Evaluating river otter (*Lontra canadensis*) translocation success:

Post-release monitoring via olfactory attractants and intraperitoneal transmitters,

and local anglers' attitudes

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ABSTRACT

The success of translocations, the intentional release of wild-caught animals for the purpose of restoring or augmenting a historic population, is highly variable. Therefore, evaluating translocations is important to the success of future conservation efforts and management techniques. The North American river otter (*Lontra candensis*) once inhabited every US state except Hawaii, but was extirpated from much of its original range due to human encroachment, habitat destruction, and overharvesting. Since 1976, reintroduction projects have been initiated in 22 states. Because of their elusive nature, it is difficult to obtain accurate, long-term data on reestablished otter populations. Exploring strategies for remotely monitoring translocated river otters will help biologists to gather accurate information on the species' local life history patterns and conservation status. Additionally, communicating with local people and assessing public attitudes toward wildlife translocations can help guide management decisions and further ensure that reestablished populations remain locally stable. This thesis comprises 3 studies related to evaluating river otter translocation efforts. The first investigates the efficacy of olfactory lures at attracting captive river otters in order to predict how they may increase otter visitations to remote tracking devices, thereby allowing biologists to obtain information on existing and reestablished otter populations. The second evaluates the use of intraperitoneal transmitters for monitoring translocated river otters; and the third assesses Pennsylvania anglers' attitudes toward river otter reintroductions within the state.

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INTRODUCTION

Translocation, the intentional release of wild-caught animals for the purpose of restoring or augmenting a historic population, is a common species conservation tool; however, translocation success is highly variable and influenced by several factors (Griffith et al. 1989, Wolf et al. 1998, Letty et al. 2000). Habitat suitability, species feeding ecology (e.g. carnivores vs. herbivores), size of founder population (Griffith et al. 1989), genetic depression (Letty et al. 2000), and physiological stress (Letty et al. 2000, Teixeira et al. 2007) can all contribute to the success or failure of wildlife translocations. Because the ultimate goal of translocations is establishing self-sustaining populations where they have become extirpated or severely diminished, the conservation strategy is dependent on the ability of animals to adapt to new environments and contribute to the expansion of their species' range and local population size. Translocated animals may fail to adequately adjust to a new area, establish territories, or reproduce effectively (Griffith et al. 1989). Contrarily, they may trigger rapid population growth exceeding local carrying capacities (Hayward et al. 2007). Monitoring translocated individuals in order to evaluate their post-release survival and mortality, movements, behavior, and reproductive performance is thus important (Hein 1997, Miller et al. 1998, Semlitsch 2002). However, tracking animals efficiently, inexpensively, and noninvasively, as well as obtaining accurate, long-term data on a species' population density and range, is challenging. Developing and improving methodology for monitoring translocated wildlife should enhance biologists' ability to establish appropriate management techniques and guide future releases (Hein 1997, Miller et al. 1998).

Translocation success depends not only on biological factors, but on public perception and attitudes toward species. Stakeholders often directly influence wildlife management decisions and policies (Lafon et al. 2003), and public sponsorship and support are vital fiscal and bureaucratic exponents for many conservation programs (Dietz et al. 1994, Linnell et al. 2000). Nevertheless, surprisingly little formal research has been dedicated to assessing public views on wildlife conservation and management issues until recently (Jacobson and McDuff 1998). Carnivore translocations can be especially controversial because of perceived threats to humans, livestock, or other resources (Gusset et al. 2007, Nilsen et al. 2007). However, when they are not formally gauged, human-wildlife conflicts can be inaccurately depicted or exacerbated by the media, often cultivating political agendas that influence public perceptions (Webb and Raffaelli 2008). Careful consideration of public opinions should enhance the success of conservation efforts by improving awareness on both sides of human-wildlife conflicts, leading to strategies that address concerns, mitigate tensions, and bolster community support (Graham et al. 2004).

The North American river otter (*Lontra candensis*) is a semi-aquatic mustelid native to the United States and Canada. Once occurring in every US state except Hawaii, the river otter was extirpated from much of its original range due to human encroachment, habitat destruction, and overharvesting (Tesky 1993). An economically valuable furbearer since Europeans began to settle the continent, the species was extensively trapped in the late 19th and early 20th centuries. Development of riparian habitat and pollution of waterways also played major roles in local population declines (Tesky 1993, Kruuk 2006). Since the 1970s, regional and statewide translocations have restored river otters to areas where the species was extirpated (Raesly 2001). Since 1976, reintroduction projects have successfully restored river otters to 22 states (Raesly 2001; Bruning 2008, personal communication). River otters now occupy at least portions of their historic range in every continental US state and Alaska, and 29 states have established regulated trapping seasons for the species (Serfass 1993*a*).

In general, translocated otters are able to adjust well to their introduced environment (Serfass et al. 1993*a*, Serfass et al. 1993*b*, Spinola et al. 2008); when investigated, survival rates in the first few years following release are high. In Indiana, 12 of the 15 radio transmitter-equipped otters survived >1 year after translocation from Louisiana (Johnson and Berkley 1999). Fifteen of 17 wild, Louisiana-born river otters survived 1 year after release in Missouri (Erikson and McCullough 1987), and 23 of 28 otters survived a year after being translocated from the Adirondack and Catskill regions of New York to the Genesee River in the western area of the state. Since 1982, the Pennsylvania River Otter Reintroduction Project (PRORP) has reintroduced 153 river otters successfully to 7 water systems in central and western Pennsylvania. Results of interviews and surveys demonstrate that river otters persist at all reintroduction sites and their populations appear to be expanding (Hubbard and Serfass 2004). However, obtaining accurate long-term data on the survival, reproduction, growth, and expansion of reintroduced populations is challenging. Testing additional strategies for remotely monitoring translocated otters will help biologists to gather accurate information on the species' local life history patterns and conservation status. Moreover, communicating with local people about translocations can lend enormous support to important management decisions and further ensure that reestablished populations remain locally stable.

This thesis comprises 3 studies related to evaluating the river otter translocation efforts. The first (Chapter I) investigates the efficacy of olfactory lures at attracting captive river otters in order to predict how they may increase otter visitations to remote tracking devices, thereby allowing biologists to obtain information on existing and reestablished otter populations. The second (Chapter II) evaluates the use of intraperitoneal transmitters for monitoring translocated river otters; and the third (Chapter III) assesses Pennsylvania anglers' attitudes toward river otter reintroductions within the state.

LITERATURE CITED

Dietz, J. M., L. A. Dietz, and E. Y. Nagagata. 1994. The effective use of flagship species for conservation of biodiversity: the example of tamarins in Brazil. Pages 32-47 *in* Creative Conservation: Interactive management of wild and captive animals. P. J. S. Olney, G. M. Mace, and A. C. T. Feistner, Editors. Chapman and Hall, London.

Erickson, D. W., and C. R. McCullough. 1987. Fates of translocated river otters in Missouri. Wildlife Society Bulletin 15:511-517.

Graham K., A. P. Beckerman, and S. Thirgood. 2005. Human-predator-prey conflicts: ecological correlates, prey losses and patterns of management. Biological Conservation 122:159-171

Griffith, B., J. M. Scott, J. W. Carpenter, and C. Reed. 1989. Translocation as a species conservation tool: status and strategy. Science 245:477-480.

Gusset, M., A. H. Maddock, G. J. Gunther, M. Szykman, R. Slotow, M. Walters, and M. J. Somers. 2008. Conflicting human interest over the reintroduction of endangered wild dogs in South Africa. Biological Conservation 17:83-101.

Hayward, M. W., J. O'Brien, and G. I. H. Kerley. 2007. Carrying capacity of large African predators: Predictions and tests. Biological Conservation 139:219-229.

Hein, E. W. 1997. Improving translocation programs. Conservation Biology 11:1270-1271.

Hubbard, B. and T. Serfass. 2004. Assessing the distribution of reintroduced populations of river otters in Pennsylvania (USA); Development of a landscape- level approach. IUCN Otter Specialist Group Bulletin 21:60-101.

Jacobson, S. K. and M. D. McDuff. 1998. Conservation education. Pages 237-255 *in* Conservation Science and Action, W. J. Sutherland, Editor. Blackwell Science Limited, Oxford, UK.

Johnson, S. A., and K. A. Berkley. 1999. Restoring river otters in Indiana. Wildlife Society Bulletin 27:419-427.

Kruuk, H. 2006. Otters: Ecology, Behaviour and Conservation. Oxford University Press Inc. New York, New York, USA.

Lafon, N. W., S. L. McMullin, and D. E. Steffen. 2003. Knowledge and opinions of stakeholders of black bear management in Virginia. Ursus 14(1):55-64.

Letty, J., S. Marchandeau, J. Clobert, and J. Aubineau. 2000. Improving translocation success: an experimental study of antistress treatment and release method for wild rabbits. Animal Conservation 3:211-219.

Linnell, J. D. C., J. E. Swenson, and R. Andersen. 2000. Conservation of biodiversity in Scandinavian boreal forests: large carnivores as flagships, umbrellas, indicators, or keystones? Biodiversity and Conservation 9:857-868.

Miller, B., K. Ralls, R. P. Reading, J. M. Scott, and J. Estes. 1998. Biological and technical considerations of carnivore translocation: a review. Animal Conservation 2:59-68.

Nilsen, E. B., E. J. Milner-Gulland, L. Schofield, A. Mysterud, N. C. Stenseth, and T. Coulsen. 2007. Wolf reintroduction to Scotland: public attitudes and consequences for red deer management. Proceedings of the Royal Society B. 274(1612):995-1003.

Raesly, E. J. 2001. Progress and status of river otter reintroduction projects in the United States. Wildlife Society Bulletin 29: 856–862.

Semlitsch, R. D. 2002. Critical elements for biologically based recovery plans of aquatic-breeding amphibians. Conservation Biology 16(3):619-629.

Serfass, T. L., Brooks, R. P., and Rymon, L. M. 1993a. Evidence of long-term survival and reproduction by translocated river otters, *Lutra canadensis*. Canadian Field-Naturalist 107:59-63.

Serfass, T. L., R. L. Peper, M. T. Whary, and R. P. Brooks. 1993b. River otter (*Lutra canadensis*) reintroduction in Pennsylvania: prerelease care and clinical evaluation. Journal of Zoo and Wildlife Medicine 24:28-40.

Spinola, R. M., T. L. Serfass, and R. P. Brooks. 2008. Survival and post-release movements of river otters translocated to western New York. Northeastern Naturalist 15:13-24.

Tesky, J. L. 1993. Lutra Canadensis in: Fire Effects Information System [Online]. U. S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer).

Teixeira, C. P., C. S. De Azevedo, M. Mendl, C. F. Cipreste, and R. J.Young. 2007. Revisiting translocation and reintroduction programmes: the importance of considering stress. Animal Behaviour 73:1–13.

Wolf, C. M., T. Garland, and B. Griffith. 1998. Predictors of avian and mammalian translocation success: reanalysis with phylogenetically independent contrasts. Biological Conservation 86:243-255.

Webb, T. J. and D. Raffaelli. 2008. Conversations in conservation: revealing and dealing with language differences in environmental conflicts. Journal of Applied Ecology 45:1198-1204.

CHAPTER I. Efficacy of Olfactory Lures at Attracting Captive River Otters (*Lontra canadensis*)

ABSTRACT

The efficacy of olfactory lures at attracting river otters has received almost no formal investigation. However, scents may potentially be useful at attracting river otters to field devices, such as scent and track stations, remote cameras, and traps, to obtain data on reestablished and existing wild populations. This study evaluated the efficacy of 6 olfactory lures (diluted Fatty Acid Scent, Synthetic Fermented Egg, skunk essence, beaver castoreum, Alaskan salmon oil, and Cronk's Otter Lure) at attracting captive river otters. To deploy each lure, a 25 x 5-mm plaster disc was soaked in liquid scent for 1 hour and subsequently inserted into a 26-mm long x 70-mm diameter, single-closed-ended PVC pipe with a 32 mm diameter, double-open-ended PVC screw-top. From April – July 2010, 17 adult river otters were observed at 7 captive facilities in Pennsylvania, West Virginia and New York. Subject animals were observed individually or in pairs in 10-minute video-taped focal sessions for a period of 6 days. Prior to each observation, 1 of the 6 lures and a blank control was situated within a large, naturalistic portion of the otter's enclosure, and then the focal animal(s) were allowed to enter and explore the area. Any time a subject animal moved within 1 meter of the lure or control, an "approach" was recorded. Subsequently, the swiftness, duration, and frequency of approaches were compared between each of the 6 lures and its corresponding control. Results demonstrated that lures outperformed controls among the 4 main parameters assessed; however, these differences were not significant. Cronk's Otter Lure (COL) yielded a stronger response than the other 5 lures for each of the 4 main parameters assessed although none of these differences were significant. Field analyses are needed to

determine whether COL or other scents are useful for attracting wild river otters to remote tracking devices.

INTRODUCTION

Following release, monitoring translocated animals is necessary to evaluate their ability to reestablish healthy populations (Hein 1997, Miller et al. 1998, Semlitsch 2002). Due to their elusive nature, obtaining demographic information on wild river otters (*Lontra canadensis*) is challenging (Robson and Humphrey 1985). In light of costs and the potentially harmful effects of stress, less invasive tracking methods, such as scent and track stations and remote cameras are often preferable. Baits, including whole fish (Melquist and Dronkert 1987) are occasionally used to attract otters to field devices, although the efficacy of baits has not been systematically assessed (Schlexer 2008). Olfactory lures may serve better as long-distance attractants than baits, as certain pungent scents should be detectable at greater distances than bait odors, and are not subject to being consumed by non-target animals.

Many carnivores rely heavily on olfactory signals for hunting and communication, as scents often are more easily and extensively transmissible and longer lasting than visual and auditory cues (Gorman and Trowbridge 1989). The primary form of social communication for the North American river otter (*Lontra canadensis*) is scent-marking. River otters deposit scent from glands located under the feet as well as in the form of urine and spraints (Kruuk 2006). Like many carnivores, otters have a superior sense of smell. Captive European otters (*Lutra lutra*) have demonstrated the ability to distinguish among the spraints of individuals (Gorman and Trowbridge 1989), and research suggests that male river otters can identify the social status of other males based on their scent-markings (Rostain et al. 2004).

The efficacy of olfactory attractants for river otters has received almost no research attention. Robson and Humphrey (1985) tested the efficacy of scents on captive and wild otters and detected no significant differences between 2 types of lures and a blank control on the behavioral responses of captive and wild otters. However, the researchers tested the lures on only 3 captive individuals, and admitted that repeatedly introducing scents to the same 3 animals probably introduced a conditioning bias. Furthermore, in their field study, Robson and Humphrey (1985) did not compare visitation rates to lure-baited scent-stations with blank controls. Therefore, the use of scents as long-distance attractants for river otters has yet to be thoroughly assessed both in captivity and the wild.

A wide variety of chemical attractants have been used in carnivore surveys, including surveys for various mustelid species. However, the efficacy of such lures has only been thoroughly, systematically assessed in canids. Among coyotes (*Canis latrans*), 2 of the most proven lures in pen and field tests are synthetic Fatty Acid Scent (FAS) (Roughton and Sweeny 1982, Phillips et al. 1990, Kimball et al. 2000), and Synthetic Fermented Egg (SFE) (Roughton 1982, Turkowski et al. 1983). FAS has been established as the standard lure for coyote surveys in the United States (Roughton 1982) and has been used effectively in a variety of other carnivore surveys (Schlexer 2008). Whereas FAS can only be purchased at a relatively high price from the USDS Pocatello Supply Company (Schlexer 2008), SFE is less expensive and commercially sold. Skunk essence is another inexpensive, commercially available lure that is commonly used to attract mustelids, including wolverines (*Gulo gulo*), American badgers (*Taxidea taxus*), American martens (*Martes americana*) (Schlexer 2008), and fishers (*Martes pennanti*) (Fuller et al. 2001, Weir 2003). Beaver castoreum [exudate from the castor sacs, or preputial scent glands, of the American beaver (*Castor canadensis*)] has proven effective at attracting wild lynx (*Lynx lynx*) (McDaniel et al. 2000) and has been used in a variety of other carnivore surveys (Mowat et al. 2001, Harrison 2006, Schlexer 2008). Fish oils and extracts, including salmon oil, have also been used extensively in mustelid surveys (Schlexer 2008), and these prey odors may elicit a predatory response in otters. Finally, a number of brand-name commercially manufactured synthetic lures are commonly used by trappers to attract predators. Cronk's Otter Lure is one of the most successfully sold commercial otter lures available.

Roughton and Sweeny (1982) evaluated 7 methods of deploying liquid scent (FAS) and determined that the most effective technique consisted of a 25 x 5 mm plaster disc immersed for 1 hour in FAS. This method produced the highest volitalization rate in laboratory tests and received the greatest number of visits by wild coyotes during field tests. Because the technique is both inexpensive and convenient, Roughton and Sweeny recommended it as the standard U.S. Fish and Wildlife Service (USFWS) procedure for liquid lure-based scent-stations.

The objectives of this study were to:

1. Quantify captive river otters' behavioral responses to 6 common olfactory lures and unscented control devices;
2. Compare otters' responses to lures and unscented control devices;
3. Compare otters' responses among the 6 different lures.

It was hypothesized that lures would perform better than controls at attracting captive river otters, based on behavioral data. Additionally, FAS was hypothesized to elicit a stronger response from otters than the other 5 scents.

METHODS

From April – July, 2010, the efficacy of 6 attractants, diluted FAS, SFE, skunk essence (SKE), beaver castoreum (BVC), Alaskan salmon oil (SAO), and Cronk's Otter Lure (COL), were evaluated on captive river otters. To deploy each lure, a 25 x 5 mm plaster disc was soaked in enough liquid scent to cover each surface in a sealed glass jar for 1 hour. Subsequently, the disc was inserted into a 26 mm long x 70 mm diameter, single-closed-ended PVC pipe, fitted with a 32 mm diameter, double-open-ended PVC screw-top to fasten the device (See Figure 1). When sealed and upright, each device stood 70-mm tall. This design prevented subjects from chewing through the device or removing the plaster disc from inside, while allowing the odor to volatilize through the 26-mm diameter opening at the top. Each scent was presented independently along with a blank control (a PVC device containing a plaster disc soaked in water).

The staff at 1 facility requested that a larger PVC device be used for testing their otters, as there was concern that otters might attempt to swallow the smaller devices. Therefore, a 6-cm long x 8-cm diameter, single-closed-ended PVC pipe, fitted with a 4-cm diameter, double-open-ended PVC screw-top was used to test 4 of the 17 subjects. The same size plaster disc (25 x 5 mm) was inserted in these devices, and the opening at the top, through which the scent was able to volatilize, was consistent with that of the smaller devices (26 mm diameter).

Study Sites

Data were collected from 7 different captive facilities: T&D's Cats of the World (Penns Creek, PA), Claws 'N' Paws Wild Animal Park (Hamlin, PA), ZooAmerica (Hershey, PA), The Lehigh Zoo (Schnecksville, PA), The Oglebay Good Children's Zoo (Wheeling, WV), The Ross Park Zoo (Binghamton, NY), and The Wild Center (Tupper Lake, NY).

Subjects

A total of 17 adult otters (8 males, 9 females) served as subjects. Otters were housed in pairs at each of the 7 facilities. The Oglebay Good Children's Zoo housed 2 pairs of otters (a pair of males and a pair of females), and 2 facilities (The Ross Park Zoo and The Wild Center) housed 3 otters each. At The Wild Center, 1 of these individuals was alternatingly paired with each of the other 2 otters. At The Ross Park Zoo, a male and female that were normally housed together were separated temporarily because the female had recently given birth.

At most of the facilities, separating social pairs to observe subjects individually was logistically challenging; moreover, many otters demonstrated strong pair bonds, causing them to become stressed when isolated. Consequently, 15 of the 17 subjects were observed in pairs. All but 2 social pairings observed were opposite-sex pairs. The social rank (dominant or subordinate) of each subject was recorded after this information was obtained from a staff member at each facility. Social rank was found to be independent of sex. Of the 17 subjects, 8 were indicated to be the dominant individual of their social pairing, and 9 were classified as subordinates.

Paired subjects did not appear to influence each other's behavior noticeably, with individuals typically moving about enclosures and responding to lures and controls independently; however, this potentially confounding factor could not be controlled for in most cases. In addition to the 17 subjects, data were collected for the 2-month-old male offspring of an adult female at The Ross Park Zoo; however, these data were omitted from analysis because the juvenile's behavior and response to lures and controls were noticeably influenced by his mother.

Procedure

Subjects or pairs of subjects were observed in 10-minute-long video-taped focal sessions. Prior to each observation, 1 of the 6 attractants and a blank control was situated within the largest, most naturalistic portion of the otters' enclosure. After the lure and control were positioned at equal distances from the subjects' point of entry as well as equal distances apart, the focal animal(s) was allowed to enter and explore the area for 10 minutes.

Each subject or pair was observed for a total of 6 days, 1 day for each of the 6 lures. Lures were introduced to subjects according to a rotating timetable, with each individual or pair following a different lure schedule to ensure that each attractant was presented an equal number of times on each day of the 6-day period in an attempt to control for a potential habituation bias. Lures and controls were placed in alternating positions in each enclosure across the 6-day period.

Following focal sessions, videotaped observations were reviewed and behaviors were recorded as follows. Each time a subject animal moved within 1 meter of a lure or control, an "approach" was indicated, and the start and end times recorded. Additionally, the following response behaviors were noted upon occurrence:

1. **Lure-Seeking Behavior (LSB):** inhale deeply or rapidly while moving toward the lure;
2. **Control-Seeking Behavior (CSB):** inhale deeply or rapidly while moving toward the control;
3. **Rub (RUB):** move back and forth or side to side with a large portion of the body in direct contact with the ground, an object, or some other surface;
4. **Scent-mark (SMK):** urinate, defecate, or rake the ground with claws;
5. **Mouth (MTH):** bite, lick, or otherwise contact the lure/control device with mouth;
6. **Move (MOV):** physically move the lure/control by pushing, pulling, or knocking it over;
7. **Carry (CAR):** physically move the lure/control while holding it in the jaws;
8. **Swim with Lure (SWL):** push or carry a lure device through the water while swimming;
9. **Swim with Control (SWC):** push or carry a control device through the water while swimming.

Analysis

To compare lures and controls and lure types, 4 main parameters were assessed. These included the percentage of total trials for each type of lure during which the lure or control device was approached, the mean swiftness of initial approaches of lures and controls, the mean frequency of approaches, and the duration of approaches. Both "mean duration" (i.e. an average of approaches during a single trial) and total duration (cumulative duration of approaches during a single trial) were averaged across subjects.

Data were analyzed using Stata® statistical software (StataCorp, College Station, Texas 77845). Repeated measures analysis of variance (ANOVA) was used to compare continuous variables (i.e., mean swiftness of initial approach, total duration of approaches, and mean duration of approaches) among lure types. The covariates sex, social rank, and facility size were nested within the model. Tukey HSD pairwise comparison was used to identify relationships among variables where significant effects were observed. Prior to analysis, data corresponding to the variable “mean swiftness of initial approach” were log10 transformed. However, these data did not completely adhere to the expectations of a repeated measures ANOVA even after the transformation. Therefore, non-parametric tests (Friedman’s test and Pearson X^2) were run as univariate categorical assessments; however, as they did not yield differences in significance from ANOVA results, they are not reported. Prior to analysis, frequency data were categorized into 4 groups: 0 approaches, 1 approach, 2 approaches, or 3 or more approaches. Additional Pearson X^2 tests were performed to compare lure type and other covariates (sex, social rank, facility size) for categorical variables (i.e., percentage of trials with at least one approach and frequency of approaches). Finally, 2-sample or paired *t*-tests were used to compare each of the 6 lures with its corresponding control. All statistical analyses were considered significant at an alpha level of 0.05.

RESULTS

Overall, otters demonstrated a stronger response to lures than controls for each of the 4 main parameters assessed. Lures were approached during a greater percentage of trials than controls (Fig. 2) and yielded a higher mean swiftness of initial approach, a higher frequency, and longer total and mean durations of approaches (Fig. 3 – 6). The only lure that differed significantly from its corresponding control for mean swiftness of initial approach was COL ($t = 2.94$, 32 df, $P = 0.003$). Comparisons among lure types revealed that COL performed better than the other 5 attractants among the 4 main parameters assessed. COL and SKE were both approached during the greatest percentage of trials (88.83%; Fig. 7). Moreover, COL demonstrated the fastest mean swiftness of initial approach (Fig. 8), and was approached most frequently (Fig. 9) and longer total and mean durations (Fig. 10 and 11, respectively) than the other 5 lures. A significant effect of lure type was observed for both total and mean duration of approaches (F = 6.01, 5 df, P < 0.000 and F = 3.03, 5 df, P = 0.022, respectively). Tukey HSD pairwise comparisons demonstrated that total and mean durations were significantly higher for COL than for FAS, BVC and SAO.

Further analyses revealed significant effects of sex on total and mean duration of approaches (F = 6.57, 1 df, P = 0.025 and F = 6.21, 1 df, P = 0.028, respectively; Fig. 12 and 13), with males (n = 9) spending longer durations within 1 m of lures than females (n = 8). There were no significant differences between males and females for percentage of trials with at least 1 approach (Fig. 14), mean swiftness of initial approach (Fig. 15), or frequency of approaches (Fig. 16). A significant effect of social rank was observed for total duration of approaches (F = 4.78, 1 df, P = 0.049; Fig. 17), with dominant individuals spending more time within 1 m of lures than subordinates; however, there was no effect of rank for mean duration of approaches (Fig. 18). Dominant and subordinate animals did not differ significantly for percentage of trials with at least 1 approach (Fig. 19), mean swiftness of initial approach (Fig. 20), or frequency of approaches (Fig. 21).

Overall, approaches of lures were preceded by a longer duration of “seeking behavior” than controls (Fig. 22), although this difference was not significant. Among the 6 lures, COL elicited the longest duration of seeking behavior, followed by SFE and SKE. FAS, BVC, and SAO demonstrated relatively short durations of seeking behavior. Only the controls for BVC and SAO were each sought for a longer mean duration than the respective lures themselves (Fig. 23).

Scent-marking only occurred within an “approach distance” (1 m) of a lure or control device a total of 17 times: twice within 1 m of a control, and 15 times within 1 m of a lure. The mean frequency of scent-marking was higher for lures than controls, although the difference was not significant (Fig. 24). Among the different lure types, scent-marking occurred most frequently within 1 m of SKE (Fig. 25). When total occurrences of scent-marking (regardless of distance from lure and control devices) were compared across trials, SKE trials were shown to have the highest frequency (Fig. 26). Moreover, there was a significant effect of sex ($X^2 = 5.82$, 1 df, $P = 0.016$), with males scent-marking significantly more frequently than females across trials (Fig. 27).

Rubbing occurred even less frequently than scent-marking during trials. Nine total instances of rubbing were recorded: 3 within 1 m of a control, and 6 within 1 m of a lure. The mean frequency of rubbing was slightly higher for controls than lures (Fig. 28). Among the different lure types, rubbing occurred most frequently within 1 m of the FAS control. Two instances of rubbing were recorded within 1 m each of SKE, SFE, and SAO (Fig. 29). When total occurrences of rubbing (regardless of distance from lure and control devices) were compared across trials, SFE, SKE, and COL trials shared the highest frequency at 4 times (Fig. 30).

Instances of moving, mouthing, carrying, and swimming with the lure or control devices were combined into “playing” for analysis. Most often, instances of playing began with moving or mouthing the lure or control device, proceeded to carrying it, and ended with swimming with the device. Playing occurred 10 times with control devices and 6 times with lures. The mean frequency of playing was higher for controls than lures, although this difference was not significant (Fig. 31). Among the 6 lures, the mean frequency of playing was highest for COL, and among the controls, it was highest for SAO (Fig. 32). COL and SAO were the only 2 lures with which the subjects played during trials (COL = 5 times, SAO = 1 time). Otters played with the controls of each lure except SKE and COL.

DISCUSSION

Results demonstrated that lures, when combined, outperformed controls for each of the 4 main parameters assessed, as was hypothesized. Lures were approached during a greater percentage of trials than controls and were approached, on average, more swiftly, more frequently, and for longer mean and total duration than controls. Moreover, lures elicited a longer mean duration of seeking behavior than controls, suggesting that approaches of lures were more often deliberate, preceded by remote detection of the odor and directed movements toward it, rather than haphazardly encountered. Nevertheless, none of the overall differences between lures and controls were significant, suggesting that the scents evaluated in this study were not sufficiently more attractive to captive river otters than unscented control devices.

According to the 4 main parameters assessed, otters demonstrated a stronger response to COL than the other 5 lures, negating the hypothesis that FAS would elicit the strongest response. COL tied with SKE for the greatest number of trials with at least 1 approach and was approached, on average, more swiftly, more frequently, and for longer durations than the other lures. Furthermore, COL was approached significantly more swiftly than its corresponding control. For 2 variables (total and mean duration of approaches), COL yielded significantly longer response times than 3 of the other lure types (FAS, BVC, and SAO). Finally, COL elicited the longest mean duration of seeking behavior, suggesting that remote detection of that scent often motivated subjects to actively search for the lure device.

Only the controls for BVC and SAO were sought for longer mean durations than the respective lures themselves. Interestingly, these 2 lures showed, overall, the weakest response according to the 4 main parameters assessed. This suggests that during trials with preferred scents (i.e., COL, SFE, and SKE), subjects devoted more attention to the lure devices, whereas during trials with less favorable scents (i.e., FAS, SAO, and BVC), otters were more occupied with the control devices.

Scent-marking and rubbing were more likely to occur within 1 m of lures than controls. Although these differences were not significant and total numbers of occurrences were low, this suggests that lure odors prompted otters to deposit their own scent nearby, either in the form of urine, spraints, or use of pedal scent glands. There were no significant differences in scent-marking or rubbing across lure types, either within 1 m of lure and control devices or when all instances of these behaviors were counted during each trial.

Otters demonstrated a higher proportion of play behavior towards controls than lure devices. Play behavior is commonly observed in captive otters (Mattive 2010, T&D’s Cats of the World, personal communication; Rosevear 2010, The Lehigh Zoo, personal communication) and has been documented in wild otters (Stevens and Serfass

2005) and may explain why responses to controls were higher for relatively unattractive scents, such as SAO and BVC. The fact that otters seemed to perceive control devices to be more favorable “toys” than lure devices may have confounded the dataset for controls and might partially account for the fact that lures and controls did not differ significantly across the 4 main parameters assessed. Play behavior was only directed at 2 of the 6 lures: SAO and COL. Five out of 6 total occurrences of playing with lures involved COL, revealing that COL not only received more attention from subjects, but was also played with more commonly than any other lure. In addition to attracting more attention than the other lures or controls, COL did not deter otters from playing with the PVC device.

Male and female otters did not respond differently to lures or controls according to any of the 4 main parameters assessed except duration (mean and total duration), with males spending significantly longer periods of time within 1 m of lures than females. The sexes also differed in the frequency of scent-marking across trials, with males marking significantly more often than females. As this analysis incorporated all instances of scent-marking, regardless of distance from lure devices, the nature of this behavior seems to be independent of the presence of odors. Dominant and subordinate animals differed in their response behavior toward lures only for total duration of approaches, with dominant animals spending significantly longer periods of time within 1 m of lures than subordinates.

Further analysis of captive otters could evaluate additional scents, especially other lures specially formulated and manufactured to attract wild otters, such as Caven’s Otter Lure. SAO was the only “food odor” assessed in this study, but this scent was relatively weak and may not have been a preferred food odor for otters. Therefore, several other types of fish oils, shellfish oils, and extracts, particularly more pungent scents, might elicit a stronger response in captive otters. It may also be worthwhile to evaluate otters' responses to the scents of conspecifics by presenting them with urine and/or spraint odors of familiar and unfamiliar individuals.

Field analyses of the scent(s) that elicited the best response among captive otters (such as COL) would ascertain whether olfactory lures constitute a useful method of attracting wild otters to remote tracking devices. If odors increase the efficacy of remote cameras, track plates, and traps, use of such lures could enhance researchers' ability to monitor wild otters, thus allowing biologists and wildlife management officials to gain more accurate data about existing and reestablished otter populations and gauge the success of otter translocations.

LITERATURE CITED

Gorman, M. L., and B. J. Trowbridge. 1989. The role of odor in the social lives of carnivores. Pages 57-88 *in* J. L. Gittleman, Editor. Carnivore behavior, ecology, and evolution. Cornell University Press, Ithaca, NY, USA.

Fuller, T. K., E. C. York, S. M. Powell, T. A. Decker, and R. M. DeGraaf. 2001. An \ \evaluation of territory mapping to estimate fisher density. Canadian Journal of Zoology 79:1691-1696.

Harrison, R. L. 2006. A comparison of survey methods for detecting bobcats. Wildlife Society Bulletin 34:548-552.

Hein, E. W. 1997. Improving translocation programs. Conservation Biology 11:1270-1271.

Kimball, B. A., J. J. Johnston, J. R. Mason, and F. S. Blom. 2000. Development of chemical coyote attractants for wildlife management applications. Proceedings of the 19th Vertebrate Pest Conference, San Diego, CA, 304-309.

Kruuk, H. 2006. Otters: Ecology, Behaviour and Conservation. Oxford University Press Inc., New York, New York, USA.

McDaniel, G. W., K. S. McKelvey, J. R. Squires, and L. F. Ruggiero. 2000. Efficacy of lures and hairs to detect lynx. Wildlife Society Bulletin 28:119-123.

Melquist, W. E., and A. E. Dronkert. 1987. River otter. Pages 626-641 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, Editors. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, Ontario, Canada.

Miller, B., K. Ralls, R. P. Reading, J. M. Scott, and J. Estes. 1998. Biological and technical considerations of carnivore translocation: a review. Animal Conservation 2:59-68.

Mowat, G., C. Kyle, and D. Paetkau. 2001. Testing methods for detecting wolverine. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report 71, Edmonton, Canada.

Phillips, R. L., S. Blom, and R. E. Engeman. 1990. Responses of coyotes to chemical attractants. Proceedings of the 14th Vertebrate Pest Conference, Sacremento, California, USA.

Robson, M. S., and S. R. Humphrey. 1985. Inefficacy of scent-stations for monitoring river otter populations. Wildlife Society Bulletin 13:558-561.

Rostain, R. R., M. Ben-David, P. Groves, and J. A. Randall. 2004. Why do river otters scent-mark? An experimental test of several hypotheses. Animal Behaviour 68:703-711.

Roughton, R. D. 1982. A synthetic alternative to fermented egg as a canid attractant. Journal of Wildlife Management 46:230-234.

Roughton, R. D. and M. W. Sweeny. 1982. Refinements in scent-station methodology for assessing trends in carnivore populations. Journal of Wildlife Management 46:217-229.

Schlexer, F. V. 2008. Attracting animals to detection devices. Pages 263-292 *in* R. A. Long, P. MacKay, W. J. Zielinski, and J. C. Ray, Editors. Noninvasive Survey Methods for Carnivores. Island Press, Washington, D. C.

Semlitsch, R. D. 2002. Critical elements for biologically based recovery plans of aquatic-breeding amphibians. Conservation Biology 16(3):619-629.

Stevens, S. S. and T. L. Serfass. 2005. Sliding behavior in nearctic river otters: locomotion or play? *Northeastern Naturalist* 12(2):241-244.

Turkowski, F. J., M. L. Popelka, and R. W. Bullard. 1983. Efficacy of odor lures and baits for coyotes. Wildlife Society Bulletin 11:136-145.

Weir, R. D. 2003. Status of the fisher in British Columbia. Ministry of Sustainable Resource Management, Conservation Data Centre, and Ministry of Water, Land and Air Protection, Biodiversity Branch. Wildlife Bulletin Number B-105. Victoria, British Columbia, Canada.

FIGURES

Figure 1. Example of lure deployment device introduced to 7 otter enclosures to assess the responses of 17 otters to 6 different scents from April – July 2010.

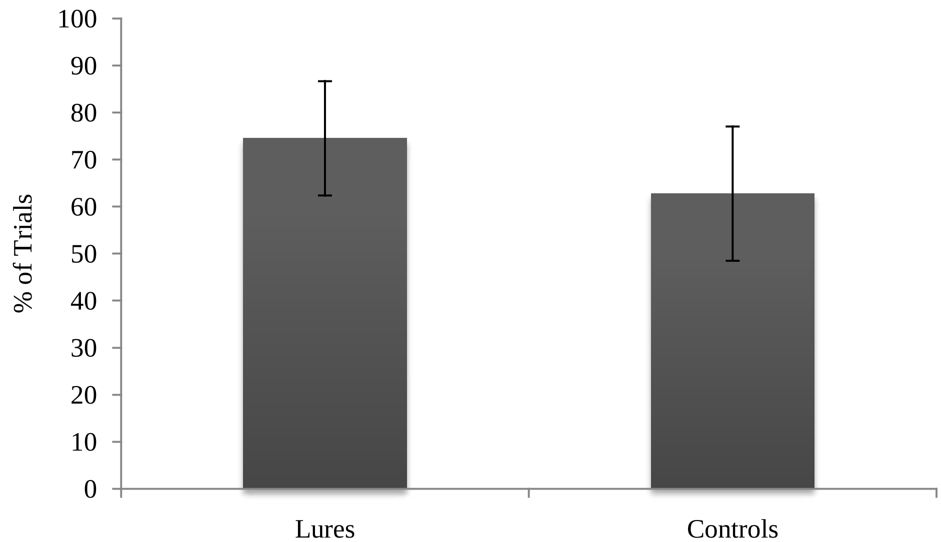

Figure 2. Mean percentage of trials with approach(es) for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

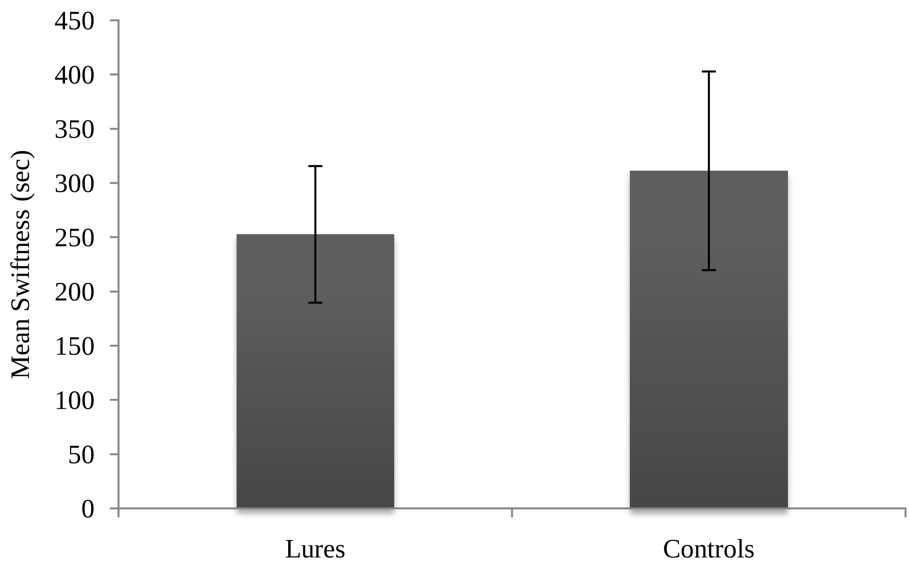

Figure 3. Mean swiftness of initial approach for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

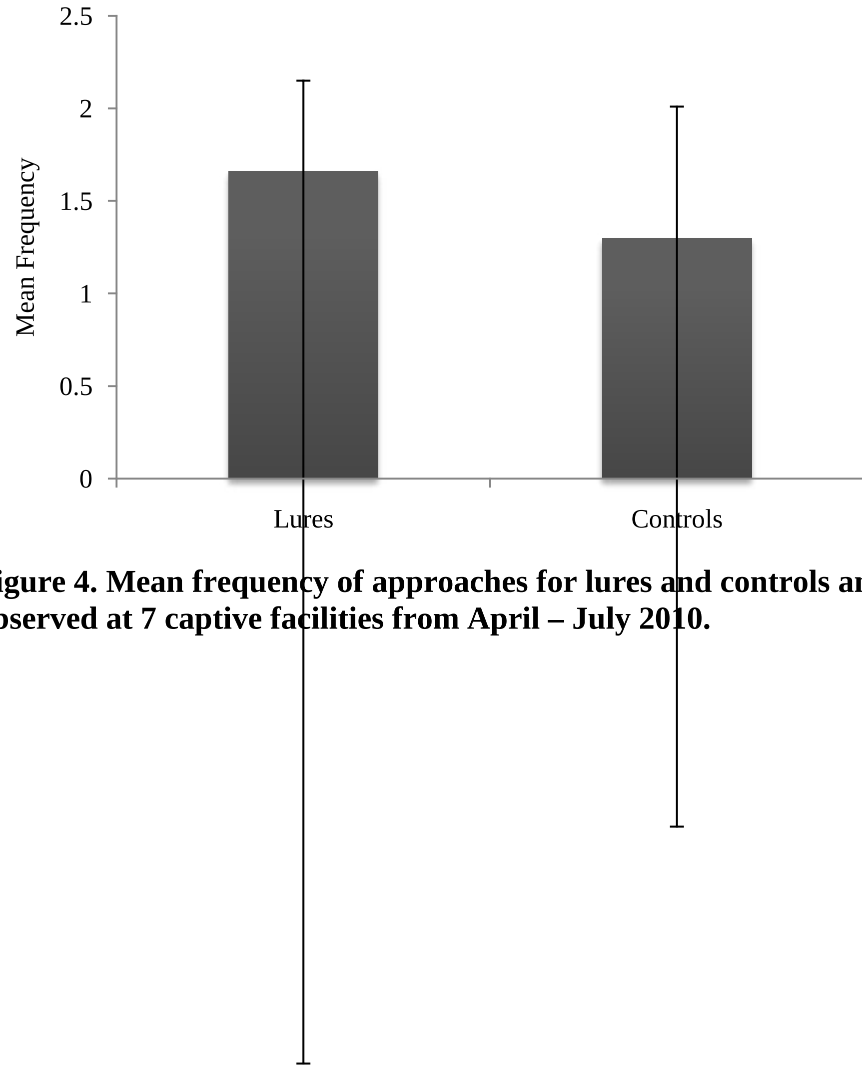

Figure 4. Mean frequency of approaches for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

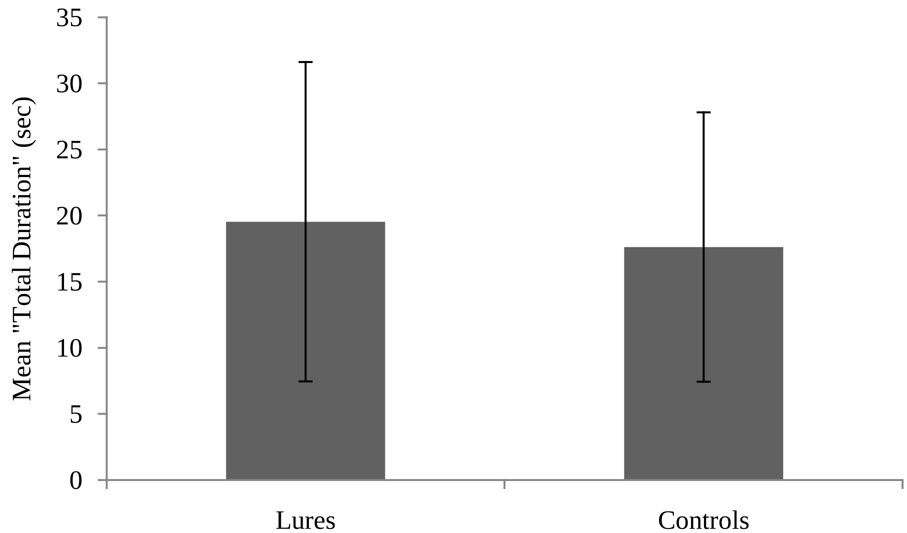

Figure 5. Mean "total duration" of approaches for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

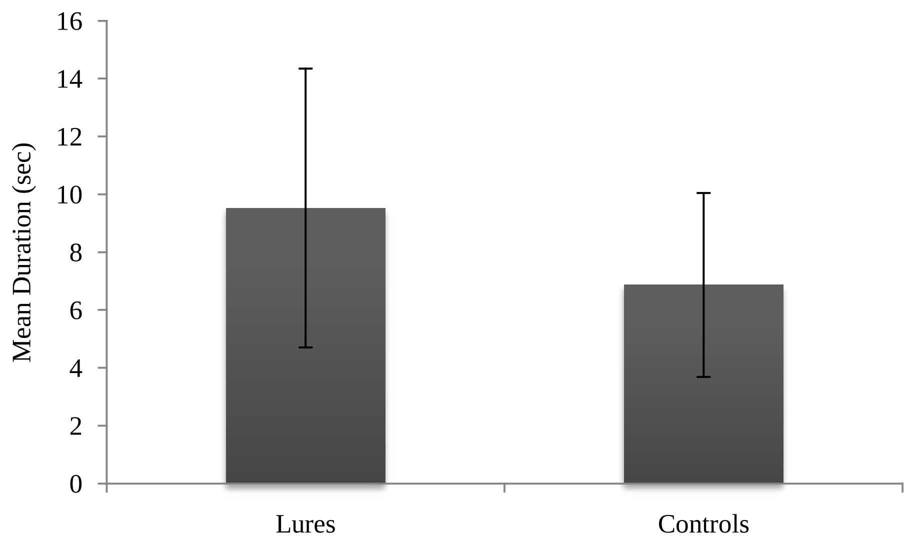

Figure 6. Mean duration of approaches for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

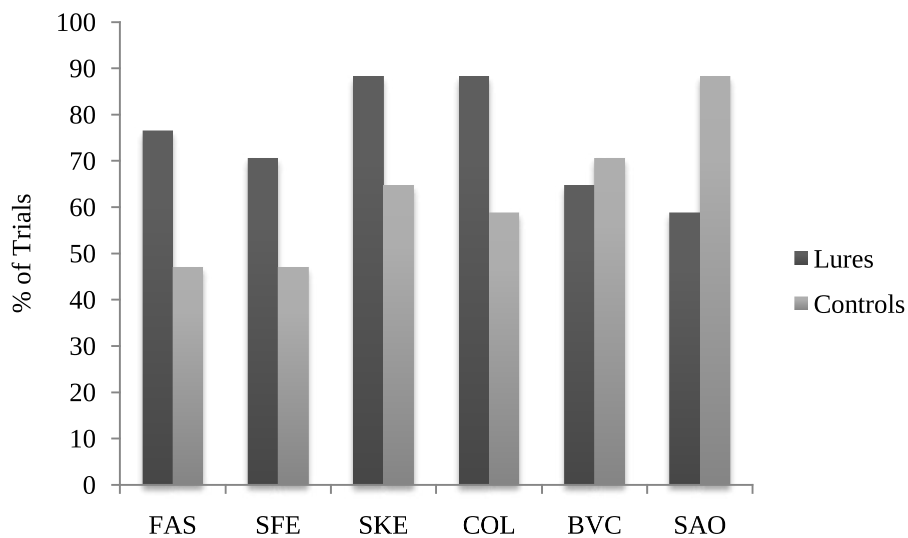

Figure 7. Percentage of trials with approach(es) among lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

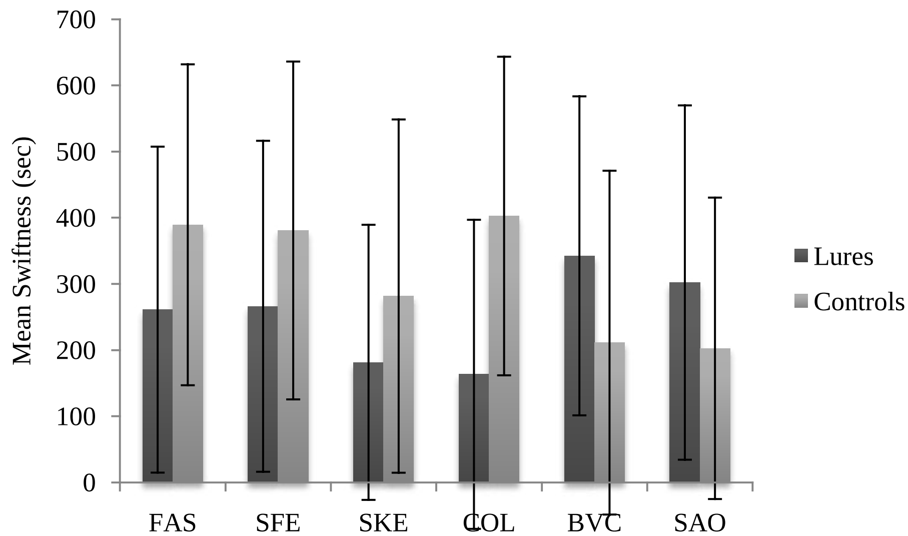

Figure 8. Mean swiftness of initial approach among lures and controls among 17 otters observed at 7 captive facilities from April – July 2010. Statistical significance detected between COL and its corresponding control (*t* = 2.94, 32 df, *P* = 0.003).

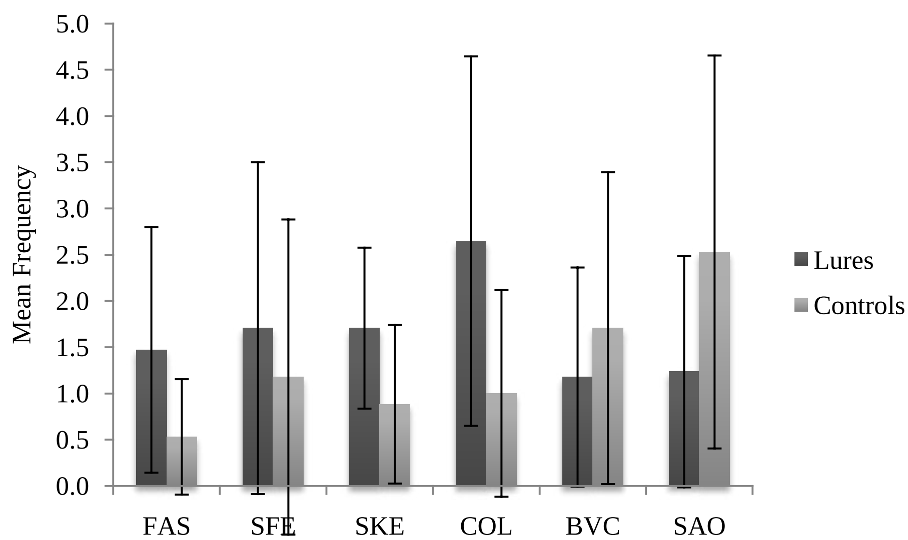

Figure 9. Mean frequency of approaches among lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

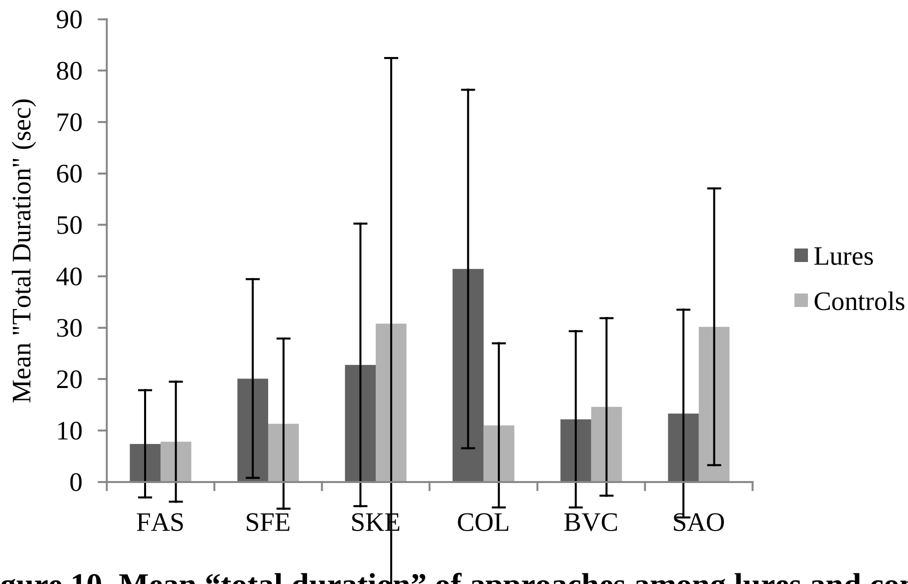

Figure 10. Mean "total duration" of approaches among lures and controls among 17 otters observed at 7 captive facilities from April – July 2010. Statistical significance detected (*F* = 6.01, 5 df, *P* < 0.001).

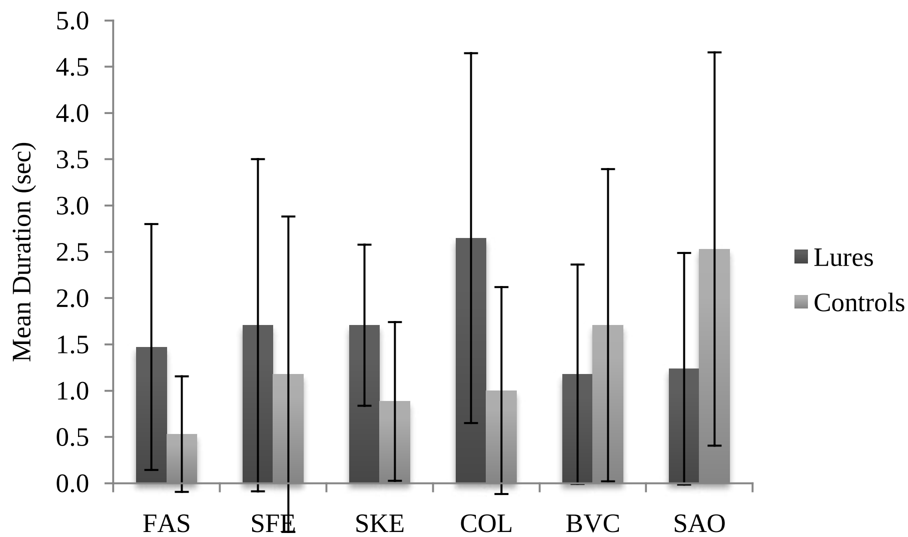

Figure 11.Mean duration of approaches among lures and controls among 17 otters observed at 7 captive facilities from April – July 2010. Statistical significance detected (*F* = 3.03, 5 df, *P* = 0.022).

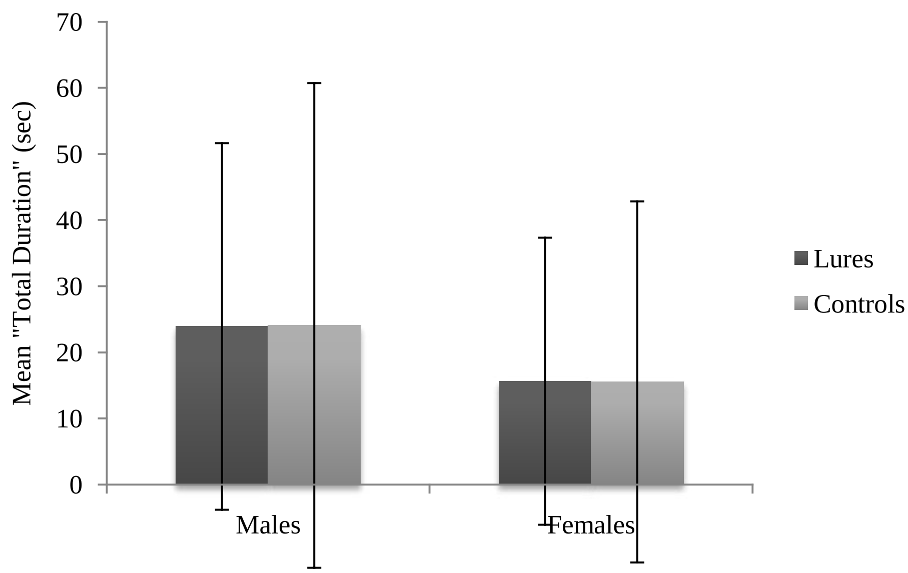

Figure 12. Mean “total duration” of approach(es) by sex for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010. Statistical significance detected at α = .05 (*F* = 6.57, 1 df, *P* = 0.025).

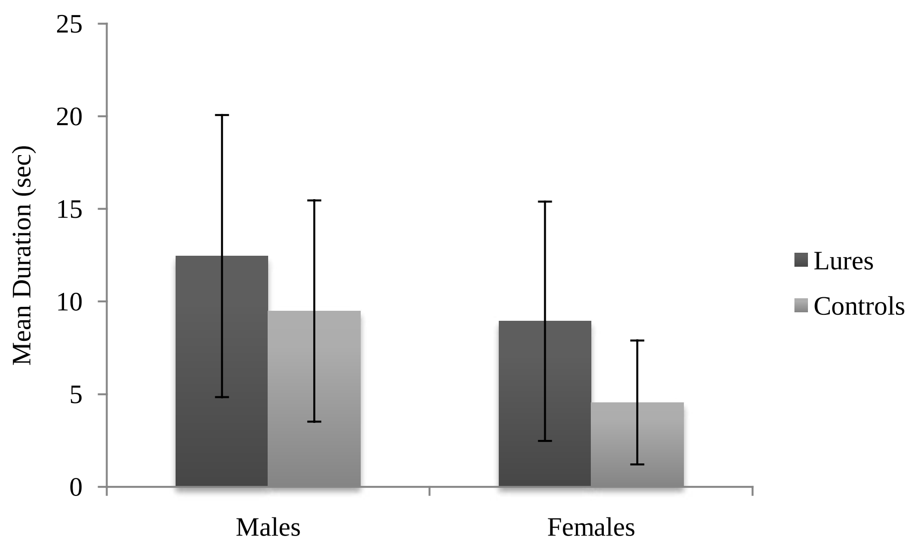

Figure 13. Mean duration of approach(es) by sex for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010. Statistical significance detected at α = .05 (*F* = 6.21, 1 df, *P* = 0.028).

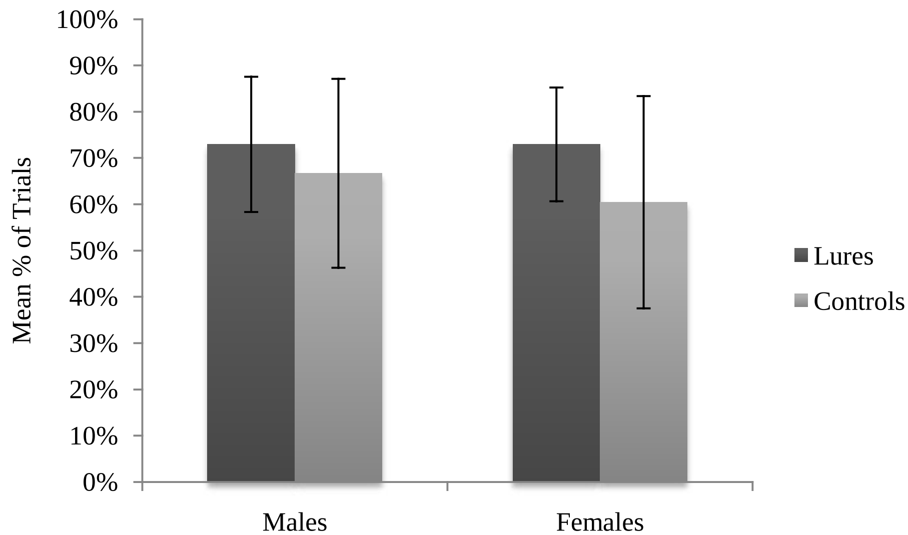

Figure 14. Mean percentage of trials with approach(es) by sex for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

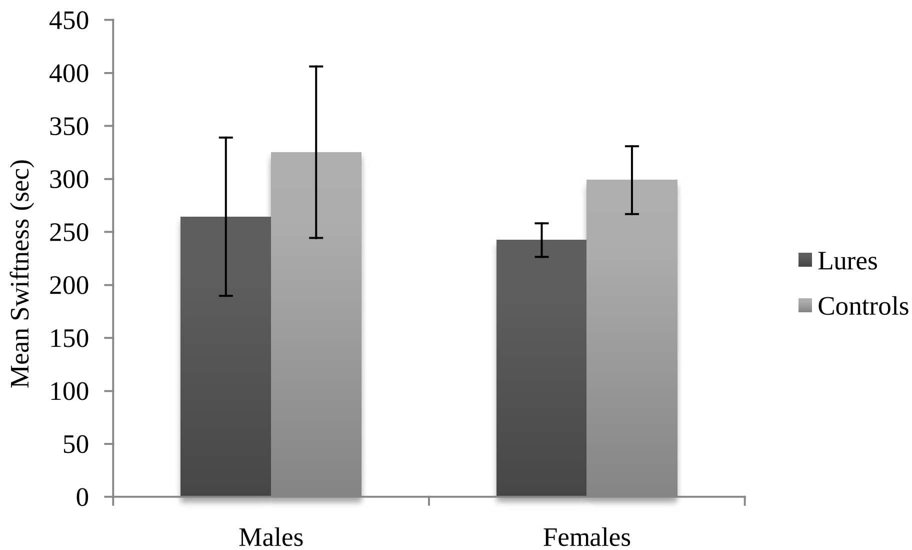

Figure 15. Mean swiftness of initial approach by sex for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

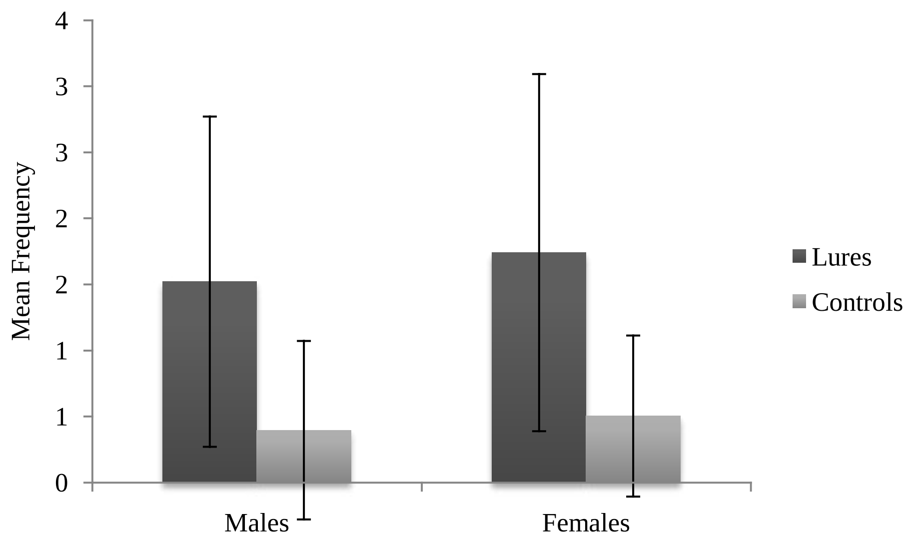

Figure 16. Mean frequency of approach(es) by sex for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

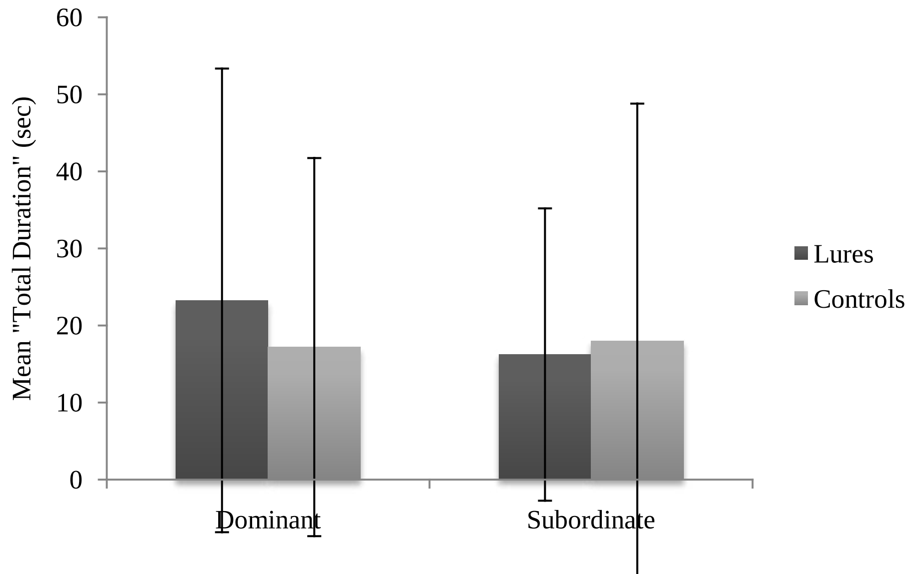

Figure 17. Mean "total duration" of approach(es) by social rank for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010. Statistical significance detected at (*F* = 4.78, 1 df, *P* = 0.049).

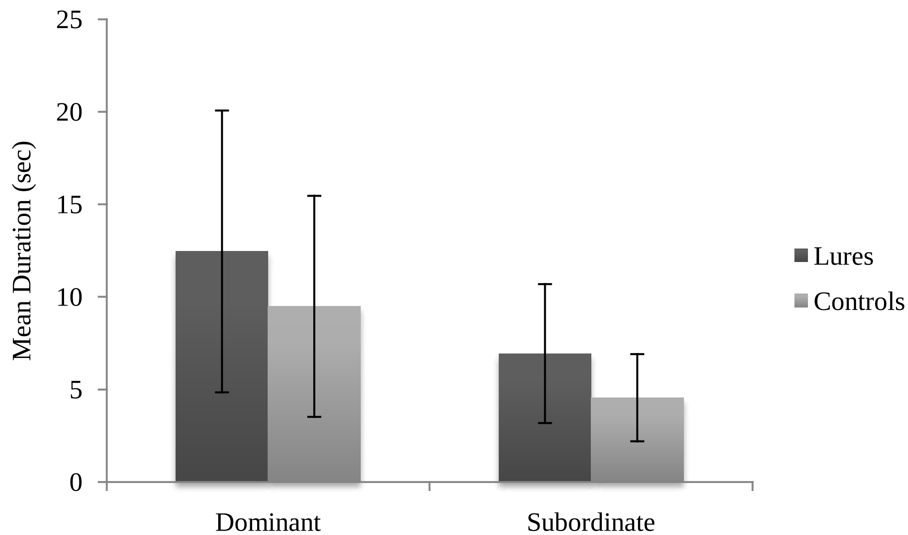

Figure 18. Mean duration of approach(es) by social rank for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

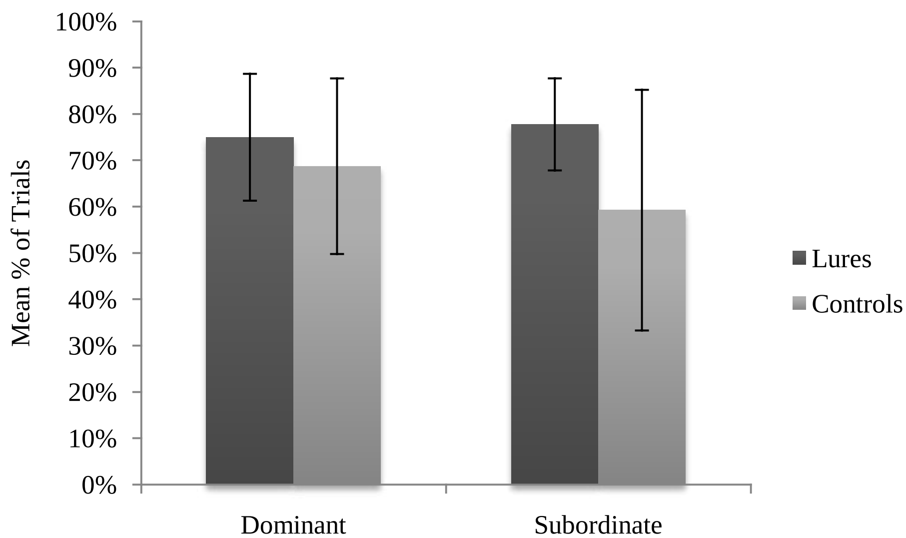

Figure 19. Mean percentage of trials with approach(es) by social rank for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

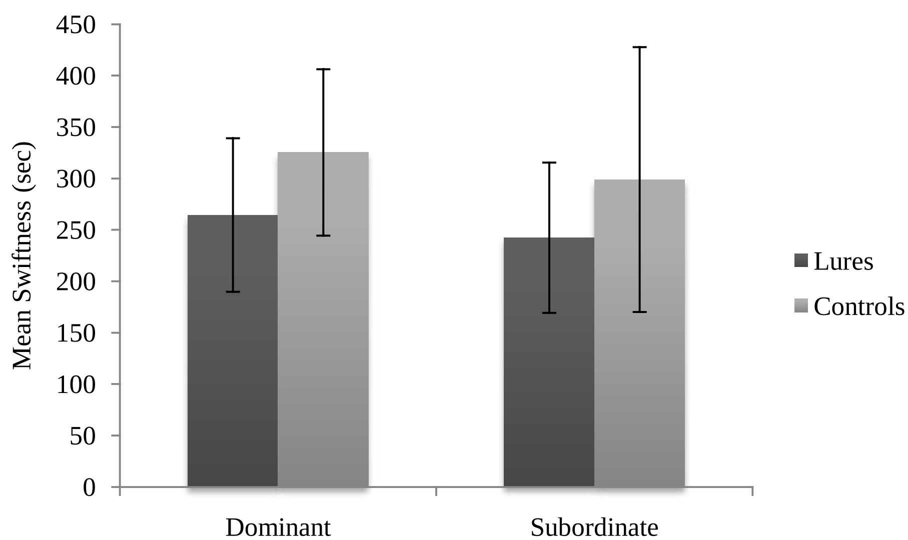

Figure 20. Mean swiftness of initial approach by social rank for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

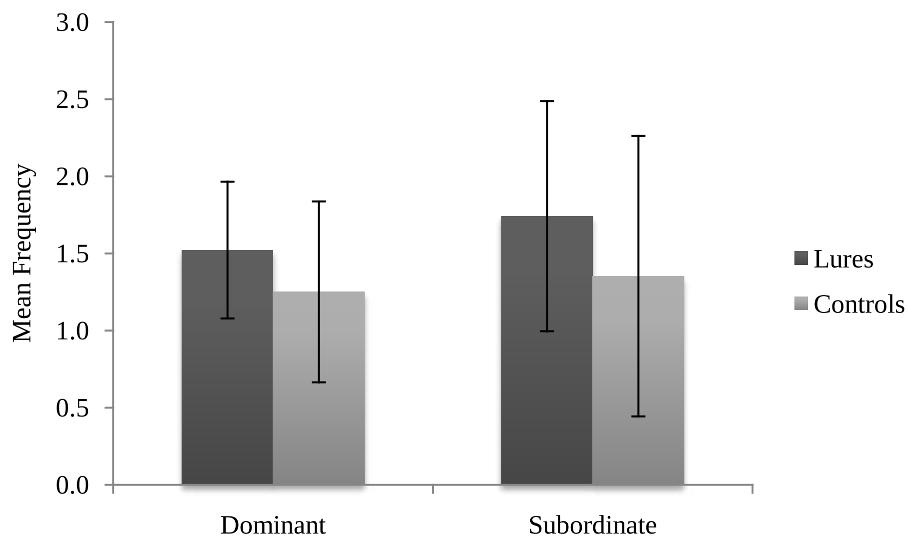

Figure 21. Mean frequency of approaches by social rank for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

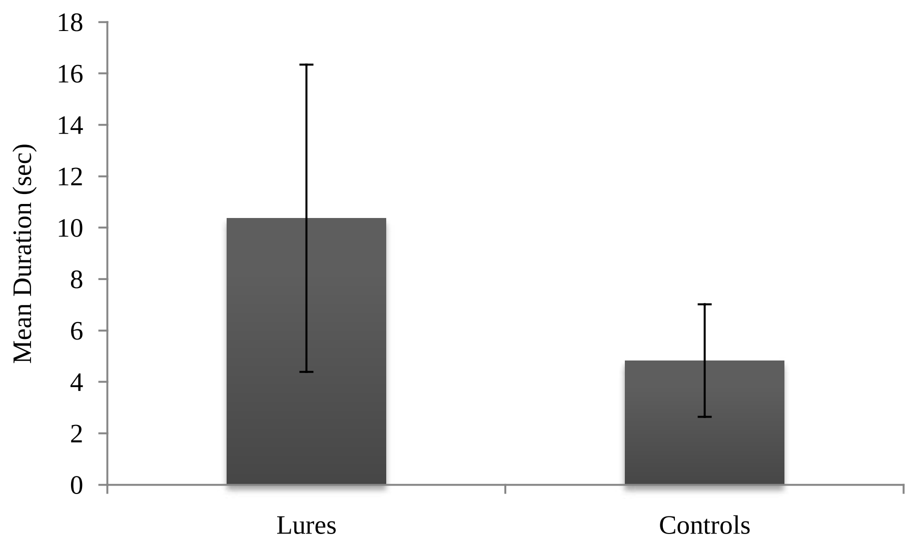

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Figure 22. Mean duration of seeking behavior for lures and control among 17 otters observed at 7 captive facilities from April – July 2010.

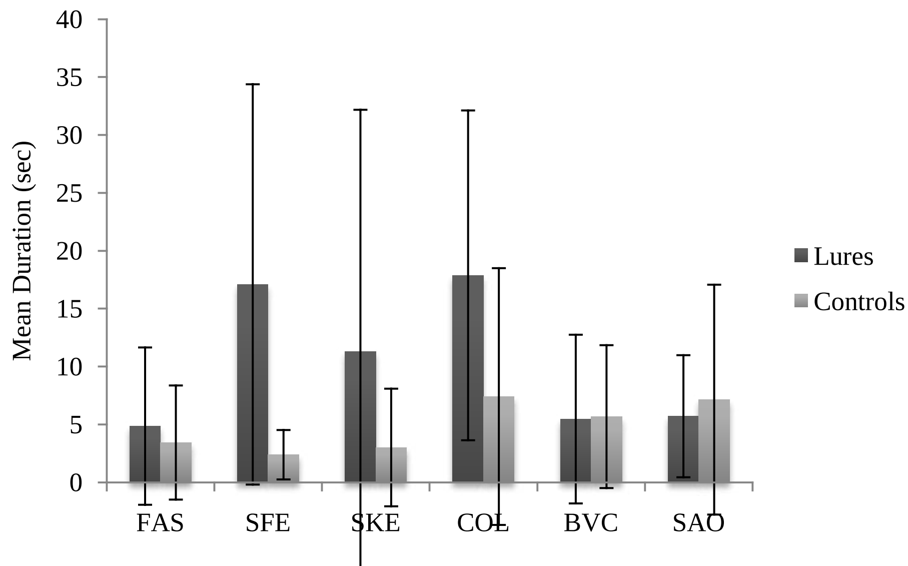

Figure 23. Mean duration of seeking behavior among lures and control among 17 otters observed at 7 captive facilities from April – July 2010.

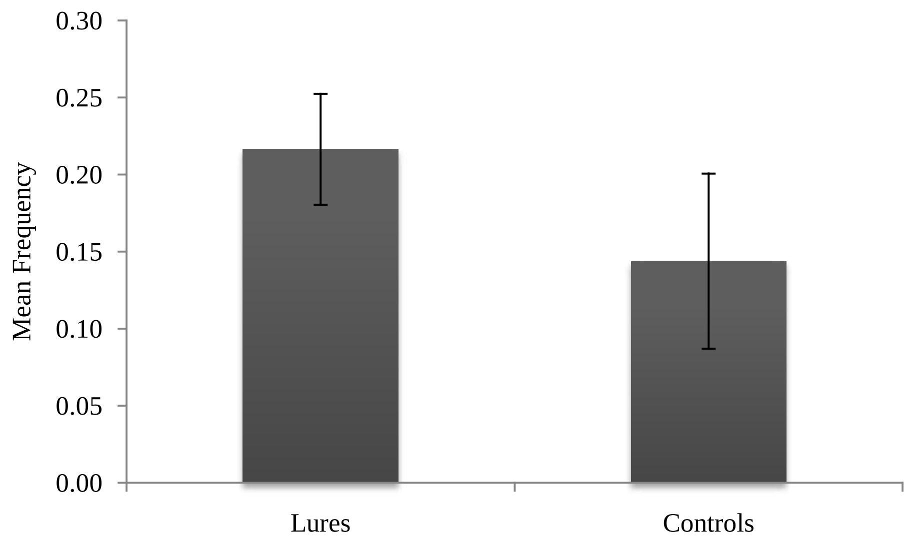

Figure 24. Mean frequency of scent-marking within 1 m of lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

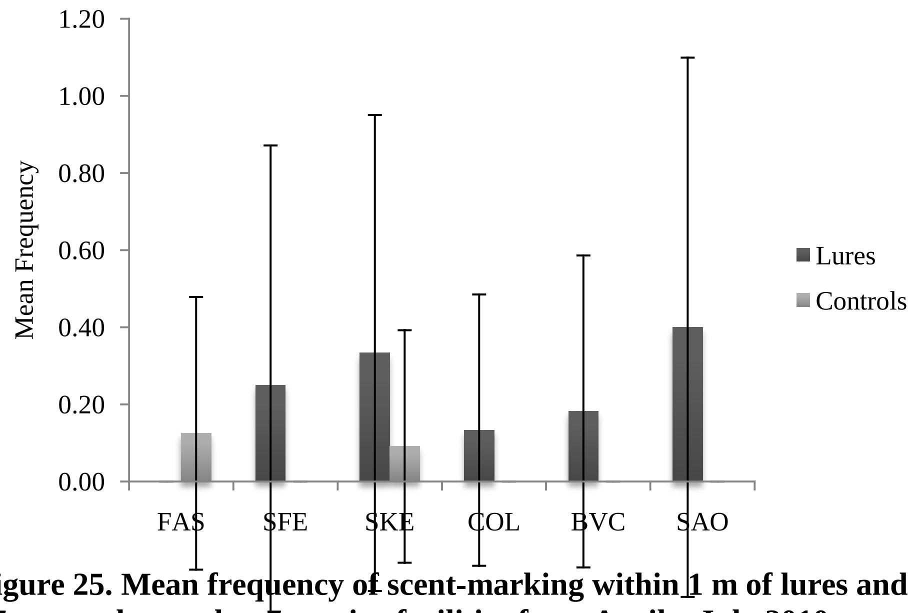

Figure 25. Mean frequency of scent-marking within 1 m of lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

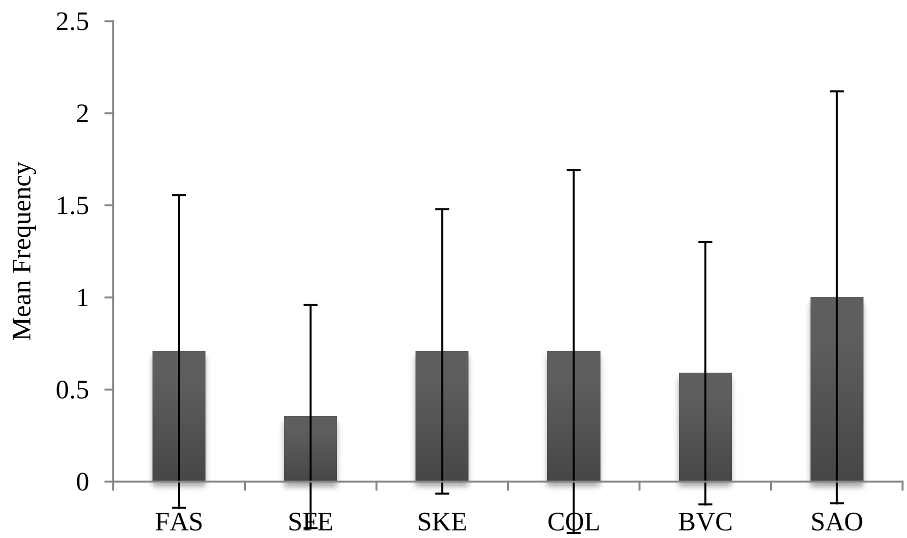

Figure 26. Mean frequency of scent-marking during trials for each type of lure among 17 otters observed at 7 captive facilities from April – July 2010.

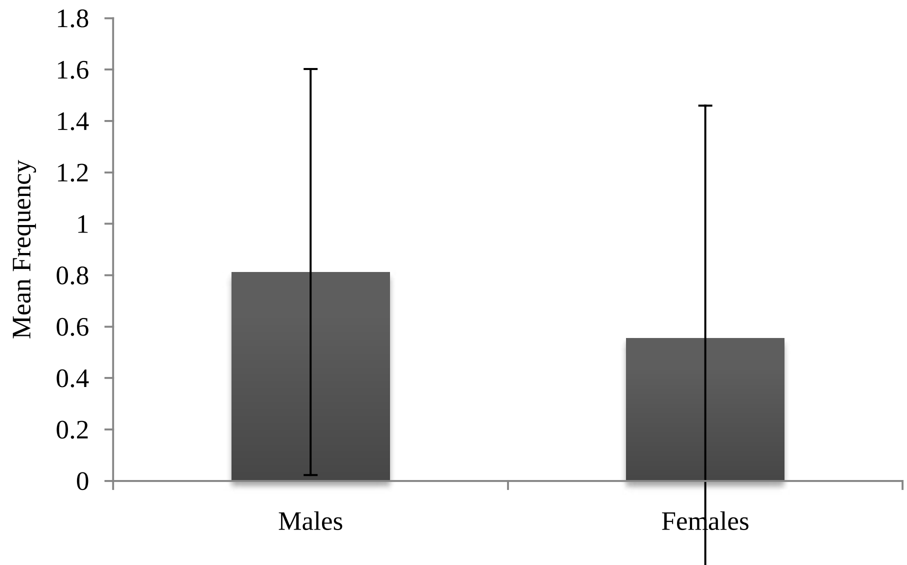

Figure 27. Mean frequency of scent-marking by sex for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010. Significance detected (X^2 = 5.82, 1 df, P = 0.016).

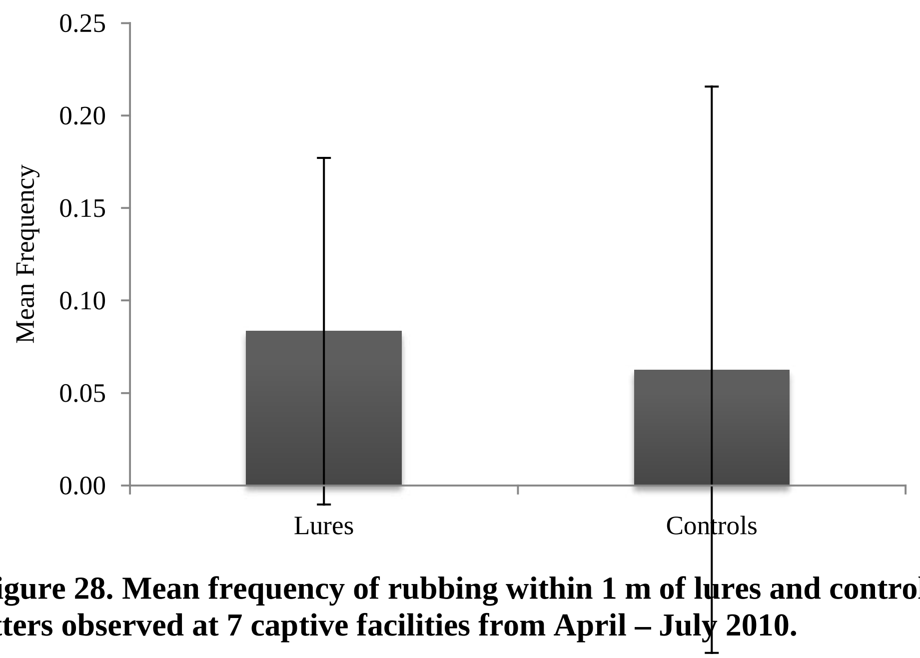

Figure 28. Mean frequency of rubbing within 1 m of lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

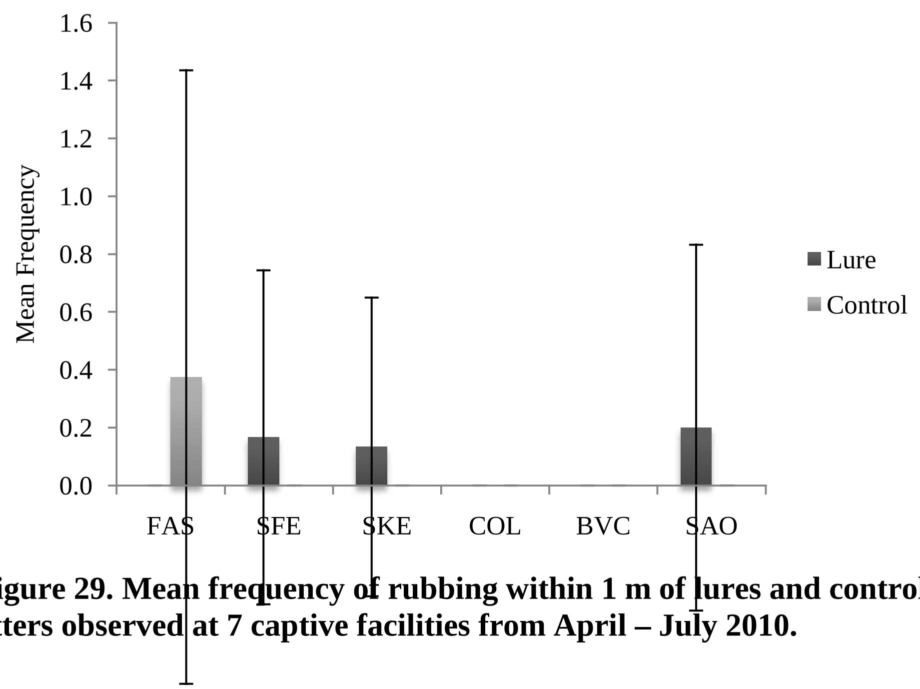

Figure 29. Mean frequency of rubbing within 1 m of lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

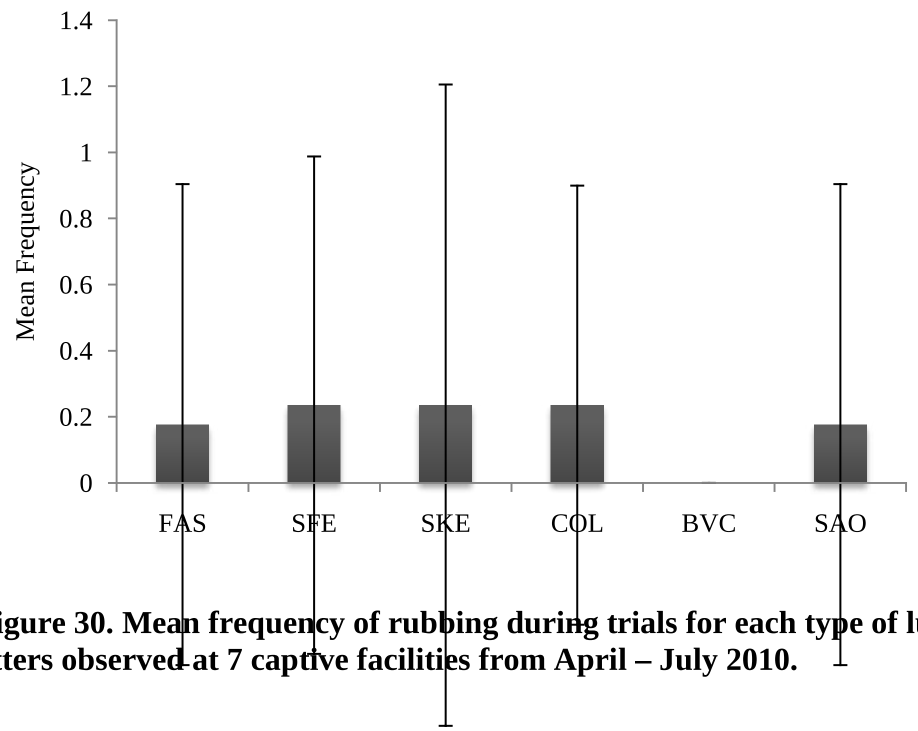

Figure 30. Mean frequency of rubbing during trials for each type of lure among 17 otters observed at 7 captive facilities from April – July 2010.

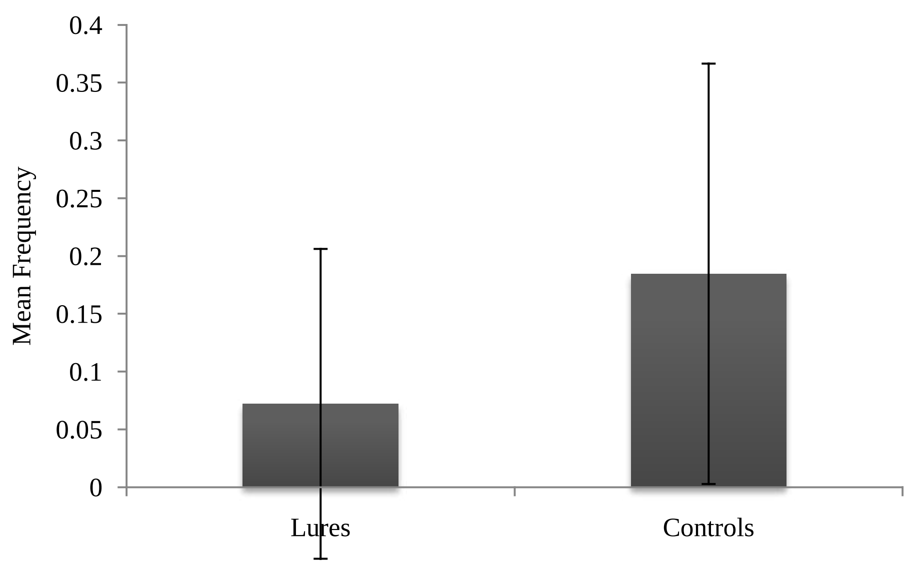

Figure 31. Mean frequency of playing for lures and controls among 17 otters observed at 7 captive facilities from April – July 2010.

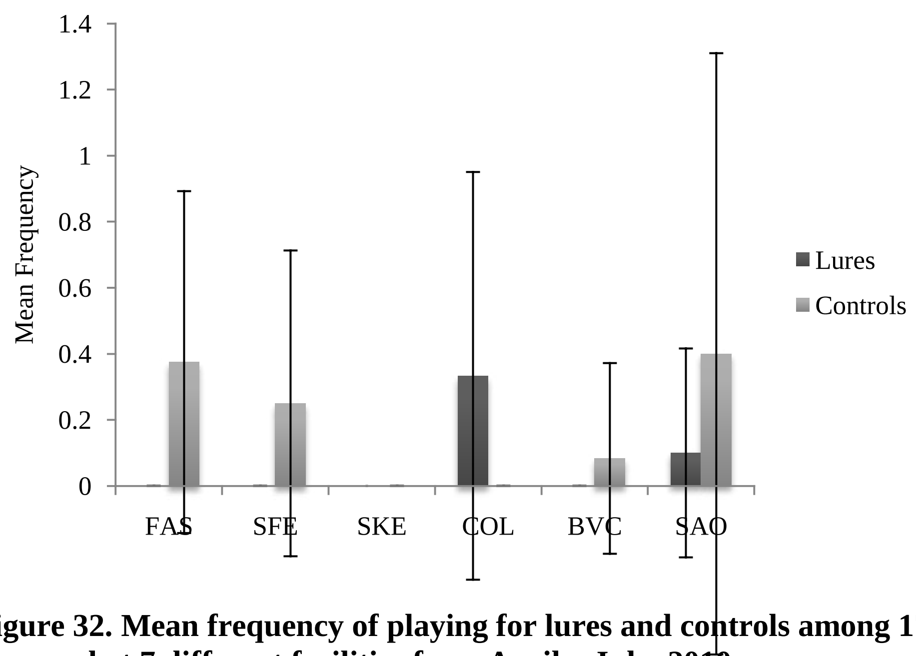

Figure 32. Mean frequency of playing for lures and controls among 17 otters observed at 7 different facilities from April – July, 2010.

CHAPTER II. Evidence of Long-term Survival and Reproductive Capacity in a Female River Otter (*Lontra canadensis*) Equipped with an Intraperitoneal Transmitter

ABSTRACT

Intraperitoneal implantation of radio transmitters is an effective method of monitoring free-ranging aquatic and semi-aquatic mammals. However, few studies have investigated the long-term consequences of such implants on survival or reproductive performance. An adult female river otter (TC-1-99a) equipped with an intraperitoneal transmitter and released in north-central Pennsylvania in June 1990 as part of a statewide reintroduction project was killed in March 1999. TC-1-99a was estimated to be 10 years old and was pregnant with two fetuses at the time of her death. This case study presents novel evidence of long-term survival and reproductive performance in a wild river otter equipped with an intraperitoneal transmitter.

INTRODUCTION

Radio telemetry is one of the most common methods of monitoring translocated animals following re-release into an area. Several different types of radio devices may be used, depending on such factors as cost, invasiveness, and species morphology and behavior. Intraperitoneal transmitters are considered particularly practical biotelemetry devices (Smith and Whitney 1977; Melquist and Hornocker 1979; Reid et al. 1986; Horning et al. 2008), because unlike radio collars and harnesses, they are appropriate for the lifestyle and body shape of various species, including aquatic and semi-aquatic mammals (Garshelis and Siniff 1983; Reid et al. 1986; Rado and Terkel 1989; Van Vuren 1989). However, several complications can potentially result from surgery and implantation of such transmitters, including infection, incision dehiscence, and blockage of internal organs. Moreover, biologists are often concerned about the potential effects of intraperitoneal transmitters on long-term survival, growth, and reproduction (Van Vuren 1989).

Over the past four decades, several studies have investigated the effects of intraperitoneal transmitters on the survival and reproduction of translocated wildlife (Horning et al. 2008). Ralls et al. (1989) discovered no complications associated with intraperitoneal implantation in adult sea otters (*Enhydra lutris)* and documented normal reproductive performance in females. Similarly, Horning et al. (2008) concluded that intraperitoneal transmitters are viable radio-tracking devices after observing low morbidity and zero mortality in captive observations and post-release tracking of California sea lions (*Zalophus californianus)* and Stellar sea lions *(Eumetopias jubatus).*

Reid et al. (1986) assessed the reproductive performance of seven adult female North American river otters (*Lontra canadensis*) equipped with intraperitoneal transmitters. Four of the otters were operated on to implant transmitters during the delayed implantation stage of gestation (autumn); three during the fetal development stage of gestation (spring), and one during lactation (late spring). Six of the otters pregnant at the time of transmitter implantation progressed successfully through parturition, and two females gave birth again in the following season. No adverse effects of the implants were documented at any stage of the reproductive cycle.

Despite the scarcity of evidence that intraperitoneal transmitters may be harmful, long-term data are not available for most studies of transmitter-equipped wild mammals. As a result of the relatively short battery life of traditional internal radio transmitters, researchers cannot generally monitor survival or reproductive performance for periods greater than three years (Horning et al. 2008).

Of the 153 river otters translocated to PA from 1982 to 2003 as part of PRORP, several individuals were equipped with intraperitoneal transmitters prior to release (Serfass et al. 1993, 1996, 2003). TC-1-99a was one of 4 otters implanted with an intraperitoneal transmitter and translocated to Tionesta Creek in northwestern PA. TC-1-99a was fitted with a transmitter and released on the Tionesta Creek (41°36’57”N 79°09’02”W) in June, 1990. In March of 1999, TC-1-99a was accidentally killed approximately 3 km from her release site, near Kellettville, PA (41°32’44”N 79°15’22”W) by a beaver trapper using a #330 Conibear® trap (Oneida Victor®, LLC., Cleveland, OH).

METHODS

TC-1-99a was captured and purchased in New York from a trapper licensed to buy and sell otters in June of 1990. She was then held at The Pennsylvania State University for 14 days to facilitate medical evaluations and surgery to implant the transmitter. Prior to surgery, she was weighed at 5.4 kg. On 6/22, TC-1-99a was sedated using an intramuscular injection of approximately 22 mg/kg ketamine hydrochloride (Serfass et al. 1993). The transmitter (IMP/200/L®, Telonics, Mesa, Arizona 85204) was implanted into her peritoneal cavity through a 4-cm lateral skin incision. A lateral approach was chosen over the more common ventral approach because of the species’ habit of dragging the ventral surface along the ground (Serfass et al. 1993).

Following TC-1-99a’s death, her carcass was retrieved from the trapper, who voluntarily contacted the Pennsylvania Game Commission, and a post-mortem physical examination was conducted at Frostburg State University. The examination included extracting teeth for age determination, inspecting the digestive tract for food content, checking for ear tags and evaluating the overall physical condition (weight, condition of teeth, etc.).

RESULTS

During the post-mortem physical examination, TC-1-99a was weighed at 5.2 kg. Her ear tags were no longer present, so her transmitter was sent back to Telonics in order to identify her via transmitter frequency. Both her upper and lower canines were worn to the incisor level. Cementum aging of extracted teeth estimated TC-1-99a to be 10 years old (+/- 1 year) at her time of death (Matson's Laboratory, LLC, 8140 Flagler Road, PO Box 308, Milltown, MT 59851). The radio transmitter was still intact within her intraperitoneal cavity, and there were no signs of post-surgical complications associated with the implant.

Further examination revealed that TC-1-99a was pregnant with two offspring, a male and a female, at the time of her death. After being preserved in ethanol, the female fetus weighed 61.2 g, and the male weighed 61.9 g. The female was 15 cm (total body length), with a head length of 3 cm, a body length of 7 cm and a tail length of 5 cm. The male cub was 17 cm (total body length), with a head length of 3 cm, a body length of 9 cm and a tail length of 5 cm. Inspection of the digestive tract revealed a poorly masticated prey content of 7 smallmouth bass (*Micropterus dolomieui*), measuring 6-7 cm in length, and approximately 20 darters (*Etheostoma spp*.), ranging from 3.2-5 cm in length.

Radio-telemetry data taken from 6/29/90 to 3/5/91 demonstrated that TC-1-99a remained within 7 km upstream and 30 km downstream of her release site.

DISCUSSION

The radio-telemetry, age, and reproductive records for TC-1-99a represent the first long-term data on a wild river otter equipped with an intraperitoneal transmitter. The maximum life expectancy of river otters in the wild is reported as 10-13 years (Reed-Smith 2008), with the oldest trapped wild otter estimated to be 14 (Kruuk 2006). At 10 years old, TC-1-99a was near the maximum reported life span of a wild otter. Her canines were severely worn, and the absence of large fish and aquatic invertebrates in her stomach during post-mortem analysis may have been related to the deteriorated condition of her teeth. Otherwise, TC-1-99a appeared to be in good health at her time of death and showed no indication of past or present complications associated with her implant.

Despite her age, TC-1-99a was still reproductively active. The two offspring she was carrying at the time of her death appear to have been healthy and developing normally. Each of the cubs weighed approximately 47% of the mean birth weight for male and female river otters. Total body lengths for the female and male were approximately 55% and 62%, respectively, that of neonatal otters (27.5 cm; Hamilton and Eadie 1981). Embryonic development models are not available for accurate age estimation of prenatal river otters (Chadwick and Sherrard-Smith 2010); however, as the body structures are recognizable and characteristic of the species, the cubs can be placed within the fetal stage of development.

TC-1-99a’s mature age and pregnancy demonstrate that her implant introduced no detriment to her longevity or reproductive performance. This case provides both novel and supplementary evidence that intraperitoneal transmitters do not disrupt the life history characteristics of wild river otters, lending more support to their usefulness as biotelemetry devices.

LITERATURE CITED

Garshelis, D. L. and D. B. Siniff. 1983. Evaluation of radio-transmitter attachments for sea otters. Wildlife Society Bulletin 11:378-383.

Hamilton J. R. and W. R. Eadie. 1964. Reproduction in the otter, *Lutra canadensis*. Journal of Mammalogy 45:242-252.

Horning**,** M., M. Haulena**,** P. A. Tuomi, and J. E. Mellish. 2007. Intraperitoneal implantation of life-long telemetry transmitters in otariids. Wildlife Research 34:1-6

Kruuk, H. 2006. Otters: Ecology, Behaviour and Conservation. Oxford University Press Inc. New York, New York, USA.

Melquist, W. E., and M. G. Hornocker. 1979. Development and use of a telemetry technique for studying river otter. Proceedings of the International Conference for Wildlife Biotelemetry 2:104-114.

Rado, R., and J. Terkel. 1989. A radio-tracking system for subterranean rodents. Journal of Wildlife Management 53(4):946-949.

Ralls, K. D., B. Siniff, T. D. Williams, and V. B. Kuechle. 1989. An Intraperitoneal radio transmitter for sea otters. Marine Mammal Science 5:376-381.

Reid, D. G., W. E. Melquist, J. D. Woolington, and J. M. Noll. 1986. Reproductive effects of intraperitoneal transmitter implants in river otters. Journal of Wildlife Management 50(1):92-94

Serfass, T. L., R. L. Peper, M. T. Whary, and R. P. Brooks. 1993. River otter reintroduction in Pennsylvania: pre-release care and clinical evaluation. Journal of Zoo and Wildlife Medicine 24:28-40

Serfass, T. L., R. P. Brooks, L. M. Rymon, and O. E. Rhodes. 1998. River otters in Pennsylvania, USA: lessons for predator reintroduction. Unpublished manuscript.

Smith, H. R., and G. D. Whitney. 1977. Intraperitoneal transmitter implants—their biological feasibility for studying small mammals. Proceedings of the International Conference for Wildlife Biotelemetry 1:109-117.

Van Vuren, D. 1989. Effects of intraperitoneal transmitter implants on yellow-bellied marmots. The Journal of Wildlife Management 53(2): 320-323

CHAPTER III. Pennsylvania anglers' attitudes toward river otters (*Lontra canadensis*) demonstrates a local understanding between sportsmen and predators

ABSTRACT

Like other otter species, including the sea otter (*Enhydra lutris*), the giant otter (*Pteronura brasiliensis*) and the Eurasian otter (*Lutra lutra*), the North American river otter (*Lontra canadensis*) is a popular, charismatic species. River otters have been described as physically and behaviorally appealing and are popular among visitors at zoos and aquaria. However, the species has also been a source of complaints from fish hatchery and private pond owners and is sometimes considered a "nuisance" predator. Although diet studies have revealed that river otters tend to feed primarily on slow-moving non-game fish, the species has been historically blamed for local declines in game fish populations. Some biologists and wildlife management officials therefore assume that fishermen, in particular, may be opposed to otter reintroductions. However, this assumption lacks supporting evidence and may be misguided. The Pennsylvania River Otter Reintroduction Project (PRORP) was initiated in 1982 to restore extirpated otter populations in north central and western Pennsylvania, and by 1990, had released 110 otters at 6 reintroduction sites. Despite efforts to develop and implement a public education program that accurately and positively depicted the role of otters in aquatic ecosystems and reviewed important aspects of otter feeding ecology, there was concern that sports fishermen would consider otters harmful to game fish populations at reintroduction sites and be generally opposed to PRORP efforts. However, a survey of 412 trout fishermen at 3 reintroduction sites conducted during 1990-1991 demonstrated that attitudes were extremely favorable towards otters and supportive of the

reintroduction program. About 85% of surveyed anglers were not concerned that otters would harm game fish populations and over 88% were pleased that the project was implemented. Support and interest for PRORP and otter management at reintroduction sites was high and generally consistent among demographic and socioeconomic classes among fishermen. These results not only undermine the perception by certain wildlife managers in some areas that fishermen harbor negative attitudes toward river otters, but expose the importance of considering social factors when designing, implementing, and evaluating wildlife translocation projects.

INTRODUCTION

Public perception and attitudes toward species can play major roles in arguments both for and against translocations (Andersone and Ozolins 2004), and directly influence policy and financial support for conservation projects (Dietz et al. 1994, Linnell et al. 2000). Because of perceived threats to humans, livestock, or other resources, translocations of predators can be especially controversial among local people (Gusset et al. 2007, Nilsen et al. 2007). Efforts to restore gray wolves (*Canis lupus*) to Yellowstone National Park and implement a recovery plan for grizzly bears (*Ursus arctos* horribilis) were both delayed because of opposition from some interest groups (primarily ranchers) (Bath and Buchanan 1989, Bangs et al. 1998, MacCracken and O'Laughlin 1998). Similarly, translocation of fishers (*Martes pennanti*) to West Virginia was halted prematurely after the animals were depicted as dangerous in local newspapers (Pack and Cromer 1981).

Until the 1800s, river otters (*Lontra canadensis*) inhabited all major water systems in Pennsylvania (Rhoads 1903). Unregulated trapping, destruction and development of riparian habitat, and pollution of waterways caused severe species declines through the early twentieth century (Tesky 1993, Kruuk 2006). By 1952, when the Pennsylvania Game Commission (PGC) provided complete legal protection for otters, the state's population was limited to the Pocono Mountains region of northeastern Pennsylvania (Eveland 1978). The Pennsylvania River Otter Reintroduction Project (PRORP) began reintroducing river otters across the state in 1982 (Serfass 1994).

Historically, river otter translocations to various states have received mixed reviews in the local media (Martin 2005, Spencer 2005, Crawford 2007, Hamilton 2007). In general, the species seems to have 2 predominant reputations in the USA. Among some audiences, river otters are viewed as playful, charismatic mammals (Stevens and Serfass 2005). A number of surveys conducted in the USA have demonstrated that both adults and children prefer animals which they consider physically attractive (Dietz et al. 1994). Like the giant otter (*Pteronura brasiliensis*), the sea otter (*Enhydra lutris*), and the Eurasian otter (*Lutra lutra*), all of which have served as conservation flagships, river otters have been described as physically and behaviorally appealing in the literature (Stevens et al. 2007) and are popular among visitors at zoos and aquaria (D. Gross, The Wild Center, E. Kramer, The Binghamton Zoo at Ross Park, J. Mattive, T&D's Cats of the World, and R. Rosevear, 2010, personal communication). In 1996, the Pennsylvania Wild Resource Conservation Program conducted an online poll to decide which endangered or threatened state animal would succeed the highly popular saw-whet owl (*Aegolius acadicus*) to be displayed on specialty license plates. The river otter prototype garnered more votes than the bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon

(*Falco peregrinus*), and by 2000, had raised $300,000 in license plate sales (PA DCNR 2000).

Despite their popularity among much of the public, river otters have also developed a more infamous reputation as nuisance predators. Although diet studies have revealed that river otters tend to feed primarily on slow-moving non-game species (Sheldon and Toll 1964, Knudson and Hale 1968, Savage and Klingel 2003, Serfass et al. 1990), the opportunistic predator has been historically blamed for local declines in game fish populations (Knudson and Hale 1968, Tesky 1993). As a result, sports fishermen are in some instances opposed to otter reintroduction programs (Kruuk 2006). Not long after the successful reintroduction of river otters to Missouri in the 1980s, the state government received hundreds of complaints about otters' negative impact on game fish populations in ponds and streams across the state (Hamilton 2004, as cited in Kruuk 2006). The reestablished predators were quickly accused of preying on smallmouth (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*), goggle eye (*Pomoxis annularis*), and catfish (Order Siluiformes). Anglers at headwater Ozark streams blamed otters for a lack of "keeper-sized" game fish, and landowners claimed that otters were decimating fish populations in commercial hatcheries and private ponds, occasionally leaving dead fish on the banks to rot (Hamilton 1999). Hamilton (1999) quotes one Missouri angler, who opined, "There's not enough room for otters and fishermen in the Ozarks." Following the reintroduction of river otters to Ohio from 1986 - 1993, numerous complaints about the species led to the initiation of a trapping season in 1995 (Martin 2005, Ohio Department of Natural Resources). Similarly, otter reintroductions to Kentucky and Illinois in 1991 and 1995, respectively, were followed by complaints to the

State Fish and Wildlife Departments and resulted in the implementation of trapping seasons in 2004 and 2008 (Crawford 2005, Lampe 2008).

Overall, the Pennsylvania River Otter Reintroduction Project garnered widespread public support and interest. Nevertheless, during public education programs conducted during development of PRORP, some local anglers initially expressed concern that otters would harm game fish populations, especially trout. As a result, some natural resource professionals in the state felt that the project was strongly opposed by fishermen. To address these perceptions, anglers' attitudes toward otters were evaluated at Kettle Creek, Pine Creek, and Tionesta Creek, where the species had been reintroduced in 1982, 1983-1984, and 1990-1994, respectively.

The objectives of this study were to:

1. Develop a character profile of surveyed anglers based on demography, residence, occupation, education, and attitudes toward hunting and trapping;
2. Evaluate anglers' knowledge about aspects of otters and otter management in Pennsylvania and PRORP;
3. Evaluate anglers' attitudes toward river otters and PRORP.

METHODS

From May through June, 1991, 412 trout fishermen were interviewed along Kettle Creek (n = 149), Pine Creek (n = 150), and Tionesta Creek (n = 113). All participants were in the process of fishing when interviewed about PRORP. Prior to being interviewed, anglers were given a brief overview of the interview process and assured that responses would remain anonymous (names of participants were not taken). Interviewers emphasized that there were no correct or incorrect responses and the purpose of the interview was to gain insight about the public's attitudes and familiarity about river otters and PRORP. No additional information about PRORP was provided until completion of the interview.

All interviews followed the same protocol. Participants were asked to respond to a set of questions or statements from a questionnaire. All questions and statements were presented in a closed format except for race, age (later categorized), and occupation. The initial portion of the questionnaire was designed to develop a character profile of the anglers based on demography, residence, occupation, education, and attitudes toward hunting and trapping. Subsequent sections of the questionnaire focused on evaluating an angler's knowledge about aspects of otters and otter management in Pennsylvania and his/her attitude towards otters and PRORP (Appendix II).

Assessment of attitudes was based primarily on anglers' responses to a set of 10 statements using a 5-point Likert-style response format. This format requires an affirmative ("strongly agree" or "agree", Likert score = 1 or 2, respectively), an opposing ("disagree" or "strongly disagree", Likert score = 4 or 5, respectively) or a "no opinion" (Likert score = 3) response to a particular statement (Appendix II). Chi-square analyses ($\alpha = 0.05$) evaluated the relationship between certain independent variables (demography, education, etc.) and responses to Likert-scale statements.

RESULTS

Characteristics of Anglers

Males represented 90% of the total surveyed population. All participants were Caucasian except for 1 American Indian, and the mean age was 44 years (SD = 15.88). The majority of respondents grew up in a town (population <50,000) (73%) and currently lived in a town (76%). Most anglers were not educated beyond a high school degree

(60%) and were employed at blue-collar jobs (68%) (Table 1). A high proportion of participants were hunters (71%), but most had never participated in trapping (84%) and few (4%) identified themselves as frequent trappers. Only 3% of surveyed anglers identified themselves as antihunters, but a larger proportion (16%) were opposed to trapping (Table 2).

Participant Knowledge

Most participants (61%) were not aware of the river otter reintroduction to the site at which they were surveyed until they were informed so during the interview. Likewise, a majority of respondents did not know that a native river otter population survived in the Poconos Mountains region of northeastern PA (71%). Most surveyed anglers did not believe that river otters are harmful to game fish populations (71%), nor that the species feeds primarily on game fish (97%) (Table 3).

Interest and support for PRORP

Interest in river otters and support for the reintroduction project were extremely high. A large percentage of respondents had an interest in viewing otters (91%, Figure 1) or otter sign (85%, Figure 7). Most surveyed anglers (81%) were glad that the Pennsylvania Game Commission was supporting an otter reintroduction project (Figure 5), and most (88%) hoped reintroduced otters would survive and their populations would expand (Figure 8). Support and interest for PRORP generally was high and consistent among demographic and socioeconomic categories. Nonetheless, distributions of Likert responses differed among levels of some independent variables (Table 4). For example, responses to 7 Likert statements, including, “I’m glad the PA Game Commission is supporting a river otter reintroduction project,” differed significantly by survey location

(X^2 = 25.85, 8 df, P = 0.001). Responses to 6 of the Likert statements differed significantly by age category, and responses to 3 statements differed significantly by each of youth residence (size of the town/city in which the respondent grew up) and education. Anglers who identified themselves as frequent or occasional hunters were significantly more likely to enjoy seeing river otter sign (slides, tracks, etc.) in the wild than non-hunters (X^2 = 22.99, 12 df, P = 0.028). Men were significantly more likely to support a regulated trapping season than women (X^2 = 13.37, 4 df, P = 0.01), and respondents who sometimes or frequently hunted or trapped were significantly more likely than those that rarely or never hunted or trapped to find trapping an otter to be a challenging and rewarding experience (X^2 = 22.12, 12 df, P = 0.027 and X^2 = 52.66, 12 df, P < 0.000, respectively), and were also more likely than non-hunters and non-trappers to support a regulated trapping season (X^2 = 30.92, 12 df, P = 0.002 and X^2 = 24.23, 12 df, P = 0.019, respectively).

Most respondents (91%) indicated that they would enjoy seeing a river otter in the wild (Fig. 1), and were glad for the reintroduction at the site at which they were surveyed (81%; Fig. 2). Sixty-three percent of anglers indicated that they were willing to support trapping restrictions on other furbearers to ensure survival of otters at the reintroduction sites (Fig. 3), 64% believed otters are beneficial to local waterways (Fig. 4), and 86% were glad that the Pennsylvania Game Commission was supporting a river otter reintroduction project (Fig. 5). Few respondents (6%) were concerned that otters would harm game fish populations (Fig. 6). A majority of surveyed anglers (85%) indicated that they would like to find river otter sign (e.g. slides, tracks, etc.) in the wild (Fig. 7), and most (88%) hoped that river otters would survive at reintroduced locations and expand their local ranges (Fig. 8). Only a small proportion of respondents (19%) would find trapping a river otter to be challenging and rewarding experience (Fig. 9). However, most anglers (72%) indicated that they would support establishment of a regulated season if otters established viable populations at reintroduction sites (Fig. 10).

DISCUSSION

Wildlife managers must consider human-social issues as well as biological issues in designing, implementing, and managing wildlife reintroduction projects. Negative attitudes toward predators can be exacerbated in the local media and complicate predator reintroduction projects. Over the years, several news stories with such titles as “Some river otters have gone wild, state agency warns” (Crawford 2005), “Ozark Otter Disaster” (Hamilton 2006), and “River otter overrunning Ohio” (Spencer 2005) have appeared in states where the river otter was reintroduced. Many of these articles, which promote controlled trapping seasons for the species, attempt to vilify otters in their claims. For instance, an article from the St. Louis Post-Dispatch stated, “[Otters] are reproducing rapidly and cleaning out game fish in lakes, streams and ponds. The end of stocking and a trapping season have failed to curb a potential aquaculture disaster (Renken 2000).” Casting any predator in enemy light, especially for the purpose of promoting hidden agendas like trapping seasons, intensifies human-wildlife conflicts and endangers their conservation (Hampshire et al. 2004). Gray wolves, which control many prey populations, were demonized for decades both in Europe and the USA. As a result of unregulated hunting and trapping, they were nearly eradicated from the lower 48 states in the early nineteenth century, and their protected status continues to be threatened in the USA (Mech 1970).

PRORP's public education program was designed to eliminate misconceptions regarding river otters and accurately depict the diet habits and role of the species in local ecosystems. During implementation, approval of PRORP by local residents, especially those attending public meetings, was high, which would appear to reflect the effectiveness of the public education program. However, most surveyed anglers (61%) were not aware of the otter reintroduction project, suggesting that high levels of acceptance and support related to a general interest and concern for otters rather than endorsement of PRORP.

Although a few surveyed individuals were strongly opposed to PRORP and concerned that otters would harm game fish populations, the majority supported the project and hoped that otter populations would expand in Pennsylvania. Anglers' general approval of the river otter reintroduction in Pennsylvania provides useful insight for basing otter management decisions at reintroduction sites. Furthermore, it highlights the importance of systematically assessing public opinion. Prior to this survey, many PA wildlife management officials had fallen under the assumption that anglers were generally opposed to PRORP (Serfass 2010, personal communication), but thorough social analysis revealed this assumption to be misguided.

Both support for and opposition to wildlife translocations can drastically influence their overall success, indirectly impacting species populations and the health and balance of entire ecosystems. Additionally, failure to incorporate public input into wildlife management decisions may instigate public criticism and political backlash (Hewitt 2001). An argument has been raised that the rise in citizen ballot initiatives since the early 20th century reflects the failure of management agencies to correctly address public concerns (Beck 1998). To ensure community support and approval, critically gauging local attitudes and involving citizens and stakeholders in decision-making should represent vital components of any conservation or management strategy.

Formal assessments of anglers' attitudes toward river otters have not been carried out in any of the states in which complaints were received about reintroduced river otters, including Missouri, Ohio, Kentucky, and Illinois. As a result, evaluation of the success or failure of these translocations and the depiction of human-otter conflict in the local media may have been based largely on assumptions. Additionally, the fact that trapping seasons were initiated after complaints and concerns began to appear in local news stories suggests the influence of hidden trapping agendas behind media portrayal. While trapping seasons represent a practical method of controlling predator populations, they should be based on scientific data rather than efforts to appeal to certain groups. In-depth social analyses such as this one should expose potential political agendas and allow biologists and wildlife managers to interpret the status of river otter conservation efforts more comprehensively and respond with the most appropriate management strategies.

LITERATURE CITED

Andersone, Z. and J. Ozolins. 2004. Public perception of large carnivores in Latvia. Ursus 15(2): 181-187.

Beck, T. D. I. 1998. Citizen ballot initiatives: A failure of the wildlife management profession. Human Dimensions of Wildlife 3(2):21-28.

Bath, A. J., and T. Buchanan. 1989. Attitudes of interest groups in Wyoming toward wolf restoration in Yellowstone National Park. Wildlife Society Bulletin 17:519-525.

Crawford, B. 2007. Some river otters have gone wild, state agency warns. The Courier-Journal (Louiseville, KY).

Dietz, J. M., L. A. Dietz, and E. Y. Nagagata. 1994. The effective use of flagship species for conservation of biodiversity: the example of tamarins in Brazil. Pages 32-47 *in* Creative Conservation: Interactive management of wild and captive animals. P. J. S. Olney, G. M. Mace, and A. C. T. Feistner, Editors. Chapman and Hall, London.

Bangs, E. E., S. H. Fritts, J. A. Fontaine, D. W. Smith, K. M. Murphy, C. M. Mack, and C. C. Niemeyer. Status of gray wolf restoration in Montana, Idaho, and Wyoming. Wildlife Society Bulletin 26:785-798.

Eveland, T. 1978. The status, distribution, and identification of suitable habitat of river otters in Pennsylvania. Thesis, East Stroudsburg University, East Stroudsburg, Pennsylvania.

Gusset, M., A. H. Maddock, G. J. Gunther, M. Szykman, R. Slotow, M. Walters, and M. J. Somers. 2008. Conflicting human interest over the reintroduction of endangered wild dogs in South Africa. Biological Conservation 17:83-101.

Hamilton, D. 1999. Controversy in times of plenty: From otterless to otterful, with hearty cheers and heartfelt complaints from every direction. Missouri Department of Conservation Magazine Online <http://mdc.mo.gov/conmag/1999/11/4.hmt> 15, March, 2004.

Hamilton, D. 2006. From near zero to fifteen thousand – in 20 years! Missouri’s river otter saga. River Otter Journal 15:1-12. Hampshire, K., Bell, S., Wallace, G., & Stepukonis, E. 2004. “Real” poachers and predators: Shades of meaning in local understandings of threats to fisheries. Society and Natural Resources 17:305-318.

Hewitt, D. 2001 Public Attitudes and Predator Control: The biologist's puppeteer, T. F. Ginnett, and S. E. Henke, Editors. Kerville, TX, Texas Agricultural Research and Extension Center, pp. 1-6.

Kellert, S. R. 1985. Public perceptions of predators, particularly the wolf and coyote. Biological Conservation 31:167-89.

Kentucky Department of Fish and Wildlife Resources. 2008. Annual Research Highlights, 2007, Volume 1.

Kirkland, G. L., Jr. and P. M. Krim. 1990. Survey of the statuses of mammals of Pennsylvania. Journal of the Pennsylvania Academy of Science 64:33-45.

Knudson, G. J. and J. B. Hale. 1968. Food habits of otters in the Great Lakes region. The Journal of Wildlife Management 32:89-93.

Lampe, J. 2008. Bobcat, otter trapping introduced. Prairie State Outdoors <http://www.prairiestateoutdoors.com/index.php?/pso/article/bobcat_otter_trapping_bill_introduced.html> 12 September 2010.

Linnell, J. D. C., J. E. Swenson, and R. Andersen. 2000. Conservation of biodiversity in Scandinavian boreal forests: large carnivores as flagships, umbrellas, indicators, or keystones? Biodiversity and Conservation 9:857-868.

Martin, C. 2005. Ohio proposal would allow trapping of river otters. Zanesville TimesRecorder <http://www.zanesvilletimesrecorder.com/ news/stories/20050109/localnews/1846553.html> 12 September 2010.

Mech, L. D. 1970. The Wolf: The Ecology and Behavior of an Endangered Species. University of Minnesota Press, Minneapolis, MN, pp. 325-334.

MacCaracken, J. G., and J. O'Laughlin. 1998. Recovery policy on grizzly bears: an analysis of positions. Wildlife Society Bulletin 26:899-907.

Nilsen, E. B., E. J. Milner-Gulland, L. Schofield, A. Mysterud, N. C. Stenseth, and T. Coulsen. 2007. Wolf reintroduction to Scotland: public attitudes and consequences for red deer management. Proceedings of the Royal Society B. 274(1612):995-1003.

Pack, J. C. and J. I. Cromer. 1981. Reintroduction of fisher in West Virginia. Worldwide Furbearer Conference Proceedings 2:1431-42.

Renkin, T. 2000. The fur flies over Missouri’s cute but greedy river otters. The St. Louis Dispatch (MO), March 2000 Records <http://business.highbeam.com/435553/ article-IGI-58661589/fur-flies-over-missouri-cute-but-greedy-river-otters> 12 September 2010.

Rhoads, S. 1903. Mammals of Pennsylvania and New Jersey. Privately printed, Philadelphia, Pennsylvania.

Savage, M. and J. Klingel. 2003. The case for river otter restoration in New Mexico. A report to the River Otters Working Group. The Four Corners Institute, Santa Fe, NM, pp. 1-10.

Serfass, T. L. 1994. Conservation genetics and reintroduction strategies for river otters. Dissertation, The Pennsylvania State University, University Park, Pennsylvania.

Serfass, T. L., M. J. Lovallo, R. P. Brooks, A. H. Hayden, and D. H. Mitcheltree. 1999. Status and distribution of river otters in Pennsylvania following a reintroduction project. Journal of the Pennsylvania Academy of Science 73:214-223.

Serfass, T. L. and Rymon, L. M. 1985. Success of river otters reintroduced into Pine Creek drainage in northcentral Pennsylvania. Transactions of the Northeast Section of the Wildlife Society 41:138-49.

Serfass, T. L., Brooks, R. P., Rymon, L. M. 1993. Evidence of long-term survival and reproduction by translocated river otters. The Canadian Field-Naturalist 107:59-63.

Serfass, T. L., Rymon, L. M., and Brooks, R. P. 1990. Feeding relationships of river otters in northeastern Pennsylvania. Transactions of the Northeast Section of the Wildlife Society 47:43-53.

Serfass, T. L., L. M. Rymon, and J. D. Hassinger. 1986. Development and progress of Pennsylvania's river otter reintroduction program. Pages 322-342 *in* S. K. Majumdar, F. J. Brenner, and A. F. Rhoads, editors. Endangered and threatened species programs in Pennsylvania and other states: causes, issues, and management. The Pennsylvania Academy of Science.

Sheldon, W. G. and W. G. Toll. 1964. Feeding habits of the river otter in a reservoir in central Massachusetts. Journal of Mammalogy 45:449-455.

Spencer, C. 2005. River otter overrunning Ohio. Salon.com <http://dir.salon.com/story/mtw/wire/2005/01/21/otter/index.html> 12 September 2010.

Stevens, S. S, T, L. Serfass, and J. F. Organ. 2007. Otters and wildlife tourism: a recipe for conservation success? Pages 489-504 *in* J. D. Keyyu, and V. Kakengi, Editors. Proceedings of the Sixth TAWIRI Scientific Conference. Tanzania Wildlife Research Institute, Arusha, Tanzania.

Tesky, J. L. 1993. Lutra Canadensis in: Fire Effects Information System [Online]. U. S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). 19 July 2010.

TABLES AND FIGURES

Table 1. Demographic and socioeconomic characteristics of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

Characteristic	Frequency	Percent
Survey Site		
Pine Creek	149	36.2
Kettle Creek	150	36.4
Tionesta Creek	113	27.1
Sex		
Male	41	10.0
Female	371	90.1
Age		
>30	84	20.4
30 - 49	180	43.7
50+	148	35.9
Education		
Some High School	72	17.4
High School Degree/ Vocational School/ Some College	243	59.0
College Degree	97	23.5
Occupation		
Employed	281	68.2
Unemployed	26	6.3
Retired	83	20.2
Student	22	5.3
Current Residence		
Farming/Rural	46	11.2
Small Town – Small City	311	75.5
Large City (Pop. >50000)	55	13.4
Youth Residence		
Farming/Rural	46	11.2
Small Town – Small City	299	72.6
Large City (Pop. >50000)	57	16.3

Table 2. Participation in and opinions toward recreational activities among 412 anglers surveyed interviewed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

Recreational Activity	Participate Freq. (%)	Pro Freq. (%)	Anti Freq. (%)	No Opinion Freq. (%)
Hunting	317 (76.9%)	361 (87.6%)	14 (3.4%)	37 (9.0%)
Trapping	68 (16.5%)	230 (55.8%)	65 (15.8%)	117 (28.4%)

Table 3. Knowledge of river otters and PRORP among 412 surveyed anglers interviewed at river otter (RO) reintroduction sites in northern Pennsylvania during May-June, 1991.

Question	Frequency	Percent
Seen a Wild River Otter?		
Yes	168	40.8
No	244	59.2
Aware of Native RO Population in Northeastern PA?		
Yes	128	30.1
No	288	70.0
RO Harmful to Game Fish Populations?		
Yes	29	7.1
No	290	70.7
Somewhat	24	5.9
No Opinion	67	16.3
Describe RO Diet		
Mostly Game Fish	12	2.9
Equal Amounts Game and Non-Game Fish	100	24.3
Mostly Non-Game Fish	220	53.4
No Opinion	78	18.9

Table 4. Significance (X^2) between demographic and lifestyle characteristics of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

	Site	Sex	Age Category	Home Town	Education	Hunter	Trapper
Likert 1	x						
Likert 2	x		x	x	x		
Likert 3	x		x				
Likert 4	x		x		x		
Likert 5	x			x	x		
Likert 6	x						
Likert 7	x		x			x	
Likert 8			x	x			
Likert 9		x	x			x	x
Likert 10						x	x

Likert 1: I would enjoy seeing a river otter in the wild.
Likert 2: I'm glad river otters were reintroduced to surveyed site.
Likert 3: If needed, I would support trapping restrictions on other furbearers to assure that river otters survive at surveyed site.
Likert 4: Overall, I believe river otters are beneficial to the streams, rivers, and lakes they inhabit.
Likert 5: I'm glad the PA Game Commission is supporting a river otter reintroduction project.
Likert 6: I'm concerned that river otters will harm game fish populations.
Likert 7: I would very much like to see river otter sign (slides, tracks, etc.) in the wild.
Likert 8: I hope reintroduced river otters survive at surveyed site and expand their population beyond release areas.
Likert 9: The opportunity to trap a river otter would be a challenging and rewarding experience.
Likert 10: If river otters establish a viable population at surveyed site, I would support a controlled trapping season on them.

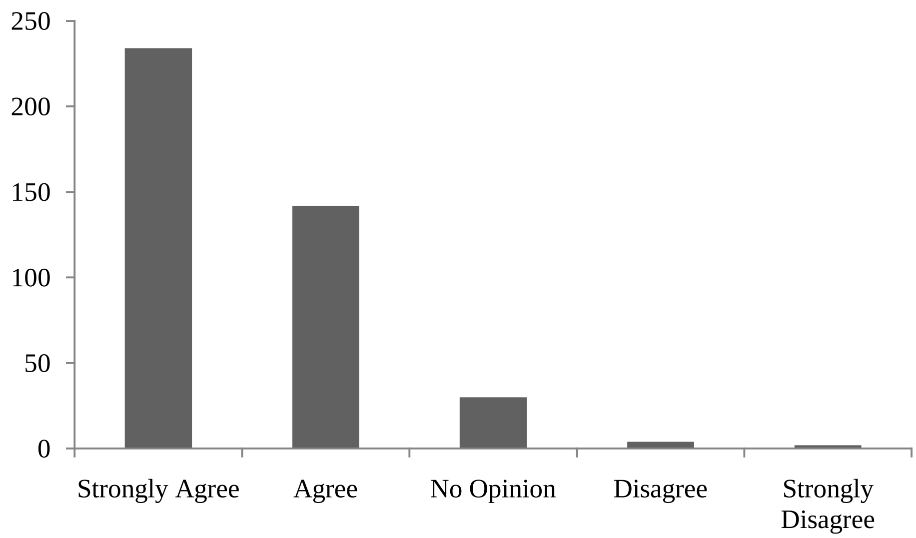

Figure 1. Proportion of responses to Likert Statement 1: “I would enjoy seeing a river otter in the wild,” of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

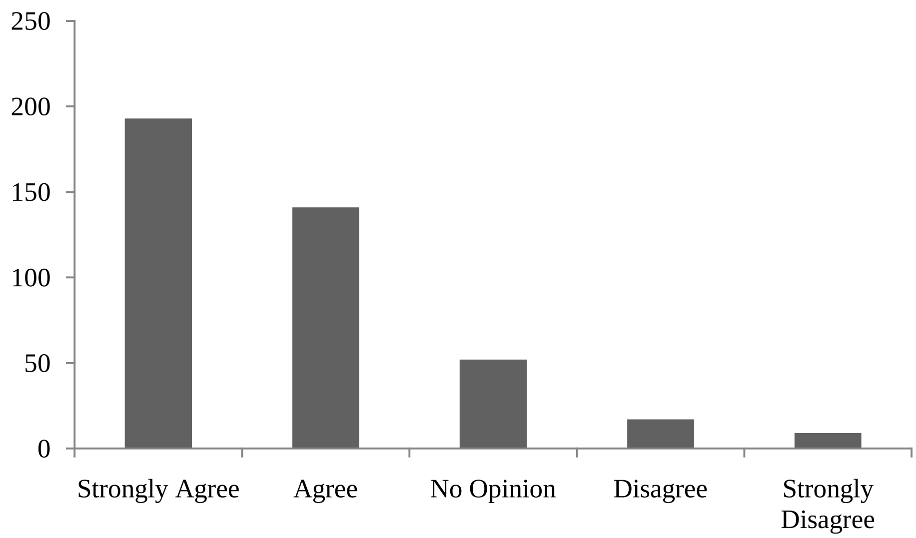

Figure 2. Proportion of responses to Likert Statement 2: "I am glad for the river otter reintroduction at surveyed site," of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

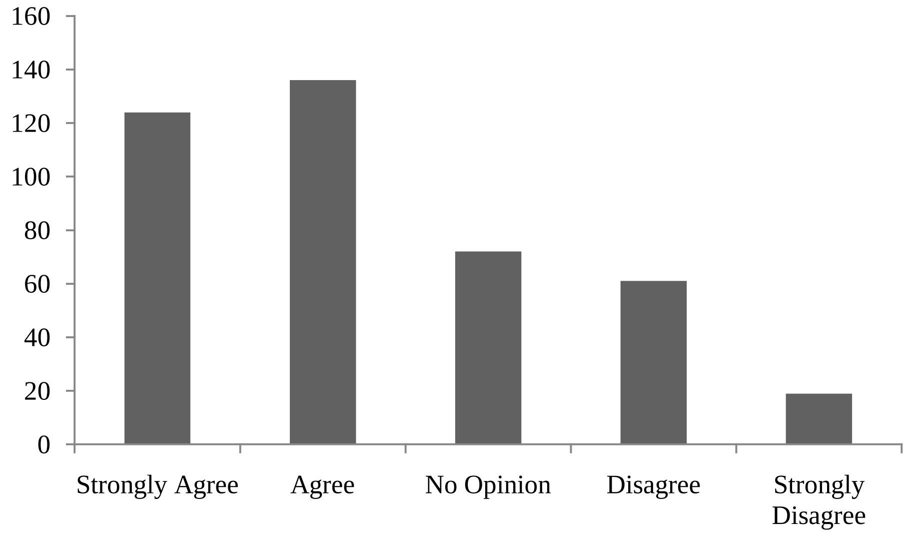

Figure 3. Proportion of responses to Likert Statement 3: "If needed, I would support trapping restrictions on other furbearer to ensure that river otters survive at surveyed site," of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

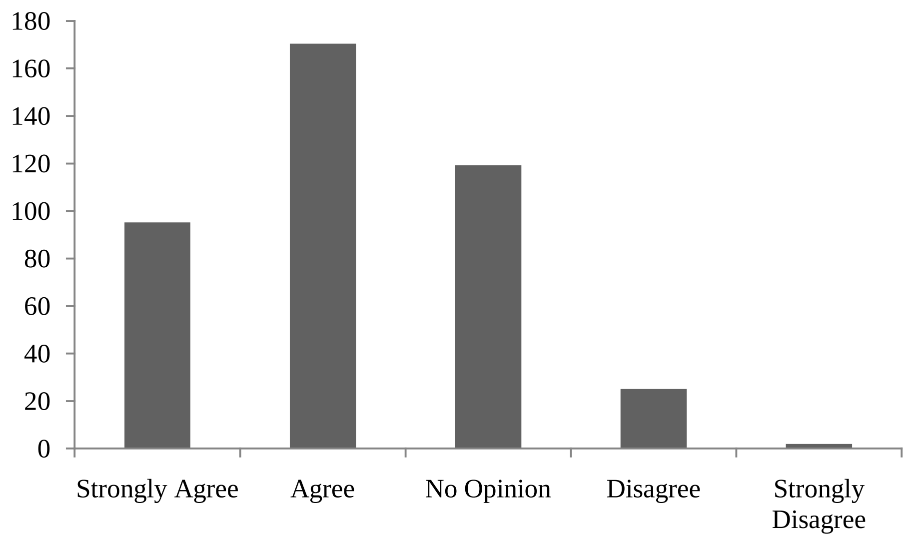

Figure 4. Proportion of responses to Likert Statement 4: "Overall, I believe river otters are beneficial to the streams, rivers, and lakes they inhabit," of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

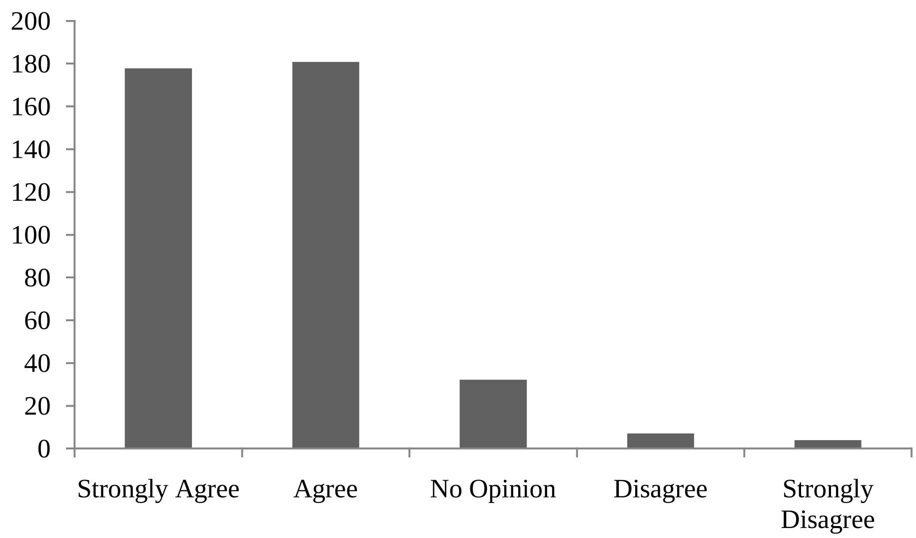

Figure 5. Proportion of responses to Likert Statement 5: "I'm glad the PA Game Commission is supporting a river otter reintroduction project," of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

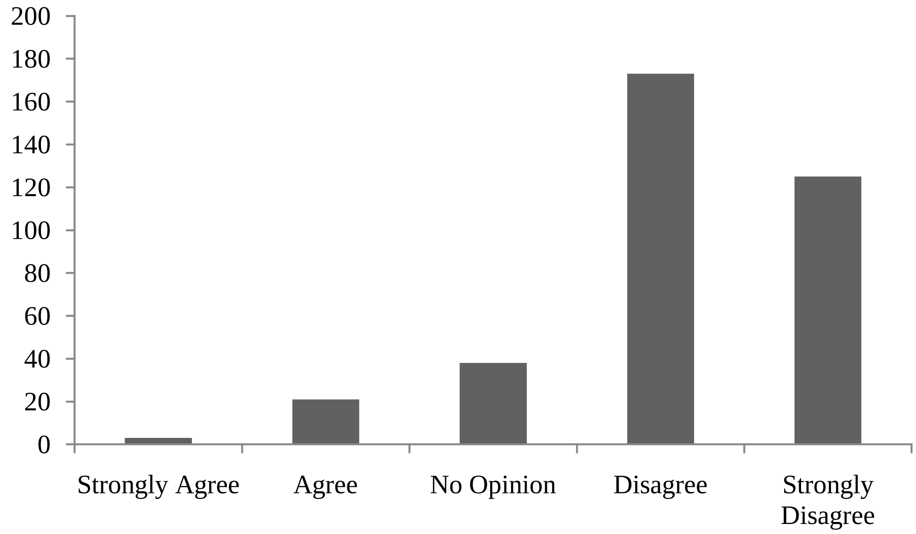

Figure 6. Proportion of responses to Likert Statement 6: "I'm concerned that river otters will harm game fish populations," of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

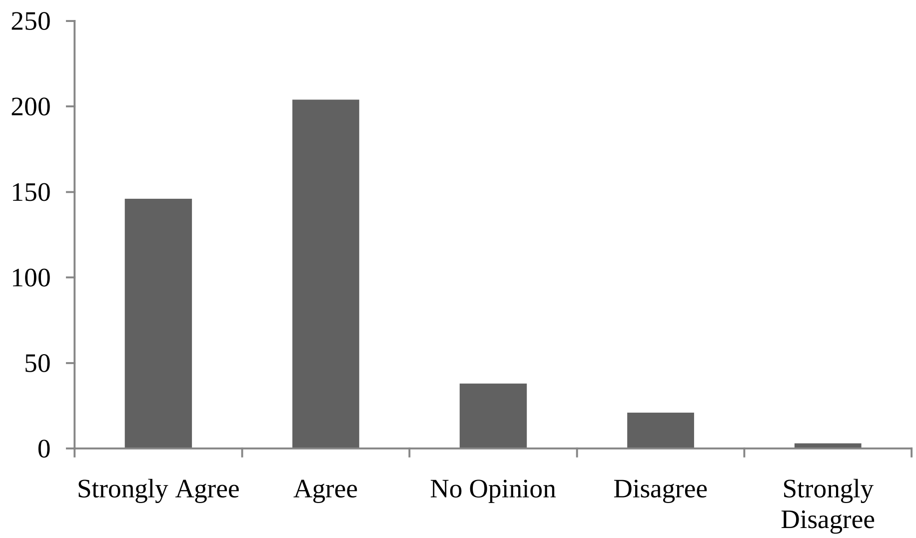

Figure 7. Proportion of responses to Likert Statement 7: "I would very much like to see river otter sign (slides, tracks, etc.) in the wild," of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

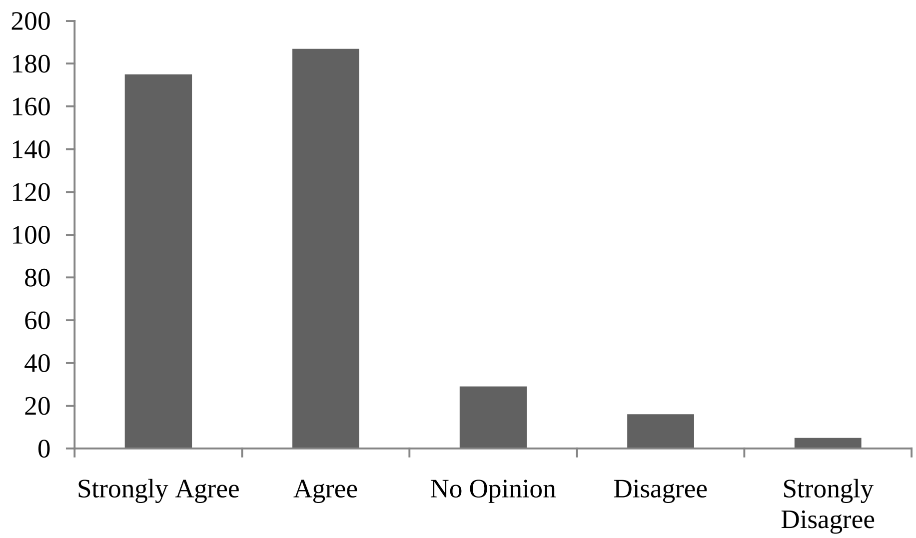

Figure 8. Proportion of responses to Likert Statement 8: "I hope reintroduced river otters survive at surveyed site and expand their population beyond release areas," of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

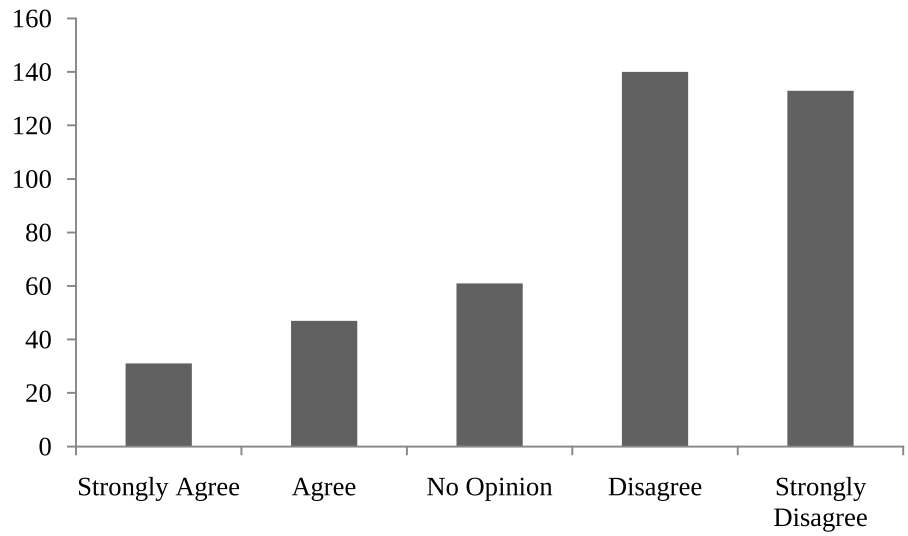

Figure 9. Proportion of responses to Likert Statement 9: "The opportunity to trap a river otter would be a challenging and rewarding experience," of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

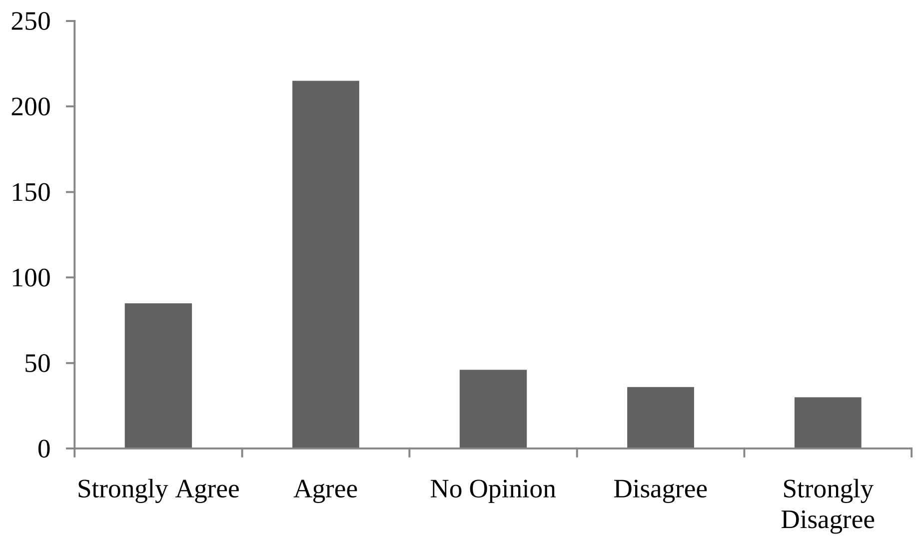

Figure 10. Proportion of responses to Likert Statement 10: "If river otters establish a viable population at surveyed site, I would support a controlled trapping season on them," of 412 anglers surveyed at river otter reintroduction sites in northern Pennsylvania during May-June, 1991.

APPENDIX I. Efficacy of Cronk's Otter Lure at Attracting Wild River Otters

Introduction

Certain odors may potentially be useful for attracting river otters to field devices, such as scent and track stations, remote cameras, and traps, to obtain data on reestablished and existing wild populations. However, the efficacy of olfactory lures at attracting wild otters has received minimal formal investigation. Robson and Humphrey (1985) assessed wild river otters' responses to scent stations containing either Cronk's Otter Lure (COL) or Synthetic Fermented Egg (SFE) in north-central Florida. The researchers established 3 scent stations at each of 15 latrine or denning sites, but recorded only 1 otter visitation over the 8-day study. Robson and Humphrey subsequently established a total of 30 scent-stations, each containing SFE, along transects at 6 sites on 2 rivers known to inhabit otters. They reported only 6 otter visitations after recording data for 2 consecutive nights in July, October, January, and April. This preliminary field study evaluated the efficacy of COL at attracting river otters to remote camera sites in southwestern and northeastern Pennsylvania.

Methods

From October 2010 through December 2010, visits by wild river otters to remote cameras baited with COL were compared with non-baited cameras. Sites were established wherever active latrines could be located and easily accessed. A total of 4 sites were established (2 in Ohiopyle State Park and 2 in the Pocono Mountains region of PA), and 3 cameras (Cuddeback Excite or Capture) were erected near each latrine site. Two of the cameras, baited with lure devices, were positioned 10 m and 100 m from each latrine. The third camera, placed directly at the latrine, served as a control, as it verified the presence of otters in the area.

Lure devices were identical to those used in the preceding captive analyses (26 mm long x 70 mm diameter, single-closed-ended PVC pipes containing a 25 x 5 mm plaster disc soaked in Cronk's Otter Lure; see Chapter I for details), except that single open-ended screw-tops were used to prevent rainwater from collecting and diluting the scent. Holes were drilled into the sides of the devices to allow the odor to volatilize, and 15.24 cm steel nails were used to stake the devices to the ground. Cameras were left up for a total of 36 days at 3 of the sites, and 12 days at the remaining 2 sites. Every 3 days, latrines were checked for the presence of otter sign, cameras were checked for otter photos, and the plaster discs were refreshed.

Results

Only 3 otter photographs were recovered from 1 of the latrine (control) sites, although fresh scats were observed regularly at 2 of the latrines. None of the experimental cameras (those with the lure devices) detected the presence of otters.

Discussion

Although COL performed better than 5 other lures according to 4 main parameters assessed for captive otters (see Chapter I for details), it did not elicit a positive response from wild otters when tested briefly in the field. However, only 4 latrine sites were located for this study, constituting an insufficient sample size for robust analysis. Moreover, data collection took place over the relatively short time span of 2 months during a single season (fall). A more thorough field analysis, comprising a greater number of sites and spanning all 4 seasons, is needed to definitively assess the efficacy of

COL at attracting wild otters. One way of increasing sample size when few latrine sites can be located would consist of positioning cameras with lure devices at regular intervals along waterways known to be inhabited by river otters. The proportion of these cameras that detected the presence of otters could then be calculated.

Appendix II. River Otter Survey

Date:_____________

Survey Location:________________

Investigator:________________

I. PERSONAL BACKGROUND

1. Sex (M, F) ______ 2. Race (white, black, etc.) _________ 3. Age ______

4. Residence:

4a. State ________________ 4b. County__________

4c. Town/City ____________ 4d. Zip Code________

4e. Check the response that best describes the area where you currently live:

____ Farming or rural area ____ Town/Small City (population <50,000)

____Large City (population >50,000)

4f. Check the response that best describes the area where you grew up:

____ Farming or rural area ____ Town/Small City (population <50,000)

____ Large City (population >50,000)

5. Occupation:

5a. Check the response that best describes your employment status:

____ Employed

____ Unemployed

____ Retired

____ Student

5b. If employed, what is your occupation? ________________________________

5c. If unemployed or retired, what is your former occupation?

____

6. Education: (Check the response indicating your level of education)

____ Some High School

____ High School Degree/Vocational School/Some College

____ College Degree

7. Consumptive Use of Wildlife: (Check the response indicating your opinion for each of the following categories)

7a. Hunting

____ Prohunting ____ Antihunting ____ No opinion

7b. Trapping

____ Protrapping ____ Antitrapping ____ No opinion

5. Participation in Outdoor Recreation

1 = Never 2 = Rarely 3 = Sometimes 4 = Frequently

____ Hunting ____ Fishing ____ Trapping

II. FAMILIARITY WITH OTTER PROJECT

1. Have you ever seen a river otter in the wild?

____ Yes ____ No

2. Do you know that a native river otter population exists in northeastern PA?

____ Yes ____ No

3. Do you know that the Pennsylvania Game Commission is involved with a river otter reintroduction project along (name of creek)?

____ Yes ____ No

4. Do you believe river otters are damaging game fish populations?

____ Yes ____ No ____ Somewhat ____ No opinion

5. Which of the following do you believe makes up the main part of the river otter's diet?

____ Mostly game fish

____ Equal amounts of game fish, pan fish (bluegills, etc.), and rough fish (shiners, suckers, etc.)

____ Primarily rough fish, pan fish, and crayfish, and occasionally game fish

____ No opinion

III. ATTITUDES

Instructions: Circle the number that best indicates the way you feel about each statement.

Key: 1 = Strongly agree

2 = Agree

3 = No opinion

4 = Disagree

5 = Strongly disagree

1. I would enjoy seeing a river otter in the wild………………….… 1 2 3 4 5
2. I'm glad river otters were reintroduced along (name of creek) …………………………………..……………………..…… 1 2 3 4 5
3. If needed, I would support trapping restrictions on other furbearers to assure that river otters survive at surveyed site…….…………….…………..…. 1 2 3 4 5

4. Overall, I believe river otters are beneficial to the streams, rivers, and lakes they inhabit

   ………..……………………………..…...…………………. 1 2 3 4 5

5. I'm glad the PA Game Commission is supporting a river otter reintroduction

   project……………………………..……………………….... 1 2 3 4 5

6. I'm concerned that river otters will harm game fish populations

   …………...……………………...…………………………… 1 2 3 4 5

7. I would very much like to see river otter sign (slides, tracks, etc.) in the wild

   ……..........................……………………………………..….. 1 2 3 4 5

8. I hope reintroduced river otters survive along (name of creek) and expand their

   population beyond release areas………….……………..…….. 1 2 3 4 5

9. The opportunity to trap a river otter would be a challenging and rewarding experience

   ……………………………………………………………… 1 2 3 4 5

10. If river otters establish a viable population along (name of creek), I would support a

    controlled trapping season on them……..……………………..… 1 2 3 4 5