leader-Williams 2002). Flagships are defined as "popular, charismatic species" that serve to attract attention to large-scale conservation issues (Heywood 1995) and "…have the ability to capture the imagination of the public and induce people to support conservation actions and/or to donate funds." (Walpole and Leader-Williams 2002).

Flagships are selected by governmental and non-governmental (NGOs) conservation organizations because of their ability to symbolize complex ecosystems and habitats, or highlight a single-species in need of conservation attention (e.g., Barua, Tamuly, & Ahmed, 2010; Eckert & Hemphill, 2005; Home, Keller, Nagel, Bauer, & Hunziker, 2009). Flagship campaigns can be focused on either a single species or habitat (e.g., 'Save the Tiger') or aimed at a suite of species ("flagship fleet") that represent a larger conservation concern, such as climate change (Seidensticker 1997; IUCN 2009). Although the two campaign designs differ in focus, the ultimate aim of either approach is to promote awareness and interest, and engage the public in a particular pre-identified objective, such as increasing conservation-based efforts (e.g., Maekawa et al., 2013; Stevens, 2011), influencing policy and management decisions (e.g., Eckert & Hemphill, 2005) or promoting conservation reserve designation (e.g., Hooker & Gerber, 2004; Sergio, Newton, Marchesi, & Pedrini, 2006).

There are specific criteria for flagship selection that have been recommended depending on the campaign strategy and intended conservation goals (e.g., Barua, Root-Bernstein, Ladle, & Jepson, 2011; Caro, Engilis, Fitzherbert, & Gardner, 2004). Some are related to physical and inherent characteristics, such as large body size (Fuhrman & Ladewig 2008), charisma (Skibins et al. 2013), geographic status and distribution (Bowen-Jones & Entwistle, 2002), and International Union of Conservation of Nature (IUCN) conservation status (Brambilla et al. 2013), which resonate with humans, engendering feelings of relatability (Tisdell et al. 2007), or other emotional responses, such as empathy (e.g., Skibins et al., 2013). Additionally, assessing characteristics such as awareness and knowledge about, as well as attitudes towards the flagship has been identified as a critical step in the selection process (e.g., van der Meer, Badza, & Ndhlovu, 2016; Schlegel & Rupf, 2010), because these factors can impact how the flagship is perceived by the local communities as well as the target audience (if different from the local communities) (Bowen-Jones & Entwistle 2002).

While the aforementioned criteria have been recommended as critical for selecting a flagship (e.g., Barua, Root-Bernstein, Ladle, & Jepson, 2011; Bowen-Jones & Entwistle, 2002), other valuable criteria for selecting a flagship such as if/when the species is visible to humans, and the diet of the flagship have not been explored extensively in the literature. In captive settings, animal visibility influences duration of exhibit visit as well as number of people at an exhibit (Bitgood et al. 1998; Moss & Esson 2010), suggesting that visibility is an important characteristic of engaging the public. Understanding the diet of the flagship can identify potential adversarial stakeholders, who may perceive the species as a threat to their livelihood or recreational opportunities (Boulhosa & Azevedo, 2014; Chavez, Gese, & Krannich, 2005). Thus, understanding these characteristics should be considered a fundamental element of selecting a flagship that will be successful over the long-term.

A comprehensive framework for flagship species selection

The flagship selection process has lacked the integration of a comprehensive understanding of all aspects that are critical for a successful flagship. I propose a comprehensive framework that incorporates the eight aforementioned recommended characteristics (i.e., large body size, charisma, wide spread geographic distribution, and endangered or threatened IUCN status), in combination with two additional criteria (i.e., visibility and diet) to ensure long-term flagship success and subsequently on-going conservation for the species and its habitat (Figure 1.1).

This refined flagship selection approach provides a more comprehensive selection process that includes both the social importance of the species, and ecological characteristics that can be incorporated into formal and informal education and outreach programs, with the ultimate goal of engaging stakeholders in conservation actions to help preserve the species and its associated habitat.

Large body size.—Smaller reptiles, such as chameleons (*Calumma tarzan*) in Madagascar (Gehring et al. 2010), and tropical birds of the Seychelles (Veríssimo et al. 2009), have served as flagships, but large mammalian species are more commonly used (Caro & O'Doherty, 1999). In captive settings, such as zoos and aquaria, large relative body size of a species has been linked with higher visitor interest (Bitgood et al. 1998; Moss & Esson 2010) and longer viewing times (Bitgood et al. 1998). Kellert (1980) determined larger animals are usually preferred by people (on a like/dislike scale), which is likely related to our ocular-central culture (i.e., preference of visual over other senses in Western culture) (Jepson & Barua 2015). A large body size also makes a species more recognizable, another important characteristic of a flagship species (Bowen-Jones & Entwistle, 2002; Barua et al. 2013). A review of Dutch non-governmental organizations (NGOs) determined that willingness of these organizations to support public conservation measures was higher for larger species (Knegtering et al. 2002) and in a review of United States (US) conservation and nature magazines, large birds, and, mammals were featured significantly more than expected based on the species relative abundance in natural systems, suggesting that these species attract more readers and potential donors for conservation (Clucas et al. 2008).

Charisma.—For not clearly established reasons, some species are considered more attractive and interesting than others, and thus have greater appeal to humans, making them better suited for flagships than others. These species have charisma, which is defined by Lorimer (2007 p. 915) as a "lively and unpredictable property of a non-human entity….which determines its perception by humans and its subsequent evaluation." While on a practical level charisma is subjective, Albert, Luque, and Courchamp (2018) concluded that large body size, and being a mammal were the primary traits of a charismatic species, and that other characteristics, such as relationship with humans and conservation status were considered not as important. Martín-López, Montes, and Benayas (2007) determined that charisma had a greater influence on willingness-to-pay than ecological role and whether the species was endemic or exotic, and Colléony et al. (2017) determined that participants in a zoo conservation program were more likely to "adopt" an animal based on charisma, rather than IUCN conservation status. Although many flagships are labeled as charismatic, there are also examples of flagships that many would not perceive as charismatic. For example, the kapok tree (*Ceiba pentandra)*, a flagship used as a symbol for conservation of forests in Belize (Bowen-Jones & Entwistle, 2002), and the freshwater pearl mussel (*Margaritifera margaritifera*) (Kalinkat et al. 2017).

Geographic distribution.—The geographic distribution of individuals of a species can impact people's ability to view and form an interest in a species, as well as influence the species ability to serve as a symbol for various ecosystems throughout its range. Species that have a narrow range, or are endemic to a particular region, have been shown to reinforce feelings of concern and of appreciation for the species (Martín-López et al. 2007), and influence peoples willingness-to-pay for conservation (Veríssimo et al. 2009). Alternatively, having a wide geographic distribution or if the species makes vast migrations increases the probability that a species will be known among a national or international target audience, as well as allows the species to protect numerous ecosystems across its range (Eckert & Hemphill 2005). A flagship species that has a wide geographic distribution might be best suited when trying to conserve a habitat type (Kontoleon & Swanson 2003), or establish a conservation reserve (Hooker & Gerber 2004).

Conservation status—Many conservation priorities are focused on species that are naturally uncommon in the landscape (i.e., species that exist in low population densities), or are classified as "threatened" or "endangered" by United States Fish and Wildlife Service (USFWS, 2018), or as "near threatened", "vulnerable", or "endangered" by the IUCN (IUCN 2001). Caro (2010) concluded that when flagships are used to raise funds in the industrialized world, the species should have a vulnerable or endangered conservation status. Additionally, Angulo and Courchamp (2009) indicated that humans have a preference towards viewing rare species, and Echeverri, Callahan, Chan, Satterfield, and Zhao (2017) concluded that people are more likely to donate when the campaign is for endangered species such as the sea otter (*Enhyrda lutris*). Additionally, Martín-López et al. (2007) determined that environmental professionals and nature users were willing to pay greater amounts for locally endangered, and legally protected species, respectively, and DeKay and McClelland (1996) determined that willingness-to-pay was highest for "endangered but savable" species. However, Colléony et al. (2017) determined that IUCN threat level had no effect in willingness to "adopt" an animal and a study in the US indicated that physical characteristics were better predictors of spending by the government than level of threat (Metrick & Weitzman, 1996). Finally, Tisdell, Nantha, & Wilson (2007) indicated that respondents were willing-to-pay for conservation of abundant species that are not endangered. Thus, the effect of the species conservation status on human preference and willing to pay is dependent on campaign objectives, and although it is beneficial in some cases for the species to have a threatened, vulnerable, or endangered conservation status, it might not be a universal trait of all flagship species (Entwistle & Stephenson, 2000).

Pre-existing usage.—Any pre-existing positive or negative cultural associations of the flagship should be identified as part of the flagship selection process, including symbolic meanings of the species, relationships to folklore, or use in traditional food or medicine (Bowen-Jones & Entwistle 2002; Jepson & Barua 2015). Additionally, if a flagship has been previously used to symbolize any polarizing socio-political disputes, it may be unsuccessful as a flagship. For example, the spotted owl (*Strix occidenetalis*) has been used to symbolize the political conflict among different forest management goals involving the control and competition of resources (i.e., timber) (Moore, 1993), and thus this species has the potential to become a "battleship" (i.e., implicated in social conflicts among various stakeholder groups) (Douglas & Veríssimo 2013).

Awareness.—A flagship fulfils a specific marketing role in conservation, and one can consider the flagship species as a "product" (Verissimo et al. 2011). From this perspective, the flagship acts as a symbol for a larger conservation campaign (Verissimo et al. 2011). Consumer decisions about a product are influenced strongly by brand awareness (Jones 2005; Konecnik & Gartner 2007). Brand awareness, as it pertains to flagship species, includes name recognition, and ability to recall the presence or absence of efforts to conserve the species (Waylen et al. 2009; Verissimo et al. 2011). A species is likely to invoke awareness if it is visible (e.g., can be encountered in the wild or captive settings), and/or is commonly used in formal (e.g., school curricula) and informal (e.g., internet and media) education venues (Clucas et al., 2008; Duarte, Dennison, Orth, & Carruthers, 2008; Entwistle & Stephenson, 2000).

Different levels of awareness can be correlated with willing/unwillingness to engage in and pay for conservation efforts. In a study assessing the economic value of the European otter (*Lutra lutra*) and the water vole (*Arvicola terrestris*), both species of conservation concern, White et al. (1997) concluded that individuals aware of specific threats towards the species were generally more willing-to-pay for conservation actions designed to conserve these species. Rahman & Asmawi (2016) determined that local residents that were "not aware" of mangrove degradation were unlikely to participate in mangrove rehabilitation programs. However, Vincenot, Collazo, Wallmo, & Koyama (2015) concluded that although residents were aware of the Ryukyua flying fox (*Pteropus dasymallus*) the willingness-to-pay for protection was low. Hence, although awareness is important, other characteristics should also be considered prior to flagship deployment.

Knowledge.—Knowing about a species conservation status, primary habitat, geographical range, role in the ecosystem, and potential threats, can influence a person's attitudes, and their willingness to engage in actions to help conserve that species (e.g., Martín-López et al., 2007; Morgan & Gramann, 1989; Yore & Boyer, 1997). Tisdell (2006) determined that if a species is considered threatened, then increased knowledge about the species' population level increases the amount donors are willing to pay for the species' conservation. Additionally, people with a greater ecological knowledge are more supportive and see the greater value in protected areas (Fiallo & Jacobson 1995; Mooreman 2006). In another study, however, Douglas & Winkel (2014) determined that knowledge of parrot-related crop loss did not significantly influence attitudes towards parrot conservation.

Attitudes.— Human attitudes towards non-human species can influence biodiversity conservation objectives (Martín-López et al. 2007; Knight 2008). Attitudes, defined as positive or negative evaluations about an object, are informed by pre-existing values, preferences, emotions, and unconscious motives (Regan & Fazio, 1977; Rosenberg & Hovland, 1960; Schultz, 2002). Attitudes can be important predictors of pro-conservation behaviors when combined with other social, political, and cultural factors (Ajzen 2002), hence understanding attitudes of the target audience towards a potential flagship is critical before deployment. When the target audience has a positive attitude towards the flagship there is a greater chance of a reaching the conservation goal (Walpole & Leader-Williams 2002; Eckert & Hemphill 2005). A positive attitude towards the species also reduces the potential of having an adversarial flagship species.

Additional recommended criteria

Visibility.—The target audience should be able to view a flagships in the species natural environment or in a zoo or aquarium. Direct exposure to wildlife and nature has been shown to increase environmental concern (Myers & Saunders, 2000) and ecological intentions (Ballantyne, Packer, & Sutherland, 2011; Dietz et al. 1994; Kals, Schumacher, & Montada, 1999). This is readily apparent in captive settings where visibility has been shown to influence time spent, and crowd sizes at exhibits (Bitgood et al. 1998; Moss & Esson 2010). In the wild, predicting visibility is a greater challenge. However, through careful ecological monitoring, such as the use of camera-traps or reported sightings, one would be able to elucidate the optimum viewing opportunities for a species.

Diet.—A species diet can influence public attitudes towards the species. For example, carnivorous species are generally not a well-liked group (Kellert, 1985), and animals that forage on crops or farmed species, or compete with humans for wild game are considered pests (West & Parkhurst 2002; Kloskowski 2011). In some cases, however, the perceived diet is different from the actual diet of a species (Chase Grey, Bell, & Hill, 2017; Chavez & Gese, 2005). For example, although diet studies have determined that livestock predation by pumas (*Puma concolor*) is low, cattle farmers in South America still perceive that pumas have a significant impact on their cattle herds, and tend to have negative attitudes towards those species (Boulhosa & Azevedo 2014). Similarly, in Minnesota, dietary analysis by Chavez & Gese, (2005) indicated that grey wolves consumed primary native prey species, but cattle farmers still held negative attitudes towards the wolves because of their perceived impact on livestock (Chavez, Gese, & Krannich, 2005).

Limitations and Conclusion

Although much research has been conducted on identifying successful flagship species, there is still need for refinement, and an approach that comprehensively applies all critical components of the flagship species concept. The framework highlights the need to incorporate many different characteristics into the flagship selection process, and that selecting a flagship on one characteristic alone will not lead to flagship success. Rather, the characteristics should all be considered, as well as the interrelationships between the characteristics. Further, the framework allows those who are deploying the flagship to better guide marketing efforts, particularly if the flagship does not entirely meet one of the characteristics. The proposed socio-ecological framework in this chapter will be applied in the following chapters of the Dissertation. In Chapter 2, I assess attitudes of a potential adversarial stakeholder group (i.e., anglers) towards the river otter and its conservation, in Chapter 3, I determine if the river otter can effectively engage people in pro-conservation behaviors, in Chapter 4, I examine if the river otter is visible, and in Chapter 5, I align the 10 characteristics identified in the framework to the river otter.

Figures and Tables

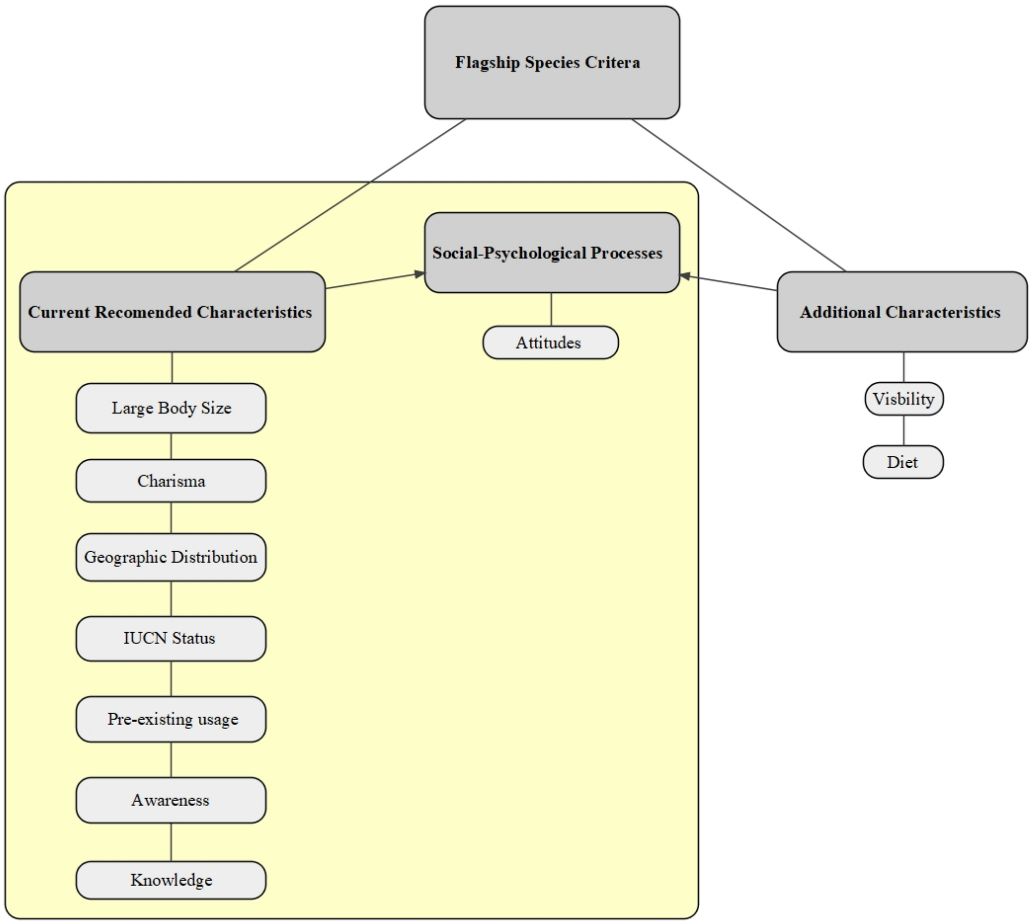

Figure 1.1. Social-ecological framework for flagship species selection. The yellow-shaded box represents current published criteria (Baura et al. 2011) to consider when selecting a flagship.

Chapter 2

Angler support for river otters as conservation flagship: does perceived resource competition influence attitudes and beliefs?

Introduction

The various perceptions humans have about wildlife influence attitudes, which can ultimately affect the success of conservation initiatives (Woodroffe et al. 2005). Although closely related to attitudes—positive or negative evaluations of an object (Vaske 2008)—perception is a general awareness about a situation, which is interpreted and organized depending on a human's previous experience of the world (Pickens 2005). Species that are perceived as attractive, intelligent, docile, and/or most similar to humans elicit positive attitudes from humans (Batt, 2009; Kellert, 1993; Knight, 2008; Plous, 1993); whereas, species that humans perceive as competing with economic or recreational goals, such as when a species forage on crops or farmed species, or compete with humans for species valued for hunting or fishing (West & Parkhurst 2002; Nilsen et al. 2007; Gusset et al. 2008; Kloskowski 2011) elicit negative attitudes (Bjerke, Reitan, & Kellert, 1998; Ericsson & Heberlein, 2003). A person's interpretation, or perception of a situation or stimuli, may often be different from reality (Pickens 2005).

The gray wolf (*Canis lupus*) serves as an illustration of how some wildlife species are perceived inversely by different stakeholders, and thus elicit both positive and negative attitudes among the public (e.g., Kellert et al., 1996; Scarce, 2005; Wilson, 1997). Many hunters and ranchers perceive the gray wolf as a competitor for game ungulates, a threat to livestock, and/or represent a social conflict over land use (Scarce, 2005; Wilson, 1997), and those groups tend to have less positive attitude towards wolves then the general public (Bruskotter et al. 2007; Røskaft et al. 2007; Dressel et al. 2015). Those groups are also more likley to believe that lethal control of predators is acceptable (Bruskotter et al. 2009). Whereas, for other stakeholders (e.g., wildlife advocates, environmentalists, non-hunters), the gray wolf symbolizes the American West and is perceived as an integral component of a functioning ecosystem, and one that must be preserved (Wilson 1997; Scarce 2005). Those groups tend to have more positive attitudes towards wolves (Bruskotter et al. 2007; Dressel et al. 2015), and be less accepting of lethal control methods to reduce populations of those perceived as a threat (Bruskotter et al. 2009). Historically, the consequence for species' needs being in perceived competition with recreational or economical pursuits of humans is persecution and sometimes elimination of that species from the landscape (Kellert et al., 1996; Musiani & Paquet, 2004).

While negative attitudes can result in lethal control and wildlife management policies to reduce the number of the species (e.g., McCagh, Sneddon, & Blache, 2015), positive attitudes towards a species can motivate people toward actions to help conserve species and their associated habitat. This can include providing monetary donations to nonprofit conservation organizations (e.g., World Wildlife Foundation, The Nature Conservancy), or engaging in pro-conservation behaviors (Knight 2008; Brambilla et al. 2013). Species that elicit positive attitudes and can engage people in socio-economic conservation actions, are known as flagships (Walpole & Leader-Williams 2002). Species that tend to garner polarizing responses are not commonly used as flagship species (e.g., in a public campaign to garner support for a conservation goal) because these species, like the gray wolf, have the potential to become a "battleship" and lead to social conflicts (Wilson 1997; Scarce 2005; Douglas & Veríssimo 2013).

A possible candidate for a flagship species is the river otter (*Lontra canadensis*). Like many other carnivore species, river otters suffered severe population declines in the late 19th century, and by the middle of the 20th century river otter populations had been extirpated from much of their previous range (Nilsson 1980). Improved water quality as well as regulated trapping resulted in the expansion of remnant river otter populations, and the implementation of reintroduction projects in 22 states, starting in Colorado in 1976 (Bricker et al. 2019). The river otter is an apex aquatic predator possessing many characteristics of a flagship species. For example, the river otter has a relatively large body size, and is considered charismatic, characteristics that have been shown to positively influence the public perceptions of an animal (Chapter 1; Fuhrman & Ladewig, 2008; Rolston, 1987; Woods, 2000). Additionally, the large geographic range of the river otter (i.e., present in all 48 continental United States and Alaska [Bricker et al., 2019]), combined with media depictions of the river otter as being cute, playful, and intelligent (Kruuk 2006; Johnson & Landis 2009), help engender public interest and familiarity of the species and its obligate dependence on aquatic environments (e.g., rivers, lakes, coastal areas) (Kruuk 2006). Combined, these characteristics suggest that the river otter possesses the potential to serve as an aquatic conservation flagship (Chapter 1, Chapter 5).

However, not all members of the public harbor positive perceptions and attitudes about the river otter. As river otter populations continue to expand and re-establish in portions of their former range, the potential perception that river otters are a threat to fish populations, or economic opportunities at private fish-rearing facilities is a prevalent headline in the media (e.g., Goedeke, 2005; Hamilton, 2006; Serfass, Bohrman, Stevens, & Bruskotter, 2014; Transylvania Times, 2018). However, these headlines conflict with the results of various diet analyses of the river otter that have indicated that non-game fish in the Cyprinidae (carp and minnows), Centrarchidae (sunfish), and Catostomidae (suckers) families are the most common prey (Greer, 1955; Serfass, Rymon, & Brooks, 1990; Stearns & Serfass, 2010), and river otters were not considered a large threat at private pond and public fish-rearing facilities in Pennsylvania

(Parkhurst 1994; Pearce et al. 2017). Such media coverage can elicit or further perpetuate possible misconceptions and unfavorable attitudes towards the river otter (e.g., Bombieri et al., 2018; McCagh et al., 2015; Sabatier & Huveneers, 2018; Siemer, Decker, & Shanahan, 2007), especially to the general public who may have little to no experience with river otters, decreasing its likelihood of being a successful flagship species.

Although a number of online media articles have portrayed a conflict between anglers and river otters (e.g., Cuff, 2015; Lampe, 2004; The Associated Press, 1998; Transylvania Times, 2018), there are only a few formal evaluations in the United States, that have assessed angler attitudes towards river otters (e.g., Bohrman, 2013; Goedeke, 2005). Bohrman (2013) found that 85% of surveyed anglers in Pennsylvania were not concerned that river otters would harm game fish populations, and that 61% of anglers believed that river otters were beneficial to the waterways they inhabit. Goedeke (2005) however, qualitatively examined the social construction of river otters by anglers during their reintroduction into Missouri in 1982 and concluded that anglers perceived the fish consumption of river otters to be "excessive" and negatively constructed the river otter as "thieves" or "vermin." Given few empirical assessments of angler attitudes towards river otters in the United States, there is currently not enough information to accurately represent the attitudes of angler communities towards river otters.

To address this gap and provide insight into the use of the river otter as a flagship, I examined angler attitudes towards river otters and if those attitudes are influenced by perceptions of the river otter as a competitor for game fish. I hypothesized that anglers who perceived the river otter as a competitor for wild food or recreation opportunities (i.e., indicated that river otters decrease the amount of game fish available to anglers) are more likely to have negative attitudes towards river otters than anglers who do not view the river otter as a competitor for game fish.

Methods

Study site

I conducted this study at public river access points on the Madison, Snake, and Yellowstone Rivers, the Jackson Lake Dam (Grand Teton National Park), and Trout Lake (Yellowstone National Park), all located within the Greater Yellowstone Ecosystem (GYE) (Figure 2.1). These waterbodies offer opportunities for high quality trout fishing, including wild rainbow trout (*Oncorhynchus mykiss*) and cutthroat trout (*Oncorhynchus clarkii*), making them a popular destination for anglers (Staples 2017) and an important component of the local economies within and surrounding the GYE (Kerkvliet et al. 2002). These sites were selected because river otter presence has been confirmed in the respective river (i.e., Snake river [Hall, 1984] or contain suitable habitat for river otters (Swimley et al. 1998; Crowley et al. 2012).

Survey

The survey instrument was an on-site questionnaire which included 14 items partitioned into 3 categories: 1) socio-demographics 2) perceptions about river otters and 3) attitudes about river otters and river otter habitat (Appendix I). Attitude items were modified from Smith and Sutton (2008) to specifically pertain to the river otter, and the perception items were based on an angling survey completed in Pennsylvania and reported in Bohrman (2013). The questionnaire items were examined for item clarity (e.g., if any terms were confusing or not understood), and the overall length of survey was evaluated during a pilot test (n = 54, 75% response rate) with visitors at a popular trailhead in Ohiopyle State Park, Pennsylvania, in May 2015. Specifically, after respondents took the questionnaire, I asked the respondent to explain which (if any) terms were unclear or confusing. Ohiopyle State Park is a popular fishing site and also provides habitat to river otters, so it represented a similar sample as my target audience. The questionnaire was approved by University of Maryland IRB (555619-1).

Socio-demographic variables were recorded for each individual, based on previously published socio-demographic variables commonly used in flagship research (e.g., Skibins & Powell, 2013; Smith & Sutton, 2008). These items included age, gender, education, and primary residence.

Two items were aimed at determining if the respondent considered the river otter as a competitor for game fish. The first item asked: "What is the diet of the river otter?" and respondents were asked to select any: game fish, non-game fish, or both game and non-game fish. The second item asked anglers to respond to the follow statement, "I feel that river otters decrease the number of fish available to anglers", and was measured on a 5-point scale, ranging from "strongly disagree" (-2) to "strongly agree" (2).

Five attitudinal items, modified from Smith and Sutton (2008) aimed at assessing attitudes towards the river otter and river otter habitat were measured on a 5-point scale, ranging from "strongly disagree" (-2) to "strongly agree" (2). Internal reliability was examined using Cronbach's alpha for the five attitude items, using the recommended value of 0.70 or higher (Nunnally 1978).

Survey administration

An intercept sampling method was used for survey collection, and efforts were made to ask every person encountered at the six sites who was over the age of 18 and engaging in an angling activity (Davis et al. 2012). Between 5 June and 25 July 2015 and 1 June and 15 August

2016, 468 anglers were approached and 406 agreed to participate in the survey, giving an overall response rate of 87%.

Statistical analysis

Data were analyzed in Stata 14.0 (Statacorp, College Station, Texas 77845, USA). All negatively worded items were reverse-coded, data were screened for missing values, and cases exhibiting missing values for more than 50% of items per variable were removed. A total of 0 cases were removed, resulting in a final sample size of N = 406. Based on the response of the angler to the perception item "I feel that river otters decrease the number of fish available to anglers" I grouped my respondents into a 3 categories: "competitor" (agreed or strongly agreed with this statement), "non-competitor" (disagreed or strongly disagreed with this statement), and "neither" (neither agreed or disagreed). Summary statistics (Mean, SD, Median) were used to describe variables.

My first perception item, "What is the diet of the river otter" had very few anglers (n = 10) who perceived the diet of the river otter to be only non-game fish, and so I used summary statistics to describe this variable, rather than univariate analysis. A one-way analysis of variance (ANOVA) compared "competitor", "neither", and "non-competitor" groups for each dependent variable (i.e., 5 attitude items, 2 belief items) (Sponarski, Vaske, & Bath, 2015; Vaske, 2008). A one-way ANOVA was selected because I had one categorical independent variable (i.e., competition [competitor, neither, non-competitor]), and my dependent Likert-type attitude items were treated as continuous (Harwell & Gatti 2001; Vaske 2008; Wu & Leung 2017). Concern over treating Likert-type items as ordinal data has long been debated in the literature (Harwell & Gatti 2001; Wu & Leung 2017; Douven 2018). However, because most Likert-type items are measurements a continous construct (e.g., an attitude), researchers have provided evidence that a

Likert-type item with 5 or more categories can be used as continuous variables (Norman 2010; Sullivan & Artino 2013; Douven 2018). The means for each competitor group were normally distributed. To account for unequal sample sizes, I conducted a Tahmane post hoc test for unequal variances to test for differences in means between the groups for each one-way ANOVA (Vaske, 2008). Effect size measures (i.e., η) compared the groups' responses for each attitudinal item (Vaske, 2008). I used an alpha level of $P < 0.05$ to designate statistical significance for all analyses, but also considered effect size measures to account for the strength of the relationship (Cohen, 1988).

I chose to use the Potential for Conflict Index (PCI_2) as a graphical technique to display my results, and to examine within-group variability among my 3 groups of anglers: competitors, non-competitors, neither (Vaske, Beaman, Barreto, & Shelby, 2010). The PCI_2 index ranges from 0 to 1, and indicates the amount of dispersion around the mean, with larger values signifying greater within-group variability or "potential for conflict" (Manfredo et al. 2003). When PCI_2 is displayed as a graph, the degree of consensus (i.e., potential for conflict) is illustrated as bubbles, where the size of the bubble depicts the magnitude of the PCI_2 value and indicates the extent of potential conflict (or consensus) regarding agreement of a particular issue. A low PCI_2 value (i.e., 0 to 0.38) and associated small bubble represents little potential for conflict (i.e., high consensus) whereas a high PCI_2 value (0.53 to 1) and associated large bubble represents greater potential for conflict (i.e., low consensus) (Sponarski et al., 2015; Vaske et al., 2010) The PCI_2 and statistical differences (d) tests for comparing two PCI_2 values were computed using software available at the PCI_2 website (http://warnercnr.colostata.edu/~jerryv/PCI2/index.htm).

Results

Sample description

Participant ages ranged from 18 to 84, with 36% (*n* = 146) of sample within 45-64 years of age; 82% (*n* = 334) were male and 18% (*n* = 74) were female. Seventy-eight percent (*n* = 74) reported having at least an Associates or Bachelor's degree. Most anglers (*n* = 240, 59%) were from states outside the GYE, 37% (*n* = 148) were from states within GYE (i.e., Idaho, Montana, Wyoming), and less than 1% (*n* = 4) were from outside of the US. The majority (*n* = 273, 68%) of anglers had previously fished at the site of the survey in the past 3 years.

Perceptions

Most (*n* = 172, 68%) anglers perceived the diet of the river otter to be both game and non-game fish, 28% (*n* = 70) perceived the diet to be only game fish, and 10 anglers (4%) perceived the diet to be only non-game fish. Forty-three percent of anglers (*n* = 149) were considered "non-competitors" (i.e., disagreed or strongly disagreed to the statement "I feel that river otters decrease the number of fish available to anglers"), 120 anglers (35%) were considered "neither" and 72 (22%) were considered "competitors" (i.e., agreed or strongly agreed to the statement "I feel that river otters decrease the number of fish available to anglers").

Difference in attitudes

In general, attitudes towards the conservation of river otter populations and river otter habitat were positive for all groups (i.e., means above 0 in Table 2.2 and Figure 2.2). However, those that agreed or strongly agreed with the statement (i.e., competitors), "I feel river otters decrease the number of fish available to anglers" had lower means that were significantly different ($p < 0.05$) than those who disagreed across all five attitude items (Table 2.1 and lowest circles Figure 2.2). There was a high consensus for all five attitudinal items for non-competitors

(PCI_2 values range = 0.02-0.11), competitors (PCI_2 values range = 0.02-0.18), and those that were neutral (PCI_2 values range = 0.01-0.04) (Figure 2.2). The PCI_2 values for anglers who agreed were significantly different from those who were neutral or disagreed on 1 of the 5 items (i.e., “I would be concerned if river otter populations on {site} declined”) (Figure 2.2).

Discussion

My results indicate that anglers held positive attitudes towards river otters, and towards the conservation of river otter populations and aquatic habitat, which did not support my first hypothesis that anglers would have negative attitudes towards river otters. Similarly, Bohrman (2013) concluded that 67% of anglers surveyed in north central Pennsylvania considered river otters to be beneficial to waterways. These results suggest that anglers will likely not be an adversarial group for those wanting to use the river otter as a conservation flagship. However, anglers who perceived that river otters “reduce the game fish available to anglers” (i.e., act as a “competitor” for game fish) tended to have less positive attitudes towards river otters, suggesting that perceptions can influence both attitudes and beliefs in regards to wildlife (Michalski et al. 2012; Boulhosa & Azevedo 2014; Tarrant et al. 2016). These results support my second hypothesis, that anglers who view the river otter as a competitor for game fish have less positive attitudes than those who do not, although it’s important to note that their attitudes were still considered positive.

When it comes to predators and their impact on prey species, perception is not always based in reality (e.g., Bombieri et al., 2018; Lennox, Gallagher, Ritchie, & Cooke, 2018). And, in most cases it is the perception that removing a predator will increase prey numbers that typically drives predator removal, rather than science-based information regarding the influence of predators on the prey within the ecosystem (Delibes-Mateos et al. 2013; Vucetich et al. 2017).

For example, there is little direct evidence that removing a predator has a long-term effect on abundance of prey populations (Knowlton 1972; Anonymous 1986; Amundson et al. 2013), but predator removal is still a systematically implemented management strategy (Bergstrom et al. 2014). Misperceptions regarding the diet of a species can influence attitudes, even though in some cases the perceived diet is different from the actual diet of the predator species (Chavez & Gese 2005; Chase Grey et al. 2017). However, in my study, 68% of anglers correctly identified that the river otter consumes both game and non-game fish (Melquist & Hornocker, 1983; Serfass et al., 1990; Stearns & Serfass, 2010). These results suggest that providing information to anglers about the diet of the river otter (e.g., that it generally eats non-game fish, but also consumes game fish when abundant and available [Serfass et al., 1990]) is not the most effective message to reduce any negative perceptions of the impact river otters have on game fish populations. Rather, portraying ecological information on the size of fish (e.g., Stearns, Fecske, & Serfass, 2011), or the amount of fish that a river otter consumes may have a stronger effect on minimizing incorrect perceptions of the river otter as a competitor for game fish, and therefore negative attitudes of anglers about the river otter.

While this study focuses on the influence of perceptions on people's attitudes towards the river otters, other factors including prior experience with a species and social norms have also been shown to influence attitudes (Bruskotter and Fulton 2016). Social norms are a set of widely accepted shared beliefs about actions that are right or wrong in a given situation (Cialdini & Trost 1998; Ostrom 2000). Research and theory suggest that the behavior of anglers tend to be strongly guided by social norms, which likely influences their attitudes and perceptions towards aquatic systems. For example, Snyder (2007) suggests that many fly-fishing anglers consider angling a religious pursuit and often consider the river as their church, which may contribute to anglers having a strong environmental and conservation ethic towards aquatic environments. This conclusion is supported by Bruskotter & Fulton (2016) who determined that anglers in Minnesota generally agreed that "people have a duty to protect fish and other parts of nature" and that Minnesota anglers exhibited a strong protectionist orientation. When compared to non-consumptive users, Theodori, Luloff, & Willits, (1998) concluded that there was a higher degree of correlation between anglers and pro-environmental behavior than appreciative users (i.e., mountain bikers, skiers, picnickers). Similarly, the results in my study demonstrate that anglers have a high consensus in their conservation attitudes (i.e., low PCI_2 values, Figure 2.2) and overall positive attitude towards the conservation of river otters and their aquatic habitat.

This study has a few limitations. The first limitation to my study was that I did not include any items in my survey that asked whether the respondent released or kept their fish on that day, or the level of experience of the angler. For example, Bryan (1977) concluded that more experienced and specialized anglers are more likely to support resource preservation then less specialized anglers. These items might have provided further insight into the attitudinal differences amongst the anglers surveyed, particularly the perception of river otters as a competitor for game fish. Depending on the survey site, fishing regulations varied from catch-and-release (Trout Lake and Snake River Dam) to catch-and-keep (Madison, Yellowstone, and Snake River) with daily limits (Parks 2018). Thus, some anglers were likely consumptive users (those who were permitted and chose to keep the fish) and some were likely appreciative users (those who released fish). Future studies could examine anglers knowledge of the presence of river otters in the river systems in which they fish (e.g., does their fishing activities overlap with river otter distribution?), and also measure previous exposure to media portrayals of the river otter (e.g., were they positive portrayals or negative portrayals). Additionally, I had only 2 items for my perception construct, and my analysis was conducted on each attitudinal item, rather than on the attitude construct.

A species used for a conservation flagships should be well-liked, and not a species that has the potential to cause conflict among stakeholders (Eckert & Hemphill 2005; Douglas & Veríssimo 2013). While the river otter has many characteristics considered important as a flagship (e.g., large body size, large geographical range, and charismatic), its role as an apex predator in aquatic systems provides a potential liability in flagship deployment. The results of this study indicate that one potential adversarial group, anglers, generally had positive attitudes towards the river otter, reducing the potential of the species to be a "battleship" (Douglas & Veríssimo, 2013). This study also highlights the importance of systematic sampling of perceptions and attitudes of potential adversarial groups rather than relying on inaccurate media portrayals of the species. By providing accurate messages and portrayal of the role the river otter has in an aquatic ecosystem, and emphasizing that both river otters and anglers are interested in the fish that these ecosystems support, attitudes towards this species could further be improved, which will help to ensure the long-term conservation of this apex predator species.

Tables and Figures

Table 2.1 Results of a one-way ANOVA between the dependent variables: attitudes and beliefs (measured on a 5-point scale [-2 to 2], and the independent variable: respondent agreement to “river otters decrease the number of fish available to anglers”. Questionnaires were completed at six population fishing sites in the Greater Yellowstone Ecosystem between 6 June and 25 July 2015 and 1 June and 15 August 2016.

	Perception of river otter as a ….					
Survey item	"Non-Competitor" (*M*)	"Neither" (*M*)	"Compet-itor" (*M*)	*F* value	*p* value	Eta (η)
Attitudes (Cronbachs alpha = 0.70)						
I am doing the right thing if I took actions to ensure healthy river otter populations	1.34[a]	0.90[b]	0.56[c]	27.45	<0.01	0.28
I am concerned about the quality of river otter habitat	1.26[a]	0.91[b]	0.81[b]	48.53	<0.01	0.22
I am concerned about the well-being of river otter populations	1.16[a]	0.73[b]	0.44[c]	220.84	<0.01	0.39
Protecting river otter habitat is *not* my responsibility (reverse coded)	1.08[a]	0.76[b]	0.67[b]	66.45	<0.01	0.19
I would be concerned if the river otter population on {river} declined	1.33[a]	0.91[b]	0.27[c]	338.11	<0.01	0.43

Scale range from -2 to 2, and all responses were coded such that 2 was the most river-otter oriented response

[a,b,c] The letter superscripts denote significant differences between means based on the Tahmane post hoc test.

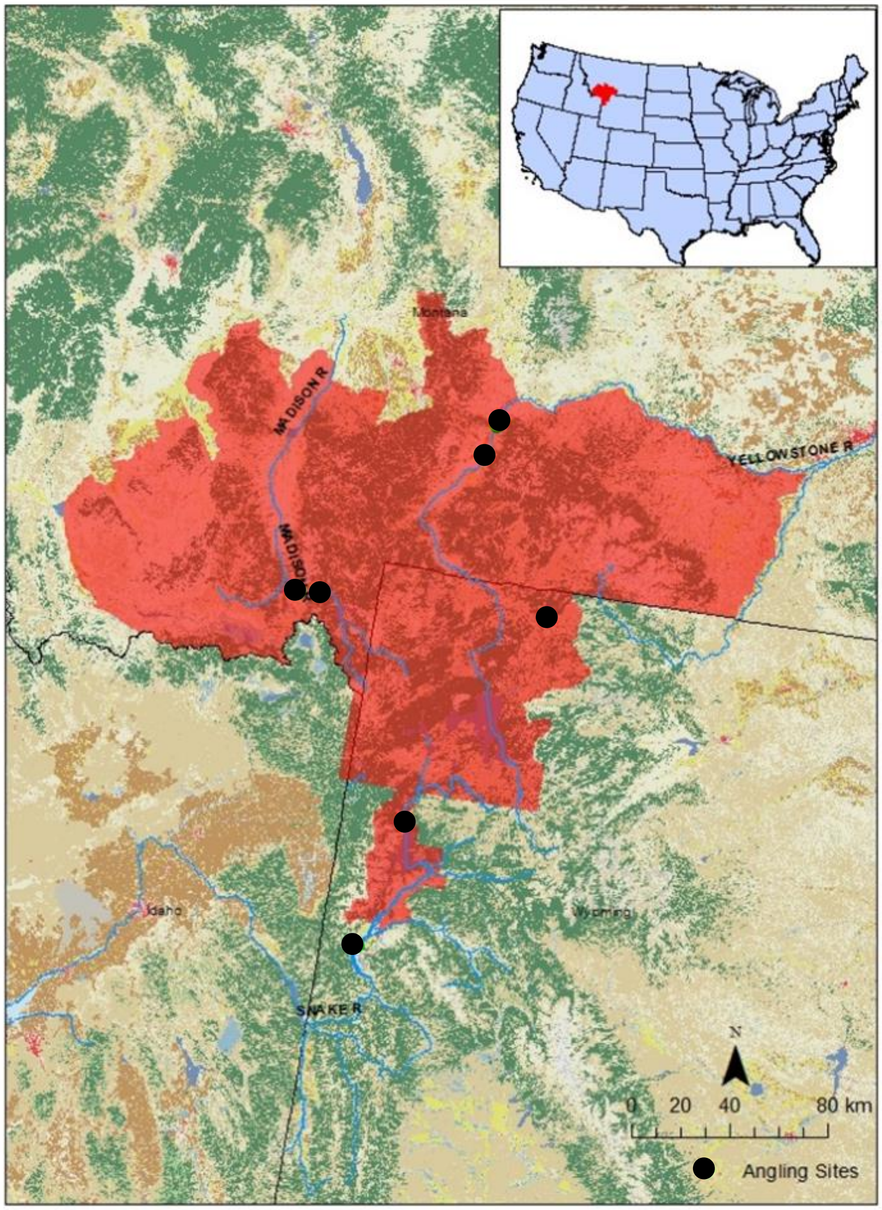

Figure 2.1. Angler survey sites. Questionnaires were conducted with anglers (n = 406) at seven popular fishing sites in the Greater Yellowstone Ecosystem between 5 June and 25 July 2015 and 1 June and 15 August 2016.

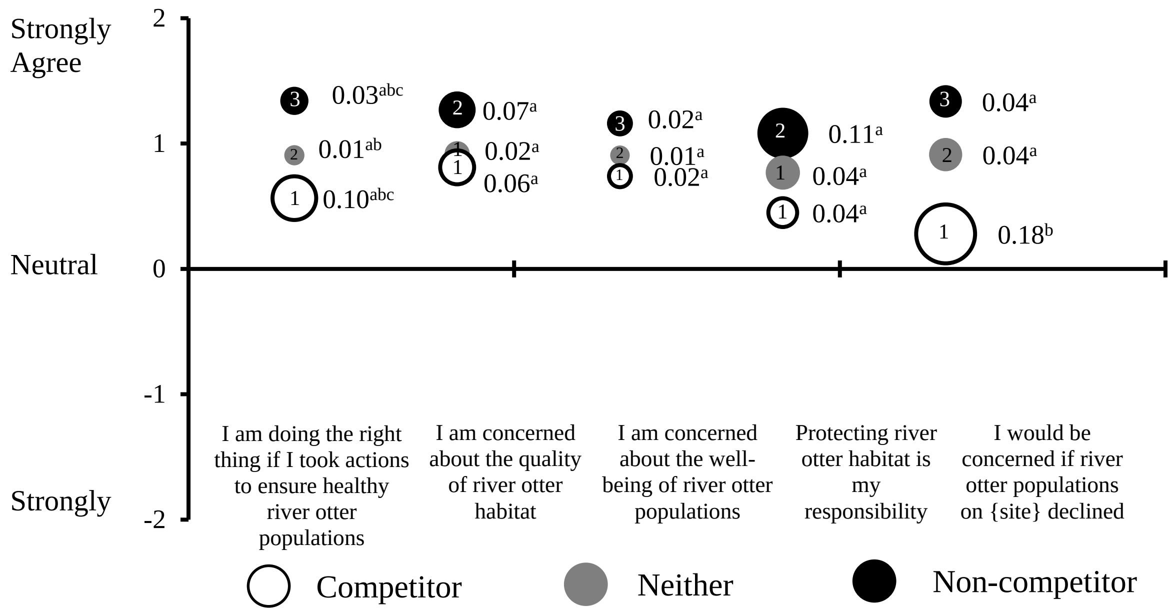

Figure 2.2. The mean response for anglers who agreed (competitors), were neutral (neither), or disagreed (non-competitor) with the statement "*river otters decrease the number of fish available to anglers*" for the five attitude items. Number alongside bubble represents Potential for Conlict$_2$ Index (PCI$_2$) statistic (bubble size) which range from 0 to 1, with higher values indicating greater within-group response variability around the mean. The numbers in the bubbles (1, 2, 3) represent whether there was a significant difference between the means. The superscript letters (a, b, c) on the PCI$_2$ represent whether there was a significant difference in the PCI$_2$ for the three groups.

Chapter 3

Influence of the river otter (*Lontra canadensis*) on the formation of pro-conservation intentions in the Greater Yellowstone Ecosystem

Introduction

Creative approaches to engaging the public in actions that support the conservation of wildlife are now more critical than ever due to the twin challenges of (1) large scale habitat loss and subsequent declines of wildlife, and (2) a general public that who limited direct contact with nature, and ranks the environment lower than most other voter concerns (Shellenberg & Nordhaus 2004; Nordhaus 2007; Kareiva 2008). One way to encourage conservation engagement is to increase opportunities for public exposure to nature and wildlife, enabling them to create memorable experiences and stimulate a connection to the environment (Lyons & Breakwell 1994; Ryan et al. 2000; Saunders 2003; Zaradic et al. 2009). Ideally, these opportunities would center on wildlife species who evoke a strong emotional responses, create a sense of attachment to a place or species, and generate public interest about their survival and habitat protection (Shackley, 1996; Woods, 2000). Governmental and private organizations can use these "flagships" to increase financial support for conservation efforts (Heywood 1995), arouse public interest (Simberloff 1998), and promote participation in pro-conservation behaviors (e.g., Skibins, Powell, & Hallo, 2013), which together lead to higher achievement of conservation objectives.

Flagships are generally well-known, charismatic species that serve as the focus of either a single focal-species promotion or an large-scale biodiversity campaign strategy (Linnell et al. 2000). A focal-species campaign uses one species to gain social or economic support to help reach a conservation goal centered on a single species. For example, the "Golden Lion Tamarin

(*Liontopithecus rosalia*) Conservation Program" in Brazil launched an education campaign to help increase the population size of the endangered golden lion tamarin (Dietz et al. 1994), and the World Wide Fund for Nature (WWF) used mountain gorillas (*Gorilla berengei berengei*) to campaign for international support to help increase the number of mountain gorillas in Uganda and Rwanda (Maekawa et al. 2013). Alternatively, a large-scale biodiversity campaign can use a flagship or "flagship fleet" to illustrate extensive environmental concerns, such as using the polar bear (*Ursus arctos*) to symbolize the global effects of climate change (IUCN 2009), or using the giant panda (*Ailuropoda melanoleuca*) as a symbol of the WWF to raise funds and public awareness internationally for biodiversity (Caro & O'Doherty, 1999). Although these two flagship campaign strategies differ in methods, the ultimate goal of both approaches is to capture the public and engender interest in a particular conservation objective (Veríssimo, MacMillan, & Smith, 2011; Walpole & Leader-Williams, 2002).

After determining a campaign a strategy, selecting a focal or suite of species that the public will have generally positive attitudes towards, and one that will not generate ill-will or become an "battleship", is essential for a successful campaign (Bowen-Jones & Entwistle 2002; Douglas & Veríssimo 2013). A flagship should generally possess a suite of attributes, such as having a large body size, charisma, a wide-spread geographic range, threatened or endangered conservation status, elicit positive attitudes, and be visible, to effectively engage the public and successfully serve as a conservation flagship (see Chapter 1; Chapter 2; Barua et al., 2011; Bowen-Jones & Entwistle, 2002 for review). Additionally, another important characteristic for selecting a flagship is assessing the willingness of people to engage in pro-conservation behaviors to help conserve the species and its habitat (Chapter 1, Figure 1.1; Skibins, Powell, & Hallo, 2013).

The North American river otter (*Lontra canadensis*) (hereafter referred to as river otter), has many physical, behavioral and ecological attributes that are inherent to flagships. For example, the river otter has a relatively large body size, is considered charismatic, and exists in low population densities across the landscape which can influence a perception of a rare conservation status (Chapter 1; Chapter 5). These characteristics have been shown to positively influence the public perceptions of an animal (Chapter 1; Fuhrman & Ladewig, 2008; Rolston, 1987; Woods, 2000). The media frequently portrays the river otter as being cute, playful, and intelligent (Kruuk 2006; Johnson & Landis 2009), depictions that help engender public support, interest, and awareness of the river otter. The large geographic range of the river otter (i.e., present in all 48 continental United States and Alaska [Bricker et al., 2018]) combined with a variety of positive media depictions may contribute to the high levels of public familiarity of the species and its obligate dependence on aquatic environments (e.g., rivers, lakes, coastal areas) (Kruuk 2006). Such associations with a variety of flagship criteria provide rationale for investigating the ability of the river otter to act as a potential flagship species.

Although the river otter appears to have inherent attributes that lend well to initiating a focal-species conservation flagship campaign, research is still lacking on the ability of the river otter to meet an important characteristic of a flagship: the ability to influence pro-conservation intentions or behaviors that help conserve the river otter and its associated aquatic habitat (Chapter 1). While researchers have assessed attitudes towards and the ability of the Asian elephant (*Elphas maximus*) (Barua et al. 2010), the platypus (*Ornithorhynchus anatinus*) (Smith & Sutton, 2008), and other charismatic megafauna (Skibins et al. 2013) to influence pro-conservation intentions and behaviors, no study has specifically examined the ability of the river otter to promote pro-conservation behaviors, or factors that influence the willingness to engage in these behaviors. Understanding which of these factors are important for influencing pro-conservation behaviors can help researchers and practitioners design an effective campaign marketing strategy with flagship species such as the river otter, and thus it the focus of this study.

Literature Review

Pro-conservation behavior includes targeted actions carried out with the goal to change (usually benefit) the environment (e.g., Bolscho, Eulefeld, Rost, & Seybold, 1990; Finger, 1994; Kals et al., 1999). A variety of factors have been hypothesized to influence pro-conservation behaviors, such as attitudes towards the object, or towards the outcome of the behavior, and socio-demographic variables (Kaiser & Gutscher 2003; Powell & Ham 2008; Ramkissoon et al. 2012). Additionally, when measuring willingess to engage in a behavior to help a specific wildlife species, previous experience, or satisfaction with the viewing experience have also been used to explain the adoption of pro-conservation beahviors (e.g.,DeGroot & Steg, 2010; Skibins & Powell, 2013). Because assessing behaviors has inherent challenges, most research focuses on behavioral intentions—the best predictor of a behavior (Glasman & Albarracin 2006).

Wildlife viewing experience in which visitors are able to observe the natural behavior of a species has been linked to increased visitor understanding and positive attitude towards conservation in general (e.g., Ballantyne, Packer, Hughes, & Dierking, 2007). Attitudes represent a person's level of positive or negative associations with an object, person, or other phenomena and are a component of action in the context of conservation action (Ardoin et al. 2013). And specifically, environmental attitudes, defined as "the collection of beliefs, affect, and behavioral intentions a person holds regarding environmentally related activities or issues" (Schultz & Tabanico 2007) can be influenced by a person's underlying values and knowledge (e.g., Madden, Ellen, & Ajzen, 1992; Schultz & Zelezny, 2003; Stern, Dietz, Abel, Guagnano, & Kalof, 1999).

Environmental attitudes formed as a result of direct experiences (e.g., playing outdoors) are a powerful predictor of nature-protective behaviors (Regan & Fazio 1977; Finger 1994; Kals et al. 1999). For example, visitors who observed eastern lowland gorillas (*Gorilla beringei graueri*) and okapis (*Okapia johnstoni*) at Brookfield Zoo expressed a strong desire to see them preserved in the wild following their zoo visit (Myers et al. 2004). Frequent and significant experiences in nature allow a person to develop an emotional affinity toward nature, which is also an important predictor of willingness to engage in nature-protection, or pro-conservation behaviors (e.g., Bolscho, Eulefeld, Rost, & Seybold, 1990; Finger, 1994; Kals et al., 1999; Stern, 2000).

Three constructs of attitudes (i.e., empathy, saliency, and responsibility) have been specifically shown to influence behavioral intentions. In the context of the environment, empathy is defined as other-oriented (i.e., altruistic) feelings of concern about the perceived welfare of another person, animal, or the biosphere, and can lead to an increased feelings of interconnectedness with nature (Schultz 2000). Davis (1983) and Stern, Dietz, & Black (1986) have demonstrated that empathy can have a low to moderate relationship with environmental behavior. Likewise, salience is a measure of how important a species, wildlife, or habitat in general is to a respondent (Kansky & Knight 2014), and includes feeling compelled to conserve a single species or the environment. Increased salience towards a specific species has been shown to enhance positive evaluation of that species (Pratkanis et al. 1990), and high levels of saliency have been correlated with stronger ecological behavioral intentions (Stern & Dietz 1994; Stern 2000). Finally, responsibility, a feeling of personal obligation to conserve the environment of a species, has also been linked to ecological intentions (e.g., Kahn, 2003; Kaiser, Ranney, Hartig, & Bowler, 1999; Kaiser & Shimoda, 1999). Kaiser et al. (1999) reported an increase of 5% of the explainable variance of ecological behavioral intention when environmental responsibility was included in the model beyond the more basic attitude model.

Beyond impacts on attitudes, researchers have evaluated how prior experience with a flagship influences willingness to engage in pro-conservation behaviors depending on type of exposure to the flagship (e.g., Smith & Sutton 2008; Skibins et al., 2013). Exposure to a flagship can be categorized into three types: 1) via an *ex situ* (wild or natural area) experience, 2) via an *in situ* (captive settings) experience, and 3) viewing websites, educational, or marketing material regarding the flagship (Smith & Sutton, 2008). These three exposure types may vary in their influence on people's attitudes and thus overall willingness to engage in conservation-friendly behaviors to help the species. For example, Ballantyne, Packer, & Sutherland (2011) indicated that viewing both captive and non-captive wildlife led to visitors adopting more sustainable behaviors, such as volunteering for conservation organizations. However, other researchers found no evidence of impact. For example, Smith & Sutton (2008) determined that there was no significant differences between different exposure types to the platypus (i.e., in the wild, habitat, environmental activities, or educational materials) and willingness to engage in pro-conservation behaviors to help conserve the platypus and its associated habitat. Skibins et al. (2013) concluded there were no significant differences in tourist pro-conservation intentions between *ex situ* (i.e., safari) and *in situ* (i.e., Brookfield Zoo) experiences, and Vining (2003) reported that exposure was not enough to influence general concern for the environment, or a specific species habitat.

Socio-demographic factors (e.g., age, income, education level, gender, and residence) may also influence pro-conservation intentions either directly or indirectly through their impact on attitudes, although findings remain unclear. In terms of age, some studies have reported older people engage in more pro-environmental behavior than younger adults (e.g., Gilg, Barr, & Ford, 2005; Swami, Chamorro-Premuzic, Snelgar, & Furnham, 2011). However, other studies support the age hypothesis, which suggests that younger adults are more concerned about environmental deterioration compared to older persons (e.g., Fransson & Gärling, 1999; Van Liere & Dunlap, 1980), and that environmental activism is negatively associated with age (Stern, 2000). Research on income and education level is also mixed. Stern et al. (1999) found a positive relationship with environmental citizenship and income. But in a review of other studies, Van Liere & Dunlap (1980) reported negligible associations between income and environmental concern. Chanda (1999) and Hsu & Rothe (1996) indicated that individuals with more education are generally more concerned about the environment, and, in a meta-analysis conducted by Hines, Hungerford, & Tomera (1987), education was only a weak positive predictor of pro-environmental behaviors. Earlier studies on gender also lack consistency, although more recent literature suggests that women tend to report stronger environmental attitudes and engage in more pro-conservation behaviors than men (e.g., Blocker & Eckberg, 1997; Luchs & Mooradian, 2012; Scannell & Gifford, 2013).

Methods

Study Site

This study took place at the Trout Lake trailhead parking lot located in the Lamar Valley of Yellowstone National Park (YNP) (Figure 3.1). Trout Lake is a 0.05 km^2 backcountry lake, accessed via a short, steep hike through a Douglas-fir (*Pseudotsuga menziesii*) forest. In the early summer, Yellowstone cutthroat trout (*Oncorhynchus clarkia bouvieri*) and rainbow trout (*Oncorhynchus mykiss*) spawn in the Trout Lake inlet, making it an attractive resource to river otters and other fish-eating predators. River otters use downed logs, and other natural cavities formed by conifer tree roots for feeding and resting sites during the daytime at Trout Lake. These behaviors provide a unique, high-quality viewing experience of river otters at Trout Lake, which has been marketed as a river otter viewing site by conservation organizations such as the National Wildlife Federation (NWF) (Bolen 2011).

Survey

The survey instrument used in this study was based on Smith and Sutton (2008) with augmentations to specifically address conservation issues related to river otters and focus on aquatic habitat. Item clarity, as well as length of the questionnaire was assessed through a pilot test (n = 44, 73% response rate) with visitors at a popular trail head in Ohiopyle State Park, Pennsylvania, in May 2015. Specifically, after the respondents completed the survey, I asked the respondent to identify any confusing terms. Ohiopyle State Park is a popular tourist destination for people to engage in aquatic-based activities such as white-water rafting, scenic rafting, and hiking next to riverine habitats used by river otters (Stevens & Serfass 2008). Thus, it represented a similar population as Trout Lake.

The final questionnaire was 2-pages in length, and included 34 items grouped among five categories: 1) previous exposure to river otters, 2) attitudes towards the environmental and river otter, 3) intentions to engage in behaviors that result in conservation of the river otter and its habitat 4) socio-demographic variables, and 5) trip characteristics (Appendix II). All exposure and intentions items were measured on a 5-point Likert scale; 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

Variables

Exposure. Building on the literature cited earlier, three closed-ended items were used to determine direct exposure to the river otter: 1) viewed river otters in the wild, 2) viewed river otters in captivity, and 3) viewed river otter marketing material regarding river otters at Trout

Lake. Respondents could select multiple exposure variables, if they had multiple previous experiences with river otters. All other direct exposure items were recorded as binary variables (i.e., yes/no).

Attitudes on environment and river otter. Following Smith and Sutton (2008), environmental concern was operationalized into two categories: (a) attitudes about general concerns for the environment and (b) attitudes about specific concerns regarding the river otter and aquatic habitat. For each category, the concern construct was then further divided into a three components: (1) empathy (two items), (2) saliency (three items), and (3) responsibility (four items) based on Bentrupperbaumer (1997), as reported in Smith and Sutton (2008).

Pro-Conservation Behavioral Intentions. Modifying constructs from Smith and Sutton (2008) and Skibins and Powell (2013), seven items were designed to address the willingness of the respondent to engage in pro-conservation behaviors to help conserve (a) the environment in general (three items) and (b) river otter populations (four items).

Socio-demographic. Respondents were asked to record their age, education, gender, and household income.

Trip Characteristics. These items addressed specific characteristics considered important for influencing visitor attitude and behaviors. Visitors reported if this was their first visit to YNP, first visit to Trout Lake, and frequency of visits to Trout Lake, not including this visit, in the past 3 years ranging from “never” to “26+”. Visitors also reported their future interest in viewing river otters in the wild.

Survey Administration

Intercept surveys were used to sample visitors after their visit between 5 June and 25 July 2015 at the Trout Lake trail head parking lot (Davis, Thompson, & Schweizer, 2012). Efforts were made to ask every visitor (over the age of 18) if they would be willing to complete a self-administered on-site questionnaire regarding their visit to Trout Lake. Of the 455 persons contacted on-site, 384 agreed to participate resulting in an 84% response rate. The questionnaire was approved by University of Maryland IRB (555619-1).

Statistical Analysis

All negatively worded items were reverse-coded, data were screened for missing values, and cases exhibiting missing values for more than 50% of items per variable were removed. A total of 0 cases were removed, resulting in a final sample size of N = 354. Internal reliability was examined using Cronbach's alpha within the general environmental concern, specific concerns regarding river otters, and pro-conservation behavior constructs. The recommended value of 0.70 or higher was used for Cronbach's alpha (Nunnally 1978). Summary statistics (Mean, SD, Median) were used to describe variables.

I conducted binary logistic regression modeling to examine the influence of (a) previous exposure to the river otter, attitudes on environment and river otter concerns, general ecological intentions, socio-demographics, and trip characteristics on (b) willingness to engage in pro-conservation behaviors that would help conserve river otter populations (Table 3.1). Binary logistic regression was chosen because my dependent variable, specific intentions to conserve the river otter, showed skewed distribution, with fewer responses in the lower categories, so I transformed it into a dichotomous variables. My other variables, including general intentions, attitudes on environment, and attitudes on river otters also showed skewed distributions, and those were also transformed in dichotomous variables. Specifically, each variable with a score of 3 or less (i.e., a stated neutrality or lack of intention or concern) was recoded to represent "no intention" (for specific and general intentions) and "not environmentally concerned" (for attitudes on river otter and general environmental concern). Scores of 4 or 5 (i.e., stated intention or concern) were recoded to represent "intention" or "environmentally concerned". Additionally, binary logistic regression has flexibility in handling categorical data that does not have to be normally distributed and because the distribution of responses for the dependent variable (i.e., intentions to conserve the river otter and its habitat) was expected to be nonlinear with one or more independent variables (Tabachnick & Fidell 1996).

To determine the most important variables influencing intentions to engage in behaviors to conserve the river otter, I fitted all possible combinations of parameters (i.e., trip characteristics, exposure, attitudes about general environmental and river otter concerns, socio-demographics, and general environmental intentions). Akaike Information Criterion with second order correction for small sample size (AIC_c) was used for ranking models that best explained the data and ΔAIC_c, and Akaike weights (w_i) were calculated and used to assess the weight of evidence in support of each model (Burnham & Anderson 2002). Because there was no model with a $w_i \geq 0.90$, a full-model averaging approach was used (Symonds & Moussalli 2011). I retained all models with a $\Delta AIC_c \leq 2$, and averaged parameter estimates across them using the zero-method approach (Burnham & Anderson, 2002). The relative importance (percentage of times the parameter showed up in the top models) and 95% confidence interval (*CI*) were examined for each averaged parameter to determine its influence on intention to engage in pro-conservation behavior to help conserve the river otter (Arnold 2010; Symonds & Moussalli 2011). All statistical analyses were conducted in R, version 3.15.1 (R Development Core Team 2018).

Results

Survey Sample Description

Just over half of respondents were female (53%, *n* = 186), and 47% (*n* = 163) were male (Table 3.1). Thirty-four percent (*n* = 119) were between 45-64 years of age, 29% (*n* = 93) were between 31-44 years of age, and 19% (*n* = 61) were <30 years of age (Table 3.1). Thirty-five percent (*n* = 121) had a college degree, whereas 38% (*n* = 131) had a graduate degree (Table 3.1). Twenty-four percent (*n* = 78) had an income of 25,000 ≤ 74,999, and 23% (*n* = 78) had an income 75,000 ≤ 124,999 (Table 3.1). Most had never visited Trout Lake (75%, *n* = 262) and most respondents did not view a river otter at Trout Lake during their visit (94%, *n* = 333).

Descriptive statistics

Exposure

The majority of respondents (80%, *n* = 268) had previously viewed a river otter in the wild, captivity, and/or marketing materials. Of those respondents, 66% (*n* = 179) had viewed a river otter in the wild, 50% (*n* = 135) had viewed a river otter in captivity, 17% (*n* = 46) had viewed a river otter in both the wild and captivity, and 49% (*n* = 130) accessed marketing material about the river otter at Trout Lake.

Attitudes on environmental and river otter

Eighty-three percent (*n* = 295) of respondents were classified as being concerned about the environment in general (not shown). For example, protecting the environment was important to most Trout lake visitors (*M* = 4.57, SD = 0.71, Table 3.3), and respondents indicated a high level of responsibility towards keeping local waterways unpolluted (*M* = 4.64, SD = 0.65, Table 3.3). Seventy-four percent (*n* = 252) were classified as being concerned about the river otter and its habitat (not shown). For example, most respondents had concerns regarding river otter populations (M = 4.34, SD = 0.93, Table 3.3) and were considered empathic towards helping individual river otters (M = 4.36, SD = 1.13, Table 3.3). Additionally, Trout Lake visitors felt responsible to take actions to help ensure healthy river otter populations (M = 4.53, SD = 0.71, Table 3.3).

Pro-conservation Intentions

Fifty-four percent (n = 192) of respondents were classified as having a willingness to engage in general pro-conservation behaviors (not shown). For example, the item with the highest score was willingness to reduce water consumption (M = 3.98, SD = 0.92, Table 3.4). Many respondents (64%, n = 228) were classified as having intentions to conserve the river otter and its habitat (not shown). For example, the item with the highest score was willingness to help an individual river otter that was injured by humans (M = 3.54, SD = 0.92, Table 3.4).

Binary Logistic Regression Analysis

A total of 15 models fulfilled the $\Delta AIC_c \leq 2$ selection process and were included in the final model average (Table 3.5). Within those top models, all covariates were included except education and gender, which had a relative importance of 0 (Table 3.6). Age, income, future interest in viewing river otters, exposure to marketing material about river otters, having a specific concern about river otters, general behavior intentions, and exposure to river otters in the wild all had a relative importance >0.75 (Table 3.6). Income ($\tilde{\tilde{\beta}}$ = -0.02) was the only variable with relative importance >0.75 to have a negative correlation (Table 3.6). All other variables with relative importance >0.75 had a positive correlation (Table 3.6). Experience with multiple exposure types (i.e., being exposed to river otters in captivity and wild, or being exposed to river otters in wild, captivity, and marketing) did not have a relative importance of >0.75). Only age, future interest in viewing river otters, and general ecological intentions had an effect as they had confidence intervals that did not span 0 (Table 3.6).

Discussion

Various studies have suggested that positive attitudes towards a species, as well as willingness to engage in pro-conservation behaviors to help conserve a species and its habitat, are important characteristics when evaluating a potential flagship (e.g., Barua et al., 2011; Caro, 2010; Smith & Sutton, 2008). Overall, attitudes about the environment and river otters of my sample population were positive, and the majority of respondents had previously been exposed to river otters. Specifically within the attitudes on the river otter construct, respondents showed a high level of empathy, saliency, and responsibility towards protecting river otter populations and their habitat, which are considered important components of positive attitudes towards a species, and strong levels of environmentally-based behavioral intentions (Pratkanis et al. 1990; Stern & Dietz 1994; Kaiser & Shimoda 1999; Kals et al. 1999). Because positive attitudes towards a species or object have been shown to increase the likelihood that a person will engage in pro-environmental behaviors (Ballantyne et al., 2011; Finger, 1994; Kals et al., 1999; Regan & Fazio, 1977), my results provide support for the river otter as a flagship species.

Determining variables that influenced people's willingness to engage in pro-conservation behaviors to help conserve the river otter and its habitat was another research aim of this study. To that end, age, future interest in viewing river otters, and general ecological intentions were all significant covariates in predicting intentions. Age had a positive correlation ($\widetilde{\bar{\beta}}$ = 0.001, Table 3.6), suggesting that in my study, older people were more likely to engage then younger people, which is similar to the conclusions of Gilg et al. (2005) and Swami et al. (2011). Future interest in viewing the river otter was also showed an effect (i.e., had a confidence interval that did not span 0, Table 3.6) with willingness to engage in river otter oriented pro-conservation behaviors. Expressing future interest in viewing a river otter indicates that the respondent has a personal interest in river otters, which is relevant, especially in the context of educational outreach regarding wildlife species. That is, this interest makes it easier to promote learning and future educational engagement on that subject, which can serve as a catalyst to future behaviors to help conserve that species (Moss & Esson, 2010; Rennie & Johnston, 2004). Intentions to engage in river otter oriented pro-conservation behaviors also showed an effect (i.e., had a confidence interval that did not span 0, Table 3.6) with intentions to engage in general environmental behaviors. This finding supports the results of Smith and Sutton (2008) who concluded general ecological intentions was a significant variable on intentions to conserve the platypus. Other socio-demographic variables (i.e., education, gender) were not important in predicting willingness to engage in conservation behaviors, which supports a general trend of researchers favoring psycho-social constructs such as attitudes over socio-demographic variables (Smith & Sutton 2008; Skibins & Powell 2013; Gifford & Nilsson 2014).

The results of my study further support the growing evidence that exposure to flagship can influence conservation intentions (Ballantyne, Packer, & Sutherland, 2011; Barua et al., 2010; Kals et al., 1999; Smith & Sutton, 2008), an often overlooked aspect of the flagship concept (Veríssimo et al. 2009). Similar to Smith and Sutton (2008) the data from my study suggest that exposure to marketing materials may be a strong predictor of species-oriented behavioral intentions. This finding is also supported by Dietz et al. (1994) and Maekawa et al. (2013) who concluded that there was increased concern after exposure to educational/outreach materials focusing on flagship species. Compared to other exposure types (i.e., viewed a river otter in the wild, viewed a river otter in a zoo or aquarium), marketing materials may have had a higher level of relative importance because the questionnaire asked about exposure to marketing material about viewing river otters at Trout Lake. Thus, it is an indication that some Trout Lake visitors actively sought out information regarding the river otter at Trout Lake, prior to their visit, suggesting that there was already an underlying interest in the river otter. The result that exposure to marketing materials as an important factor also could have greater eco-tourism impacts. For example, using educational and or/marketing material in ecologically sensitive areas, or for less visible flagships may be as effective as actually viewing a flagship species. Surprisingly, exposure to the river otter in the wild was not considered to have an effect on conservation intentions to help conserve river otters, although it had a high relative importance. This contrasts with advocates for wildlife tourism who suggest that viewing wildlife can stimulate a connection to nature, thereby increasing tourists' awareness and participation in conservation-friendly behaviors such as philanthropy, volunteering, and activism (Ryan et al. 2000; Powell & Ham 2008; Zaradic et al. 2009; Skibins et al. 2013). Interestingly, there was no additive effect of being exposed to both wild and captive river otters, or to all three types of exposure. This may be because my study did not measure the quality of these previous exposure experiences, or their sense of emotional connections with the river otter, which are both suggested to influence behavioral intentions (Kals et al., 1999; Myers, & Saunders, 2000; Skibins & Powell, 2013).

Overall, my study provides evidence that many people held positive attitudes towards the river otter (i.e., they are concerned about the river otter and its associated aquatic habitat), and are willing to engage in a variety of pro-conservation behaviors to help conserve the river otter. The results serve as an important foundation to the selection process of determining if the river otter can effectively serve as a conservation flagship, and indicate characteristics that can be used to help predict willingness to engage in conservation behaviors to help conserve river otter populations.

There are some limitations to my study. The results presented here represents a sample of Yellowstone National Park visitors, thus they are indicative of visitors to National Parks and similar venues, but should not be generalized to a wider audience. Specifically, visitors to National Parks may already have a higher level of environmental concern as compared to the general public, and may also be more willing to engage in pro-conservation behaviors. However, the results could apply to other protected areas, such as National Parks throughout the United States. Further, behavioral intentions, and not actually behaviors were assessed. Therefore, the results represent visitor's willingness to engage in behaviors, and not actual behavior performance. Future studies could examine attitudes and willingness to engage in pro-conservations to help conserve the river otter and its habitat with the general public, and not just on visitors to National Parks. Finally, determining if people actually engaged in the behavior, rather than just behavioral intention could also be measured.

Tables and Figures

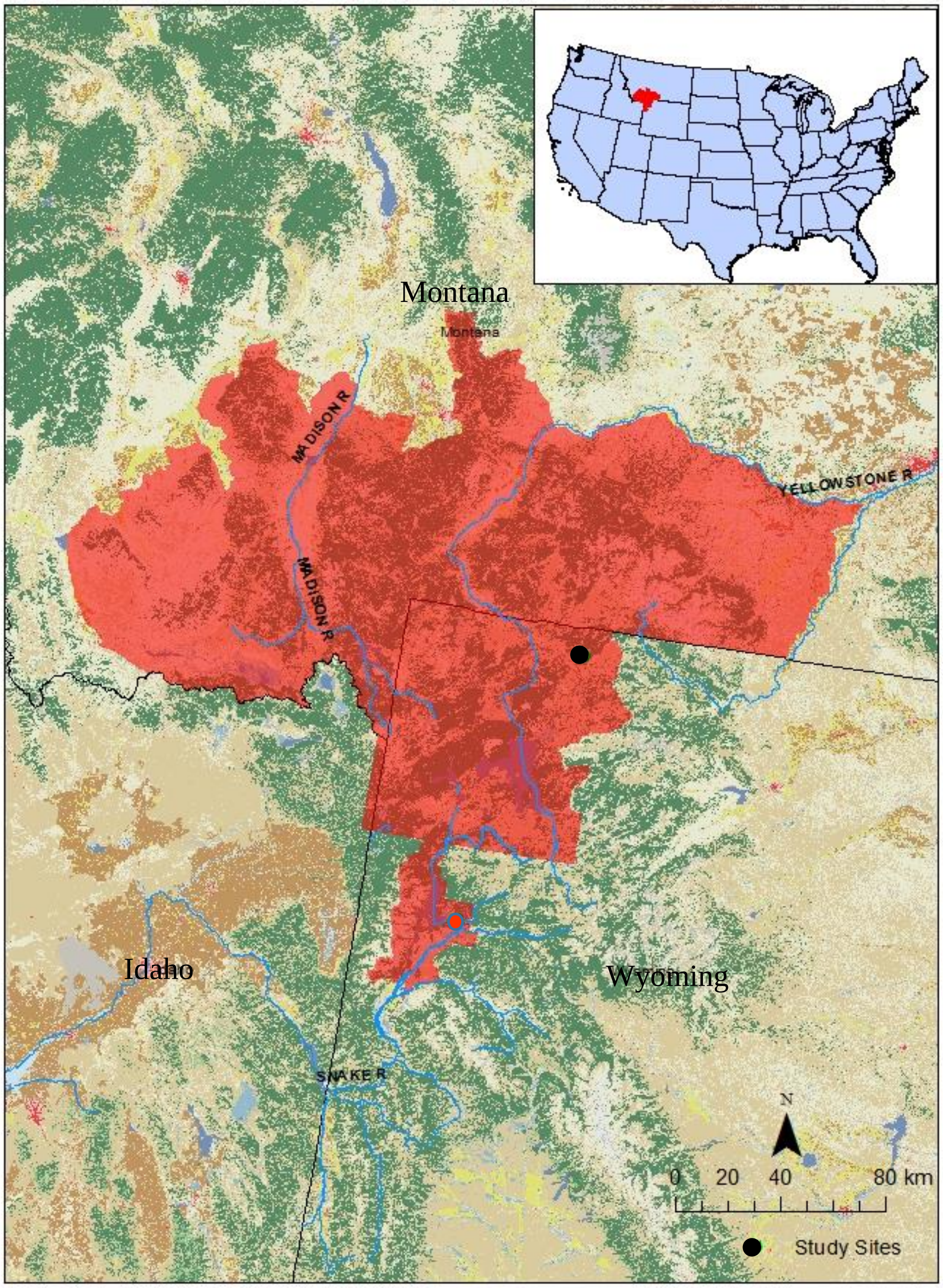

Figure 3.1. Trout Lake survey sites. On-site questionnaires (n = 354) were administered in the parking lot of Trout Lake, located in the northeast portion of Yellowstone National Park. A total of 15 survey days were completed between 5 June and 25 July 2015**.**

Table 3.1. Sample description of Trout Lake respondents. Questionnaires were conducted in the Northeast portion of Yellowstone National Park between 5 June and 25 July 2015.

Characteristic	Frequency	Percent
Gender		
Male	163	47
Female	186	53
Age		
< 30 years	61	19
31 - 44 years	93	29
45 - 64 years	119	34
> 65 years	48	12
Education		
Some High School or Less	2	<1
High School Diploma	20	6
Some College	35	10
College Degree	121	35
Some Graduate Work	29	9
Graduate Degree	131	38
Income		
≤ 24,999	15	4
25,000 ≤ 74,999	83	24
75,000 ≤ 124,999	78	23
125,000 ≤ 174,999	41	12
≥ 175,000	35	10
Prefer not to answer	87	26
Previous visit(s) to Trout Lake		
Never	262	75
1 time	29	8
2-5 times	34	10
6-15 times	17	4
6-25 times	5	1
≥ 26	6	2

Table 3.2. Parameter abbreviations and descriptions that were used in logistic regression modeling to analyze willingness to engage in river otter oriented conservation behaviors. Questionnaires were completed by visitors to Trout Lake in the Northeast portion of Yellowstone National Park between 5 June and 25 July 2015.

Parameter Abbreviation	Variable description
Trip Characteristics	
firstvisitYELL	First visit to Yellowstone (no, yes)
firstvisitl	First visit to Trout Lake (no, yes)
feqvisit	Frequency of visits to Trout Lake in last 3 years (0, 1, 2-5, 6-15, 16-25, 26+)
futint	Future interest in viewing river otters (not at all, a little, very, extremely)
Exposure	
exp_wildb	Viewed a river otter in wild (no, yes)
exp_captb	Viewed a river otter in captivity (no, yes)
exp_market	Viewed a river otter in marketing material (no, yes)
exp_both	Viewed a river otter in both captivity and wild (no, yes)
exp_all	Viewed a river otter in all wild, captivity, marketing (no, yes)
Concern	
avgGenConDI	Concern about the environment (no concern, concern)
ROConDI	Concern about river otters (no concern, concern)
Socio-demographics	
age	Age of respondent (years)
educ	Education of respondent (High school, some college, bachelors, graduate)
gender	Gender of respondent (male, female)
income	Annual household income (< $24,999, $25,000-$74,999, $75,000-$124,999, $125,000-$174,999, $175,000+)
Pro-conservation behavior	
GenIntDI	Intentions to conserve the environment (no intentions, intentions)

Table 3.3. Descriptive statistics for attitudes on the environmental. Self-administered (*n* = 354) questionnaires were completed by visitors to Trout Lake in the Northeast portion of Yellowstone National Park between 5 June and 25 July 2015.

Type	**Component**	**Variables in scale**	***n***	**Mean**[a]	**SD**	**Median**[a]
General (Cronbach's alpha = 0.70)						
	Saliency	Taking actions to protect the environment is among my top priorities	350	4.57	0.71	5
	Empathy	I would get upset if I saw an animal that was injured by people	345	4.24	0.94	5
	Responsibility	Everyone should help in keeping local rivers and streams unpolluted	339	4.64	0.65	5
	Responsibility	I do *not* feel personally obligated to help care for the environment	341	4.43	0.92	5[a]
Specific (Cronbach's alpha = 0.71)						
	Saliency	I am concerned about the well-being of river otter populations	338	4.34	0.93	5
	Saliency	I am concerned about the quality of river otter habitat (i.e, clean, undisturbed lakes, rivers, wetland areas)	344	4.40	0.86	5
	Empathy	I would get very upset if I saw a river otter that was injured by people	343	4.36	1.13	5
	Responsibility	Protecting river otter habitat is *not* my responsibility	344	4.06	0.85	4[a]
	Responsibility	I am doing the right thing if I took actions to ensure healthy river otter populations	346	4.53	0.71	5

[a] Scale ranged from 1 to 5 and all responses were coded such that 5 is the most environmentally oriented response

Table 3.4. Descriptive statistics for pro-conservation behavioral intentions. Self-administered (*n* = 354) questionnaires were completed by visitors to Trout Lake in the Northeast portion of Yellowstone National Park between 5 June and 25 July 2015.

Items in scale	***n***	**Mean[a]**	**SD**	**Median[a]**
General (Cronbach's alpha = 0.70)				
I would be willing to plant trees along my local river if it helped to improve water quality	316	3.64	0.94	4
I would *not* be willing to spend some of my time to help keep my local waterways as unpolluted as possible (reverse coded)	320	3.80[a]	1.03	4[a]
I will be looking for ways to reduce water consumption	322	3.98	0.92	4
Specific (Cronbach's alpha = 0.73)				
I would be willing to send a letter of support to my members of Congress in support of Clean Water Legislation (e.g.., Restoring Clean Water Act) for protections of wetlands and streams to help conserve the river otter	303	3.40	1.02	3
I would be willing to make a charitable contribution of up to $150 to help purchase aquatic habitat in the wild for river otters	293	2.85	1.01	3
I would do whatever I could to help a river otter that was injured by humans	315	3.54	0.92	4
I would be willing to donate to river otter conservation through a tax donation check-off box in my state	296	3.12	1.02	3

[a] Scale ranged from 1 to 5 and all responses were coded such that 5 is the most environmentally oriented response..

Table 3.5. Model parameters in the ΔAICc ≤ 2 set considered important. Models were fitted using logistic regression to determine characteristics of pro-conservation intentions to conserve the river otter and its habitat. Surveys were administered at Trout Lake, Yellowstone National park between 5 June and 25 July 2015. The number of parameters (K), log likelihood, AIC_c, ΔAIC_c, and AIC_c weight (AIC_{Wi}) are shown for each model.

Model	**K**	**LL**	**AIC_c**	**ΔAIC_c**	**AIC_cW_i**
feqvisit + age + income + futint + ROConDI + GenIntDI + exp_wildb + exp_all + exp_market	9	-100.46	224.63	0.00	0.11
age + income + futint + ROConDI + GenIntDI + exp_wildb+ exp_market	7	-101.71	224.83	0.19	0.10
feqvisit + age + income + futint + ROConDI + GenIntDI + exp_wildb + exp_both + exp_market	9	-100.96	225.63	0.99	0.07
age + income + futint + ROConDI + GenIntDI + exp_captb + exp_market	7	-103.27	225.69	1.05	0.07
feqvisit + age + income + futint + ROConDI + GenIntDI + exp_wildb + exp_captb + exp_market	9	-101.01	225.73	1.09	0.06
firstvisitl + feqvisit + age + income + futint + ROConDI + GenIntDI + exp_wildb + exp_all + exp_market	10	-99.88	225.78	1.14	0.06
feqvisit + age + income + futint + avgGenConDI + ROConDI + GenIntDI + exp_wildb + exp_all + exp_market	10	-99.92	225.90	1.26	0.06
feqvisit + age + income + futint + ROConDI + GenIntDI + exp_captb + exp_market	8	-102.28	225.97	1.33	0.06
age + income + futint + avgGenConDI + ROConDI + GenIntDI + exp_wildb + exp_all + exp_market	9	-101.15	226.02	1.38	0.06
firstvisitl + feqvisit + age + income + futint + ROConDI + GenIntDI + exp_wildb + exp_both + exp_market	10	-101.20	226.11	1.47	0.05
feqvisit + age + income + futint + ROConDI + GenIntDI + exp_wildb + exp_captb + exp_all + exp_market	10	-100.06	226.16	1.52	0.05
firstvisitYL + age + income + futint + ROConDI + GenIntDI + exp_wildb + exp_all + exp_market	9	-101.30	226.31	1.67	0.05
age + income + futint + avgGenConDI + ROConDI + GenIntDI + exp_wildb + exp_market	8	-102.47	226.37	1.73	0.05
firstvistl + feqvisit + age + income + futint + ROConDI + GenIntDI + exp_wildb + exp_captb + exp_market	10	-100.21	226.46	1.82	0.04

age + income + futint + ROConDi + GenIntDI + exp_wildb + exp_captb + exp_all + exp_market	9	-101.42	226.54	1.90	0.04

Table 3.6. Model averaging results of top logistic regression models (ΔAICc $\leq$ 2) for pro-conservation behaviors to help conserve the river otter and its associated aquatic habitat in Yellowstone National Park between 5 June and 25 July 2015. Averaged estimate, unconditional standard error (SE), 95% confidence interval (CI), and relative importance for each parameter are shown. The relative importance is the frequency in which the variable occurred in the top model.

Parameter	Estimate ($\tilde{\tilde{\beta}}$)	SE	95% CI	Relative Importance
Trip Characteristics				
First Yellowstone visit	0.0001	0.02	-0.04, 0.05	0.05
First Trout Lake visit	-0.03	0.09	-0.21, 0.15	0.17
Visit frequency	0.04	0.05	-0.05, 0.13	0.61
Future interest	0.13	0.05	0.04, 0.22	1.00
Exposure				
River otter in wild	0.14	0.11	-0.35, 0.18	0.76
River otter in captivity	0.07	0.09	-0.12, 0.25	0.46
River otter marketing	0.001	0.08	-0.16, 0.15	1.00
Captivity and wild	0.02	0.06	-0.11, 0.14	0.07
Wild, captivity, marketing	0.16	0.18	-0.19, 0.51	0.57
Concern				
General concern	0.01	0.09	-0.18, 0.18	0.17
Specific concern	0.17	0.09	-0.01, 0.36	1.00
Socio-demographics				
Age	0.001	0	0, 0.01	1.00
Education	.	.	.	0
Gender	.	.	.	0
Income	-0.02	0.03	-0.08, 0.03	1.00
Pro-conservation behavior				
General intentions	0.36	0.1	0.17, 0.55	1.00

Chapter 4

River otter visibility at latrines in Grand Teton National Park, Wyoming, USA: can latrines serve as a focal area for river otter viewing?

Introduction

North American river otters (*Lontra canadensis*) exist at low population densities, have large home ranges, and are elusive, all of which make direct observations challenging (Kruuk 2006). Thus, monitoring of this species has primarily focused on latrines, riparian areas where river otters eat, roll, scent mark, urinate, and deposit scats (i.e., feces) repeatedly (Kruuk & Conroy 1987; Swimley et al. 1998). Latrines are usually located several meters from the water on elevated ground, and are generally associated with a prominent features, such as large flat rocks, downed logs, or beaver dams, making them relatively easy to detect by humans during riparian surveys (Swimley et al. 1998; Depue & Ben-David 2010). Thus, latrine surveys in riparian and wetland habitats have been the primary approach used in investigations to evaluate river otter presence/absence, distribution, latrine site selection, visitation rates, and population estimates (e.g., Dubuc et al. 1990; Swimley et al. 1998; Stevens & Serfass 2008).

Latrines are hypothesized to serve a variety of biological functions, depending on social status and sex of the river otter (Bowyer et al. 2003; Rostain et al. 2004). In a comparison of social and non-social river otters in coastal Alaska, Ben-David et al. (2005) concluded social river otters used scent-marking at latrines for intragroup communication, whereas non-social river otters most likely marked as a signal to facilitate mutual avoidance, and females typically marked to defend their territory. Similarly, Oldham and Black (2009) suggested a social group of river otters in California used scent-marking as a signal for intra-group communication and, in a captive study, Rostain et al. (2004) concluded scats are deposited at latrines to communicate social status.

If paired with remote cameras (hereafter camera traps), information derived from latrines can be used to study seasonal river otter visitation patterns, group composition, and marking tendencies (Stevens & Serfass 2008; Green et al. 2015). Using camera-trap data, a few studies on non-coastal river otters (i.e., Hall 2001; Olson et al. 2008; Stevens & Serfass 2008; Green et al. 2015), and one study on marine-coastal river otters (Lawrence 2016) have depicted latrine activity patterns (e.g., frequency, time, group size, and duration of visits). In a study on the Snake River in Grand Teton National Park (GTNP), Hall (2001) recorded more daytime visits than night. In contrast, Olson et al. (2008) concluded that the 70% of visits were nocturnal, and that the frequency of visitation was highest in April, with most visits by a single individual. Similarly, Stevens and Serfass (2008) reported that most river otter latrine visits occurred during the night, by a single river otter, and lasted <1 minute. Green et al. (2015) concluded that, when visiting as a group (≥2 river otters), the duration of latrine visits were longer compared to solitary river otter visits. Similarly, Lawrence (2016) depicted marine-coastal river otter latrine activity as primarily nocturnal and, by solitary individuals. Together, these studies represent all available peer-reviewed information regarding river otter activity at latrines as determined from remote cameras.

Additional information on diel activity patterns (i.e., animal activity patterns that vary over a daily [24h] cycle) derived from telemetry studies have indicated that although river otters remain active during the day, their diel peak activity occurs during the night, between 22:00-04:00 (Martin et al. 2010; Helon et al. 2013). Compared to non-coastal river otters, coastal river otters were more diurnal than in other areas (Larsen 1983; Foy 1984). A study conducted by Martin et al. (2010) in southeastern Minnesota on a population of river otters concluded that biotic factors (i.e., sex), and abiotic factors (e.g., biological season and temperature) most influenced river otter movement, whereas lunar phase and barometric pressure were not signifigant predictors of river otter movement. Melquist and Hornocker (1983) suggested that season exerted the greatest influence on activity patterns of river otters in west central Idaho, although other factors, such as human disturbance, also affected their movement. Additionally, Melquist and Hornocker (1983) indicated that group size affected river otter activity patterns, with family groups with young pups having greater periods of rest between activity periods as compared to individual river otters.

Although these aforementioned studies provide important ecological information regarding river otter activity patterns and movements, no studies have assessed the potential of activity patterns at latrines to serve as an index for potentially viewing river otters by the public or visitors to an area. Establishing when, where, and how people can potentially view a species is a critical aspect of increasing the chance of many long-term conservation initiatives, because of the established connection between species observation in an *ex situ* or *in situ* setting and positive attitudes towards conservation, as well as increased visitor understanding of the species (Ballantyne, Packer, Hughes, & Dierking, 2007; Skibins & Powell, 2013). Additionally, because of the demonstrated link between species observation and increased empathy and desire to preserve the species in the wild (Myers et al. 2004), visibility by the focal audience has been identified as an important characteristic of a flagship species (Stevens et al. 2011; Veríssimo et al. 2014). A flagship species serves as a motivator of pro-conservation behaviors and symbolizes the conservation of the ecosystem that it inhabits (Heywood 1995).

River otters are charismatic semi-aquatic predators that have natural history traits are important for engaging wildlife tourism experiences, and has the potential to serve as a flagship species (Chapter 5). For example, river otters have a large body size, are widely distributed, and are considered charismatic (Melquist et al. 2003; Johnson & Landis 2009; Stevens & Serfass 2015; Bricker et al. 2019). However, compared to other flagship species, such as the Bengal tiger (*Panthera tigris*) and the Asian elephant (*Elphas maximus*), which spend their time on terrestrial landscapes, river otters spend time in both the aquatic and riparian environments. Furthermore, river otters are primarily nocturnal (e.g., Olson et al. 2008; Stevens & Serfass 2008), and have low population densities and large home ranges (Dubuc et al. 1990; Crowley et al. 2017). When combined, these factors reduce the potential to view the river otter. Because being visible is an important characteristic of a successful flagship (Chapter 1), these combined aforementioned factors create a potential barrier to using the river otter as a flagship, unless optimum viewing opportunities for the species can be elucidated from ecological monitoring, such as from camera traps.

A study conducted on spotted necked otters (*Lutra maculicollis*) by Amulike et al. (2013) in Rubondo Island National Park, Tanzania, concluded that activity frequently occurred in close proximity to latrines, demonstrating that latrines could potentially serve as focal areas for visitors to observe the species. Given that river otters are also known to establish and frequently visit latrines, these areas may serve as favorable viewing areas for river otters, overcoming this potential flagship liability of lack of visibility. Thus, locating and assessing latrine visitation patterns in my study area can serve as an *a priori* approach in establishing potentially favorable viewing areas for otters (Amulike et al. 2013), and provide valuable conservation information on the potential of latrines to serve as the focus of viewing opportunities of river otters, ultimately increasing the value of the species as a flagship.

A variety of factors, such as rainfall events, river height, date, and moon illumination may influence probability that a river otter will visit a latrine. Rainfall events may wash away scats at latrines, which may impact river otter scent-marking habits at latrines (Crowley, Johnson, & Hodder, 2012; Torgenson, 2014). Further, weather events have been documented to influence detection probabilities for other mammalian species using camera traps (Thorn et al. 2009). Discharge was an important variable for predicting river otter occupancy in Nebraska (Bieber et al. 2018), and changing tidal heights influenced river otter latrine visitation in coastal areas (Lawrence 2016). Date was selected as an important variable in predicting probability of viewing to account for temporal variability throughout the study period. River otters exhibit seasonal marking behaviors and visitation to latrines, which is likely related to various reproductive and social behaviors (i.e., breeding, attracting mates) (Bowyer et al. 2003; Rostain et al. 2004). Moon illumination (%) has been demonstrated to influence activity patterns of other mammals, likely to decrease risk of predation, or increase ability to capture prey (Martin et al. 2010).

As part of a larger project studying the potential of the river otter to serve as a flagship species, my intent in this study was to use camera-traps at latrines to evaluate variables that can best predict when a river otter will most likely visit a latrine. I also examined how the time of day river otter visited latrines was influenced by group size, duration of visit, site, and month. Further, I evaluated how various abiotic factors (i.e., rain, river discharge, date, and moon illumination) influenced probability of detecting river otters at latrines, and probability of detecting a river otter at a latrine during diurnal or crepuscular times (i.e., probability of viewing).

Methods

Study area

Established in 1929, Grand Teton National Park (GTNP) occupies an area of 1,300 km^2 in the northwest portion of Wyoming. Grand Teton National Park is centered within the Greater Yellowstone Ecosystem (GYE), one of the largest intact temperate ecosystems in the world (National Park Service 2019). Originating in the southeastern portion of Yellowstone National Park (YNP), the Snake River flows south through GTNP, then west to its confluence with the Columbia River. The Snake river is impounded by Jackson Lake Dam in GTNP, which regulates the discharge by controlled release from Jackson Lake reservoir, for the purpose of flood control and to maintain artificially high discharges for recreational boating (Schmidt & White 2003). Minimum flow discharge occurs in March, and peak discharge usually occurs in June (United States Geological Survey 2019). Grand Teton National Park was selected as the study area because of its high annual visitation rates (approximately 3.3 million visitors in 2017), the popularity of aquatic-based recreation such as kayaking, fishing, and floating on the Snake River, and because it is inhabited by a legally-protected population of river otters (Hall 1984). My study was conducted during late spring and summer (June-September) to represent peak periods of aquatic-based recreation in GTNP.

Latrine identification and camera traps

I conducted shoreline surveys to locate active latrines between Jackson Lake Dam and Pacific Creek from 1 June to 15 June 2015, and resurveyed Jackson Lake Dam to Pacific Creek in addition to surveying portions of Pacific Creek to Deadmans Bar, 15 May to 30 May 2016, and 1 June to 14 June 2018 on the Snake River, GTNP (Figure 4.1). An active latrine was defined as having >2 fresh river otter scat deposits. I attached *Cuddeback Attack* and *Cuddeback C-Series* (white flash, black flash, and infrared models) 20.0-megapixel cameras (Nontypical Inc., Green Bay WI) to a tree using a mounting strap at varying heights (0.25 m – 1 m), and positioned to face perpendicular to the shoreline with the lens facing to the center of the latrine. Cameras were deployed at 2 sites from 7 July 2015 to 20 August 2015, at 3 sites from 15 June to 3 October and at 8 sites from 13 June to 17 August 2018, although specific dates of camera deployment varied between latrine sites (Table 4.1). Camera-traps operated 24 hours a day and programmed to take a 3-image burst over 7 seconds when triggered, with a 30-second trigger delay between picture sets. Each camera was set to record time, date, and a unique camera ID on each image.

Data analysis

All images were reviewed, cataloged, and ancillary data (i.e., time, date, and camera ID) were summarized. To allow my analyses to account for annual variation in data, a site that was trapped during consecutive years was treated individually, for a total of 13 sites used in data analysis. River otter images from the same site were categorized as temporally independent if separated by >60 minutes (i.e., an independent detection).

I quantified capture frequency as the number of independent detections per 100 camera trap days (Sollmann et al. 2013). A camera-trap day (TD) was defined as a 24-hour period in which the camera was operational. I used images of river otters to calculate the overall and mean number of days latrines were visited (hereafter referred to as detection days) (Wagnon & Serfass 2016). I evaluated month, time of day, group size, duration, and periodicity of latrine visits. I recorded time of day each independent river otter visit occurred, and then pooled the time of visit across latrines and years into 3 categories: crepuscular, nocturnal, and diurnal. I defined a crepuscular visit as the nautical twilight hours after sunset and before sunrise, nocturnal as a visit following nautical twilight after sunset and before nautical twilight sunrise, and diurnal as a visit between sunrise and sunset, on the basis of daily data from the website sunrise-sunset.org (http://sunrise-sunset.org/us/jackson-wy/2018/7, last accessed 15 December 2018). I defined a group as ≥2 individuals and estimated group size during a single visitation as the maximum number of river otters visible on camera within that visitation. The river otters in this study were not individually marked or identified, and I did not assume any relationship between river otters at any time during the study. I defined duration of visit as time spent at the latrine by a solitary or a group of river otters. I determined duration of visit by counting the number of minutes that river otters were at the latrine, starting when the river otters came into the frame of view, and ending when the river otters were no longer visible. To determine periodicity of visits, I calculated the number of consecutive detection days at each site, as well as the number of days that multiple latrine sites were visited on the same day.

Data were analyzed using R (version 3.5.1) (R Development Core Team, 2018). Descriptive statistics were used to describe number of overall TD, TD per latrine site, time of day detection occurred, group size, and duration of visit. Non-parametric analysis was used for my categorical datasets that did not fit normal distribution curves. I used Chi-square analysis (McDonald 2014) to test for significant differences between time of detection and group composition by month and individual latrine site. I tested for significant differences between duration of visit by time of day and month with the use of Kruskal-Wallis test (McDonald 2014). Each aforementioned test was independently tested and any variable revealing an association at a significance level of 0.05 were regarded as significant.

Probability of detection and viewing

I used a likelihood-based information-theoretical modeling framework to estimate detection probability (p). I also estimated detection probability based on the time categories that a river otter could be potentially viewed, and refer to this as viewing probability. Specifically, I only used detections that occurred during diurnal or crepuscular time periods, assuming that during these time periods a person has the potential to view a river otter as they are engaging in aquatic recreation. I standardized all continuous covariates to a mean of 0 and standard deviation of 1 to aid in convergence of the maximum likelihood algorithm and to compare influence of covariates on *p* and viewing probability. I used data from my 2018 season in a single-species, single-season modeling framework with the package unmarked (Fiske & Chandler 2011). I compared models using Akaike's Information Criterion (AIC) corrected for small sample size (AIC_c) to separately rank all *p* and viewing probability models to determine the best-fit models for detection-non-detection (Burnham & Anderson 2002; Mackenzie et al. 2006). I used Akaike weights (w_i) to assess evidence of support of each model, and ranked all models by AIC_c values, and considered models competing if $\Delta AIC_c \leq 2$ (Burnham & Anderson 2002). I used plots of predicted detection values to examine how covariates were related to detection.

I estimated *p* and viewing probability for 4 selected co-variables (moon illumination [%], rain [cm], river discharge [ft^3/sec], and Julian date) that may influence the probability that a river otter will be detected at a latrine (Table 4.2). Moon illumination data was acquired from the United States Naval observatory (http://aa.usno.navy.mil/data/docs/MoonFraction.php, accessed 1 Feb 2019). I acquired daily climate data from the National Weather Service (www.weather.gov, accessed 1 Feb 2019), and daily river discharge from the Moose, WY, United States Geological Survey (USGS) (https://nwis.waterdata.usgs.gov/, accessed 1 Feb 2019).

Results

A total of 12 of 13 cameras (93%) yielded 160 independent river otter detections over 788 TD ($\bar{x}$ = 60.6 ± 15.6 TD, Range= 34–97 TD, Table 4.1) across 3 field seasons, with most (90%, *n* = 144) independent detections in 2018 (Table 4.3). River otters were detected a total of 122 days, with 50% (*n* = 62) of those days having only one detection (not shown). Over the study period there was an overall detection frequency of 20.30 detections/100 TD (not shown). June had the second lowest total TDs (*n* = 131) and the highest overall capture frequency (10.91 detections/100 TD) (Table 4.4).

Time of day

River otter activity peaked during nocturnal hours, with an additional small peak during crepuscular hours (Figure 4.2). Over half (66%, *n* = 105) of the detections were categorized as nocturnal, 24% (*n* = 38) as diurnal, and 10% (*n* = 11) as crepuscular. Time of day of independent detections varied significantly by month (χ^2 = 47.43, *df* = 6, $p \leq 0.001$), with the greatest deviation from expected values occurring during June diurnal and nocturnal visits. There was also a significant difference between time of day the detection occurred and latrine site (χ^2 = 34.8717, *df* = 22, $p \leq 0.010$). Specifically, Camera ID 7 and Camera ID 3 both experienced a greater frequency of nocturnal visits than expected.

Group size

Average number of river otter visiting a latrine was 2.0 (± 1.3 SD) with maximum group size of 8.0 river otters, and on average, the number of river otters visiting a latrine was the largest for crepuscular detections ($\bar{x}$ = 3.0 ± 2.0, Range = 1–8) (Figure 4.3). Latrines were visited by groups (≥2) of river otters (*n* = 90) more often than by solitary river otters (*n* = 85) (not shown). There was a significant difference between group size and time of day (χ^2 = 16.42, *df* = 2, $p \leq 0.001$), with the frequency of visits by solitary river otters during diurnal hours less than expected, and the frequency of visits by solitary river otters during nocturnal hours greater than expected. I contrast, groups of river otters had a greater frequency of diurnal visits than expected, and a smaller frequency of nocturnal visits than expected. Group size varied significantly by month ($\chi^2 = 19.63$, $df = 3$, $p \leq 0.001$), with the greatest deviation from expected values occurring during June for both single and group visits. There was no significant difference between group size and camera site ($\chi^2 = 17.55$, $df = 13$, $p = 0.09$).

Duration of visit

Most river otter detections (76%, $n = 122$) lasted ≤ 3 minutes ($\bar{x} = 4.7 \pm 8.6$ minutes, Range = 1 minute – 48 minutes). There were no significant differences between duration of visit and group size ($\chi^2 = 0.83$, $df = 1$, $p = 0.36$). There were also no significant differences between duration of visit and month ($\chi^2 = 1.28$, $df = 3$, $p = 0.73$), or time of day ($\chi^2 = 0.17$, $df = 2$, $p = 0.92$).

Periodicity

There were 26 occasions that river otters visited a latrine on consecutive days, ranging from 2-7 days (2.76 ± 1.48 days), and 28 occasions where ≥2 latrines were visited on the same day (Table 4.5).

Probability of detection

Estimated probability of detection (*p*) was 0.22 (±0.18), when discharge, moon illumination, rain, and date were fixed at their mean value. My top detection model indicated a positive influence of discharge on river otter detection ($\beta = 0.71 \pm 0.12$) (Tables 4.6 and 4.7). My estimated detection probability was moderately low at low flow rates and was estimated to increase as flow rates increased (Figure 4.4). Date was included in the next top model, which showed a negative influence on detection probability ($\beta = -0.04 \pm 0.022$) (Tables 4.8 and 4.9).

Detection probability was estimated to decline from 0.45 at Julian date 164 to 0.12 at Julian date 229 (Figure 4.5).

Probability of viewing

Estimated viewing probability was 0.07 (±0.18) when discharge, moon illumination, rain, and Julian date were fixed at their mean value. My top detection model indicated a positive influence of moon illumination (%) on viewing probability (β = 0.35 ± 0.19) (Tables 4.8 and 4.9). My probability of viewing was generally low and was estimated to slightly increase from 0.07 on nights with 0% moon illumination (new moon) to 0.09 on nights with 100% moon illumination (full moon; Figure 4.6).

Discussion

Wildlife experiences are enhanced when the species of interest is visible but because of inherent natural history traits, some species are more visible and easily observed than others. River otter detections occurred at almost all of the latrines during my study period, indicating that remote cameras were an effective approach for better understanding visitation patterns of river otters at active latrines in GTNP. The greatest frequency of detections occurred in June, suggesting that this may be the best summer month to potentially view river otters in GTNP. Monthly variation in latrine site visitation likely corresponds with the variation in scent marking at latrines by river otters (Olson et al. 2008). Scent marking at latrines is usually at its highest intensity in March-April corresponding to the breeding season, as well as in September, when young-of-the-year have increased mobility and thus start traveling with adults to latrine sites (Olson, Stevens, & Serfass, 2005; Stevens & Serfass, 2008). However, compared to studies in Pennsylvania and Maryland, which indicated very low latrine visitation rates in June (e.g., Olson et al. 2008; Stevens & Serfass 2008), and slightly higher visitation rates in September (Olson et al. 2008), my latrine site visitation in June were much higher, whereas my September visitation rates were much lower than these studies. Assuming that visitation rates are a reliable indicator of breeding season in the spring (Crait et al. 2006), my results may indicate a slightly later breeding season for river otters in GTNP. Breeding season and parturition varies for river otters throughout their range (Melquist et al. 2003) and is dependent on resource availability (Polechla 1987; Crait et al. 2006). A study in Yellowstone Lake, YNP, Wyoming by Crait et al. (2006) suggested that river otters breed in June to coincide with the spawning of their main prey, Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*). My high visitation rates in June would seemingly support the results of Crait et al. (2006), although research that spans additional months at my study site should be conducted.

Just over half of river otter visits to latrines were categorized as nocturnal, which is similar to other camera-trapping studies (e.g., Olson, Stevens, & Serfass, 2005; Stevens & Serfass, 2008) and likely reflects of the overall activity pattern of river otters at latrines throughout their range (Melquist & Hornocker 1983; Foy 1984; Helon et al. 2013). Diel activity patterns of river otters is influenced by foraging behavior (Martin et al. 2010) and social or reproductive behavior, such as marking at latrines to seek potential mates or denning sites (Martin et al. 2010). Level of human activity has also been identified as potentially influencing the nocturnal habits of river otters (Melquist & Hornocker 1983; Lawrence 2016). This study took place in a National Park, so human activity such as development or timber extraction is limited, however activity of aquatic-based recreationists on the Snake River occurs regularly, which could potentially help explain a slightly more nocturnal latrine visitation pattern.

Compared to other mustelids, river otters are considered to be more social (Melquist and Hornocker 1983), although group size varies between river otter populations. For example, average group size in California estuarine environments was 1.6 river otters, with maximum group size of 7 animals (Brzeski et al. 2013), whereas in Idaho, adult and yearling river otter males were generally solitary, as were females (Melquist and Hornacker, 1983). I recorded more group visits than solitary visits, and my average group size (2.0 ± 1.3 SD, Range = 1.0 – 8.0) was similar to the average group size reported in Olson et al. (2008) from river otters in Pennsylvania, but smaller than coastal Newfoundland river otter group sizes (2.6, Range 1.0-8.0) (Lawrence 2016). In coastal Alaska, large groups of river otters form to increase foraging efficiency of schooling pelagic fishes in nearshore environments (Blundell et al. 2001). However, the benefit of large group sizes in inland river otter populations is less studied, and could be evaluated further in my study area.

The large group size of river otters in my study area may also increase the quality and uniqueness of viewing river otters in GTNP. For example, the duration of viewing by tourists from Amboseli National Park in Kenya was longer for large aggregates of species, carnivores, and animals that were interacting (e.g., allogrooming) compared to single individuals, non-carnivores, and stationary individuals (Okello et al. 2008). The study by Green et al. (2015) on river otters in Illinois found that 5% of observed river otter events at latrines involved allogrooming, 5% involved wrestling, and 10% involved self-grooming, and that overall, river otters were significantly more likely to be engaged in activity (e.g., self-grooming, wrestling, stomping, defecating) at a latrine, rather than traveling through a latrine without stopping. These findings by Green et al. (2015) provides support that latrines possess the potential to serve as a viewing area for river otter.

Periodicity of visits in 2015 and 2016 were inconsistent. This may have been because of the relative small sample size of latrines in those years (n = 2 and n = 3, respectively), and also because in 2015, camera-traps were not placed until 11 July, which is after the peak frequency of visitation that occurred in 2016 and 2018. In 2018, there were 25 occasions when a river otter visited a latrine on consecutive days, and 27 occasions ≥ 2 or more latrines were visited on the same day. There were also days when river otters visited multiple latrines in a day, which could result in additional opportunities to view the river otter when they are traveling in the river between latrines.

My estimated detection probability 0.22 (±0.19) was slightly lower than the detection probability reported in Kansas (Jeffress, Paukert, Whittier, Sandercock, & Gipson, 2011) and Nebraska (Bieber 2016). The lower detection probability could be because my study area was smaller, which was predicated on my intent to focus on the portion of the Snake River that is used daily between June-October by aquatic-based recreationists. Jeffress et al. (2011) reported a 3-fold increase of detection probability as survey length increased. Detection probability was generally positively influenced by discharge, and negatively influenced by Julian date. Bieber et al. (2018) found a significant negative effect of river flow rate on river otter occupancy in Nebraska. River otters tend to prefer rivers with large, deep pools and open-water sections (Swimley et al., 1998; Tranl and Chapman, 2007), and in my study area, high discharge rates increase the volume of water in the river, making the river deeper, and potentially increasing suitability for river otters, and providing easier access to latrines. For example, estimated detection probability when river discharge is near 9,000 ft^3/sec was 0.55 (± 0.202). High detection probability for lower Julian dates corresponds with my high June visitation rates, further suggesting that compared to later in the summer, June is the best month to detect river otters on the Snake River. Other factors not included in this study could also influence probability of detection. For example, other carnivores visiting the latrine site may influence river otter detections (Wagnon & Serfass 2016), as could the activity of aquatic recreationists on the Snake River (Lawrence 2016).

Probability of viewing (i.e., detection probability of a river otter at a latrine during morning crepuscular and diurnal time periods) was generally low (0.074 ± 0.188). My top model indicated a weak positive influence of moon illumination on viewing probability. However, goodness-of-fit for this model was weak, indicating an inadequate model fit. The lack of fit may be due to low sample size for morning and crepuscular detections, or because other variables not included in my analysis could be influencing probability of detection during these time categories. Additional research could include river use by recreationists to compare activity levels of aquatic recreationists and river otter activity.

Direct exposure to wildlife and nature has been shown to increase environmental concern (Myers & Saunders, 2000) and ecological intentions (Ballantyne, Packer, & Sutherland, 2011; Dietz et al. 1994; Kals, Schumacher, & Montada, 1999). This is readily apparent in captive settings where visibility has been shown to influence time spent, and crowd sizes at exhibits (Bitgood et al. 1998; Moss & Esson 2010). In the wild, predicting visibility is a greater challenge, especially for species like the river otter that uses both aquatic and riparian areas. The results of my study suggest that during June, and periods of high river discharge aquatic recreationists have the greatest potential to view river otters on the Snake River in GTNP. Furthermore, because my study demonstrates that groups of river otters tend to spend more time at the latrines than solitary otters, and river otters will sometimes visit multiple latrines in a day, or a single latrine on consecutive days, the potential opportunity to see a river otter is enhanced in this area, compared to other areas where a similar study design occurred. However, latrines in GTNP have the potential to provide a unique opportunity to view river otters in the wild, where they are exhibiting interacting behavior (e.g., allogrooming, wrestling) and the river is a suitable and popular place for aquatic recreation.

The low probability of viewing river otters does not necessarily act as a barrier to using the river otter as a flagship species. For example, visitors in Australia were still satisfied when no whales were seen on a whale-watching tour (Orams 2000), and visitors also described their experience as satisfying when they did not see wolves in YNP (Montag et al. 2005). Green et al. (2001) concluded that an animals does not need to be directly viewed if evidence of an animal's occurrence (e.g., call, song, tracks) is present. And the results of Chapter 3 suggest that viewing marketing material about river otters has a high relative importance in determining pro-conservation behaviors to help conserve the river otter and its aquatic habitat. Thus, regardless of whether or not a river otter is viewed at a latrine, if tour operators, educators, or naturalists are aware of the location of river otter latrines along the Snake River, pointing those focal areas out and providing a short interpretation of those sites still has the potential to have a positive conservation impact.

Figures and Tables

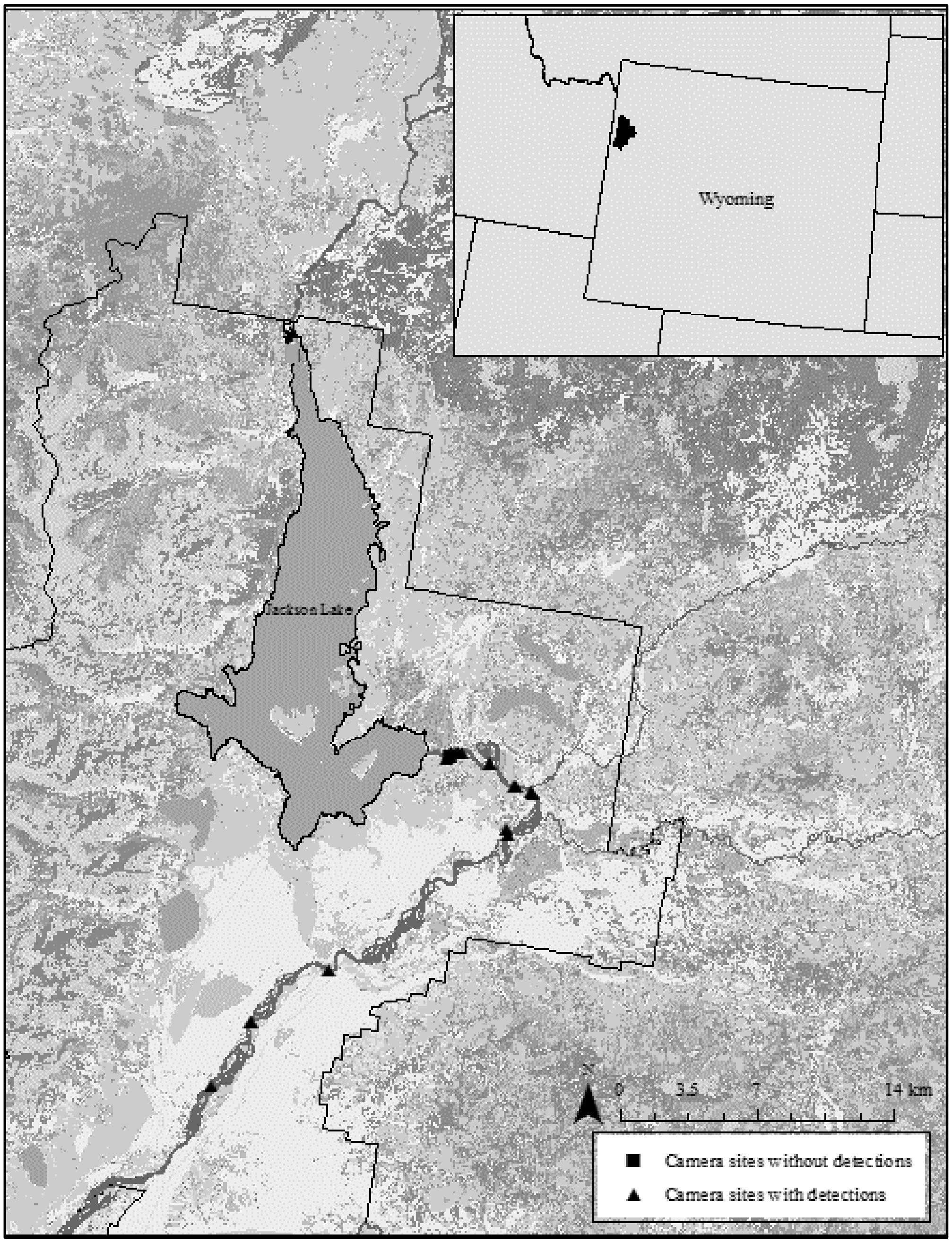

Figure 4.1. Location of remote field cameras deployed at latrines from 7 July 2015 to 20 August 2015, 15 June to 3 October, and 13 June to 17 August 2018 on the Snake River below Jackson Lake Dam, Grand Teton National Park.

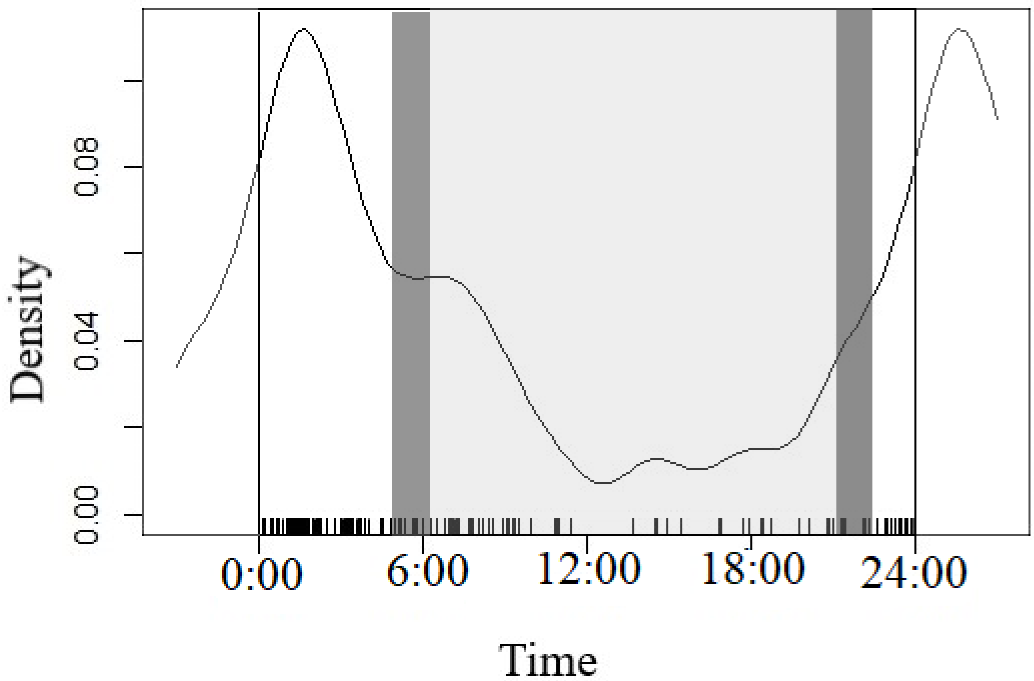

Figure 4.2. Kernel density estimates of diel activity pattern of river otters (*Lontra canadensis*) on the Snake River, Grand Teton National Park, Wyoming, USA from 7 July 2015 to 20 August 2015, 15 June to 3 October, and 13 June to 17 August 2018. Unshaded areas, light grey shaded area and dark grey shaded areas indicate nocturnal, diurnal and crepuscular time categories, respectively.

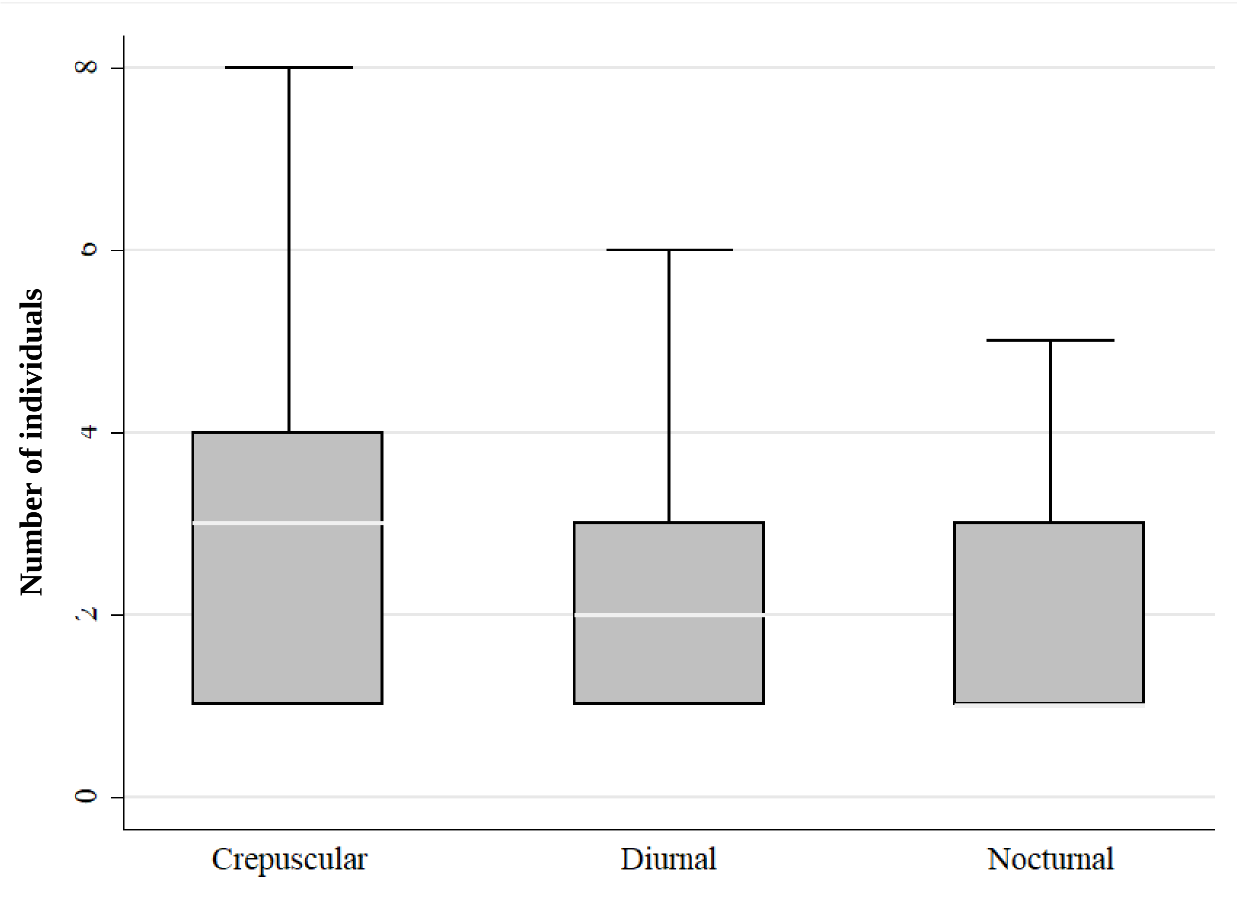

Figure 4.3. River otter (*Lontra canadensis*) group size by time of day at latrines in Grand Teton National Park during 3 camera trapping seasons 7 July 2015 to 20 August 2015, 15 June to 3 October 2016, and 13 June to 17 August 2018 in Grand Teton National Park, Wyoming, USA.

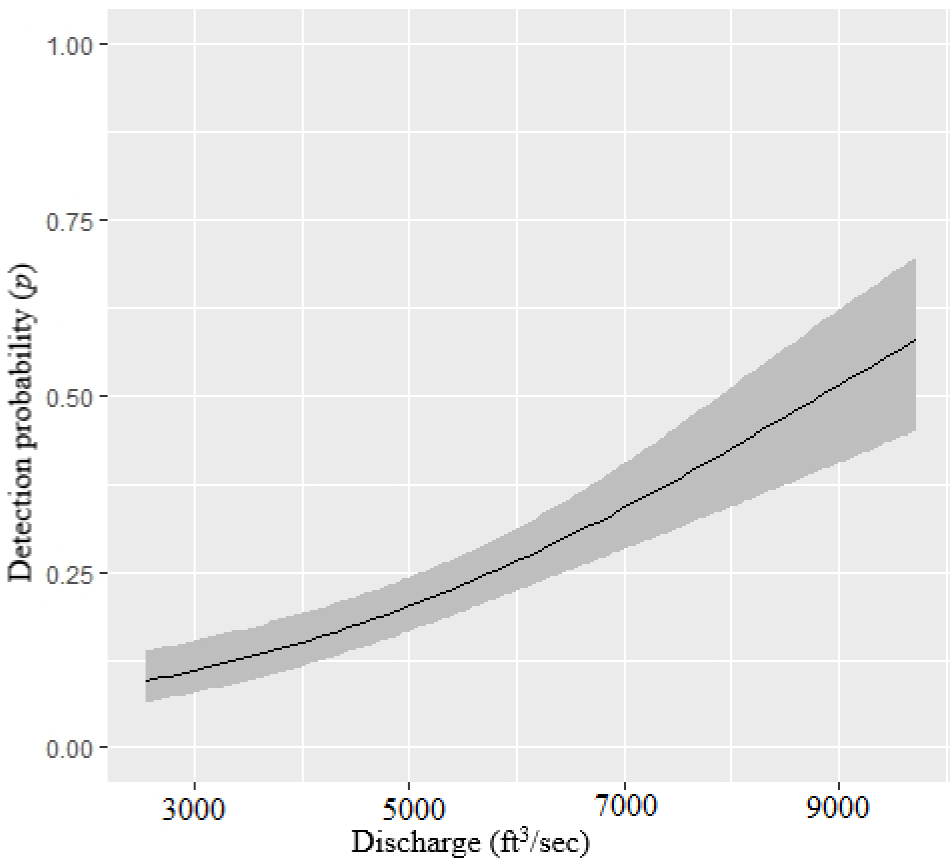

Figure 4.4. River otter (*Lontra canadensis*) probability detection (p) (± SE) as a function of discharge (ft^3/sec) on the Snake River, Grand Teton National Park, Wyoming, USA, 13 June to 17 August 2018.

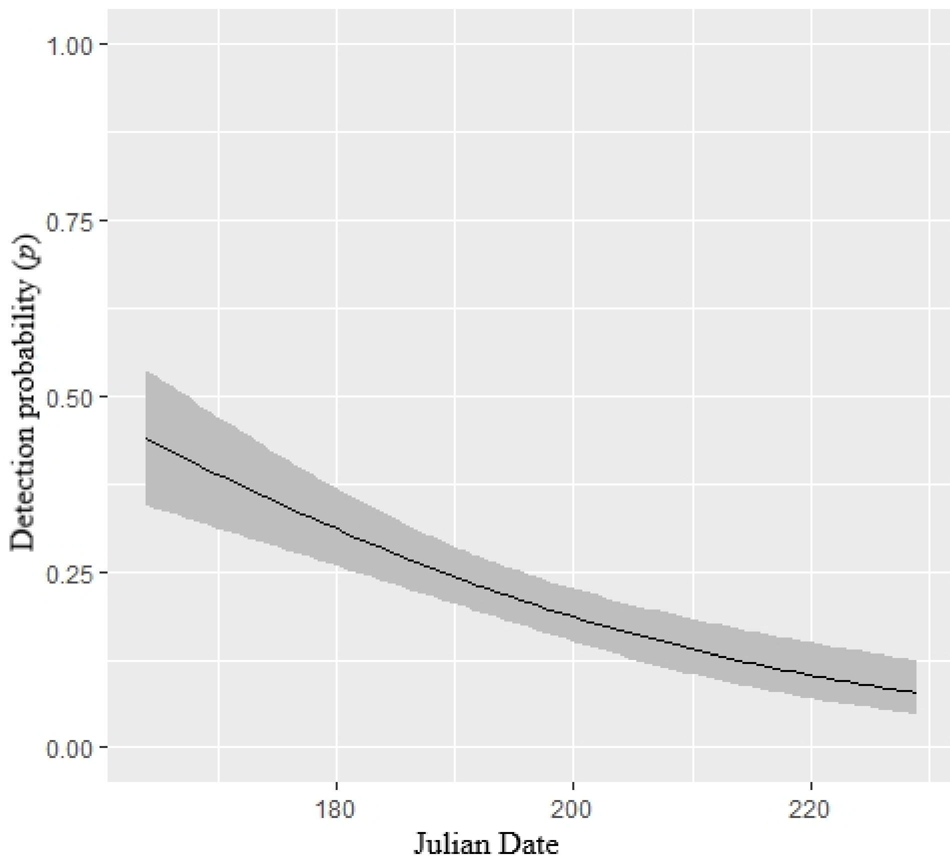

Figure 4.5. River otter (*Lontra canadensis*) probability of detection (± SE) as a function of Julian date on the Snake River, Grand Teton National Park, Wyoming, USA, 13 June to 17 August 2018.

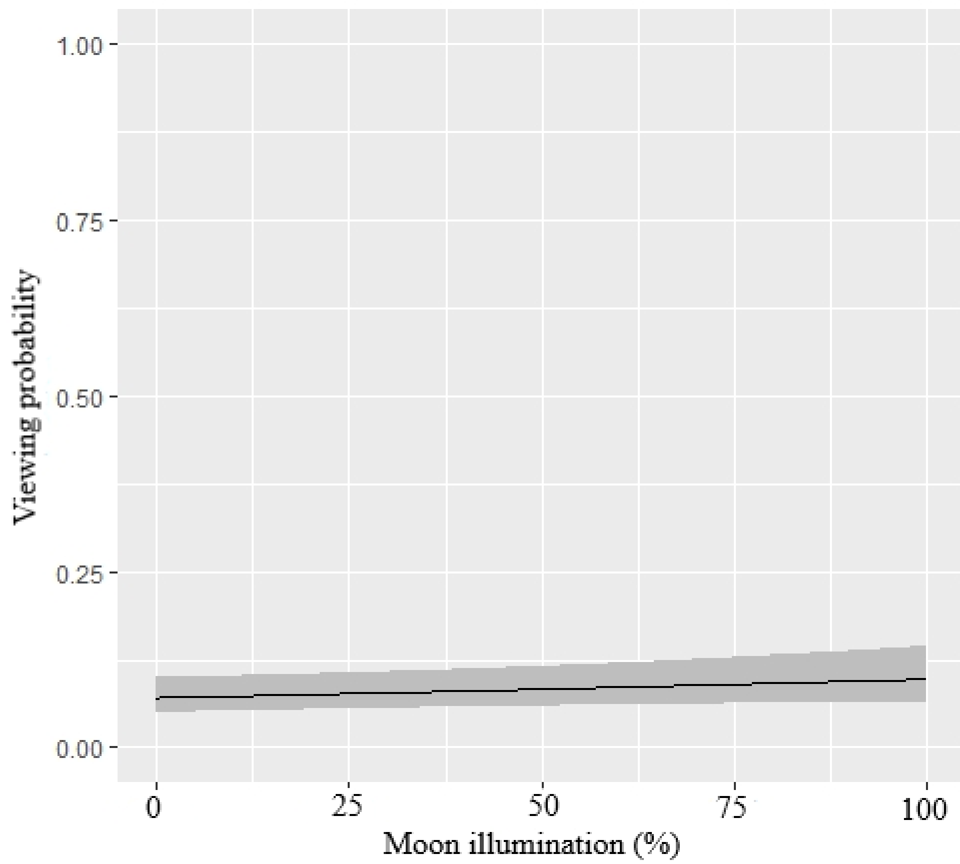

Figure 4.6. River otter (*Lontra canadensis*) probability of viewing (± SE) as a function of moon illumination (%) on the Snake River, Grand Teton National Park, Wyoming, USA, 13 June to 17 August 2018.

Table 4.1**.** Remote camera locations, dates of deployment, and number of trap days (defined as a 24 hr period for which the camera is deployed and functioning) for each camera during the study of river otters (*Lontra canadensis*) in Grand Teton National Park, Wyoming, USA.

General Site Location	Site ID	Camera ID	Latitude	Longitude	Date out	Day in	Trap days
Below dam, Snake River[a]	SR20151	2	43.86043	-110.5712	17-Jul-15	20-Aug-15	34
Near Pacific Creek, Snake River[b]	SR20152	9	43.84844	-110.5317	11-Jul-15	24-Aug-15	44
Signal Mountain, Snake River	SW0014	14	43.82848	-110.5337	26-Jun-16	1-Oct-16	97
Bar BC Ranch, Snake River	SW0016	216	43.69207	-110.6944	7-Jul-16	1-Oct-16	67
Deadmans Bar, Snake River	SE0009	224	43.75273	-110.6321	6-Aug-16	4-Oct-16	59
Below dam, Snake River	SR0001	1	43.85772	-110.5776	13-Jun-18	17-Aug-18	65
Below dam, Snake River	SR0003	5	43.8591	-110.5759	13-Jun-18	17-Aug-18	65
Below dam, Snake River[a]	SR0002	3	43.86043	-110.5712	13-Jun-18	17-Aug-18	65
Cattlemans, Snake River	SR0004	7	43.85748	-110.5505	14-Jun-18	16-Aug-18	63
Near Pacific Creek, Snake River[b]	SR0005	9	43.84844	-110.5317	13-Jun-18	16-Aug-18	64
Near Pacific Creek, Snake River	SR0006	1112	43.84694	-110.5208	13-Jun-18	16-Aug-18	64
Signal Mountain, Snake River	SR007	1415	43.8265	-110.5319	14-Jun-18	15-Aug-18	62
Schwabachers Landing, Snake River	SR008	17	43.72323	-110.6753	7-Jul-18	15-Aug-18	39
Totals							869

[a] Same latrine site camera-trapped in 2015 and 2018
[b] Same latrine site camera-trapped in 2015 and 2018

Table 4.2. Covariates used to estimate detection and viewing probability of river otters (*Lontra canadensis)* on the Snake River, Grand Teton National Park, Wyoming, USA, 13 June to 17 August 2018.

Covariate	**Mean ($\bar{x}$)**	**Standard deviation**	**Range**
Moon illumination (%)	0.49	0.36	0-100
Rain (cm)	0.09	0.41	0-2.84
Discharge (ft^3/sec)	5418.50	2329.52	2530-10,900
Julian Day	196.50	NA	164-229

Table 4.3. Number of independent river otter (*Lontra canadensis*) detections (defined by >60 minutes separation between images) during the 3 camera trapping seasons 7 July 2015 to 20 August 2015, 15 June to 3 October 2016, and 13 June to 17 August 2018 in Grand Teton National Park, Wyoming, USA.

General Site Location	**Site ID**	**Camera ID**	**Independent detections**	**Days detected**	**Average group size (± SD)**
Below dam, Snake River[a]	SR20151	2	0	0	NA
Near Pacific Creek, Snake River[b]	SR20152	3	5	12	4.0 ± 3.0
Signal Mountain, Snake River	SW0014	14	2	2	1.0 ± 0.0
Bar BC Ranch, Snake River	SW0016	216	2	1	1.5 ± 0.7
Deadmans Bar, Snake River	SE0009	224	7	7	2.3 ± 0.5
Below dam, Snake River	SR0001	1	13	12	2.0 ± 1.0
Below dam, Snake River	SR0003	5	6	6	3.0 ± 1.0
Below dam, Snake River[a]	SR0002	3	45	26	2.0 ± 1.0
Cattlemans, Snake River	SR0004	7	18	14	2.0 ± 0.9
Near Pacific Creek, Snake River[b]	SR0005	9	18	4	2.0 ± 1.5
Near Pacific Creek, Snake River	SR0006	1112	26	19	2.0 ± 1.0
Signal Mountain, Snake River	SR007	1415	17	16	2.0 ± 1.3
Schwabachers Landing, Snake River	SR008	17	1	1	1.0 ± 0
Totals			160	122	2.0 ± 1.3

[a] Same latrine site camera-trapped in 2015 and 2018
[b] Same latrine site camera-trapped in 2015 and 2018

Table 4.4. Number of trap days and monthly capture frequency (number of independent detections/100 TDs) by river otters (*Lontra canadensis*) at latrines on the Snake River in Grand Teton National Park during 3 camera trapping seasons 7 July 2015 to 20 August 2015, 15 June to 3 October 2016, and 13 June to 17 August 2018 in Grand Teton National Park, Wyoming, USA.

Month	**No. Trap days**	**Capture Frequency**
June	127	10.1
July	369	6.09
August	252	3.29
September	40	0.76

Table 4.5. Periodicity of visits by river otters (*Lontra canadensis*) at latrines between 7 July 2015 to 20 August 2015 (CamID 2 and 9), 15 June to 4 October 2016 (CamID 14, 216 and 224), 13 June to 17 August 2018 (CamID 1,3,5,7,9,17,1112, and 1415) in Grand Teton National Park, Wyoming, USA. Black indicates a detection, gray indicates a non-detection, and white indicates that a camera-trap was not deployed on that day.

	Camera ID												
Date	**2**	**9**	**14**	**216**	**224**	**1**	**3**	**5**	**7**	**9**	**17**	**1112**	**1415**
13-Jun													
14-Jun													
15-Jun													
16-Jun													
17-Jun													
18-Jun													
19-Jun													
20-Jun													
21-Jun													
22-Jun													
23-Jun													
24-Jun													
25-Jun													
26-Jun													
27-Jun													
28-Jun													
29-Jun													
30-Jun													
1-Jul													
2-Jul													

Table 4.5 cont.

	Camera ID												
Date	**2**	**9**	**14**	**216**	**224**	**1**	**3**	**5**	**7**	**9**	**17**	**1112**	**1415**
3-Jul													
4-Jul													
5-Jul													
6-Jul													
7-Jul													
8-Jul													
9-Jul													
10-Jul													
11-Jul													
12-Jul													
13-Jul													
14-Jul													
15-Jul													
16-Jul													
17-Jul													
18-Jul													
19-Jul													
20-Jul													
21-Jul													
22-Jul													
23-Jul													
24-Jul													
25-Jul													
26-Jul													
27-Jul													
28-Jul													

Table 4.5 cont.

	Cam ID												
Date	**2**	**9**	**14**	**216**	**224**	**1**	**3**	**5**	**7**	**9**	**17**	**1112**	**1415**
29-Jul													
30-Jul													
31-Jul													
1-Aug													
2-Aug													
3-Aug													
4-Aug													
5-Aug													
6-Aug													
7-Aug													
8-Aug													
9-Aug													
10-Aug													
11-Aug													
12-Aug													
13-Aug													
14-Aug													
15-Aug													
16-Aug													
17-Aug													
18-Aug													
19-Aug													
20-Aug													
21-Aug													
22-Aug													
23-Aug													

Table 4.5 cont.

						Cam ID							
Date	**2**	**9**	**14**	**216**	**224**	**1**	**3**	**5**	**7**	**9**	**17**	**1112**	**1415**
24-Aug													
25-Aug													
26-Aug													
27-Aug													
28-Aug													
29-Aug													
30-Aug													
31-Aug													
1-Sep													
2-Sep													
3-Sep													
4-Sep													
5-Sep													
6-Sep													
7-Sep													
8-Sep													
9-Sep													
10-Sep													
11-Sep													
12-Sep													
13-Sep													
14-Sep													
15-Sep													
16-Sep													
17-Sep													
18-Sep													

Table 4.5 cont.

						Cam ID							
Date	**2**	**9**	**14**	**216**	**224**	**1**	**3**	**5**	**7**	**9**	**17**	**1112**	**1415**
19-Sep													
20-Sep													
21-Sep													
22-Sep													
23-Sep													
24-Sep													
25-Sep													
26-Sep													
27-Sep													
28-Sep													
29-Sep													
30-Sep													
1-Oct													
2-Oct													
3-Oct													
4-Oct													

Table 4.6. Model selection results for detection probability (*p*) of river otters (*Lontra canadensis*) on the Snake River, Grand Teton National Park, Wyoming, USA, 13 June to 17 August 2018. I held occupancy constant and fit survey data from 8 camera stations to the candidate model set to estimate *p*. Models ranked based on Akaike Information Criterion corrected for small sample size (ΔAIC_c). The number of parameters (K), log likelihood (LL), AIC_c, ΔAIC_c, and AIC_c weight (w_i) are shown for each model.

Model	**K**	**LL**	**AIC_c**	**ΔAIC_c**	**w_i**
p (discharge)	3	-233.49	479.00	0	0.66
p (discharge + date)	4	-229.62	480.60	1.59	0.29
p (discharge + rain)	4	-231.91	485.20	6.19	0.03
p (lunar + discharge)	4	-232.86	487.10	8.09	0.01
p (date)	3	-239.99	492.00	13.00	0.00
p (discharge + rain + date)	5	-227.86	495.70	16.74	0.00
p (rain + date)	4	-237.65	496.60	17.66	0.00
p (discharge + lunar + date)	5	-229.17	498.30	19.36	0.00
p (lunar + date)	4	-239.16	499.70	20.80	0.00
p (discharge + lunar + rain)	5	-230.67	501.30	22.36	0.00
p (rain)	3	-247.08	506.20	27.18	0.00
p (lunar + rain)	4	-244.52	510.40	31.39	0.00
p (lunar + rain + date)	5	-236.07	512.10	33.17	0.00
p (.)	2	-254.17	214.70	35.76	0.00
p (lunar)	3	-252.97	517.90	38.96	0.00
p (discharge + lunar + rain + date)	6	-226.68	594.40	70.39	0.00

Table 4.7. Parameter estimates for the two best supported model selection results for detection probability *(p)* of river otters (*Lontra canadensis*) on the Snake River, Grand Teton National Park, Wyoming, USA, 13 June to 17 August 2018.

Model	**Parameter**	**Estimate**	**SE**	***p*-value**
p (discharge)	discharge	0.718	0.121	<0.001
p (discharge + date)	discharge	1.4662	0.426	<0.001
	date	0.0427	0.022	0.05

Table 4.8. Model selection results for viewing probability of river otters (*Lontra canadensis*) on the Snake River, Grand Teton National Park, Wyoming, USA, 13 June to 17 August 2018. I held occupancy constant and fit survey data from 8 camera stations to the candidate model set to estimate viewing probability. Models ranked based on Akaike Information Criterion corrected for small sample size (ΔAIC_c). The number of parameters (K), log likelihood (LL), AIC_c, ΔAIC_c, and AIC_c weight (w_i) are shown for each model.

Model	**K**	**LL**	**AIC_c**	**ΔAIC_c**	**w_i**
p (lunar)	2	-123.78	254.0	0.0	0.65
p (.)	3	-121.95	255.9	1.93	0.249
p (discharge)	3	-123.76	259.5	5.56	0.041
p (date)	3	-123.78	259.6	5.61	0.04
p (rain)	3	-125.45	262.9	8.94	0.007
p (lunar + rain)	4	-121.81	265	11.01	0.003
p (lunar + date)	4	-121.89	265.1	11.16	0.002
p (lunar + discharge)	4	-121.94	265.2	11.27	0.002
p (discharge + date)	4	-123.76	268.9	14.9	0.000
p (rain + date)	4	-123.78	268.9	14.94	0.000
p (discharge + rain)	4	-125.44	272.2	18.26	0.000
p (discharge + lunar + date)	5	-121.68	283.4	29.39	0.000
p (lunar + rain + date)	5	-121.72	283.4	29.49	0.000
p (discharge + lunar + rain)	5	-121.81	283.6	29.66	0.000
p (discharge + rain + date)	5	-123.77	287.5	33.58	0.000
p (discharge + lunar + rain + date)	6	-122.11	340.2	86.27	0.000

Table 4.9**.** Parameter estimates for the two best supported model selection results for viewing probability of river otters (*Lontra canadensis*) on the Snake River, Grand Teton National Park, Wyoming, USA, 13 June to 17 August 2018.

Model	**Parameter**	**Estimate**	**SE**	***p*-value**
p (lunar)	intercept	0.35	0.19	<0.01
p (.)	lunar	-2.52	0.18	0.075

Chapter 5

Evaluating a conservation flagship species: the river otter in the Greater Yellowstone Ecosystem

Prior to European settlement, the river otter (*Lontra canadensis*) occupied all states and provinces in continental North America (Kruuk 2006). Unregulated trapping, exacerbated by poor water quality as a result of the Industrial Revolution resulted in the river otter becoming extirpated from most of its range by the late 19th century (Kruuk 2006). To address the severe water pollution in the middle of the 20th century, the United States (US) passed the Federal Water Pollution Control Act of 1948 (Environmental Protection Agency 1948), which was amended in 1972 to what is commonly known as the Clean Water Act (Environmental Protection Agency 1972). The newly amended law allowed the US federal government to regulate pollutant discharges, implement wastewater standards, set water quality standards for surface water contaminants, and address critical issues posed by nonpoint source pollution (Environmental Protection Agency 1972). The Clean Water Act in combination with federal legislation designed to reduce environmental degradation from Agriculture (e.g., the "Farm Bill" [Bolen & Robinson 2003]) drastically improved water quality, enabling remnant river otter populations to naturally expand, as well as providing an opportunity for wide-spread reintroductions of river otters throughout the United States. Through these efforts, the river otter now occupies portions of its historic range in the continental US (Bricker et al. 2019).

Although river otters have returned to most of their previously extirpated range, population expansion is still limited by their inherent low population densities (Melquist & Hornocker 1983; Kruuk 2006) and availability of suitable aquatic and riparian habitat (Kruuk 2006). Specifically, river otters rely on undisturbed riparian areas with clean water that is able to harbor adequate prey species (Serfass et al. 1990; Swimley et al. 1998). Thus, any major alterations to aquatic systems or the protections of these aquatic systems has the potential to adversely affect river otter populations. To ensure continued protections of waterways in the US, the Clean Water Rule was enacted in 2015 clarifying which waters are protected by replacing the word "navigable waters" with the term "waters of the United States" in the Clean Water Act (Environmental Protection Agency 2015). However, recent amendments proposed by the Environmental Protection Agency to repeal the definition of "waters of the United States" (Environmental Protection Agency 2017) jeopardize federal clean water protections, as well as those species, such as the river otter, that rely on unpolluted water, healthy wetlands, streams, and lake habitats.

Because of its obligate dependence on clean water, the river otter has the potential to act as a flagship—a species that symbolizes a conservation issue and rally's public support through awareness and action (Heywood 1995)—for the Clean Water Act to symbolize clean and unpolluted aquatic systems in the United States. A few of the world's 13 species of otters have served as flagship species to raise awareness and promote protection of wetlands and riparian conservation of aquatic systems in many areas, including the Eurasian otter (*Lutra lutra)* in Europe (White et al. 1997; Kruuk 2006; Cianfrani et al. 2011), the giant otter (*Pteronura brasiliensis*) in Peru (Recharte et al. 2014), and the spotted-necked otter (*Lutra maculicollis*) in Tanzania (Stevens 2011). However, success with one group of species as a flagship does not necessarily translate to success in others. Thus, prior to using the river otter as an aquatic flagship, it is necessary to evaluate if the species meets certain criteria that have been determined as critical for success (e.g., Barua, Root-Bernstein, Ladle, & Jepson, 2011; Caro, Engilis, Fitzherbert, & Gardner, 2004), and to ensure that the species will not become a "battleship"—a species that is implicated in social conflict and tension among various groups (Douglas & Veríssimo 2013). Herein I review if the river otter meets pre-established criteria considered important for a conservation flagship (see Chapter 1). Specifically, I provide evidence in the form of supporting literature, and results from previous chapters of this Dissertation, as well as other evidence from white-paper reports associated with this project. The focus of this assessment is the Greater Yellowstone Ecosystem (GYE), an ideal study area to examine the potential of the river otter as a flagship species because of its high number of annual tourists (i.e., combined Yellowstone [YNP] and Grand Teton [GTNP] National Parks receive over 6 million local, regional, national, and international visitors [National Park Service 2011]), and because the river otter has been documented to occur throughout the GYE (e.g., Hall 1984, 1997; Ben-David & Crait 2007).

Ultimately, a flagship's success depends on its ability to achieve the pre-determined conservation objective, such as raising money for a campaign, establishing habitat reserves, or increasing the population of the species. There are 10 characteristics that are criteria for selecting a flagship (see Chapter 1 for a detailed review). Some are related to physical and inherent characteristics, such as such as large body size (Fuhrman & Ladewig 2008), charisma (Skibins et al. 2013), geographic status and distribution (Bowen-Jones & Entwistle 2002), and International Union of Conservation of Nature (IUCN) status (Brambilla et al. 2013). Other criteria include that there is no prior usage of the species that could cause conflict (Barua et al. 2011), that people are aware of, knowledgeable about, and have positive attitudes towards the species (Bowen-Jones & Entwistle 2002). Additionally, the species should be visible to humans, and the diet of the flagship should not be in competition with the needs or recreational pursuits of certain stakeholders so that it fosters a negative attitude. Herein I present if the river otter possesses the aformentioned characterstics, and thus is a suitable flagship species.

Large body size.—River otters are a mid-sized mammal species weighing between 5 to 14 kilograms, with a total length between 0.96 and 1.57 meters, including a muscular tail that accounts for 39% of the length (Melquist & Hornocker 1983). Although not considered "large" relative to other terrestrial carnivore species (i.e., mountain lions [*Puma concolor*], gray wolves [*Canis lupus*]), the river otter is the largest mammalian riverine predator in the United States. In a comparison of size of an animal and visitor interest in the United Kingdom, the Asian small-clawed otter (*Aonxy cinereus*) attracted more visitors and held visitor attention longer than average compared to species of smaller stature (Moss & Esson 2010). Further, the size of the river otter is large enough to make it recognizable, allowing for a person to make the association of the river otter and aquatic habitat on which they depend.

Charisma.—A charismatic species have a certain aesthetic appeal that makes it attractive and interesting to humans (Ducarme et al. 2013). River otters possess characteristics that would seemingly qualify them as a charismatic species, although charisma is inherently subjective. Their behavior is certainly a key drive of their charismatic perception, and this behavioral is well-known. For example, National Geographic films have shown river otters sliding, and playing in snow (Johnson & Landis 2009; Landis & Johnson 2018), fostering the perception that river otters are playful and intelligent, characteristics that allow humans to relate to the species (Lorimer 2007). Other documented play behavior of the river otter include wrestling with conspecifics (Green et al. 2015; Stevens & Serfass 2015), tail-chasing, and playing with prey (Lariviere & Walton 1998).

Geographic distribution.—Following natural expansions of remnant populations and successful reintroduction projects in 22 states, river otters now inhabit portions of their former range throughout the continental US (the river otter was never present in Hawaii), including coastal environments (Bricker et al. 2019). Within this range, the river otter inhabits rivers, lakes, wetlands, and coastal areas, which allows it to serve as a flagship that encompasses a wide variety of aquatic habitats, and serve to protect numerous ecosystems. Additionally, the wide-spread geographic range increases the probability the species is known among the national target audience, and enhances viewing probability for people throughout the continental United States.

Conservation status.—The river otter is classified as Least Concern by the IUCN Red List (Serfass et al. 2018). Throughout the US, the legal conservation status varies by state. In a recent survey of agency biologists, Bricker et al. (2019) reported that river otters are a legally-harvested furbearer in 43 states, of Least Concern in Arizona, Protected furbearer in New Mexico, and Wyoming, and Threatened in Colorado, Nebraska, and South Dakota. In the GYE, river otters are a protected furbearer in both YNP and GTNP, as well as throughout Wyoming, where they are ranked as both S3 (vulnerable) to S4 (apparently secure), and seem to be limited to the Yellowstone, Green, and Snake River drainages (Keinath et al. 2010). However, in Montana, where I conducted some of my social surveys with anglers, river otters are a harvested furbearer species, ranked as S4. Regardless of conservation status however, river otters exist in low population densities (e.g., 1 river otter per 3.58 km of habitat [Melquist & Hornacker 1983], and so they are relatively uncommon compared to more generalist aquatic species such as the beaver (*Castor candensis*) (Gibson & Olden 2014). This ultimately may influence people's perception that river otters are an uncommon or rare species on the landscape, and therefore in need of conservation attention, which has the potential to influence willingness-to-pay and other conservation actions (e.g., DeKay & McClelland 1996; Echeverri et al. 2017).

Pre-existing usage.—The use of the river otter in cultural and social contexts is mixed. There are various examples of Native American folklore involving otters, as well as the use of otters are clan animals in some Native American cultures (e.g., Bruchac 1992; Lake-Thom 1997; Ross 2003), although more in-depth research is needed to elucidate the role of river otters within Native American culture. Restoration activities, such as the reintroduction of predators to the landscape, have the potential to cause social conflicts to flare (e.g., Wilson 1997; Goedeke 2005; Scarce 2005; Goedeke & Rikoon 2008). While some states, like Pennsylvania, worked closely with stakeholder groups (i.e., anglers, owners of fish-rearing facilities) and had few conflicts among stakeholder groups during the river otter reintroduction projects (Serfass et al. 2003), other states, such as Missouri experienced controversy in regards to their river otter restoration project (Goedeke, 2005). As a result, the social construction of river otters in the state of Missouri was one of "devils," "angels," or "animals" (Goedeke, 2005; Goedeke & Rikoon, 2008). Further, the popular media has portrayed the river otter as harmful to fish populations, and a concern at fish-rearing facilities (Serfass et al. 2014), although the findings of a few empirical studies refute those perceptions (Pearce, Serfass, Ashcraft, & Stevens, 2017; Serfass et al., 1990).

Awareness.—As indicated earlier, the river otter if frequently featured in population media, including in various National Geographic films (i.e., Johnson & Landis, 2009; Landis & Johnson, 2018) and PBS programs (e.g., Birnbaum & Godeanu, 1998), which help engender public interest and familiarity of the species and its obligate dependence on aquatic environments (e.g., rivers, lakes, coastal areas) (Kruuk 2006). Furthermore, the river otter is a resident at various aquaria in the U.S., which can help to increase awareness about the species (Waylen et al. 2009). In a study of opinions and preferences regarding GYE and its wildlife among recreationists participating in guided river-raft trips on the Snake River, 85% (n = 638) of participants knew what a river otter looked like (Pearce & Serfass, 2014). In a second example, most (80%, *n* = 268) visitors to Trout Lake, YNP, WY had previously been exposed to a river otter in the wild, in a zoo or aquaria, or other forms of marketing material (e.g., media, guide book, park service brochure) (Chapter 3).

Knowledge.—The public may have modest knowledge of river otters, although very little has been formally assessed on this topic. In one example, thirty-five percent (*n* = 271) of guided-raft trip participants on the Snake River, GTNP, WY, considered themselves somewhat, or very knowledgeable about the river otter (Pearce & Serfass, 2014).

Attitudes.— People tend to have more negative attitudes towards carnivores that have the ability to injure humans, compete with humans for wildlife valued for recreational hunting and fishing, or cause property damage (e.g., Naughton-Treves et al. 2003; Woodroffe et al. 2005; Inskip & Zimmermann 2009; Romañach et al. 2011). Thus, as an apex aquatic predator, the river otter has inherent natural history characteristics (i.e., fish-eating) that could contribute to negative attitudes (Serfass et al. 1990, 2014). River otters have been implicated in negative human-wildlife interactions such as competing with anglers for game fish (Hamilton 1999, 2006; Serfass et al. 2014) and depredation at private ponds and public fish-rearing facilities (Goedeke, 2005; Hamilton, 1999). However, most available social science research indicates that anglers generally have favorable attitudes about river otters (Chapter 2, Bohrman 2013). In New Mexico, out-of-state anglers and wildlife viewing recreationists were estimated to be willing-to-pay between $15.40 and $18.80 for the river otter reintroduction (Kroeger 2005), providing additional evidence that most anglers understand the value of river otters in an ecosystem. Finally, 74% (*n* = 252) of general visitors to Trout Lake were classified as having attitudes regarding concerns about river otters (Chapter 3).

Visibility.— Most studies of river otter visits to latrines indicate activity is primarily nocturnal (Chapter 4; Olson, Serfass, & Rhodes, 2008; Stevens & Serfass, 2008). Probability of viewing (i.e., detecting a river otter at a latrine during diurnal or crepuscular time-periods) on the Snake River was low (0.07 [±0.18]) (Chapter 4). In my study area, the best viewing opportunities tended to be in June, and during periods of high river discharge (Chapter 4). In general, because visibility of the river otter is low, it is a potential liability of using the river otter as a flagship.

Diet.—The carnivorous diet of the river otter has the potential to be in conflict with recreational pursuits of anglers. However, in my study even when anglers perceived that river otters consumed game fish, or if they perceived that river otters decreased the amount of game fish available to anglers, they still held positive attitudes (Chapter 2). Further, in most aquatic systems, the most abundant and slowest-moving fish are the main diet items of the river otter Preliminary diet assessments on the Snake River, GTNP revealed fish from the Catostomidae, Salmonidae, and Cyprinidae families were in 48%, 38% and 44% of scats sampled, respectively (Pearce & Serfass, 2015b). Because recreational fishing is a critical tourism activity in GYE (Kerkvliet et al. 2002), it will be critical to disseminate factual information regarding the diet of the river otter in these systems, and its role as an apex aquatic predator.

In conclusion, the river otter strongly reflects many of the criteria possessed by a successful conservation flagship species. It has a large body size, a wide-spread geographic distribution, and although it does not have an endangered or threatened IUCN status, it exists in low densities across the landscape. Frequent popular media portrays the river otter as cute and playful which makes which increases people's awareness the perceived charisma of the species. My study also suggested that visitor attitudes and angler attitudes are favorable towards the river otter (Chapter 2). However, I believe there are two potential liabilities of the river otter as a flagship species:

visibility and pre-existing usage. River otters are primarily nocturnal, although they do have peaks of activity during early morning hours (Chapter 4). However, latrines could be used as a surrogate for river otter viewing, whereby tour guides, and naturalists use the latrines as a talking point for river otter conservation in the area. Latrines can also serve as the focus of future public monitoring programs. Pre-existing usage, in the form of negative media messaging on the river otter is another potential liability for the use of the river otter as a flagship species. There are various examples of media headlines portraying negative messaging regarding river otters, and thus it is important for conservation scientists and government agencies to provide accurate and useful information about river otter ecology and behavior to the media, so that their reporting can effect changes in public perceptions and attitudes. More research should be conducted to better understand knowledge about the river otter. For example, understanding if people know that habitat of the river otter, and their current threats. This information is important so that marketing campaigns can be better designed to inform the public about general knowledge on the river otter, and any common misconceptions.

Flagship species are used to further specific goals of conservation biology, and the integration of social and ecological science is critical in selecting a conservation flagship species. When selecting a flagship, none of the 10 criteria presented in this Dissertation should be used alone. Instead, the framework should serve as a comprehensive guide for identifying characteristics the flagship already possesses, understanding the characteristics that are currently unknown but could be elucidated from additional research, and emphasizing certain characteristics that can be used to inform the marketing of the flagship. Further, many of the characteristics identified in the framework are not mutually exclusive, they are interdependent and possessing one characteristic subsequently leads to the possession of another characteristic.

For example, when a person knows threats that a certain species faces, that can influence their attitudes, and their willingness to engage in pro-conservation behaviors to help conserve the species. In this Dissertation, I applied to the framework to one species, the river otter. Additional research could determine how this framework fits other “successful” flagships in a more broad application. Ultimately, the river otter possess many of the characteristics identified in my framework, and the use of the river otter as a flagship in the GYE is supported, but should continually be monitored, to ensure that specific conservation objectives are being met, and there are no unintended consequences, such as social conflict that is a result of using the river otter as a flagship.

Your Wildlife Experiences during Angling on the Yellowstone River

Thank you for agreeing to complete this survey about your wildlife viewing experience while angling. Your input is very important. Please read each question carefully before responding. Answer to the best of your ability and save any additional comments to the end. You may stop the survey at any time and your responses are confidential.

1. **During the last 3 years**, and **not** including this trip, how often have you fished on the Yellowstone River?

Never □	1-5 times □	6-10 times □	11-15 times □	16-25 times □	26+ times □

2. Viewing wildlife is an important part of your fishing experience: (Please ✓ one answer)

Strongly Disagree □	Disagree □	Neutral □	Agree □	Strongly Agree □	Not sure □

3. The opportunity to view wildlife is important in selecting a fishing site: (Please ✓ one answer)

Strongly Disagree □	Disagree □	Neutral □	Agree □	Strongly Agree □	Not sure □

4. Do you fish exclusively on the Yellowstone River? □ Yes □ No

   If **no**, where else do you like to fish? ____

5. What types of fish do you prefer fishing for? ____

6. Have you ever seen a river otter while fishing somewhere other than on the Yellowstone River? □ Yes □ No □ Not Sure

7. Have you ever seen a river otter while fishing on the Yellowstone River? □ Yes □No □ Not Sure

8. What types of fish do you think river otters primarily feed on the Yellowstone River?

   □ Game fish □Non-game fish □Both game and non-game fish □ Not Sure

9. Anglers have different perceptions and beliefs regarding the river otter. Please indicate your level of agreement with the following statements (Please ✓ one answer):

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Sure
I feel that river otters decrease the number of fish available to anglers	□	□	□	□	□	□
I believe it is important to conserve river otter populations	□	□	□	□	□	□
I would enjoy seeing river otters near rivers where I fish today	□	□	□	□	□	□
I would be concerned if the river otter population on the Yellowstone River declined	□	□	□	□	□	□
I believe that the presence of river otters is an indicator of a healthy aquatic environment	□	□	□	□	□	□
I believe river otters do *not* pose a threat to game fish populations such as trout	□	□	□	□	□	□
I would consider myself knowledgeable about river otters	□	□	□	□	□	□
I believe river otters are beneficial to game fish populations such as trout	□	□	□	□	□	□

10. Anglers have different feelings attitudes regarding the environment and wildlife. Please indicate your level of agreement with each of the following statements (Please ✓ one answer):

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Sure
Taking actions to protect the environment is among my top priorities	□	□	□	□	□	□
If I saw an animal that was injured by humans, I would do whatever I could to help it	□	□	□	□	□	□
I am doing the right thing if I took actions to ensure healthy river otter populations	□	□	□	□	□	□
If I saw a river otter that was injured by humans, I would do whatever I could to help it	□	□	□	□	□	□

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Sure
I am concerned about the quality of river otter habitat (i.e, clean, undisturbed lakes, rivers, wetland areas)	☐	☐	☐	☐	☐	☐
I am concerned about the well-being of river otter populations	☐	☐	☐	☐	☐	☐
Everyone should help in keeping local rivers and streams unpolluted	☐	☐	☐	☐	☐	☐
I do *not* feel personally obligated to help care for the environment	☐	☐	☐	☐	☐	☐
Protecting river otter habitat is not my responsibility	☐	☐	☐	☐	☐	☐

11. Anglers are willing to participate in different activities related to the environment. Please indicate below how willing you would be to participate in the following **over the next 12 months**:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Sure
Over the next 12 months, I would be willing to donate to river otter conservation through a tax donation check-off box in my state	☐	☐	☐	☐	☐	☐
Over the next 12 months, I would be willing to send a letter of support to my members of Congress in support of Clean Water Legislation (e.g., Restoring Clean Water Act) for protections of wetlands and streams to help conserve the river otter	☐	☐	☐	☐	☐	☐
Over the next 12 months, I would be willing to plant trees along my local river if it helped to improve water quality	☐	☐	☐	☐	☐	☐
Over the next 12 months, I would *not* be willing to spend some of my time to help keep my local waterways as unpolluted as possible	☐	☐	☐	☐	☐	☐
Over the next 12 months, I would be willing to make a charitable contribution up to $150 to help purchase aquatic habitat in the wild for the river otter	☐	☐	☐	☐	☐	☐
Over the next 12 months, I would do whatever I could to help an injured river otter	☐	☐	☐	☐	☐	☐
Over the next 12 month, I will be looking for ways to reduce water consumption.	☐	☐	☐	☐	☐	☐

Gender ☐ Male ☐Female	In what year were you born? ______	Primary Residence: State:___________ Zip: _________ Country (if **NOT** U.S.) ____________
Highest Level of Education: ☐ Some high school or less ☐High School Diploma ☐Some College ☐ Associates or Bachelors Degree ☐Some Graduate work ☐Graduate Degree (Masters, PhD, M.D.)		
What is your annual household income? ☐ Less than $24,999 ☐Between $25,000 and $74,999 ☐ Between $75,000-124,999 ☐Between $125,000 and $174,999 ☐$175,000+ ☐Prefer not to answer		

Thank you for your participation. If you are interested in completing a follow-up survey, please print your email below:

____@________________________________

Your Wildlife Experience at Trout Lake, Yellowstone National Park

Thank you for agreeing to complete this survey about your experience at Trout Lake. Your input is very important. Please read each question carefully before responding. Answer to the best of your ability and save any additional comments to the end. You may stop the survey at any time and your responses are confidential.

1. Is this your first visit to **Yellowstone National Park**?	□ Yes	□ No
2. Is this your first visit to **Trout Lake**?	□ Yes	□ No
3. Prior to this visit were you or your group aware of **Trout Lake**?	□ Yes	□ No

4. **During the last 3 years**, and **not** including this trip, how often have you visited Trout Lake? (Please ✓ one)

Never	1 time	2-5 times	6-15 times	16-25 times	26+
□	□	□	□	□	□

5. Approximately how many hours did you spend at Trout Lake today? □ 0-1 hrs □ 1-2 hrs □ 2-3 hrs □ 3+ hrs

6. Did you take photographs/videos of wildlife today at Trout Lake? □Yes □No

If yes, of what wildlife?____

7. Prior to your visit today to Trout Lake today, have you ever seen a river otter?

□Yes, in the wild □Yes, at a zoo □No □Not sure

8. Prior to this visit, how did you or your personal group obtain information on viewing river otters at Trout Lake?

□ I did not know river otters could be viewed □National Park Service website □ Yellowstone Association website

□National Wildlife Federation website □ Friend/Family member □other (________________)

9. Please describe your wildlife viewing experiences at Trout Lake below:

Did you see these wildlife species today at Trout Lake?		**About how long did you spend viewing this animal?**		**About how far away were you from viewing these animals? Close (<25 feet), Medium (25-50 feet), Far (50+ feet)**		
River Otter	□Yes □No	If YES:	Minutes	□ Close	□Medium	□Far
Osprey	□Yes □No	If YES:	Minutes	□ Close	□Medium	□Far
Cutthroat Trout	□ Yes □No	If YES:	Minutes	□ Close	□Medium	□Far
Please specify any other species you saw:						
			Minutes	□ Close	□Medium	□Far
			Minutes	□ Close	□Medium	□Far

10. Whether you viewed a river otter today or not, would you be **more interested** in seeking viewing opportunities for river otters in the wild in the future? (Please ✓ one answer)

□ Not at all more interested □A little more interested □Very more interested □Extremely more interested

11. On a scale of 1 to 10, with 10 being the best wildlife viewing experience, how would you rate the overall quality of your wildlife viewing experience at Trout Lake today? (Please ✓ one answer)

1	2	3	4	5	6	7	8	9	10
Very poor □	□	□	□	Neutral □	□	□	□	□	Best wildlife viewing □

12. Please indicate your level of agreement with each of the following statements (Please ✓ one answer):

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Sure
Taking actions to protect the environment is among my top priorities	□	□	□	□	□	□
I would get upset if I saw an injured animal	□	□	□	□	□	□
I am doing the right thing if I took actions to ensure healthy river otter populations	□	□	□	□	□	□

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Sure
I would get very upset if I saw an injured river otter	□	□	□	□	□	□
I am concerned about the quality of river otter habitat (i.e, clean, undisturbed lakes, rivers, wetland areas)	□	□	□	□	□	□
I am *not* concerned about the well-being of river otter populations	□	□	□	□	□	□
Everyone should help in keeping local rivers and streams unpolluted	□	□	□	□	□	□
I *do not* feel personally obligated to help care for the environment	□	□	□	□	□	□
Protecting river otter habitat is my responsibility	□	□	□	□	□	□

11. People visiting Trout Lake are willing to participate in different behaviors related to the environment. Please indicate below how willing you would be to participate in the following **over the next 12 months**:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Sure
Over the next 12 months, I would be willing to donate to river otter conservation through a tax donation check-off box in my state	□	□	□	□	□	□
Over the next 12 months, I would be willing to send a letter to my members of Congress in support of Clean Water Legislation (e.g., Restoring Clean Water Act) for protections of wetlands and streams to help conserve the river otter	□	□	□	□	□	□
Over the next 12 months, I would be willing to plant trees along my local river if it helped to improve water quality	□	□	□	□	□	□
Over the next 12 months, I would *not* be willing to spend some of my time to help keep my local waterways as unpolluted as possible	□	□	□	□	□	□
Over the next 12 months, I would be willing to make a charitable contribution up to $150 to help purchase habitat in the wild for the river otter	□	□	□	□	□	□
Over the next 12 months, I would do whatever I could to help an injured river otter	□	□	□	□	□	□
Over the next 12 month, I will be looking for ways to reduce water consumption.	□	□	□	□	□	□

Gender □ Male □Female

In what year were you born? _______

Primary Residence: State:_______ Zip: ___________

Country (if **NOT** U.S.) ___________________________

Highest Level of Education: □ Some high school or less □High School Diploma □Some College
□ Associates or Bachelors Degree □Some Graduate work □Graduate Degree (Masters, PhD, M.D.)

What is your annual household income?

□ Less than $24,999 □Between $25,000 and $74,999 □ Between $75,000-124,999
□Between $125,000 and $174,999 □$175,000+ □Prefer not to answer

Thank you for your participation in our survey today. If you are interested in completing up a follow-up survey, please indicate your email address: ____

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