Influence of Interpretation on Visitors' Knowledge Gain and Respect for Fossil Resources in a National Monument

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Abstract

This two-part research project evaluated the effectiveness of interpretive messages at Fossil Butte National Monument in conveying knowledge about the place and its resources and promoting respect for the fossil resource. The first study measured the short and long-term knowledge gains from a trip to the Visitor Center and the influence of a specially designed fossil respect message on the fossil protection beliefs of Monument visitors. The Visitor Center was successful in conveying information about the fossil resource and story of Fossil Lake, and that knowledge was retained for at least several weeks. However, neither the Visitor Center nor the special message, were successful in improving the fossil respect beliefs of respondents. The second study combined a visitor survey with direct observations of visitor behavior to evaluate the effectiveness of interpretive materials along a nature trail in improving the knowledge of ancient Fossil Lake, increasing fossil respect beliefs, and reducing depreciative behaviors. Six different treatments were applied that evaluated an interpretive sign, box of fossils that visitors were invited to touch, and participation in an interactive interpretive program. Only the interpretive program increased knowledge of the Fossil Lake story. None of the trail interpretive materials improved fossil respect beliefs. The sign was somewhat effective in reducing entry into a closed research quarry. While it is generally thought that those most knowledgeable about natural resources will have the higher resource protection beliefs, Fossil Butte visitors who reported being the most interested in fossils had the greatest knowledge of the Fossil Lake story but had the lowest fossil protection beliefs. Therefore, there was some evidence that fossil enthusiasts were the least likely to respect the resource.

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Chapter 1

Introduction – Literature Review

Enormous amounts of time and resources are devoted to promoting stewardship or pro-environmental behaviors toward the environment in outdoor recreation settings. Many of these efforts are designed to reduce depreciative behaviors and minimize the human impact on the environment. Interpretive messages, regulations, and physical barriers can be used to encourage visitors to behave in a manner to minimize resource impacts. Because more indirect methods (e.g., interpretation) are typically preferred over more direct interventions (e.g., fines) in a recreational setting, where visitor freedom is valued and visitor use is dispersed, research efforts have typically been directed at designing interpretive or persuasive messages. The messages are often theoretically grounded in persuasion theory, moral reasoning theory, Theory of Planned Behavior, and environmental education theory. Message success is measured by achieving a change in attitudes, increasing knowledge, or minimizing depreciative behaviors. No one model or theory seems to dominate this research, with different independent and dependent measures used and conceptualized in different ways. This chapter will review the key models and theorize and summarize the most important antecedent variables to acting as a good steward while recreating.

The primary objectives of this research were to evaluate the effectiveness of a Visitor Center and various interpretive materials and programs along a nature trail in increasing knowledge, improving respect beliefs about fossils, and reducing depreciative behaviors toward fossils. There were two components to the research, which was conducted in Fossil Butte National Monument, Wyoming. The first was conducted at the Visitor Center, and it assessed

both short and long-term knowledge gain and effect on fossil respect beliefs from a visit to the Visitor Center and exposure to a fossil respect message, developed for this study. The second study was designed to determine if increasing the level of interaction with fossils through interpretation along a nature trail increases knowledge of the resource, improves fossil respect attitudes, and decreases depreciative behaviors (e.g., entering a closed research quarry). The research will focus on the knowledge – attitude – behavior relationship, as well as investigate the influence of demographics, prior experience, and interest in fossils on fossil respect beliefs.

This literature review will focus on the research on reducing depreciative behaviors in natural settings and on interpretive messages designed to reduce those behaviors. I will first discuss and characterize depreciative behavior in outdoor recreation settings. I will then review the major theoretical models that have been used to promote stewardship behavior or reduce depreciative behaviors in a recreation setting. After discussing key studies and findings, I will summarize the most important antecedent variables to stewardship or pro-environmental behaviors that have been identified in research to date.

Depreciative Behaviors in National Parks

Each year millions of people visit National Parks and other outdoor recreation areas and benefit from positive experiences gained from participating in recreational activities. Unfortunately, some visitor activities damage the natural, historical, and paleontological resources. According to the National Park Service Organic Act 1916, the National Park Service has a dual mandate: …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 a manner and by such means as will leave them unimpaired for the enjoyment of future generations. Thus, park

managers must decide how to balance protection of resources and provision of positive recreational experiences.

Resource damage by visitors in many National Park Service units is considerable. A 1992 survey of National Park Service units estimated that reparable damage to renewable resources resulting from noncompliant visitor behavior cost of $79 million dollars (Johnson and Vande Kamp 1996). For the purposes of the 1992 study, noncompliant behavior included such activities as off trail hiking, souvenir collection of natural and cultural objects, feeding wildlife, littering, and camping inappropriately. It does not include major acts of vandalism or behavior motivated by criminal intent. The survey also reveals that almost all units sustain nonreparable damage to nonrenewable resources such as historic, archeological, and paleontological sites.

Despite efforts of park managers, and some social scientists, to minimize visitor impacts on the resources they are mandated to protect, many questions remain as to how best to protect resources while still providing for a positive recreational experience. Two major categories of strategies for reducing depreciative behavior in natural and historical areas have emerged. Direct methods of regulating visitor behavior include zoning, enforcing rules and regulations, and limiting visitor access. Indirect visitor regulation methods include informational, educational, and interpretive services.

Managers have tended to prefer indirect techniques for minimizing noncompliant behavior for several reasons. Direct approaches have the potential negative side effect of limiting visitor freedom, something highly valued in recreational settings (McAvoy and Dustin 1983). Also, direct approaches may be highly effective at the location of the intervention, but do not encourage the visitor to behave appropriately in similar situations where enforcement is lacking. Conversely, indirect techniques educate the visitor about ethical behavior and

consequences for inappropriate behavior. It is theorized that increased knowledge will lead to more positive resource protection attitudes, which will lead to more appropriate visitor behavior in similar circumstances (Vande Kamp, Johnson, and Swearingen 1994). Zoning or closing an area may remove visitors from a sensitive site, but the opportunity to educate may be lost. On the other hand, indirect techniques both educate the visitors about a resource problem and provide them with information about how to behave to minimize their impact on the environment.

Lastly, for direct techniques to be most effective, they need to be enforced. While some visitors may behave appropriately with the threat of a fine, others will not comply with a rule unless they feel the risk of being caught and disciplined is relatively high. The presence of a uniformed volunteer has been shown to reduce improper behavior more than interpretive techniques (Swearingen and Johnson 1988), but placing uniformed rangers in all potential places for resource damage is not a practical solution. Other research has shown that interpretive messages are just as effective as uniformed staff in reducing depreciative behavior (Widner and Roggenbuck 2000).

There has been much debate about which method (direct or indirect) is most effective in reducing depreciative behavior, but no clear answers have emerged. There is most likely no one solution to diverse visitor-related resource problems. It has been suggested that direct and indirect techniques vary in their effectiveness to reduce depreciative behavior depending on the motivation behind the damaging activity. Based on prosocial behavior theory, Gramann and Vander Stoep (1987) described six different types of normative violations that result in damaging activities, and suggested the form of management intervention most likely to effectively address

each type. Hendee, Stankey, and Lucas (1990) also categorized undesirable behavior and suggested which types were more likely to be reduced by persuasive messages.

According to Hendee *et al.* (1990), educational messages may be very effective in persuading visitors who are engaged in unskilled actions (e.g., a novice picking an improper campsite). Gramann and Vander Stoep (1987) also feel that unintentional violations (i.e., those committed because the visitor does not know the rules) can also be effectively addressed with indirect techniques. Therefore, if visitors engage in the depreciative activity simply because they are uninformed or unskilled, interpretive messages should have a high possibility of success when they explain the negative consequences of a behavior on the environment.

Both typologies suggest that illegal or willful violations almost always require some form of direct enforcement because violators know they are committing a crime and choose to do so for personal benefit. Hendee *et al* . (1990) feels that indirect methods of persuasion are also less likely to reduce careless actions (e.g., littering), or unavoidable actions (e.g., human waste). Gramann and Vander Stoep classify these behaviors as "responsibility-denial" violations and acknowledge they may be difficult to decrease with interpretation, unless acceptable alternatives are suggested and available. Status-confirming violations (e.g., feeding wildlife to impress a peer group) may also be difficult to address with interpretation alone (Gramann and Vander Stoep 1987). Some visitors are thought to behave improperly because they see others, or evidence of others' depreciative acts (e.g., carvings on picnic tables). According to Gramann and Vander Stoep (1987), these "releasor-cue" violations are difficult to reduce with interpretation, but they should be addressed by communicating the rules, and trying to remove the physical evidence (releasor cue) of past inappropriate behavior.

Theoretical Approaches to Reducing Depreciative Behaviors in Outdoor Recreation Areas

Many different theoretical approaches have been used to reduce resource damage and depreciative actions in outdoor recreation areas. While there is some research on direct approaches (i.e., fines and barriers) which target more willful depreciative actions, the discussion below will focus on the bodies of literature used to inform and develop interpretive or persuasive messages and programs that target unskilled or uninformed depreciative actions because this is the topic of my research.

Persuasion Theory

Regardless of the theoretical model used to predict and describe the antecedent variables to stewardship or depreciative behaviors, many studies use persuasion theories to develop a message that would be most effective in changing attitudes and therefore possibly influencing behaviors. The Elaboration Likelihood Model of persuasion, which describes two routes for a persuasive message to change an attitude (Petty and Cacioppo 1986), is a commonly referenced model. In the peripheral route, attitude change involves relatively non-effortful thinking. In contrast, the central route involves careful and effortful thinking to evaluate the information or arguments presented. The central route is equivalent to Chaiken's (1980) systematic information processing. The central route of persuasion has been shown to produce an attitude that is more resistant to change, enduring, and more predictive of behavior than the peripheral route because of the effortful thinking and elaboration involved (Petty and Cacioppo 1986). Therefore, interpretive interventions should encourage central route processing of the message, if the goal is to produce long-term attitude or behavior change.

The route used by an individual in a given situation is determined by his or her motivation and ability to process the information. Therefore, interpretive messages intended to be persuasive must be designed for easy comprehension and relate to the visitor. Because increased personal relevance improves the chances a message will be processed through the central route (Petty and Cacioppo 1986; Chaiken 1980), messages should motivate people by describing how the message is important to them personally. It has also been shown that environmental education messages have stronger impacts on attitudes if the receiver is already interested in the topic or environment (Leeming, Porter, Dwyer, Cobern, and Oliver 1997). Therefore, those who are the most interested in the environment should be the most receptive to interpretation and persuasive messages urging natural resource protection.

Prior knowledge or experience with the specific attitude object or issue has also been shown to have a direct effect on the persuasion process (Manfredo and Bright 1991). Increasing levels of prior knowledge tends to decrease the amount of elaboration of a message and makes it more difficult to change the attitude because the attitude is more stable. Research in recreational settings has shown that inexperienced users are influenced more by persuasive messages than experienced users (Krumpe and Brown 1982; Roggenbuck and Berrier 1982; Daniels and Marion 2005). Therefore, visitors with prior experience at a location or with a certain activity may be influenced less by persuasive messages than first time visitors, because they have past experiences and behaviors influencing and solidifying their attitudes.

Theory of Planned Behavior

Ajzen's (1985, 1987) Theory of Planned Behavior has been used to predict behavior in leisure settings (e.g., Ajzen and Driver 1991; Ajzen and Driver 1992) as well as in many other

applications. The theory proposes that attitudes toward the behavior, subjective norms, and perceived behavioral control are predictive of a person's behavioral intentions and behavior. The model proposes that attitudes (overall evaluations of the behavior) can be represented by two components: beliefs about the outcomes of the behavior and evaluations of those outcomes (i.e., expectancy-value components) (Ajzen 1991; Francis, Eccles, Johnston, Walker, Grimshaw, Foy, Kaner, Smith, and Bonettie 2004). The model describes subjective norms as the perceptions or beliefs of the behavioral expectations of others and the importance of those others to the individual. For example, a visitor considering taking a piece of petrified wood may consider the reactions of other group members when he or she decides whether or not to take home a fossil. Perceived behavioral control relates to the perceptions one has about his or her control over acting (volition) and ability to perform the behavior (self-efficacy). Therefore, perceived behavioral control can be influenced by both perceived situational factors outside the individual's control and internal factors (Ajzen 2002a; Francis *et al.* 2004). The inclusion of perceived behavior control in the Theory of Planned Behavior allows for the model to be used to predict behavior in situations where the action is not completely volitional (i.e., the actor perceives there are constraints). Where volition is high, perceived behavioral control's influence on the model will be low; so the importance of this variable on predicting behavior will vary depending on the specific behavior and situation being studied (Ajzen 1991).

A meta-analysis of 185 studies using the Theory of Planned Behavior found that the model explained 39% of the variance in behavioral intention and 27% of the variance in actual behavior (Armitage and Connor 2001). Attitudes were found to be the single strongest predictors of behavioral intention (explained 24% of the variance), and perceived behavioral control was also a good predictor of intention (explained 18% of the variance). Subjective norms

were found to be the weakest predictors of intention (explained 12% of the variance). The authors proposed that this could be in part due to weaknesses in measurement, specifically, the frequent use of single item measures. The authors also suggest further research into including different types of norms (e.g., injunctive, descriptive, and moral norms) that might be more relevant to predicting behavior. Moral norms might have increased importance when studying behaviors that are unethical (Ajzen 1991).

Variables not included in the Theory of Planned Behavior, but considered by Ajzen and others to be potentially important include past experience, moral norms, and affect. Ajzen and Driver (1992) found that affect or mood was an important component in determining leisure activity choice. Although only looking at the attitude-behavior relationship, Bright and Manfredo (1996) also found that affect or emotions were more important than knowledge and beliefs in influencing attitudes toward wolf reintroduction in Colorado.

There has been considerable discussion about the role of past behavior, especially actions that could be considered habits, on predicting future behavior. Ajzen (2002b) reviewed the arguments for and against including the frequency of past behavior in the Theory of Planned Behavior. Ajzen (2002b) argued that past experiences with the action influence the other model components (i.e., attitudes, norms, and behavioral control) and do not need to be independently measured. Ajzen (2002b) concluded that the inclusion of past experiences would likely only be important if behavioral intentions are relatively weak and unstable (i.e., person does not have a well-developed plan of action) or when underlying expectations are inaccurate. However, when intentions are strong and stable, past experience measures likely add little to the predictability of the model.

While there have been many studies in outdoor recreation that have studied the relationships between knowledge, attitudes, and behaviors, few have utilized all components of the Theory of Planned Behavior to understand or predict outdoor recreation behavior. In a study of Vermont hunters and non-hunters, Hrubes, Ajzen, and Daigle (2001) used the Theory of Planned Behavior to predict self-reported hunting behavior. Attitudes toward hunting, subjective norms, and perceived control all strongly influenced intentions to hunt, and intentions to hunt were good predictors of self-reported hunting behavior.

Bright, Manfredo, Fishbein, and Bath (1993) studied the influence of positively and negatively framed persuasive messages about the National Park Service's controlled burn policy on intention to support the policy using the Theory of Reasoned Action (the Theory of Planned Behavior minus the perceived control variable). They found that the model had predictive validity in understanding the effect of changing beliefs on attitudes and changing attitudes had on the intentions to support burn policy. The model was useful for both treatments and the control group.

Ajzen and Driver (1992) used the Theory of Planned Behavior to study the leisure behaviors of college students (e.g., jogging, going to the beach, mountain climbing). They found that attitudes, subjective norms and perceived behavioral control were good predictors of intentions to engage in the study activities, and intentions and perceived behavioral control were good predictors of leisure behavior.

Attitude-Behavior Relationship

Although perceived behavioral control and social norms have been shown to influence behavior, because attitudes have been shown to be the strongest predictors of behavior (Armitage

2001; Kraus 1995), and they are the target of persuasive messages, they have independently been the focus of much research. It has been found that there is a stronger correlation between attitudes and behavior when both are measured at the same level of specificity (Petty 1995) and specific situations or actions are defined (Kraus 1995). For example, a general positive attitude toward the environment might not be a very good predictor of a person's recycling behavior in a specific situation.

An additional factor influencing the attitude-behavior relationship is the strength of the attitude or attitude certainty (Kraus 1995). Stronger attitudes predict behavior better than weaker ones. This has implications for persuasion because attitudes formed from the central route of persuasion (see Elaboration Likelihood Model discussion above) should be stronger than those formed from the peripheral route (Petty 1995). Therefore, all of the variables that influence the route of persuasion (accessibility, direct experience, etc.) should affect attitude strength and the attitude behavior relationship (Kraus 1995; Petty 1995). In summary, attitudes most influence and predict behavior when they are accessible, strong, not in conflict with subjective norms, and when constraints to follow through with the behavior are minimal.

Knowledge-Attitude-Behavior Relationship

Most research conducted by environmental education practitioners or researchers tends to focus on the knowledge – attitude – behavior relationship and largely ignores the subjective norm and perceived behavioral control components of the Theory of Planned Behavior. A review of this literature in the context of application to environmental interpretation follows.

While interpretive messages are developed to tell a story of the resource for the enjoyment of the visitor, park staff and environmental educators hope that increased knowledge

of the resource will lead to more favorable attitudes related to resource protection. This idea has evolved from the theory that attitudes (i.e., the evaluation a person holds about an object or issue) can be based on cognition (beliefs), affect, behavior, or some combination of the three (Petty 1995). Therefore, it follows that increasing knowledge or beliefs about an issue or object may influence a person's related attitude. In fact, a review of several studies in environmental education found that students with higher knowledge scores also had more positive attitudes toward natural resources (Zimmerman 1996). More recent research on high school students has also supported the positive correlation between environmental knowledge and attitudes (Campbell Bradley, Waliczek, and Zajicek 1999). However, other studies suggest that knowledge does not necessarily lead to more positive attitudes toward the environment (Borden and Schettino 1979; Hungerford and Volk 1990). Because of the mixed research findings, this study not only will focus on the ability of a visitor center to increase knowledge and the relationship between knowledge level and positive attitudes, it also will create a special message to promote ethical attitudes toward the fossil resource and test its effectiveness.

Interpretation effect on Knowledge and Attitudes

Much of the research conducted to date has focused on the effectiveness of environmental education programs on improving knowledge and attitudes about the environment. While these studies are informative, they are typically based on a series of lessons and on-site experiences of school-aged children rather than a single exposure to an interpretive program during a visit to a national park targeted at adult visitors. Leeming *et al.* (1997) found that an environmental education program administered over the academic year to elementary school classes positively impacted attitudes, but not knowledge of environmental issues.

Conversely, in a study of visitors to a nuclear power plant visitor center, Lee and Balchin (1995) found that the interpretive materials significantly increased knowledge, but only changed some attitudes related to the impact on the environment and the economy; attitudes regarding safety were positively changed for men, but for women became more negative. O'Brien and Pease (2004) found that an environmental education program at a national wildlife refuge was successful in improving environmental attitudes and increasing knowledge of 4th, 5th, and 6th graders. However, they did not directly test the relationship between knowledge gain and attitudes. In a study conducted on adult visitors to state parks in Ohio, interpretive services were found to significantly increase knowledge and attitudes toward the resource (Olson, Bowman, and Roth 1984). Although not considering the influence of interpretive messages, other researchers have also found environmental knowledge to be correlated with environmental attitudes among recreationists (Hwang, Kim, and Jeng 2000).

Norm Activation Model and Norm Research

Moral appeals are frequently used in outdoor recreation settings in attempts to inform visitors of their impacts on the environment and ask for their help in reducing those impacts. Two key components used in messages to increase the effectiveness of moral appeals are awareness of consequences (AC) and ascription of responsibility (AR). These concepts were borrowed from Schwartz's (1970) Norm Activation Model, which was originally developed to explain altruism and helping behavior. The model predicts that in order for a person to perform an altruistic act, he or she must be aware of the consequences of his or her action (or inaction) and feel a personal responsibility to act.

The limited research in outdoor settings evaluating the effectiveness of including AC and AR in messages has shown mixed results. Van Liere and Dunlap (1978) found that AR had a strong correlation with yard burning behavior, with AC only showing a weak correlation. Vander Stoep and Gramann (1987) found that AC messages reduced depreciative behavior around monuments in an historical park by 88%. The addition of an AR message to the AC message did not reduce depreciative behavior.

In another study focusing on an awareness of consequences message, Medio, Ormond, and Pearson (1997) evaluated the effectiveness of a single "environmental awareness briefing" given to SCUBA divers in Ras Mohammed National Park, Egypt on the rate of contacts per hour with coral reefs. The educational briefings were given to divers after their 3rd dive in a 10 dive vacation package. While not eliminating harmful contacts with the reef, direct observation of the divers showed the educational briefing significantly reduced contacts with the reef from an average of 1.4 contacts/7 minutes to 0.4 contacts/7 minutes. Another encouraging finding was that voluntary contacts (i.e., appeared to be intentional contact) and the touching of live coral were disproportionately reduced; only 10% of contacts after the briefing were voluntary touches of live coral, versus 59% prior to the briefing.

While many studies utilize AC and AR components in test messages, much of the recent research on using norms in persuasive messages has shifted to looking at whether injunctive or descriptive norms are more effective in reducing depreciative behaviors. Injunctive norm messages describe what "ought" to be (i.e., the level of other's disapproval); descriptive messages what "is" (i.e., the level of others' behavior). Research has also investigated whether the messages should be framed positively (prescriptive) or negatively (proscriptive). Winter (2006) found that injunctive-proscriptive messages were the most successful in reducing off-trail

hiking; descriptive-proscriptive messages were the least effective. Cialdini, Demaine, Sagarin, Barrett, Rhoads, and Winter (2006) reported similar findings in Petrified Forest National Park in a study to evaluate the effectiveness of different messages in reducing fossil theft. They found that the injunctive-proscriptive message was the most effective in deterring theft, and the descriptive-proscriptive message was the least.

Environmental Education Models

Because research has not proven that increasing knowledge about the environment necessarily leads to more responsible pro-environmental behaviors, Environmental Education researchers have expanded the basic knowledge-attitude-behavior models to include many more antecedent variables that have been shown to influence stewardship behaviors (Hungerford and Volk 1990). Hines, Hungerford, and Tomera (1987) proposed a model of Responsible Environmental Behavior based on a meta-analysis that, in addition to attitudes and locus of control, added personal responsibility, action skills, knowledge of action strategies, and knowledge of issues as predictors of pro-environmental behaviors. Hungerford and Volk (1990) built on Hines *et. al.* (1987) to propose a model that includes "Entry Level", "Ownership", and "Empowerment" variables, which lead to "Citizenship Behaviors". They suggest that Entry Level variables (environmental sensitivity, knowledge of ecology, attitudes toward environmental issues, and androgyny) are good predictors of good citizenship behaviors and are important pre-requisites to action. Ownership variables (in-depth knowledge of issues, personal investment in issues and the environment, knowledge of the consequences of behavior, and personal commitment to issue resolution) make the environmental issue personally relevant and important. Empowerment variables (knowledge of and skill in action strategies, locus of control,

and intention to act) are necessary for an individual to believe that he or she can behave in an environmental way.

The comprehensive models of Hines *et. al.* (1987) and Hungerford and Volk (1990) have not been embraced or tested extensively in the context of predicting or improving stewardship or depreciative behaviors in outdoor recreation. One exception was a study of Maryland boat owners and their sewage disposal behavior (Cottrell and Graefe 1997). They created a model based on Hines *et al.* (1987) and Hungerford and Volk (1990) to study the influence of 19 sociodemographic, boating background, general environmental variables, specific issue variables, and situational variables on sewage disposal. Among background variables, level of education and years of boating experience were significant predictors of behavior. General environmental concern was a moderate predictor, but the strongest predictors were the variables specific to the situation. Knowledge of water pollution issues, dumping regulations, and awareness of the consequences of dumping raw sewage on water quality were all relatively strong predictors of sewage dumping behaviors.

Experiential Learning Theory

Two theoretical constructs support the hypothesis that increased interpretive interaction with the resource should promote greater learning. According to Langer's concept of mindfulness (Chanowitz and Langer 1980), interactive exhibits induce mindfulness and thus promote the active, analytical processing of information that result in changes to cognitive structures. Therefore, active or mindful processing of the information in an interpretive message would improve the chances for central route processing. Passive exhibits, however, could lead to a state of mindlessness.

A second theoretical approach that suggests more interaction will lead to greater understanding and appreciation for the resource is experiential learning theory. In 1994 the Association for Experiential Education defined experiential education as "a process through which a learner constructs knowledge, skill, and value from direct experiences". In outdoor education, experiential learning can be promoted by active interaction with a resource, followed by reflection of the experience, critical analysis, and synthesis (Adkins and Simmons 2002). Thus, experiential learning is a process that can be promoted by a carefully crafted interpretive program.

While many interpreters and educators feel that hands-on activities enhance learning and promote more positive attitudes and behaviors, little interpretive research exists to empirically support the idea. Exceptions are that researchers have shown that interactive interpretive programs and displays are more likely to attract visitors (Moscardo and Pearce 1986), generate support for conservation (Swanagan 2000), and increase interest in the topic (Flexer and Borun 1984). Knapp and Benton (2005) found that two years after an interpretive program in an Indiana state park, the most remembered components of the program by the six adults they interviewed were "active involvement" exercises that encouraged participants to touch deer artifacts or cup their ears to hear like deer. In a review of environmental education literature, Zelezny (1999) found that interventions that actively involved participants were most effective in improving environmental behaviors, but that classroom settings improved behavior to a greater extent than interventions in non-traditional settings. These limited research findings suggest a need for further investigation into the value of experiential learning on improving knowledge and changing attitudes and behaviors, especially in a recreational setting.

Key Variables Summary

While many different models have been used to understand why people engage in pro-environmental or depreciative acts in a recreation setting, there is a general consensus about what the most important antecedent variables are. Specific beliefs about the target resource or behavior, sometimes measured in the form of knowledge or contained in messages conveying an "awareness of consequences," are clearly pre-requisites for behaving in a pro-environmental way (i.e., if I perform "x" behavior, it will have a "y" effect on the environment). Knowledge or beliefs along with emotions about the behavior or object also relate to behavioral intentions and behavior. While emotion or affect is not always measured, environmental education research suggests evoking positive emotions toward the environment or place could help to promote stewardship behaviors. Another important antecedent to behaving in a pro-environmental way is related to knowledge, but at a later stage in the decision-making process is self-efficacy, or the belief that you have the knowledge or skills to behave as you feel is appropriate (Empowerment variables, Hungerford and Volk 1990). The confidence that one has the knowledge and skill to perform the action required is important to acting on beliefs about how one should act. Ownership and the related concept of personal responsibility are also clearly important in both being receptive to persuasive or informative messages and acting in a pro-environmental manner.

Other variables that likely influence behavior and the processing of persuasive or interpretive messages are past experience (both for the activity and location) and interest in the target activity or topic. These variables influence the strength of attitudes and the likelihood of a message to change behavior. Those with a great deal of experience in an activity or who are repeat visitors to an area will be more difficult to reach with new interpretive materials or persuasive messages because they have stronger beliefs about the way to behave in a given

situation because of past behaviors. On the other hand, those with strong interest in a topic might be more attracted to receiving messages if they deem the messages to be personally relevant.

Promoting pro-environmental behavior in a recreation setting poses challenges because of the nature of the experience. Unlike environmental education programs, that typically have a longer time frame, interpretive opportunities that reach the masses of visitors to parks are typically brief contacts (i.e., signs or brief personal messages at entry stations). Therefore, developing specific issue knowledge and ownership or sense of responsibility is difficult when many visitors are only at a given park once in a lifetime. While developed for Environmental Education programs in classroom settings, Hungerford and Volk (1990) and Hines *et al.* (1987) models might still be useful in informing messages and strategies to reduce depreciative actions in outdoor recreation settings. Research has shown that increasing environmental sensitivity, affect, or emotion are as important as knowledge in influencing behaviors, so messages should be designed to elicit emotional responses. It is also clear that visitors need to have the knowledge and skills in order to act to prevent harm to the environment.

A comprehensive educational plan should be designed at each park unit to target different types of visitors. Longer-term environmental education programs that allow repeat visitors or locals to move from basic caring of the environment to caring for the place would reach those who would likely be unaffected by new interpretive messages that challenge the way they have always done things. At a national level, educational programs such as Leave No Trace teach ethics and skills to carry out those ethics for those who are heavily involved in an activity, but may not visit the same location repeatedly. First time visitors or novices are most likely to be

influenced positively by on-site information that provides them with the knowledge of local, site-specific issues and teaches the skills necessary to behave in a stewardship manner.

If research money is available, the most effective way to reduce depreciative behaviors is to conduct a study that would characterize depreciative actions in terms of rate of noncompliance and more importantly, identifying the problem audience. Because persuasive messages and strategies would be different for repeat visitors than novices, and for older visitors vs. younger ones, it is important to understand who the primary offenders are and understand their motivations, beliefs, attitudes, values, and prior experiences to develop the most relevant and persuasive message. Once the primary offenders are known, more targeted messages can be developed. For example, you can make effective anthropocentric arguments or biocentric arguments to achieve conservation, depending on the value orientation and beliefs of the target group. If it is not possible to identify a target group, a "shot gun" approach that includes various arguments and message strategies might be the best option to reducing depreciative behaviors. One example of this was a sign developed by Widner and Roggenbuck (2000) to reduce theft of petrified wood in Petrified Forest National Park. They developed a sign that utilized personal and injunctive norms, sanction messages (aimed at different levels of moral reasoning), and used photos to convey what would happen if even a small percentage of visitors took wood to make visitors aware of the consequences of theft and invoke a sense of personal responsibility. The sign was found to significantly reduce fossil theft rates.

Finally, the last, and perhaps most important step is to evaluate the effectiveness of the message or strategy in reducing the targeted behavior. While it is easier and less expensive to hand out a visitor survey to measure changes in beliefs or attitudes, it is most important to measure behavioral change. Behavior change is the ultimate goal and measure of success.

Chapter 2

Manuscript 1: Knowledge Gain at a Visitor Center and the Influence of an Ethical Message on Fossil Respect Beliefs

Abstract

This study measured the short and long-term knowledge gains from a trip to the Visitor Center at Fossil Butte National Monument using both on-site and mail surveys. The influence of a trip to the Visitor Center and the influence of a specially designed fossil respect message on the fossil protection beliefs of Monument visitors were also evaluated. Respondents exiting the Visitor Center achieved higher knowledge scores than entering visitors, and the knowledge gains were still present several weeks after the visit (when the mail survey was administered). However, neither the Visitor Center nor the special fossil respect message, which was included in the Monument's brochure, improved the fossil respect beliefs of respondents. Interestingly, those who reported the highest interest level in fossils were more likely to find it acceptable to take home a small piece of fossil fish than those reporting a lower interest level in fossils, and the most interested also had lower fossil respect beliefs in general.

Introduction

Each year the millions of people visiting national parks and other natural areas benefit from their interactions with the resources in those areas. Unfortunately, some visitor activities damage the natural, cultural, historical, and paleontological resources those parks are also mandated to protect. Thus, park managers must decide how to balance protection of resources and provision of desired recreational experiences.

Despite a variety of efforts attempted by park managers to minimize visitor impacts on the resources they are mandated to protect, many questions remain as to how best to protect resources, while still providing positive and fulfilling recreational experiences. Two major categories of strategies for reducing depreciative behavior in natural and historical areas have emerged. Direct methods regulate visitor behavior through zoning, enforcing rules and regulations, and limiting visitor access. Indirect management methods are less forceful and include informational, educational, and interpretive services.

Managers have tended to prefer indirect techniques for minimizing noncompliant behavior for several reasons. One reason is that direct approaches have the potential negative side effect of limiting visitor freedom, something highly valued in recreational settings (McAvoy and Dustin 1983; Marion and Reid 2007). Also, direct approaches may be highly effective at the location of the intervention, but they do not necessarily encourage the visitor to behave appropriately in similar situations where a prohibitory sign or law enforcement official is absent. Conversely, indirect techniques focus on educating the visitor about the consequences to the resource for inappropriate behavior and how to act ethically toward the environment. It is believed that knowledge about the resource and potential visitor impacts to the resource will lead to more positive resource protection attitudes, which will lead to more appropriate visitor behavior in similar circumstances, regardless of whether or not a reminder message is present (Vande Kamp, Johnson, and Swearingen 1994). In other words, unlike direct techniques that are relatively site-specific, environmental education and interpretation has the ability to increase appropriate behavior toward the environment by altering beliefs and attitudes that may continue to affect behavior over the longer-term.

This research focused on preventing damage to fossil resources in Fossil Butte National Monument, Wyoming. Despite signs posted along the only road into the Monument indicating that federal law prohibits disturbance or theft of the fossil resource (i.e, a direct strategy), the Monument's staff remained concerned about possible damage to the paleontological resource from enthusiastic visitors hunting for fossils along trails. This research evaluated the effectiveness of the current interpretive material in the Visitor Center in increasing the knowledge of the paleontological resources of the Monument and improving beliefs about fossil protection. In addition to evaluating existing messages, a new interpretive fossil respect message (i.e., indirect strategy) for reducing damaging digging and fossil theft along Monument trails was developed and evaluated.

Theoretical Background

While some studies have demonstrated that direct techniques such as sanctions are more effective in reducing depreciative behaviors in recreational settings (Johnson and Swearingen 1992; Martin 1992), other researchers have found that interpretive messages are equally effective as sanction messages in reducing the intention to engage in depreciative behaviors (Duncan and Martin 2002). Direct techniques not only have the disadvantage of possibly detracting from the visitors' experiences by cluttering the environment with regulatory signs, but they also are impractical because of the personnel costs required to enforce the regulations. Interpretive messages have the disadvantage that they likely have little to no influence on the visitors who know it is wrong to steal fossils but intend to do it anyway because these types of behaviors are intentional or willful (Gramann and Vander Stoep 1987; Hendee, Stankey, and Lucas 1990). However, some visitors may not know or consider the long-term effects on the resource of just a

small number of visitors taking a piece of fossil. Also, many may not understand the lost scientific value when fossils are dug up and removed from their rock layer by novice fossil hunters (even if they are not ultimately stolen). These behaviors may be engaged in because visitors are unaware of the damage their actions are causing on the resource and fossil record. It is hypothesized that these unintentional or uniformed behaviors are more likely to be influenced by interpretive messages (Gramann and Vander Stoep 1987; Hendee *et al.* 1990; Roggenbuck 1992) that inform visitors of the consequences of their actions. In fact, research has shown that interpretive messages are at times just as effective as uniformed staff (a direct technique) in reducing the theft of petrified wood (Widner and Roggenbuck 2000).

While interpretive messages are typically developed with the goal of telling a story of the resource for the enjoyment of the visitor, it is thought that increased knowledge of the resource might lead to more favorable attitudes related to resource protection. This idea is supported by the theory that attitudes (i.e., the evaluation a person holds about an object or issue) can be based on cognition (beliefs), affect, behavior, or some combination of the three (Petty 1995). Therefore, it follows that increasing knowledge about an issue or object may influence a person's related beliefs and attitudes. In fact, a review of several studies in environmental education found that students with higher knowledge scores also had more positive attitudes toward natural resources (Zimmerman 1996). More recent research on high school students has also supported the positive correlation between environmental knowledge and attitudes (Campbell Bradley, Waliczek, and Zajicek 1999). However, other studies suggest that knowledge does not necessarily lead to more positive attitudes toward the environment (Borden and Schettino 1979; Hungerford and Volk 1990). Because of the mixed research findings, this study not only will

evaluate the ability of a visitor center to increase knowledge, it will also examine the relationship between knowledge level and fossil protection beliefs.

Interpretation's Effect on Knowledge and Attitudes

Much of the research conducted to date has focused on the effectiveness of environmental education programs designed for school-aged children on improving knowledge and attitudes about the environment. While these studies are informative, they are typically based on a series of lessons and on-site experiences rather than on a single exposure to an interpretive program or visitor center displays, which is more typical of a visit to a national park or other natural area.

In general, most research found that environmental education programs increased knowledge and attitudes toward natural resources or management actions. O'Brien and Pease (2004) found that an environmental education program at a national wildlife refuge was successful in improving environmental attitudes and increasing knowledge of 4^{th}, 5^{th}, and 6^{th} graders. In a study conducted on adult visitors to state parks in Ohio, interpretive services were found to significantly increase knowledge and improve attitudes toward the resource (Olson, Bowman, and Roth 1984). Loomis, Bair, and González-Cabán (2001) found that a booklet was successful and in increasing knowledge about prescribed burning and increased tolerance for prescribed fires among Florida residents. However, Leeming, Porter, Dwyer, Cobern, and Oliver (1997) found that an environmental education program administered over the academic year to elementary school classes positively impacted attitudes, but not knowledge of environmental issues. Conversely, an outreach program by Manatee Watch in Florida found that brief contacts with boaters and outreach materials had little impact on boater's knowledge, attitudes, or

behaviors regarding low impact boating practices in manatee habitats (Morris, Jacobson, and Flamm 2007). Although not considering the influence of interpretive messages, other researchers have also found environmental knowledge to be correlated with environmental attitudes among recreationists (Hwang, Kim, and Jeng 2000).

Potential Effects on Attitudes of Message Comprehension, Past Experiences, and Interest in Fossils

While environmental education and interpretation messages are often limited to telling a story, the content of the sign, video, or program can also be designed with the goal to persuade visitors to change their attitudes or beliefs about the resource. One theory used to explain the way persuasive messages act on message receivers is the Elaboration Likelihood Model of persuasion which describes two routes for a persuasive message to change an attitude (Petty and Cacioppo 1986). In the peripheral route, attitude change involves relatively non-effortful thinking. In contrast, the central route involves careful and effortful thinking to evaluate the information or arguments presented. The central route of persuasion has been shown to produce an attitude that is more resistant to change, enduring, and more predictive of behavior than the peripheral route because of the effortful thinking and elaboration involved (Petty and Cacioppo 1986). Therefore, interpretive interventions should encourage central route processing of the message, if the goal is to produce long-term attitude or behavior change.

The route used by an individual in a given situation is determined by his or her motivation and ability to process the information. Therefore, interpretive messages intended to be persuasive must be designed for easy comprehension. Because increased personal relevance improves the chances a message will be processed through the central route (Petty and Cacioppo 1986; Chaiken 1980), messages should motivate people by describing how the message relates to

them personally. It has also been shown that environmental education messages have stronger impacts on attitudes if the receiver is already interested in the topic or environment (Leeming *et. al*. 1997). Therefore, those who are the most interested in fossils should be the most receptive to interpretation and reading persuasive messages urging fossil protection. However, those most involved in a topic have also been shown to be more resistant to persuasive messages attempting to change opinions than those less involved (Johnson and Eagly 1989).

Prior experience with the specific attitude object or issue has also been shown to have a direct effect on the persuasion process (Manfredo and Bright 1991). Increasing levels of prior knowledge or experience with an object or situation tends to decrease the amount of elaboration of a message and makes it more difficult to change the attitude because the attitude is more stable. Research in recreational settings has shown that inexperienced users are influenced more by persuasive messages than experienced users (Roggenbuck and Berrier 1982; Krumpe and Brown 1982). Therefore, visitors who have been to Fossil Butte National Monument before may be influenced less by persuasive messages than first time visitors because they have past experiences and behaviors influencing their attitudes toward fossil protection.

Fossil Respect Message

In addition to the Visitor Center interpretive messages that were primarily designed to convey information about the Fossil Lake story and explain why the fossil resource is so valuable, a special message to promote more ethical fossil respect attitudes among visitors was developed and tested. The message relied on a moral appeal to persuade visitors to adopt ethical fossil protection attitudes and behaviors. The message was not designed to convey detailed information about the Fossil Lake story (i.e., it was not intended to influence knowledge gain); it

was designed to educate about the importance of maintaining the integrity of the fossil record by leaving fossils where they are found in the Monument.

Two key components to increase the effectiveness of a moral appeal are awareness of consequences (AC) and ascription of responsibility (AR). These concepts were borrowed from Schwartz's (1970) Norm Activation Model, which was originally developed to explain altruism and helping behavior. The model predicts that in order for a person to perform an altruistic act, he or she must be aware of the consequences of his or her action (or inaction) and feel a personal responsibility to act. Therefore, the fossil respect message described the negative consequences for the fossil resource and science if visitors disturb fossils or remove them from the Monument. The message also used personal language to promote a sense of personal responsibility for acting in a way that will help protect the resource and the story of Fossil Lake embedded in the fossil record.

The limited research in outdoor settings evaluating the effectiveness of including AC and AR in messages has shown mixed results. Van Liere and Dunlap (1978) found that AR had a strong correlation with yard burning behavior, with AC only showing a weak correlation. Vander Stoep and Gramann (1987) found that AC messages reduced depreciative behavior around monuments in an historical park by 88%. The addition of an AR message to the AC message did not further reduce depreciative behavior.

Research Objectives

There are four major research objectives to assess the influence of the Visitor Center on knowledge transfer and retention and on the fossil protection beliefs of Fossil Butte National Monument visitors:

1. Assess short-term gain and longer term knowledge retention from a visit to the Monument Visitor Center.
2. Assess the impact of a trip to the Visitor Center and a specially designed fossil respect message on fossil respect beliefs.
3. Assess the relationship between knowledge of the Fossil Lake Story and fossil respect beliefs.
4. Assess the relationship between interest level in fossils and knowledge, and between interest level and beliefs.

Methods

Study Location

This research was conducted at Fossil Butte National Monument, which is located near Kemmerer, Wyoming. Visitation is relatively light, with approximately 23,000 people visiting the 8,200 acre Monument each year. The Monument sits on a 50 million old lakebed (Fossil Lake) that is world renowned for the quality and quantity of fossil fish, plants, reptiles, birds, and insects. Interpretive materials in the Visitor Center and wayside exhibits tell the story of Fossil Lake and showcase fossils collected from commercial quarries in the area. While visitors to the area can purchase and dig for fossils at local commercial quarries, they are prohibited from taking fossils from the Monument. The prohibition is posted at trailheads and along the only road into the Monument.

Experimental Design

One person, aged 17 years and older, from each group visiting the Visitor Center in Fossil Butte National Monument was asked to participate in this study on 15 randomly selected days during the sampling period (June 28, 2001 to August 25, 2001). An effort was made to alternate between asking adult males and females, but if the person who was initially asked to participate refused, any adult group member who volunteered to complete the survey was

accepted. The sampling days were stratified by weekday (9 days) and weekend days (6 days) and time of day. On some randomly determined days visitors entering the Visitor Center received a survey, and on the remaining days visitors were not administered a survey until after they had visited the Visitor Center. Therefore, the same people did not receive both an entry and exit survey. On 3 randomly determined "entry" survey days and 3 of the "exit" survey days, a special ethics message created for this study was included in the National Park Service's Fossil Butte National Monument brochure that was handed out to each group as it entered the Visitor Center (Figure 2.1). The insert (8 inches x 3 inches) was printed on cream-colored cardstock. Thus, there were four groups of on-site survey respondents: entry survey/no ethics message (n=124); entry survey/ethics message (n=83); exit survey/no ethics message (n=98); and exit survey/ethics message (n=102).

The fossil respect message was designed to educate the visitor about the lost scientific value when a fossil is removed from its associated rock layer. It was an ethical/moral appeal to respect the fossil resource. In addition to informing of the consequences (AC portion of Schwartz's Norm Activation Model), it also ascribed responsibility (AR) by informing visitors of what they personally should do, using personal language. The message specifically told visitors not take fossils or even dig for them in the monument. It also instructed them that they may look at fossils they see lying on the ground, but to always leave them where they are found.

Survey Administration

Visitor contact occurred outside the Visitor Center. A research technician randomly selected one adult from each visitor group and asked him or her to participate in the study by filling out a short survey (3 pages). The last page of the on-site survey asked respondents to

provide their names and addresses so that we could send them a follow-up mail survey. On-site survey respondents who provided their names and addresses were mailed a follow-up survey within two to four weeks of their visit to Fossil Butte National Monument. A modified Dillman method was used to contact mail survey non-respondents (Dillman 2000). Approximately 10 days after the initial mailing, a postcard reminder was sent. If the visitor did not return the survey within three weeks of the initial mailing, a new survey was sent. A third mailing of the survey was sent to non-respondents approximately six weeks following the initial mailing.

Survey Instrument

The on-site surveys (Appendices A and B) and mail survey (Appendix C) contained sociodemographic items (age, gender, income, and education), a question on prior visits to Fossil Butte National Monument, and an opportunity for visitors to self-evaluate their personal interest level in fossils. The on-site survey contained 11 multiple-choice questions about Fossil Butte National Monument and the Fossil Lake story; 10 of those questions were repeated on the mail survey. The quiz questions asked specific details of the Fossil Lake story, what made Fossil Butte National Monument so special, and about the management agency and priorities of Fossil Butte National Monument. The content of quiz questions was developed from interpretive signs, videos, and displays in the Visitor Center. Fossil respect beliefs were measured with 6 items related to the fossil respect message insert (Figure 2.1) and other fossil protection issues of concern to Monument staff. The questions focused on taking fossils from the Monument, searching for fossils in the Monument, and the buying and selling of local fossils.

Data Analysis

The responses of visitors entering the Visitor Center were compared to those exiting to determine possible knowledge gain from a visit to the Visitor Center by calculating an overall score based on the responses of the 11 "quiz" questions. Long-term knowledge retention was determined by comparing on-site quiz results to mail survey responses using a paired t-test. Survey respondents were screened by age and gender to ensure that the same individual completed both on-site and mail surveys prior to analysis. There was no overlap in the content of the "quiz" questions and the fossil respect ethics message, so the message should not have affected knowledge scores; therefore, those who received the respect message were combined with those who had not for the knowledge analysis.

In order to test the effect of the fossil ethics message on visitor beliefs about fossil protection, mail survey responses were compared between those who received the special ethics insert and those who did not on a set of questions about possible behaviors toward fossils in Fossil Butte National Monument and the surrounding area. The respect responses of entering visitors were compared to exiting visitors to determine if the Visitor Center experience influenced fossil protection beliefs.

Non-response Bias and Response Rate

The on-site response rate was relatively high at 86%. Of those who completed on-site surveys, 70% provided names and addresses to receive a mail survey. The mail survey had a 69% response rate. There was a 41% response rate from contact at the visitor center to completion of the mail survey. A non-response bias analysis showed that there was no difference between mail respondents and non-respondents in gender, but older individuals were

more likely to return a mail survey than younger individuals (T-test, t=-2.909, p=0.003, df=397). Additional analyses confirmed that this trend did not affect any of the results presented. There was also no difference between mail survey respondents and non-respondents in regard to number of previous visits to Fossil Butte National Monument, self-reported interest level in fossils, or participation in various activities at the Monument and in the surrounding area.

Results

Visitor Characteristics

On-site survey respondents were 61% male and had a mean age of 47.0 years. Visitors to Fossil Butte National Monument tended to be very highly educated, with 40.1% having completed an advanced degree and an additional 31.3% having completed at least a bachelor's degree (only asked of mail survey respondents). Few had visited the Monument before (15%, on-site survey), but 54.2% said they had quite a lot or a strong interest in fossils. In fact, 60.9% of the mail survey respondents reported reading about fossil fishes prior to their visit, and 25.9% had read about Fossil Lake. The vast majority of visitors had read about dinosaurs (90.3%) and other prehistoric life (81.6%). Therefore, Fossil Butte National Monument visitors tended to be very well-educated, interested in fossils in general, and had read about the Fossil Lake Story prior to their visit, but they had little prior experience at Fossil Butte National Monument.

Knowledge Gain from Visitor Center

Visitors exiting the Visitor Center at Fossil Butte National Monument scored higher (74.0%) on the on-site survey knowledge quiz than those entering the Visitor Center (64.7%) (T-test, t=-6.00, p<00005, df=394). The most significant differences in correct responses between

entering and exiting visitors were in the very specific questions about details of the Fossil Lake story such as the scientific name of the most common fish found in the area, the type of rock the fossils are encased in, and the hypothesized scenario that explained how the fossils became fossilized (Table 2.1). There were no significant knowledge differences between entering and exiting visitors in their perceptions of what agency manages Fossil Butte National Monument, management goals, or the primary purpose for the Monument.

A comparison of the demographic and fossil activity-related characteristics of entering and exiting visitors revealed considerable similarity between the two groups (Table 2.2), so the difference in knowledge scores was not due to group differences. Gender, age, income, and education level were statistically similar between entry and exit survey visitors. The two groups were also similar in the proportion who had made prior visits to Fossil Butte National Monument. There was a slightly significant trend for exiting visitors to report a higher interest level in fossils (self-report) than entry visitors (Chi-square=6.30, p=0.043). While a greater interest in fossils might be expected and desired from a visit to a Visitor Center, an additional t-test on knowledge score was conducted after controlling for interest level in fossils to rule interest level out as the reason for the difference in knowledge scores; the knowledge scores of exiting visitors (74.0%) remained significantly greater than entering visitors (65.1%) (T-test, t=-5.665, $p<0.0005$, df=392) after controlling for interest level by applying a weighting adjustment (Pike 2007).

Longer-term Knowledge Retention

Ten of the 11 on-site quiz questions were repeated on the mail survey instrument. Before conducting a paired t-test to compare scores, mail respondents were screened by age and gender

to make sure they were the same respondent who answered the on-site survey; if someone different completed the on-site and corresponding mail survey, he or she was removed from the analysis (n=18 removed).

Those who took an exit survey scored similarly on-site as on the mail survey (Table 2.3). This suggests that knowledge gained at the Visitor Center was retained for at least the 3-6 weeks between the trip to Fossil Butte National Monument Visitor Center and mail survey completion. A comparison of on-site and mail quiz scores of visitors who completed an on-site entry survey confirmed that knowledge was gained about the Fossil Butte story from a trip to the Visitor Center and retained. Note that the on-site scores for this analysis were not identical to the results reported in Table 2.1 because only 10 of 11 questions were repeated on the mail survey and only scores from mail survey respondents were included. While the difference between on-site entry and exit scores was somewhat less in the 10 question set than with the complete 11-question score, exit scores remained significantly greater than entry scores (T-test, t= -2.240, p= 0.027, df=158)

Influence of the Visitor Center on Fossil Respect

The survey asked visitors to rate the acceptability of six fossil-related behaviors or scenarios they might encounter at Fossil Butte National Monument or the surrounding area. In order to evaluate the effect of a visit to the Visitor Center on the acceptability ratings, on-site survey responses of entering visitors were compared to exiting visitors; only those who did not receive the special ethics insert were included in the analysis. In all behavior scenarios, the more fossil-protection oriented response was to disagree with the acceptability of the scenario. The

entering and exiting visitors included in this analysis were statistically similar in terms of gender, age, prior visits to Fossil Butte National Monument, and self-reported interest level in fossils.

Entering and exiting visitors had similar opinions of the acceptability of all six fossil-related scenarios presented to them (Table 2.4). Therefore, a trip to the Visitor Center had no significant impact on fossil respect beliefs. However, very few visitors, regardless of whether they had been in the Visitor Center or not, felt that it was acceptable (i.e., agreed to statement by answering 1, 2, or 3 on a 7-point Likert-type scale where 1=strongly agree, 4=neutral, and 7=strongly disagree) to take home even a small piece of fossil fish (3.2%) or common fossil (5.1%) from the Monument. The vast majority of visitors (94.4%) also agreed that it was unacceptable to remove a fossil from its rock layer, even if it was put back.

While there was strong agreement that it was not acceptable to take fossils or dig them out of the rocks in the Monument, there was less of a consensus on the acceptability of picking up a fossil seen lying on the ground, even if it is put back. While many visitors (35.8%) felt that it was acceptable to pick up a fossil found on the ground, almost half (49.5%) felt that picking up fossils was not acceptable, even if put back. There was also no consensus on the commercial marketing of fossils from the area outside of the Monument. Many (31.8%) felt that it would be acceptable for the Monument to sell fossils collected in the area in its book store and an even greater percentage (56.3%) felt it was acceptable to buy area fossils at commercial rock shops outside the monument.

Influence of the Special Insert on Fossil Respect Beliefs

Responses to the six fossil-respect related questions from the mail survey were used to evaluate the impact of the special fossil respect insert on beliefs about the fossil-related

behaviors. While it would have been ideal to measure the impact of the special insert shortly after it was given to the visitor and in the environment that the fossil-related behavior decisions would be made, it was observed (n=77 visitors) that the Monument's brochure and accompanying special ethics message insert were not read by visitors during their trip to the Visitor Center. Therefore, mail survey responses of visitors who were surveyed both entering and exiting the Visitor Center were included in the analysis because they had both experienced the Visitor Center and had a much greater opportunity to read the insert (if they were in that treatment) at the time they completed the mail survey.

A comparison of visitors who had received the special fossil respect message and those who did not revealed that the special insert had little impact on the opinions of visitors about appropriate fossil-related behaviors (Table 2.5). Although visitors who received the fossil respect insert tended to be more likely to respond in a more fossil-protection orientation, only 1 of the 6 scenarios had a statistically significant difference. Visitors who received the fossil respect message were slightly more likely to disagree than those who did not receive the insert that it is acceptable to pick up a fossil, even if it is put back (T-test, t=-2.050, p=0.042, df=177). Interestingly, the message on the insert actually instructed visitors that it was OK to look at fossils as long as they were left where they were found.

In addition to the similarity in fossil respect beliefs, there was also no significant difference in self-reported behavior regarding fossil resources of the region between those who had and had not received the special fossil respect insert. A similar percentage of those who did not receive the ethics message (29.8%) and those who received the ethics insert (21.3%) either dug for fossils at a local commercial quarry, bought fossils at a commercial quarry, or purchased fossils from a local rock shop. While not explicitly asked not to engage in those activities, the

message in the insert did state that fossils lose their meaning (i.e., scientific value) when removed from their rock layer. This indirectly implies that non-scientific removal and selling to individuals negatively impacts the ability of scientists to understand the Fossil Lake story.

Knowledge – Belief Relationship

In order to test the relationship between knowledge of the Fossil Lake story and the level of acceptance for the fossil-related ethical scenarios presented, the knowledge scores and acceptability responses were considered among visitors exiting the visitor center. It was decided to use this group of respondents for this analysis because it captured the knowledge and opinions of visitors at the time when they were preparing to explore the Monument and would be tempted to hunt for and possibly take home fossils. Because the ethical message was already shown to have no impact on fossil respect attitudes and it was likely that few had read the message in the brochure during their trip to the visitor center, exiting visitors who had received the fossil-respect message and those who did not were combined for this analysis.

The overall knowledge score was slightly correlated to the fossil protection beliefs related to fossil theft, but the positive relationships were not strong (Table 2.6). This suggests that more detailed knowledge of the Fossil Lake story does not in itself lead to more fossil protection oriented beliefs. However, there was some limited evidence that knowledge that the National Park Service manages Fossil Butte National Monument does improve fossil-protection related beliefs (Table 2.7). However, the small sample size (n=16) of those not knowing who manages Fossil Butte National Monument makes drawing strong conclusions from these results suspect.

Interest Level Influence on Knowledge and Fossil Respect Beliefs

All on-site respondents (entry and exit) were included in the analyses investigating the relationships between interest level in fossils and the knowledge of the Fossil Lake story and between interest level and fossil respect beliefs. While it would have been ideal to investigate the influence of interest level on knowledge gain and belief change, sample size limitations prevented these analyses. Both entry and exit responses were included in order to get sufficient sample sizes of the three different fossil interest levels (none/some, a lot, and strong interest). Also, there was no reason to believe a trip to the Visitor Center would influence the direction of the relationship.

Those who reported that they had a strong interest in fossils had higher knowledge scores (74.6%) than those who were reported they had a lot of interest in fossils (68.2%) or none/some interest (67.6%) (ANOVA, $p=0.002$). An opposite trend occurred in terms of fossil respect beliefs. Those reporting the strongest interest level in fossils tended to be the least likely to have strong fossil protection beliefs when considering all belief statements combined (Table 2.8), although only 2 of the 6 individual belief statements resulted in significant differences when considered individually.

Discussion

While many studies have documented an increase in knowledge about environmental issues from environmental education programs in schools or camps, which tend to last from several hours to months, few studies have documented an increase in knowledge from a brief trip to a visitor center. This research documents that visitors to Fossil Butte National Monument's Visitor Center do gain significantly in their knowledge of the facts of the Fossil Lake story. This

study also documents that those gains in knowledge remain and show no evidence of decline at least a few weeks following the visit. This is encouraging and somewhat surprising given that other researchers looking at knowledge retention following environmental education programs that are much more intensive in terms of time exposed to the message have reported declines after a month or more. Daniels and Marion (2005) reported that the pre- to post-trip knowledge gains from a two-day Leave No Trace Trainer course showed some erosion after 4 months, but knowledge scores were still higher than pre-test scores. Youth participants in a zoo conservation camp self-reported a gain in knowledge from pre- to post-program, but reported a decline one month after the program (Kruse and Card 2004). However, one study evaluating the effectiveness of a 2-hour adult workshop featuring hands-on activities on wildland fire found that gains in knowledge and increased support for fire management was still present a month after the workshop (Parkinson, Force, and Smith 2003).

Another interesting finding of this study was the relatively high level of knowledge about the Fossil Lake story that visitors had prior to their visit to Fossil Butte National Monument. This has implications both for the provision of appropriate interpretive programs and the development of persuasive messages. While it is generally thought that interpretive materials should be aimed at a middle school aged reading level (Knudson, Cable, and Beck 1999), this strategy may not be appropriate for specialty parks such as Fossil Butte National Monument that attract individuals who are very interested in the resource, highly educated, and very knowledgeable about the story of the place prior to visitation. Interpretation and associated messages to promote ethical behavior such as reducing fossil theft should be developed relative to the knowledge level of visitors (Manfredo and Bright 1991).

While it is difficult to quantify damage to paleontological and archeological resources, nonreparable damage to such resources is widespread among Park Service units with 93% reporting some level of damage (Johnson and Vande Kamp 1996). While it is likely that only a minority of visitors damage the resource, it doesn't take many to deplete a non-renewable resource such as fossils. For example, observations of visitors to Petrified Forest National Park suggest that only 1.2% are thieves of petrified wood (Roggenbuck, Widner, and Stratton 1997). However, despite direct and indirect interventions to reduce theft, and the opportunity to buy petrified wood at the visitor center, park staff estimated that visitors remove 12 tons of petrified wood from the park each year (USDI-NPS 1992). In an extreme case of resource mismanagement, Fossil Cycad National Monument in South Dakota was forced to close because all cycads (fossilized plants) had been depleted due to unauthorized fossil collecting, unlimited research collections, and neglect (Santucci and Hughes 1998).

While Fossil Butte National Monument has not documented losses of the fossil resource on the scale of Petrified Forest National Park, the potential exists for significant losses of the fossil resource. Although the vast majority of visitors felt it was not acceptable to take home fossils, 3.2% felt it was acceptable to take home a small piece of fossil, and 5.1% felt it was acceptable to take home common fossils. The percentage of visitors who actually believe it is acceptable to take fossils home is likely somewhat higher because of social desirability bias when filling out a survey. While visitation to the Monument is much lower than that of Petrified Forest National Park, if 5% or more of the visitors hunt for and remove fossils, significant loss would occur over time.

Unfortunately, neither a trip to the Visitor Center nor exposure to a special fossil-respect message had a significant impact on reducing the percentage of respondents who felt it was

acceptable to dig for fossils and remove them from the Monument. Therefore, making the visitor more knowledgeable of the Fossil Lake story and exposing them to the consequences to the resource of fossil theft did not significantly influence beliefs about fossil theft or digging for fossils in the monument. This suggests that the digging for and removal of fossils is more of an intentional or willful act, rather than an uniformed type of behavior. Therefore, more direct, sanction-oriented management techniques may need to be employed to reduce theft (Vander Stoep 1987; Hendee *et al*. 1990; Roggenbuck 1992).

Research dealing with similar resource-related behaviors has produced mixed results when comparing sanction messages with other types of messages to reduce theft. A sanction sign at Mount St. Helen's National Monument was significantly more effective in reducing the percentage of visitors who took pieces of pumice than other message types (Martin 1992). Conversely, Widner and Roggenbuck (1999) found that interpretive messages were at least as effective as a sanction message in reducing theft of petrified wood at Petrified Forest National Park. In a hypothetical study of college students in a classroom environment, Duncan and Martin (2002) found that the students said they would be similarly likely to take cultural artifacts while on a backpacking trip when exposed to a sanction or interpretive message. While these studies are instructive, the situational contexts are somewhat different from that of Fossil Butte National Monument. The pumice and petrified wood are readily visible on the surface of the ground and therefore appear abundant, and one could rationalize that one little piece does not matter. This in fact was found to be the case when thieves were interviewed at Petrified Forest National Park; Ward and Roggenbuck (2003) found that thieves rationalized that only taking larger pieces was bad. On the other hand, very few fossils at Fossil Butte National Monument are visible lying on the surface. Also, Fossil Butte visitors likely differ from visitors to Mt. St.

Helen's and the Petrified Forest National Park in that they are highly interested in fossils and have made a special trip to the remotely located Fossil Butte National Monument to experience it first-hand.

The finding that those who reported the most interest level in fossils tended to have lower fossil protection beliefs than those who reported none or only some interest in fossils supports the idea that the specialized nature of Fossil Butte National Monument visitors should be addressed when developing strategies to reduce fossil theft. While research on some groups such as anglers has suggested that more involved or specialized anglers develop more preservationist beliefs and behaviors (Bryan 1977), more recent research on scuba divers duplicates the pattern seen between interest level and fossil protection beliefs. Todd, Cooper, and Graefe (2000) found that scuba divers generally tend to increase in knowledge and ethical beliefs as they move up the specialization spectrum from beginners to experts, but experience a decline in both knowledge and ethical beliefs as they become post-experts. Beginners were more likely to think that touching or taking artifacts while diving was wrong and were more supportive of stiff fines than experts. The authors felt that one explanation for this trend could be that those with more diving experience had more tempting opportunities to touch or take artifacts, which subsequently led to a compromise in their stated beliefs; however, it should also be noted that expert divers also tended to be older and began diving when collection of artifacts was more accepted, which could also account for the observed pattern of beliefs. Other research on scuba divers has demonstrated that specialization is a strong mediator of the relationship between knowledge of reef ecology and pro-environmental behavior (Thapa, Graefe and Meyer 2005).

The suggestion that more interested visitors are more likely to think it is acceptable to remove fossils is a challenge to managers because it puts in direct conflict the dual goals of

managers to provide for a recreation experience and protect the resource. Highly interested visitors want to experience the thrill of finding a fossil themselves, not just view museum specimens in the Visitor Center. Fossil Butte National Monument has developed a unique interpretive program to attempt to alleviate this conflict in management goals. The Monument maintains and staffs a small abandoned commercial quarry within its borders. Interpretive staff conduct informal programs in the quarry that instruct visitors about the scientific method of data collection and the information that it can provide scientists who are trying to understand the Fossil Lake story. Visitors are allowed to dig for fossils with the help of the interpretive staff; however, they are not allowed to take what they find home with them. Instead, the fossils are photographed, archived, and the visitor is presented with a "fish finder" card that documents the type of fish found.

Although the interpretive quarry program is a creative way of channeling fossil-digging urges, it likely does not completely discourage amateur fossil hunters from digging along trails in the Monument. Survey findings suggest that the persuasive message included in the brochure and the materials in the Visitor Center had no significant impact on fossil respect beliefs. Aside from not impacting beliefs about theft, the message also did not change beliefs about the more subtle issue of commercial marketing of fossils in and around the Monument. Although it was stated that fossils have the most scientific value if they are systematically removed from the rock and studied in relation to other fossils, similar percentages approved of commercial marketing of fossils from the area, regardless of whether they had received the fossil-respect message or not. This is further evidence that little elaboration of the message occurred because visitors did not associate the commercial fossil harvest with the loss of scientific information.

The lack of persuasive ability of the message from highly interested people has been demonstrated in the past. Individuals with a high level of issue involvement are less persuaded by message arguments than individuals who care less about an issue (Johnson and Eagly 1989). Manfredo and Bright (1991) also demonstrated in a recreational setting that there was a negative relationship between past experience and elaboration of messages. This again highlights the need to know the visitor and his or her motivations before developing messages to reduce depreciative behavior.

Future research should focus on understanding the relationships between knowledge, beliefs, and behaviors. While factual knowledge of the Fossil Lake story had little relationship to fossil-respect beliefs, there was some evidence that knowledge that the National Park Service managed the Monument had a positive influence. This could be because source credibility has a strong effect on the persuasion process (Manfredo and Bright 1991) and suggests that the National Park Service should do more to educate visitors that it also manages National Monuments. Other areas of research have suggested that environmental education should focus on emotions and beliefs instead of knowledge (Pooley and O'Connor 2000; Newhouse 1990). Regardless of the specific theory or construct studied, there is a real need to conduct more research on the influence of interpretive services experienced during a typical park visit on environmental attitudes and behaviors.

Limitations

One of the major limitations of this study was that the survey instrument was largely insufficient in detecting differences in knowledge and beliefs among visitors. The unexpectedly high knowledge scores of even visitors who had not yet entered the Visitor Center made it

difficult to detect changes in scores from the interpretive materials inside the Visitor Center. A similar issue arose from the attempt to measure the increase in fossil protection beliefs. The very high percentages who felt that it was unacceptable to take fossils from the Monument home made it difficult to detect any impacts of the messages. An increase in sample size or the design of belief statements that receive less of a consensus would have helped this issue. Unfortunately, this is a problem when studying rare events (e.g., fossil theft) or the voluntary disclosure that taking fossils is acceptable.

It was also hard to evaluate the impact of the fossil respect message because it was unknown whether the respondent ever read the special insert or not. It would have been useful to include a question on the mail survey asking if visitor remembered reading the special insert in the National Park Service brochure.

Another limitation was that the same visitors were not sampled prior to entering and upon exiting the Visitor Center. This was not an option because of the response burden this would have placed on the visitor. There was also anecdotal evidence from this study that the entry survey actually encouraged visitors to search out the answers to the "quiz" questions during their visit, either to score themselves or to find answers to the questions they did not know. Another potential limitation of the sampling method was that if the individual who was initially approached refused to complete the survey, any other group member who volunteered was allowed to participate. It is not known what impact this had on the results, but it is possible that those most interested in fossils and most knowledgeable about the Fossil Lake story were more likely to volunteer to participate in the study.

The relatively small sample size and complex design (entry vs. exit survey and message vs. no message) also prevented an analysis into the relationship between knowledge gain and

change in beliefs. This is the crucial relationship in the proposition that increasing knowledge leads to increased ethical beliefs and attitudes toward the environment, and it could not be explored with this data set. Future research should be designed to more deeply explore this relationship.

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Please Respect the Fossil Resource

The fossil record in the monument is an ancient book about life on earth millions of years ago. The rock layers are the pages and the fossils are the words in this book. If you remove a fossil from its place in the rock layers, the book begins to lose its meaning. Everyone loses.

What should visitors do to help?

- Do not dig for fossils unless you are with a monument staff member.
- Look at fossils, but always leave fossils where you find them.
- Do not take fossils from the monument under any circumstances.

Figure 2.1. Fossil respect message included in the Fossil Butte National Monument brochure on 6 of the 15 sampling days.

Table 2.1. Knowledge quiz results comparing visitors who were entering or exiting the Visitor Center.

Question	%Correct Entry[1]	%Correct Exit[2]	Chi-square	p-value
Fossil Butte NM is managed by the…	86.2	91.9	χ^2=3.35	0.67
The management staff at Fossil Butte NM work to achieve the following goal(s):	88.1	91.4	χ^2=1.18	0.277
During the time of Fossil Lake, the climate was…	72.3	79.0	χ^2=2.46	0.116
Fossil Lake was present in this area ____ million years ago.	51.7	63.0	χ^2=5.20	0.023
Fossil Lake is special because…	81.6	82.5	χ^2=0.06	0.813
What scenario best describes how fish in Fossil Lake came to be fossilized?	60.2	73.0	χ^2=7.38	0.007
One of the most common fossils in Fossil Lake are small herring-like fish called _____.	21.2	55.1	χ^2=48.05	<0.0005
The pressure of accumulating layers of sediment over thousands of years turned old lake sediments into _____, which encases the fossil fish found today.	38.5	53.0	χ^2=8.47	0.004
The age that a fossil fish was when it died can be determined by _____.	31.3	39.7	χ^2=3.04	0.81
What is the primary reason that fossils are protected in national parks and monuments?	87.6	92.5	χ^2=2.78	0.096
Fossil A is located several rock layers above Fossil B. This suggests that….	93.0	90.0	χ^2=1.13	0.289
Overall Quiz Score	64.8	74.1	-6.00	<0.0005

[1] n=198 to 203
[2] n=198 to 201

Table 2.2. Demographic comparison between entry and exit survey respondents.

Characteristic	Chi-square	p-value
Gender	χ^2=0.49	0.483
Age[1]	χ^2=3.03	0.552
Education[2]	χ^2=1.80	0.616
Income[3]	χ^2=8.97	0.110
Prior visit	χ^2=2.80	0.094
Interest Level[4]	χ^2=6.30	0.043

[1] Age categories: 17-29, 30-39, 40-49, 50-59, and 60-100

[2] Education categories: High school or less, Associates degree or some college, Bachelors, and Advanced degrees

[3] Income categories: < $40,000, $40,000-59,999, $60,000-79,999, $80,000-99,999, $100,000-149,999, and $150,000 and up

[4] Interest levels: none/some, a lot, and strong

Table 2.3. Comparison of on-site and mail knowledge scores using a paired t-test to evaluate long-term knowledge retention.

	On-site	Mail	Paired t-test	p-value	df
Entry	71.4	79.6	-4.43	<0.0005	76
Exit	77.0	79.5	-1.65	0.102	82
t-test	t=-2.240 p=0.027 df=158	t=0.044 p=0.965 df=158			

Table 2.4. Effect of a trip to the Visitor Center on fossil respect beliefs.

Statement	Level of Agreement: Entry (n=117-120)	Level of Agreement: Exit (n=97-99)	t-test	p-value	df
It is acceptable to take a small piece of fossil home from Fossil Butte National Monument.	6.45[1]	6.68	-1.52	0.130	216.9
It is acceptable to take home common fossils from Fossil Butte National Monument.	6.39	6.55	-1.21	0.229	214
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back.	6.32	6.25	0.41	0.685	212
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back.	4.57	4.38	0.59	0.559	216
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center.	4.33	4.79	-1.46	0.145	215
It is acceptable to buy fossils at commercial rock shops.	3.09	3.41	-1.14	0.255	211

[1] 7-point scale: 1=strongly agree, 4=neutral, and 7=strongly disagree.

Table 2.5. Effect of fossil respect message on fossil respect beliefs (mail survey results).

Statement	No Ethics (n=94-96)	Ethics (n=83-85)	t-test	p-value	df
It is acceptable to take a small piece of fossil home from Fossil Butte National Monument.	6.51[1]	6.59	-0.454	0.650	179
It is acceptable to take home common fossils from Fossil Butte National Monument.	6.45	6.52	-0.383	0.702	179
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back.	6.23	6.52	-1.550	0.123	174.8
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back.	3.89	4.56	-2.050	0.042	177
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center.	3.97	4.33	-1.114	0.267	178
It is acceptable to buy fossils at commercial rock shops.	2.78	3.02	-0.920	0.359	175

[1]7-point scale: 1=strongly agree, 4=neutral, and 7=strongly disagree.

Table 2.6. Correlation between knowledge (quiz scores) and fossil protection beliefs (on-site exiting respondents only, n=191-198).

Statement	Pearson Correlation	p-value
It is acceptable to take a small piece of fossil home from Fossil Butte National Monument.	0.146	0.041
It is acceptable to take home common fossils from Fossil Butte National Monument.	0.141	0.049
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back.	0.137	0.057
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back.	0.021	0.765
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center.	-0.025	0.724
It is acceptable to buy fossils at commercial rock shops.	-0.118	0.104

Table 2.7. Comparison of fossil respect beliefs between those who knew Fossil Butte National Monument was managed by the National Park Service and those who did not.

Statement	NPS Manages Fossil Butte NM: Knew (n=177-181)	NPS Manages Fossil Butte NM: Did not know (n=15-16)	t-test	p-value	df
It is acceptable to take a small piece of fossil home from Fossil Butte National Monument.	6.68[1]	5.19	-2.765	0.014	15.6
It is acceptable to take home common fossils from Fossil Butte National Monument.	6.54	4.93	-2.265	0.019	14.7
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back.	6.23	5.25	-1.841	0.084	16.4
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back.	4.43	3.81	-1.002	0.302	195
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center.	4.67	4.44	-0.405	0.686	193
It is acceptable to buy fossils at commercial rock shops.	3.13	3.25	0.249	0.804	189

[1]7-point scale: 1=strongly agree, 4=neutral, and 7=strongly disagree.

Table 2.8. Influence of interest level in fossils on fossil respect beliefs

Statement	Interest Level			F-statistic	p-value
	None/Some (n=181-186)	A lot (n=119-123)	Strong/Favorite (n=89-92)		
It is acceptable to take a small piece of fossil home from Fossil Butte National Monument.	6.65 [1 a 2]	6.52 [ab]	6.23 [b]	3.86	0.022
It is acceptable to take home common fossils from Fossil Butte National Monument.	6.47	6.44	6.21	1.23	0.295
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back.	6.36	6.16	6.13	1.04	0.353
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back.	4.69	4.41	4.27	1.17	0.311
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center.	4.73	4.26	4.16	2.61	0.075
It is acceptable to buy fossils at commercial rock shops.	3.51 [a]	3.10 [ab]	2.63 [b]	6.47	0.002
Average (Cronbach's alpha=0.744)	5.40 [a]	5.14 [ab]	4.91 [b]	5.82	0.003

[1] 7-point scale: 1=strongly agree, 4=neutral, and 7=strongly disagree.
[2] Superscripts indicate similarities and differences based on Tukey's post-hoc comparisons.

Chapter 3

Manuscript 2: Influence of Nature Trail Interpretation on Knowledge, Beliefs, and Behavior Toward Fossils

Abstract

This research combined survey results with direct observations of visitor behavior to evaluate the effectiveness of interpretive materials along a nature trail in Fossil Butte National Monument in improving the knowledge of ancient Fossil Lake, increasing fossil respect beliefs, and reducing depreciative behaviors. Six different treatments were tested that evaluated an interpretive sign, box of fossils that visitors were invited to touch, and participation in an interactive interpretive program. The sign and box of fossils did not increase knowledge or respect beliefs; however, visitors in the control group expressed high knowledge and positive respect beliefs, so detection of improvement was difficult. The interpretive program improved knowledge of some advanced topics, but did not improve respect beliefs. The interpretive sign significantly reduced entry into the closed research quarry, but entry rates remained relatively high (32%), and most adults who entered the quarry (52%) were seen picking up rocks.

Introduction

Each year the millions of people visiting National Parks benefit from their interactions with the resources contained in those areas. Unfortunately, some visitor activities damage the natural, cultural, historical, and paleontological resources those parks are also mandated to protect. Thus, park managers must decide how to balance protection of resources and provision

of desired recreational experiences. This balance is particularly challenging in parks that protect collectible resources such as fossils.

This research focused on evaluating the effectiveness of interpretive materials in reducing damage to fossil resources in Fossil Butte National Monument, Wyoming. Despite signs posted along the only roadway and all trailheads in the Monument indicating that federal law prohibits disturbance or theft of the fossil resource, the Monument's staff remained concerned about possible damage to the paleontological resource from enthusiastic visitors hunting for fossils along trails. Of particular concern was the protection of a demonstration research quarry. On weekends, this research quarry was open to the public, who were allowed to help Monument staff dig for fossils. The quarry was considered closed to the public when an interpreter was not present.

This research evaluated the effectiveness of interpretive materials in reducing the entry of visitors into the research quarry when it was closed. The study also evaluated the effectiveness of an interpretive sign along the trail and the interpretive program at the demonstration quarry in conveying the story of Fossil Lake and promoting fossil respect beliefs.

Theoretical Approach

Ajzen's (1985, 1987) Theory of Planned Behavior has been used to predict behavior in leisure settings (e.g., Ajzen and Driver 1991; Ajzen and Driver 1992). The theory proposes that attitudes toward the behavior, subjective norms, and perceived behavioral control interact to form a person's behavioral intentions, which lead to the performance of a certain behavior. Attitudes, or overall evaluations of the behavior, are represented by two components in the model: beliefs about the outcomes of the behavior and evaluations of those outcomes (i.e., expectancy-value components; Ajzen 1991). Subjective norms are perceptions of the

expectations of important others. In the case of fossil theft, the visitor may consider the reactions of other group members when he or she decides whether or not to take home a fossil found in the Monument. Perceived behavioral control relates to the perceptions one has about his or her ability to perform the behavior. This is often related to the relative ease of performing the behavior. Attitudes, therefore, are not the only force behind behaviors.

Although perceived normative influence and behavioral control influence behavior, attitudes have been shown to be relatively good predictors of behavior (Kraus 1995), and they are the focus of this research. Attitudes of park visitors were targeted because it is believed that carefully developed interpretive materials can be effective in persuading visitors to adopt more environmentally friendly attitudes, which in turn may lead to stewardship behaviors. This idea has evolved from the theory that attitudes (i.e., the evaluation a person holds about an object or issue) can be based on cognition, affect, behavior, or some combination of the three (Petty 1995). Therefore, it follows that increasing knowledge of natural resources (in this case, the Fossil Lake story) may lead to more favorable beliefs and attitudes about stewardship of the fossil resource, which may lead to increased stewardship behavior.

An interpretive sign was specifically designed to persuade visitors to behave appropriately toward the fossil resources in the Monument using concepts outlined in the Elaboration Likelihood Model of persuasion. This model describes two routes for a persuasive message to change an attitude (Petty and Cacioppo 1986). In the peripheral route, attitude change involves relatively non-effortful thinking. In contrast, the central route involves careful and effortful thinking to evaluate the information or arguments presented. The central route of persuasion has been shown to produce an attitude that is more resistant to change, enduring, and more predictive of behavior than the peripheral route because of the effortful thinking and

elaboration involved (Petty and Cacioppo 1986). Therefore, interpretive interventions in this study were designed to encourage central route processing of the message.

The route used by an individual in a given situation is determined by his or her motivation and ability to process the information. Therefore, interpretive messages intended to be persuasive must be designed for easy comprehension. Because increased personal relevance improves the chances a message will be processed through the central route (Petty and Cacioppo 1986; Chaiken 1980), messages should motivate people by describing how the message relates to them personally. It has also been shown that environmental education messages have stronger impacts on attitudes if the receiver is already interested in the topic or environment (Leeming, Porter, Dwyer, Cobern and Oliver 1997). Therefore, those who are the most interested in fossils should be the most receptive to interpretation and reading persuasive messages urging fossil protection. However, those most involved in a topic have also been shown to be more resistant to persuasive messages attempting to change opinions than those less involved (Johnson and Eagly 1989).

Prior experience with the specific attitude object or issue has also been shown to have a direct effect on the persuasion process (Manfredo and Bright 1991). Increasing levels of prior knowledge or experience with an object or situation tends to decrease the amount of elaboration of a message and makes it more difficult to change the attitude because the attitude is more stable. Research in recreational settings has shown that inexperienced users are influenced more by persuasive messages than experienced users (Roggenbuck and Berrier 1982; Krumpe and Brown 1982). Therefore, visitors who have been to Fossil Butte National Monument before may be influenced less by persuasive messages than first time visitors because they have past experiences and behaviors influencing their attitudes toward fossil protection.

An additional factor influencing the attitude-behavior relationship is the strength of the attitude or attitude certainty (Kraus 1995). Stronger attitudes predict behavior better than weaker ones. This has implications for persuasion because attitudes formed from the central route should be stronger than those formed from the peripheral route (Petty 1995). Therefore, all of the variables that influence the route of persuasion (accessibility, direct experience, etc.) affect attitude strength and the attitude behavior relationship (Kraus 1995; Petty 1995).

In this study, three different interpretive treatments were tested to evaluate their effectiveness in increasing knowledge, improving fossil respect attitudes, and reducing depreciative behaviors (i.e., entering the closed research quarry, digging for fossils, and stealing fossils). It is hypothesized that increasing levels of interpretive interaction with the fossil resource will increase knowledge, improve attitudes, and reduce depreciative behaviors by increasing the chances of central route processing. The lowest, most passive, form of visitor interaction with the fossil resource is an interpretive sign treatment. The second level of interpretation added a box of fish fossils for people to touch near the interpretive sign. The most active and interactive interpretive treatment was an interpreter-guided Quarry Program where the interpreter told the story of Fossil Lake, explained research sampling methods and the benefits of scientifically collected data, and allowed the visitor to dig for fossils in the quarry.

Two theoretical constructs support the hypothesis that increased interpretive interaction with the resource should promote greater learning. According to Langer's concept of mindfulness (Chanowitz and Langer 1980), interactive exhibits induce mindfulness and thus promote the active, analytical processing of information that result in changes to cognitive structures. Therefore, active or mindful processing of the information in an interpretive message

would improve the chances for central route processing. Passive exhibits, however, could lead to a state of mindlessness.

A second theoretical approach that suggests more interaction will lead to greater understanding and appreciation for the resource is experiential learning theory. In 1994 the Association for Experiential Education defined experiential education as " a process through which a learner constructs knowledge, skill, and value from direct experiences". In outdoor education, experiential learning can be promoted by active interaction with a resource, followed by reflection of the experience, critical analysis, and synthesis (Adkins and Simmons 2002). Thus, experiential learning is a process that can be promoted by a carefully crafted interpretive program.

While many interpreters and educators feel that hands-on activities enhance learning and promote more positive attitudes and behaviors, little research on interpretive programs exists to empirically support the idea. Exceptions are that researchers have shown that interactive interpretive programs and displays are more likely to attract visitors (Moscardo and Pearce 1986), generate support for conservation (Swanagan 2000), and increase interest in the topic (Flexer and Borun 1984). Knapp and Benton (2005) found that two years after an interpretive program in an Indiana state park, the most remembered components of the program by the six adults they interviewed were "active involvement" exercises that encouraged participants to touch deer artifacts or cup their ears to hear like deer. In a review of environmental education literature, Zelezny (1999) found that interventions that actively involved participants were most effective in improving environmental behaviors, but that classroom settings improved behavior to a greater extent than interventions in non-traditional settings. In an adult workshop setting,

hands-on activities to promote understanding of wildland fire ecology and management issues were successful in improving knowledge and increasing support for fire management (Parkinson, Force, and Smith 2003). These limited research findings suggest a need for further investigation into the value of experiential learning on improving knowledge and changing attitudes and behaviors, especially in the context of relatively brief visitor contact in a recreational setting.

Objectives

1. Determine if increasing the level of interaction with fossils through interpretation results in greater knowledge of the Fossil Lake story, greater fossil respect beliefs, and decreases depreciative behaviors (i.e., entering the closed research quarry).
2. Describe the relationships among knowledge, fossil respect beliefs, and behavior.

Methods

Study Site

This research was conducted at Fossil Butte National Monument, which is located near Kemmerer, Wyoming. Visitation is relatively light, with approximately 23,000 people visiting the 8,200 acre Monument each year. The Monument sits on a 50 million year old dry lakebed (Fossil Lake) that is world renowned for the quality and quantity of fossil fish, plants, reptiles, birds, and insects. This study was conducted along the 1 ½ mile Fossil Lake Trail. It is a loop trail that ascends about 300 ft as it winds through an aspen grove and over an open high desert landscape of sagebrush and grasses. The trail had an interpretive sign near the highest and farthest point of the loop trail (Figure 3.1). A research fossil quarry that was open to the public during scheduled interpretive sessions was accessed by ascending an additional 50 ft up a short spur trail located near the interpretive sign. The interpretive program in the quarry allowed

visitors to dig for fossils and instructed them on the scientific method of data collection. Visitors were not allowed to keep fossils that they found in the quarry, and they were prohibited from taking fossils they might find anywhere in the Monument. This prohibition was posted at both Fossil Lake Trail trailheads and along the only road into the Monument. While visitors were prohibited from taking fossils from the Monument and digging for fossils (unless with an interpreter), several commercial quarries in the nearby area provided the opportunity to dig for fossils that could be taken home, and fossils dug from local quarries outside the park are sold in area rock shops.

Experimental Design

Six different treatments involving different levels of interaction with the fossil resource were tested to evaluate if increasing levels of interaction would improve knowledge gain about the Fossil Lake story, increase ethical attitudes about fossils and fossil protection, and reduce improper behavior toward fossils in the Monument. The treatments were evaluated using on-site surveys and observations of visitor behavior.

Treatments were organized in a 3 x 2 design. Three different levels of interpretation were offered at the junction of the spur trail to the research quarry and main trail (no interpretive sign, interpretive sign, and interpretive sign plus a box of fossils to touch). Two levels of interpretation were offered in the research quarry (no interpreter and interpreter). The lowest level of interpretation was considered to be the sign, which only provided visitors with an opportunity to read about fossils. The box of fossils was a higher level of interpretive interaction because it encouraged visitors to pick up and examine fossils from the area. The highest level of interpretive interaction occurred in the research quarry where visitors were invited to dig for fossils and interacted with the on-site uniformed volunteer or ranger. The resulting six levels of

interpretation tested are given in Table 3.1. The control condition had no interpretive sign, no box of fossils to touch, and no interpreter. The sign panel was removed from the armature on control days, but the empty armature remained at the trail junction.

Sampling occurred on the Fossil Lake Trail on 38 randomly determined days between 29 June and 27 August, 2001. This study was limited to these months because they represent the main tourist season at Fossil Butte National Monument, and the research quarry was staffed during this period. Sampling was stratified by weekend and weekday and each treatment was applied on at least 6 days.

On study days, a hidden researcher collected observational data on all visitors who hiked the trail, including approximate age, gender, time spent with available interpretive services, and fossil searching and theft behavior. After completing their hike, all adult hikers (≥16 years) who hiked the trail were approached by a second research technician in the trailhead parking lots and asked to complete a short (3-page) survey. Only hikers who were observed reaching the main-spur trail junction, where the interpretive resources for the study treatments were located, were approached to fill out the survey. Both researchers (observer and survey administrator) recorded the time, approximate age, gender, and clothing worn by each adult visitor so that survey responses could be matched with their observed behavior along the trail and in the quarry. This allowed analysis evaluating the effect of differing levels of interpretation received on the trail (observation data) with fossil respect beliefs and knowledge (survey data). Observed behaviors were evaluated with respect to the amount and type of interpretation received.

Treatment Descriptions

Interpretive Sign

An interpretive sign was designed to meet the study objectives of evaluating the effectiveness of the sign in communicating a fossil respect message and the effectiveness of the sign in deterring visitors from entering the research quarry when it is closed. The sign graphically represented the flora and fauna present 50 million years ago when Fossil Lake existed. In colorful, personal language the text of the sign also described the plants, animals, and climate of Fossil Lake (Figure 3.2). Additionally, the message described how scientists learn about the story of Fossil Lake by peeling back the layers of rock in the research quarry and comparing the fossils discovered to words on the pages of a book. It also described why it is important to leave the fossil layers intact so that paleontologists can learn about how the climate and biotic community changed over time. In a separate colored box in the upper right-hand corner of the sign, a fossil respect message was included to tell visitors how to properly behave in Fossil Butte National Monument to protect the fossil resource. Specifically, it told visitors not to go into the research quarry unless there was a staff member present. It also said not to dig for fossils (unless with a staff member), and not to take fossils from the Monument. The message was designed to make a moral appeal to visitors by promoting an awareness of the consequences for improper behavior and using personal language to promote a sense of personal responsibility.

The sign was placed at the junction of the main trail and the spur trail in order to present the fossil respect and quarry closed message at a key decision point. Attitudes are much more predictive of behavior if they are accessible and salient (Schultz 2000). Therefore, the sign

would likely have the best chance of reducing improper behavior if it is located where that depreciative behavior is most likely to occur.

Box of Fossils

Five fish fossils from the region were placed in a wooden crate beneath the interpretive sign (Figure 3.3), and visitors were encouraged to pick-up the fossils by an attached sign stating: "Touch a Fish from Ancient Fossil Lake."

Interpreter-led Quarry Program

On summer weekends the research quarry was staffed with uniformed volunteers, who were geology or paleontology college students or park rangers. The program was informal, with no scheduled presentation time (i.e., an interpreter was present from 10:00 A.M. to 4:00 P.M.), and there was no set presentation format. Visitors were greeted upon arrival to the quarry and invited in. Some interpreters gave a brief description of the quarry, while others simply engaged the visitor(s) in conversation about Fossil Lake and its story. While there was no set program, all interpreters typically talked about the age of Fossil Lake, the type of rock in which the fossils were preserved (limestone), and the type of fossil data collected in the research quarry. However, the visitors, who were encouraged to ask questions, largely controlled discussion topics and depth of the conversations. After a brief discussion and demonstration of the techniques used to search for fossils in the quarry and scientific methods of cataloguing the fossils found, visitors were invited to help the interpreter look for fossils.

Because there was not a set program, the length of time visitors stayed in the quarry was entirely dependent on their interest level. While some stayed only a few minutes and simply

talked with the interpreter, other enthusiasts stayed several hours digging for fossils. The only limitations on length of stay were weather (i.e., the quarry closed during storms for safety reasons), number of other visitors (i.e., no more than 10 visitors were allowed in the quarry at any given time), and the 4 p.m. closing time.

Visitor Observations

A hidden research technician (dressed in camouflage) positioned herself so that she could observe visitors both at the junction of the spur and main trails (i.e., where the interpretive sign and fossil box were placed) and the research quarry. The researcher concealed herself between two bushes approximately 40 yards from the quarry and used binoculars to more clearly observe visitor behavior.

The observer recorded the approximate age and gender of each hiker, as well as interaction with available trail interpretation (depending on treatment) and behavior toward the fossil resource. If the interpretive sign was present, she recorded whether each individual looked at the sign and the time spent reading the sign. If the box of fossils was available, she recorded interaction with the box (i.e., did the visitor look at the fossils and/or pick them up) and the length of time spent touching or holding the fossils. The observer also recorded visitor behavior in the research quarry, whether an interpreter was present or not. If the interpreter was present, length of time in the quarry was recorded, as well as level of visitor interaction with the fossils (i.e., did they just listen to the interpreter, handle fossils others dug up, or get down on their knees and dig for fossils). If the interpreter was present, the observer recorded whether or not each visitor hiked up the spur trail to the research quarry and how long he or she stayed in the quarry.

If the interpreter was not present (and thus the quarry was considered closed), the observer recorded if visitors hiked up to and entered the quarry. She also noted how long the visitor remained in the quarry and if he or she dug for fossils or picked up rocks inside the quarry. It should be noted that the only sign indicating there was a research quarry up the spur trail and that visitors should not go there unless there was an interpreter present was the study sign. Therefore, during control (no sign) conditions, there was not a sign indicating the area was closed to the public or any information indicating that the spur trail was a formal trail or that something to see was located up the trail. However, the safety railing along the edge of the research quarry was clearly visible from the main trail.

Survey Design

The survey instrument (Appendix D) contained several questions to describe some basic demographic information of the respondent such as age, gender, and highest level of education. Several questions also attempted to characterize the respondent's interest in fossils generally and any specific interest in the Fossil Lake story. In order to assess the impact of the various interpretive treatments on knowledge gain, eight multiple choice "quiz" questions were asked about the Fossil Lake story. Some of the questions were general, while others were taken from the text of the sign, or were commonly discussed by interpreters during the quarry program. A multi-item question was asked to characterize visitors' attitudes about fossils and fossil protection within Fossil Butte National Monument and the surrounding region.

Results

Sample Size and Response Rate

A total of 360 surveys were completed and observations of 549 adults were made on the Fossil Lake Trail (Table 3.2). Visitors were very receptive to helping out with the survey; 93.7% of groups had at least one member who filled out a survey and 77.9% of all adults contacted completed a survey (Table 3.2).

Respondent Characteristics

Although some general respondent characteristics (age estimates and gender) were recorded during observations of visitors, only survey data are reported here. Survey respondents were generally balanced between males (51%) and females (49%). The average age was 42.9 years old with about half of the respondents (50.7%) between the ages of 31 and 50; fewer were between the ages of 16 and 30 (19.7%) or older than 51 years (29.6%). Most had a bachelors (34.4%) or an advanced degree (36.1%); few had only a high school education or less (10.0%) or some college (19.5%).

The vast majority of survey respondents (87.4%) had not previously visited Fossil Butte National Monument. About half (47.2%) reported having "no" or only a "little" interest in fossils, with 30.9% reported having "quite a lot" of interest and 21.9% a "strong" interest in fossils. Prior to coming to Fossil Butte National Monument 33.3% of survey respondents had read about Fossil Lake and 52.6% had read about fossil fishes. Most (90.6%) reported watching a TV program or video about fossils or prehistoric life on earth.

Use of Interpretation Along the Trail

Sign Viewing Rates and Reading Times

It was estimated that it would take at least 1 minute to thoughtfully read every word and look at the graphics on the interpretive sign (Figure 3.2) designed to tell the story of Fossil Lake, promote fossil respect beliefs, and instruct visitors not to enter the closed research quarry. When considering all adults (those estimated to be age 16 and older) from all treatments in which the sign was present, few (15.6%) read the sign for more than 1 minute (Table 3.3). The majority (53.3%) did not spend more than 30 seconds reading the sign.

Adults spent more time looking at or reading the sign than children (estimated ages between 2 and 15 years old) (Chi-square=82.029, $p<0.0005$). When the interpreter was present and the research quarry was open, adults tended to spend less time reading the sign (Chi-square=16.002, $p=0.001$) (Table 3.4). The presence of the box of fossils to touch did not influence the amount of time adult hikers spent looking at the interpretive sign (Chi-square=4.649, $p=0.199$).

Fossil Box Behavior

Most hikers (54.6%) picked up fish fossils from the box that was placed beneath the interpretive sign (Figure 3.3). Children (ages 2-15) were more likely (74.6%) than adults (47.6%) to pick up the fossils (Chi-square=12.97, $p=0.002$). Most (73.0%) spent < 30 seconds handling the fossils from the box and only 4.9% spent over 60 seconds with the fossils; there was no difference in handling times between children and adults (Chi-square=2.18, $p=0.336$). Similar percentages of adult visitors picked up fossils from the box, regardless of whether an interpreter was present in the research quarry (45.5%) or not (47.5%) (Chi-square=0.114,

p=0.945). The length of time adults spent handling the fossils from the box was also similar during the no interpreter and interpreter present treatments (Chi-square 1.874, p=0.392).

Use of Interpretive Research Quarry Program

When the research quarry was open and an interpreter was present, 84.9% of groups had at least one member who entered the quarry to experience the quarry program. In fact, most individuals (83.9%) who hiked the trail participated in the quarry program. Groups spent an average of 22 minutes in the quarry with the interpreter. Among the people who entered the quarry to listen to the interpreter, children were more likely to actively participate in digging for fossils (69.9%) than adults (52.7%) (Chi-square=7.075, p=0.008)

The presence of the sign seemed to reduce the number of people who hiked up the spur trail to the research quarry to hear the interpretive program. Among adult hikers, 90.3% participated in the quarry program when the interpretive sign was not present and only 78.7% participated when the sign was present (Chi-square=5.908, p=0.015). The presence of the box of fossils did not have a significant impact on the percentage of adults who attended the quarry program and did not decrease the amount of time spent in the quarry.

Effect of Sign on Knowledge and Fossil Respect Beliefs

In order to evaluate the effectiveness of the sign in communicating knowledge of the Fossil Lake story and promoting fossil respect beliefs, survey responses from the No Sign, No Interpreter (n=38) treatment were compared with the Sign, No Interpreter treatment (n=56). Respondents in these two treatments were similar in gender (Chi-square=4.50, p=0.503), age (T-test, t=0.414, p=0.680, df=91), educational attainment (Chi-square=1.620, p=0.655), interest in

fossils (Chi-square= 0.304, p=0.859), and prior visits to Fossil Butte National Monument (Chi-square=0.264, p=0.607).

Overall knowledge (8 multiple choice quiz questions, Table 3.5) was similar when the sign was present (70.1% correct) to when it was not (68.9% correct) (T-test, t=-0.366, p=0.715, df=91). Even when only considering the four questions directly taken from the sign content, the scores were nearly identical (79.7% no sign vs. 79.5% sign present). There also was no significant relationship between the amount of time spent reading the sign and the overall quiz score (Anova, F=0.519, p=0.670) or the sign content-only quiz score (Anova, F=0.507, p=0.678). In addition to having no influence on knowledge of the Fossil Lake Story, the length of time spent reading the sign also had no significant influence on fossil respect beliefs (Anovas; Table 3.6).

Effect of Box of Fossils on Knowledge and Fossil Respect Beliefs

In order to evaluate the effectiveness of the box of fossils visitors on knowledge and fossil respect beliefs, the Sign, No Interpreter treatment (n=57) was compared to the Sign + Box of Fossils, No Interpreter treatment (n=50). The treatments were similar in gender proportions (Chi-square=0.949, p=0.330), age (T-test, t=-0.346, p=0.730, df=102), educational attainment (Chi-square=7.811, p=0.050), self-reported interest in fossils (Chi-square= 4.895, p=0.087), and percentage who had previously visited Fossil Butte National Monument (Chi-square=2.821, p=0.093).

The presence of the box of fossils had no impact on overall knowledge scores (70.1%, no box vs. 69.5% box of fossils) (T-test, t=0.205, p=0.838, df=104). While those who picked up the fossils had a slightly higher score (72.2%) than those who did not pick them up (66.7%), the

difference was not statistically significant (T-test, t=-1.302, p=0.199, df=46). However, those who picked up fossils from the box were more likely to think it acceptable to pick up fossils found on the ground and remove fossils from their rock layers than those who did not pick them up (Table 3.7).

Effect of Interpreter on Knowledge and Fossil Respect Beliefs

A comparison of knowledge scores and fossil respect beliefs was conducted between the No Sign, No Interpreter (n=37) and No Sign, Interpreter treatment (n=71) to evaluate the effectiveness of the interpreter in communicating the Fossil Lake Story and fossil respect beliefs. These two treatments were similar in gender proportions (Chi-square=0.110, p=0.740), age (T-test, t=0.157, p=0.876, df=151), educational attainment (Chi-square=3.545, p=0.327), self-reported interest in fossils, (Chi-square=0.999, p=0.607), and percentage who had previously visited Fossil Butte National Monument (Chi-square=0.444, p=0.505). When comparing knowledge scores and fossil respect beliefs, the only respondents included in the No Sign, Interpreter treatment were individuals who participated in the Quarry Program, and thus were exposed to the interpretive message (n=59); those who had the opportunity to participate, but did not, were excluded.

The research quarry interpretive program did not have a significant effect on overall quiz scores (T-test, t=-1.373, p=0.173, df=94; 68.9% no interpreter vs. 73.5% with interpreter), but it did improve the percent correct of two questions that addressed advanced topics (i.e., what caused the large fish kills in the lake and the type of rock the fossils are embedded) covered in the interpretive program and not in the sign (32.4%, no interpreter vs. 57.3% interpreter; T-test,

t= - 0.573, p<0.0005, df=94). The interpretive program had no significant impact on fossil respect beliefs (Table 3.8).

Effect of Interpretation on Entry and Behavior In the Closed Research Quarry

In order to test the influence of the sign and fossil box on deterring visitors from entering the closed research quarry, the behavior of adult visitors in the three quarry closed treatments [No Sign (n=38), Sign (n=56), and Sign plus Fossil Box (n=49)] were compared. Without the interpretive sign, 56.5% of all adults entered the closed research quarry. The interpretive sign reduced entry into the research quarry to 31.7% and the treatment with the sign and box of fossils resulted in 37.9% of adults entering the closed quarry (Chi-square=7.718, p=0.021). Once inside the closed quarry, 75.0% of adults were observed picking up rocks or fossils in the no sign treatment. The percentage picking up rocks in the closed quarry was reduced to 52.0% with the interpretive sign and 47.8% with the box of fossils, although the difference was not a statistically significant reduction (Chi-square=4.20, p=0.122). The presence of the sign also reduced the amount of time spent in the quarry. When no sign was present, adults spent an average of 6.7 minutes in the closed quarry; when the sign was present adults only spent an average of 2.9 minutes in the quarry, which was significantly shorter (Tukey post-hoc, p=0.020); however, the presence of the box of fossils along with the sign did not significantly reduce the amount of time spent in the closed quarry (5.0 minutes; p=0.443).

Because group members do not act independently, group behavior was also considered. When no sign was present, 61.9% of groups had at least one member who entered the closed research quarry. When the sign was present 47.4% of groups had at least one member enter the closed quarry and the addition of the fossil box resulted in 41.2% of groups that entered the

closed quarry. While the trend that the sign reduced entry into the closed quarry was similar to individual results, the reduction was not statistically different among treatments (Chi-square=2.260, p=0.323).

Although entry into the closed research quarry was relatively high, and most adults picked up rocks in the quarry, only a few visitors were observed actively digging for fossils or breaking up rocks to look for fossils within the quarry. The vast majority of visitors who picked up rocks did not actively dig in or damage the quarry. The rocks that were picked up were generally non-fossil rocks in the quarry that interpreters sometimes placed over exposed fossil fish to protect them from the elements, until they could be removed and preserved. During the course of the study, only 5 individuals (out of 757) were observed actively digging for fossils in the quarry (as opposed to simply picking up loose rocks), which resulted in significant resource damage. Because of the extent of the damage, it was not possible to determine if any fossils were removed. However, it should also be noted that no fossils were stolen from the interpretive box of fossils during the course of the study.

Relationship between Knowledge, Beliefs, and Behavior

All adults in all treatments were considered when analyzing the relationship between knowledge of the Fossil Lake Story, fossil respect beliefs, and behavior. Across all treatments there was no significant relationship (Pearson correlation) between knowledge of the Fossil Lake Story (i.e., quiz score) and fossil respect beliefs. Knowledge scores and fossil respect beliefs were also similar between those adults in the closed quarry treatments who entered the closed research quarry and those who did not (T-tests). Therefore, there was no detectable relationship between fossil respect beliefs and behavior or between knowledge of the Fossil Lake story and behavior.

However among those who entered the closed quarry, there were some differences between visitors who picked up fossils or rocks (n=30) and those who did not (n=20). Those who picked up fossils scored higher on the knowledge quiz (75.0%) than those who did not pick up anything (64.4%) (T-test, t=-2.622, p=0.012, df=48). There was also a tendency for those who entered the closed quarry and picked up fossils to have weaker fossil respect beliefs than those who only entered the closed quarry, but the differences were not generally significant (Table 3.9).

Discussion

Protection of the fossil resources at Fossil Butte National Monument is a difficult challenge for managers because visitors to the Monument tended to be fossil enthusiasts, who were likely seeking a memorable experience with fossils during their visit. However, allowing visitors to dig or search for fossils within the Monument degrades the resource. Fossil Butte National Monument has developed a unique interpretive program to provide visitors with a chance to dig for fossils under the supervision of a staff member. During the dig, the interpretive staff promoted fossil respect beliefs by emphasizing the importance of scientific data collection in learning about the Fossil Lake Story. However, the research quarry was vulnerable to theft when the interpreter was not present.

This study developed an interpretive sign to tell the story of Fossil Lake and promote fossil respect beliefs by instructing visitors about the proper way to interact with the fossil resource. The sign, utilizing persuasive language to promote central route processing (Petty and Cacioppo 1986), clearly stated that visitors were not to enter the closed research quarry. Based on experiential learning theory, it was hypothesized that providing a box of local fossils that

visitors were encouraged to handle would increase the level of interaction with the resource and further minimize entry into the closed quarry (Zelezny 1999).

It was anticipated that the interpretive sign and research quarry program would increase knowledge of the Fossil Lake Story and improve fossil respect beliefs. Because the interpretive quarry program was more interactive, both with the resource and personal communication with a National Park Service interpreter, than the interpretive sign, it was expected that participants in the quarry program would score higher on the knowledge quiz and profess greater fossil respect beliefs. The observational and survey components of this study allowed for an evaluation of the level of interaction with the fossil resource and knowledge of the Fossil Lake story and fossil respect beliefs.

The sign did not improve knowledge of the Fossil Lake story or fossil respect beliefs among survey respondents. Few adults (16%) read the sign for longer than 1 minute, which would have been necessary to read the entire message. However, even those who read the sign for longer did not have higher knowledge scores or greater fossil respect beliefs. The lack of knowledge gain can be explained in part by the fact that even visitors in the No Sign treatment scored relatively high on the knowledge quiz (69%). Therefore, most visitors knew about the basic Fossil Lake story before reading the interpretive sign. In fact, many likely knew the answers to the quiz before coming to Fossil Butte National Monument. A surprising 52.6% reported having read about fossil fishes and 33.3% had read about Fossil Lake before visiting the Monument. This finding suggests that visitors to specialized parks may desire and benefit from more advanced information about the stories and resources of those locations.

The interpretive sign also did not improve fossil respect beliefs of hikers, even when considering the length of time spent reading the sign. Therefore, even those who spent more

time reading the sign, which would have given them more opportunity to read the fossil respect message in the corner of the sign, did not report greater fossil respect beliefs than those who only glanced at the sign. As with knowledge of the Fossil Lake story, most visitors held strong fossil respect beliefs prior to arriving at the Monument (see results of Chapter 2). Therefore, there was little room to change beliefs or detect subtle changes from interpretation, especially given the relatively small sample sizes in some of the treatments.

More visitors interacted with the box of fossils than with the interpretive sign, especially children. The sign did not improve knowledge, and those who picked up fossils tended to have lower fossil respect beliefs than those who did not pick up the fossils. Therefore, the increased interaction with the fossils by handling them did not improve respect as was hypothesized.

The interpretive quarry program improved knowledge of visitors for two of the more advanced quiz questions that asked about information not included in the sign, although overall quiz scores did not improve. Again, this is likely due to the fact that most visitors knew the basic story of Fossil Lake before arriving at the Monument and demonstrates the benefit of presenting more advanced topics in interpretive materials. It was hypothesized that the quarry program would improve fossil respect beliefs by teaching in an interactive manner the value of scientific methods of fossil removal; however, the program did not improve fossil respect beliefs.

The increased levels of interpretation (sign, box of fossils, and interpreter) did not necessarily result in increased time spent with the resource. In fact, when the sign was present, participation in the quarry program tended to be lower, and when the quarry was open, sign reading rates declined. This finding, along with quiz scores and fossil respect belief comparisons, suggests that increasing the number of interpretive opportunities will not necessarily have an additive effect on visitor knowledge and beliefs.

Although many did not read the sign for very long, the presence of the sign did reduce the number of people and groups who hiked up to the research quarry when it was closed. However, entry rates remained relatively high (31.7%, Sign to 37.9%, Sign + Fossil Box), as did the proportion of visitors who picked up rocks when in the closed quarry (52.0%, Sign to 47.8%, Sign + Fossil Box). The box of fossils did not significantly reduce rate of entry or the picking up of fossils below the rate achieved from the sign alone. It was expected that providing fossils for visitors to handle would reduce the curiosity to explore the closed area in search of fossils, but this did not occur.

One interesting finding was the lack of relationship between knowledge of the Fossil Lake story and behavior. Based on the Theory of Planned Behavior (Ajzen 1987), it was expected there would be positive relationships between those variables. One reason for the lack of relationship might be the nature of the resource and motivations of visitors. Visitors most knowledgeable of the Fossil Lake story likely had high interest levels in fossils and were probably the most likely to have strong motivations to explore the Monument in search of finding fossils. Therefore, the high level of interest in fossils likely made those individuals more likely to be accepting of fossil hunting behavior because that is why they came to the Monument. In fact, those who picked up rocks in the closed research quarry scored higher on the knowledge quiz than those who did not pick anything up. The strong interest in fossils and motivation to hunt also likely made those individuals more resistant to the persuasive message in the sign (Johnson and Eagly 1989).

Fossil respect beliefs were also not related to behavior of entering the closed research quarry. Those who entered the closed quarry had similar beliefs to those who chose not to.

However, among visitors who entered the closed quarry, there was a slight tendency for those with weaker fossil respect beliefs to be more likely to pick up rocks in the quarry.

Management Implications

One major management implication is that visitors to this specialized Monument already know a great deal of the story of the place before arriving. The amount of time spent in the research quarry with the interpreter and the gain in knowledge on advanced topics discussed in that program suggest educational programs should provide opportunities for advanced learning in these specialized parks. Most visitors are also highly educated, so can receive a more complex message.

Another major implication of this research, which is also related to the interest level in the resource, is that signage alone with a fossil respect message is not enough to reduce fossil hunting behavior in a group of visitors apparently highly motivated to learn. The interpretive quarry program provided an outlet for the desire to dig for fossils, but it was not always available. However, it should be noted that these programs and other messages should be sensitive to the fact that they provide visitors with the tools necessary to actually do more damage to the resource, so the programs need to contain a consistent and strong ethics message. For example, many who had attended the program were seen digging for fossils on the way down the slope from the quarry program. Because of their participation in the quarry program those visitors knew the correct strata to search in and were thus capable of causing more damage than the uninformed visitor who searched in strata that did not contain fossils. More direct management techniques like "area closed" signs or fencing may be required to keep fossil enthusiasts out of sensitive areas.

It should also be noted that our fossil respect message likely did not reach many visitors given the short length of time adults spent reading the interpretive sign. The respect message was also located in the corner of the large sign and instructions to not enter the closed research quarry were located within a section titled “What should visitors do?”. This was not an effective way to communicate to visitors that the quarry was closed. In order to reduce visitor exploration of the closed quarry, a separate sign should have been developed that had a single goal of conveying the message that the research quarry and spur trail up to it were closed. A simple, direct message that the area is closed for research purposes, placed at the junction of the spur trail and main trail would have been more effective in communicating this message.

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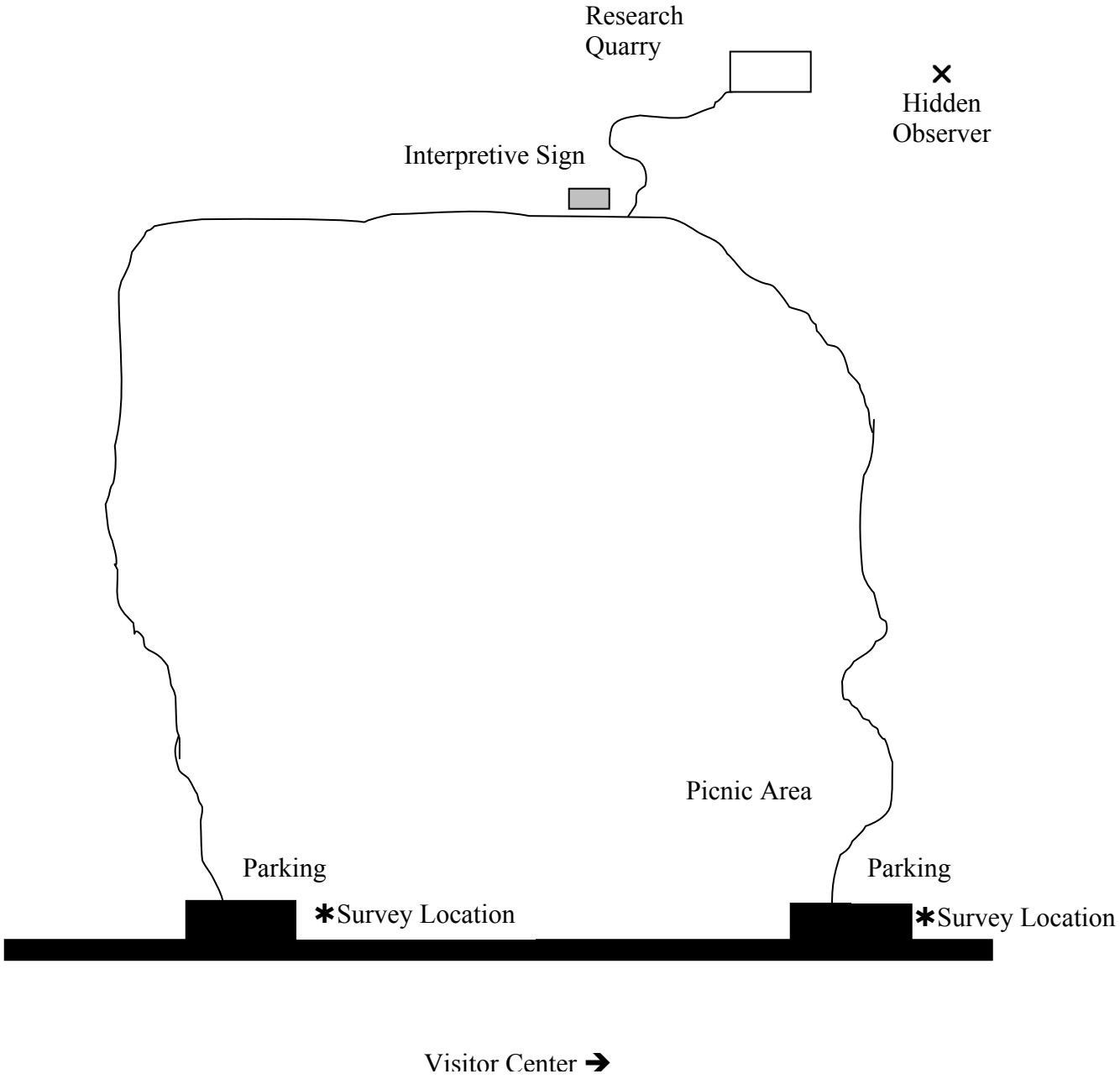

Figure 3.1. Map of the Fossil Lake Trail (not drawn to scale).

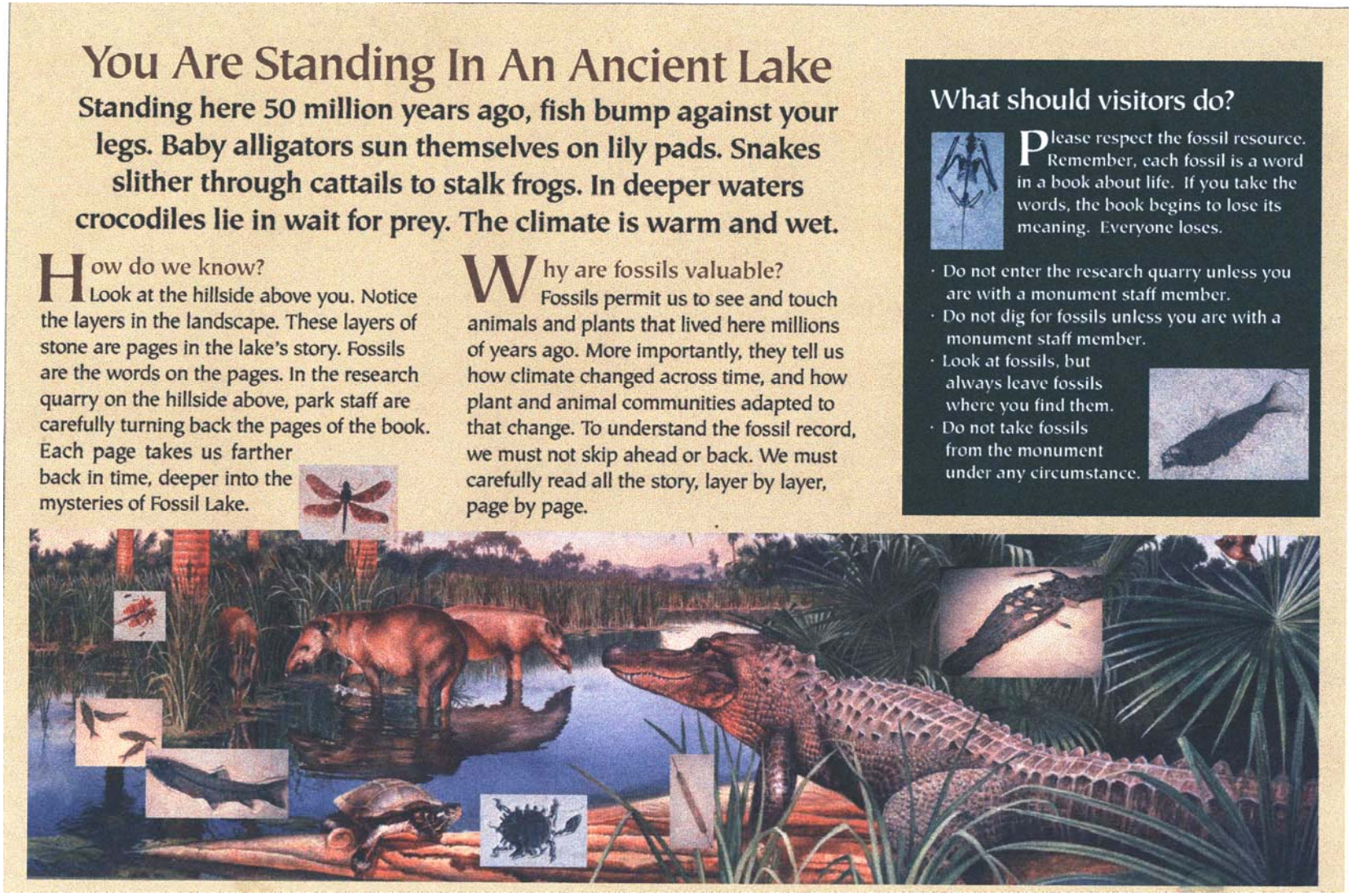

Figure 3.2. Interpretive sign placed on the Fossil Lake Trail near the spur trail to the research quarry.

Figure 3.3. Interpretive sign with the box of fossils located underneath. Visitors were invited to "Touch a Fish from Ancient Fossil Lake."

Table 3.1. Interpretive treatment experimental design.

Trail Interpretation	Quarry Interpretation	
	No Interpreter	**Interpreter**
No Sign	No S, No I	No S, I
Interpretive Sign	S, No I	S, I
Interpretive Sign + Box of Fossils to Touch	S+F, No I	S+F, I

Note: S=Interpretive sign, I=Interpreter, and F=Box of Fossils

Table 3.2. Sample sizes of observations and survey respondents by treatment.

Treatment	Total # of Visitor Observations	# Adult Observations	# of Surveys	Individual Response Rate	Group Response Rate[1]
No S, No I	78	57	42	82.4 %	90.9 %
No S, I	150	103	71	84.5	97.9
S, No I	135	98	55	69.6	91.9
S, I	137	99	65	82.3	97.3
S+F, No I	107	77	50	75.8	88.2
S+F, I	150	115	77	74.8	93.3
Total	757	549	360	77.9	93.7

[1] Percentage of groups in which at least one adult member completed the survey.

Table 3.3. Time spent reading the interpretive sign for adults in all treatments in which the sign was present (n=333).

Length of Time Read	Frequency	Percent
Didn't look at sign	14	4.2
Glanced at sign	65	19.5
Read <30 sec	99	29.7
Read 30-60 sec	103	30.9
Read 1-2 min	41	12.3
Read 2-3 min	11	3.3

Table 3.4. Comparison of sign viewing rates when there was an interpreter present in the research quarry and when there was no interpreter and the quarry was closed.

Length of Time Read	Interpreter (n=183)	No Interpreter (n=150)
No look/ glance at sign	27.9% [1]	18.7%
Read <30 sec	30.1	29.3
Read 30-60 sec	33.3	28.0
Read >60 sec	8.7	24.0

[1] Chi-square=16.002, p=0.001

Table 3.5. Quiz question categories and comparison of the scores from the No Sign, No Interpreter and Sign, No Interpreter treatments.

Source of Question Content	Question	Percent Correct		Chi-square	p-value
		No Sign	Sign		
General	What is the primary reason that fossils are protected in national parks and monuments?	89.5%	85.7%	0.287	0.592
General	Fossil Lake is special because…	78.4	71.9	0.491	0.484
Sign	Fossil _____ have never been found in Fossil Lake.	63.2	71.4	0.713	0.399
Sign	During the time of Fossil Lake, the climate was _____.	92.1	87.5	0.505	0.477
Sign	Fossil Lake was present in this area _____ million years ago.	78.4	60.7	3.181	0.074
Sign	Fossil A is located several rock layers above Fossil B. This suggests that….	84.2	96.5	4.459	0.035
Interpreter	While many things could have caused the large fish kills observed in Fossil Lake deposits, a popular theory suggests the kills were caused by:	8.1	17.5	1.676	0.195
Interpreter	The pressure of accumulating layers of sediments over thousands of years turned old lake sediments into _____, which encases the fossil fish found today.	56.8	66.7	0.943	0.332

Table 3.6. Impact of the length of time spent reading the interpretive sign on fossil respect beliefs (Sign, No Interpreter and the Sign, Box, No Interpreter treatments).

	Time Read Sign				Anova	
Belief Statement	**No look/ glance (n=13)**	**<30 sec (n=30-31)**	**30-60 sec (n=29-32)**	**>60 sec (n=27)**	**F**	**p-value**
It is acceptable to take a small piece of fossil home from Fossil Butte National Monument.	6.69[1]	6.65	6.34	6.44	0.358	0.783
It is acceptable to take home common fossils from Fossil Butte National Monument.	6.85	6.39	6.41	6.41	0.464	0.708
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back.	6.61	6.10	6.29	6.22	0.347	0.791
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back.	3.08	3.71	3.44	3.00	0.632	0.596
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center.	3.23	3.10	3.94	3.78	1.261	0.292
It is acceptable to buy fossils at commercial rock shops.	3.15	3.13	3.31	3.44	0.165	0.920

[1]7-point scale: 1=strongly agree, 4=neutral, and 7=strongly disagree.

Table 3.7. Comparison of fossil respect beliefs of trail hikers between those who picked up the fossils and those who did not.

Belief Statement	Picked up Fossils? Yes (n=26-27)	Picked up Fossils? No (n=19-21)	t-test	p-value	df
It is acceptable to take a small piece of fossil home from Fossil Butte National Monument.	6.62[1]	6.90	1.013	0.316	46
It is acceptable to take home common fossils from Fossil Butte National Monument.	6.48	6.90	1.735	0.093	30.0
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back.	6.08	6.90	2.457	0.021	27.2
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back.	2.63	3.86	2.164	0.036	46
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center.	3.41	3.57	0.287	0.776	46
It is acceptable to buy fossils at commercial rock shops.	3.42	3.31	-0.209	0.835	43

[1]7-point scale: 1=strongly agree, 4=neutral, and 7=strongly disagree.

Table 3.8. A comparison of fossil respect beliefs between those who did not participate in the quarry program (No Sign, No interpreter treatment) and those who did utilize the quarry program (No Sign, Interpreter treatment).

Belief Statement	Interpreter Present		t-test	p-value	df
	Yes[2] (n=56-58)	No (n=36-37)			
It is acceptable to take a small piece of fossil home from Fossil Butte National Monument.	6.32[1]	6.16	-0.559	0.577	93
It is acceptable to take home common fossils from Fossil Butte National Monument.	6.31	6.08	-0.756	0.452	93
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back.	6.02	6.41	1.304	0.195	91.8
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back.	4.03	3.16	-1.908	0.059	93
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center.	3.96	3.84	-0.281	0.779	92
It is acceptable to buy fossils at commercial rock shops.	3.37	3.50	0.313	0.757	90

[1] 7-point scale: 1=strongly agree, 4=neutral, and 7=strongly disagree.
[2] Those who did not utilize the interpreter when the Quarry Program was open were eliminated from this analysis.

Table 3.9. Relationship between fossil respect beliefs and the action of picking up rocks or fossils in the closed research quarry.

Belief Statement	Picked Up Rocks		t-test	p-value	df
	Yes (n=30)	No (n=19-20)			
It is acceptable to take a small piece of fossil home from Fossil Butte National Monument.	6.30[1]	6.90	1.94	0.060	35.4
It is acceptable to take home common fossils from Fossil Butte National Monument.	6.27	6.80	1.91	0.063	39.9
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back.	5.70	6.63	2.48	0.017	47.0
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back.	3.00	4.15	1.88	0.067	48
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center.	3.33	4.00	1.23	0.227	48
It is acceptable to buy fossils at commercial rock shops.	3.20	3.26	0.117	0.907	47

[1]7-point scale: 1=strongly agree, 4=neutral, and 7=strongly disagree.

Chapter 4

Summary and Conclusions

The primary objective of this research was to evaluate the effectiveness of different interpretive materials on increasing knowledge of the Fossil Lake story, improving fossil respect beliefs, and reducing depreciative behaviors in Fossil Butte National Monument. Overall, the study found that visitors gained in knowledge about the Fossil Lake story from a visit to the visitor center, and they retained that knowledge for at least several weeks. However, a special message designed to improve respect for the fossil resource in the Monument, which was inserted in the Fossil Butte National Monument brochure, did not improve fossil respect beliefs of visitors. Interpretive opportunities along a nature trail (i.e., sign, box of fossils to touch, and interpretive quarry program) were generally not successful in increasing knowledge of the Fossil Lake story or improving fossil respect beliefs. A more detailed discussion of the major findings, as well as implications of the findings on future research directions, follows.

The mixed findings with regards to the impact of gains in knowledge of the Fossil Lake story (i.e., gains in the visitor center and not along the nature trail) may be explained by several observations. One primary reason for lack of gain in knowledge along the nature trail was that visitors did not spend much time reading the interpretive sign (only 16% read the sign for longer than 1 minute). Another possible reason for only modest gains in the visitor center and no gains from the interpretive sign was the knowledge measure itself. Visitors along the nature trail averaged 80% correct on the four questions coming from the content of the sign when the sign was not present. Visitors had likely gone to the visitor center prior to hiking the nature trail, so knowledge of the Fossil Lake story was high, regardless of whether or not one read the sign. Also, visitors to Fossil Butte National Monument scored very highly on the knowledge quiz,

even before visiting the visitor center (entering visitors got 65% correct). Therefore, visitors were relatively knowledgeable about the Fossil Lake story prior to visitation, so perhaps because of this, the quiz was unable to detect knowledge gains. This highlights the importance of pre-testing the survey instrument; unfortunately, pre-testing was not possible due to the extremely low visitation rate of the monument during winter months, when this survey was developed.

Although making it difficult to address the research question asked, the high knowledge level of visitors to Fossil Butte National Monument prior to visitation raises an interesting issue related to the level of information included in interpretive materials. A primary principle of interpretation put forth by Freeman Tilden is to know your audience and their interests (Knudson, Cable, and Beck 1995). Visitors to Fossil Butte National Monument were very well informed about the Fossil Lake story prior to arriving. Although few had visited the Monument before (only 15%, onsite visitor center survey), most (63%) had visited other National Park Service fossil parks or monuments. The majority (54%) of respondents to the on-site survey said they had "quite a lot" or a "strong" interest in fossils. A surprising 61% of mail survey respondents had read about fossil fishes and 26% had read about Fossil Lake prior to visiting the Monument. Therefore, most visitors to Fossil Butte National Monument were highly interested in fossils and the Fossil Lake story. Visitors also tended to be highly educated (40% had completed an advanced degree, 31% a bachelor's).

The findings of both studies suggest that these highly educated and interested visitors would have needed more than the basic story of the region and resource presented in the interpretive materials in the visitor center or the sign along the nature trail to expand their knowledge, and perhaps satisfy their motivations for visiting Fossil Butte National Monument. This challenges another interpretive convention that information should be provided at a 5th to 8th

grade reading level (Knudson *et al.* 1995). Although this issue may be more pronounced for Fossil Butte National Monument because it is a small monument with a relatively narrow resource and activity focus (i.e., fossils), the issue of attracting highly educated visitors is not unique to Fossil Butte National Monument. Visitors to national parks tend to be very highly educated, in general. While they may not have a degree in ecology, they are well-educated and perhaps can digest a more complicated story of the place than what has traditionally been presented. Fossil Butte National Monument visitors in particular are there because they have a strong interest in the reason for the site. It is likely that there are other "specialty" parks with similar visitor characteristics, whether it is special resources such as fossils or historical sites. Although there are casual visitors to specialty parks, many visitors are likely enthusiasts who desire a more in-depth interpretive experience. Therefore, at least some interpretive materials or programs should be developed that go beyond the basic story of the place to satisfy those who are seeking a more in-depth story and experiences.

Another major focus of this research was determining if the interpretive materials improved fossil respect beliefs. The belief statements focused on proper visitor behavior in the Monument in regard to digging for fossils and taking fossils home, activities that are prohibited to protect the fossil resource within the Monument. None of the interpretive materials or programs evaluated in these two studies improved the fossil respect beliefs of visitors. Although designed using personal and persuasive language, even the special fossil respect message placed in the National Park Service brochure and fossil respect message included in the interpretive sign along the nature trail did not significantly improve fossil respect. Increased interaction with the resource through handling of local fossils in the fossil box or participating in the fossil dig in the

interpretive Quarry Program did not improve respect either, which was contrary to what was expected based on experiential learning theory.

Although it is discouraging that the interpretive messages and programs did not improve fossil respect beliefs, it should be noted that very few visitors agreed (5.1%, visitor center survey) that it was acceptable to take home even common fossils from Fossil Butte National Monument This high degree of agreement that taking fossils is not acceptable made detecting any improvements difficult, especially given the relatively low visitation to the monument and resulting low sample sizes. This is a common methodological problem with studying relatively rare depreciative events with a social bias against self-reporting of perceived unethical behavior.

In retrospect, we should have targeted behaviors that were not so clearly right or wrong, such as "searching" for fossils along a trail (as opposed to "taking" or "removing"). Asking about a wider range of behaviors, from "searching" to "picking-up" interesting rocks to "turning over" rocks to "digging" to "breaking-up" rocks in the quest for fossils would have been instructive to understand what visitors thought was acceptable behavior. Our study was limited by only asking about "taking" fossils vs. "picking-up and putting back down." Although not reported in the previous chapters, about 10% of hikers were observed actively searching for fossils along the nature trail. These activities ranged from simply picking up rocks and setting them back down to digging through rock piles and breaking rocks in search of fossils. No one was observed taking any rocks or fossils, but it was not possible to see the entire trail from the observation location. Small piles of fossils left by visitors along the trails in the Monument suggests it is not uncommon for visitors to search for fossils, but not take them; they simply leave them in piles for others to see, as is seen in other areas with cultural artifacts (e.g., Native American pottery shards). In fact, the searching for fossils and artifacts leads to the destruction

of the resource, even if the fossils are not taken, because the removal from the rock layers causes the loss of ecological and historical context. It would be better from a management perspective to periodically remove the fossil piles because the piles may serve as a signal to visitors that the behavior is acceptable because others have done it (i.e., releaser-cue or normative cue).

Another major focus of this research was exploring the knowledge – attitude – behavior relationship. Neither the visitor center nor nature trail study found a strong positive relationship between knowledge and fossil respect beliefs. In fact, among those who entered the closed research quarry, those who picked up rocks within the quarry tended to have greater knowledge of the Fossil Lake story (75% correct) than those who did not pick up rocks or dig for fossils (64% correct). There was a slight, and weakly significant, positive relationship between knowledge of the Fossil Lake story and respect beliefs found in the visitor center study.

There was a slight positive relationship between fossil respect beliefs and behavior in the closed quarry; those who did not pick up rocks had slightly stronger fossil respect beliefs than those who chose to pick up rocks. However, there was no relationship between fossil respect beliefs and a decision to enter the closed quarry. It should be noted though, that if the interpretive sign was not read, there was nothing to indicate that the quarry was closed, so this limited the testing of this relationship.

It is not entirely clear why the expected positive relationships between knowledge, beliefs, and behavior were not seen. One possibility that has already been discussed was that the relatively high base knowledge of visitors and low agreement with the acceptability of stealing fossils made it difficult to detect differences. Another interesting possibility that was also suggested from the results was that the high level of interest in fossils, expressed by a majority of respondents, somehow influenced the relationship between these variables. For example, people

who picked up rocks in the closed quarry had greater knowledge levels than those who did not, and the visitor center survey found that those with the strongest interest levels had greater knowledge scores and lower fossil respect beliefs. The trend for more knowledgeable and interested visitors to have lower respect for the resource has been mirrored in research on scuba divers and suggests that this is a fertile area for future research. Todd, Cooper, and Graefe (2000) found that as scuba divers moved from beginners to experts they initially gained more ethical beliefs, but that trend was eventually reversed in who they defined as "post-experts." Thapa, Graefe, and Meyer (2005) found that specialization was a strong mediator of the relationship between knowledge of reef ecology and pro-environmental behavior. Perhaps those with the most interest and knowledge are the most highly motivated to search for fossils. More research should be conducted to understand how specialization either in the activity or place (i.e., place bonding or attachment) impacts behavior and how interpretive or persuasive programs can be designed to reduce depreciative behavior from these highly motivated and experienced groups of visitors.

Another major implication of this research is to not just know your audience for interpretation, but determine the characteristics of those who are the most likely to engage in depreciative behaviors. Persuasive messages or interventions are most likely to be successful if they are designed specifically for the target audience. People have different value systems, different motivations, and different skill sets. Understanding who is offending and why is crucial to designing the most effective intervention or message. Once there is a better understanding of the visitor, more complex and layered interpretive programs and behavioral interventions could be developed. It is likely that more than one message or intervention needs to be developed to target different visitor segments (e.g., novices and experts).

I began in the introduction by discussing the key antecedent variables to ethical behavior while recreating identified in the literature. While this research did not directly test the Theory of Planned Behavior, the findings did suggest that more variables should be included in models trying to understand recreation behavior. Although the model might predict behavior when all components are included (unlike these studies), it is clear that more information should be gathered from visitors to better design interpretive programs and persuasive messages. I encourage interpretive researchers to move beyond simply looking at attitudes, beliefs, and knowledge to including more variables in their research, such as the ownership and empowerment variables that are included in Hungerford and Volk's (1990) model.

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Appendix A

Visitor Center Survey: On-site, Entry

Fossil Butte National Monument
Visitor Survey (I)

Thank you for participating in the Fossil Butte National Monument Visitor Survey. We are working on a research project to help managers at Fossil Butte National Monument do the best possible job. Your participation is voluntary. Any information collected will remain confidential.

1. How many times have you visited Fossil Butte National Monument **before** this trip?

☐ This is my first visit ☐ 2-3 times ☐ 6-10 times ☐ I don't recall

☐ Once ☐ 4-5 times ☐ More than 10 times

2. Have you visited any other fossil monuments or parks in the United States?

☐ Yes
☐ No
☐ I don't know

3. While at Fossil Butte National Monument, which activities have you participated in or plan to participate in?

	Already did	Plan to do	Didn't/Don't plan to do
Attend an educational talk by a uniformed park ranger or volunteer at the Visitor Center	☐	☐	☐
Watch educational video at the Visitor Center	☐	☐	☐
Participate in the quarry program with a uniformed park ranger or volunteer	☐	☐	☐

4. While in the **Kemmerer** area, which activities have you done, or plan to do?

	Already did	Plan to do	Didn't/Don't plan to do
Dig fossils at a commercial quarry outside the park	☐	☐	☐
Purchase fossils from a local rock shop	☐	☐	☐
Visit the Fossil County Museum in Kemmerer, WY	☐	☐	☐

5. How would you rate your own interest in fossils? (Mark one)

☐ I have little or no interest in fossils
☐ I am somewhat interested in fossils
☐ I have quite a lot of interest in fossils
☐ I have strong interest in fossils
☐ Learning about fossils is my favorite hobby.

We would like to ask you a few questions about the national monument and its fossils. We want this information to help managers make program improvements. For all questions below, please give us the one answer you believe to be true. If you don't know the answer, give us your best guess.

6. Fossil Butte National Monument is managed by the:
   a. US Fish and Wildlife Service
   b. Bureau of Land Management
   c. Wyoming Geological Survey
   d. National Park Service
   e. Wyoming State Parks and Historic Sites

7. The management staff at Fossil Butte National Monument work to achieve the following goal(s):
   a. educate the public about fossilized plants and animals at the monument
   b. provide for the public's enjoyment of scenery, natural and historic objects, and wildlife
   c. protect the fossils from theft and vandalism
   d. conduct research to understand the fossil record
   e. all of the above

8. During the time of Fossil Lake, the climate was_____
   a. wet and warm
   b. wet and cold
   c. dry and warm
   d. dry and cold

9. Fossil Lake was present in this area _____million years ago
   a. 2 b. 30 c. 50 d. 100

10. Fossil Lake is special because……
   a. It preserved whole communities of plants and animals
   b. Fossils are well preserved
   c. Fossil fish found here are relatively rare around the world
   d. All of the above

11. What scenario best describes how fish in Fossil Lake came to be fossilized.
   a. a lava flow encased the lake
   b. lake sediments buried the fish after they died
   c. the lake dried up and the sun dried and preserved the fish
   d. volcanic ash buried the fish
   e. all of the above

12. One of the most common fossils in Fossil Lake are small herring-like fish called_____
   a. Knightia
   b. Notogoneus
   c. Pareodus
   d. Mioplisus
   e. Amia

13. The pressure of accumulating layers of sediments over thousands of years turned old lake sediments into _____, which encases the fossil fish found today.
   a. granite
   b. sandstone
   c. dolomite
   d. limestone
   e. quartz

14. The age that a fossil fish was when it died can be determined by_____
   a. counting the growth rings on scales
   b. measuring the size of fish
   c. looking at the size of the teeth
   d. none of the above

15. What is the primary reason that fossils are protected in national parks and monuments?
    a. fossils are beautiful
    b. fossils are fragile
    c. fossils tell us about plants and animals that lived millions of years ago
    d. fossils can be used to bring extinct species back to life
    e. fossils may provide us a cure for some of today's diseases

16. Fossil A is located several rock layers above Fossil B. This suggests that…….
    a. Fossil A lived more recently than Fossil B
    b. Fossil B lived more recently than Fossil A
    c. Both lived about the same time
    d. We can't tell from this information

17. Visitors vary in their opinions about fossils and fossil protection. Please indicate how much you agree or disagree with the following statements.

	Strongly Agree			Neutral			Strongly Disagree
It is acceptable to take a small piece of fish fossil home from Fossil Butte National Monument	1	2	3	4	5	6	7
It is acceptable to take home common fossils from Fossil Butte National Monument	1	2	3	4	5	6	7
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back	1	2	3	4	5	6	7
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center	1	2	3	4	5	6	7
It is acceptable to buy fossils at commercial rock shops	1	2	3	4	5	6	7
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back	1	2	3	4	5	6	7

18. Your present age: _____years

19. Are you ☐ Male or ☐ Female

We would like some additional information from you about how you planned your trip, activities you participated in at Fossil Butte, and opinions on the services the monument provides. In order to send you a survey, we would like your name and address. This information will be kept confidential. Your name and address will be used for no purpose other than mailing the surveys and follow-ups.

Name:_____

Street Address:_____

City/State:_____

Zip Code:_____

Thank you,
Dr. Joseph Roggenbuck
Virginia Tech, Dept. of Forestry
Blacksburg, VA 24060

OMB#1024-0224

NPS ID# 01-021

Exp. Date: 4/30/02

PRIVACY ACT and PAPERWORK REDUCTION ACT statement:

16 U.S.C. 1a-7 authorizes collection of this information. This information will be used by park managers to better serve the public. Response to this request is voluntary. No action may be taken against you for refusing to supply the information requested. Your name is requested for follow-up mailing purposes only. When analysis of the questionnaire is completed, all name and address files will be destroyed. Thus, permanent data will be anonymous. Data collected through visitor surveys may be disclosed to the Department of Justice when relevant litigation or anticipated litigation, or to appropriate Federal, State, local or foreign agencies responsible for investigating or prosecuting violation of law. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

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Appendix B

Visitor Center Survey: On-site, Exit Form

Fossil Butte National Monument
Visitor Survey (O)

Thank you for participating in the Fossil Butte National Monument Visitor Survey. We are working on a research project to help managers at Fossil Butte National Monument do the best possible job. Your participation is voluntary. Any information collected will remain confidential.

1. How many times have you visited Fossil Butte National Monument **before** this trip?

☐ This is my first visit ☐ 2-3 times ☐ 6-10 times ☐ I don't recall
☐ Once ☐ 4-5 times ☐ More than 10 times

2. Have you visited any other fossil monuments or parks in the United States?

☐ Yes
☐ No
☐ I don't know

3. While at Fossil Butte National Monument, which activities have you participated in or plan to participate in?

	Already did	Plan to do	Didn't/Don't plan to do
Attend an educational talk by a uniformed park ranger or volunteer at the Visitor Center	☐	☐	☐
Watch educational video at the Visitor Center	☐	☐	☐
Participate in the quarry program with a uniformed park ranger or volunteer	☐	☐	☐

4. While in the **Kemmerer** area, which activities have you done, or plan to do?

	Already did	Plan to do	Didn't/Don't plan to do
Dig fossils at a commercial quarry outside the park	☐	☐	☐
Purchase fossils from a local rock shop	☐	☐	☐
Visit the Fossil County Museum in Kemmerer, WY	☐	☐	☐

5. How would you rate your own interest in fossils? (Mark one)

☐ I have little or no interest in fossils
☐ I am somewhat interested in fossils
☐ I have quite a lot of interest in fossils
☐ I have strong interest in fossils
☐ Learning about fossils is my favorite hobby.

We would like to ask you a few questions about what you learned during your visit. We are not evaluating you; rather we want this information so that we can make program improvements. For all questions below, please give us the one answer you believe to be true. If you don't know the answer, give us your best guess.

6. Fossil Butte National Monument is managed by the:
   a. US Fish and Wildlife Service
   b. Bureau of Land Management
   c. Wyoming Geological Survey
   d. National Park Service
   e. Wyoming State Parks and Historic Sites

7. The management staff at Fossil Butte National Monument work to achieve the following goal(s):
   a. educate the public about fossilized plants and animals at the monument
   b. provide for the public's enjoyment of scenery, natural and historic objects, and wildlife
   c. protect the fossils from theft and vandalism
   d. conduct research to understand the fossil record
   e. all of the above

8. During the time of Fossil Lake, the climate was_____
   a. wet and warm
   b. wet and cold
   c. dry and warm
   d. dry and cold

9. Fossil Lake was present in this area _____million years ago
   a. 2 b. 30 c. 50 d. 100

10. Fossil Lake is special because……
   a. It preserved whole communities of plants and animals
   b. Fossils are well preserved
   c. Fossil fish found here are relatively rare around the world
   d. All of the above

11. What scenario best describes how fish in Fossil Lake came to be fossilized.
   a. a lava flow encased the lake
   b. lake sediments buried the fish after they died
   c. the lake dried up and the sun dried and preserved the fish
   d. volcanic ash buried the fish
   e. all of the above

12. One of the most common fossils in Fossil Lake are small herring-like fish called_____
   a. Knightia
   b. Notogoneus
   c. Pareodus
   d. Mioplisus
   e. Amia

13. The pressure of accumulating layers of sediments over thousands of years turned old lake sediments into _____, which encases the fossil fish found today.
   a. granite
   b. sandstone
   c. dolomite
   d. limestone
   e. quartz

14. The age that a fossil fish was when it died can be determined by_____
   a. counting the growth rings on scales
   b. measuring the size of fish
   c. looking at the size of the teeth
   d. none of the above

15. What is the primary reason that fossils are protected in national parks and monuments?
    a. fossils are beautiful
    b. fossils are fragile
    c. fossils tell us about plants and animals that lived millions of years ago
    d. fossils can be used to bring extinct species back to life
    e. fossils may provide us a cure for some of today's diseases

16. Fossil A is located several rock layers above Fossil B. This suggests that…….
    a. Fossil A lived more recently than Fossil B
    b. Fossil B lived more recently than Fossil A
    c. Both lived about the same time
    d. We can't tell from this information

17. Visitors vary in their opinions about fossils and fossil protection. Please indicate how much you agree or disagree with the following statements.

	Strongly Agree			Neutral			Strongly Disagree
It is acceptable to take a small piece of fish fossil home from Fossil Butte National Monument	1	2	3	4	5	6	7
It is acceptable to take home common fossils from Fossil Butte National Monument	1	2	3	4	5	6	7
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back	1	2	3	4	5	6	7
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center	1	2	3	4	5	6	7
It is acceptable to buy fossils at commercial rock shops	1	2	3	4	5	6	7
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back	1	2	3	4	5	6	7

18. Your present age: _____years

19. Are you ☐ Male or ☐ Female

We would like some additional information from you about how you planned your trip, activities you participated in at Fossil Butte, and opinions on the services the monument provides. In order to send you a survey, we would like your name and address. This information will be kept confidential. Your name and address will be used for no purpose other than mailing the surveys and follow-ups.

Name:_____

Street Address:_____

City/State:_____

Zip Code:_____

Thank you,
Dr. Joseph Roggenbuck
Virginia Tech, Dept. of Forestry
Blacksburg, VA 24060

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Appendix C

Visitor Center Survey: Mail

Description of Your Recent Visit to Fossil Butte National Monument

The following questions refer to your recent visit to Fossil Butte National Monument. During your visit, we contacted you and asked your cooperation in this important survey.

1. How many people were in your group? (the number of people in your car, or your bus if you came as part of a tour group) _____ people

2. What type of group were you with? (Mark one)
   - ☐ I came alone
   - ☐ A family group
   - ☐ A group of friends
   - ☐ A family/friend group
   - ☐ An organized group –If so, indicate kind of group (e.g., Scouts, church group, or tour group)_____

3. Some possible reasons why people visit Fossil Butte National Monument are listed below. Tell us how important each reason was in your decision to visit the monument.

	Not at all Important	Somewhat Important	Moderately Important	Very Important	Extremely Important
To discover new things	1	2	3	4	5
To do something with my family	1	2	3	4	5
To view the scenic beauty	1	2	3	4	5
To learn more about nature	1	2	3	4	5
To experience the peace and quiet	1	2	3	4	5
To do something with my friends	1	2	3	4	5
To learn more about fossils	1	2	3	4	5
To teach my family about nature	1	2	3	4	5
To get some exercise	1	2	3	4	5
To relax	1	2	3	4	5
To learn more about history	1	2	3	4	5
To say I've been to another National Park Service area	1	2	3	4	5
It was just a convenient place to stop	1	2	3	4	5
To view wildlife	1	2	3	4	5
To attend a scheduled program	1	2	3	4	5
I was just curious to learn about the place	1	2	3	4	5
To teach my family about fossils	1	2	3	4	5

4. Which activities did you participate in during your visit to Fossil Butte National Monument? (Check all that apply)

- ☐ Visited the visitor center
- ☐ Read exhibits in the visitor center
- ☐ Viewed 12-minute interpretive video at the visitor center
- ☐ Viewed the 3-minute video at the visitor center about fossil excavation and cleaning
- ☐ Purchased items from the sales counter at the visitor center
- ☐ Read outdoor educational exhibits along roads or trails
- ☐ Hiked the Historic Quarry Trail
- ☐ Hiked the Fossil Lake Trail
- ☐ Hiked one of the park's other trails
- ☐ Used restrooms
- ☐ Attended an educational talk by a uniformed park ranger or volunteer
- ☐ Participated in the quarry program with a uniformed park ranger or volunteer
- ☐ Participated in the JR/SR ranger program
- ☐ Participated in educational programs other than ranger talks and quarry program
- ☐ Drove on the monuments scenic drive (i.e., the gravel road)
- ☐ Observed wildlife
- ☐ Took photographs
- ☐ Picnicking
- ☐ Other:_____

5. Which of the following time blocks comes closest to the amount of time you spent at Fossil Butte National Monument? (Mark one)

- ☐ Less than an hour
- ☐ 1-2 hours
- ☐ 2-3 hours
- ☐ 3-4 hours
- ☐ 4-5 hours
- ☐ 5-6 hours
- ☐ 6-7 hours
- ☐ 7-8 hours
- ☐ more than 8 hours on a single day
- ☐ two days
- ☐ three days

6. Do you plan to return to the park for another visit? (Mark one)

- ☐ Yes, likely
- ☐ No, unlikely
- ☐ Unsure

7. What other recreation activities did you do outside the national monument and in the Kemmerer area on this trip? (Check as many as apply.)

- ☐ Dug fossils at a commercial fossil quarry
- ☐ Bought fossils at a commercial fossil quarry
- ☐ Purchased fossils at a "rock shop" in the Kemmerer area
- ☐ Visited the Fossil Country Museum, Kemmerer
- ☐ Went fishing in the Kemmerer area
- ☐ Other recreational activities in the Kemmerer area, please specify:_____

_____

Planning Your Recent Trip to Fossil Butte National Monument

8. On this trip, what was the primary reason that you visited the Kemmerer, Wyoming area? (Mark one)
   - ☐ Visit Fossil Butte National Monument
   - ☐ Visit other attractions in the Kemmerer area
   - ☐ Visit friends or relatives in the Kemmerer area
   - ☐ Visit the Kemmerer area for business reasons
   - ☐ I was on my way to Grand Teton and/or Yellowstone National Parks
   - ☐ I was just passing through the Kemmerer area on my way somewhere else
   - ☐ Other, please specify_____

9. Was Fossil Butte National Monument the only recreation destination of your trip away from home?
   - ☐ Yes, If yes, go to Question 11
   - ☐ No, If no, go to Question 10

10. Did you visit other National Park Service Areas on this trip?
    - ☐ No, If no, go to Question 11
    - ☐ Yes, If yes, what other National Park Service Areas did you visit on this trip (Check all that apply.)

☐ Dinosaur National Monument (UT/CO) ☐ Florissant Fossil Beds National Monument (CO)
☐ Grand Teton National Park (WY) ☐ Agate Fossil Beds National Monument (NE)
☐ Yellowstone National Park (WY/MT) ☐ Hagerman Fossil Beds National Monument (ID)
☐ Badlands National Park (SD)
☐ Other National Park Service areas, name them_____
_____

11. Which of the following were sources of information you used while planning for this trip to Fossil Butte National Monument? (Check as many as apply.)

☐ Family or friends	☐ Internet
☐ A teacher at school	☐ The Fossil Butte National Monument website
☐ Highway sign/billboard	☐ National Park Service Brochure
☐ A highway map	☐ Wyoming Welcome Center
☐ Television/radio program	☐ Tour company
☐ Newspaper story	☐ Travel agent
☐ Magazine story	☐ Kemmerer Chamber of Commerce
☐ Books	☐ Wyoming Tourism Board

☐ Other_____

12. What one source of information was most useful in planning your visit to Fossil Butte National Monument? (Some of the possible sources are contained in Question 11)

_____

Your Involvement with National Park Service Fossil Sites

13. How many times have you visited Fossil Butte National Monument **before** this trip?

☐ This is my first visit ☐ 2-3 times ☐ 6-10 times ☐ I don't recall
☐ Once ☐ 4-5 times ☐ More than 10 times

14. Please indicate whether you have ever visited the following fossil parks/monuments managed by the National Park Service.

	Yes	No	Don't Know
Dinosaur National Monument (Utah/Colorado)	☐	☐	☐
Agate Fossil Beds National Monument (Nebraska)	☐	☐	☐
Badlands National Park (South Dakota)	☐	☐	☐
Florissant Fossil Beds (Colorado)	☐	☐	☐
Hagerman Fossil Beds National Monument (Idaho)	☐	☐	☐
Petrified Forest National Monument (Arizona)	☐	☐	☐
John Day Fossil Beds National Monument (Oregon)	☐	☐	☐

15. How would you rate your own interest in fossils? (Mark one)

☐ I have little or no interest in fossils.
☐ I am somewhat interested in fossils.
☐ I have quite a lot of interest in fossils.
☐ I have strong interest in fossils.
☐ Learning about fossils is my favorite hobby.

16. Before coming to Fossil Butte National Monument on this visit, had you…..

	Yes	No
Read a book or books on fossils or prehistoric life on earth?	☐	☐
Watched TV program(s) or video(s) on fossils or prehistoric life on earth?	☐	☐
Read about fossil fishes?	☐	☐
Read about dinosaurs?	☐	☐
Read about Fossil Lake and the Green River formation in Wyoming?	☐	☐
Visited internet sites about fossils?	☐	☐

Your Evaluation of Site Conditions and Program Services

17. Overall, how would you rate your experience at Fossil Butte National Monument?

1----------2----------3----------4----------5----------6----------7
Very Poor Average Very Good

18. Below is a list of conditions and services at Fossil Butte National Monument. First rate the importance of each item as it contributes to your ideal experience during a visit. Rate importance by circling the appropriate number in the IMPORTANCE block. Then rate your satisfaction with each item during your visit to Fossil Butte National Monument. Rate satisfaction by circling the appropriate number or "don't know/does not apply" in the SATISFACTION block. You should have an importance rating and a satisfaction rating for each item.

	Importance (to your experience)					Satisfaction (with your experience)					
	Not at all Important				Extremely Important	Not at all Satisfied				Extremely Satisfied	Don't Know/ Does Not Apply
Monument information/education services											
Number of ranger talks available	1	2	3	4	5	1	2	3	4	5	DK
Quality of ranger talks given	1	2	3	4	5	1	2	3	4	5	DK
Quality of information services in the visitor Center	1	2	3	4	5	1	2	3	4	5	DK
Quality of the exhibits in the visitor center	1	2	3	4	5	1	2	3	4	5	DK
Quality of the videos shown in the visitor center	1	2	3	4	5	1	2	3	4	5	DK
Number of outdoor educational exhibits	1	2	3	4	5	1	2	3	4	5	DK
Quality of outdoor educational exhibits	1	2	3	4	5	1	2	3	4	5	DK
Availability of park brochures	1	2	3	4	5	1	2	3	4	5	DK
Quality of park brochures	1	2	3	4	5	1	2	3	4	5	DK
Variety of books and other printed materials on sale in the visitor center	1	2	3	4	5	1	2	3	4	5	DK
Availability of information about hiking trails in the park	1	2	3	4	5	1	2	3	4	5	DK
Number of guided quarry programs at the monument	1	2	3	4	5	1	2	3	4	5	DK
Quality of guided quarry programs at the monument	1	2	3	4	5	1	2	3	4	5	DK
Availability of information about commercial fossil quarries outside the monument	1	2	3	4	5	1	2	3	4	5	DK
Monument Facilities											
Number/miles of hiking trails	1	2	3	4	5	1	2	3	4	5	DK
Condition of hiking trails	1	2	3	4	5	1	2	3	4	5	DK
Number and condition of picnic tables	1	2	3	4	5	1	2	3	4	5	DK
Adequate directional signs to find one's way in the monument	1	2	3	4	5	1	2	3	4	5	DK
Condition and quality of the visitor center	1	2	3	4	5	1	2	3	4	5	DK
Number and location of restroom facilities	1	2	3	4	5	1	2	3	4	5	DK
Cleanliness of restroom facilities	1	2	3	4	5	1	2	3	4	5	DK
Amount of litter along walking paths	1	2	3	4	5	1	2	3	4	5	DK
Amount of litter along the highway	1	2	3	4	5	1	2	3	4	5	DK
Surface conditions on the gravel scenic drive	1	2	3	4	5	1	2	3	4	5	DK
Surface conditions of paved roads	1	2	3	4	5	1	2	3	4	5	DK
Number and location of trash cans/bins	1	2	3	4	5	1	2	3	4	5	DK
Number and location of drinking fountains	1	2	3	4	5	1	2	3	4	5	DK
Availability of campgrounds	1	2	3	4	5	1	2	3	4	5	DK
Adequate directional signs to find the monument	1	2	3	4	5	1	2	3	4	5	DK

19. For those information/education services or facilities listed in Question 18 which were important to you and about which you were dissatisfied during your visit, indicate how you would like the situation improved.

a. Problem 1: _____
Your recommended solution: _____

b. Problem 2: _____
Your recommended solution: _____

c. Problem 3: _____
Your recommended solution: _____

Your Knowledge of the National Monument Story

We would like to ask you a few questions about what you learned during your visit. We are not evaluating you; rather we want this information so that we can make program improvements. For all questions below, please give us the one answer you believe to be true. If you don't know the answer, give your best guess.

20. Fossil Butte National Monument is managed by:
    a. US Fish and Wildlife Service
    b. Bureau of Land Management
    c. Wyoming Geological Survey
    d. National Park Service
    e. Wyoming State Parks and Historic Sites

21. The management staff at Fossil Butte National Monument work to achieve the following goal(s):
    a. educate the public about fossilized plants and animals in the monument
    b. provide for the public's enjoyment of scenery, natural and historic objects, and wildlife
    c. protect fossils from theft and vandalism
    d. conduct research to understand the fossil record
    e. all of the above

22. Which of the following is the best statement of the mission of the National Park Service?
    a. providing the public with outdoor recreation opportunities comes first; preserving resources like fossils comes second
    b. protecting cultural/historical resources comes first; protecting natural resources and providing for compatible outdoor recreation are less important
    c. protecting cultural/historical resources is not important to the National Park Service; protecting scenic resources and providing for outdoor recreation are important
    d. protecting scenery is most important; protecting things like fossils is less important
    e. protecting natural resources like fossils for present and future generations and providing for compatible outdoor recreation use

23. National monuments have less protection from overuse and misuse than do the national parks.
☐ True ☐ False

24. National monuments and national parks typically have different purposes.
☐ True ☐ False

25. National monuments contain only historical/cultural resources; national parks contain only natural resources.
☐ True ☐ False

26. Providing developed, recreational facilities for visitor comfort is more important than protecting native wildlife in national monuments.
☐ True ☐ False

27. Providing for developed recreational facilities for visitor comfort is more important than protecting fossils at Fossil Butte National Monument.
☐ True ☐ False

28. The two primary purposes of Fossil Butte National Monument stated in the monument's enabling legislation are:
a. To provide opportunities to see wildlife and educate the public about fossils
b. To protect the fossil record and provide opportunities to see wildlife
c. To protect the fossil record and educate the public about fossils
d. To educate the public about early pioneers to the area and provide opportunities to see wildlife
e. To provide for recreation development and opportunities to see wildlife

29. What is the primary reason that fossils are protected in national parks and monuments?
a. fossils are beautiful
b. fossils are fragile
c. fossils tell us about plants and animals that lived millions of years ago
d. fossils can be used to bring extinct species back to life
e. fossils may provide a cure for some of today's diseases

30. Fossil Lake is special because……
a. it preserved whole communities of plants and animals
b. fossils are well preserved
c. fossil fish found here are relatively rare around the world
d. all of the above

31. During the time of Fossil Lake, the climate was_____
a. wet and warm c. dry and warm
b. wet and cold d. dry and cold

32. Fossil Lake was present in this area _____ million years ago
a. 2 b. 30 c. 50 d. 100

33. While many things could have caused the large fish kills observed in Fossil Lake deposits, a popular theory suggests the kills could have been caused by:
    a. a hurricane
    b. disease break-out
    c. toxins from blue-green algae
    d. sudden water level changes

34. Fossil A is located several rock layers above Fossil B. This suggests that…….
    a. Fossil A lived more recently than Fossil B
    b. Fossil B lived more recently than Fossil A
    c. Both lived about the same time
    d. We can't tell from this information

35. Fossils at Fossil Butte can help scientists or paleontologists learn more about the following:
    a. How much the climate has changed over millions of years
    b. The skin color of animals who lived millions of years ago
    c. The sounds animals made millions of years ago
    d. How dinosaurs lived millions of years ago
    e. How many fish lived in Fossil Lake

36. When scientists find different types of fish in the same rock layer, this tells them:
    a. the number of years that the fish lived
    b. how the lake water chemistry changed over millions of years
    c. about the community in which the fish lived
    d. the size of schools the fish swam in
    e. the type of habitat the fish lived in

37. What scenario best describes how fish in Fossil Lake came to be fossilized.
    a. lava flow encased the lake
    b. lake sediments buried the fish after they died
    c. the lake dried up and the sun dried and preserved the fish
    d. volcanic ash buried the fish
    e. all of the above

38. The pressure of accumulating layers of sediments over thousands of years turned old lake sediments into _____, which encases the fossil fish found today.
    a. granite
    b. sandstone
    c. dolomite
    d. limestone
    e. quartz

39. The age that a fossil fish was when it died can be determined by_____
    a. Counting the growth rings on scales
    b. Measuring the size of fish
    c. Looking at the size of the teeth
    d. None of the above

Your Attitudes About Fossils and Fossil Protection

40. Visitors vary in their opinions about fossils and fossil protection. Please indicate how much you agree or disagree with the following statements.

	Strongly Agree			Neutral			Strongly Disagree
It is acceptable to take a small piece of fish fossil home from Fossil Butte National Monument	1	2	3	4	5	6	7
It is acceptable to take home common fossils from Fossil Butte National Monument	1	2	3	4	5	6	7
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back	1	2	3	4	5	6	7
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center	1	2	3	4	5	6	7
It is acceptable to buy fossils at commercial rock shops	1	2	3	4	5	6	7
It is acceptable to remove a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back	1	2	3	4	5	6	7

41. Park visitors differ in their opinions of what actions are acceptable. Below, we have listed twelve things that visitors might do in a park. For each, rate the relative seriousness of the action (not how frequent the problem is). Indicate the level of seriousness for each item by placing the letter of the item along the scale given below. When you are finished, you should have twelve letters placed along the scale.

|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
0 10 20 30 40 50 60 70 80 90 100

Not a Problem — Extremely serious problem

A Traveling 40 miles per hour in a 30 miles per hour speed zone in the park
B. Removing a fossil dinosaur bone in the park
C. Removing a fish fossil from the park
D. Removing a small piece of fossil fish from the park
E. Removing a piece of prehistoric Native American pottery from the park
F. Removing a piece of petrified wood from the park
G. Picking a flower in the park
H. Littering in the park
I. Purposely harming an endangered plant or animal in the park
J. Feeding wildlife in the park
K. Driving off designated roads in the park
L. Entering a closed area in the park

Socio-Demographic Characteristics of Visitors

In order to make comparisons among the many kinds of visitors to Fossil Butte National Monument, we would like some general information about you. All information is voluntary and confidential, and will not be identified with your name.

42. Your present age: _____ years

43. Are you ☐ Male or ☐ Female?

44. What is the highest level of education you have completed? (Mark one)

- ☐ Elementary school
- ☐ Some high school
- ☐ High school diploma or equivalent
- ☐ Some college
- ☐ Associate's degree or equivalent
- ☐ Bachelor's degree or equivalent
- ☐ Some graduate work
- ☐ Master's degree or equivalent
- ☐ Ph.D., M.D., or equivalent

45. What was your approximate total household income before taxes last year? (Mark one)

- ☐ Under $19,999
- ☐ $20,000 – 39,999
- ☐ $40,000 – 59,999
- ☐ $60,000 – 79,999
- ☐ $80,000 – 99,999
- ☐ $100,000 – 149,999
- ☐ $150,000 – 199,999
- ☐ $200,000 or more

46. In what ethnicity and race would you place yourself?

a. Ethnicity:

- ☐ Hispanic or Latino
- ☐ Not Hispanic or Latino

b. Race: (check one or more races to indicate what you consider yourself to be)

- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Other (please specify) _____
- ☐ Do not wish to answer

47. Please indicate if you belong to a paleontological or conservation association. (Mark all that apply.)

- ☐ National park protection association
- ☐ Other conservation association
- ☐ A paleontological association

Thank you for your time!

OMB ID#: 1024-0224
NPS ID #: 01-021

Exp. Date: 4/30/2002

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Appendix D

Fossil Lake Trail Survey

Fossil Lake Trail Visitor Survey

Thank you for participating in the Fossil Butte National Monument Visitor Survey. We are working on a research project to help managers at Fossil Butte National Monument do the best possible job. Your participation is voluntary. Any information collected will remain confidential.

1. How many times have you visited Fossil Butte National Monument **before** this trip?

☐ This is my first visit ☐ 2-3 times ☐ 6-10 times ☐ I don't recall
☐ Once ☐ 4-5 times ☐ More than 10 times

2. Have you visited any other fossil monuments or parks in the United States?

☐ Yes ☐ No ☐ I don't know

3. While in the **Kemmerer** area, which activities have you done, or plan to do?

	Already did	Plan to do	Didn't/Don't plan to do
Dig fossils at a commercial quarry outside the park	☐	☐	☐
Purchase fossils from a local rock shop	☐	☐	☐
Visit the Fossil County Museum	☐	☐	☐

4. How would you rate your own interest in fossils? (Mark one)

☐ I have little or no interest in fossils
☐ I am somewhat interested in fossils
☐ I have quite a lot of interest in fossils
☐ I have strong interest in fossils
☐ Learning about fossils is my favorite hobby.

5. Before coming to Fossil Butte National Monument on this visit, had you…..

	Yes	No
Read a book or books on fossils or prehistoric life on earth?	☐	☐
Watched TV program(s) or video(s) on fossils or prehistoric life on earth?	☐	☐
Read about fossil fishes?	☐	☐
Read about dinosaurs?	☐	☐
Read about Fossil Lake and the Green River formation here in Wyoming?	☐	☐
Visited internet sites about fossils?	☐	☐

6. I came to Fossil Butte National Monument **primarily** because…(Please mark only one.)

☐ Fossils seem interesting to me
☐ A member of my group was interested in fossils
☐ I wanted to show fossils to my children, family, or friends
☐ I was just curious about what was here
☐ I wanted to hike
☐ I wanted to picnic
☐ I wanted to see wildlife
☐ Other_____

We would like to ask you a few questions about what you learned during your visit. We are not evaluating you; rather we want this information so that we can make program improvements. For all questions below, please give us the one answer you believe to be true. If you don't know the answer, give us your best guess.

7. What is the primary reason that fossils are protected in national parks and monuments?
   a. fossils are beautiful
   b. fossils are fragile
   c. fossils tell us about plants and animals that lived millions of years ago
   d. fossils can be used to bring extinct species back to life
   e. fossils may provide us a cure for some of today's diseases

8. Fossil _____ have never been found in Fossil Lake.
   a. crocodiles c. dinosaurs e. snakes
   b. alligators d. frogs

9. During the time of Fossil Lake, the climate was_____
   a. wet and warm c. dry and warm
   b. wet and cold d. dry and cold

10. Fossil Lake was present in this area _____million years ago
   a. 2 b. 30 c. 50 d. 100

11. While many things could have caused the large fish kills observed in Fossil Lake deposits, a popular theory suggests the kills could have been caused by:
   a. hurricane c. toxins from blue-green algae
   b. disease break-out d. sudden water level changes

12. Fossil Lake is special because……
   a. it preserved whole communities of plants and animals
   b. fossils are well preserved
   c. fossil fish such as found here are relatively rare around the world
   d. all of the above

13. The pressure of accumulating layers of sediments over thousands of years turned old lake sediments into _____, which encases the fossil fish found today.
   a. granite c. dolomite e. quartz
   b. sandstone d. limestone

14. Fossil A is located several rock layers above Fossil B. This suggests that…….
   a. fossil A lived more recently than fossil B
   b. fossil B lived more recently than fossil A
   c. both lived about the same time
   d. we can't tell from this information

15. Visitors vary in their opinions about fossils and fossil protection. Please indicate how much you agree or disagree with the following statements.

	Strongly Agree			Neutral			Strongly Disagree
It is acceptable to take a small piece of fish fossil home from Fossil Butte National Monument	1	2	3	4	5	6	7
It is acceptable to take home common fossils from Fossil Butte National Monument	1	2	3	4	5	6	7
It is acceptable to pick up and look at a fossil you found on the ground in Fossil Butte National Monument, as long as you put it back	1	2	3	4	5	6	7
It would be acceptable for Fossil Butte National Monument to sell fossils quarried outside the monument at the Visitor Center	1	2	3	4	5	6	7
It is acceptable to buy fossils at commercial rock shops	1	2	3	4	5	6	7
It is acceptable to chip a fossil from its rock layer in Fossil Butte National Monument, so long as you put it back	1	2	3	4	5	6	7

16. Park visitors differ in their opinions of what actions are acceptable. Below, we have listed twelve things that visitors might do in a park. For each, rate the relative seriousness of the action (not how frequent the problem is). Indicate the level of seriousness for each item by placing the letter of the item along the scale given below. When you are finished, you should have twelve letters placed along the scale below.

```
l----------1----------1----------1----------1----------1----------1----------1----------1----------1
0         10         20         30         40         50         60         70         80         90        100
Not a                                                                                          Extremely
Problem                                                                                    serious problem
```

A. Traveling 40 miles per hour in a 30 miles per hour speed zone in the park
B. Removing a fossil dinosaur bone from the park
C. Removing a fish fossil from the park
D. Removing a small piece of fossil fish from the park
E. Removing a piece of prehistoric Native American pottery from the park
F. Removing a piece of petrified wood from the park
G. Picking a flower in the park
H. Littering in the park
I. Purposely harming an endangered plant or animal in the park
M. Feeding wildlife in the park
N. Driving off designated roads in the park
O. Entering a closed area in the park

17. Your present age: _____years

18. Are you ☐ Male or ☐ Female?

19. What is the highest level of education you have completed? (Mark one)

☐ Elementary school
☐ Some high school
☐ High school diploma or equivalent
☐ Some college
☐ Associate's degree or equivalent
☐ Bachelor's degree or equivalent
☐ Some graduate work
☐ Master's degree or equivalent
☐ Ph.D., M.D., or equivalent

Thank you for participating in our study!

Karen Hockett and Dr. Roggenbuck
Virginia Tech Dept. of Forestry
Blacksburg, VA 24061

OMB# 1024-0224
NPS ID# 01-021
Exp. Date: 4130102

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