ABSTRACT

INGLE, MARGARET CHRISTINE. The Development and Testing of a Procedure for Monitoring Visitor-Horse Interactions at Assateague Island National Seashore (Under the direction of Dr. Yu-Fai Leung.)

Developing visitor impact indicators and associated monitoring techniques are critical first steps to sustain a balance between two national park mandates, protecting resources and providing recreation opportunities. The first paper of this thesis provides a comprehensive and organized assessment of major techniques that have been developed for monitoring visitor impacts in coastal areas, with a special focus on sandy coasts and barrier islands. Four major types of monitoring techniques are identified: remote sensing, on-site assessment, behavior observation, and perception survey. Current trends in impact monitoring, including a global expansion of impact studies, integrated methodological approaches, and an increase in the application of technology, are discussed.

The second paper of this thesis describes the development of a procedure to monitor visitor-feral horse interactions at Assateague Island National Seashore. The procedure uses behavior observation of visitors and wildlife and remote sensing with Global Positioning System units. The behavior observation portion adopts behavior sampling and one-zero recording based on the ethological literature. General categories of behaviors of both visitors and wildlife are recorded: neutral, attraction, avoidance, and aggression. For visitors, two additional behaviors, touching and feeding, are recorded because they are illegal behaviors and of special concern to park managers.

The behavior observation portion was tested on undergraduate students for inter-observer reliability and accuracy using video surveys. Three behaviors did not occur on the

video clips, visitor and wildlife aggression and visitor feeding. Students recorded wildlife aggression, number of wildlife, closest distance, and visitor touching with the highest combinations of inter-observer reliability and accuracy. Observations with the lowest combinations of inter-observer reliability and accuracy were visitor aggression, visitor feeding, and wildlife avoidance. There were minimal differences in the inter-observer reliability and accuracy among demographic groups. There were stronger differences between the two clips shown. The roadside clip was recorded with lower inter-observer reliability and higher accuracy, most likely because it contained less action that the campground clip.

Recommendations for implementing the monitoring protocol include a thorough training session in which video clips of behaviors are shown to help observers better understand the behaviors, and monitored practice observation sessions in the field.

THE DEVELOPMENT AND TESTING OF A PROCEDURE FOR MONITORING VISITOR-HORSE INTERACTIONS AT ASSATEAGUE ISLAND NATIONAL SEASHORE

by

MARGARET CHRISTINE INGLE

A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the requirements for the
Degree of Master of Science

NATURAL RESOURCES

Raleigh, North Carolina

April, 2004

APPROVED BY:

Dr. J. Douglas Wellman

Dr. George R. Hess

Dr. Yu-Fai Leung
Chair of Advisory Committee

DEDICATION

This thesis is dedicated to my parents, Bill and Peggy Ingle, for their love and support throughout my graduate education and to the memory of my grandfather, H.C. "Bill" Newton, who passed away December 7th, 2003.

BIOGRAPHY

Margaret "Chrissie" Ingle was born March 5, 1980 in Rockingham, NC. She lived in Fayetteville, NC from ages 6 through 15 before moving to Wagram, NC in 1995.

Chrissie earned a B.S. in Natural Resources-Policy and Administration with a minor in Environmental Science from North Carolina State University in 2002. During her undergraduate years, Chrissie participated in several Habitat for Humanity trips in Sea Island, SC, Columbus, GA, and Barahona, Dominican Republic. She also spent 3 weeks in Nepal on a class field trip to study the country's environmental issues and culture. It was then that she became interested in environmental tourism and specifically the impacts tourists can have on the environment. After receiving her M.S. degree, Chrissie plans to combine her interests in service and environmental tourism with a position in the Peace Corps working in the parks and wildlife areas.

RELEVANT PRESENTATIONS AND PUBLICATIONS

Ingle, C., & Leung, Y. (2004). The development and evaluation of a behavior observation procedure to monitor visitor-horse interactions at Assateague Island National Seashore. Oral presentation delivered at 2004 Southeast Recreation Research Conference, Charleston, SC.

Ingle, C., Leung, Y.-F., Monz, C., & Bauman, H. (2004). Monitoring visitor impacts in coastal national parks: a review of techniques. In: Harmon, D., Kilgore, B. M., & Vietzke, G. E. (eds.) *Protecting Our Diverse Heritage: The Role of Parks, Protected Areas, and Cultural Sites -- Proceedings of the 2003 George Wright Society/National Park Service Joint Conference; April 14-18, 2003; San Diego, CA* (pp. 228-233). Hancock, MI: The George Wright Society.

Monz, C., Leung, Y.-F., Ingle, C., & Bauman, H. (2004). Visitor impact monitoring in the Coastal and Barrier Island Network. In: Harmon, D., Kilgore, B. M., & Vietzke, G. E. (eds.) *Protecting Our Diverse Heritage: The Role of Parks, Protected Areas, and Cultural Sites -- Proceedings of the 2003 George Wright Society/National Park Service Joint Conference; April 14-18, 2003; San Diego, CA* (pp. 135-139). Hancock, MI: The George Wright Society.

Ingle, C., Leung, Y., Monz, C., & Bauman, H. (2003). Monitoring visitor impacts for coastal national parks: a review of techniques. Poster presented at the 2003 George Wright Society/National Park Service Joint Conference; April 14-18, 2003; San Diego, CA.

Monz, C., Leung, Y.-F., Ingle, C., & Bauman, H. (2003). Visitor impact monitoring in the Coastal and Barrier Island Network.. Oral presentation delivered at the 2003 George Wright Society/National Park Service Joint Conference; April 14-18, 2003; San Diego, CA.

Leung, Y., Monz, C., Ingle, C., & Bauman, H. (2003). Establishing visitor impact monitoring programmes for seven coastal protected areas in the eastern United States: First-year experiences. Poster presented at the 5th International Conference on Science and the Management of Protected Areas; May 11-16, 2003; Victoria, BC, Canada.

ACKNOWLEDGEMENTS

I would like to thank Dr. Yu-Fai Leung, Dr. Hess, and Dr. Wellman for their guidance and wisdom in this thesis; the professors who allowed me to use their classes for the video surveys; Leigh Jaite for volunteering a weekend in October to observe, photograph, and videotape the horses at Assateague Island National Seashore; Megan Alexander for keeping me company in the grad lab, listening to me talk about horses over and over again, and being a good friend; and my roommates, Elaina and Scott, for taking care of Bailey G. Pig while I was away watching horses and going to conferences.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1: Introduction

Study Background

In 1916 the National Park Service (NPS) was created to:

> …promote and regulate the use of Federal areas known as national parks, monuments, and reservations…to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations… (NPS, 2000, p. 11).

Accordingly, national park managers are charged with dual mandates – providing quality recreational opportunities and protecting the treasured park resources. Although visits to national parks have declined in recent years, total visits have increased from approximately 282 million in 1979 to approximately 421 million in 2002 (U.S. NPS Public Use Statistics Office, n.d.). The potentially conflicting nature of the two mandates has become a significant concern among park scientists and managers, as growing recreational activities increasingly threaten the ecological health of national parks.

This thesis addresses the impacts of visitor activities in sandy coasts and barrier islands with implications for coastal protected areas. Visitor impacts in this thesis refer to "disturbance to natural areas as a result of recreational use" (Hammitt & Cole, 1998, p. 5). In 2002, recreational visits made up 97% of the total visits to the National Seashores (U.S. NPS Public Use Statistics Office, n.d.). There is a need in these areas for proactive management. Developing visitor impact indicators and associated monitoring techniques are the critical first steps to sustain a balance between the dual mandates.

Visitor impact monitoring can be an effective tool to manage visitors and resources in coastal national parks (Marion, Roman, Johnson, & Lane, 2001). The purpose of a monitoring program is to collect data at the same location using the same methods on a long-term basis in order to detect changes. These could be changes caused by management action, human influence, or natural processes. As part of the agency's Natural Resource Challenge action plan the NPS created the *Vital Signs* monitoring program for the purpose of long-term monitoring of natural resources in national park units. A vital sign is a "key indicator of change," which acts as a warning system for changes that can harm the overall health of the natural resources (U.S. NPS Natural Resource Program Center, 2003).

For example, the park units within the Great Plains Prairie Cluster (a prototype for small parks) are creating programs to monitor prairie plant communities, rare plants, stream macroinvertebrates, butterflies, grassland birds, black-tailed prairie dogs, and the weather in response to three management concerns: "(1) sustainability of small remnant and restored prairie ecosystems, (2) the effects of external land use and watersheds on small prairie reserves, and (3) the effects of fragmentation on the biological diversity of small prairie parks" (U.S. NPS, n.d., Prototype Monitoring Programs section, para.10). Approximately 270 parks have been divided into 32 networks. These networks contain similar natural resources and geographies so they can share information and save costs in the development of monitoring programs.

My work is part of a larger and ongoing *Vital Signs* research project that was initiated to develop visitor impact indicators and monitoring protocols for seven park units within the Northeast Coastal and Barrier Network. The impacts of visitor activities have been identified as a threat, or stressor, to the natural resources within these National Park units. The first phase consisted of field visits to each of the park units and meetings with park managers to identify significant visitor impact concerns. The second phase involved additional field visits to selected park units to develop potential monitoring techniques and collect further information on major impact issues. During this phase, draft protocols were developed for the most salient visitor impact concerns. As some of the units have similar concerns, these protocols may be implemented in more than one park with appropriate site-specific modifications. The third phase, which has not been carried out, will involve extensive field-testing of monitoring protocols and the implementation of the developed procedures at the park units.

Study Objectives

The overall goal of this study is to contribute to the National Park Service (NPS) *Vital Signs* monitoring program by evaluating the state of knowledge on visitor impact monitoring and developing valid and reliable monitoring procedures for sandy coasts and barrier islands. Two specific objectives of this thesis are to: (1) review the research literature and classify existing methodologies for monitoring visitor impacts, and (2) develop and empirically test procedures for monitoring one particular type of visitor impact -- visitor-horse interactions at Assateague Island National Seashore.

Thesis Overview

This thesis consists of two manuscripts intended for journal submission. Following a brief introduction, Chapter Two provides a thorough review of the literature on visitor impact studies in sandy coasts with special reference to monitoring methodologies for which a classification system was developed. I discuss the geographical distribution of techniques, the publication mediums, and identify trends and knowledge gaps.

In Chapter Three, I apply the knowledge gained from the literature review. Managers at Assateague Island National Seashore have identified the improper interactions between visitors and feral horses as a major visitor impact concern. I developed a procedure to monitor visitor-feral horse interactions at Assateague Island National Seashore using behavior observation methods. The behavior observation instrument adapted methods from Martin and Bateson (1993). To test the accuracy and inter-observer reliability of this procedure, I conducted a video survey using undergraduate students in the College of Natural Resources at North Carolina State University.

Chapter Four concludes this thesis with a concise discussion of general management and research implications.

References

Hammitt, W.E., & Cole, D.N. (1998). *Wildland Recreation: Ecology and Management* (2nd ed.). New York: John Wiley & Sons, Inc.

Marion, J. L., Roman, C., Johnson, B., & Lane, B. (2001). Summary of Visitor Use Management Working Group, Vital Sign Workshop for the North Atlantic Coastal Park Network, Gateway National Recreation Area, NY.

Martin, P., & Bateson, P. (1993). *Measuring Behavior* (2nd ed.). New York: Cambridge University Press.

U.S. National Park Service. (2000). Management Policies 2001. (Publication No. NPS D-1416). Washington, DC: NPS Office of Policy. Retrieved 2/21/2004 from http://www.nps.gov/policy/mp/policies.pdf

U.S. National Park Service. (n.d.) *Natural Resource Monitoring-Program Administration and Organizational Framework.* Retrieved 1/24/2004 from http://science.nature.nps.gov/im/monitor/vsmAdmin.htm#ProgramAdmin

U.S. National Park Service Natural Resource Program Center. (2003). *Park Vital Signs Monitoring: A commitment to resource protection.* [Brochure].

US National Park Service Public Use Statistics Office. (n.d.). Retrieved January 24, 2000, from http://www2.nature.nps.gov/stats

Chapter 2: Monitoring Visitor Impacts in Coastal National Parks: A Methodological Assessment

Introduction

Coastal areas, particularly sandy coasts and barrier islands, are prime destinations for outdoor recreation activities. In 2000, 40% of the US population had visited a beach within the past 12 months (NSRE, 2000). These areas possess diverse, dynamic and often sensitive ecosystems (Beatley, Brower, & Schwab, 2002). For example, beach areas area habitats for many plant and animal species including endangered species such as the sea beach amaranth (*Amaranthus pumilus)* and piping plover (*Charadrius melodus)*. It is also an area of nutrient recycling, drift-line deposition, and sand dune development (Leatherman, 1988). Beach visitors participate in water-based activities such as those listed in Table 2.1 as well as in shore/land-based activities such as off-road vehicles (ORVs), walking on the beach, beach combing, and observing wildlife. These activities can trample vegetation, accelerate soil erosion, reduce sand dune height, disturb wildlife, and alter wildlife behavior and populations.

Activity	Percentage of US population	Percentage in Millions
Saltwater fishing	10.0%	20.7
Snorkeling	6.6%	13.7
Sailing	5.1%	10.6
Scuba Diving	1.9%	3.9
Surfing	1.5%	3.1

Table 2.1. Participation of US population in coastal recreation activities.
Numbers generated from weighted data. Source: NSRE, 2000

The National Park Service (NPS) is charged with two key mandates, to provide recreation opportunities and protect the parks' resources. For their ecological and social values, ten National Seashores have been designated on the Atlantic, Pacific, and Gulf Coasts (National Park Service, 2003). Visitor use and impacts have become an important and growing concern in national parks located in these sensitive zones.

The utility of visitor impact monitoring as an effective tool for managing visitation in coastal parks has been recognized (Marion, Roman, Johnson, & Lane, 2001). The National Park Service has begun a system wide program to monitor environmental changes called *Park Vital Signs Monitoring*. The goal is to create long-term programs to monitor "vital signs" that will alert staff to changes in the natural environment (National Park Service Natural Resource Program Center, 2003). The monitoring programs can prompt new management action or evaluate current management practices. One integral part of this program is monitoring the environmental impacts of visitors. In the conceptual ecosystem models developed for the Vital Signs program in the Northeast Coastal and Barrier Network (NCBN), Milstead and Steven (2003) identified visitor/recreation use as one of the major threats to all northeast coastal ecosystem types, particularly sandy coasts such as beaches, spits, and dunes where recreational use tends to be concentrated.

Monitoring visitor impacts in coastal areas can be difficult. Coastal areas are dynamic and diverse, subject to high temperatures and extreme weather conditions. However, after recording data for several years as part of a long-term monitoring program, changes caused by naturally occurring environmental factors may be distinguished from changes caused by visitors. While techniques have been developed for assessing and monitoring a variety of visitor impacts in coastal areas, there has been little evaluation of the state of knowledge in this topical area.

This paper presents a comprehensive and organized assessment of scientific literature on visitor impacts in coastal areas, with a special focus on sandy coasts and barrier islands. Specific objectives are to (1) identify, review, and classify visitor impact monitoring techniques that have been applied to sandy coasts and barrier islands since 1970s and (2) evaluate current trends of monitoring methods.

Methods

Publications and reports in this review include only those published since 1970. Few visitor impact studies in this area were published before the 1970s and Steiner and Leatherman (1987) completed an annotated bibliography of ORV impacts, which included studies before the 1970s. Relevant scientific publications were identified using reference lists of related articles and searches of reference databases through the North Carolina State University libraries. Reference databases used were CAB abstracts, Web of Science, BiblioLine, and Agricola. These databases were chosen because they include references related to recreation, coastal areas, and the environment in the physical, biological, and social sciences. A substantial number of references for visitor impacts in coastal areas were located, but only a small portion of these references applied to sandy coasts and barrier islands.

Articles were selected for inclusion in this review if they were empirical and contained sufficient detail. The research methods and procedures documented in each study were reviewed and each study was assigned into a methodological group that best described its study design. In some occasions a study was assigned to more than one group, because multiple methods were employed.

Research on Visitor Impacts on Sandy Coasts

Publications relevant to this topic examined coasts around the world, including North America (such as Patterson, Fraser, & Roggenbuck, 1991; Peregoodoff, 1997; Steiner & Leatherman, 1981), Australia (such as Barros, 2001; Hockings & Twyford, 1997), the Middle East (Kutiel, Eden, & Zhevelev, 2000; Kutiel, Zhevelev, &. Harrison, 1999), Africa (Rikard, McLachlan, &Kerley, 1994), and Europe (Chandrasekara & Frid, 1996; Lundberg, 1984), with the majority of research based in North America.

Publications were found in journals, conference proceedings, books, and management reports. *Biological Conservation,* the *Journal of Applied Ecology,* and *Ocean and Coastal Management* published the most relevant articles. Several management reports were located for the National Seashores including Cape Cod National Seashore, Fire Island National Seashore, and Assateague Island National Seashore (Andes & Leatherman, 1981; Bloget, 1978; Brodhead & Godfrey, 1979; Zaremba, Godfrey, & Leatherman, 1979; Leatherman, 1979).

Earlier studies of visitor impacts to coastal areas have been reviewed by Leatherman (1988) and Vaske, Deblinger, & Donnelly (1992). Leatherman and Steiner (1987) compiled an annotated bibliography with 110 entries on the impacts of off-road vehicles and walking traffic on coastal ecosystems. This bibliography included both social and environmental impacts, and most of the entries are rather dated (1970s or earlier).

The past research falls into four categories based on their emphasis on visitor activities (specific or general) and the ecological components (specific or general) impacted by the activities (Table 2.2). For example, McAtee and Drawe (1981) used this theme in their research on the impacts of ORV use (specific activity) to the microclimate of dunes (specific ecological component). Hockings and Twyford (1997) studied beach camping (specific activity) and its impacts to the beach area (general ecological component). Barros (2000) compared the abundance of ghost crabs (specific ecological component) in urban and nonurban beaches (general activities). Finally, both the visitor activity and the ecological community studied can be general, although articles in this category are typically not empirical in nature and were not included in this review.

Past research has been limited as far as its application to monitoring programs in that many studies were not designed as long-term monitoring programs. These methods were acceptable for a short time period, but may need adjustment for long-term monitoring. Along the same lines, the studies were designed with the expectation that researchers would conduct the measurements. In reality, although researches may design a long-term monitoring program, park staff or volunteers will likely conduct the programs on a regular basis. Volunteers have often been used to conduct monitoring programs (Newman, Buesching, & Macdonald, 2003). While the measurements should still be accurate and reliable, the level of detail to be recorded may need to be reduced.

Table 2.2. Research Categories and Selected Examples of the Visitor Impact Research in Coastal Areas

Research Category	Study	Activity	Ecological Component	Variables measured
Activity specific, ecological component specific	Kutiel et al. 2000	Vehicular and pedestrian traffic	Soil and annual plants on trails in coastal dunes	Annual Plants: Overall percent cover, overall average height, percent cover for each species Soil: compaction level, organic matter content, soil moisture
	Rickard et al. 1994	Vehicular and pedestrian traffic	Dune shrubland	Experimental; Vegetation height and cover
	McAtee & Drawe, 1981	Vehicular and pedestrian traffic	Dune microclimate	Dune elevation, wind speed, evaporation, atmospheric salinity, wind-transported sand particles, soil salinity, soil pH, soil & air temperature, bulk density, and soil moisture
	Hosier & Eaton, 1980	Vehicular traffic	Dune and grassland vegetation	Vegetation: Average percent cover, percent of unvegetated quadrats, species diversity, & aerial extent for each vegetation type, & total number of species Soil: sediment characteristics and compaction

Table 2.2. Research Categories and Selected Examples of the Visitor Impact Research in Coastal Areas, Continued

Research Category	Study	Activity	Ecological Component	Variables measured
Activity Specific, Ecological component general	Monz, 1998	Camping	Coastal wildland	Size of impacted area, vegetation cover, mineral soil & root exposure, number of trails, litter, & trash, tree damage & stumps fire sites, human waste, condition class
	Peregoodoff, 1998	Camping	Coastal campground sites	Use area condition class, shoreline condition class, trail condition, percent vegetative ground cover on & off site, percent lose organic matter on & off site, percent consolidated organic material on and off site, exposed soil, tree damage, root exposure, trees stumps, fire sties, litter, human waste
	Hockings & Twyford, 1997	Camping	Beach area	Extent of clearing, vehicle tracks

Table 2.2. Research Categories and Selected Examples of the Visitor Impact Research in Coastal Areas, Continued

Research Category	Study	Activity	Ecological Component	Variables measured
Activity general, Ecological component specific	Bolduc & Guillemette, 2003	Human presence	Common Eider nesting success	Experimental; laying dates, egg density
	Thomas, Kvitek, & Bretz, 2003	Visitor activities	Shorebird foraging behavior	Observations: time spent foraging, disturbed by people; number of: times moved b/c of people, people causing disturbance; response to disturbance, distance moved b/c of disturbance, distance from bird to person at time of disturbance
	Barros, 2000	Urban vs. Nonurban beach (high and low recreation use)	Ghost Crab burrows	Number of burrows
	Burger, 1986	Visitor activities	Shorebird behavior	Observations: when person, dog aircraft, or boat was in the study site recorded type of disturbance, number of birds that remained, flew up and returned, flew away entirely

Major Focuses of Research

Early research into the impacts of pedestrian and vehicular traffic was conducted by Liddle and associates in Britain (Hylgaard & Liddle, 1981; Liddle & Greig-Smith, 1975a; Liddle & Greig-Smith, 1975b). More recent work on these recreational impacts to coastal areas can also be found (Priskin, 2003).

The use of off-road vehicles (ORV) has been an early but persistent visitor/recreation use of concern in coastal areas, particularly on barrier islands and near sand dunes (Rickard, et al., 1994). At Cape Cod National Seashore, Godfrey and Godfrey (1980) conducted a comprehensive study on the effects of ORV use. They looked at different ecological components such as birds, sand dunes, and salt marshes. In North Padre Island, Texas, McAtee and Drawe (1981) compared the microclimate of the beach and foredune in areas with varying intensities of vehicular and pedestrian traffic from late fall to early summer. Areas with higher levels of traffic were found to have higher levels of wind velocity, evaporation, soil salinity, and soil pH. As the intensity of vehicular and pedestrian traffic increased, dune height, vegetation cover, and the diversity of vegetation species decreased.

In North Carolina, Hosier and Eaton (1980) compared soil compaction and vegetation patterns in areas of high and low ORV use. Soil compaction was higher and vegetation cover and species diversity were lower in areas of high ORV use. Wolcott and Wolcott (1984) investigated the potential impacts of ORVs to macroinvertebrates. Their findings suggest that ghost crabs are more at risk by night driving than day driving.

Beach camping is another visitor activity of concern in sandy coastal areas. Hockings and Twyford (1997) studied the impacts, availability, and usage of beach campsites using ground and aerial surveys in Queensland, Australia. They attributed coastal degradation to impacts from beach camping. Monz (1998) also documented substantial vegetation loss on beach campsites in Baja California, Mexico and Prince William Sound, Alaska. Peregoodoff (1997) evaluated the current conditions of coastal campsites to use as baseline data for a monitoring program. The majority of campsite impacts in this study occurred near kitchen areas and tent entrances.

The question of natural recovery of visitor impacts in dynamic coastal environments was addressed by Buerger, Hill, Herstine, & Taggert (2000). They assessed recreation impacts on a barrier island in North Carolina such as soil compaction, vegetation loss, and human litter on recreation sites and trails. They found the degree of natural mitigation depends largely on the location of the impact on the island, with sites closer to the water exhibiting a higher level of natural mitigation over time.

Disturbance to wildlife, especially shorebirds, as a result of visitor/recreation use has been studied extensively. The effects of human activities on wildlife behavior (Burger, 1986; Thomas, Kvitek, & Bretz, 2003) and productivity (Bolduc & Guillemette, 2003; Loegering & Fraser, 1995; Patterson, et al., 1991) are popular in the literature. Bolduc and Guillemette (2000) found that human disturbance had an adverse effect on the nesting behavior of Common Eiders. They suggest that if human disturbance is limited to late in the incubation period, these effects can be minimized. Thomas et al. (2003) found that the number of visitors and their activity caused a reduction in the amount of time sanderlings spent foraging. However, Patterson et al. (1991) found no evidence to suggest that recreationists were having detrimental effects on piping plover productivity on Assateague Island, Maryland.

Classifying Monitoring Methodologies and Techniques

A thorough review of relevant scientific literature suggests that there are two primary methodological approaches to visitor impact monitoring in coastal areas (Figure 2.1). The *biophysical* approach includes studies that evaluate the extent and intensity of visitor impacts based on remotely sensed data, on-site assessments of recreation sites, or the direct observation of wildlife behavior. Studies that employ the *social science* approach evaluate the extent and intensity of visitor impacts based on the direct observation of visitor behavior that has high impact potential, or the perceptions of park visitors, managers, local experts and the general public.

Biophysical: Remote Sensing

In remote sensing, sensors onboard aircraft or satellites detect and record values of emitted or reflected electromagnetic radiation. Remote sensing is particularly useful for monitoring visitor impacts that occur in a large span of coastal areas and are easily detectable. Butler and Wright (1983) discussed the potential of remote sensing in recreation research (though not specifically coastal) particularly to measure user density and intensity and compare changes over time.

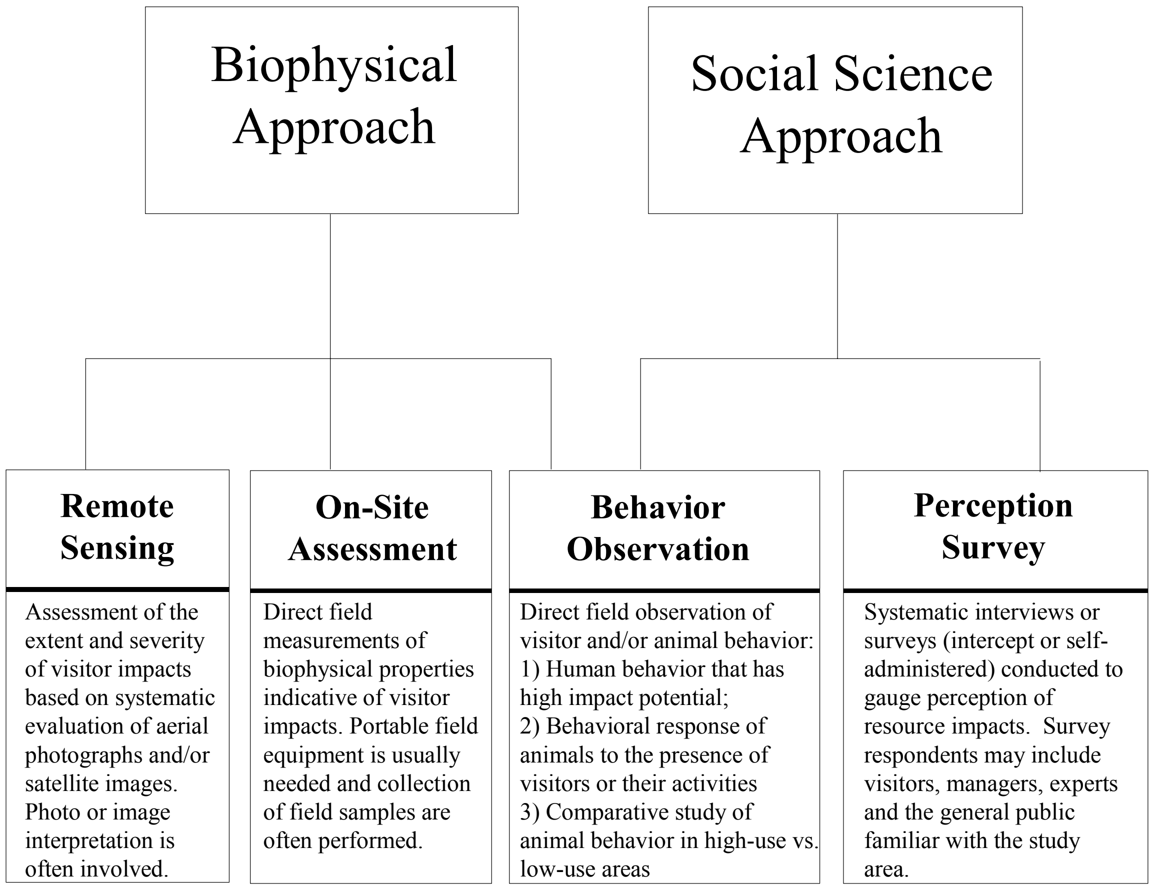


Figure 2.1. A classification of visitor impact monitoring techniques developed for coastal parks and protected areas.

Hockings and Twyford (1997) used aerial photography to identify the impacts of beach camping. They chose visitor impact indicators that could be identified easily on aerial photographs: vehicle tracks and the extent of clearing specifically for campsites. They compared their findings to ground surveys and found aerial photography to be a valid measure. Aerial photography was also used in the study to monitor spatial and temporal changes within campsites.

Welch, Madden, & Doren (1999) used remote sensing in conjunction with global positioning systems (GPS), mapping, and geographic information systems (GIS) to create digital databases of maps detailing vegetation and ORV trails for use in management and modeling. Aerial photography was used by Priskin (2003) to study the impacts of off-road vehicle use on a coastal environment in Western Australia from 1965 to 1998. In 1998, there were 296 more kilometers of four-wheel drive tracks and 487 additional access points than there were in 1965.

Evaluation

Remote sensing has not been used to its fullest potential in visitor impact monitoring in sandy coastal areas. Remote sensing is useful to monitor changes through time across large areas, though its utility is limited on fine-scale measurements. Temporal comparisons of ORV and pedestrian trails, vegetation cover, and dune size and location could be enhanced through the use of remote sensing technologies. Some parks and natural areas may find remote sensing too costly to implement as a long-term monitoring technique. GIS software, GPS units, and aerial photography would be required. The software, equipment (both for running the software and taking measurements), and staff training are expensive. The benefits and costs will have to be assessed before implementation.

Biophysical: On-Site Assessment

On-site assessment involves on-the-ground biophysical measurements of properties indicative of visitor impacts, usually with portable field equipment. This research approach can involve the collection of field samples for laboratory analysis. A number of campsite impact studies conducted recently in North America (Gajda, Brown, Peregoodoff, & Bartier, 2000; Monz, 1998) extended field procedures from earlier studies conducted in inland forests and parks (Leung & Marion, 2000).

Trampling and pedestrian traffic are commonly studied using the on-site assessment method (Chandrasekara & Frid, 1996; Kutiel et al., 2000; Kutiel et al., 1999; McAtee & Drawe, 1981; Rickard, et al., 1994). Chandrasekara and Frid (1996) used on-site measurements to determine the effects of trampling on tidal flat invertebrates. Sediment pH was measured on site while faunal and sediment samples were taken to the lab for further analysis. Their findings suggest that human trampling does cause a change in the composition of benthic fauna.

Kutiel et al. (1999) compared trails of high and low visitor use to assess the impacts on soil and annual plants in coastal woodlands. They measured soil properties such as compaction, organic matter, and moisture; and vegetation characteristics such as overall percent cover, overall average height, and percent cover for each species. Measurements were taken during a five-month period. They found that while impacts in high use areas were greater, they were more localized than in low use areas. They recommend reducing the number of low use trails.

Ghost crabs have been measured as an indicator species for the adverse effects of visitor activities with on-site assessment methods (Barros, 2001; Steiner & Leatherman, 1981). Steiner and Leatherman (1981) studied the distribution of ghost crabs at Assateague Island National Seashore in relation to ORV and pedestrian traffic using on-site assessment. Pedestrians were found to have no harmful effects on ghost crabs. In fact, the density was higher in these areas, possibly due to the abundance of food scraps. The ORV sites contained significantly fewer ghost crabs than the pedestrian sites. The difference between areas of high and low ORV use was not significant, indicating that any amount of ORV use is harmful.

Evaluation

Various on-site assessment methods have been used extensively to study visitor impacts in coastal areas. Collection methods and equipment used vary even when the phenomenon studied are the same. For use in a long-term monitoring program, staff must select the methods and equipment that work best for the area and not change the protocol for the duration of the study. Monitoring staff is likely to change through time (especially if volunteers are used), but it is important that new staff are trained extensively so that data are collected and analyzed in a consistent manner.

Biophysical and Social Science: Behavior Observation

Behavior observation includes a group of techniques that may fall within either the biophysical or social science methodological approach, depending on the subject of observation. Under the social science approach, human behaviors that cause impacts are observed and recorded. Under the biophysical approach, the behavioral response of wildlife to either the presence of visitors or specific visitor activities is observed and recorded. The two approaches can be used together (Burger, 1986; Thomas, et al., 2003) or separately (Loegering & Fraser, 1995; Patterson, et al., 1991).

Burger (1986) studied the behavioral responses of shorebirds to visitor activities. Shorebird responses were recorded as one of three behaviors: remained at the site, flew away but returned, and flew away and did not return. Only 30% of birds were unaffected by human activity; most birds flew away in response. Visitors walking on the beach and fisherman were responsible for the majority of the observed disturbances to shorebirds. Burger was unable to determine if these activities were harmful to the overall health of the birds, but indicated that disturbance during prime foraging times would likely have an adverse affect on health.

Thomas, et al. (2003) observed shorebird behavior to examine the impact of visitors on sanderling foraging behavior. During one-minute sampling periods they observed: total time spent foraging, total time disturbed by people, number of times the sanderling moved because of people, response of sanderlings to disturbance (run or fly), distance moved due to disturbance, number of people causing disturbance, type of activity causing disturbance, and distance between person and bird during disturbance. They found that the number, distance, and activity of visitors as well as the presence of free running dogs significantly reduced the amount of time sanderlings spend foraging.

Observation of behavior has also been used to determine if human disturbance has an effect on animal survival, specifically productivity, and the success of offspring (Loegering & Fraser, 1995; Patterson et al., 1991). Loegering and Fraser (1995) observed chick behavior in ten-second intervals during five-minute periods. They recorded behavior as foraging, locomotion, preening, alert, or resting. Any natural or human disturbances that occurred during the five-minute sample period were recorded. In this particular study, they also used on–site assessments to measure prey availability, predation, and disturbance. Patterson et al. (1991) observed nest sites and used on-site assessments to examine factors that could affect productivity. They found no evidence to suggest recreational activities had a detrimental affect on the productivity of piping plovers. Low productivity was attributed to predation.

Evaluation

Behavior observation has most commonly been used to study visitor impacts to wildlife. Some researchers observe visitor-wildlife interactions directly and record the activities of visitors and the responses of wildlife. Other researchers compare observations of wildlife in areas of high and low visitor activity. However, the effects of visitor behavior or activities on other aspects of the coastal environment, such as sand dunes or vegetation, are not often studied using this method. Trampling and ORV studies typically employ on-site assessment, although the use of remote sensing is increasing. Observation of visitor activities could add important information to the monitoring program. Adding a behavior observation component may help researchers determine why changes are occurring instead of just knowing that they are occurring.

Social Science: Perception Survey

The extent and severity of visitor impacts may be evaluated based on human perceptions of such problems. This social science approach can be implemented through systematic interviews and surveys. Survey respondents typically include visitors and managers of the study area. However, the general public and professionals who are familiar with the study area may also be surveyed.

Vaske, et al. (1992) used written self-administered surveys to understand visitors' perceptions of conflict between user groups and of the natural environment. Responses were separated by user group and by use area. Based on the survey responses, boaters were less educated about the ecology of the area, regulations, and human impacts than ORV users or pedestrians. Survey responses also revealed that visitors felt the beach area was becoming crowded. The information gathered from the surveys was combined with ecological data to create new management techniques, which included visitor education programs.

Priskin (2003) studied visitors' perceptions of environmental impacts caused by specific visitor activities based on a 5-point scale. Respondents were asked to rate land-based activities such as camping and four-wheel driving, and marine-based activities such as boating and fishing. Overall, visitors' perceived impacts to be less harmful than the author. Participants in three activities, fishing, sandboarding, and four-wheel driving, perceived their activities to be less harmful than non-participants, indicating a possible bias of visitors' ability to perceive impacts caused the their activities.

A survey or interview of managers may be used to gauge the extent and intensity of visitor impacts based on managers' or experts' perception. Becker, Dottavio, & Menning (1986) assessed the threats of human impacts to coastal areas based on a survey of visitors, the general public, managers and experts.

As part of the Northeast Coastal and Barrier Network Vital Signs monitoring project, Monz and Leung (2003) conducted interviews of park managers to evaluate their perceptions of visitor impacts. Information about the type, severity, and locations of these impacts was collected, as well as the managers' perceptions of which impacts should receive the highest priority in a monitoring program.

Evaluation

Perception surveys can be an effective first step in creating a long-term monitoring program. These surveys can identify areas or activities of concern that need to be monitored. By repeating perception surveys every several years, researchers can discover if any of the initial areas or activities of concern have changed as new visitor activities emerge. However, researchers must be aware of possible biases related to participation, as in Priskin (2003). Few published studies were found using this approach. If surveys were conducted during the initial stages of development or informally with management, they may not have been included in the final report.

Current Trends

The scientific assessment and monitoring of visitor impacts to sandy coasts and barrier islands emerged about 30 to 40 years ago, though our knowledge of direct impacts of visitors to coastal resources is still limited. The current state of knowledge indicates that visitor activities can have negative impacts on the coastal resources. These impacts include disturbance to wildlife resulting in lower survival and productivity and a change in dune morphology resulting in less vegetation cover on dunes and reduced dune height. Knowledge gaps exist where new visitor activities have emerged, such as kite surfing. A variety of monitoring techniques have been developed or adapted for a wide array of impact indicators, although on-site assessment and behavior observation are the most popular methodological approaches. Studies that integrate different methodological approaches to obtain a more comprehensive assessment of impacts are increasing.

On-site assessment has been applied in most regions of the world, while remote sensing and behavior observation techniques were largely developed and currently being used in North America. Three current trends in coastal visitor impact monitoring methodology were identified.

1. Expanding geographic scale of studies on visitor impacts in sandy coasts, from primarily North America to different world regions in recent years, perhaps as a result of the rapid growth in coastal ecotourism.

The earliest articles within the scope of this review and outside of North America are from 1975-1984 in the United Kingdom (Liddle & Greig-Smith, 1975a; Liddle & Greig-Smith, 1975b), Denmark (Hylgaard & Liddle, 1981) and Norway (Lundberg, 1984). A ten ten-year gap was found in articles outside of North America, with the next group of articles outside of North America appearing in 1994, representing Europe, Africa, and Australia (Barros, 2001; Chandrasekara & Frid, 1996; Hockings & Twyford, 1997; Kutiel et al. 1999; Priskin, 2003a; Priskin, 2003b; Rickard, et al., 1994). Further geographic expansion of visitor impact monitoring is likely to occur with the rapid growth of nature tourism and ecotourism worldwide in areas where visitor impacts have not traditionally been a concern.

2. Increased number of integrated studies that include both biophysical and social research components.

Vaske et al. (1992) used perception surveys and on-site assessment to create a management plan for three barrier beaches in Massachusetts. Remote sensing was used by Burger (1986) to determine the population of shorebirds while the major methodology used was behavior observation. Several researchers studying human-wildlife interactions have used the biophysical and social science methodological approaches by observing both visitor and wildlife behavior (Burger, 1986; Thomas et al., 2003).

Using the biophysical and social science approaches together can prove helpful in the selection of monitoring sites. Researchers can use perception surveys of visitors and managers to determine which areas have the highest or lowest use and then on-site assessments to obtain detailed information.

3. Increased application of technology in visitor impact monitoring studies. These technologies, such as GPS, GIS, and remote sensing, enhance the overall quality and especially the spatial accuracy of monitoring data.

In 1983, Butler and Wright investigated the possibilities of using remote sensing in recreation research. Since then, it has been applied to ORV (Priskin, 2003; Welch et al., 1999) and campsite (Hockings & Twyford, 1997) impacts. In all cases, the areas measured were too large for ground measurements to be practical over the long term. As the technologies used in remote sensing become more developed, the cost will decline and opportunities for training and higher education in these areas will increase, increasing its use in visitor impact monitoring. Remote sensing technologies such as aerial photography can be used to select study sites based on use level, type of activity present, and impact level, followed by ground surveys using on-site assessment (if more detailed measurements are needed).

Implications and Conclusion

Empirical research on visitor impacts in sandy coasts and barrier islands since the 1970s followed three themes based on their emphasis on the ecological component (specific or general) and visitor activity (specific or general). The methods used to study visitor impacts were classified into two main approaches: biophysical, including remote sensing, on-site assessment, and behavior observation and social science, including behavior observation and perception surveys. After reviewing these studies, it has become clear that none of these techniques alone provides a complete picture of the complex dynamics involved in visitor impacts. A comprehensive evaluation of a visitor impacts may necessitate the use of multiple methods. For example, a visitor perception survey alone may include biases based on the respondents' user groups. Remote sensing can identify use patterns, but not the level of soil compaction in the use areas. Managers and researchers creating a new monitoring program in response to a change in traditional activities or new visitor activities should create a program that involves multiple techniques.

Three important trends in monitoring methods were identified: a global expansion of impact studies, an increase in studies that use both biophysical and social science methodological approaches, and an increase in the application of technology to monitor visitor impacts. This trend will continue as spatial information becomes more available and equipment and training become less expensive. Managers and researchers can promote this development by creating spatial data with high quality and resolution and allowing that information to be accessible.

The research themes and methodological approaches identified in this review do apply to other coastal zones, such as rocky shores, but the visitor activities and ecological components studied may be different. Visitor activities such as ORV use and camping may not be as great of a concern in coastal areas with rocky shores. Remote sensing may be less applicable to rocky shores because it may be difficult to identify tracks on the rocky substrate.

Being informed of the state of the knowledge of visitor impact monitoring in sandy coastal areas and barrier islands is key to adapting or developing impact indicators and monitoring protocols. This assessment of scientific literature highlighted the results of several studies that found negative impacts resulting from visitor activities. Managers should take these findings into consideration as they develop management plans for their areas. There are ways to provide recreation opportunities and minimize impacts, such as creating a few major trails instead of multiple low use trails (Kutiel et al., 1999). Researchers should consider a multiple-method approach in the development of a monitoring program. By approaching the impacts from a variety of angles, a more comprehensive assessment of the impacts can be made. Through the use of monitoring programs, managers can strive to protect the coastal resources for future generations.

References

Anders, F. J., & Leatherman, S. P. (1981). *Final report on the effects of off-road vehicles on beach and dune systems Fire Island National Seashore.* (Report No. 50). Amherst: University of Massachusetts, The Environmental Institute.

Barros, F. (2001). Ghost crabs as a tool for rapid assessment of human impacts on exposed sandy beaches. *Biological Conservation, 97*, 399-404.

Beatley, T., Brower, D. J., & Schwab, A. K. (2002). *An Introduction to Coastal Zone Management* (2^{nd} ed.). Washington, DC: Island Press.

Becker, R. H., Dottavio, F. D., & Menning, N. L. (1986). Threats to coastal national parks: A technique for establishing management priorities. *Leisure Sciences, 8,* 241-256.

Blodget, B. G. (1978). The effect of off-road vehicles on least terns and other shorebirds. (UM-NPSCRU Report Number 26). Amherst: University of Massachusetts, Institute for Man and Environment.

Bolduc, F., & Guillemette, M. (2003). Human disturbance and nesting success of Common Eiders: Interaction between visitors and gulls. *Biological Conservation, 110*, 77-83.

Brodhead, J. M. B., & Godfrey, P. J. (1979). *The effects of off-road vehicles on coastal dune vegetation in the province lands, Cape Cod National Seashore, Massachusetts.* (UM-NPSCRU Report Number 32). Amherst: University of Massachusetts, The Environmental Institute.

Buerger, R., Hill, J., Herstine, J., & Taggert, J. (2000). The impact of recreation on barrier islands: A case study of Masonboro Island. *Coastal Management, 28,* 249-259.

Burger, J. (1986). The effect of human activity on shorebirds in two coastal bays in northeastern United States. *Environmental Conservation, 13*, 123-130.

Butler, R. W., & Wright, C. J. (1983). The application of remote sensing to recreation research. *Recreation Research Review, 10*(2), 13-18.

Chandrasekara, W. U., & Frid, C. L. J. (1996). Effects of human trampling on tidalflat infauna. *Aquatic Conservation: Marine and Freshwater Ecosystems, 6,* 299-311.

Carlson, L. H., & Godfrey, P. J. (1989). Human impact management in a coastal recreation and natural area. *Biological Conservation, 49,* 141-156.

Gajda, A. M. T., Brown J., Peregoodoff, G., & Bartier, P. (2000). Managing coastal recreation impacts and visitor experience using GIS. In D. N. Cole, S. F. McCool, W. T.

Borrie, J. O'Loughlin (Eds.), *Wilderness Science in a Time of Change Conference: Vol. 5. Wilderness Ecosystems, Threats, and Management*. (115-123). Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

Godfrey, P. J., &. Godfrey, M. M. (1980). Ecological effects of off-road vehicles on Cape Cod. *Oceanus, 23*(4), 56-66.

Hylgaard, T., & Liddle, M. J. (1981). The effect of human trampling on a sand dune ecosystem dominated by Empetrum nigrum. *Journal of Applied Ecology, 18,* 559-569.

Hockings, M., & Twyford, K. (1997). Assessment and management of beach camping impacts within Fraser Island World Heritage Area, South-East Queensland. *Australian Journal of Environmental Management, 4*, 26-39.

Hosier, P. E., & Eaton, T. E. (1980). The impact of vehicles on dune and grassland vegetation on a south-eastern North Carolina barrier beach. *Journal of Applied Ecology*, *17,* 173-182.

Kutiel, P., Eden, E., & Zhevelev, Y. (2000). Effect of experimental trampling and off-road motorcycle traffic on soil and vegetation of stabilized coastal dunes, Israel. *Environmental Conservation, 27*(1), 14-23.

Kutiel, P., Zhevelev, H., & Harrison, R. (1999). The effect of recreational impacts on soil and vegetation of stabilized coastal dunes in Sharon Park, Israel. *Ocean and Coastal Management, 42*, 1041-1060.

Leatherman, S. P. (1988). *Barrier Island Handbook*. College Park, MD: The University of Maryland, Laboratory for Coastal Research.

Leatherman, S. P. & Steiner, A. J. (1987). An Annotated Bibliography of the Effects of Off-Road Vehicles and Pedestrian Traffic on Coastal Ecosystems. Public Administration Series P2238. Moticello, IL: Vance Bibliographies.

Leung, Y., & Marion, J. L. (2000). Recreation impacts and management in wilderness: A state-of-knowledge review. In D. N. Cole, S. F. McCool, W. T. Borrie, and J. O'Loughlin (Eds.), *Wilderness Science in a Time of Change Conference: Vol. 5. Wilderness Ecosystems, Threats, and Management*. (23-48). Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

Liddle, M. J., & Greig-Smith, P. (1975a). A survey of tracks and paths in a sand dune ecosystem. I. Soils. *Journal of Applied Ecology, 12,* 893-908.

Liddle, M. J., & Greig-Smith, P. (1975b). A survey of tracks and paths in a sand dune ecosystem. II. Vegetation. *Journal of Applied Ecology, 12,* 919-930.

Loegering, J. P., & Fraser, J. D. (1995). Factors affecting piping plover chick survival in different brood-rearing habitats. *Journal of Wildlife Management, 59*(4), 646-655.

Lundberg, A. (1984). A controversy between recreation and ecosystem protection in the sand dune areas on Karmoy, southwestern Norway. *Geo-Journal, 8.2*, 147-157.

Marion, J. L., Roman, C., Johnson, B., & Lane, B. (2001). Summary of Visitor Use Management Working Group, Vital Sign Workshop for the North Atlantic Coastal Park Network, Gateway National Recreation Area, NY.

McAtee, J. W., & Drawe, D. L. (1981). Human impact on beach and foredune microclimate on North Padre Island, Texas. *Environmental Management, 5,* 121-134.

Milstead, B., & Steven, S. (2003). *Northeast Coastal and Barrier Network Vital Signs monitoring plan – Phase II report.* Kingston, RI: National Park Service Inventory and Monitoring Program.

Monz, C. A. (1998). Monitoring recreation resource impacts in two coastal areas of western North America: An initial assessment. In A. E. Watson, G. H. Alphet, and J. C. Hendee (Eds.), *Personal, Societal and Ecological Values of Wilderness. Vol. 1. Sixth World Wilderness Congress Proceedings on Research, Management and Allocation.* (117-122) Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

National Park Service. (2003). Designation of National Park System Units. Retrieved February 22, 2004, from http://www.nps.gov/legacy/nomenclature.html.

National Park Service Natural Resource Program Center. (2003). *Park Vital Signs Monitoring: A commitment to resource protection.* [Brochure].

National Survey on Recreation and the Environment (NSRE): 2000-2002. The Interagency National Survey Consortium, Coordinated by the USDA Forest Service, Recreation, Wilderness, and Demographics Trends Research Group, Athens, GA and the Human Dimensions Research Laboratory, University of Tennessee, Knoxville, TN.

Newman, C., Buesching, C. D., & Macdonald, D. W. (2003). Validating mammal monitoring methods and assessing the performance of volunteers in wildlife conservation—*"Sed quis custodiet ipsos custodies?" Biological Conservation, 113*, 189-197.

Monz, C., & Leung, Y. (2003). *Phase 1 project report: National Park Service Coastal Visitor Impact Monitoring*. Unpublished report.

Patterson, M. E., Fraser, J. D., & Roggenbuck, J. W. (1991). Factors affecting piping plover productivity on Assateague Island. *Journal of Wildlife Management, 55*(3), 525-531.

Peregoodoff, G. (1998). Recreation impact monitoring of coastal campsites in Gwaii Haanas National Park Reserve/ Haida Heritage Site. In: N.W.P. Munro, & J.H. Willison (Eds.), *Proceedings of the Third International Conference on Science and Management of Protected Areas: Linking Protected Areas with Working Landscapes Conserving Biodiversity*, 967-971.

Priskin, J. (2003a). Physical impacts of four-wheel drive related tourism and recreation in a semi-arid, natural coastal environment. *Ocean and Coastal Management, 46*¸ 127-155.

Priskin, J. (2003b). Tourist perceptions of degradation caused by coastal nature-based recreation. *Environmental Management, 32*(2), 189-204.

Rickard, C. A., McLachlan, A., & Kerley, G. I. H. (1994). The effects of vehicular and pedestrian traffic on dune vegetation in South Africa. *Ocean and Coastal Management, 23*, 225-247.

Steiner, A. J., & Leatherman, S. P. (1981). Recreational impacts on the distribution of ghost crabs *Ocypode quadrata* fab. *Biological Conservation, 20,* 111-122.

Steiner, A. J., & Leatherman, S. P. (1979). A preliminary study of the environmental effects of recreational usage on dune and beach ecosystems of Assateague Island. (UM-NPSCRU Report Number 44). Amherst: University of Massachusetts, The Environmental Institute.

Thomas, K., Kvitek, R. G., & Bretz, C. (2003). Effects of human activity on the foraging behavior of sanderlings *Calidris alba*. *Biological Conservation, 109*, 67-71.

Vaske, J. J., Deblinger, R. D., & Donnelly, M. P. (1992). Barrier beach impact management planning: Findings from three locations in Massachusetts. *Canadian Water Resources Journal, 17*, 278-290.

Welch, R., Madden, M., & Doren, R. F. (1999). Mapping the Everglades. *Photogrammetric Engineering and Remote Sensing, 109*, 163-170.

Wolcott, T. G., & Wolcott, D. L. (1984). Impact of off-road vehicles on macroinvertebrates of a Mid-Atlantic beach. *Biological Conservation, 29*, 217-240.

Zaremba, R. E., Godfrey, P. J., & Leatherman, S. P. (1979). The ecological effects of off-road vehicles on the beach/backshore (drift line) zone in Cape Cod National Seashore, Massachusetts. (UM-NPSCRU Report Number 29). Amherst: University of Massachusetts, The Environmental Institute.

CHAPTER 3: DEVELOPMENT AND TESTING OF A PROCEDURE FOR MONITORING VISITOR-HORSE INTERACTIONS FOR ASSATEAGUE ISLAND NATIONAL SEASHORE

Introduction

Although people visit National Parks for many reasons, observing wildlife is often a major one (Wright, 1992). Hastings (1986) surveyed visitors to the Great Smoky Mountains National Park and found that for 73% of the respondents, the expectation of seeing wildlife was the major reason for their visit; 92% indicated that viewing wildlife was very important to the enjoyment of their trip. In 2001, 66.1 million U.S. residents participated in wildlife watching activities, including observing, feeding, and photographing and spent approximately $38.4 billion dollars (U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau, 2001).

Some visitors may use human food as an attractant to increase their chance of observing wildlife at a close distance, creating negative impacts including aggressive wildlife behavior within species and toward visitors, altered behavior patterns, injury, and disease (Orams, 2002). Improper visitor-wildlife interactions are a common management concern in many protected natural areas such as U.S. National Park Service (NPS) units (Bath & Enck, 2003).

The NPS recently established the *Vital Signs* monitoring program as part of a larger initiative called the Natural Resource Challenge aiming at more effective natural resource protection through sustained long-term monitoring efforts (U.S. National Park Service, n.d.). Such monitoring programs, if implemented effectively, can alert park managers to important changes in natural resource conditions, prompt informed management decisions, evaluate the effectiveness of current management practices, and distinguish human-caused disturbance from natural changes (U.S. National Park Service, 2003). A part of the *Vital Signs* program focuses on monitoring visitor impacts because recreational activities have been identified as a significant and growing threat to natural resources in most ecosystems. In the NPS Northeast Coastal and Barrier Network, a *Vital Signs* scoping project recently identified visitor-feral horse interactions as a major management concern at Assateague Island National Seashore based on interviews with park staff (Monz & Leung, 2003).

Previous research has examined visitor interactions with bears (Fagen and Fagen, 1994; Jacobs and Schloeder, 1992; Albert and Bowyer, 1991; Gunther, 1989; Warner, 1986), coyotes (Bounds and Shaw, 1994), prairie dogs (Bekoff and Ickes, 1999), and shorebirds (Bolduc and Guillemette, 2003; Lafferty, 2000). These studies used behavior observation and perception surveys to measure visitor-wildlife interactions. In many situations behavior observation may provide more accurate results than a visitor or manager survey. Visitors may be hesitant to admit to engaging in prohibited interaction behavior, and managers may not be aware of all of the behaviors occurring. Behavior observation can document wildlife behavior systematically, which is an element missing in the visitor and manager surveys. Information about which subject initiated the interaction, and the behavioral response of the other subject might be more accurately recorded by a third person.

Among the behavior observation studies reviewed in this paper, highly trained researchers typically conducted the field observations. Such procedures would probably not be very efficient and cost-effective in long-term visitor impact monitoring programs. Instead, volunteers are likely to be recruited by organizations and park agencies to conduct parts or all of a monitoring program (Newman, Buesching, & Macdonald, 2003). The purposes of this study are: (1) to review various behavior observation techniques, (2) to adapt and develop a procedure for future use in monitoring visitor-wildlife interactions at Assateague Island National Seashore can be implemented by observers with diverse backgrounds and (3) to empirically evaluate a part of the procedure for accuracy and inter-observer reliability.

Review of Behavior Observation Literature

Martin and Bateson (1993) are often cited in the visitor-wildlife interaction literature. Their book provides a comprehensive and concise evaluation of behavior observation methods for both human and wildlife subjects. It is structured as a "practical guide book," but it is thorough enough to use as an authoritative source for quantitative research (p.i).

They categorize behavior observation methods as sampling rules and recording rules. Sampling rules, which include *ad libitum* (as one pleases), focal animal, scan, and behavior sampling, identify which subjects to watch and when. Recording rules describe how to record observations and include continuous and time sampling methods.

Sampling Rules

Ad libitum sampling uses no systematic method to record behavior. This method is useful when gathering preliminary data or rare events (Martin & Bateson, 1993).

When using *focal animal sampling*, the observer records the behavior of a chosen subject or group of subjects (Martin & Bateson, 1993). Loegering and Fraser (1995) used this method to study piping plover chick survival to determine if visitors where having an adverse effect. All chicks in a brood was randomly selected and observed for five minutes. Thomas, Kvitek, and Bretz (2003) randomly selected and observed individual sanderlings for one minute to study the impacts of visitor recreation on their foraging behavior.

When using focal sampling, the observer needs a plan in case the animal moves out of view. In some cases, the observation ends and the data are discarded. Alternatively, the observation might continue if the subject returns to view within a predetermined amount of time. Loegering and Fraser (1995) continued observations only if the animal returned within two minutes.

In *scan sampling*, the entire group of animals or humans is scanned at regular intervals and the behavior of each individual is recorded at the instant the interval begins (Martin & Bateson, 1993). This is typically used when few behaviors are being recorded. Warner (1986) used scan sampling to study visitor impacts on brown bears. The first scan began at the beginning of each hour, and scans were repeated every 5 minutes for 45 minutes resulting in nine scans per hour. The behavioral states of visitors and bears were recorded in addition to the weather, tides, type of bear, interactions between bears and visitors, and distance between bears and between bears and visitors. Fagen and Fagen

(1994) also used this method to study brown bears and visitor interactions. They scanned every 15 minutes during the first two years of the study, and then every 10 minutes for the following four years. Each bear's identification, behavior, and location were recorded as well as visitor presence.

Behavior sampling requires observation of the entire group of subjects, but only a particular behavior and the subsequent details are recorded. This method is useful for recording rare or infrequent behaviors when it is important to document each occurrence (Martin & Bateson, 1993). Fagen and Fagen (1994) used behavior sampling in conjunction with scan sampling. All interactions between visitors and bears were recorded regardless of whether they occurred during the systematic scan. For each interaction, they recorded the bear's identification, type of interaction, travel route of bear, initiator, location, date, time, and approximate age of bear.

Recording Rules

Continuous recording can provide an exact record of behavior. The time of each occurrence of a behavior or behaviors is recorded. Lehner (1996) suggests three categories of continuous recording: all-occurrences, sequence, and the socio-metric matrix. All-occurrences sampling requires that all occurrences of one or a few selected behaviors are recorded with the time each occurred. Sequence sampling documents a chain of behaviors. This may involve one individual or an interaction between individuals. For example, if A=jump, B=sit, and C=walk, the resulting data recorded might look something like ACBCAA. Observations recorded using the socio-metric matrix method are placed in a table that documents interactions between pairs or groups of identifiable subjects. In a study observing fights, for example, each individual would be represented by one row and one column, with the columns representing winners and the rows representing losers. The observer would then enter a tally mark in the appropriate box after each fight.

Time sampling divides the observation period into multiple intervals. There are two types of time sampling methods, instantaneous sampling (also called point sampling) and one-zero sampling (Martin & Bateson, 1993). Instantaneous sampling records behavior at the instant each sampling interval begins. Instantaneous sampling is often used in conjunction with scan sampling, as in Warner (1986) and Fagen and Fagen (1994).

With one-zero sampling, observations take place throughout the sampling interval and the observer records the presence or absence of selected behaviors during each interval. This method does not record the exact number of events during the interval, nor does it record the amount of time a subject displayed a behavior. Therefore, this method does not produce information on the frequency or duration of observed behaviors, which are among the reasons it has been criticized in the literature (Kraemer, 1979; Altmann, 1974). However, one-zero recording is useful in predicting the probability of the occurrence of at least one behavior in a time period when the behaviors are clustered (Bernstein, 1991).

Selecting a Method

To decide the appropriate combination of behavior observation rules, one must consider the research or monitoring questions to be answered, and who will conduct observations. To answer the monitoring questions, it may be important to record the identification of the individuals involved. In this case, the sociometric matrix or focal animal sampling would be appropriate, but scan sampling may not be. If the question concerns the duration of behavior, all-occurrence recording is appropriate, whereas one-zero recording is not. The observers are another key element. Volunteers with minimal training may not be able to discern individual subjects or behaviors, and they may have difficulty recording information on large numbers of subjects or behaviors. On the other hand, researchers or staff with ample training should be able to record more detailed information.

After selecting a method and creating an instrument, the procedure should be thoroughly tested on at least three evaluative criteria: inter-observer reliability, accuracy, and efficiency. The inter-observer reliability measures the degree to which different observers give consistent evaluations or estimates of the same phenomenon (Trochim, 2001). Comparing an observer's answers to an expert observer's answers, by simultaneous observations or videos, can assess accuracy. Efficiency is a measure of how much time and equipment is needed for each observation. The remainder of this paper will address the inter-observer reliability and accuracy of a behavior observation instrument to monitor visitor-horse interactions.

Study Site

The procedure described in this paper was developed for use at Assateague Island National Seashore. Assateague Island is a 64 km long barrier island in both Maryland

and Virginia. It is home to Chincoteague National Wildlife Refuge in Virginia and Assateague Island National Seashore and Assateague Island State Park in Maryland.

Assateague's feral horses are most likely descendents of domesticated horses brought to island in the 17th century to avoid taxes and a fencing requirement (Keiper, 1985). There are two herds separated by a fence, one herd in the National Park and one herd in Chincoteague National Wildlife Refuge. The Chincoteague horses are owned by the Virginia Volunteer Fire Company and receive veterinary care and supplemental food. The National Seashore horses are managed by the NPS as a wild species and do not receive these services unless an injury is caused by humans, in which case a veterinarian is called. Pregnancy inhibitors are used to control the National Seashore horse population, which was estimated by park staff at 176 in 2002 (C. Zimmerman, personal communication, September 2002). The horses are often referred to as ponies because they are smaller than most domesticated horses because of their diet of beach and sea grass.

Viewing the feral horses is one of the top reasons visitors come to Assateague Island National Seashore (Rodgus, 1985). There are several signs within the National Seashore warning visitors not to approach the horses. However, reports of visitors being kicked or bitten by horses are not uncommon during the peak season when visitors ignore the regulations and pet or feed the seemingly tame horses. It is important that visitors not engage in these improper interactions for several reasons. Eating food other than that provided by the island, even if it is an apple or carrot, interferes with their digestion and can harm a horse's health. Feeding the horses on the roadside causes them to become attracted to the roads. Horses have been hit and even killed by cars on the island.

Interactions have also caused some horses to become aggressive, forcing the NPS to remove the horses from the National Seashore. In the past, these horses have joined the Chincoteague herd. Recently, the NPS has started sending these horses to a rehabilitation farm where they eventually go on to become someone's domesticated pet.

There have been a few studies on the feral horses of Assateague Island National Seashore. In 1978, Keiper and Keiper conducted a survey of visitors' knowledge, attitudes, and judgments toward the horses. Results indicated that visitors understood the risk associated with wild horses; 69% of those surveyed felt the Assateague "ponies" should be considered "wild and potentially dangerous." When asked how the ponies should be managed, 87.9% agreed with "[for the] good health and well being of the ponies." The horses' body condition (Rudman & Keiper, 1991), reproduction (Keiper & Houpt, 1984), natal dispersal (Rutberg & Keiper, 1993), and population control methods (Points & Kirkpatrick, 1997) have also been studied.

Development of Procedures

The visitor component of a visitor-wildlife interaction can include photographing, petting, feeding, observing, or in some other way experiencing wildlife (Orams, 2002). A horse involved in an interaction might approach visitors, accept food handouts, antagonize visitors, or remain neutral to their presence. The park staff at Assateague Island National Seashore expressed a need for a program to monitor visitor-horse interactions that addressed four questions: (1) Are there a locations where more interactions occur? (2) Is there a time of day when interactions are most frequent? (3) Which horses are involved in interactions? and (4) What type of behaviors are involved in interactions?

Logistically, two other factors had to be considered. First, the park staff was unsure of who would eventually conduct the observations: permanent park employees, volunteers, or seasonal staff. Their volunteers range in age from 13-78 years old. Therefore, the monitoring protocol was designed so that observers with different backgrounds and education levels could use and yield the same results. Secondly, the interactions monitored by this procedure could occur anywhere throughout the developed section of Assateague Island National Seashore including the roadsides, campgrounds, and beach areas. The procedure had to be designed to sample several places during each sampling session.

The behavior sampling method (Martin and Bateson, 1993) was selected to systematically record behaviors in this study. Behavior sampling was selected because the monitoring questions were concerned only with visitor-feral horse interactions. It was also important to record each interaction seen during the sampling period. With focal animal or scan sampling, it would be possible to miss interactions if they involved an animal other than the focal horse or between intervals.

After pilot testing several instruments that used different recording methods from Martin and Bateson (1993) between August and October 2003, the one-zero method was determined to be the most feasible method to record observations. Visitor-horse interactions often involve many visitors and horses. As these numbers increase, it becomes more difficult to record detailed information. Instantaneous recording proved very difficult when the total number of subjects exceeded ten. Based on the questions to be answered by the monitoring protocol, frequency and duration estimates were not needed. Therefore, one-zero was appropriate in this case.

Content validity of the instrument was assessed by including behaviors that had been used previously in the literature and definitions of those behaviors based on the literature. Hastings, Gilbert, and Turner (1983) categorized human and bear behaviors during interactions as fear/avoidance, neutrality, approach, and aggression. Face validity was addressed by selecting behavior terms that could be understood intuitively by observers unfamiliar with behavior observation terminology.

Observation Procedure

A sampling session consists of one drive along the 21 km designated route in the developed section of the National Seashore. This route includes the main roads, bayside and oceanside campsite areas, and two beach areas (where the observers will park and go onto the beach to observe interactions). Observers will work in pairs and drive the selected route together. They will stop for all interactions and record observations over a five-minute sampling period. The observers will also record a Global Positioning System (GPS) point of the interaction location and photograph each horse involved. The GPS point simultaneously records the time and location of each interaction. If GPS is unavailable, the observers can mark the location on a paper map. The time is also recorded on the observation instrument. Analysis of these data will allow the managers to identify any locations or times of day where interactions occur more frequently. A Park employee will later use the photographs to identify the horses, allowing managers to monitor which horses are involved in interactions.

Two forms were created for observers to record behaviors involved in visitor-horse interactions. Observers use Form A (Appendix A) to systematically record visitor and wildlife behavior over a five-minute sampling period.

The five minutes are divided into ten 30-second intervals, and behaviors will be checked if they occur within each 30-second interval. The behaviors on this form are general categories of visitor behavior toward horses and horse behavior toward visitors: neutral, attraction, avoidance, and aggression. For visitors, observers will record two specific attraction behaviors, petting and feeding, because the park staff is especially concerned about these two prohibited behaviors. Observers will also record three count variables for each interval: (1) the total number of visitors, (2) the total number of stopped vehicles, and (3) the total number of horses. In addition, observers record the closest distance between a visitor and a horse (given in ranges).

If there is more than one horse involved, observations will be recorded for all horses, but one horse will be randomly selected before observation begins. If the horses move in different directions during the five minutes, the observation will continue with the chosen horse. Otherwise, both horses will be included in the observation. Just before beginning the observation period, the observer will record the session and event number, date, weather, temperature, and location description (such as bayside campground).

Observers use Form B (Appendix A) to record detailed observations of visitors involved in close interactions. A close interaction is defined as an interaction between a visitor and horse that occurs within three meters. Form B is only used if a close interaction occurs during the same five-minute sampling period as Form A. This form also uses the behavior sampling method, as it only applies to interactions that occur within three meters. It records specific information only about the visitor such as age, gender, mode of transportation (on foot, car, or bicycle), closest distance (<1m or 1-3m), and his/her specific behaviors (e.g. taking pictures).

Methods

Testing Procedure

As part of the ongoing process of evaluating the proposed monitoring procedure, this study evaluated the inter-observer reliability and accuracy of Form A using a video survey. Two 5-minute video clips (one on the roadside and another on a campground) of visitor-horse interactions were recorded in the field in October 2003 and shown to classes between November 2003 and January 2004. These clips were shown to undergraduate natural resources, parks, recreation, and tourism, and forestry management classes at North Carolina State University. Students were included in this test as they are believed to represent the potential users of the procedure as either potential park employees or volunteers.

In the roadside clip, a total of two horses and six people were involved; for the first 2.5 minutes, there were only three people. One person touched a horse one time. In the campground clip, there were six horses and seven people involved in the interaction throughout the five minutes, though the numbers fluctuated during each interval. Three people touched the horses several times in that clip. There were no instances of visitor or wildlife aggression or visitor feeding in either clip, although these behaviors can occur during interactions at Assateague Island National Seashore. Students were not told these behaviors would not occur during the video clips.

The same person administered the video surveys to all six classes. The students received approximately five minutes of verbal instruction prior to watching the videos. The instructions included directions to fill out each portion of the form and descriptions of each general behavior with specific examples (Table 3.1). The students also received a handout that reiterated these directions and descriptions. During the running of the videos, students were alerted every 30 seconds to move to the appropriate interval by a digital watch beep. Approximately half of the students were also given a verbal command. There was a brief 20-second pause between clips. After the two video clips, the students filled out a survey with demographic information and a comment section. The clips were shown in random order to allow later assessment of the effect of clip sequence.

Inter-observer reliability or precision was assessed by comparing the coefficient of variation (CV) among behavior and demographic groups. This has been suggested as a way to compare the inter-observer reliability in volunteer monitoring programs (Rector, 1995). Fagot and Hagan (1988) found observers who watched videotapes were less reliable (12%) than observers watching live situations. Our observers only received five minutes of training, whereas in practice they would receive more. Therefore, rather than setting a level for inter-observer reliability, each observation was ranked to determine

Table 3.1: Visitor and wildlife behaviors as explained to student observers.

Behavior	Definition	Examples
Neutral	One subject has no response to the presence of another subject	**Human:** someone happens to pass a horse while jogging, but pays no attention to the horse **Horse:** Chewing grass even though people are around, not changing behavior when people show up
Attraction	One subject is attracted to the presence of another subject	**Human:** taking pictures, feeding, touching, watching **Horse:** walking toward person, moving head to look at person
Avoidance	One subject moves away in response to the presence of another subject	**Human:** running or walking away from horse **Horse:** leaving area when people show up, move away when person tries to touch horse
Aggression	One subject threatens another subject	**Human:** Hitting, shaking a stick at, yelling at horse **Horse:** biting, kicking

which had the highest reliability (lowest CV) and which observation had the lowest reliability (highest CV). Those with the lowest reliability would indicate a need for further instruction or testing.

The CV rank was assessed overall, compared for each clip, and compared among demographic variables including gender, major, year in school, experience with behavior observation, and experience with horses. Because students could record information on two clips, when appropriate the overall CVs were calculated separately for each clip and then averaged to obtain the overall CV within comparison groups. For example, the CV for females was obtained by computing the CVs for the roadside clip and the campground clip separately and then averaging those numbers together.

All students except one recorded zero occurrences of wildlife aggression. One student recorded two occurrences of wildlife aggression. When that one student was included in the CV calculation for wildlife aggression, that behavior showed the lowest inter-observer reliability. When that student was not included in the CV for wildlife aggression, that behavior showed the highest inter-observer reliability. Therefore, the student was determined to be an outlier and removed from *only* the wildlife aggression CV.

Accuracy was determined based on the number of intervals students' correctly recorded the presence or absence of each behavior. For example, a student was able to record the presence or absence of visitor neutral over 10 intervals during the roadside clip. Those answers were then compared to the correct answers. If a student recorded the presence or absence of visitor neutral correctly 9 out of the 10 intervals, he or she received 90% accuracy for recording visitor neutral in the roadside clip. This was repeated for all behaviors and for each clip. The accuracy results were compared among demographic groups using independent sample t-tests.

For accuracy, a minimum acceptable level was chosen. It was set at 75% for observed behaviors (such as visitor neutral) and +3 to –3 for count variables (such as number of visitors). This level seemed appropriate for first-time observers and observers receiving five minutes of training. Behaviors that are recorded with less than 75% accuracy indicate a need for further explanation or practice. The ultimate acceptable level of accuracy will depend on the intended use of the information gathered from the monitoring program. Information used in legal proceedings may require 95%-100% accuracy, whereas information used to improve educational programs may only require 90% accuracy. More training will be required to achieve a higher level of accuracy. The more training required, the more cost and time it will require of its trainers and participants in the monitoring program.

Each clip had 10 intervals, so students had the opportunity to record 20 observations for each behavior, although some students only recorded information on one clip. Natural resources (NR) majors included students in natural resources, environmental science, and forestry management. Parks, recreation, and tourism (PRT) majors only include those students. Underclassmen included freshman and sophomore students, and upperclassmen included junior and senior students. All data analyses were performed using SPSS version 12.0 for Windows and Microsoft Excel 2000.

Results of Video Surveys

Sample Demographics

The video survey was conducted in six classes, yielding a sample size of 151 students, however only 93 students turned in completed observation forms. Of these 93 students: 66 students recorded observations on both clips; 17 students recorded observations on only the roadside clip; and 10 students recorded information on only the campground clip. Of the 93 students who submitted completed observation forms there were: 31 females, 62 males; 64 PRT majors, 20 NR majors, 9 other; 11 underclassmen and 81 upperclassmen (one student did not indicate a year in school); 18 students with behavior observation experience, 75 students without behavior observation experience; and 71 students with none to minimal experience with horses, 22 students with moderate to extensive experience with horses. There were 53 students who watched the roadside clip first and 40 students who watched the campground clip first. There were 49 students who received additional verbal prompts for each interval, and 44 students who received no additional verbal prompts.

Effect of Clip Sequence and Verbal Interval Prompt on Inter-Observer Reliability and Accuracy

The overall inter-observer reliability did not change substantially based on clip sequence. Students who watched the roadside clip first had a CV of 1.39, and students who watched the campground clip first had a CV of 1.40. The sequence of clips had a significant effect on the students' ability to accurately record four observations (Table 3.2). Students who watched the roadside clip first were significantly more accurate in their ability to record visitor neutral. Students who watched the campground clip first were significantly more accurate in their ability to record wildlife neutral, the number of vehicles, and the number of people.

Table 3.2. Effect of clip sequence on the accuracy (as a percentage) of students' ability to record observations.
Means were compared using independent t-tests (equality of variances not assumed). The standard deviation is in parenthesis. The "n" represents the total number of completed responses, which could equal up to 2 per student (one response for each clip). Significant at .05 ** Significant at .01 *** Significant at <=.001

Observation	Road-Camp Sequence n=73-95	Camp-Road Sequence n=43-64
Behaviors	***Percent Accuracy***	***Percent Accuracy***
Visitor neutral	86.3%*** (53.6)	69.8 % (33.5)
Wildlife neutral	69.9 % (36.2)	81.9% * (26.9)
Count Variables	***Total over- or under-estimate of the correct number of count variables***	***Total over- or under-estimate of the correct number of count variables***
Number of vehicles	+7.2 (6.3)	+3.0 *** (5.5)
Number of visitors	-5.5 (5.2)	-2.8 ** (5.7)

There was little difference in the overall inter-observer reliability between students who received the verbal interval prompt and those who did not. Students with the verbal prompt had a CV of 1.41, and students without the verbal prompt had a CV of 1.38. Students who received the additional verbal prompts were significantly more accurate recording four observations: visitor touching, wildlife neutral, the number of vehicles, and the number of people. Students who did not receive the additional verbal prompts were significantly more accurate recording visitor neutral (Table 3.3).

Table 3.3. Effect of verbal interval prompts on the accuracy of students' ability to record observations.
Means were compared using independent t-tests (equality of variances not assumed). The standard deviation is in parenthesis. The "n" represents the total number of completed responses, which could equal up to 2 per student (one response for each clip). *Significant at .05 ** Significant at .01 *** Significant at <=.001

Observations	**Verbal Prompt** n=43-47	**No Verbal Prompt** n=73-76
Behaviors	***Percent Accuracy***	***Percent Accuracy***
Visitor neutral	75.7% (33.0)	87.1%*** (22.1)
Visitor touch	90.6%* (9.6)	87.3% (8.4)
Wildlife neutral	83.3% *** (24.6)	65.6% (38.5)
Count Variables	***Total over- or under-estimate of accurate number of count variables***	***Total over- or under-estimate of accurate number of count variables***
Number of vehicles	+3.0*** (5.5)	+7.2 (6.3)
Number of visitors	-2.8** (5.7)	-5.5 (5.2)

Inter-Observer Reliability

The overall CV for students' ability to record behaviors was 2.1 (Table 3.4). Looking at specific behaviors, wildlife aggression, wildlife neutral, and visitor attraction were recorded with the highest inter-observer reliability, and visitor aggression, visitor feeding, and wildlife avoidance were recorded with the lowest inter-observer reliability (Table 3.4). Students recorded observations from the campground clip with a higher combined inter-observer reliability than on the roadside clip.

Table 3.4: Inter-observer reliability among students' recorded behavior observations: Overall and comparison of clip types using the coefficient of variation.
The "n" represents the total number of completed responses, which could equal up to 2 per student (one response for each clip).

Observed Behaviors	Overall n=156	Roadside Clip n=83	Campground Clip n=73
Visitor neutral	1.4	1.5	1.3
Visitor attraction	0.56	0.49	0.60
Visitor avoidance	1.9	1.9	2.0
Visitor aggression	6.6	5.2	8.7
Visitor touching	5.0	7.3	2.8
Visitor feeding	1.1	1.1	0.80
Wildlife neutral	0.44	0.15	0.43
Wildlife attraction	1.8	2.2	1.4
Wildlife avoidance	2.0	6.2	1.2
Wildlife aggression	0.0	0.0	0.0
AVERAGE	**2.1**	**2.6**	**1.9**

The inter-observer reliability rank of count variables from highest to lowest was number of visitors, number of wildlife, and number of vehicles (Table 3.5). When compared with the count variables, the closest distance estimates had the lowest inter-observer reliability. Students recorded count variables and the closest distance with higher inter-observer reliability on the roadside clip than the campground clip.

The largest differences in the overall inter-observer reliability (including behaviors and count variables) of demographic groups were found comparing majors and year in school (Table 3.6). NR students had an overall CV of 0.85 while PRT majors had an overall CV of 1.36. Underclassmen had an overall CV of 1.04 while upperclassmen had an overall CV of 1.84. The differences in the CVs of specific observations between demographic groups are displayed in Figures 3.2-3.6 and in Appendix B.

Table 3.5: Overall inter-observer reliability and comparison of clip types for count variables using the coefficient of variation.
The "n" represents the total number of completed responses, which could equal up to 2 per student (one response for each clip).

Count Variables	Overall n=156	Roadside Clip n=83	Campground Clip n=73
Number vehicles	0.60	0.44	0.69
Number visitors	0.18	0.14	0.20
Number wildlife	0.33	0.15	0.15
Closest distance (average in meters)	0.76	0.60	0.92
AVERAGE	**0.47**	**0.33**	**0.49**

Table 3.6: A comparison of the overall inter-observer reliability among demographic groups using coefficient of variation.
The "n" represents the total number of completed responses, which could equal up to 2 per student (one response for each clip).

Demographic Category	Group	Number of Responses (n)	Overall CV	Difference
Gender	Females	55	1.20	0.32
	Males	104	1.52	
Major	Parks, Recreation, and Tourism (PRT)	108	1.36	0.51
	Natural Resources (NR)	33	0.85	
Year in school	Underclassmen	16	1.06	0.78
	Upperclassmen	142	1.84	
Experience in behavior observation	With experience	31	1.09	0.32
	Without experience	128	1.41	
Experience with horses	Minimal experience	121	1.35	0.42
	Maximum experience	38	0.93	

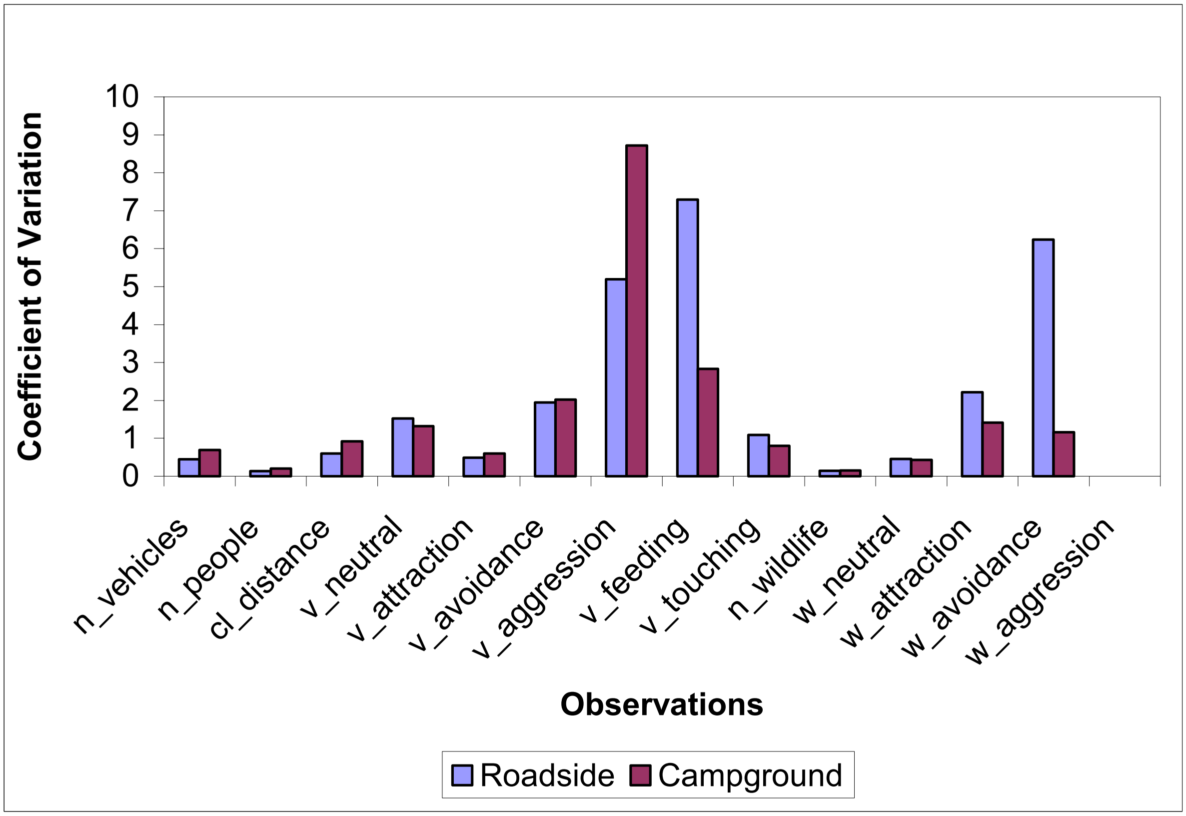


Figure 3.1. Inter-observer reliability: Roadside clip vs. campground clip

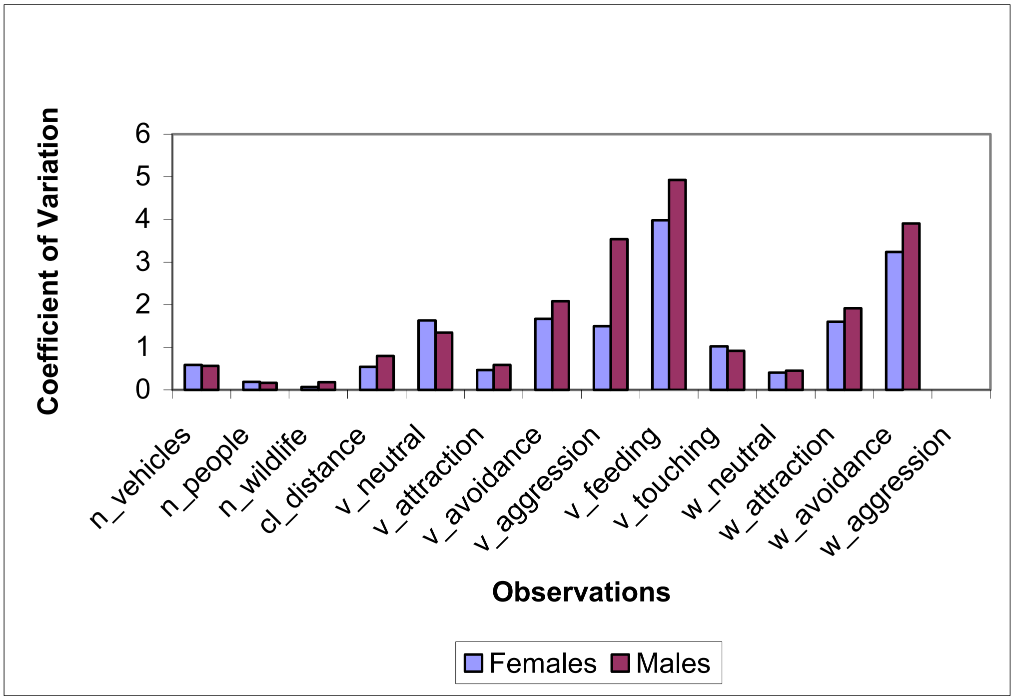


Figure 3.2. Inter-observer reliability: Females vs. males

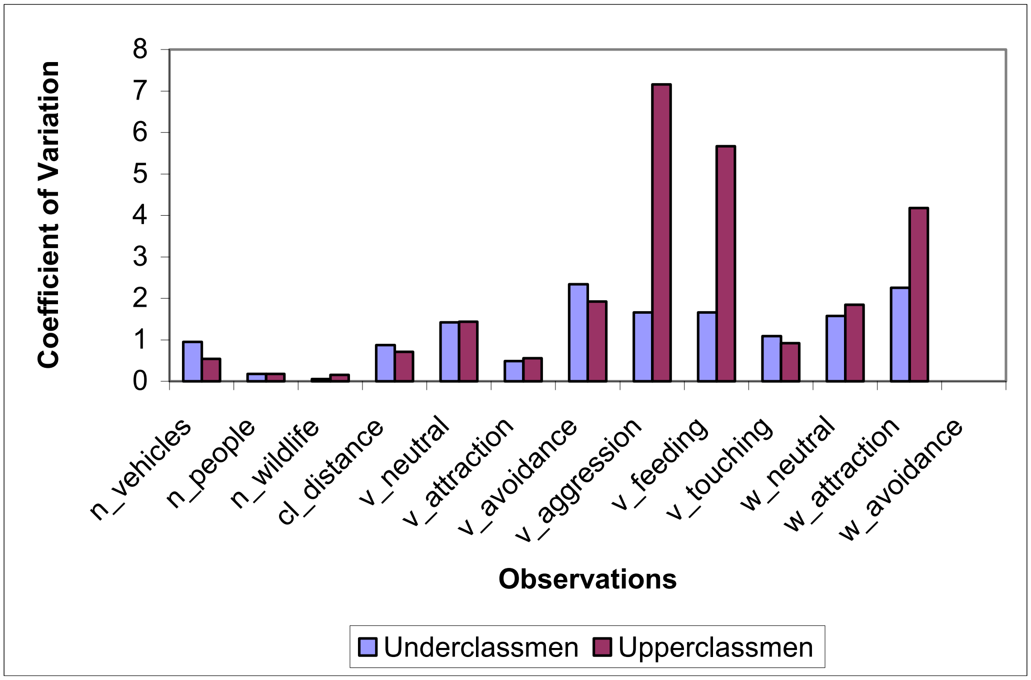


Figure 3.3. Inter-observer reliability: Underclassmen vs. upperclassmen

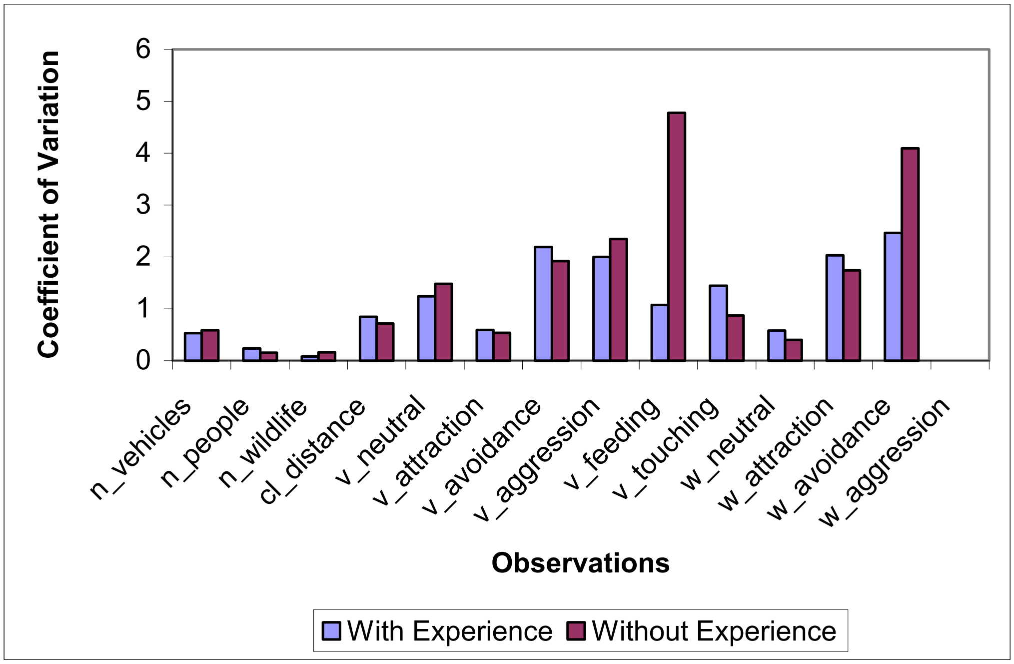


Figure 3.4. Inter-observer reliability: Students with previous behavior observation experience vs. students without previous behavior observation experience

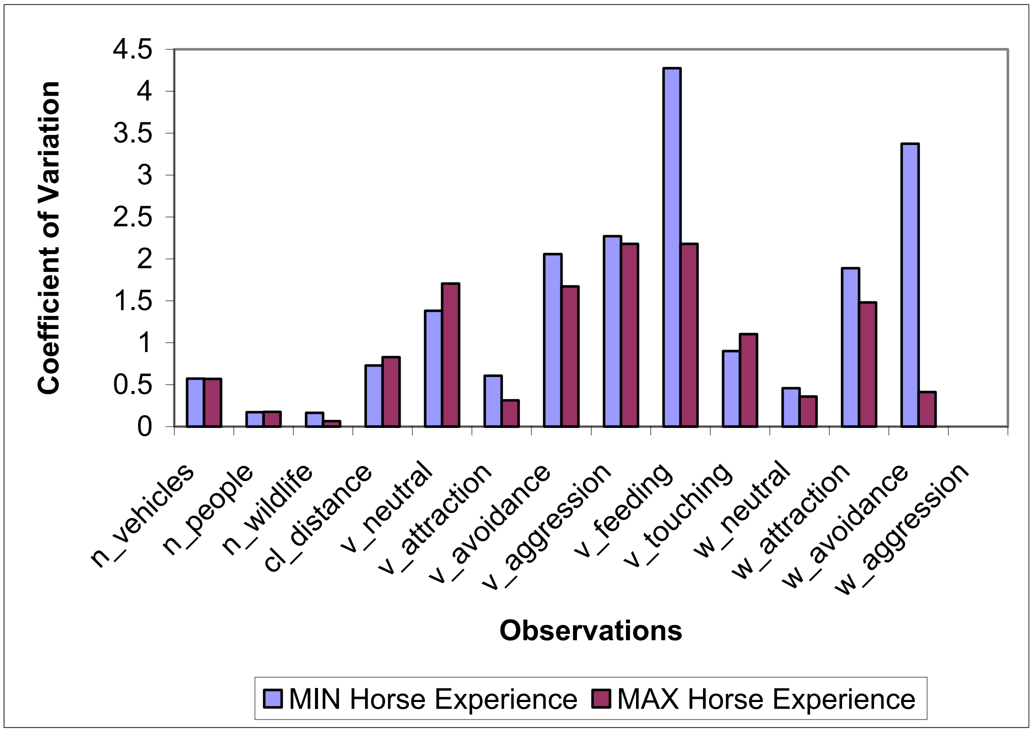


Figure 3.5. Inter-observer reliability: Students with none-minimal experience (min) vs. students with moderate-extensive experience (max) with horses.

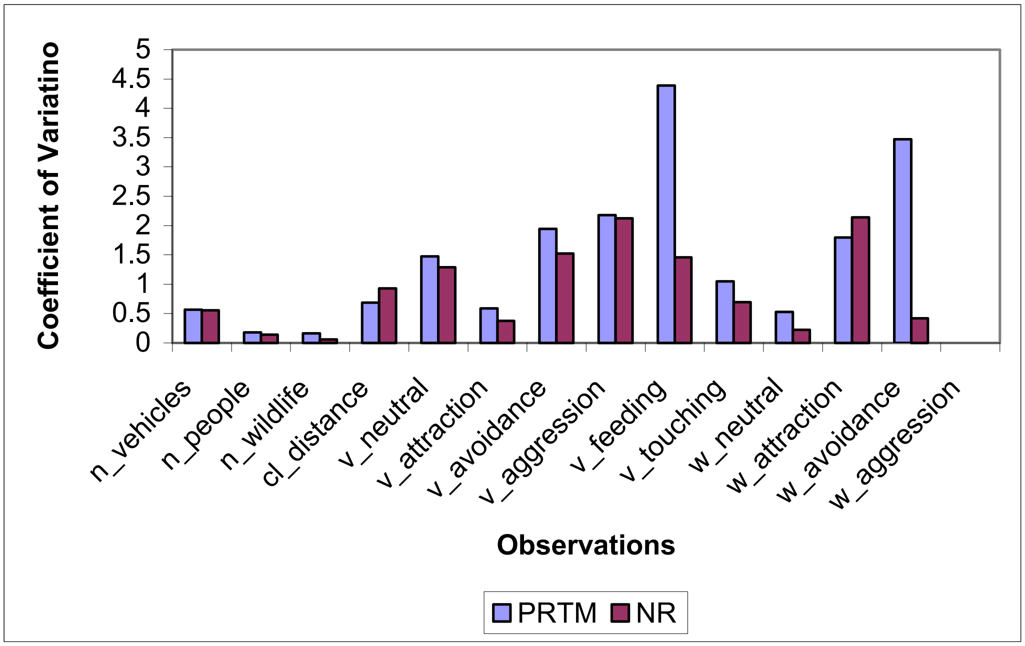


Figure 3.6. Inter-observer reliability: PRT majors vs. NR majors

Accuracy

Overall, students recorded behaviors with 83.5% accuracy. Most specific behaviors were recorded with greater than 75% accuracy except visitor attraction and visitor avoidance (Table 3.7). Students recorded behaviors on the roadside clip more accurately at 87.9% than on the campground clip at 78.6%. On the roadside clip, students recorded observations of visitor attraction, visitor touching, wildlife attraction, and wildlife avoidance significantly more accurately than on campground clip.

Table 3.7. Overall accuracy and comparison of clip types for visitor behaviors. Each number represents the accuracy (as a percentage) of students' ability to record observations. The standard deviation is in parenthesis. The means between the roadside and campground clips were compared using independent t-tests (equal variances not assumed). The "n" represents the total number of completed responses, which could equal up to 2 per student (one response for each clip).
*Significant at .05
** Significant at .01 *** Significant at <=.001

Observed Behaviors	Overall n=156	Roadside Clip n=83	Campground Clip n=73
Visitor neutral	79.7 (29.1)	79.6 (31.1)	79.7 (26.9)
Visitor attraction	63.9 (31.9)	70.2** (34.3)	57.0 (27.6)
Visitor avoidance	71.9 (8.8)	71.8 (10.1)	72.1 (7.2)
Visitor aggression	99.7 (2.1)	99.6 (1.9)	99.7 (2.3)
Visitor touching	98.2 (9.2)	98.4 (11.4)	97.9 (6.0)
Visitor feeding	89.0 (9.2)	93.3*** (6.1)	84.3 (9.7)
Wildlife neutral	75.2 (32.9)	78.8 (34.6)	71.4 (30.7)
Wildlife attraction	77.2 22.6)	89.0*** (24.3)	64.2 (10.5)
Wildlife avoidance	79.8 (21.7)	98.2*** (11.3)	59.7 (8.6)
Wildlife aggression	99.9 (1.6)	100.0 (0.0)	99.7 (2.3)
AVERAGE	**83.5**	**87.9**	**78.6**

Overall, the number of stopped vehicles was overestimated and the number of visitors was underestimated, both outside of the acceptable range of +3 to –3 (Table 3.8). The number of wildlife was underestimated but well within the acceptable range. The closest distance was overestimated within the acceptable range. On the roadside clip, two observations were recorded significantly more accurate than on the campground clip: the number of visitors and the number of vehicles.

Table 3.8: Overall accuracy and comparison of clip types for count variables using the coefficient of variation.
A positive number indicates students overestimated the correct number, and a negative number indicates students underestimated the correct number. The numbers of vehicles, visitors, and wildlife are shown as the total over- or under- estimation for the entire 5-minute sampling period. The closest distance is shown as the average over or under estimation of meters for the 5-minute sampling period. Means between groups were compared using independent t-tests (equality of variances not assumed). The standard deviation is in parenthesis. The "n" represents the total number of completed responses, which could equal up to 2 per student (one response for each clip).

*Significant at .05 ** Significant at .01 *** Significant at <=.001

Count Variables	Overall n=156	Roadside Clip n=83	Campground Clip n=73
Number vehicles	6.1 (6.6)	7.1* (7.3)	4.8 (5.3)
Number visitors	-4.4 (5.6)	-1.7*** (3.9)	-7.4 (5.7)
Number wildlife	0.32 (4.0)	-0.18 (2.6)	-0.85 (5.1)
Closest distance (average in meters)	2.3 (3.5)	1.9 (2.9)	2.7 (4.1)

Overall, there were no major differences among demographic groups in the accuracy of recording observations (Table 3.9), although there were a few significant differences for specific behaviors. Students with none-minimal experience with horses recorded visitor attraction significantly lower than students with moderate-extensive experience with horses. NR majors recorded visitor attraction and wildlife neutral significantly more accurately than PRT majors. Students with moderate to extensive experience with horses recorded visitor attraction significantly more accurately than students with none to minimal experience with horses. Upperclassmen recorded the closest distance significantly more accurately than underclassmen. The differences in accuracy of each observation between demographic groups are displayed in Appendix B.

Table 3.9: Comparison of overall accuracy among demographic groups of observed behaviors. Each number represents the accuracy (as a percentage) of students' ability to record observations. The standard deviation is in parenthesis. The means between the roadside and campground clips were compared using independent t-tests and considered significant at the .05 level. The "n" represents the total number of completed responses, which could equal up to 2 per student (one response for each clip).

*Significant at .05 ** Significant at .01 *** Significant at <=.001

Demographic Category	Group	Number of Responses (n)	Accuracy
Gender	Females	55	84.3
	Males	104	83.0
Major	Parks, Recreation, and Tourism (PRT)	108	82.3
	Natural Resources (NR)	33	85.7
Year in school	Underclassmen	16	83.7
	Upperclassmen	142	83.4
Experience in behavior observation	With experience	31	82.2
	Without experience	128	83.8
Experience with horses	Minimal experience	121	83.0
	Maximum experience	38	85.7

Discussion

Observations

Students tended to record wildlife behaviors more accurately and with higher inter-observer reliability than visitor behaviors. Wildlife aggression, the number of wildlife, and closest distance was recorded with high inter-observer reliability and high accuracy, indicating that most students understood what they were observed and recorded it correctly (Figure 3.7). Wildlife aggression did not occur on the video clips. These results indicate that students accurately and reliably recorded the absence of wildlife aggression, but further testing is needed to determine if observers can accurately and reliably record the presence of wildlife aggression. The horses on the videos were larger than the visitors and usually standing with enough distance that students could discern individual horses with little difficulty.

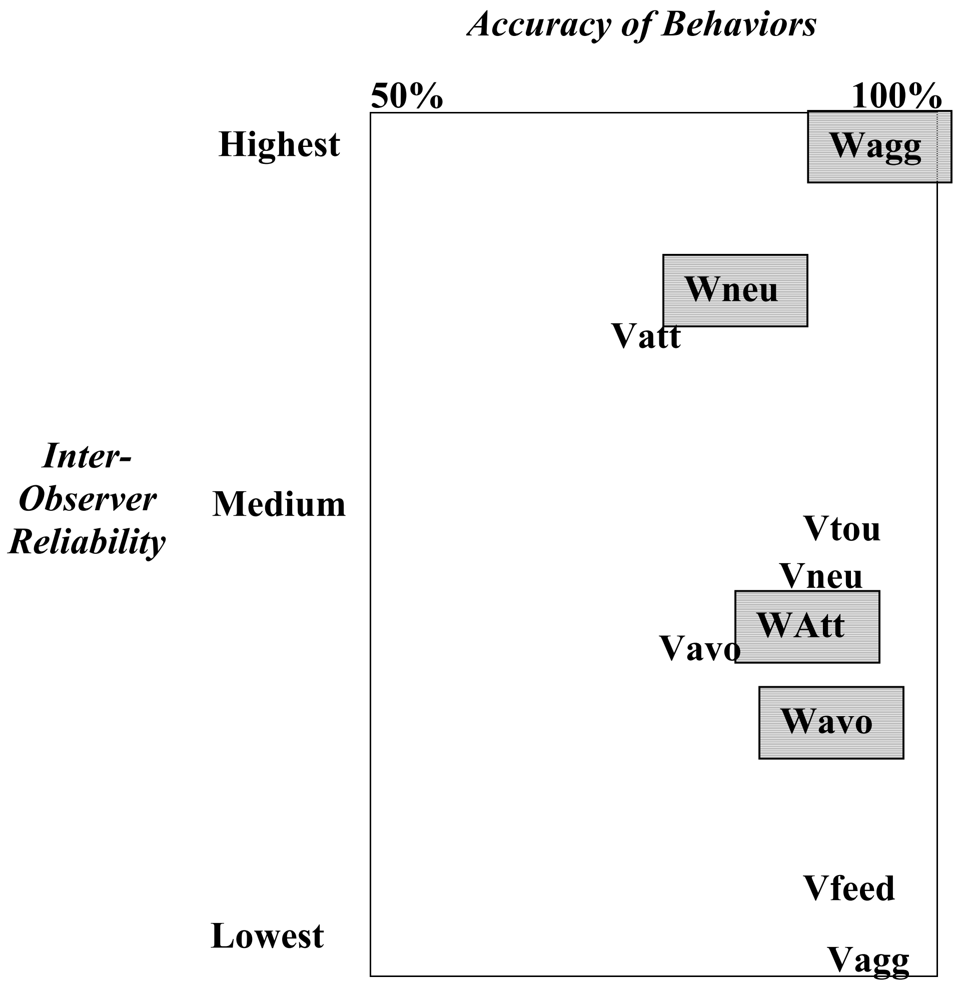
Visitor avoidance was recorded with low inter-observer reliability and low accuracy, indicating that students had inconsistent agreement on what they were supposed to observe and record.

Visitor feeding, visitor aggression, and wildlife avoidance were recorded with high accuracy, but low inter-observer reliability indicating that students need more practice recording these behaviors. They understood what they were supposed to observe as indicated by the high accuracy, but did not record it with much reliability. The reliability could improve with additional practice. Visitor feeding did not occur in the video clips. Students may have thought they observed video feeding when they were actually observing touching or close contact, but because of the videos this may have been difficult to determine.

The number of visitors, visitor attraction, wildlife neutral, and the number of vehicles were recorded with high inter-observer reliability, but with low accuracy. This indicates that the majority of students misunderstood what they were supposed to observe and record, and they misunderstood in the same way. Based on students' responses, this was definitely the case for the number of vehicles. Several students stated that they recorded all vehicles in the clip and not just the stopped vehicles as they were instructed on the handout and verbally. However, Form A only stated "number of vehicles," and this may have caused the confusion. The final version of the form will clearly state "number of stopped vehicles."

The results of the number of visitors could be explained another way. The low accuracy is most likely due to the nature of video technology. In rooms with poor lighting, it was sometimes difficult to determine the number of people if they were standing close together. This affected all students, which could explain the high reliability. Field observers will not have the same problem as video observers of discerning the number of people and horses, and so these variables should increase in accuracy and inter-observer reliability when used in practice.

Figure 3.7. Relationship of inter-observer reliability and accuracy of behavior observations. Inter-observer reliability ranking of highest to lowest includes behaviors only. The placement of the variables from left to right indicate their accuracy, with starting with 0% accuracy on the left to 100% accuracy on the right for behaviors. The placement of the variables from the top to the bottom of the graph indicate their ranking from highest (at the top of the figure) to lowest (at the bottom of the figure) inter-observer reliability.



Key of Observation Codes
Wildlife behaviors are in shaded boxes

Vneu: Visitor Neutral
Vatt: Visitor Attraction
Vavo: Visitor Avoidance
Vagg: Visitor Aggression
Vtou: Visitor Touching
Vfeed: Visitor Feed

Wneu: Wildlife Neutral
Watt: Wildlife Attraction
Wavo: Wildlife Avoidance
Wagg: Wildlife Aggression

The results of the demographic comparisons show only minor differences in the accuracy and inter-observer reliability between these different groups of people. Therefore, it is feasible that volunteers of different backgrounds could participate in this visitor-horse monitoring program and yield the same results.

Clip: Roadside vs. Campground

Students tended to record behaviors on the roadside clip more accurately, but with lower inter-observer reliability than on the campground clip. This is most likely due to the fact that there were more people, horses, and action involved in the interaction portrayed on the campground clip. The additional action may have made it difficult to record information on that clip accurately. However, when frequencies of behaviors are low, inter-observer reliability can also be lower (Caro, Roper, Young, & Dank, 1979). Observers may not be paying attention when there is less action as was the case in the roadside clip. So although their observations may be accurate overall, the variability among observations may be increased.

Limitations

Only 20 minutes were available to conduct the video surveys because they were conducted during regular class time. Ten minutes were needed to view the clips and five minutes were needed to answer questions and give students time to complete the demographic survey. That left only five minutes for instructions. In reality, observers will receive extensive training and practice before conducting observations on their own. Many students responded that the form was difficult, they did not completely understand the directions, and the intervals were too short. With practice and additional instruction, observers will become more comfortable with the form and the length of the intervals should not be a problem.

Of the six classes participating, only two met in the same classroom. The difference in screen size, projection equipment, distance to the screen, and lighting could have caused variability in recording observations.

Although the video clips represented real interactions, they did not portray all of the behaviors listed on the observation form. Visitor feeding did not occur in either clip nor did visitor or wildlife aggression. It was considered inappropriate to instigate or encourage aggressive or feeding behaviors. The one–zero recording method records the presence or absence of behaviors, so it is appropriate to analyze behaviors even when the do not occur, because students can record that behavior as absent. However, one must use caution interpreting the results of accuracy and inter-observer reliability tests on these behaviors as students were not given the chance to record present behaviors.

Implications and Conclusion

The results of the inter-observer reliability and accuracy tests of visitor and feral horse behavior observations will assist in the implementation of the final monitoring procedure at Assateague Island National Seashore. The students' biggest complaint was the time allotted for each interval, not the method of recording behaviors. With practice, observers will become more comfortable with the length of the intervals. Therefore, the one-zero recording can be used in this procedure. The behaviors with low inter-observer reliability and/or accuracy will require more attention during the training session. For example, visitor avoidance was low in both accuracy and inter-observer reliability, indicating a need for more detailed explanations and examples of these behaviors because students varied in their understanding of the behaviors.

More time should be allotted to train the actual observers of this from at Assateague Island National Seashore. During this training, a video showing examples of specific behaviors can be used to improve participants' understanding of the behaviors, thereby improving the inter-observer reliability. As part of their training, the observers should practice in the field several times before conducting observations on their own. Trainees can ride along with trained observers and record the same interactions. The trainees can use this opportunity to gain practice and become comfortable with the observations procedures and ask further questions that may not have occurred to them during the initial training session.

The Park Service will need to test the participants of the program for accuracy and inter-observer reliability before allowing them to conduct observations on their own. Acceptable levels of each will need to be determined based on the intended use of the monitoring program's information. If the information is to be used to change management policies, a high level of accuracy and reliability may be required. If the information is to be used to enhance the current efficiency of the pony patrol volunteers, a lower level of accuracy and reliability may be acceptable.

Although some observations on Form A need additional work, overall this form can be used to monitor the visitor-feral horse interactions at Assateague Island National

Seashore. The inter-observer reliability and accuracy test results have provided information to improve Form A and implications for a training program. This information will be used during the implementation phase of the Northeast Coastal and Barrier Network Vital Signs project. Once implemented, the protocol will provide managers with information about the behaviors involved in visitor-horse interactions. This data can be linked to spatial data collected with the GPS unit to determine which locations are more likely to have interactions involving a particular behavior.

Testing the instrument with video surveys on undergraduate students was an efficient and cost effective method to test the inter-observer reliability and accuracy of the instrument as compared to testing students in the field. However, future researchers may find it more beneficial to survey fewer students and spend more time on the instructional portion, perhaps during a class's scheduled lab time rather than during regular class time.

With site and animal specific modifications, this procedure could be adopted for other wildlife involved in visitor interactions if the monitoring objectives are the same. Depending on the size and behaviors of the animal, the time intervals may need to be lengthened or shortened. Observations of feral monkey-visitor interactions, for example, may require longer time intervals. Feral monkeys move much faster than feral horses, so more time would be needed to observe and record behaviors. All of the current observation categories may not be necessary, or some categories may need to be added. In visitor-bird interactions the number of birds involved can be very high. In that situation, the observation that requires counting the total number of wildlife species per interval may need to be eliminated.

References

Albert, D. M., & Bowyer, R. T. (1991). Factors related to grizzly bear-human interactions in Denali National Park. *Wildlife Society Bulletin, 19,* 339-349.

Altmann, J. (1974). Observational study of behavior: sampling methods. *Behaviour, 48,* 227-265.

Bath, A. J., & Enck, J. W. (2003). Wildlife-human interactions in national parks in Canada and the USA. *Social Science Research Review, 4*(1), 1-43.

Bekoff, M., & Ickes, R. W. (1999). Behavioral interactions and conflict among domestic dogs, black-tailed prairie dogs, and people in Boulder, Colorado. *Anthrozoos, 12*(2), 105-110.

Bernstein, I.S. (1991). An empirical comparison of focal and ad libitum scoring with commentary on instantaneous scans, all occurrence and one-zero techniques. *Animal Behavior, 42,* 721-728.

Bounds, D. L., & Shaw, W. W. (1994). Managing coyotes in U.S. National Parks: Human-coyote interactions. *Natural Areas Journal, 14*(4), 280-284.

Buldoc, F., & Guillemette, M. (2003). Human disturbance and nesting success of Common Eiders: interaction between visitors and gulls. *Biological Conservation, 110,* 77-83.

Caro, T. M., Roper, R., Young, M., & Dank, G. R. (1979). Inter-observer reliability Part 3-4. *Behavior, 69,* 303-315.

Fagen, J. M., & Fagen, R. (1994). Interactions between wildlife viewers and habituated brown bears, 1987-1992. *Natural Areas Journal, 14*(3), 159-164.

Fagot, B., & Hagan, R. (1988). Is what we see what we get? Comparisons of taped and live observations. *Behavioral Assessment, 10,* 367-374.

Hastings, B. C. (1986). Wildlife-related perceptions of visitors in Cades Cove, Great Smoky Mountains National Park. (Doctoral dissertation, University of Tennessee, 1986). *Dissertation Abstracts International, 47,* 11B.

Hastings, B. C., Gilbert, B. K, & Turner, D.L. (1983). Black bear aggression in the backcountry of Yosemite National Park. *Proceedings of the Eighth International Conference on Bear Research and Management: Bears--Their Biology and Management, 6,* 145-149.

Gunther, K. A. (1989). Visitor impact on grizzly bear activity in Pelican Valley, Yellowstone National Park. In L. M. Darling & W. R. Archibald (Eds.), *Proceedings of the Eighth International Conference on Bear Research and Management: Bears--Their Biology and Management, 8,* 73-78.

Jacobs, M. J., & Schloeder, C. A. (1992). Managing brown bears and wilderness recreation on the Kenai Peninsula, Alaska, USA. *Environmental Management, 16*(2), 249-254.

Keiper, R. R., & Houpt, K. (1984). Reproduction in feral horses: An eight year study. *American Journal of Veterinary Research, 45*(5), 991-995.

Keiper, R. R. (1985). *The Assateague Ponies*. Centreville, MD: Tidewater Press.

Kraemer, H. C. (1979). One-zero sampling in the study of primate behavior. *Primates, 20*(2), 237-244.

Lafferty, K. D. (2001). Birds at a Southern California beach: seasonality, habitat use, and disturbance by human activity. *Biodiversity and Conservation, 10*, 1949-1962.

Lehner, P. N. (1996). *Handbook of Ethological Methods* (2nd ed.). New York: Cambridge University Press.

Loegering, J. P., & Fraser, J. D. (1995). Factors affecting piping plover chick survival in different brood-rearing habitats. *Journal of Wildlife Management, 59*(4), 646-655.

Martin, P., & Bateson, P. (1993). *Measuring Behavior* (2nd ed.). New York: Cambridge University Press.

Monz, C., & Leung, Y. (2003). *Phase 1 project report: National Park Service Coastal Visitor Impact Monitoring*. Unpublished report.

Newman, C., Buesching, C. D., & Macdonald, D. W. (2003). Validating mammal monitoring methods and assessing the performance of volunteers in wildlife conservation—*"Sed quis custodiet ipsos custodies?" Biological Conservation, 113,* 189-197.

Orams, M. B. (2002). Feeding wildlife as a tourism attraction: a review of issues and impacts. *Tourism Management, 23,* 281-293.

Points, L. G., & Kirkpatrick, J. F. (1997, July/August). The wild horses of Assateague: A look at the role of education in controversial research. *Legacy,* 6-33.

Rector, J. (1995, Spring). Variableity happens: Basic descriptive statistics for volunteer programs. *The Volunteer Monitor, 7*(1).

Rodgus, R. B. (1985). Assateague Island Feral Pony Management Plan. Unpublished report.

Rudman, R., & Keiper, R. R. (1991). The body condition of feral ponies on Assateague Island. *Equine Veterinary Journal, 23*(6), 453-456.

Rutberg, A. T., & Keiper, R. R. (1993). Proximate causes of natal dispersal in feral ponies:

some sex differences. *Animal Behavior, 46*, 969-975.

Thomas, K., Kvitek, R. G., & Bretz, C. (2003). Effects of human activity on the foraging behavior of sanderlings *Calidris alba*. *Biological Conservation, 109*, 67-71.

Trochim, W. M. K. (2001). *The Research Methods Knowledge Base.* Cincinnati: Atomic Dog Publishing.

U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. (2001). 2001 National survey of fishing, hunting, and wildlife-associated recreation.

U.S. National Park Service. (2003). Discovering and protecting America's natural heritage. Retrieved 2/20/04 from http://www1.nature.nps.gov/protectingrestoring/im/inventoryandmonitoring.htm

U.S. National Park Service. (n.d.). Natural Resource Monitoring-Program Administration and Organizational Framework. Retrieved 1/24/04 from http://science.nature.nps.gov/im/monitor/vsmAdmin.htm#ProgramAdmin

Warner, S. H. (1986). Visitor impact on brown bears, Admiralty Island, Alaska. *Proceedings of the Seventh International Conference on Bear Research and Management: Bears--Their Biology and Management, 7,* 377-382.

Wright, R. G. (1992). *Wildlife Research and Management in the National Parks*. Urbana, IL: University of Illinois Press.

CHAPTER 4: GENERAL CONCLUSIONS

The overall goal of this study was to contribute to the National Park Service (NPS) *Vital Signs* monitoring program by evaluating the state of knowledge on visitor impact monitoring and developing valid and reliable monitoring procedures for sandy coasts and barrier islands. Two specific objectives of this thesis were to: (1) review the research literature and classify existing methodologies for monitoring visitor impacts, and (2) develop and empirically test procedures for monitoring one particular type of visitor impact: visitor-horse interactions at Assateague Island National Seashore using a video survey.

I reviewed a body of scientific literature from a variety of publishing outlets. Several dominant research themes, such as the impacts of specific activities (i.e. off-road vehicles and beach camping) to specific ecological components were identified. Two primary methodological approaches, namely biophysical and social science-oriented, emerged from this literature review. Within the biophysical approach, techniques using remote sensing, on-site assessment, and behavior observation were included. Within the social science approach, behavior observation and perception survey were included. Techniques using on-site assessment were used most often, followed by behavior observation, remote sensing, and perception survey.

Three trends emerged from this review: (1) an expansion in the geographic scale of studies on visitor impacts in sandy coasts, perhaps as a result of the rapid growth in coastal ecotourism and the introduction of visitors to areas previously not used as a tourist attraction; (2) an increase in studies that include both biophysical and social research components; (3)

and an increase in the application of technologies in visitor impact monitoring studies which enhance the overall quality and especially the spatial accuracy of monitoring data.

None of these techniques alone provides a complete picture of the complex dynamics involved in visitor impacts. A comprehensive evaluation of a visitor impact problem may require monitoring techniques from both approaches. For example, on-site assessment techniques may yield useful information about the resource condition and its trend, but behavior observation may be needed to understand the possible causes of such a trend. Data collected using any of the techniques can be input into a GIS to investigate spatial patterns and relationships. Other contributions of this review include the classifications of monitoring methods and research themes.

I used the knowledge gained from the literature review was used to develop a monitoring procedure for visitor-feral horse interactions. Methods within the social science (human behavior observation) and biophysical approaches (remote sensing and wildlife behavior observation) were adapted to develop a program to monitor visitor-feral horse interactions at Assateague Island National Seashore.

Two observation instruments were created. Form A is used to record general behaviors of both visitors and horses, and Form B is used to record specific information about the visitor such as gender, age, and specific behavior (e.g. taking pictures). Form A is used for every interaction while Form B is only used when visitors come within 3 meters of a horse.

Form A was tested for inter-observer reliability and accuracy. The information gained from this analysis is being used to further revise the form and to provide insight into the creation of a training program. Students recorded wildlife aggression, number of wildlife, closest distance, and visitor touching with the highest combinations of inter-observer reliability and accuracy. Observations with the lowest combinations of inter-observer reliability and accuracy were visitor aggression, visitor feeding, and wildlife avoidance. There were limited differences in the inter-observer reliability and accuracy among demographic groups. There were stronger differences between the two clips shown. The roadside clip was recorded with lower inter-observer reliability and higher accuracy, most likely because it contained less action that the campground clip.

To increase the inter-observer reliability and accuracy, I recommend that videotaped examples of visitor and horse behaviors be shown to trainees in addition to the verbal and written definitions of behaviors. The bulk of the training should be conducted in the field with live interactions. Trainees will ride along with a trained observers and record observations on the same interactions. This will give trainees field experience and allow for questions. When the trainees are able to observe interactions with the same results as the trained observers, they would be invited to join the monitoring program and record observations on their own.

The park staff at Assateague Island National Seashore was unsure who would conduct the final monitoring program. Participants in the video surveys were chosen based on their major area of study with the assumption that future NPS employees would come from this group as well as potential volunteers. These results indicate that for the most part, the students showed an aptitude for recording observations and with more training, the actual park staff or volunteers conduction the monitoring program should also be able to perform the tasks.

Remote sensing with geographic position system (GPS) units will be used to record each interaction site in the final implementation. With just the basic point location information, managers can use a GIS to create density maps of locations based on time of day. This information could inform park staff of temporal differences in the locations of interactions within the park and help them become more efficient in their patrols. By using a data dictionary, more information could be stored with each GPS point location such as the behaviors involved in the interaction. This information could be displayed on a map, allowing the user to identify areas where prohibited behaviors are more likely to occur.

Managers from Assateague Island National Seashore indicated that traditional visitor activities such as the use of ORVs on the beach area are increasing and new visitor activities such as kite surfing are emerging. As the NPS is charged with protecting resources and providing recreational opportunities, visitor impact monitoring will become more important in the future. This thesis has synthesized the knowledge base of techniques to monitor visitor impacts in coastal sandy beaches. This knowledge base can assist managers and researchers who are beginning a monitoring program in response to an increase in traditional visitor activities or a new visitor activity. This thesis has also provided an empirical test of a procedure to monitor one specific impact, visitor-horse interactions. As visitation increases in these natural areas, the likelihood of visitor-wildlife interactions also increases. This procedure can be used by managers outside of Assateague Island National Seashore to monitor these interactions with adaptations specific to the area and wildlife involved.

APPENDIX A: OBSERVATION FORMS

Observation of Visitor-Wildlife Interactions: FORM A – One-Zero Sampling

Session No.:_____ Event No.: _____ Date:___(m)/___(d)/___ (y) Event Loc GPS (Y/N)? _____ Marked on Map (Y/N)? ____
Start Time: ___:___(am/pm) End Time: ___:___(am/pm) Weather:______________ Temperature (approx): ___(°F) Observing Staff:____________
Start Location: ____________ Event Location Description:____

BEHAVIORAL ACT (√ as appropriate)	OBSERVATION PERIOD (30-SECOND INTERVALS)									
	0-30s	30-60s	60-90s	90-120s	120-150s	150-180s	180-210s	210-240s	240-270s	270-300s
Human Behavior Toward Wildlife										
# Motor Vehicles										
# Visitors (not in motor vehicles)										
Closest dist. (class 1-5)*										
Neutral										
Attraction										
Avoidance										
Aggression										
Feeding										
Touching										
Other:__________										
Wildlife Behavior Toward Human										
# Animals										
Species (Deer, Horse, etc.)										
Neutral										
Attraction										
Avoidance										
Aggression										
Other:___________										

* Closest Distance Classes: 1= <1m (3ft) 2= 1-3m (3-10ft) 3=3.1-6m (10-20ft) 4= 6.1-15m (20-50ft) 5: >15m (50ft)

GPS Notes -- File Name: _____________ Offset: No___ Yes___ (If Yes, Bearing______°, Distance______m)
Horse Photo – File Name: ____________________
Other Comments:

NPS Vital Signs Program -- Coastal Visitor Impact Monitoring Project – Assateague Island NS

Observation of Visitor-Wildlife Interactions: FORM B – Close Contacts Only (< 3m/10ft)

Session No.:______ Event No.: __________ (Refer to Form A for other background information)

Human Behavior to Horses						
Gender (check one)	M____ F____	M____ F____	M____ F____	M____ F____	M____ F____	M____ F____
Age (check one)	<18___ 19-35___ 36-50___ >50___ ?____	<18___ 19-35___ 36-50___ >50___ ?____	<18___ 19-35___ 36-50___ >50___ ?____	<18___ 19-35___ 36-50___ >50___ ?____	<18___ 19-35___ 36-50___ >50___ ?____	<18___ 19-35___ 36-50___ >50___ ?____
On Foot / In Car / On Bicycle (circle one)	On Foot / In Car / On Bicycle	On Foot / In Car / On Bicycle	On Foot / In Car / On Bicycle	On Foot / In Car / On Bicycle	On Foot / In Car / On Bicycle	On Foot / In Car / On Bicycle
Closest distance (circle one)	1 = <1m (3ft) 2 = 1-3m (3-10ft)	1 = <1m (3ft) 2 = 1-3m (3-10ft)	1 = <1m (3ft) 2 = 1-3m (3-10ft)	1 = <1m (3ft) 2 = 1-3m (3-10ft)	1 = <1m (3ft) 2 = 1-3m (3-10ft)	1 = <1m (3ft) 2 = 1-3m (3-10ft)
Attraction Behaviors (Check Box)						
Filming						
Feeding						
Touching						
Looking						
Avoidance Behaviors (Check Box)						
Moving Away						
Aggressive Behaviors (Check Box)						
Shouting						
Hitting						
Shaking object at horse						

APPENDIX B: ADDITIONAL TABLES

Table B.1. A comparison of inter-observer reliability of students' ability to record observations of visitor behaviors.

The first number is the mean number of checks (indicating that the behavior was present) for each behavior. The number in parenthesis is the coefficient of variation. Numbers in bold indicate the ranking of CVs, where 1=most reliable and 7=least reliable. When group ranking differs from overall ranking, the different ranking is included.

Observations	Overall	Location		**Gender**		**Major**		**Year**		**Experience with Behavior Observation**		**Experience with horses**	
	n=159	Road n=83	Camp n=76	Female n=55	Male n=104	PRT n=108	NR n=33	Under n=16	Upper n=142	Yes n=31	No n=128	Min n=121	Max n=38
Neutral	2.03 (1.4) **3**	2.04 (1.5) **3**	2.03 (1.3)	1.54 (1.6) **4**	2.3 (1.3) **3**	2.38 (1.5) **3**	2.25 (1.3)	2.65 (1.4) **3**	1.97 (1.4) **3**	2.03 (1.2) **3**	2.03 (1.5) **3**	2.20 (1.4) **3**	1.47 (1.7) **3**
Attraction	6.04 (0.56) **1**	7.02 (0.49) **1**	4.96 (0.60)	6.28 (0.46) **1**	5.8 (0.59) **2**	4.56 (0.59) **1**	6.96 (0.38)	6.45 (0.48) **1**	5.92 (0.55) **2**	5.64 (0.59) **1**	6.08 (0.54) **1**	5.58 (0.61) **1**	7.34 (0.31) **1**
Avoidance	0.50 (1.9) **4**	0.47 (1.9) **4**	0.53 (2.0)	0.59 (1.7) **5**	0.45 (2.1) **4**	0.87 (1.9) **4**	0.37 (1.5)	0.25 (2.3) **6**	0.54 (1.9) **4**	0.62 (2.2) **5**	0.48 (1.9) **4**	0.51 (2.1) **4**	0.47 (1.7) **4**
Aggression	0.03 (6.6) **6**	0.04 (5.2) **5**	0.03 (8.7)	0.05 (1.5) **3**	0.02 (3.5) **5**	0.03 (2.17) **5**	0.06 (2.12)	0.05 (1.7) **4-tie**	0.02 (2.3) **5**	0.03 (2.3) **6**	0.02 (4.8) **5-tie**	0.02 (2.3) **5**	0.05 (2.2) **5-tie**
Feeding	0.18 (5.0) **5**	0.16 (7.3) **6**	0.21 (2.8)	0.35 (4.0) **6**	0.10 (4.9) **6**	0.46 (4.4) **6**	0.06 (1.5)	0.13 (1.7) **4-tie**	0.18 (5.7) **6**	0.09 (1.1) **2**	0.20 (4.8) **5-tie**	0.21 (4.3) **6**	0.11 (2.2) **5-tie**
Touching	1.09 (1.1) **2**	0.59 (1.1) **2**	1.64 (0.80)	0.95 (1.0) **2**	1.2 (0.19) **1**	0.87 (1.0) **2**	1.4 (0.70)	1.17 (1.1) **2**	1.1 (0.92) **1**	0.79 (1.4) **4**	1.20 (0.87) **2**	1.13 (0.90) **2**	1.08 (1.1) **2**

Table B.2. A comparison of inter-observer reliability of students' ability to record observations of wildlife behaviors.
The first number is the mean number of checks (indicating that the behavior was present) for each behavior. The number in parenthesis is the coefficient of variation. Numbers in bold indicate the ranking of CVs, where 1=highest inter-observer reliability and 5=lowest inter-observer reliability. When group ranking differs from overall ranking, the different ranking is included.

Observations	**Overall**	**Location**		**Gender**		**Major**		**Year**		**Experience with Behavior Observation**		**Experience with horses**	
	n=159	Road n=83	Camp n=76	Female n=55	Male n=104	PRT n=180	NR n=33	Under n=16	Upper n=142	Yes n=31	No n=128	Min n=121	Max n=38
Neutral	7.53 (0.44) **2**	7.88 (0.15)	7.14 (0.43) **2**	7.48 (0.40)	7.52 (0.45)	5.43 (0.53)	8.7 (0.22) **2**	8.0 (0.37)	7.49 (0.43)	6.8 (0.58)	7.68 (0.40)	7.43 (0.46)	7.76 (0.36) **2**
Attraction	1.2 (1.8) **3**	1.09 (2.2)	1.28 (1.41) **4**	1.21 (1.6)	1.17 (1.9)	1.65 (1.8)	0.57 (2.1) **4**	1.4 (1.6)	1.15 (1.8)	1.04 (2.0)	1.21 (1.7)	1.22 (1.9)	1.08 (1.5) **4**
Avoidance	0.76 (2.0) **4**	0.18 (6.2)	1.39 (1.2) **3**	0.99 (3.2)	0.68 (3.9)	1.04 (3.5)	0.58 (0.42) **3**	1.1 (2.3)	0.74 (4.2)	1.11 (2.5)	0.71 (4.1)	0.79 (3.4)	0.76 (0.41) **3**
Aggression	0.00 (0.0) **1**	0.00 (0.0)	0.00 (0.0) **1**	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0) **1**	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0) **1**

Table B.3. A comparison of inter-observer reliability of students' ability to record count variables.
The first number is the mean response for each variable. The number in parenthesis is the coefficient of variation. Numbers in bold indicate the ranking of CVs, where 1=most reliable and 4=least reliable. When group ranking differs from overall ranking, the different ranking is included.

Observations	**Overall**	**Location**		**Gender**		**Major**		**Year**		**Experience with Behavior Observation**		**Experience with horses**	
	n=103-157	Road n=52-82	Camp n=51-75	Female n=29-54	Male n=74-103	PRT n=64-107	NR n=24-33	Under n=12-16	Upper n=91-140	Yes n=18-30	No n=85-187	Min n=77-121	Max n=26-36
Number vehicles	1.38 (0.60) **3**	1.8 (0.44)	0.93 (0.69) **3**	1.36 (0.59) **3**	1.34 (0.56)	1.16 (0.57)	1.37 (0.56) **3**	1.0 (0.94) **4**	1.38 (0.54) **3**	1.39 (0.53) **3**	1.34 (0.58)	1.34 (0.57) **3**	1.37 (0.57) **3**
Number visitors	3.47 (.18) **1**	3.5 (0.14)	3.4 (0.20) **2**	3.37 (0.18) **1**	3.52 (0.16)	2.12 (0.18)	3.53 (0.14) **2**	3.37 (0.18) **2**	3.47 (0.17) **2**	3.46 (0.24) **2**	3.47 (0.15)	3.46 (0.17) **2**	3.51 (0.17) **2**
Number Wildlife	2.6 (0.33) **2**	1.9 (0.15)	3.4 (0.15) **1**	2.69 (0.64) **4**	2.65 (0.18)	1.24 (0.17)	2.7 (0.06) **1**	2.69 (0.05) **1**	2.66 (0.16) **1**	2.70 (0.08) **1**	2.65 (0.16)	2.63 (0.16) **1**	2.74 (0.06) **1**
Closest Distance (m)	4.9 (0.76) **4**	5.0 (0.60)	4.8 (0.92) **4**	4.41 (0.54) **2**	5.06 (0.80)	4.82 (0.69)	1.43 (0.93) **4**	7.27 (0.87) **3**	4.61 (0.71) **4**	5.19 (0.84) **4**	4.77 (0.71)	4.86 (0.73) **4**	4.97 (0.83) **4**

Table. B.4. A comparison of accuracy of students' ability to record observations of visitor behaviors.
Each number represents the accuracy (as a percentage) of students' ability to record observations. The means between groups were compared using independent t-tests (equal variances not assumed) and considered significant at the .05 level. The standard deviation is in parenthesis.
*Significant at .05
** Significant at .01
*** Significant at <=.001

Observations	Overall	Location		Gender		Major		Year		Experience with Behavior Observation		Experience with horses	
	n=159	Road n=83	Camp n=76	Female n=55	Male n=104	PRT n=108	NR n=33	Lower n=16	Upper n=142	Yes n=31	No n=128	Min n=121	Max n=38
Neutral	79.7 (29.1)	79.6 (31.1)	79.7 (26.9)	84.5 (25.3)	77.1 (30.7)	80.1 (29.5)	77.0 (28.2)	72.5 (37.0)	80.4 (28.1)	79.7 (24.7)	79.7 (30.1)	77.9 (30.5)	85.3 (23.2)
Attraction	63.9 (31.9)	70.2** (34.3)	57.0 (27.6)	66.4 (29.5)	62.6 (32.2)	59.4 (32.6)	71.8* (26.1)	68.8 (30.3)	63.1 (32.1)	61.3 (33.7)	64.5 (31.5)	60.0 (33.1)	76.3*** (34.0)
Avoidance	71.9 (8.8)	71.8 (10.1)	72.1 (7.2)	73.3 (7.5)	71.3 (9.4)	71.9 (10.1)	72.4 (6.1)	70.6 (4.4)	72.1 (9.2)	70.3 (12.2)	72.3 (7.8)	71.7 (9.5)	72.9 (6.1)
Aggression	99.7 (2.1)	99.6 (1.9)	99.7 (2.3)	99.5 (2.3)	99.8 (2.0)	99.7 (1.7)	99.4 (3.5)	99.4 (2.5)	99.7 (2.0)	99.4 (3.6)	99.8 (1.5)	99.8 (1.6)	99.5 (3.2)
Feeding	98.2 (9.2)	98.4 (11.4)	97.9 (6.0)	96.5 (14.7)	99.0 (3.8)	97.6 (11.0)	99.4 (2.4)	98.1 (7.5)	98.2 (9.4)	99.0 (3.0)	98.0 (10.1)	99.9 (9.9)	98.9 (6.5)
Touching	89.0 (9.2)	93.3*** (6.1)	84.3 (9.7)	89.5 (8.7)	88.8 (9.4)	88.5 (9.3)	89.7 (8.8)	92.5 (5.8)	88.7 (9.4)	85.8* (7.2)	89.8 (9.4)	89.5 (9.0)	87.4 (9.5)

Table B.5. A comparison of accuracy of students' ability to record observations of wildlife behaviors.
Each number represents the accuracy (as a percentage) of students' ability to record observations. The means between groups were compared using independent t-tests (equal variances not assumed) and considered significant at the .05 level. The standard deviation is in parenthesis.
*Significant at .05
** Significant at .01
*** Significant at <= .001

Observations	Overall	Location		Gender		Major		Year		Experience with Behavior Observation		Experience with horses	
	n=159	Road n=83	Camp n=76	Female n=55	Male n=104	PRT n=108	NR n=33	Under n=16	Upper n=142	Yes n=31	No n=128	Min n=121	Max n=38
Neutral	75.2 (32.9)	78.8 (34.6)	71.4 (30.7)	75.3 (30.7)	75.2 (30.7)	69.6 (36.7)	87.0** (20.1)	76.3 (36.3)	75.0 (32.7)	68.1 (39.3)	77.0 (31.1)	74.5 (34.3)	77.6 (28.3)
Attraction	77.2 (22.6)	89.0*** (24.3)	64.2 (10.5)	77.5 (20.7)	77.0 (23.7)	76.7 (23.6)	80.0 (18.5)	75.0 (30.6)	77.5 (21.7)	82.3 (17.8)	75.9 (23.6)	77.2 (23.7)	77.1 (19.3)
Avoidance	79.8 (21.7)	98.2*** (11.3)	59.7 (8.6)	80.4 (20.8)	79.5 (22.3)	79.7 (22.5)	80.3 (19.8)	83.8 (25.8)	79.6 (21.2)	76.5 (24.4)	80.6 (21.1)	79.2 (22.5)	81.8 (19.4)
Aggression	99.9 (1.6)	100.0 (0.0)	99.7 (2.3)	99.6 (2.7)	100.0 (0.0)	100.0 (0.0)	100.0 (0.0)	100.0 (0.0)	99.9 (1.7)	100.0 (0.0)	99.8 (1.8)	99.8 (1.8)	100.0 (0.0)

Table B.6. A comparison of accuracy of students' ability to record count variables.
A positive number indicates students overestimated the correct number, and a negative number indicates students underestimated the correct number. The numbers of vehicles, visitors, and wildlife are shown as the total over- or under- estimation for the entire 5 minute sampling period. The closest distance is shown as the average over or under estimation of meters for the 5 minute sampling period. Means between groups were compared using independent t-tests (equal variances not assumed) and considered significant at the .05 level. The standard deviation is in parenthesis.

*Significant at .05
** Significant at .01
*** Significant at <=.001

Observations	**Overall**	**Location**		**Gender**		**Major**		**Year**		**Experience with Behavior Observation**		**Experience with horses**	
	n=103-157	Road n=52-82	Camp n=51-75	Female n=29-54	Male n=74-103	PRT n=64-107	NR n=24-33	Under n=12-16	Upper n=91-140	Yes n=18-30	No n=85-127	Min n=77-121	Max n=26-36
Number vehicles	6.1 (6.6)	7.1* (7.3)	4.8 (5.3)	5.8 (6.5)	6.2 (6.6)	5.6 (6.3)	6.3 (6.5)	4.8 (7.3)	6.2 (6.5)	6.2 (6.3)	6.0 (6.6)	6.0 (6.4)	6.1 (7.1)
Number visitors	-4.4 (5.6)	-1.7*** (3.9)	-7.4 (5.7)	-5.1 (5.3)	-4.0 (5.8)	-4.3 (5.5)	-4.6 (6.3)	-4.0 (6.7)	-4.4 (5.2)	-4.4 (6.5)	-4.4 (5.4)	-4.5 (5.4)	-4.0 (5.5)
Number Wildlife	0.32 (4.0)	-0.18 (2.6)	-0.85 (5.1)	-0.08 (2.3)	-0.46 (4.7)	-0.62 (4.4)	0.16 (2.5)	0.06 (1.6)	-0.37 (4.2)	.03 (3.2)	-0.41 (4.2)	-0.53 (4.3)	-0.37 (2.8)
Closest Distance (average in meters)	2.3 (3.5)	1.9 (2.9)	2.7 (4.1)	1.8 (2.4)	2.5 (3.9)	2.7 (3.4)	1.9 (.42)	4.7 (2.0)	2.0* (3.1)	3.0 (5.1)	2.2 (3.1)	2.3 (3.2)	2.3 (4.4)