Public Knowledge and Perceptions of the Desert Tortoise

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Executive Summary

- The desert tortoise (*Gopherus agassizii*) was listed as a threatened species under the Endangered Species Act in 1990. Much of the tortoises' critical habitat is located in the Mojave Desert. This study examined the relationship between public knowledge of the desert tortoise and:
  1. prior visitation to and recreation activity participation in the Mojave Desert
  2. perceived threats to the desert tortoise population
  3. acceptability of alternative management strategies for protecting the desert tortoise
  4. attitudes and normative beliefs regarding the desert tortoise and endangered species
  5. trust in federal / state agencies involved in desert tortoise recovery efforts
  6. willingness to limit desert-related recreation activities to help protect the desert tortoise
  7. support for efforts to recover the desert tortoise and endangered species in general
  8. sources used to obtain information about the desert tortoise
  9. membership in environmental / off-highway vehicle groups
  10. demographics (e.g., age, sex, education, income, place of residence, ethnicity, race).
- The data were obtained from mail and phone surveys of California residents (n = 1011, response rate = 53%). The sample was weighted by U.S. Census data to reflect population characteristics (i.e., county of residence, ethnicity, sex, age).
- Knowledge was based on the responses to 10 true – false statements. None of the respondents answered all 10 questions correctly. Respondents who answered between 0 and 2 questions correctly (34%) were considered to have "low" knowledge. Individuals with 3 to 5 correct responses (44%) were labeled as having "medium" knowledge, and those answering between 6 and 8 questions correctly (22%) were assigned to a "high" knowledge category.

Results

Demographics

- Individuals in the high knowledge category tended to be older (*M* age= 47.43) non-Hispanic (76%) white (78%) males (64%), with a two-year associates degree or less (69%), who earned more than $70,000 per year (57%). By comparison, the low knowledge groups was characterized as younger (*M* age = 39.90), more educated (46% four-year college degree or beyond), white (83%) females (64%), with 64% earning over $70,000. There was a larger proportion of Hispanics (42%) in the low knowledge group than in the high knowledge category (24%).
- Individuals living in the California desert tended to be more knowledgeable about desert tortoises. More individuals in the low knowledge category resided in San Bernardino County (84%) than those in the medium (59%) or high (61%) knowledge groups. Two thirds (67%) of individuals in the low knowledge group lived in cities of 100,000 or more residents, as compared to 55% (medium) and 42% (high) of the other knowledge categories. A third of the high knowledge individuals lived in small towns or rural areas, compared to 9% and 13% of the low and medium knowledge groups respectively.
- About a fifth of the respondents in the high knowledge group belonged to environmental or wildlife groups. This compares to 5% of the low and 4% of the medium knowledge groups. There were no differences among the three groups in terms of OHV organization membership. Less than a fifth of each group belonged to an organized OHV club.
- More individuals in the low knowledge category (54%) owned an off-highway vehicle, compared to the high (42%) and medium (33%) knowledge groups. Over two-thirds of all groups had driven an OHV in the California desert.

Prior Desert Recreation Experience

- Individuals with higher knowledge about the desert tortoise spent more days recreating in the Mojave Desert and were more familiar with the Desert than respondents in the other two knowledge categories.
- Participation in *viewing* (e.g., scenic driving, wildlife viewing, photography), *physical* (i.e., hiking, mountain biking, climbing), and *consumptive* (i.e., rock hounding, prospecting, hunting) activities increased with increasing knowledge of the desert tortoise. For off-highway vehicle activities (e.g., OHV motorcycles, ATVs, 4-wheel drive vehicles), the medium knowledge group participated less in desert recreation activities than the low and high knowledge respondents.

Awareness of and Encounters with Desert Tortoises

- Nearly all individuals in the three knowledge categories had heard of the desert tortoise prior to receiving the survey. Slightly less than half (47%) of the low knowledge respondents had ever seen a desert tortoise in the wild, compared to 55% of the medium and 80% of the high knowledge groups. Over two thirds of individuals in all three knowledge categories were aware of anyone who has picked up a desert tortoise in the wild. Eighty percent or more of all respondents did not know anyone who has taken a desert tortoise from the wild.
- More of the individuals in the high knowledge category (48%) knew someone who had adopted a wild desert tortoise as a pet, when compared to either the medium (32%) or low (18%) knowledge groups. Very few individuals in any of the knowledge categories admitted to knowing someone who had released a pet desert tortoise into the wild.

Perceived Threats to Desert Tortoises

- Humans, other animals and disease were viewed as more threatening to the desert tortoise by individuals in the high knowledge category when compared to the low knowledge group. Respondents in the low knowledge category believed pesticides or other toxic chemicals were more of a threat than those in the other two groups. The three groups did not differ on natural threats or habitat loss.
- Habitat loss by human development was considered the one main threat by at least 30% of all respondents. Nearly 30% of individuals in the high knowledge category viewed ravens as the most serious threat, compared to a fifth of respondents in the medium knowledge group and a tenth of people assigned a low knowledge score. Lack of nutritional food (11% - low knowledge) and off-highway vehicles unintentionally disturbing tortoises (11% - medium knowledge) were the only other items judged as the one main threat by more than 10% of the sample.

Beliefs and Attitudes toward Desert Tortoises

- Individuals were asked to indicate whether the number of desert tortoises had declined dramatically in recent years. About three-quarters (73%) of the high and two-thirds (67%) of the medium knowledge groups agreed with this statement. Less than a third (32%) of the low knowledge group thought the desert tortoise population had declined.
- Support for efforts to recover the desert tortoise increased as knowledge level increased. As knowledge increased, more respondents agreed that government should do more to protect desert tortoise populations. Individuals in the high knowledge category were basically neutral on the belief statement that land managers are doing everything they can to save the desert tortoise, whereas the low and medium groups were more likely to disagree. All three groups disagreed that the laws protecting the desert tortoise are too strict.
- All respondents held positive attitudes toward: (a) endangered species and the desert tortoise, and (b) efforts to recover all endangered species and the desert tortoise. As knowledge increased, these attitudes were held with more conviction.

Acceptability of Management Actions

- The acceptability of 18 specific management actions was compared by knowledge level. All respondents believed that taking no action was unacceptable. On the remaining 17 items, however, the three groups differed statistically in their acceptability evaluations. The most acceptable management strategy for all three groups was to enhance native vegetation food sources for the desert tortoise, although the degree of acceptability for this action increased as knowledge level increased. Limiting or banning hikers were rated least acceptable.
- For 10 of the management actions, evaluations went from negative to positive as knowledge increased:
  1. vaccinate desert tortoises to control disease
  2. fence roads to reduce road kills of desert tortoises
  3. eliminate *ravens* that threaten juvenile desert tortoises
  4. eliminate *feral dogs* that threaten desert tortoises
  5. limit *new human development* in desert tortoise habitat
  6. ban *cattle / sheep grazing* in some areas of desert tortoise habitat
  7. ban *hunting* in some areas of desert tortoise habitat
  8. limit number of *off-highway vehicles* in some areas of desert tortoise habitat
  9. ban *off-highway vehicles* in some areas of desert tortoise habitat
  10. ban *dual sport rides* in some areas of desert tortoise habitat

Information Sources

- With the exception of information from conservation groups, individuals in the high knowledge category used each of the 14 media sources listed in the survey more frequently than the other two knowledge groups. On average, the most frequently used sources for the high knowledge group were friends or family, traditional media (e.g., newspapers, television), and off-highway vehicle groups or brochures. The medium knowledge group used traditional media, websites and information from federal or state employees more often than the low group. Individuals in the low knowledge category were most likely to use information from friends or family and off-highway vehicle groups. Across all knowledge levels, none of the respondents used any of the media sources more than twice on average.
- When asked about their preferred main source for learning about desert tortoises, television programs ranked first for the low (39%) and medium (26%) knowledge groups, and second for the high knowledge category (16%). The preferred information source for the high knowledge group was off-highway vehicle groups (18%).

Predicting Knowledge from Information Sources

- The sources currently used to obtain information about desert tortoises were used to predict the respondents' overall knowledge scores. Three regression models were examined. For the model including the entire sample (model 1), 7 of the 11 independent variables statistically influenced respondents' knowledge level. Television programs such as the Discovery Channel, newspapers, magazines and books, federal or state employees, and websites were positively related to knowledge. Three independent variables in the entire sample model had negative and statistically significant relationships with desert tortoise knowledge (outdoor videos, television news, and off-highway vehicle groups).
- Model 2 included only individuals who did not have a four-year education. Three variables (television programs, newspapers, and conversation groups) were positively associated with desert tortoise knowledge. Information from outdoor videos was negative and statistically significant. None of the other predicator variables had a statistical influence in this model.
- Model 3 included individuals who had completed a four-year college degree or an advanced degree (e.g., masters, Ph.D.). Seven of the independent variables had a statistical influence on respondents' knowledge. In contrast to the first two models, however, newspapers had a negative rather than a positive effect on knowledge. Other variables negatively and statistically related to desert tortoise knowledge in model 3 included television news and outdoor videos. The variables having a positive influence on respondents' knowledge in this model were: (a) federal or state employees, (b) websites, (c) friends and family, and (d) television programs such as those on the Disney Channel. Although some of the variables in this model can be influenced by desert managers (e.g., federal or state employees), other predictors are not as easily manipulated (e.g., family and friends).
- The regression models highlighted the challenges associated with developing an effective communication strategy:
  1. Not all traditional media channels (e.g., radio) influenced knowledge.
  2. Some media channels functioned differently for different stakeholders. Information obtained from newspapers, for example, was positively related to knowledge in model 2 and negatively related in model 3. The positive and "substantial" impact of interacting with federal / state employees was evident in model 3, but not in model 2.
  3. Understanding the negative relationships observed in some of the models requires further exploration.
  4. These models only explained at best 38% of the variability in respondents' knowledge. Accounting for the unexplained 62% of the variance will necessitate inclusion of additional predictor variables.

Agency Trust

- Knowledge was not statistically related to agency trust. Individuals in all three knowledge groups "slightly" trusted the agencies. The low and high knowledge groups rated the believability of agency information higher than those in the medium group, although all three groups rated the information as "moderately believable."
- Respondents were asked to "grade" the government in managing the desert tortoise using a traditional "A" to "F" format. Of those who did give a letter grade, 15% or less of all respondents gave agencies an A in performance. The modal response for the low (64%) and high (41%) knowledge groups was a B. For the medium knowledge group, the modal response was a C (43%). The highest grade point average was observed for the low knowledge category (M = 2.71 or a B-). On average, respondents in the high knowledge category gave the agencies a C+ (M = 2.49) and those in the medium group gave a C (M = 2.27).

Understanding and Predicting Public Support for Desert Tortoises

- The cognitive hierarchy served as the conceptual framework for understanding public perceptions. In this model, general value orientations (e.g., biocentric – anthropocentric basic beliefs) influence specific attitudes (e.g., attitudes toward recovery efforts) and norms (e.g., awareness of consequences, ascription of responsibility). Attitudes and norms, in turn, are hypothesized to influence individual behavioral intentions (i.e., limiting recreational use) and evaluations of agency actions (i.e., support for desert tortoise recovery efforts).
- As knowledge increased, respondents were less anthropocentric (human centered) and more biocentric (nature centered). Individuals with higher levels of knowledge were more likely to be aware of the consequences humans can have on desert tortoises and more willing to take responsibility for their actions than those with less knowledge. Finally, as knowledge increased, respondents were more willing to limit their recreation activities to help protect the desert tortoise.

Predicting Intentions to Limit Recreation to Protect the Desert Tortoise

- As predicted, regression analyses indicated that attitudes toward desert tortoise recovery efforts influenced respondents' behavioral intentions to limit their desert recreation activities to protect the tortoise. Respondents with a positive attitude were more likely to constrain their behavior. Individuals who were aware of the consequences of human activity on desert tortoises and ascribed personal responsibility for their actions were also more likely to limit their desert recreation participation.
- Three variables had a significant influence on respondents' attitudes toward desert recovery efforts. Individuals who believed that desert tortoise populations have declined had a more favorable attitude toward desert tortoise recovery efforts. Those who trusted government agency management of desert tortoises held more positive attitudes. Finally, consistent with the cognitive hierarchy, individuals on the biocentric end of the value orientation continuum were more positive about desert tortoise recovery efforts.
- Three variables predicted ascription of responsibility (AR). A more biocentric value orientation was positively related to AR. People who believed the information provided by government agencies were also more likely to ascribe personal responsibility to themselves. Finally, increases in knowledge were associated with increases in the AR variable.
- The same three variables predicted respondents' awareness of consequences (AC). Believability of government information had the strongest influence on AC, followed by knowledge of the desert tortoise, and the biocentric-anthropocentric value orientation.

Predicting Intentions to Support Desert Tortoise Recovery Efforts

- A path model predicting behavioral intentions to support desert tortoise recovery efforts was also examined. As expected, the attitude toward desert tortoise recovery efforts and the two norms variables were statistically significant.
- Four predictor variables influenced the attitude toward recovery efforts. Beliefs about declines in the tortoise population was the strongest predictor, followed by trust in government agencies. Although believability of government information and knowledge of the desert tortoise were significant predictors, their influence was weak.
- Three variables influenced AR: knowledge of desert tortoises, believability of government information, and the belief that desert tortoise populations have declined. Two variables (believability of government information and knowledge of the desert tortoise) influenced AC.

Although some of the variables in the cognitive hierarchy are not likely to be influenced by persuasion techniques (e.g., value orientations), others can be. For example, the manual by Berry and Duck (1999) "Answering questions about desert tortoises" implicitly attempts to increase the publics' awareness of the consequences and personal ascription of responsibility for their actions in desert tortoise habitat. Each of these variables (AC and AR) directly influenced respondents' willingness to: (a) constrain their recreation behavior to protect the desert tortoise and (b) support recovery efforts of the desert tortoise. Recent brochures published by the Desert Managers Group present similar messages to achieve identical objectives.

Knowledge, agency trust, believability of agency information and beliefs about the status of desert tortoise populations, all influence these behaviors (i.e., limit use, support recovery efforts), but their impact is mediated by a person's attitude and norms. Efforts to increase public knowledge and agency trust are likely to foster more positive attitudes and norms, which in turn will build public support for and involvement with the desert tortoise recovery effort.

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Introduction

In 1990, the desert tortoise (*Gopherus agassizii*) was listed as a threatened species under the Endangered Species Act. The U.S. Fish and Wildlife Service designated 6.4 million acres of the desert tortoises' range as critical habitat in 1994. About 75%, or 4.8 million acres of this habitat, is located in California primarily on Bureau of Land Management, National Park Service, and Department of Defense lands. Much of this critical habitat is in the Mojave Desert.

Threats to desert tortoise populations can be either direct or indirect (Boarman, 2002). Direct threats include variables such as road mortality, illegal collecting, disease, and predation. Collecting desert tortoises for pets, for example, can lead to population declines (Berry & Nicholson, 1984), although most evidence is anecdotal (Boarman, 2002). Collecting tortoises was banned under California State law in 1961 and federal law in 1989. Diseases weaken individuals, reduce their reproductive capabilities and cause mortality. Some desert tortoise populations can be affected by three known diseases: Upper Respiratory Tract Disease (Jacobson et al., 1991), cutaneous dyskeratosis that affects the shell (Jacobson, Schumacher, & Berry, 1994), and a herpesvirus (Berry et al., 2002; Origgi, Romero, Klein, Berry, & Jacobson, 2002). An understanding of the consequences of such diseases on the desert tortoise, however, remains incomplete given that some of the published research was conducted on captive turtles or other species of turtles (e.g., gopher tortoise, *Gopherus polyphemus*, Jacobson, 1994). Desert tortoises have several natural predators (e.g., coyotes, foxes, feral dogs, ravens). The most serious threat from predation probably varies temporally, spatially, and with size of the tortoise (Berry, 1990, as amended), but few studies have quantified mortality rates attributable to predators at specific sites (Boarman, 2002).

Indirect threats affect tortoise populations primarily through habitat changes (e.g., drought, livestock grazing, recreational activities). Peterson (1994), for example, speculated that drought-induced stress in combination with other threats (e.g., disease, predation) results in significant tortoise mortality, but little empirical data exists to support the hypothesis. Livestock grazing is also hypothesized to have direct and indirect effects on tortoise populations. Mortality can occur from crushing the animals or their burrows (Balph & Malecheck, 1985; Berry, 1978), or from vegetation changes (Nicholson & Humphreys, 1981), soil compaction (Gifford & Hawkins, 1978), and competition for food (Avery, 1998). Findings from these studies, however, are sometimes mixed and direct causal inference regarding the impacts of livestock grazing on desert tortoises remains incomplete. Similar to other threats, recreation activities (e.g., Off-Highway Vehicles [OHV], hiking) can influence the stability of desert tortoise populations in multiple ways. Off-highway vehicles can directly crush a tortoise on the surface or in their burrows. Bury & Luckenbach (1986), for example, found fewer tortoises and active burrows in an area where OHVs were allowed than in a comparable control area where OHVs were not allowed. Hikers who handle desert tortoises, either because they are curious or to remove them from harm (e.g., a road), can also have negative indirect impacts on the animal. When tortoises are handled they sometimes void the contents of their bladders. The loss of this important fluid is thought to be potentially fatal (Averill-Murray, 1999), especially in drought years.

These examples (see Boarman, 2002, for a complete review) highlight the complex direct and indirect interactions that occur between desert tortoises and humans, and suggest the speculative nature of much of the existing ecological literature. At least four factors limit biological studies and introduce difficulties in identifying human impact (Wall & Wright, 1977, Vaske, Decker, & Manfredo, 1995): (a) there are often no baseline data for comparison to natural conditions; (b) it is difficult to disentangle the roles of humans and nature; (c) there are spatial and temporal

discontinuities between cause and effect; and (d) in light of complex ecosystem interactions, it is difficult to isolate individual components. Some impacts take the form of naturally occurring processes that have been accelerated by human interference. Even without human activity, however, severe impacts can occur because of natural fluctuations and disturbances that render effects associated with humans insignificant.

Study Objectives

Although the biological research on desert tortoises has limitations, the social research is virtually non-existent. This study, the "Desert Tortoise Public Attitude and Public Outreach Effectiveness" study was designed to obtain baseline information that will facilitate the development and implementation of an education program to build public support for and involvement in the desert tortoise recovery effort.

Wildlife agencies attempt to inform and educate their publics about wildlife-related topics (Eschenfelder, 2006). The ability to successfully inform and educate is dependent on: (a) source, (b) receiver, (c) channel, and (d) message factors (Ajzen, 1992). Source factors are the observed or inferred characteristics of the communicator (e.g., state and federal agencies) and include issues related to agency credibility and trust (Frewer & Miles, 2003; Trumbo & McComas, 2003). Receiver factors include characteristics of message recipients (e.g., off-highway vehicle owners, hikers) such as their demographic profiles. Channel factors are the different modes of communication (e.g., brochures, websites, personal interactions). Message factors refer to ways in which information is presented and communicated (e.g., one-sided versus two-sided arguments). Combining these factors provides a context for contributing to the effectiveness of persuasive communication efforts (Ajzen, 1992).

Knowledge is an important component of information processing and decision-making (Johnson & Russo, 1984; Raju, Lonial, & Mangold, 1995). For example, hunters' knowledge about a potential relationship (or the lack thereof) between chronic wasting disease and human heath has been shown to influence how they think about the disease and the types of management strategies that they deem appropriate (Vaske, Needham, Stafford, Green & Petchenik, 2006). Past research (e.g., Berkes, 1993; Roepstorf, 2000; Wilson, 2003) highlights differences in knowledge between scientists and the public. The public often bases knowledge on local information sources, whereas scientists typically rely on empirically grounded information (e.g., Sjöberg, 1999; Thompson & Dean, 1996). This difference may lead these groups to view issues in fundamentally different ways and can result in communication breakdowns. Given the complexities of the biological data on desert tortoises, baseline information on the publics' knowledge is necessary to develop effective communication strategies.

The specific objectives of this report were to examine the relationships between the publics' knowledge of the desert tortoise and:

1. prior visitation to and recreation activity participation in the Mojave Desert
2. perceived threats to the desert tortoise population
3. acceptability of alternative management strategies for protecting the desert tortoise
4. attitudes and normative beliefs regarding the desert tortoise and endangered species
5. trust in federal / state agencies involved in desert tortoise recovery efforts
6. willingness to limit desert-related recreation activities to help protect the desert tortoise
7. support for efforts to recover the desert tortoise and endangered species in general
8. sources used to obtain information about the desert tortoise
9. membership in environmental / off-highway vehicle groups
10. demographics (e.g., age, sex, education, income, place of residence, ethnicity, race).

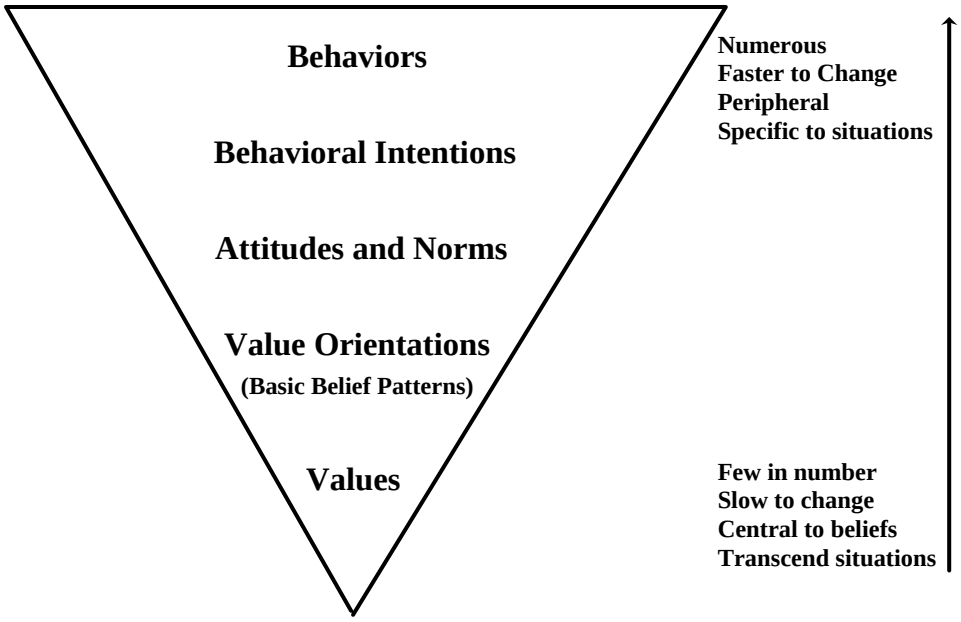
Appendices included in the report examine these same variables relative to: (a) OHV ownership (Appendix C) and (b) residence in the California desert (Appendix D). We also analyze two models that predict the publics' willingness to: (a) limit desert recreation activities to help protect the desert tortoise, and (b) support or oppose government efforts to recover the desert tortoise. The conceptual foundation for these models follows.

Conceptual Framework

Popular media commonly assert that values influence environmental attitudes and / or behaviors, but empirical evidence showing direct predictive validity is sparse. Stern (2000), for example, suggests that basic environmental beliefs have varying effects on specific forms of environmental activism such as signing environmental petitions and recycling. Similarly, pro-environmental "values" may not predict support for wildlife management actions such as efforts to protect endangered species in a given location.

Social-psychological theories offer explanations for these disparities, suggesting that attitudes, beliefs, and norms mediate the relationships between values and behavior (Schwartz, 1992; Whittaker, Vaske, & Manfredo, 2006). These theories distinguish stable but abstract values (Rokeach, 1973; Homer & Kahle, 1988) from more specific cognitions (e.g., attitudes and norms) that evaluate objects or situations encountered in daily life (Eagly & Chaiken, 1993). These cognitions are best understood as part of a "hierarchy" from general to specific (Homer & Kahle 1988). Specific belief, attitudinal, or normative variables are more likely to predict behaviors than more general measures like values (Fishbein & Ajzen 1975, Fiske & Taylor 1991). These elements build upon one another in what has been described as an inverted pyramid (Figure 1). One research tradition has applied this "cognitive hierarchy" to evaluations and behavior associated with wildlife (Fulton, Manfredo, & Lipscomb, 1996, Tarrant, Bright, & Cordell, 1997, Manfredo, Fulton, & Pierce, 1997, Zinn, Manfredo, Vaske, & Wittmann, 1998) and forest planning issues (Vaske & Donnelly, 1999, Vaske, Donnelly, Williams & Jonker, 2001).

Figure 1. The cognitive hierarchy (Source: Vaske & Donnelly, 1999)



Values

Values represent the most basic social cognitions and differ from other elements in the model because they transcend situations and issues (Rokeach, 1973). For example, a person who holds "honesty" as a value would be expected to be honest when completing IRS tax forms, conducting business deals, or interacting with friends.

Value Orientations

Because values are abstract, linking them to more specific cognitions or behavior is difficult, leading to the inclusion of "value orientations" in the model (Bright, Manfredo, & Fulton, 2000; Fulton et al., 1996; Vaske & Donnelly, 1999; Vaske et al., 2001). Value orientations refer to patterns of "basic beliefs" about general objects, which give meaning to more abstract values (Manfredo, Teel, & Bright, 2004). For example, while values measure the extent to which people identify with abstract concepts like altruism or honesty, value orientations explore patterns of beliefs about broad classes of objects (e.g., wildlife, endangered species), which are thought to link back to underlying values-level cognitions.

With this research tradition, one wildlife value orientation focuses on a single "protection-use" continuum that is measured by the degree of agreement with a series of statements about "wildlife use" and "wildlife rights" (Fulton et al., 1996). Example statements include "Recreational use of desert environments is more important than protecting the endangered species that live there" (use) and "The rights of endangered species to live is more important than the negative effects that their recovery may have on humans" (rights).

The wildlife "protection-use" orientation is similar to the biocentric-anthropocentric value orientation continuum (Shindler, List, & Steel, 1993; Steel, List, & Shindler, 1994; Thompson & Barton, 1994; Vaske & Donnelly, 1999; Vaske et al., 2001). An anthropocentric value orientation represents a human-centered view of the non-human world (Eckersley, 1992). The approach assumes that providing for human uses and benefits is the primary aim of natural resource allocation and management, whether those uses are for commodity benefits (e.g., timber) or for aesthetic, spiritual, or physical benefits (e.g., desert recreation). The environment is seen as "material to be used by humans as they see fit" (Scherer & Attig, 1983). There is no notion that the non-human parts of nature are valuable in their own right or for their own sake. In short, an anthropocentric value orientation emphasizes the instrumental value of natural resources for human society, rather than their inherent worth (Steel et al., 1994).

In contrast, a biocentric value orientation is a nature-centered or eco-centered approach. The value of all eco-systems, species, and natural organisms is elevated to center stage. Human desires and human values are still important, but are viewed from a larger perspective. This approach assumes that environmental objects have inherent as well as instrumental worth and that human economic uses and benefits are not necessarily the most important uses of natural resources. In matters of natural resource management, these inherent values are to be equally respected and preserved, even if they conflict with human-centered values (Thompson & Barton, 1994).

Biocentric and anthropocentric value orientations are not mutually exclusive. Rather, these value orientations can be arranged along a continuum with biocentric viewpoints on one end and anthropocentric orientations on the other. The mid-point of this scale represents a mixture of the two extremes. Research conducted in Colorado (Vaske & Donnelly, 1999; Vaske et al., 2001) and Oregon (Shindler et al., 1993; Steel et al., 1994) supports this conceptual continuum.

Depending on the author, these latent constructs (i.e., protection-use, biocentric-anthropocentric) have been labeled general environmental values, value orientations, general attitudes, and even "world views." Regardless of the label, each concept fundamentally measures an underlying general "environmental values" dimension.

Attitudes

Value orientations are predicted to influence a person's attitudes (Homer & Kahle, 1988; Manfredo et al., 1997). Attitudes have been scientifically investigated by social psychologists for half a century and have been used extensively in human dimensions research (see Manfredo et al., 2004, for a review). Although alternative definitions of the concept have appeared in the literature, most definitions agree that an attitude (a) is a mental state reflected by cognitive (beliefs) and affective (e.g., emotions) components and (b) must refer to some object such as endangered species or desert tortoises (Eagly & Chaiken, 1993). Attitudes represent an individual's consistent tendency to respond favorably or unfavorably toward the object in question. As measured in survey research, such affect is typically defined on scales ranging from positive to negative evaluations (Fishbein & Ajzen, 1975).

Research has addressed the correspondence between expressed attitudes and subsequent behavior. One influential line of research in the area of attitude-behavior correspondence has centered on the Theory of Reasoned Action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). Research conducted within this theoretical framework has demonstrated that specific attitudes can be strong predictors of specific behaviors (Eagly & Chaiken, 1993; Fishbein & Manfredo, 1992). According to the Theory of Reasoned Action, the most direct predictor of a behavior is the intention to engage in that behavior. Once a behavior of interest is identified, analysis of the determinants of the intention to perform the behavior is often identical to an analysis of the determinants of the behavior itself (Fishbein & Manfredo, 1992). In the study here, two behavioral intentions were examined: (a) willingness to limit desert recreation activities to help protect the desert tortoise, and (b) support or opposition for government efforts to recover the desert tortoise.

Norms

Norms are standards that individuals use to evaluate whether behavior or conditions should occur (Vaske & Whittaker 2004) or judgments about appropriate actions in a specific situation (Wittmann, Vaske, Manfredo, & Zinn, 1998, Zinn et al., 1998). Like attitudes, norms have both cognitive and affective components, and vary in their ability to influence behavior (Heywood, 2002). The norm activation model (Schwartz 1968, 1973, 1977), for example, suggests that norms only influence behavior when certain conditions are met. First, individuals need to be *aware of the consequences* (AC) their behavior has on others or the environment. Second, individuals must *ascribe responsibility* (AR) for their actions to themselves. AC and AR are predicted to influence how situations are evaluated, the extent of *norm activation*, and whether behavior will change.

Although the norm activation model was initially used to explain norm-behavior consistency in helping behaviors (Schwartz, 1973, 1977), its applicability to environmental behavior is well demonstrated. Heberlein (1972) argued that decisions regarding the environment have become a moral issue, and that the collective effect of individual behaviors is important. Increasing concern over greenhouse effects, for example, illustrates how heightened awareness of, and personal responsibility for, global warming consequences (e.g., flooding of coastal areas due to

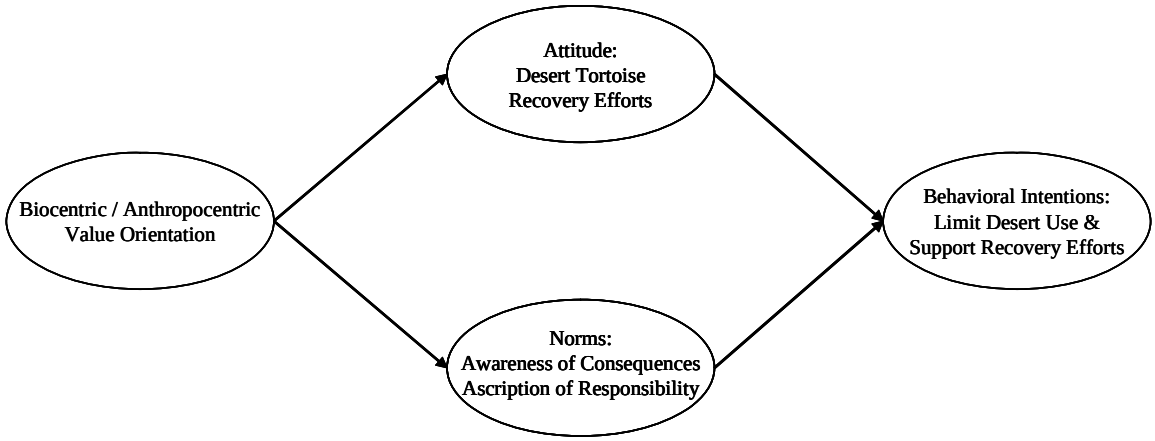
rising sea levels, increased skin disease) has stimulated efforts to reduce potentially harmful emissions.

Research has documented the utility of the AC and AR constructs in predicting behavioral changes or evaluations of those behaviors. Specific issues have included recycling (Hopper & Nielsen, 1991); littering, the purchase of lead-free gasoline, and other energy conserving behavior (Heberlein, 1971); environmental conservation behavior (Black, 1978); support for environmental laws and regulations with links to moral judgments about government and industry responsibilities (Stern, Dietz, & Black, 1986); yard burning (Van Liere & Dunlap, 1978); and water pollution related to human waste dumped by boaters (Cottrell & Graefe, 1997).

Norm variables examine acceptability evaluations (what a person, group or institution should do), while attitude measures focus on positive or negative evaluations. While there are measurement and conceptual distinctions between attitudes and norms, both are fundamentally evaluative variables that can vary considerably by the specificity of their object. For example, if the object is "desert tortoises," the evaluation reflects the mix of cognitions that form a general attitude or norm. If the object is "efforts to recover desert tortoise populations in the Mojave Desert in 2007," the evaluation reflects a narrower context and time frame, and thus a more specific evaluation. The specificity of the norm or the attitude is critical for determining whether they will accurately predict behavior.

In the cognitive hierarchy model examined here (Figure 2), value orientations influence both attitudes and norms. Attitudes and norms are hypothesized to influence individual behavioral intentions (i.e., limiting recreational use) and evaluations of agency actions (i.e., support for desert tortoise recovery efforts). Zinn et al. (1998), for example, found that individuals on the protection end of the protection-use continuum were less willing to have agencies destroy an animal (a norm) across three different wildlife species (beavers, coyotes, mountain lions) and situation contexts (e.g., seeing the animal in a residential area, human injury or death caused by wildlife). Respondents on the use end of the continuum were more accepting of this management response.

Figure 2. Value-attitude-behavior model predicting intentions toward desert tortoises



Methods

Sampling Design

This study used mail and phone surveys to collect the information. The Colorado State University Human Dimensions in Natural Resources Unit developed the survey in cooperation with representatives from the Department of Interior and selected stakeholder groups (e.g., OHV and conservation group members). The questionnaire was pre-tested before conducting the surveys. A random sample of the California general public who resided in five counties (i.e., Imperial, Kern, Los Angeles, Riverside, San Bernardino) in and around the Mojave Desert was purchased from Survey Sampling Inc. (n = 1,200). The California Department of Motor Vehicles provided a random sample of names and addresses of OHV license holders (n = 1,200) from the five counties.

Data collection for the mailed survey involved: an initial mailing of the survey, a post card reminder, and a final survey mailing to non-respondents. Twelve percent (n = 114) of the general public sample and 10% (n = 97) of the OHV sample completed the mail survey, resulting in an overall response rate of 11% (n = 211) (Table 1). Although this response rate is low, it is consistent with other recent human dimensions mail surveys conducted in California. Teel, Dayer, Manfredo, and Bright (2005), for example, reported a 13% response rate from California residents using mailing procedures identical to those in this study.

To improve the response rate, phone surveys were conducted with individuals who did not respond to the mail survey. A total of 542 individuals in the general sample, and 258 people in the OHV sample completed the phone interview. Using the Council of American Survey Research Organizations' (CASRO) estimator (Frankel et al., 1982), the response rates for the phone survey were 64% (general public sample) and 31% (OHV sample). The total sample size was 1,011 and the overall response rate was 53%.

Table 1. Mail and phone survey response rates

	General Public Sample	OHV Sample	Total
Mail survey			
Number mailed	1200	1200	2400
Undeliverable	234	258	492
Total usable sample	966	942	1908
Number completed mail surveys	114	97	211
Response rate (Total usable / number returned)	12%	10%	11%
Phone survey			
Foundation for phone survey (non-respondents to mail survey)	852	845	1697
Number completed phoned surveys	542	258	800
Response rate (CASRO formula)	64%	31%	47%
Overall			
Total sample (combined mail & phone)	656	355	1011
Overall response rate	68%	38%	53%

Ancillary analyses compared the responses from the mail and phone samples. Results indicated that the two samples did not statistically differ ($p > .05$) on any of the key analysis variables in the survey. Cramer's *V* and point-biserial correlations (r_{pb}) effect sizes were less than .10, indicating only minimal (Vaske, Gliner, & Morgan, 2002) or weak (Cohen, 1988) differences between the two samples. For these reasons, the mail and phone samples were combined for purposes of this report.

Of the 656 individuals in the general public sample, a substantial number: (a) owned at least one OHV, (b) participated in OHV-related desert activities, or (c) both owned and participated in OHV activities. Given this overlap in the two strata, the general public and OHV samples were not compared. Appendix C, however, contrasts the responses of OHV owners who recreated in the desert with their vehicles and non-OHV owners.

Data Weighting Strategy

To better reflect the actual population of individuals living in the five counties included in this study, the sample was weighted by U.S. Census 2000 data (U.S. Census Bureau, 2000). Four weighting variables were used: (a) county (i.e., Imperial, Kern, Los Angeles, Riverside, San Bernardino), (b) ethnicity (Hispanic vs. Non-Hispanic), (c) sex (male vs. female), and (d) age (18-29, 30-39, 40-49, 50-59, 60-69, 70+). The combination of these four variables and their associated levels resulted in 120 cells (i.e., 5 counties * 2 levels of ethnicity * 2 levels of sex * 6 age categories = 120). The population size and population percent for these 120 cells were based on Census 2000 data. The percent of the sample in these cells was based on the survey data. Weights were calculated using the formula:

$$\text{Weight} = \frac{\text{Population \%}}{\text{Sample \%}}$$

Details on the actual weights are described in Appendix B. For analysis, the weighted number of cases should equal the unweighted number of cases and the mean of the weights should be 1 (Glynn, 2004). If the weighted number of cases differs dramatically from the unweighted number of cases, significance tests may not be valid. To address this issue, the weights were adjusted by dividing the weight by the mean of the weights:

$$\text{Adjusted Weight} = \frac{\text{Weight}}{\text{Mean of the Weights}}$$

Using this strategy, the relative values of the weights are not changed, but they are normalized to have a mean of 1 and the sum of the weights equals the number of cases.

Variables Measured

The 9-page survey included questions on a range of topics (e.g., prior visitation, activity participation, awareness of the desert tortoise, support for recovery efforts). The actual survey wording and basic descriptive findings are presented in Appendix A.

The primary independent variable for most analyses in this report was the respondents' level of knowledge about the desert tortoise. Other variables in the survey were considered dependent measures. Appendix C compares OHV owners who recreate in the Mojave Desert with their vehicles against non-OHV owners on all of the dependent variables. Appendix D includes similar tables for individuals who live in the California desert (yes or no).

Results

Knowledge about Desert Tortoises

The survey included 10 true – false desert tortoise-related statements. Responses were coded as "correct," "incorrect" or "unsure." None of the respondents answered all 10 questions correctly. The number of correct responses given by each individual was used to compute a knowledge level variable. Respondents who answered between 0 and 2 questions correctly (n = 314, 34%) were considered to have "low" knowledge (Table 2). Individuals with 3 to 5 correct responses (n = 406, 44%) were labeled as having "medium" knowledge, and those answering between 6 and 8 questions correctly (n = 200, 22%) were assigned to the "high" knowledge category.

Table 2. Respondents' knowledge level

Knowledge level	Number of Correct Responses	Number of Respondents	Percent of Respondents
Low	0 – 2	314	34
Medium	3 – 5	406	44
High	6 – 8	200	22

Partial validation for the three knowledge categories is provided in Table 3. The percent of correct responses for 9 of the 10 statements comprising the knowledge scale increased significantly from low to medium to high knowledge levels. The one exception (i.e., "desert tortoises may live to 100 years or longer") followed the same pattern of correct responses (i.e., 0% - low, 4% - medium, 5% - high), however, over 70% of the respondents in each of the knowledge categories answered the question incorrectly.

Columns 4 (χ^2) and 5 (p-value) in Table 3 indicate that the 10 distributions for each of the specific true-false statements differed statistically by the 3-level knowledge scale. *In general, when the p-value associated with any of the statistical tests (i.e., χ^2, F-value) presented in this report is $\leq$ .05, a statistically significant relation was observed between the independent and dependent variables.* All 10 p-values in Table 3 were < .001.

In addition to tests of statistical significance, we used Cramer's V to compare the strength of the relationships. *A value of .1 on this effect size statistic can be considered a "minimal" (Vaske et al., 2002) or "weak" relationship (Cohen, 1998). A Cramer's V of .3 is considered "typical" and effect sizes of .5 or greater are "substantial" relationships. These rules of thumb (i.e., .1 = minimal, .3 = typical, .5 = substantial) apply to all effect sizes (i.e., Cramer's V, eta) reported here. Larger effect sizes imply a stronger relationship.*

The effect sizes in Table 3 ranged from .151 (desert tortoises may live to 100 years or longer) to .466 (Desert tortoises build up most of their fat and water reserves during the spring). The average effect size in Table 3 was .366, with five of the effect sizes greater than .4.

Table 3. Specific knowledge indicators by overall knowledge

	Knowledge Level					
	Low (%)	Medium (%)	High (%)	χ^2	*p*-value	Cramer's *V*
The desert tortoise is the California state reptile				173.84	< .001	.292
Correct	14	43	63			
Incorrect	21	7	0			
Unsure	65	50	37			
Desert tortoises hibernate from October through February				397.75	< .001	.436
Correct	15	65	94			
Incorrect	0	1	0			
Unsure	85	34	6			
Desert tortoises may live to 100 years or longer				49.54	< .001	.151
Correct	0	4	5			
Incorrect	71	83	80			
Unsure	29	13	15			
Adult desert tortoises are typically longer than 20 inches				156.87	< .001	.292
Correct	30	36	62			
Incorrect	18	42	29			
Unsure	52	22	9			
Desert tortoises spend only a small percent of their time in their burrows				360.38	< .001	.411
Correct	5	40	66			
Incorrect	12	21	25			
Unsure	83	39	9			
Desert tortoises do not need water to survive				292.37	< .001	.380
Correct	1	12	48			
Incorrect	60	68	52			
Unsure	39	20	0			
Desert tortoises eat mainly plants such as grasses and flowers				224.48	< .001	.333
Correct	52	87	95			
Incorrect	2	3	5			
Unsure	46	10	0			
The summer sun can kill an unsheltered desert tortoise within an hour				435.16	< .001	.449
Correct	2	32	73			
Incorrect	17	28	23			
Unsure	81	40	4			
Desert tortoises build up most of their fat and water reserves during the spring				458.66	< .001	.466
Correct	7	50	91			
Incorrect	0	6	0			
Unsure	93	44	9			
Desert tortoises may be active any time of the year following a rainfall				429.23	< .001	.451
Correct	3	29	72			
Incorrect	1	14	14			
Unsure	96	57	14			

Prior Desert Recreation Experience

Individuals with higher knowledge about the desert tortoise spent more days (*M* = 59.96 days) recreating in the Mojave Desert than respondents in the other two knowledge categories (*M* = 15.79 days for low and *M* = 24.54 days for medium, Table 4). The *F*-value (37.75) was statistically significant ($p < .001$) and the effect size (eta) was .299, indicating a typical or medium relationship. The superscripts displayed on the means associated with average days of recreation participation in the Mojave Desert were all different (i.e., a, b, c). This indicates that the three means differed statistically from each other. *Throughout this report, means with different superscripts differ significantly from each other.*

Respondents with a high level of knowledge about the desert tortoise were also more familiar with the Mojave Desert (*M* = 6.77) than either the medium (*M* = 5.19) or low (*M* = 5.05) groups. As indicated by the identical superscripts (i.e., a), the means for these latter two groups did not differ significantly. The effect size reflected a typical relationship (eta = .277). There were no statistical differences between the three knowledge groups for the average number of days recreating in other desert areas, $F = 2.25$, $p = .106$, eta = .082.

Table 4. Prior experience by knowledge

	Knowledge Level [1]					
Prior recreation experience	Low	Medium	High	*F*-value	*p*-value	eta
Average days recreating in Mojave Desert [2]	15.79 [a]	24.54 [b]	59.96 [c]	37.35	< .001	.299
Familiarity with the Mojave Desert [3]	5.05 [a]	5.19 [a]	6.77 [b]	38.12	< .001	.277
Average days recreating in other desert areas [4]	22.32	14.95	24.80	2.25	.106	.082

1. Means with different superscripts differ statistically at $p < .05$.
2. Variable coded from fill-in-the-blank responses.
3. Variable coded on a 9-point scale ranging from (1) not at all familiar to (9) extremely familiar.
4. Variable coded from fill-in-the-blank responses.

With the exception of visitation to California State Parks, there were statistical differences among the three knowledge categories for visits to National Park Service (NPS), Bureau of Land Management (BLM), and U.S. Fish and Wildlife Service (FWS) areas (Table 5). Two-thirds or more of all respondents, however, had visited California State Parks, National Parks and BLM properties within the Mojave Desert. The effect sizes for all of these relationships were minimal.

Table 5. Types of areas visited within the Mojave Desert by knowledge

	Knowledge Level [1]					
Areas visited	Low (%)	Medium (%)	High (%)	χ^2	*p*-value	Cramer's *V*
California State Parks	75	70	69	2.78	.250	.055
National Park Service	74	66	79	11.86	.003	.113
Bureau of Land Management	78	82	93	20.87	< .001	.141
U.S. Fish & Wildlife Service	41	37	48	7.10	.029	.088
I have never visited the Mojave Desert	2	7	1	24.33	< .001	.155

1. Variables coded as "yes" or "no." Percent yes is reported.

Desert Recreation Activities

The survey included 15 statements regarding typical yearly participation in specific recreation activities in California desert areas (Table 6). The original scales for these variables were coded as 0 = 0, 1 = once, 2 = 2 times, 3 = 3 to 5 times, 4 = 6 to 10 times, 5 = 11 to 20 times, 6 = 21 to 30 times, and 7 = 31+ times. For analysis purposes, values representing a range of participation times were recoded to the mid-point of the range (e.g., 6 to 10 was recoded to 8); for 31+ times, the value was coded as 31. Although this latter coding scheme results in a conservative estimate, relatively few individuals (< 5%) on average participated 31 or more times in the activities.

We grouped these activities into four general categories. The "viewing" category included viewing scenery, scenic driving, wildlife viewing, birding, and photography. The OHV category included driving off-highway motorcycles, all terrain vehicles, 4-wheel drive vehicles, dune buggies or rails. Our "physical" recreation category included hikers, mountain bikers, and climbers. The last category, "consumptive" was represented by rock hounders, prospectors, and hunters.

Table 6. Reliability of desert participation indicators

Type of Activity [1]	Mean	Standard Deviation	Corrected Item-Total Correlation	Alpha If Item Deleted	Cronbach Alpha
Viewing					.78
Scenic driving	7.61	9.92	.46	.76	
Viewing scenery	6.39	9.70	.71	.65	
Wildlife viewing	3.73	7.79	.54	.72	
Birding	1.36	5.26	.45	.76	
Photography	2.97	7.07	.61	.71	
OHV					.85
Off-highway motorcycle	7.38	11.12	.65	.81	
All Terrain Vehicle (ATV)	6.33	9.88	.80	.73	
4-wheel drive vehicle	6.16	9.77	.73	.77	
Dune buggy / rail	2.45	6.56	.55	.85	
Physical					.66
Hiking	4.42	7.38	.50	.47	
Mountain biking	1.41	4.30	.47	.39	
Climbing	0.79	2.53	.44	.54	
Consumptive					.56
Rock hounding	0.91	3.79	.31	.32	
Prospecting	0.39	2.16	.45	.28	
Wildlife hunting	1.22	4.79	.23	.56	

1. Variables coded 8-point scales: 0 = 0, 1 = once, 2 = 2 times, 3 = 3 to 5 times, 4 = 6 to 10 times, 5 = 11 to 20 times, 6 = 21 to 30 times, and 7 = 31+ times.
For items representing a range of participation times, the mid-point of range was used in the calculations (e.g., 6 to 10 was recoded to 8). For 31+ times, the value was coded as 31.

Among the viewing activities, scenic driving (*M* = 7.61 times per year) and viewing scenery (*M* = 6.39) were the most popular desert activities (Table 6). Given that our sampling included individuals who had purchased an off-highway vehicle license from the California Department of Motor Vehicles, it is not surprising that respondents participated between 6 and 7 times per year for 3 of the 4 OHV activities (i.e., off-highway motorcycles, ATVs, 4-wheel drive vehicles). Of the physical recreation activities, respondents participated more often in hiking (*M* = 4.42) than mountain biking (*M* = 1.41) and climbing (*M* = 0.79). Relatively few individuals participated in hunting, rock hounding or prospecting.

The measurement reliability of the four groupings of recreation activities was examined using Cronbach's alpha. This test statistic measures the internal consistency of the variables associated with a given concept (e.g., viewing activities). *Cronbach's alpha is based on the average correlation among the items and can range from 0 (no measurement reliability) to 1 (perfect measurement reliability). An alpha of .65 is generally viewed as acceptable*.

The Cronbach's alpha for the viewing activities was .78. Deleting any of the items from the scale did not improve the overall reliability (see column labeled "alpha if item deleted" in Table 6). *The corrected item total correlations represent the correlation between the score on a given variable (e.g., viewing scenery) and the sum of the other variables associated with the concept (i.e., viewing in this example). In general, these corrected item total correlations should be* $\geq$ *.4.* All of the items in the viewing scale meet this criterion. Overall, the reliability statistics for the viewing concept suggest that the five variables can be combined into a single index.

The reliability statistics (i.e., corrected item total correlations, alpha if item deleted, Cronbach's alpha) for OHV and physical activities also met the requirements for combining the variables associated with these activities into the concepts. For example, the Cronbach's alpha for OHV activities was .85; the alpha for physical activities was .66. The overall alpha for consumptive activities was .56, but still reflected a reasonable amount of internal consistency.

Participation in viewing, physical, and consumptive activities increased with increasing knowledge of the desert tortoise, $F > 18.15$, $p < .001$, for all three concepts (Table 7). For example, respondents in the low knowledge category participated in viewing activities an average of 3.14 times per year, compared to 4.96 times for the medium and 6.63 for the high knowledge groups. For the OHV activities, the medium knowledge group participated less than the low and high knowledge respondents. There was no difference in times visiting the desert with an OHV for the low and high groups; each group visited about seven times.

Table 7. Desert activities by knowledge

	Knowledge Level [1]					
Type of Activity	Low	Medium	High	*F*-value	*p*-value	eta
Viewing [2]	3.14 [a]	4.96 [b]	6.63 [c]	22.50	< .001	.216
OHV [3]	7.03 [a]	4.78 [b]	7.05 [ab]	9.24	< .001	.141
Physical [4]	1.52 [a]	2.49 [a]	3.60 [c]	44.31	< .001	.195
Consumptive [5]	0.20 [a]	0.77 [b]	2.38 [c]	18.15	< .001	.297

1. Means with different superscripts differ statistically at $p < .05$.
2. Composite variable constructed from the average of scenic driving, viewing scenery, wildlife viewing, birding, and photography.
3. Composite variable constructed from the average of off-highway motorcycling, ATV, 4-wheel driving, dune buggy / rail.
4. Composite variable constructed from the average of hiking, mountain biking, and climbing.
5. Composite variable constructed from the average of rock hounding, prospecting, and hunting.

Awareness of and Encounters with Desert Tortoises

Table 8 examines the respondents' awareness of and encounters with desert tortoises by knowledge level. Nearly all individuals in the three knowledge categories had heard of the desert tortoise prior to receiving the survey. Slightly less than half (47%) of the low knowledge respondents had ever seen a desert tortoise in the wild, compared to 55% of the medium and 80% of the high knowledge groups, $\chi^2 = 64.87$, $p < .001$, Cramer's $V = .179$. Over two thirds of the individuals in all three knowledge categories were aware of someone who has picked up a desert tortoise in the wild. Eighty percent or more of all respondents did not know anyone who has taken a desert tortoise from the wild.

More of the individuals in the high knowledge category (48%) knew someone who had adopted a wild desert tortoise as a pet, when compared to either the medium (32%) or low (18%) knowledge groups, $\chi^2 = 82.00$, $p < .001$, Cramer's $V = .207$. Very few individuals in any of the knowledge categories admitted to knowing someone who had released a pet desert tortoise into the wild.

Table 8. Awareness of and encounters with the desert tortoise by knowledge

	Knowledge Level					
	Low (%)	Medium (%)	High (%)	χ^2	*p*-value	Cramer's *V*
Prior to receiving this survey, had you ever heard of the desert tortoise?				5.03	.284	.048
No	3	3	1			
Yes	97	97	99			
Unsure	0	0	0			
Have you ever seen a desert tortoise in the wild?				64.87	< .001	.179
No	51	43	20			
Yes	47	55	80			
Unsure	2	2	0			
Do you know anyone who has picked up a desert tortoise in the wild?				25.06	< .001	.113
No	67	74	81			
Yes	31	26	19			
Unsure	2	0	0			
Do you know anyone who has taken a desert tortoise from the wild?				53.86	< .001	.174
No	80	88	90			
Yes	4	9	8			
Unsure	16	3	2			
Do you know anyone who has adopted a wild desert tortoise as a pet?				82.00	< .001	.207
No	77	68	52			
Yes	18	32	48			
Unsure	5	0	0			
Do you know anyone who has released a pet desert tortoise into the wild?				37.11	< .001	.135
No	96	89	95			
Yes	1	9	3			
Unsure	3	2	2			

Perceived Threats to Desert Tortoises

The survey included 16 variables addressing perceived threats to the desert tortoise population. Individuals rated each threat on 7-point scales ranging from (1) not at all a threat to (7) extreme threat. Six of the items referred to human impacts (e.g., OHVs or hikers unintentionally disturbing tortoises, collecting by humans) and had a reliability coefficient of .90 (Table 9). Deleting any specific variable from the *human threats* index did not improve the reliability. Two questions addressed *natural threats* (i.e., drought, lack of nutritional food); the Cronbach's alpha = .78. Impacts caused by *other animals* was measured using four variables (i.e., being eaten by feral dogs or ravens, grazing, competition for habitat with other wildlife) (alpha = .76). Two variables (i.e., habitat loss due to human development or agriculture) constituted a *habitat loss* index with a Cronbach's alpha of .83. Each of these indices thus met the requirements for reliability. The final two threats (i.e., pesticides and disease) were retained as single-item variables.

Table 9. Reliability of perceived threat indicators

Type of Threat [1]	Mean	Standard Deviation	Corrected Item-Total Correlation	Alpha If Item Deleted	Cronbach Alpha
Human					.90
OHVs unintentionally disturbing tortoises	4.08	2.07	.81	.88	
Hikers unintentionally disturbing tortoises	3.43	1.86	.78	.88	
Road kill due to tortoises crossing roads	4.55	1.96	.72	.89	
Collecting by humans	4.26	1.94	.78	.88	
Hunting	3.13	2.01	.72	.89	
Military training in the desert	4.43	1.89	.62	.90	
Nature					.78
Drought	4.71	1.81	.64	*	
Lack of nutritional food	4.46	1.98	.64	*	
Other animals					.76
Being eaten by feral dogs	4.06	1.92	.65	.64	
Being eaten by ravens	4.79	2.07	.58	.68	
Competition for habitat with other wildlife	4.14	1.85	.45	.75	
Cattle / sheep grazing	3.27	2.00	.53	.71	
Habitat loss					.83
Habitat loss due to human development	5.24	1.92	.71	*	
Habitat loss due to agriculture	4.78	2.00	.71	*	

1. Variables coded on 7-point scales ranging from (1) not at all a threat to (7) extreme threat.

Table 10 examines the perceived threats relative to respondents' knowledge levels. Across all respondents each of the threats were viewed on average as a 4 (i.e., the mid-point of the scale) or higher. Four of the six relationships varied by knowledge. For example, humans, other animals and disease were viewed as more threatening to the desert tortoise by individuals in the high knowledge category when compared to the low knowledge group. Respondents in the low knowledge category believed pesticides or other toxic chemicals were more of a threat than those in the other two groups. The three groups did not differ on natural threats or habitat loss.

Table 10. Perceived threats by knowledge

	Knowledge Level [1]					
Perceived threats [2]	Low	Medium	High	*F*-value	*p*-value	eta
Human [3]	4.01 [a]	4.14 [a]	4.67 [b]	10.26	< .001	.155
Nature [3]	4.67	4.62	4.95	2.43	.089	.077
Other animals [3]	4.11 [a]	4.47 [b]	4.73 [b]	9.51	< .001	.148
Habitat loss [3]	4.93	5.03	5.28	2.32	.099	.073
Pesticides or other toxic chemicals [4]	5.58 [a]	4.38 [b]	4.90 [c]	25.33	< .001	.247
Disease [4]	4.91 [a]	5.12 [ab]	5.45 [b]	5.47	.004	.119

1. Means with different superscripts differ statistically at $p < .05$.
2. Variables coded on 7-point scales ranging from (1) not at all a threat to (9) extreme threat.
3. Composite variables constructed from the items shown in Table 9.
4. Single-item variable.

Habitat loss by human development was considered the one main threat by at least 30% of all respondents (Table 11). Nearly 30% of individuals in the high knowledge category viewed ravens as the most serious threat, compared to a fifth of respondents in the medium knowledge group and a tenth of people assigned a low knowledge score. Lack of nutritional food (11% - low knowledge) and off-highway vehicles unintentionally disturbing tortoises (11% - medium knowledge) were the only other items judged as the one main threat by more than 10% of the sample.

Table 11. One main threat to desert tortoise populations by knowledge

	Knowledge Level		
One main perceived threat	Low (%)	Medium (%)	High (%)
Habitat loss due to human development	43	40	30
Lack of nutritional food	11	1	0
Being eaten by ravens	10	20	29
Drought	8	2	8
Pesticides or other toxic chemicals	7	2	4
Road kill due to tortoises attempting to cross roads	6	5	2
Collecting by humans	5	5	2
Off-highway vehicles unintentionally disturbing tortoises	3	11	4
Military training in the desert	3	1	0
Disease	2	4	9
Competition for habitat with other wildlife	1	0	2
Cattle / sheep grazing	1	1	0
Being eaten by feral dogs	0	6	2
Habitat loss due to agriculture	0	1	5
Hunting	0	1	1
Hikers unintentionally disturbing tortoises	0	1	0

$\chi^2 = 257.32$, $p < .001$, Cramer's $V = .364$

Beliefs about Endangered Species Act and Desert Tortoise Populations

Prior to receiving the survey, at least 9 out of 10 respondents in the medium and high knowledge groups had heard of the Endangered Species Act (ESA) (Table 12). About two-thirds of individuals in the low knowledge category were aware of the ESA. Individuals were asked to indicate whether the number of desert tortoises have declined dramatically in recent years. Significant differences were observed among the three knowledge classifications, $\chi^2 = 135.48$, $p < .001$, Cramer's $V = .270$. About three-quarters (73%) and two-thirds (67%) of the high and medium groups, respectively, agreed with this statement. Less than a third (32%) of the low knowledge group thought the desert tortoise population had declined.

Table 12. Awareness of Endangered Species Act (ESA) and desert tortoise declines by knowledge

	Knowledge Level					
	Low (%)	Medium (%)	High (%)	χ^2	*p*-value	Cramer's *V*
Heard of ESA prior to this survey				102.01	< .001	.222
Yes	69	90	95			
No	21	9	0			
Unsure	10	1	5			
The number of desert tortoises have declined dramatically in recent years				135.48	< .001	.270
Agree	32	67	73			
Neither	61	26	19			
Disagree	7	7	8			

Individuals in the medium ($M = 1.14$) and high ($M = 1.53$) categories were more likely to support the Endangered Species Act than those in the low knowledge group ($M = 0.70$, Table 13). Support for efforts to recover the desert tortoise increased as knowledge level increased, $F = 13.14$, $p < .001$, eta = .169. As knowledge increased, more respondents agreed that government should do more to protect desert tortoise populations. Individuals in the high knowledge category were basically neutral ($M = 0.06$) on the belief statement that land managers are doing everything they can to save the desert tortoise, whereas the low ($M = -0.50$) and medium ($M = -0.61$) groups were more likely to disagree. All three groups disagreed that the laws protecting the desert tortoise are too strict. For this question, the low ($M = -0.14$) and medium ($M = -0.18$) groups were statistically equivalent; the mean for the high knowledge group was -0.83.

Table 13. Support for management actions by knowledge

	Knowledge Level [1]					
	Low	Medium	High	*F*-value	*p*-value	eta
Do you support or oppose [2]						
The Endangered Species Act	0.70 [a]	1.14 [b]	1.53 [b]	10.63	< .001	.153
Efforts to recover the desert tortoise	1.08 [a]	1.47 [b]	1.89 [c]	13.14	< .001	.169
Beliefs about management actions [3]						
The government should do more to protect desert tortoise populations	0.15 [a]	0.85 [b]	1.40 [c]	30.34	< .001	.249
Land managers are doing everything they can to save the desert tortoise	-0.50 [a]	-0.61 [a]	0.06 [b]	16.61	< .001	.187
Laws protecting the desert tortoise are too strict	-0.14 [a]	-0.18 [a]	-0.83 [b]	12.11	< .001	.160

1 Means with different superscripts differ significantly at $p < .05$.
2 Variables coded on 7-point scales ranging from (-3) strongly oppose to (+3) strongly support.
3 Variables coded on 7-point scales ranging from (-3) strongly disagree to (+3) strongly agree.

Attitudes toward Endangered Species and Desert Tortoises

All respondents held positive attitudes toward: (a) endangered species and the desert tortoise, and (b) efforts to recover all endangered species and the desert tortoise (Table 14). As knowledge increased, these attitudes were held with more conviction.

Table 14. Attitudes toward endangered species and desert tortoises by knowledge

	Knowledge Level [1]					
Attitude [2]	Low	Medium	High	*F*-value	*p*-value	eta
Attitude towards *all endangered species*	1.09 [a]	1.64 [b]	1.94 [c]	20.19	< .001	.206
Attitude towards recovery efforts to save *all endangered species*	0.83 [a]	1.34 [b]	1.67 [b]	14.80	< .001	.177
Attitude towards the *desert tortoise*	1.12 [a]	1.67 [b]	2.38 [c]	43.05	< .001	.296
Attitude towards recovery efforts to save the *desert tortoise*	0.99 [a]	1.53 [b]	1.94 [c]	19.62	< .001	.204

1 Means with different superscripts differ significantly at $p < .05$.
2 Variables coded on 7-point scales ranging from (-3) extremely negative to (+3) extremely positive.

Acceptability of Management Actions

The acceptability of 18 specific management actions was compared by knowledge level (Table 15). All respondents believed that taking no action was unacceptable, $F = 2.25$, $p = .107$, eta = .070. On the remaining 17 items, however, the three groups statistically differed in their acceptability evaluations. The most acceptable management strategy for all three groups was to enhance native vegetation food sources for the desert tortoise, although the degree of acceptability for this action increased as knowledge level increased ($M = 0.53$ [low], $M = 1.29$ [medium], $M = 1.78$ [high]). Limiting ($M = -1.40$ [low], $M = -0.03$ [medium], $M = -0.62$ [high]) or banning ($M = -1.71$ [low], $M = -0.74$ [medium], $M = -0.78$ [high]) hikers were rated least acceptable.

For 10 of the management actions, evaluations went from negative to positive as knowledge increased:

1. vaccinate desert tortoises to control disease
2. fence roads to reduce road kills of desert tortoises
3. eliminate *ravens* that threaten juvenile desert tortoises
4. eliminate *feral dogs* that threaten desert tortoises
5. limit *new human development* in desert tortoise habitat
6. ban *cattle / sheep grazing* in some areas of desert tortoise habitat
7. ban *hunting* in some areas of desert tortoise habitat
8. limit number of *off-highway vehicles* in some areas of desert tortoise habitat
9. ban *off-highway vehicles* in some areas of desert tortoise habitat
10. ban *dual sport rides* in some areas of desert tortoise habitat

Table 15. Acceptability of specific management actions by knowledge

How acceptable is it for federal / state agencies to: [2]	Knowledge Level [1] Low	Medium	High	*F*-value	*p*-value	eta
take no action to protect the desert tortoise	-1.11	-1.38	-1.10	2.25	.107	.070
vaccinate desert tortoises to control disease	-0.29 [a]	0.93 [b]	1.37 [c]	62.38	< .001	.346
enhance native vegetation food sources for the desert tortoise	0.53 [a]	1.29 [b]	1.78 [c]	32.78	< .001	.258
fence roads to reduce road kills of desert tortoises	-0.26 [a]	0.68 [b]	0.70 [b]	21.39	< .001	.211
eliminate *ravens* that threaten juvenile desert tortoises	-1.05 [a]	-0.36 [b]	1.23 [c]	72.38	< .001	.369
eliminate *feral dogs* that threaten desert tortoises	-0.28 [a]	0.06 [a]	1.41 [b]	50.75	< .001	.316
purchase private land to slow human development in desert tortoise habitat	0.24 [a]	0.47 [a]	1.03 [b]	8.49	< .001	.135
limit *new human development* in desert tortoise habitat	-0.13 [a]	0.81 [b]	1.41 [c]	39.82	< .001	.283
limit *military training maneuvers* in some areas of desert tortoise habitat	0.05 [a]	0.45 [b]	0.52 [b]	3.98	.019	.093
ban *cattle / sheep grazing* in some areas of desert tortoise habitat	-0.53 [a]	0.41 [b]	0.86 [c]	38.52	< .001	.278
limit *agricultural uses* in some areas of desert tortoise habitat	0.03 [a]	0.56 [b]	0.68 [b]	11.01	< .001	.153
ban *hunting* in some areas of desert tortoise habitat	-0.09 [a]	0.63 [b]	0.50 [b]	9.24	< .001	.141
limit the number of *hikers* in some areas of desert tortoise habitat	-1.40 [a]	-0.03 [b]	-0.62 [c]	40.61	< .001	.285
ban *hikers* in some areas of desert tortoise habitat	-1.71 [a]	-0.74 [b]	-0.78 [b]	23.29	< .001	.220
limit number of *off-highway vehicles* in some areas of desert tortoise habitat	-0.71 [a]	0.11 [b]	0.17 [b]	12.46	< .001	.163
ban *off-highway vehicles* in some areas of desert tortoise habitat	-1.11 [a]	-0.22 [b]	0.06 [b]	16.99	< .001	.189
ban *dual sport rides* in some areas of desert tortoise habitat	-0.97 [a]	-0.02 [b]	0.08 [b]	17.33	< .001	.191
enact seasonal closures to all human activity	-1.29 [a]	-0.22 [b]	-0.27 [b]	21.41	< .001	.211

1 Means with different superscripts differ significantly at $p < .05$.
2 Variables coded on 7-point scales ranging from (-3) highly unacceptable to (+3) highly acceptable.

Potential for Conflict Index (PCI)

A goal of human dimensions research is to provide input that will improve wildlife management decision-making. When communicating results to managers, it is imperative that researchers provide clear statistical information and convey the practical implications of their findings. Basic summary statistics describe variables in terms of central tendency (e.g., mean), dispersion (e.g., standard deviation), and form (e.g., skewness) (Loether & McTavish, 1976). Although these statistics can efficiently convey meaning, an accurate understanding of a variable's distribution requires consideration of all three indicators simultaneously. The Potential for Conflict Index (PCI), was developed to facilitate understanding and interpreting statistical data (Manfredo, Vaske, & Teel, 2003; Vaske, Needham, Newman, Manfredo, & Petchenik, 2006).

The management strategy variables in this study used response scales with an equal number of response options surrounding a neutral center point. Numerical ratings were assigned in ordinal fashion with the neutral point being 0 (e.g. -3, -2, -1, 0, 1, 2, 3 where -3 = highly unacceptable, 0 = neutral, and 3 = highly acceptable.). The PCI describes the ratio of responses on either side of a rating scale's center point. The greatest possibility for conflict (PCI = 1) occurs when there is a bimodal distribution between the two extreme values of the response scale (e.g., 50% highly unacceptable, 50% highly acceptable, 0% neutral). A distribution with 100% at any one point on the response scale yields a PCI of 0 and suggests no potential for conflict. Computation of the PCI uses a frequency distribution and follows the formula:

$$\text{PCI} = \left[1 - \left| \frac{\sum_{i=1}^{n_a} |X_a|}{Xt} - \frac{\sum_{i=1}^{n_u} |X_u|}{Xt} \right| \right] * \frac{Xt}{Z}$$

where:

X_a = an individual's "acceptable" (or "favor" or "likely") score
n_a = all individuals with acceptable scores
X_u = an individual's "unacceptable" (or "oppose" or "unlikely") score
n_u = all individuals with unacceptable scores

$$Xt = \sum_{i=1}^{n_a} |X_a| + \sum_{i=1}^{n_u} |X_u|$$

Z = the maximum possible sum of all scores = *n*extreme score on scale* (e.g., $Z = 3n$ for scale with 7 response options); n = total number of subjects.

Following computation of the PCI, results are displayed as bubble graphs to visually and simultaneously describe a variable's form, dispersion, and central tendency. The size of the bubble depicts the PCI and indicates degree of dispersion (e.g., extent of potential conflict regarding the acceptability of a management strategy). A small bubble suggests little potential conflict; a larger bubble suggests more potential conflict. A standard deviation is centered on the mean while the PCI is centered on the neutral point. Although both statistics can communicate agreement, the PCI bubble graphs have a more intuitive appeal.

The center of the bubble is plotted on the Y-axis and indicates the mean response (central tendency) to the measured variable. With the neutral point of the response scale highlighted on the Y-axis, it is apparent that respondents' average evaluations are situated above or below the neutral point (i.e., the action, on average, is acceptable or unacceptable). Information about a distribution's skewness is reflected by the position of the bubble relative to the neutral point (i.e., bubbles at the top or bottom of the graph suggest high degrees of skewness).

Figures 3 through 19 display the PCI graphs for each of the management actions. Bubbles are shown for the three knowledge levels and the entire sample. The medium and high knowledge groups evaluated vaccinating desert tortoises to control disease as more acceptable and showed less dispersion in their responses (i.e., smaller bubbles) than those in the low knowledge group (Figure 3). All three groups supported enhancing native vegetation food sources, although the degree of acceptability (i.e., means) and the amount of consensus (i.e., smaller bubbles) increased, as knowledge increased (Figure 4).

Figure 3. PCI values for vaccinate desert tortoises to control disease

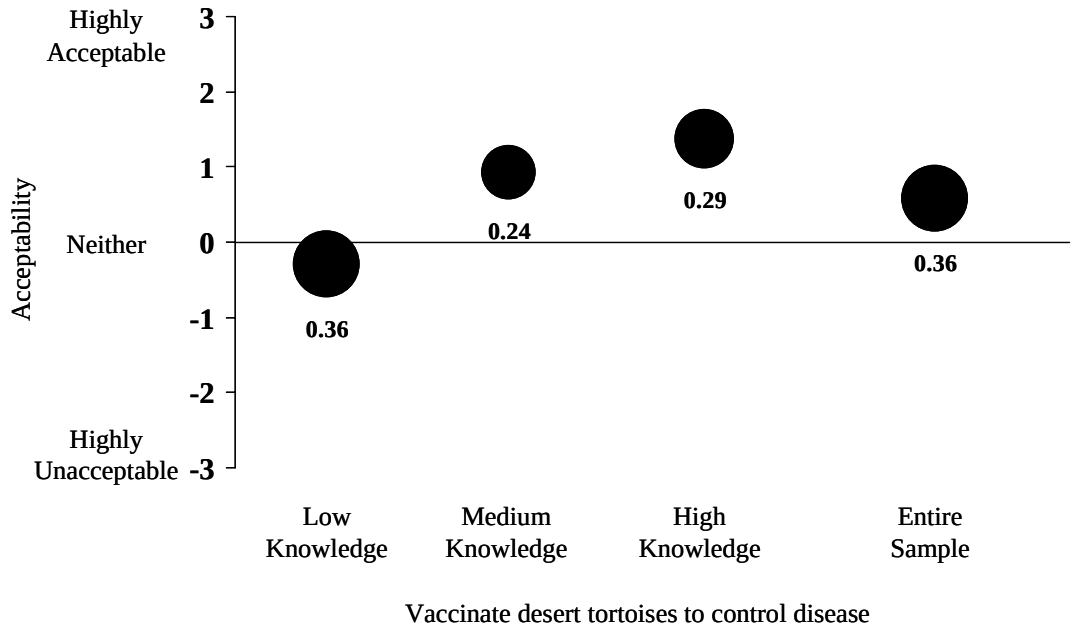
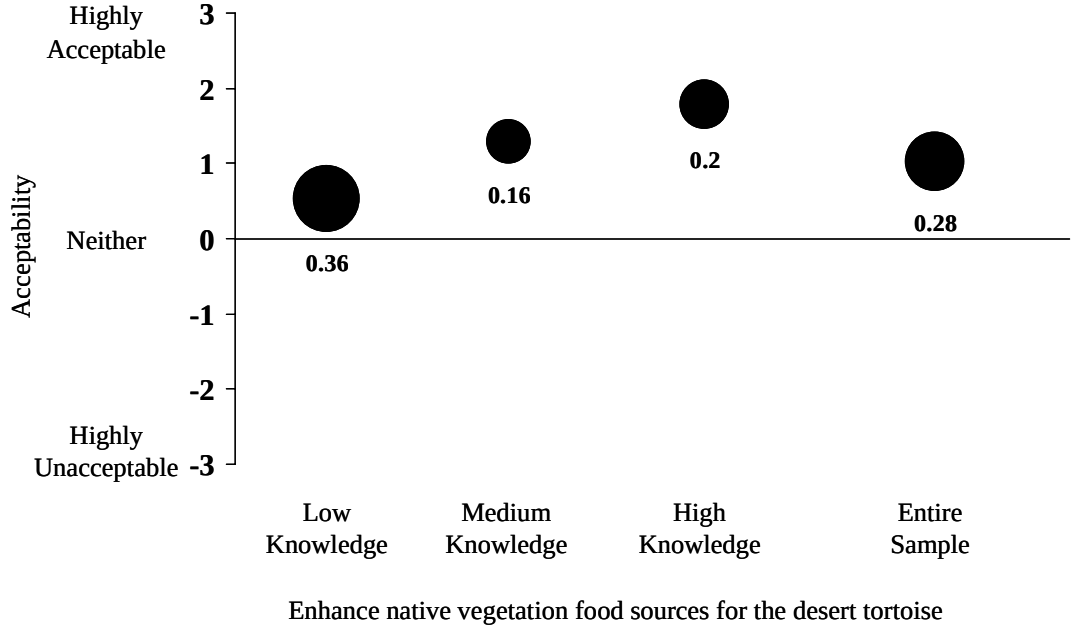
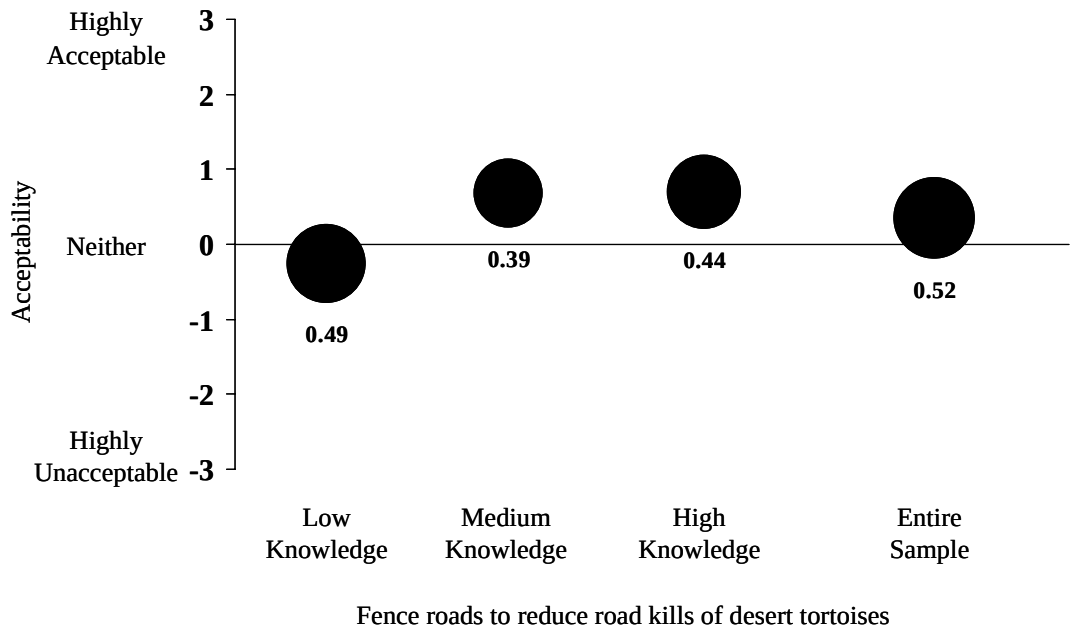


Figure 4. PCI values for enhancing native vegetation food sources.



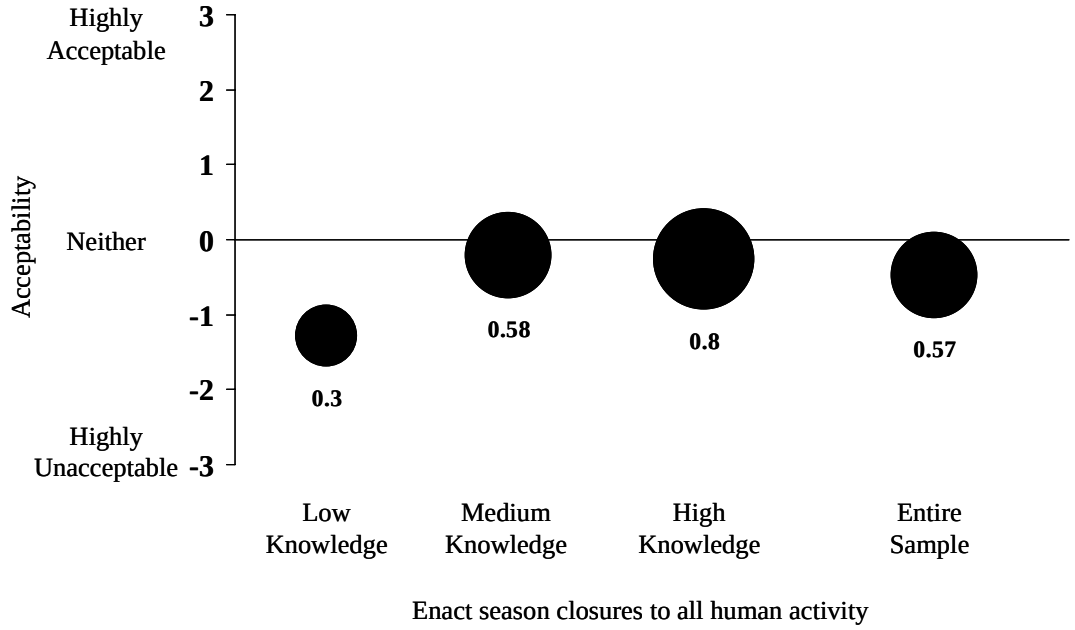
The acceptability of fencing roads to reduce road kills of desert tortoises was slightly unacceptable to the low knowledge group and slightly acceptable for those in the medium and high categories (Figure 5).

Figure 5. PCI values for fence roads to reduce road kills of desert tortoises



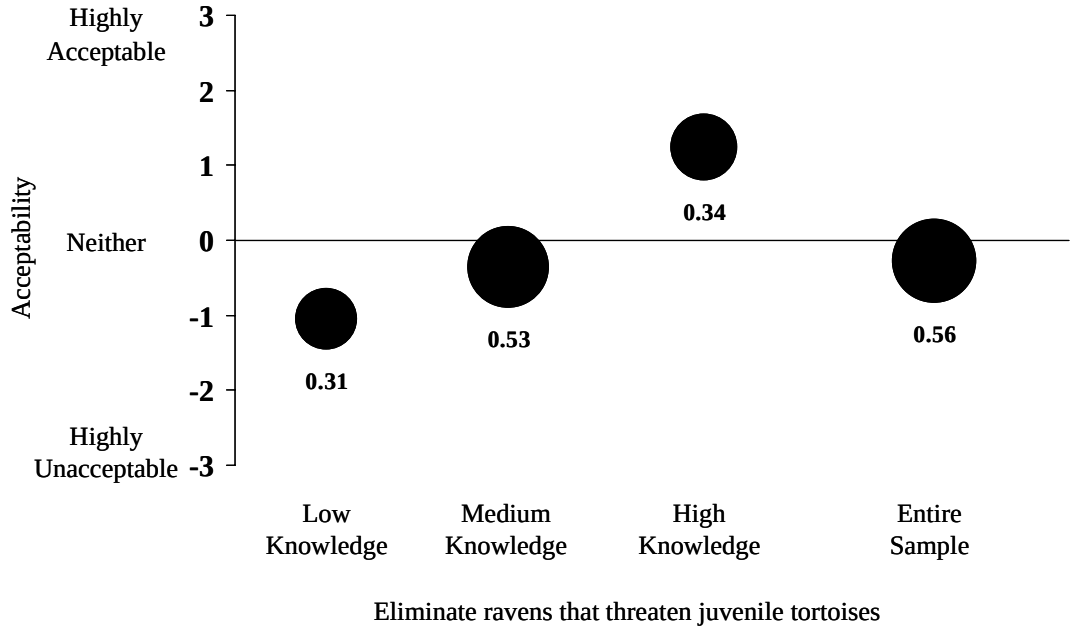
On average, all three knowledge groups were against season closures to all human activity (Figure 6). The low knowledge group exhibited considerable consensus in this opinion (PCI = .3), whereas the medium (PCI = .58) and high (PCI = .80) groups were more divided in their evaluations.

Figure 6. PCI values for enact season closures to all human activity



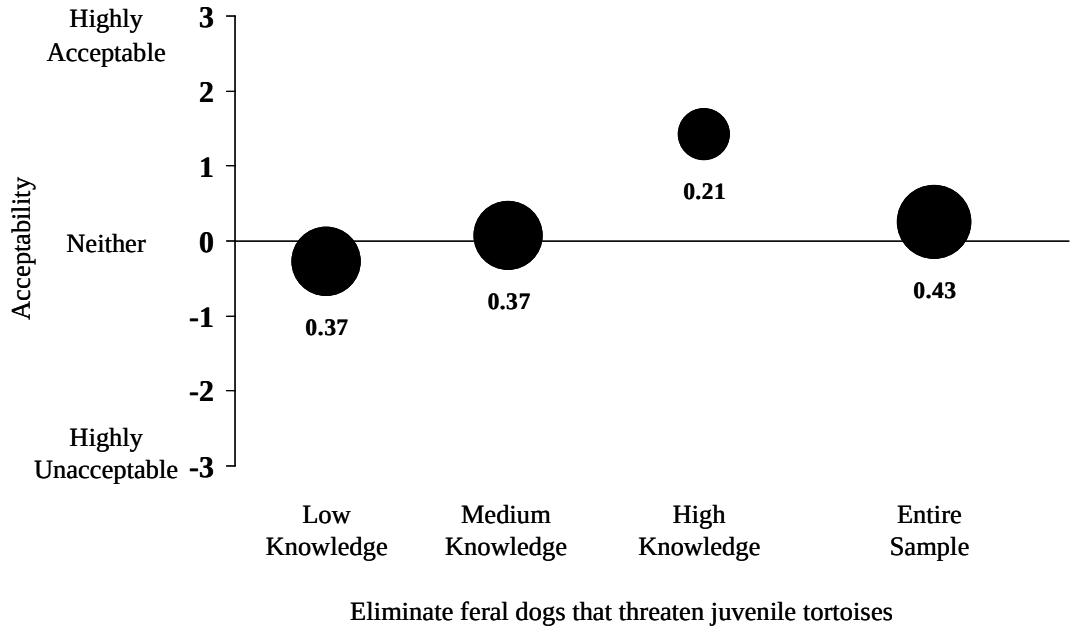
Eliminating ravens that threaten juvenile tortoises was evaluated as unacceptable by the low and medium knowledge categories and as acceptable by the high knowledge group (Figure 7). The least amount of consensus was found for the medium group (PCI = .53).

Figure 7. PCI values for eliminate ravens that threaten juvenile tortoises



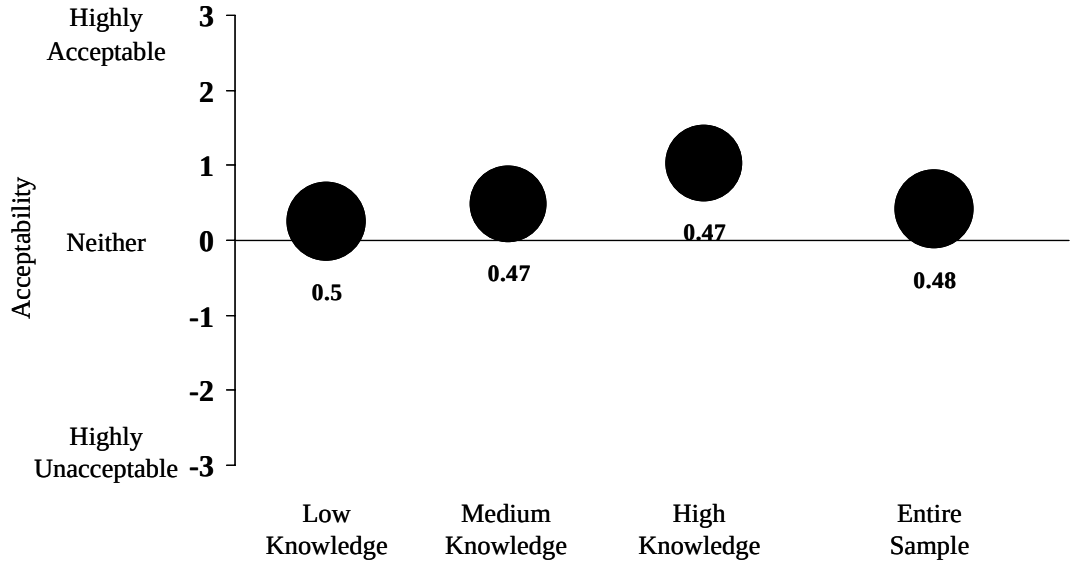
The high knowledge group also generally agreed (PCI = .21) that eliminating feral dogs was an acceptable management strategy (Figure 8). The low and medium groups were more divided in their evaluations (PCI = .37 for both groups).

Figure 8. PCI values for eliminate feral dogs that threaten juvenile tortoises



Purchasing private land to slow human development in desert tortoise habitat was slightly positive (i.e., means about 0) for all three groups (Figure 9), but there was considerable variation (PCI ranging from .47 to 50) among all respondents.

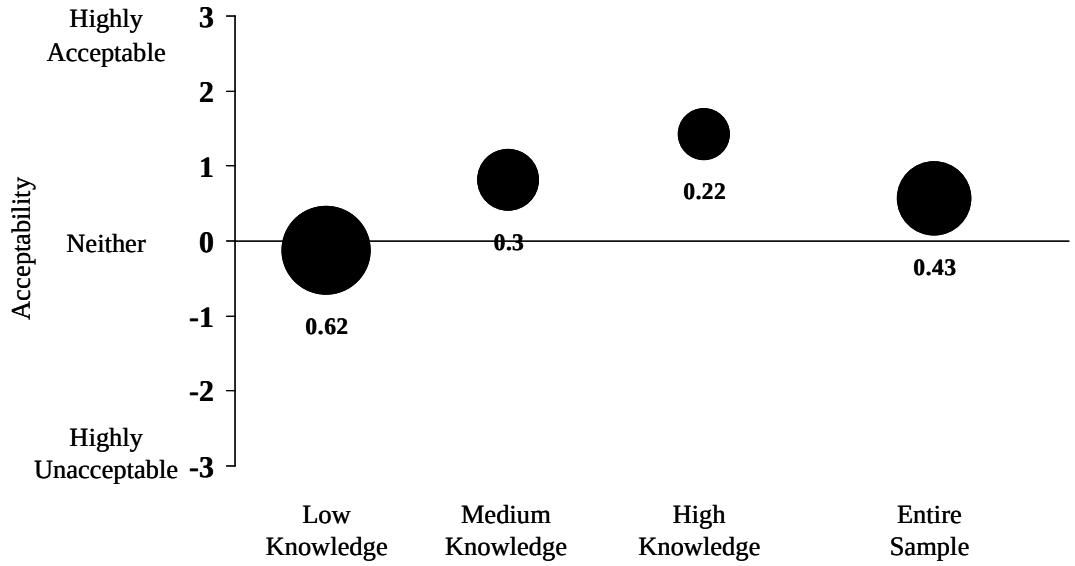
Figure 9. PCI values for purchase private land to slow human development in desert tortoise habitat



Purchase private land to slow human development in desert tortoise habitat

Individuals with low knowledge were divided in their views (bubble straddles neutral line, PCI = .62) on limiting new human development in desert tortoise habitat (Figure 10). Those in the medium and high groups found this management alternative more acceptable with higher agreement (smaller bubbles).

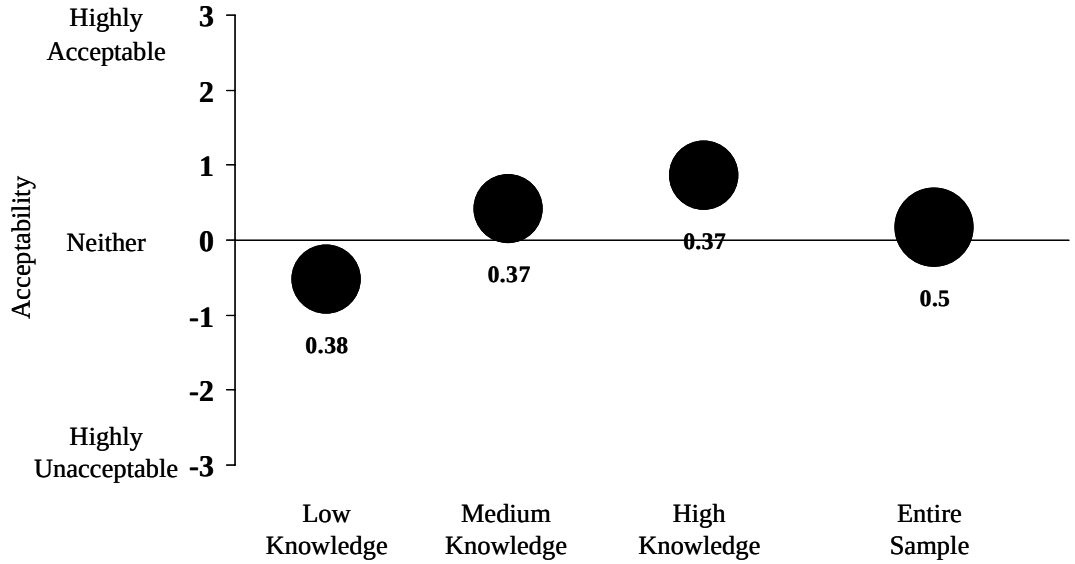
Figure 10. PCI values for limit new human development in desert tortoise habitat



Limit new human development in desert tortoise habitat

The level of acceptability for banning cattle and sheep grazing increased as knowledge increased (Figure 11). For the entire sample, however, the bubble straddled the neutral line and the PCI = .5, suggesting that this management strategy is controversial.

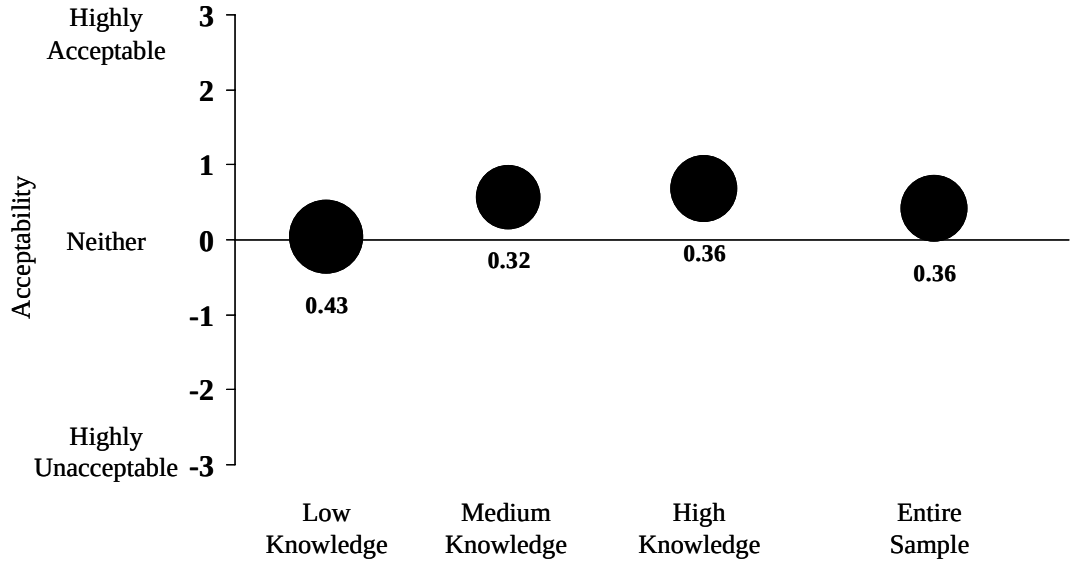
Figure 11. PCI values for ban cattle and sheep grazing in some areas of desert tortoise habitat



Ban cattle and sheep grazing in some areas of desert tortoise habitat

Reactions to limiting agricultural uses in some areas of desert tortoise habitat were slightly acceptable for the medium and high knowledge groups (Figure 12). Those in the low knowledge category were more divided in their acceptability ratings, which resulted in a somewhat larger PCI value.

Figure 12. PCI values for limit agricultural uses in some areas of desert tortoise habitat



Limit agricultural uses in some areas of desert tortoise habitat

Limiting (Figure 13) and banning (Figure 14) hikers was unacceptable to all three knowledge groups. The low knowledge group rated both management actions as least acceptable and had the most consensus in their views.

Figure 13. PCI values for limit the number of hikers in some areas of desert tortoise habitat

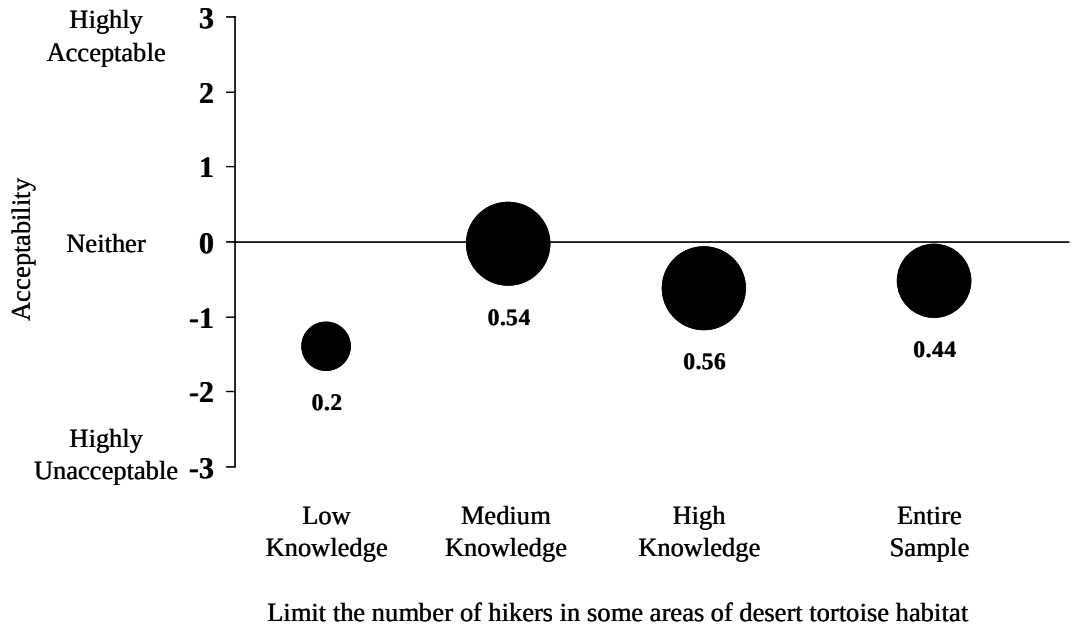
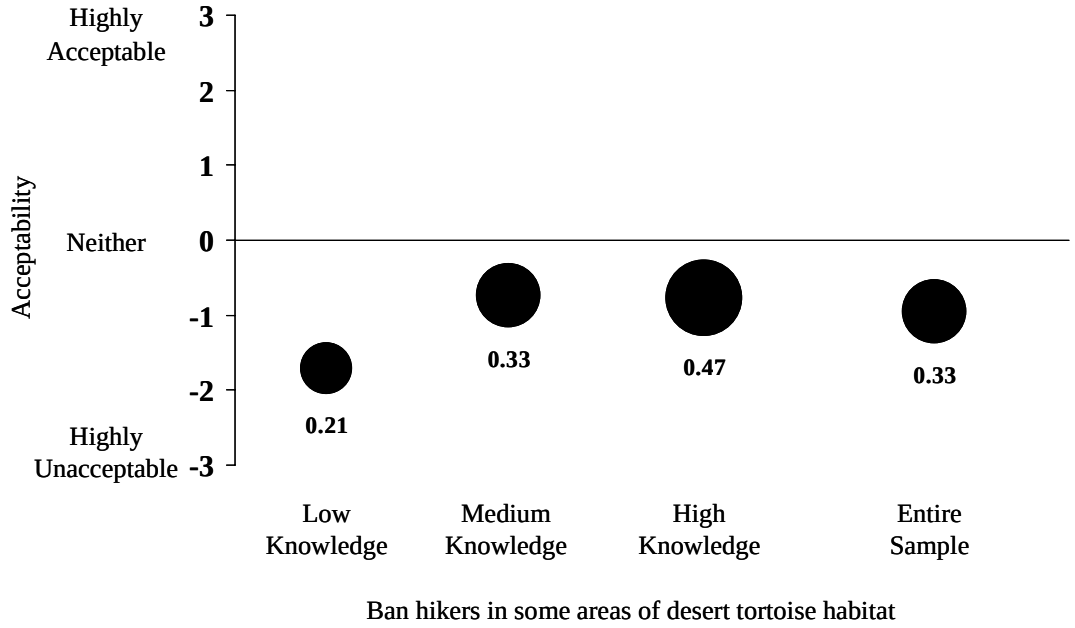


Figure 14. PCI values for ban hikers in some areas of desert tortoise habitat



Reactions to limiting (Figure 15) and banning (Figure 16) OHVs were mixed. The low knowledge group rated these strategies as slightly unacceptable. The means for the other two knowledge groups were near the neutral line and the PCI values were large. This suggests bimodal distributions where some individuals found these management alternatives as highly acceptable, while others rated the actions as highly unacceptable.

Figure 15. PCI values for limit the number of OHVs in some areas of desert tortoise habitat

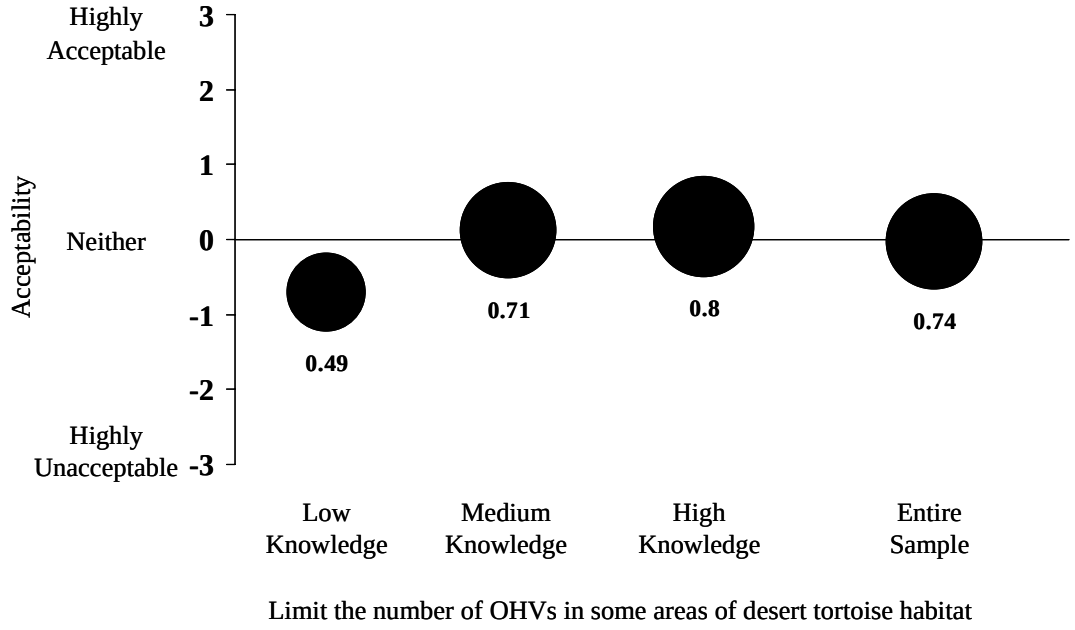
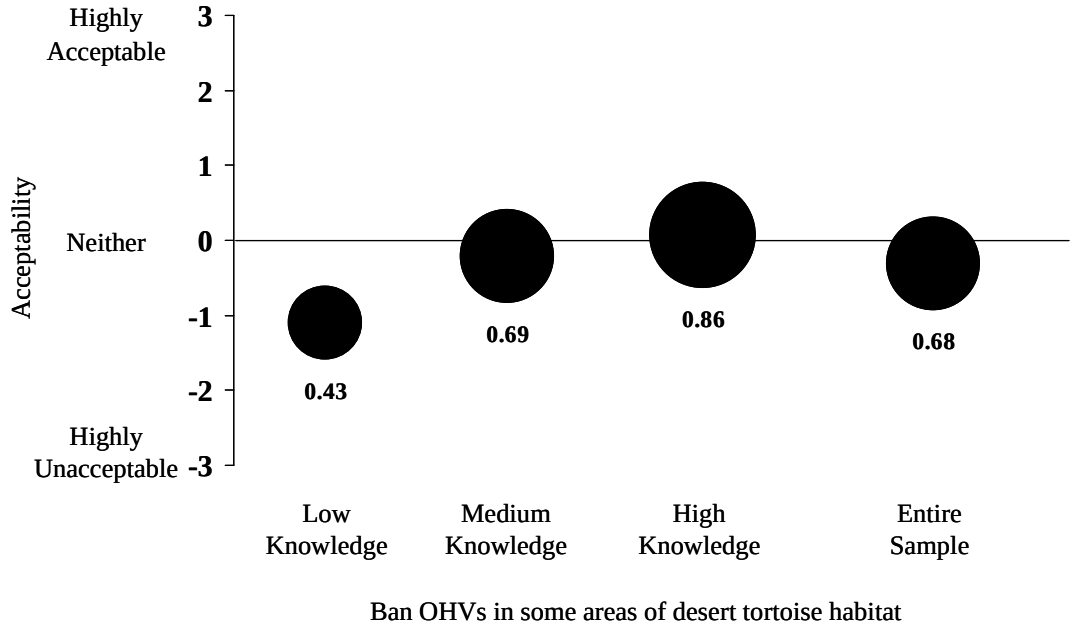
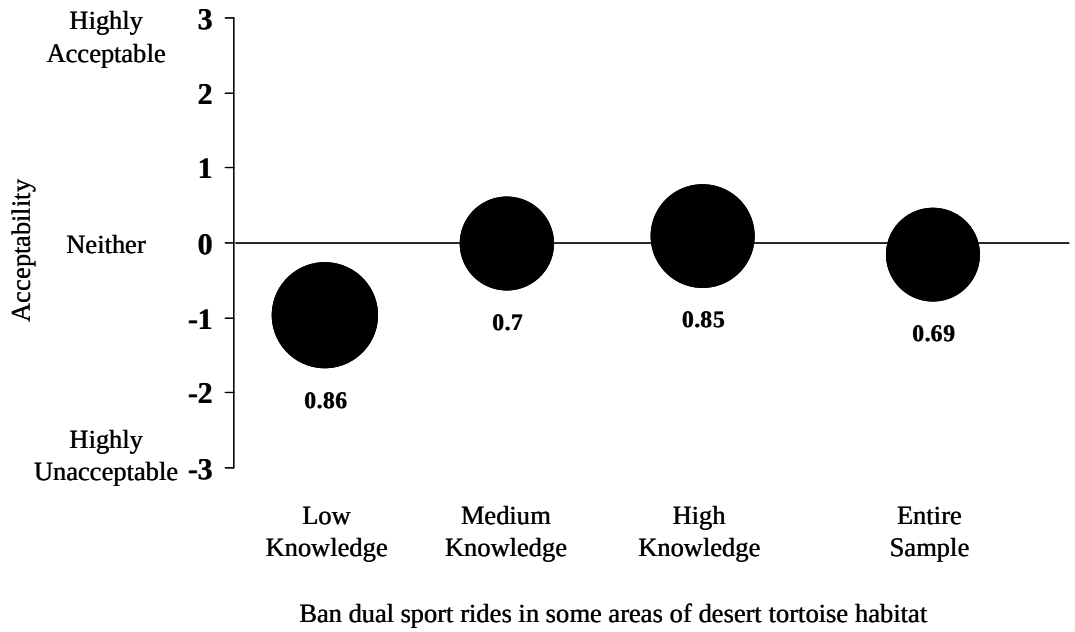


Figure 16. PCI values for ban OHVs in some areas of desert tortoise habitat



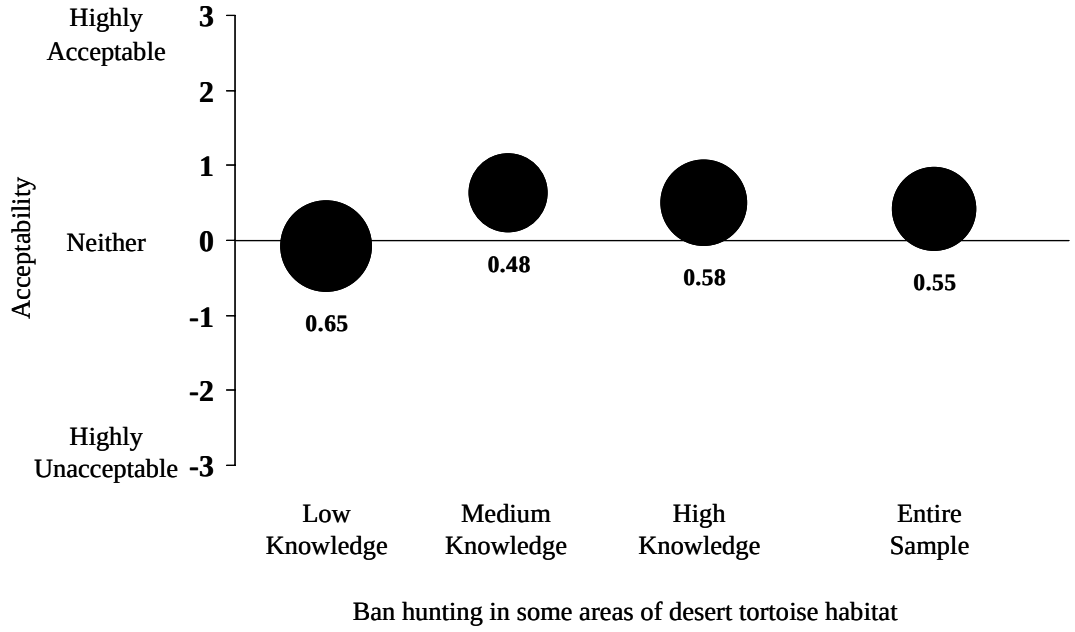
A similar pattern was found for banning dual sport rides (Figure 17). For this analysis, the PCI values ranged from .70 (medium knowledge) to .86 (low knowledge), suggesting that implementation of this alternative would be controversial.

Figure 17. PCI values for ban dual sport rides in some areas of desert tortoise habitat



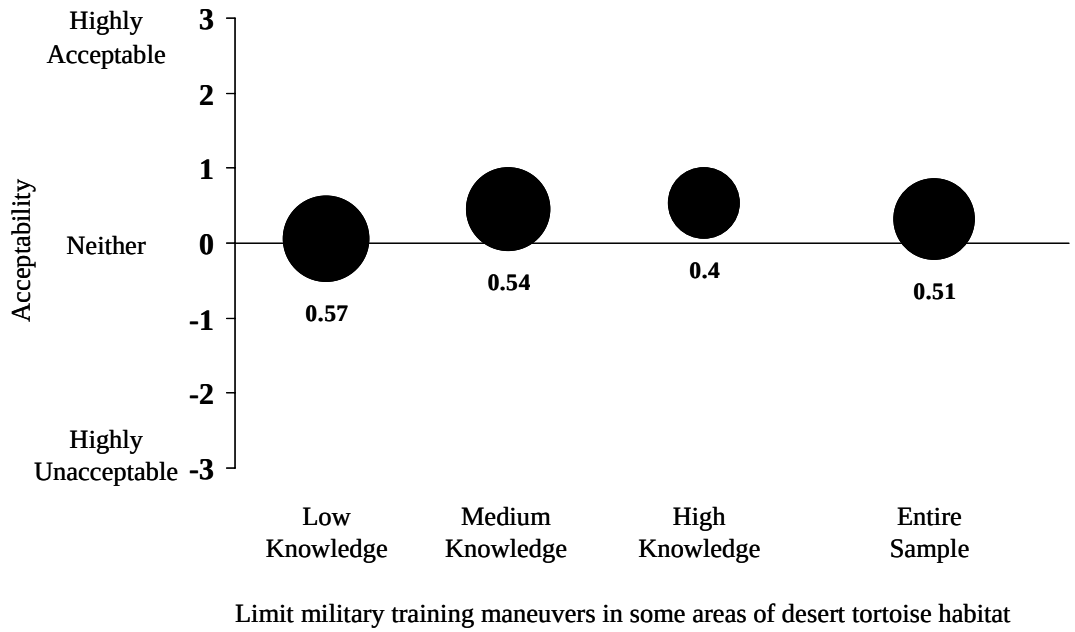
Banning hunting in some areas of desert tortoise habitat was generally viewed as acceptable to the medium and high knowledge groups, but the PCI values were relatively large. The distribution for the low knowledge group straddled the neutral line, with a PCI value of .65.

Figure 18. PCI values for ban hunting in some areas of desert tortoise habitat



With respect to limiting military training maneuvers in some areas of desert tortoise habitat, the means for the medium and high knowledge groups were slightly above the neutral line; the mean for those in the low knowledge category, was on the neutral line (Figure 19).

Figure 19. PCI values for limit military training maneuvers in some areas of desert tortoise habitat



Information Sources

The survey asked respondents to indicate how often they had obtained information about desert tortoises from 14 different sources. For some analyses, traditional media (e.g., newspapers, radio, television) were grouped into a single index (Table 16). The reliability was .71. Deleting any of the items did not improve the overall reliability. State and federal brochures were combined into a brochure index (alpha = .90). The three website variables (i.e., state agency, federal agency, other internet) were also combined to reflect a website index (alpha = .80).

Table 16. Reliability of information source indicators [1]

	Mean	Standard Deviation	Corrected Item-Total Correlation	Alpha If Item Deleted	Cronbach Alpha
Traditional media					.71
Newspapers, magazines, books	1.77	1.88	.54	.60	
Radio	0.30	0.89	.38	.70	
Television news	0.72	1.31	.54	.60	
Other television programs (e.g., PBS)	1.54	1.71	.54	.59	
Brochures					.90
State agency brochures	.80	1.34	.82	*	
Federal agency brochures	.64	1.24	.82	*	
Websites					.80
State agency websites	.28	0.90	.77	.59	
Federal agency websites	.27	0.90	.80	.56	
Other internet websites	.46	1.03	.42	.77	

1 Variables coded on 6-point scales: (0) never, (1) once, (2) twice, (3) 3 times, (4) 4 times, and (5) 5 or more times.

With the exception of information from conservation groups, individuals in the high knowledge category used each of the media sources more frequently than the other two knowledge groups (Table 17). On average, the most frequently used sources for the high knowledge group were friends or family (M = 2.66), traditional media (M = 1.80), and off-highway vehicle groups or brochures (M = 1.55). The medium knowledge group used traditional media, websites and information from federal or state employees more often than the low group. Individuals in the low knowledge category were most likely to obtain information from friends or family and off-highway vehicle groups. Across all knowledge levels, none of the respondents used any of the media sources more than twice on average.

Table 17. Sources of information by knowledge

	Knowledge Level [1]					
Information Source [2]	Low	Medium	High	*F*-value	*p*-value	eta
Traditional media [3]	0.72 [a]	1.24 [b]	1.80 [c]	72.04	< .001	.369
Brochures [4]	0.54 [a]	0.61 [a]	1.55 [b]	51.17	< .001	.317
Websites [6]	0.10 [a]	0.43 [b]	0.68 [c]	33.39	< .001	.261
Conservation groups [6]	0.67	0.87	0.81	1.97	.140	.065
Off-highway vehicle groups [6]	1.19 [ab]	0.95 [a]	1.55 [b]	9.33	< .001	.141
Outdoor videos and / or DVD's [6]	0.29 [a]	0.27 [a]	0.70 [b]	13.80	< .001	.171
Federal or state employees [6]	0.30 [a]	0.59 [b]	1.33 [c]	41.07	< .001	.287
Friends / family members, word of mouth [6]	1.50 [a]	1.59 [a]	2.66 [b]	28.77	< .001	.243

1. Means with different superscripts differ statistically at $p < .05$.
2. Variables coded on 6-point scales: (0) never, (1) once, (2) twice, (3) 3 times, (4) 4 times, and (5) 5 or more times.
3. Composite variable constructed from the average of newspapers, magazines, books, radio, and television.
4. Composite variable constructed from the average of state and federal agency brochures.
5. Composite variable constructed from the average of state, federal and other internet websites.
6. Single-item variable.

When asked about their preferred main source for learning about desert tortoises, television programs ranked first for the low (39%) and medium (26%) knowledge groups, and second for the high knowledge category (16%). The preferred information source for the high knowledge group was off-highway vehicle groups.

Table 18. Preferred main source for obtaining desert tortoise information by knowledge

	Knowledge Level		
Preferred main source of information	Low (%)	Medium (%)	High (%)
Television programs (e.g., Discovery Channel, PBS)	39	26	16
Friends / family members, word of mouth	12	0	4
Newspapers, magazines, books	11	20	9
State agency brochures	10	9	5
Off-highway vehicle groups	9	12	18
Other internet websites	7	1	1
Federal agency brochures	6	7	4
State agency websites	3	3	2
Television news	1	12	4
Federal agency websites	1	2	11
Conservation groups	1	6	1
Outdoor videos and / or DVD's	0	1	4
Radio	0	0	1
Federal or state employees	0	0	6

χ^2 = 358.98, $p < .001$, Cramer's V = .448.

The sources currently used to obtain information about desert tortoises were used to predict the respondents' overall knowledge score (i.e., 0 to 8). Three separate regression equations were examined. The first model included the entire sample. Because formal education has been shown to influence knowledge of wildlife-related issues (Vaske et al., 2006), a second model included only those respondents who had not completed a four-year college degree (n = 665, 66% of the sample). The third regression examined was limited to individuals who had a four-year college degree or higher (n = 346, 34% of the sample).

The cell entries in Table 19 are standardized regression coefficients. These coefficients range from -1 to +1. The larger the coefficient in either direction (- or +), the stronger the effect. A "*" assigned to a coefficient implies that the relationship between that independent variable and the dependent variable was statistically significant (no * means not statistically significant). These coefficients can be thought of as correlation coefficients, with the caveat that an observed relationship between the predictor and a person's knowledge controls for the effects of the other independent variables in the model.

Table 19. Regression models predicting overall knowledge by information sources [1]

		Education Level: 4-year college degree	
Independent variables – Information sources	Entire Sample Model 1	No Model 2	Yes Model 3
Newspapers, magazines, books	.20 *	.32 *	-.19 *
Radio	.04	.01	.06
Television news	-.12 *	-.04	-.22 *
Television programs (e.g., Discovery Channel)	.30 *	.35 *	.18 *
Brochures	.03	.04	.00
Websites	.12 *	.02	.27 *
Conservation groups	.03	.08 *	.05
Off-highway vehicle groups	-.10 *	-.05	-.10
Outdoor videos and / or DVD's	-.18 *	-.13 *	-.36 *
Federal or state employees	.13 *	- .03	.49 *
Friends / family members, word of mouth	.06	.01	.25 *
R^2	21%	28%	38%

1. Cell entries are standardized regression coefficients. (* $p < .05$)

For the entire sample model, 7 of the 11 independent variables statistically influenced respondents' knowledge level. Television programs such as the Discovery Channel ($\beta = .30$, $p < .001$), newspapers, magazines and books ($\beta = .20$, $p < .001$), federal or state employees ($\beta = .13$, $p = .001$), and websites ($\beta = .12$, $p = .005$) were positively related to knowledge (Table 19). In other words, individuals, for example, who watched more desert tortoise programs on the Discovery Channel had more knowledge about the reptile.

Three independent variables in the entire sample model had negative and statistically significant relationships with desert tortoise knowledge (outdoor videos [β= -.18], television news [β= -.12], off-highway vehicle groups [β= -.10]). The negative relationship between television news and desert tortoise knowledge might be explained by the "sound byte" nature of this communication channel. Television news stories must communicate complex messages in a short time span, which might lead to incorrect knowledge.

To illustrate this potential for miscommunication, consider the following example. Chronic wasting disease (CWD) is related to scrapie in sheep, bovine spongiform encephalopathy in cattle (i.e., BSE, mad cow) and Creutzfeld-Jakob (CJD) in humans (Vaske et al., 2006). A recent television news story on "mad cow" disease indicated that people could die from the genetically related CJD. The news cast ended by saying that there is a similar disease in deer, elk and moose (i.e., CWD). Although the broadcast did not explicitly state that there is a human-health risk associated with CWD, an implication was made. To date, there is no empirical evidence, to suggest that CWD has directly caused any human health problems (Belay et al., 2004).

The negative relationships between information from outdoor videos / OHV groups and desert tortoise knowledge may be a function of: (a) the source, (b) the receiver, (c) message factors (e.g., one-sided arguments), or (d) a combination of all of these characteristics. Radio, brochures, and information from conservation groups or family / friends had no influence on desert tortoise knowledge in the entire sample model. Taken together, this collection of independent variables in model 1 explained 21% of the variance in respondents' knowledge.

For the model that included only individuals who did not have a four-year education (model 2), three variables (television programs [$\beta = .35$], newspapers, [$\beta = .30$], conversation groups [$\beta = .08$]) were positively associated with desert tortoise knowledge. Information from outdoor videos was negative and statistically significant ($\beta = -.13$). None of the other predicator variables had a statistical influence in this model. Overall, model 2 explained 28% of the variance in respondents' knowledge.

The final regression (model 3, Table 19) included individuals who had completed a four-year college degree or an advanced degree (e.g., masters, Ph.D.). Similar to the entire sample model, seven of the independent variables had a statistical influence on respondents' knowledge. In contrast to models 1 (entire sample) and 2, however, newspapers had a negative ($\beta = -.19$) rather than a positive effect on knowledge. Other variables negatively and statistically related to desert tortoise knowledge in model 3 included: (a) television news ($\beta = -.22$) and (b) outdoor videos ($\beta = -.36$). The variables having a positive influence on respondents' knowledge in this model were: (a) federal or state employees ($\beta = .49$), (b) websites ($\beta = .27$), (c) friends and family ($\beta = .25$), and (d) television programs such as those on the Disney Channel ($\beta = .18$). Although some of the variables in this model can be influenced by desert managers (e.g., federal or state employees), other predictors are not as easily manipulated (e.g., family and friends). Taken together, model 3 explained 38% of the variance in respondents' knowledge.

The three regression models examined here highlight the complexities of developing an effective communication strategy. First, not all traditional media channels (e.g., radio) influenced knowledge. Second, some media channels function differently for different stakeholders. Information obtained from newspapers, for example, was positively related to knowledge in model 2 (i.e., individuals who did not have a four-year college degree) and negatively related in model 3 (i.e., respondents who completed at least a four-year college degree). Information obtained from websites had a positive influence in model 3, but no statistical effect in model 2. The positive and "substantial" ($\beta = .49$) impact of interacting with federal / state employees was evident in model 3, but not in model 2. Third, understanding the negative relationships observed in some of the models requires further exploration. Finally, these models only explained at best 38% of the variability in respondents' knowledge. Accounting for the unexplained 62% of the variance will necessitate inclusion of additional predictor variables.

Agency Trust and Believability of Agency Information

The desert tortoise survey included four statements related to agency trust and six questions regarding the believability of agency information (Table 20). The Cronbach's alphas for these two indices exceeded .90.

Table 20. Reliability of agency trust and believability of information indicators

	Mean	Standard Deviation	Corrected Item-Total Correlation	Alpha If Item Deleted	Cronbach Alpha
I *trust* the federal / state agencies to: [1]					.96
provide the best available information on desert tortoise issues	.19	1.94	.89	.95	
provide truthful information about desert tortoise issues	.44	1.91	.91	.94	
make good management decisions regarding the desert tortoise	-.10	1.85	.89	.95	
follow the best available science in managing the desert tortoise	.10	1.83	.90	.95	
Believability of information from federal / state agencies [2]					.93
Biological information about the desert tortoise	6.02	2.03	.76	.92	
The status of desert tortoise populations	5.75	2.15	.82	.92	
Information on threats to desert tortoise populations	5.58	2.31	.87	.91	
Information about desert tortoise recovery strategies	5.58	2.18	.87	.91	
Actions I can take to help protect the desert tortoise	6.01	2.08	.75	.93	
How my personal actions affect the desert tortoise	6.06	2.26	.73	.93	

1. Variables coded on 7-point scales ranging from (-3) strongly disagree to (+3) strongly agree.
2. Variables coded on 9-point scales ranging from (1 &2) not at all believable, (3 & 4) slightly believable (5, 6 & 7) moderately believable, and (8 & 9) highly believable.

Knowledge was not statistically related to the trust index (Table 21). Individuals in all three knowledge groups "slighted" trusted the agencies. The low and high knowledge groups rated the believability of agency information higher than those in the medium group ($F = 9.10$, $p < .001$), although all three groups rated the information as "moderately believable."

Table 21. Agency trust and believability of information by knowledge

	Knowledge Level [1]					
	Low	Medium	High	*F*-value	*p*-value	eta
Trust federal / state agencies [2]	.25	.09	.24	0.84	.431	.043
Believability of information [2]	6.00 [a]	5.46 [b]	6.02 [a]	9.10	< .001	.146

1. Means with different superscripts differ statistically at $p < .05$.
2. Composite variables constructed from the items listed in Table 19.

Respondents were asked to "grade" the government in managing the desert tortoise using a traditional "A" to "F" format. About a third of the high knowledge group (32%) indicated that they did not know enough about the management program to give a letter grade, compared to 39% of the low and 42% of the medium knowledge groups (Table 22). Of those who did give a letter grade, 15% or less of all respondents evaluated agency performance as an A. The modal response for the low (64%) and high (41%) knowledge groups was a B. For the medium knowledge group, the modal response was a C (43%). The highest grade point average was observed for the low knowledge category (*M* = 2.71 or a B-). On average, respondents in the high knowledge category gave the agencies a C+ (*M* = 2.49) and those in the medium group gave a C (*M* = 2.27).

Table 22. Overall evaluation of government management of the desert tortoise by knowledge

	Knowledge Level					
	Low (%)	Medium (%)	High (%)	χ^2 or *F*	*p*-value	Effect Size
Provided a letter grade				6.54	.038	.084
No – do not know enough to give a letter grade	39	42	32			
Yes	61	58	68			
Letter grade				74.80	< .001	.243
A	5	12	15			
B	64	30	41			
C	29	43	30			
D	0	4	5			
F	2	11	9			
Grade point average [1]	2.71 [a]	2.27 [b]	2.49 [ab]	11.49	< .001	.199

1 Variable coded on a 5-point scale: (0) F, (1) D, (2) C, (3) B, and (4) A
Means with different superscripts differ statistically at $p < .05$.

Cognitive Hierarchy Concepts

The survey included a series of questions related to basic beliefs (i.e., anthropocentrism, biocentrism), norms (i.e., awareness of consequences [AC], ascription of responsibility [AR]) and behavioral intentions to limit desert recreation use to help protect the desert tortoise (Table 23). The three anthropocentric items had an overall reliability of .77. The Cronbach's alpha for the three biocentric variables was .75. Reverse coding the anthropocentric items and combining them with biocentric questions, produced an overall alpha of .83 for the biocentric-anthropocentric continuum.

The reliability for the three AC questions was .88 and for the three AR items was .92. Combining the three behavioral intentions resulted in a Cronbach's alpha of .97. Each of these analyses indicated that the variables associated with each concept could be combined into the respective indices.

Table 23. Reliability of beliefs about endangered species and desert tortoises [1]

	Mean	Standard Deviation	Corrected Item-Total Correlation	Alpha If Item Deleted	Cronbach Alpha
Anthropocentric basic beliefs					.77
Endangered species should not be recovered unless there is a direct benefit to humans	-1.28	1.93	.55	.76	
The needs of people are always more important than any rights endangered species may have	-.73	2.13	.63	.68	
Recreational use of desert environments is more important than protecting the endangered species that live there	-.97	1.84	.66	.64	
Biocentric basic beliefs					.75
We should strive for a society that emphasizes environmental protection rather than economic growth	-.06	1.79	.63	.63	
Endangered species should be protected for their own sake rather than to simply meet our needs	.63	2.08	.50	.75	
The rights of endangered species to live is more important than the negative effects that their recovery may have on humans	-.15	1.85	.64	.61	
Awareness of consequences					.88
I am aware of the impacts that humans can have on the desert tortoise	1.32	1.60	.80	.81	
My personal actions can impact the ability of the desert tortoise to recover	1.09	1.84	.81	.78	
If I touch a desert tortoise, it could hurt the animal's ability to survive	.94	2.01	.70	.88	
Ascription of responsibility					.92
I feel a strong personal obligation to protect the desert tortoise	.48	1.96	.87	.86	
I feel an obligation to educate others about the importance of protecting desert tortoises	.41	1.94	.87	.86	
It is *not* my responsibility to protect the desert tortoise [2]	.96	1.80	.78	.92	
Behavioral intentions					.97
I would be willing to limit the number of my visits to the desert to help protect the desert tortoise	.16	2.13	.91	.97	
I would be willing to limit the areas I visit in the desert to help protect the desert tortoise	.59	2.08	.94	.94	
I would be willing to limit my recreational use of the desert during certain seasons to help protect the desert tortoise	.69	2.05	.94	.94	

1. Variables coded on 7-point scales ranging from (-3) strongly disagree to (+3) strongly agree.
2. Variable was reverse coded.

Table 24 examines the relationships between knowledge and each of the five indices described in Table 23. All of the comparisons were statistically significant ($F > 16.27$, $p < .001$, in all cases) and the effect sizes ranged from .185 (anthropocentric beliefs) to .409 (ascription of responsibility).

As knowledge increased, the respondents' world views were less anthropocentric (human centered) and more biocentric (nature centered). Individuals with higher levels of knowledge were more likely to be aware of the consequences humans can have on desert tortoises and more willing to take responsibility for their actions than those with less knowledge. Finally, as knowledge increased, respondents were more willing to limit their recreation activities to help protect the desert tortoise.

Table 24. Beliefs about endangered species and desert tortoises by knowledge

	Knowledge Level [1]					
Belief concepts [2]	Low	Medium	High	*F*-value	*p*-value	Eta
Basic beliefs / value orientations						
Anthropocentric	-0.53 [a]	-1.04 [b]	-1.33 [b]	16.27	< .001	.185
Biocentric	-0.22 [a]	0.11 [b]	0.77 [b]	24.89	< .001	.227
Norms						
Awareness of consequences	0.83 [a]	1.23 [b]	2.02 [c]	40.78	< .001	.286
Ascription of responsibility	-0.11 [a]	0.64 [b]	1.89 [c]	92.22	< .001	.409
Behavioral intentions	-0.28 [a]	0.68 [b]	0.86 [b]	28.10	< .001	.240

1. Means with different superscripts differ statistically at $p < .05$.
2. Belief concepts constructed from the items in Table 23.

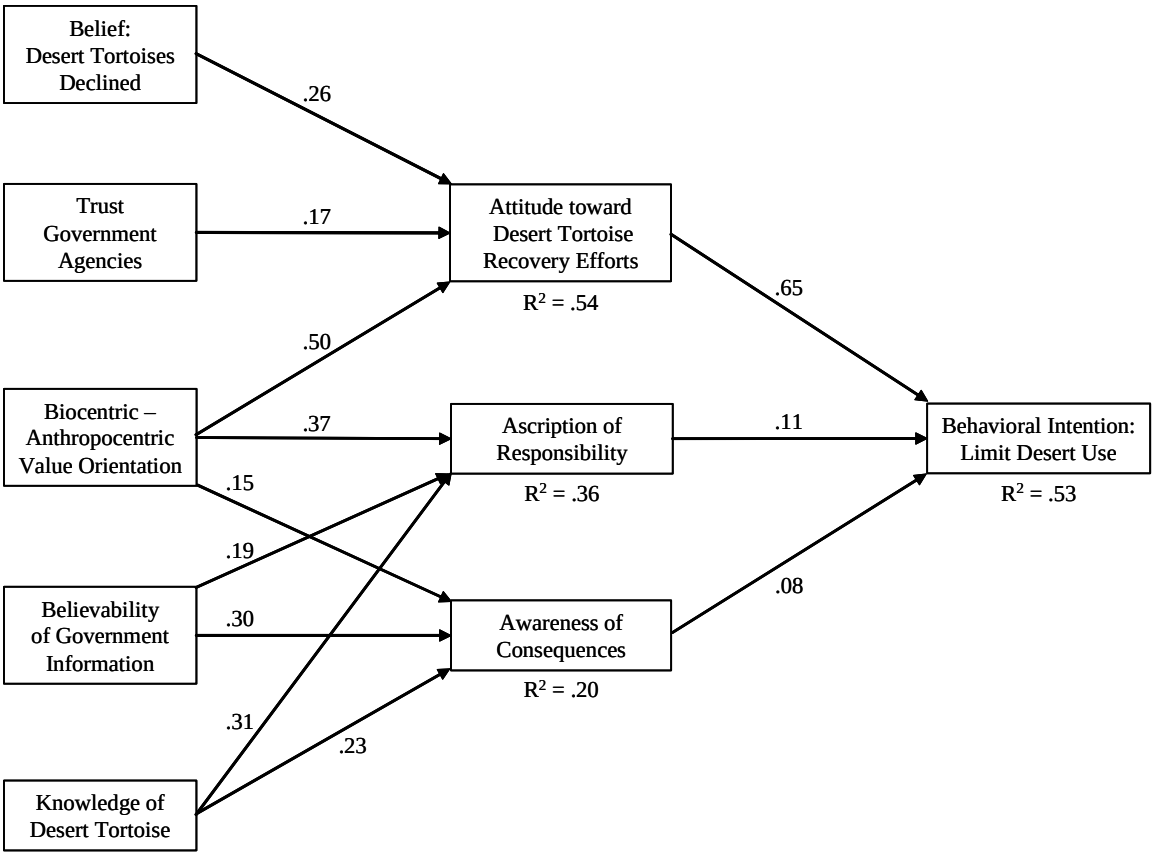
The cognitive hierarchy predicts that value orientations influence higher order constructs (e.g., attitudes, norms), which in turn influence behavioral intentions. Figure 20 diagrams these hypothesized variable relationships. The extent to which individuals trust federal / state agencies and believe the information that they provide has also been shown to influence specific attitudes and norms (Vaske, Timmons, Beaman, & Petchenik, 2004; Vaske, Absher, & Bright, 2007). Given the current context, two additional variables were included in the diagram: (a) the belief that desert tortoise populations have declined and (b) knowledge of desert tortoises (coded: 0 to 8).

Figure 20 basically reflects a series of four regression models (described earlier). Concepts on the far left hand side of the diagram are independent or predictor variables. These variables are independent of (not caused by) other variables in the model[1]. Predictor variables have arrows that point away from them. The direction of the arrows connecting the rectangles illustrates the hypothesized relationships between the concepts. Behavioral intention, on the far right side of the figure, is a dependent or criterion variable, and has arrows that point to it. The attitude and two norm variables (awareness of consequences, ascription of responsibility) are in the middle of the diagram and are referred to as mediator variables. These variables

[1] It is usually impossible to prove causation in surveys where the researcher has not experimentally manipulated the variables. The "causal" sequence of variables in Figure 20 is based on the logic of the cognitive hierarchy where general variables (e.g., value orientations) are predicted to influence more specific variables (e.g., attitudes toward desert tortoise recovery efforts).

"mediate" the relationship between the variables on the left and the behavioral intention on the right. The biocentric-anthropocentric variable, for example, does not have a *direct* effect on the behavioral intentions. Rather, the influence of this concept on behavior occurs *indirectly* through the attitude and norms variables. Whether or not a variable serves as mediator or a predictor depends on theory (i.e., the cognitive hierarchy in this example) and the variables included in the model. Only statistically significant paths (i.e., arrows) are shown in Figure 20. The numbers on the paths are standardized regression coefficients.

Figure 20. Path model predicting behavioral intentions to limit recreational use to protect the desert tortoise



As predicted by the cognitive hierarchy, attitudes toward desert tortoise recovery efforts influenced respondents' behavioral intentions to limit their desert recreation activities (β = .65). Respondents with a positive attitude were more likely to constrain their behavior. Individuals who were aware of the consequences of human activity on desert tortoises (β = .11) and ascribed personal responsibility for their actions (β = .08) were also more likely to limit their desert recreation participation. Of the three predictors, attitudes had a "substantial" (i.e., > .5) influence on the behavioral intention, while the influence of the two norm variables would be characterized as "minimal" (i.e., ≅ .1). Taken together, these three independent variables accounted for 53% of the variance in respondents' behavioral intentions.

Of the five potential predictor variables (far left of Figure 20), three variables had a significant influence on respondents' attitudes toward desert tortoise recovery efforts. Individuals who believed that desert tortoise populations have declined had a more favorable attitude toward recovery efforts (β = .26). Those who trusted government agency

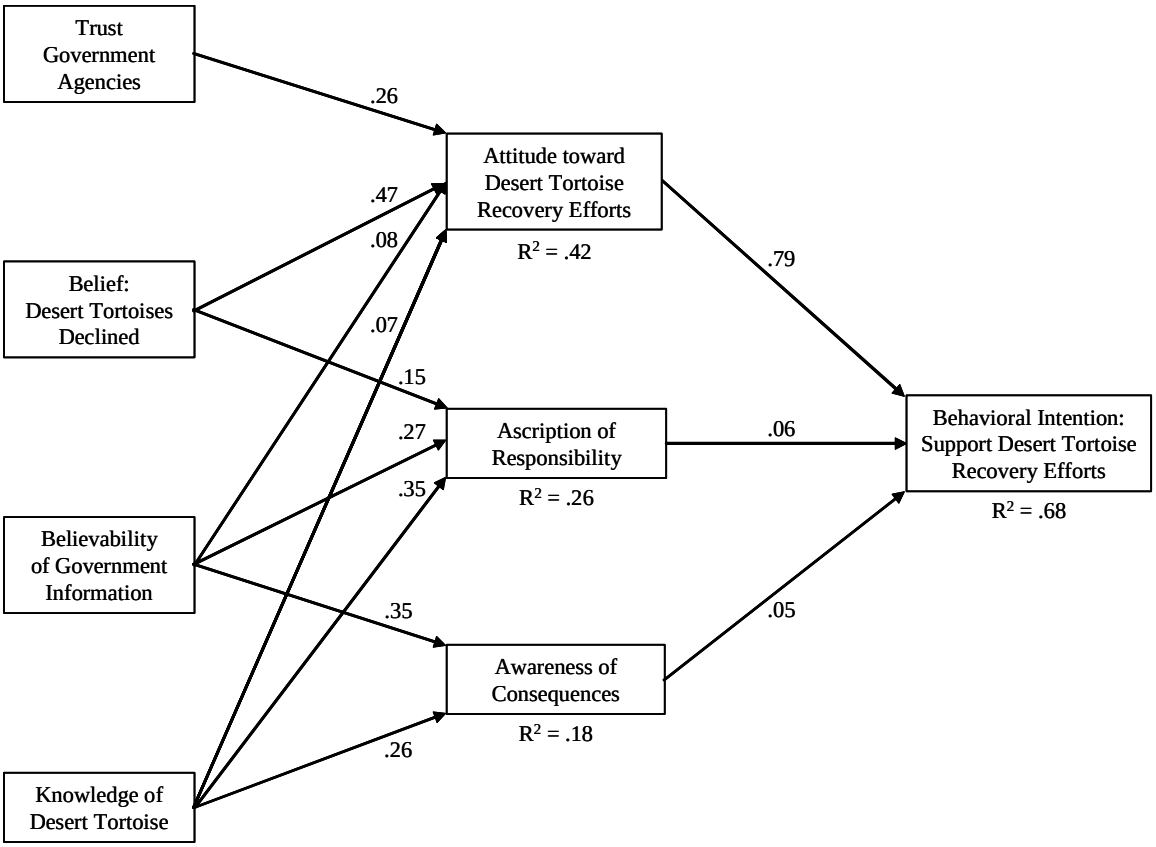
management of desert tortoises held more positive attitudes (β = .17). Finally, consistent with the cognitive hierarchy, individuals on the biocentric end of the value orientation continuum were more positive about desert tortoise recovery efforts (β = .50). These three predictor variables explained 54% of the variance in the attitude measure.

Three variables predicted ascription of responsibility (AR). A more biocentric value orientation was positively related to AR (β = .37). People who believed the information provided by government agencies were also more likely to ascribe personal responsibility to themselves (β = .19). Finally increases in knowledge were associated with increases in the AR variable (β = .31). Taken together, these variables explained 36% of the variance in the AR measure.

The same three variables predicted respondents' awareness of consequences (AC). Believability of government information had the strongest influence on AC (β = .30), followed by knowledge of the desert tortoise (β = .23), and the biocentric-anthropocentric value orientation (β = .15). This model explained 20% of the variance in AC.

Figure 21 presents a path model predicting behavioral intentions to support desert tortoise recovery efforts. As expected, the attitude toward desert tortoise recovery efforts had the strongest influence (β = .79). The two norms, however, were also statistically significant in this model. These three variables explained 68% of the variance in the behavioral intention to support recovery efforts.

Figure 21. Path model predicting behavioral intentions to support desert tortoise recovery efforts



Four predictor variables of respondents' attitudes and norms were included in Figure 21. All four of the independent variables influenced the attitude towards recovery efforts. Beliefs about declines in the tortoise population was the strongest predictor ($\beta = .47$), followed by trust in government agencies ($\beta = .26$). Although believability of government information ($\beta = .08$) and knowledge of the desert tortoise ($\beta = .07$) were significant, their influence was weaker. This model explained 42% of the variance in attitude.

Three variables influenced AR: knowledge of desert tortoises ($\beta = .35$), believability of government information ($\beta = .27$), and the belief that desert tortoise populations have declined ($\beta = .26$). The model accounted for 26% of the variance in AR. Two variables (believability of government information [$\beta = .35$] and knowledge of the desert tortoise [$\beta = .26$]) influenced AC, explaining 18% of the variance.

Demographics

Table 25 compares the three knowledge groups on demographic variables. Each of these analyses was statistically significant ($\chi^2 \geq 17.09$, $p < .001$), although the Cramer's *V* effect sizes ranged from .136 (ethnicity) to .290 (income). Individuals in the high knowledge category tended to be older (*M* age= 47.43) non-Hispanic (76%) white (78%) males (64%), with a two-year associates degree or less (69%), who earned more than $70,000 per year (57%). By comparison, the low knowledge group was characterized as younger (*M* age = 39.90), more educated (46% four-year college degree or beyond), white (83%) females (64%), with 64% earning over $70,000. There was a larger proportion of Hispanics (42%) in the low knowledge group than in the high knowledge category (24%).

Individuals living in the California desert tended to be more knowledgeable about desert tortoises (Table 26). More individuals in the low knowledge category resided in San Bernardino County (84%) than those in the medium (59%) or high (61%) knowledge groups. Two thirds (67%) of individuals in the low knowledge group lived in cities of 100,000 or more residents, as compared to 55% (medium) and 42% (high) of the other knowledge categories. A third of the high knowledge individuals lived in small towns or rural areas, compared to 9% and 13% of the low and medium knowledge groups, respectively.

About a fifth of the respondents in the high knowledge group belonged to environmental or wildlife groups (Table 27). This compares to 5% of the low and 4% of the medium knowledge groups. There were no differences among the three groups in OHV organization membership. Less than a fifth of each group belonged to an organized OHV club.

More individuals in the low knowledge category (54%) owned an off-highway vehicle, compared to the high (42%) and medium (33%) knowledge groups (Table 28). Over two-thirds of all groups had driven an OHV in the California desert.

Table 25. Demographics by knowledge

Demographics	Knowledge Level Low (%)	Medium (%)	High (%)	χ^2	*p*-value	Cramer's *V*
Sex				39.49	< .001	.206
Male	36	48	64			
Female	64	52	36			
Age				54.96	< .001	.172
18 – 29	22	20	13			
30 – 39	33	22	19			
40 – 49	22	26	28			
50 – 59	13	14	20			
60 – 69	9	12	7			
70+	1	6	13			
Mean age	39.90 [a]	43.67 [b]	47.43 [c]	17.09	< .001	.190
Education				145.18	< .001	.263
Less than high school diploma	5	1	0			
High school or GED	30	26	12			
2 year associate degree or trade school	40	28	57			
4 year college degree (bachelors)	24	23	16			
Advanced degree beyond 4 year degree	22	22	15			
Income				167.03	< .001	.290
Less than $10,000	3	0	4			
$10,000 to $29,999	1	8	7			
$30,000 to $49,999	20	12	29			
$50,000 to $69,999	12	9	4			
$70,000 to $89,999	21	27	12			
$90,000 to $109,999	22	19	15			
$110,000 to $129,999	4	6	16			
$130,000 to $149,999	14	6	6			
$150,000 to $199,999	1	3	4			
$200,000 to $249,999	1	3	4			
more than $250,000	1	7	0			
Ethnicity				17.39	< .001	.136
Hispanic or Latino	42	34	24			
Not Hispanic or Latino	58	66	76			
Race				44.12	< .001	.142
American Indian or Alaska Native	2	5	0			
Asian	9	3	5			
Black or African American	1	5	7			
Native Hawaiian / other Pacific Islander	5	7	10			
White	83	80	78			

Table 26. Place of residence by knowledge

Place of residence	Knowledge Level Low (%)	Medium (%)	High (%)	χ^2	*p*-value	Cramer's *V*
Do you live within the California desert?				49.42	< .001	.218
No	35	26	9			
Yes	65	74	91			
County of residence				97.54	< .001	.213
Imperial	3	1	2			
Kern	0	9	14			
Los Angeles	9	18	10			
Riverside	5	14	14			
San Bernardino	84	59	61			
Size of community				208.62	< .001	.329
Large city (250,000+ people)	13	13	14			
City (100,000 to 249,999 people)	54	42	28			
City (10,000 to 99,999 people)	19	22	2			
Small city (25,000 to 49,999 people)	6	10	24			
Town (10,000 to 24,999 people)	6	9	11			
Town (5,000 to 9,999 people)	0	1	9			
Small town / village (< 5,000 people)	3	0	11			
A farm or rural area	0	3	2			

Table 27. Organizational membership by knowledge

Organizational membership	Knowledge Level Low (%)	Medium (%)	High (%)	χ^2	*p*-value	Cramer's *V*
Environmental or wildlife groups				46.66	< .001	.249
No	95	96	79			
Yes	5	4	21			
Off-Highway vehicle groups				2.05	.359	.047
No	82	85	84			
Yes	18	15	14			

Table 28. Off-highway vehicles by knowledge

	Knowledge Level Low (%)	Medium (%)	High (%)	χ^2	*p*-value	Cramer's *V*
Off-highway vehicle ownership				31.86	< .001	.186
No	46	67	58			
Yes	54	33	42			
Driven OHV in California desert				7.22	.027	.088
No	24	33	28			
Yes	76	67	72			

Discussion

The "Desert Tortoise Public Attitude and Public Outreach Effectiveness" study was designed to obtain baseline information that will facilitate the development and implementation of an education program to build public support for and involvement in the desert tortoise recovery effort. Analyses presented here compared individuals with varying levels of knowledge about the desert tortoise. The three knowledge level groups differed in terms of their:

- prior visitation to and recreation activity participation in the Mojave Desert
- perceived threats to the desert tortoise population
- acceptability of alternative management strategies for protecting the desert tortoise
- attitudes and normative beliefs regarding the desert tortoise and endangered species
- trust in federal / state agencies involved in desert tortoise recovery efforts
- willingness to limit desert-related recreation activities to help protect the desert tortoise
- support for efforts to recover the desert tortoise and endangered species in general
- sources used to obtain information about the desert tortoise
- membership in environmental / off-highway vehicle groups
- demographics (e.g., age, sex, education, income, place of residence, ethnicity, race).

The sources respondents currently used to obtain information about desert tortoises were used to predict the respondents' overall knowledge scores. The regression models highlighted the challenges associated with developing an effective communication strategy. First, not all traditional media channels (e.g., radio) influenced knowledge.

Second, some media channels functioned differently for different stakeholders, for example:

- Information obtained from newspapers was positively related to knowledge for individuals who did not have a four-year college degree, and negatively related for respondents who completed at least a four-year college degree.
- Information obtained from websites had a positive influence for those with more formal education, but no statistical effect was found for those with less education.
- The positive and "substantial" impact of interacting with federal / state employees was evident for those with more education, but not for those with less than a four-year degree.

Third, some relationships observed between the sources of information and overall knowledge were negative. In other words, as information from a given source increased, knowledge decreased. Although the data do not allow us to explore these inverse relationships in detail, tentative hypotheses are suggested. For example, the negative relationship between television news and desert tortoise knowledge might be explained by the "sound byte" nature of this communication channel. Television news stories must communicate complex messages in a short time span, which might lead to incorrect knowledge. Understanding the negative relationships observed in some of the models requires further exploration.

Fourth, some of the information sources that increased respondents' knowledge can be controlled by desert managers (e.g., information distributed by government employees). Other information sources are not as easily manipulated by managing agencies (e.g., family and friends).

Finally, our information source regression models only explained at best 38% of the variability in respondents' knowledge. Accounting for the unexplained 62% of the variance will necessitate inclusion of additional predictor variables in future studies.

Understanding and Predicting Public Support for Desert Tortoises

The cognitive hierarchy served as the conceptual framework for understanding and predicting public perceptions. In this model, general value orientations (e.g., biocentric – anthropocentric basic beliefs) influence specific attitudes (e.g., attitudes toward recovery efforts) and norms (e.g., awareness of consequences [AC], ascription of responsibility [AR]). Attitudes and norms, in turn, are hypothesized to influence individual behavioral intentions (i.e., limiting recreational use) and evaluations of agency actions (i.e., support for desert tortoise recovery efforts).

As predicted, regression analyses indicated that attitudes toward desert tortoise recovery efforts influenced respondents' behavioral intentions to limit their desert recreation activities to protect the tortoise. Respondents with a positive attitude were more likely to constrain their behavior. Individuals who were aware of the consequences of human activity on desert tortoises and ascribed personal responsibility for their actions were also more likely to limit their desert recreation participation. A second path model predicting behavioral intentions to support desert tortoise recovery efforts was also examined. As expected, the attitude toward desert tortoise recovery efforts and the two norm variables (AC and AR) were statistically significant in this model.

Four predictor variables influenced the attitude toward recovery efforts. Beliefs about declines in the tortoise population was the strongest predictor, followed by trust in government agencies. Although believability of government information and knowledge of the desert tortoise were significant predictors, their influence was weak. Three variables influenced AR: knowledge of desert tortoises, believability of government information, and the belief that desert tortoise populations have declined. Two variables (believability of government information and knowledge of the desert tortoise) influenced AC.

Although some of the variables in the cognitive hierarchy are not likely to be influenced by persuasion techniques (e.g., value orientations), others can be. For example, the manual by Berry and Duck (1999) "Answering questions about desert tortoises" implicitly attempts to increase the publics' awareness of the consequences and personal ascription of responsibility for their actions in desert tortoise habitat. Each of these variables (AC and AR) directly influenced respondents' willingness to: (a) constrain their recreation behavior to protect the desert tortoise and (b) support recovery efforts of the desert tortoise. Recent brochures published by the Desert Managers Group present similar messages to achieve identical objectives.

Knowledge, agency trust, believability of agency information and beliefs about the status of desert tortoise populations, all influence these behaviors (i.e., limit use, support recovery efforts), but their impact is mediated by a person's attitude and norms. Efforts to increase public knowledge and agency trust are likely to foster more positive attitudes and norms, which in turn will build public support for and involvement with the desert tortoise recovery effort.

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Appendix A

Survey and Descriptive Findings

Public Perceptions of the Desert Tortoise

Photo by Matt McMillan

All Responses Are Confidential

Please Complete This Survey. Thank You for Your Cooperation

Postage-Paid Return Envelope Provided

A Study Funded by the National Fish & Wildlife Foundation and Conducted Cooperatively By:

DESERT MANAGERS GROUP

Colorado State University

Knowledge to Go Places

The California deserts include 25 million acres. About 4.8 million acres or 20% of the California deserts are designated as critical habitat for the desert tortoise. Much of this critical habitat is located in the Mojave Desert.

1. In a typical year (12 months), about how many days do you recreate in the Mojave Desert?

Days recreating in Mojave Desert per year	Percent
0	20
1 to 2	12
3 to 7	10
8 to 14	14
15 to 30	24
31 to 90	13
91 to 365	7
Total	100
I can't remember	17
Mean days	27.37
Range	0 to 365

2. On the scale below, please indicate how familiar you are with the Mojave Desert?

%	14	5	9	11	9	11	20	12	9	5.19
Scale:	1	2	3	4	5	6	7	8	9	Mean
	Not at all familiar							Extremely Familiar		

3. Which of the following types of areas (e.g., State Parks, National Parks) in the Mojave Desert have you ***ever visited***?

Types of Area	Percent
California State Parks	70
National Park Service	71
Bureau of Land Management	78
U.S. Fish & Wildlife Service	39
I have never visited the Mojave Desert	4

4. In a typical year (12 months), about how many days do you recreate in desert areas ***other than*** the Mojave Desert?

Days recreating in other deserts per year	Percent
0	24
1 to 2	15
3 to 7	19
8 to 14	16
15 to 30	14
31 to 90	9
91 to 365	3
Total	100
I can't remember	29
Mean days	18.59
Range	0 to 365

5. In a typical year (12 months), about how often do you do ***each*** of the following recreation activities in California desert areas?

	Times in a Typical Year								
Scale:	0	1	2	3 to 5	6 to 10	11 to 20	21 to 30	31+	Mean [1]
Scenic driving	33	4	9	17	12	11	5	10	7.61
Off-highway motorcycle	55	2	2	6	8	8	6	12	7.38
Viewing scenery	45	4	9	9	12	10	2	9	6.39
All Terrain Vehicle (ATV)	56	3	4	5	9	10	8	7	6.33
4 Wheel drive vehicle	60	1	3	3	10	11	6	7	6.16
Hiking	49	8	7	12	9	9	4	2	4.42
Wildlife viewing	61	3	8	9	7	4	2	5	3.73
Photography	71	1	5	9	5	4	1	4	2.97
Dune buggy / rail	82	2	0	2	4	7	1	3	2.45
Mountain biking	80	5	3	4	6	3	0	1	1.41
Birding	88	2	3	1	1	4	0	2	1.36
Wildlife hunting	86	4	2	3	1	2	2	1	1.22
Rock hounding	85	3	4	3	2	1	0	1	0.91
Climbing	82	5	5	5	2	2	0	0	0.79
Prospecting	93	1	1	4	1	0	0	0	0.39

1. Variables have been rank ordered based on the mean. For these analyses, the means were coded as the mid-point of the scale category: for example: (0 =0) (1 = 1) (2 = 2) (3 to5 = 4) (6 to 10 = 8) (11 to 20 = 15) (21 to 30 = 25) (31+ = 31)

The following questions ask about your awareness of and knowledge about the desert tortoise.

1. These questions ask about your awareness of and encounters with the desert tortoise. (***Circle ONE number for EACH question***)

	No	Yes	Unsure
Prior to receiving this survey, had you ever heard of the desert tortoise?	5	95	0
Have you ever seen a desert tortoise in the wild?	45	53	2
Do you know anyone who has picked up a desert tortoise in the wild?	75	24	1
Do you know anyone who has taken a desert tortoise from the wild?	87	6	7
Do you know anyone who has adopted a wild desert tortoise as a pet?	71	28	1
Do you know anyone who has released a pet desert tortoise into the wild?	94	4	2

2. Please indicate if you believe that ***each*** of the following statements related to the desert tortoise is true or false. Circle "U" for "unsure" if you are not sure if the statement is true or false.

	Correct	Incorrect	Unsure
The desert tortoise is the California state reptile	34	9	57
Desert tortoises hibernate from October through February	49	0	51
Desert tortoises may live to 100 years or longer	3	71	26
Adult desert tortoises are typically longer than 20 inches	36	28	36
Desert tortoises spend only a small percent of their time in their burrows	31	17	52
Desert tortoises do not need water to survive	15	56	29
Desert tortoises eat mainly plants such as grasses and flowers	70	2	28
The summer sun can kill an unsheltered desert tortoise within an hour	28	21	51
Desert tortoises build up most of their fat and water reserves during the spring	41	2	57
Desert tortoises may be active any time of the year following a rainfall	27	9	65

3. The desert tortoise population faces a number of problems.
How much of a threat do ***you think each*** of the following are to the desert tortoise population?

	Potential Threat to the Desert Tortoise								
	Not at all a threat						Extreme threat		% Unsure
Scale:	1	2	3	4	5	6	7	Mean	
A. Pesticides or other toxic chemicals	8	10	13	11	10	8	40	4.89	17
B. Disease	5	2	10	20	16	17	29	5.06	19
C. Being eaten by feral dogs	11	12	16	16	20	9	17	4.16	27
D. Being eaten by ravens	10	6	11	11	12	13	38	4.99	20
E. Competition for habitat with other wildlife	14	5	20	16	15	13	17	4.18	22
F. Drought	7	6	11	17	16	21	22	4.78	19
G. Habitat loss due to agriculture	8	10	9	10	19	13	30	4.84	15
H. Lack of nutritional food	8	11	15	16	15	12	24	4.47	24
I. Cattle / sheep grazing	27	12	17	15	12	9	8	3.34	28
J. Habitat loss due to human development	7	6	7	10	17	15	38	5.22	12
K. Road kill due to tortoises attempting to cross roads	7	10	13	11	19	15	26	4.74	14
L. Military training in the desert	6	12	13	18	13	15	23	4.56	22
M. Hunting	26	20	14	12	8	5	16	3.33	23
N. Collecting by humans	8	14	15	13	16	11	23	4.42	16
O. Hikers unintentionally disturbing tortoises	15	22	17	16	10	8	12	3.56	14
P. Off-highway vehicles unintentionally disturbing tortoises	11	14	13	12	18	10	23	4.35	10

4. From the list of potential threats in Question 3 (above), which do you feel is the ***one*** **main threat** to the desert tortoise population? **(*Write only ONE LETTER*)**

	Percent
J. Habitat loss due to human development	42
D. Being eaten by ravens	17
P. Off-highway vehicles unintentionally disturbing tortoises	7
A. Pesticides or other toxic chemicals	5
F. Drought	5
B. Disease	4
H. Lack of nutritional food	4
K. Road kill due to tortoises attempting to cross roads	4
N. Collecting by humans	4
C. Being eaten by feral dogs	2
L. Military training in the desert	2
E. Competition for habitat with other wildlife	1
G. Habitat loss due to agriculture	1
I. Cattle / sheep grazing	1
M. Hunting	1
O. Hikers unintentionally disturbing tortoises	0

The following questions ask about your opinions regarding the management of the desert tortoise.

1. Following are a number of management actions that federal / state agencies could take to help protect the desert tortoise. How acceptable would it be for a government agency to take each of the following actions?

How acceptable is it for federal / state agencies to:	Highly Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither Unacceptable nor Acceptable	Slightly Acceptable	Moderately Acceptable	Highly Acceptable	Mean
take no action to protect the desert tortoise	45	13	10	10	10	7	5	-1.31
vaccinate desert tortoises to control disease	12	7	4	22	21	13	22	0.57
enhance native vegetation food sources for the desert tortoise	10	4	4	17	17	18	31	1.03
fence roads to reduce road kills of desert tortoises	18	7	10	15	15	11	25	0.34
eliminate *ravens* that threaten juvenile desert tortoises	27	12	9	15	9	12	17	-0.28
eliminate *feral dogs* that threaten desert tortoises	15	8	10	17	20	15	15	0.24
purchase private land to slow human development in desert tortoise habitat	17	10	3	13	25	10	23	0.42
limit *new human development* in desert tortoise habitat	14	9	7	11	22	13	24	0.56
limit *military training maneuvers* in some areas of desert tortoise habitat	19	6	7	16	17	13	21	0.31
ban *cattle / sheep grazing* in some areas of desert tortoise habitat	12	15	8	15	23	13	14	0.16
limit *agricultural uses* in some areas of desert tortoise habitat	9	10	7	22	23	15	15	0.41
ban *hunting* in some areas of desert tortoise habitat	18	12	4	12	14	10	30	0.42
limit the number of *hikers* in some areas of desert tortoise habitat	27	13	9	18	10	10	12	-0.52
ban *hikers* in some areas of desert tortoise habitat	38	13	7	19	8	7	9	-0.95
limit number of *off-highway vehicles* in some areas of desert tortoise habitat	29	9	9	4	13	9	27	-0.03
ban *off-highway vehicles* in some areas of desert tortoise habitat	38	7	6	6	10	9	25	-0.32
ban *dual sport rides* in some areas of desert tortoise habitat	32	8	8	10	7	9	26	-0.16
enact seasonal closures to all human activity	37	8	6	14	7	9	20	-0.47

Animals that are at risk of becoming extinct are known as endangered species. Such animals are protected by laws to help save them from extinction. The questions in this section ask about your views regarding endangered species and the desert tortoise.

1. Prior to receiving this survey, had you ever heard of the ***Endangered Species Act***?

Heard of ESA	Percent
No	13
Unsure	7
Yes	80

1. In general, do you support or oppose the ***Endangered Species Act*** and efforts to ***recover the desert tortoise***?

Do you support or oppose	Strongly Oppose	Moderately Oppose	Slightly Oppose	Neither Oppose nor Support	Slightly Support	Moderately Support	Strongly Support	Mean	% Unsure
Scale:	-3	-2	-1	0	1	2	3		
Endangered Species Act	8	9	2	14	14	19	34	1.10	3
Efforts to recover the desert tortoise	6	2	4	13	17	19	39	1.45	2

3. How would you describe your attitude toward ***endangered species and the desert tortoise***?

Overall, I would say that my:	Extremely Negative	Moderately Negative	Slightly Negative	Neither Negative nor Positive	Slightly Positive	Moderately Positive	Extremely Positive	Mean	% Unsure
Scale:	-3	-2	-1	0	1	2	3		
Attitude towards *all endangered species* is …	3	3	6	11	16	25	36	1.52	1
Attitude towards recovery efforts to save *all endangered species* is …	7	4	7	7	22	21	33	1.27	1
Attitude towards the *desert tortoise* is …	3	3	3	14	14	23	41	1.64	2
attitude towards recovery efforts to save the desert tortoise is …	5	4	5	11	15	22	38	1.45	1

4. To what extent do you agree or disagree with each of the following statements about the desert tortoise and endangered species.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither	Slightly Agree	Moderately Agree	Strongly Agree	
Scale:	-3	-2	-1	0	1	2	3	Mean
The number of desert tortoises have declined dramatically in recent years	3	2	2	42	16	11	24	0.96
The government should do more to protect desert tortoise populations	7	7	9	22	18	15	22	0.71
Land managers are doing everything they can to save the desert tortoise	8	14	19	41	8	8	2	-0.42
Laws protecting the desert tortoise are too strict	16	10	6	47	6	7	7	-0.31
Endangered species should not be recovered unless there is a direct benefit to humans	43	13	8	20	6	3	8	-1.28
The needs of people are always more important than any rights endangered species may have	31	14	13	12	9	8	13	-0.73
Recreational use of desert environments is more important than protecting the endangered species that live there	32	12	20	13	12	7	5	-0.97
We should strive for a society that emphasizes environmental protection rather than economic growth	9	16	16	21	16	12	10	-0.06
Endangered species should be protected for their own sake rather than to simply meet our needs	16	4	6	12	20	18	23	0.63
The rights of endangered species to live is more important than the negative effects that their recovery may have on humans	17	9	12	26	15	12	9	-0.15
I would be willing to limit the number of my visits to the desert to help protect the desert tortoise	21	5	10	15	16	16	17	0.16
I would be willing to limit the areas I visit in the desert to help protect the desert tortoise	16	7	4	10	22	22	20	0.59
I would be willing to limit my recreational use of the desert during certain seasons to help protect the desert tortoise	15	6	5	9	20	23	22	0.69
I would be willing to contribute money to help protect the desert tortoise	21	8	6	27	16	9	14	-0.09
I am aware of the impacts that humans can have on the desert tortoise	4	3	5	14	19	28	27	1.32
My personal actions can impact the ability of the desert tortoise to recover	9	2	5	19	12	26	28	1.09
If I touch a desert tortoise, it could hurt the animal's ability to survive	11	5	4	21	12	13	34	0.94
I feel a strong personal obligation to protect the desert tortoise	14	6	7	22	13	22	17	0.48
I feel an obligation to educate others about the importance of protecting desert tortoises	14	6	6	25	16	16	17	0.41
It is *not* my responsibility to protect the desert tortoise	27	19	16	15	10	9	4	-0.96
Off-highway vehicles are unfairly blamed for harming desert tortoises	14	7	5	26	9	12	27	0.53

4. To what extent do you agree or disagree with ***each*** of the following statements regarding your **trust** in the federal / state agencies involved in the desert tortoise recovery effort?

I **trust** the federal / state agencies to:	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Moderately Agree	Strongly Agree	
Scale:	-3	-2	-1	0	1	2	3	Mean
provide the best available information on desert tortoise issues	13	12	10	17	19	17	13	0.19
provide truthful information about desert tortoise issues	12	10	7	14	24	19	15	0.44
make good management decisions regarding the desert tortoise	14	12	12	25	15	11	11	-0.10
follow the best available science in managing the desert tortoise	14	8	11	23	21	11	11	0.10

6. How believable would you rate ***each*** of the following types of desert tortoise information from federal / state agencies?

	Not at all Believable		Slightly Believable		Moderately Believable			Highly Believable			% Unsure
Scale:	1	2	3	4	5	6	7	8	9	Mean	
Biological information about the desert tortoise	4	3	5	4	19	23	19	13	10	6.00	19
The status of desert tortoise populations	4	5	6	7	16	23	14	13	12	5.86	13
Information on threats to desert tortoise populations	4	7	10	11	13	13	21	8	12	5.58	12
Information about desert tortoise recovery strategies	6	6	8	5	19	22	14	10	10	5.57	14
Actions I can take to help protect the desert tortoise	5	4	7	7	16	19	14	11	16	5.93	14
How my personal actions affect the desert tortoise	7	3	6	10	14	15	14	11	20	5.98	15

7. Taking everything into consideration, how would you grade the government in managing the desert tortoise?

Grade	Percent	Valid Percent
A+	1	2
A	3	5
A-	3	5
B+	4	6
B	18	32
B-	3	5
C+	8	13
C	6	10
C-	6	11
D	2	3
F	4	8
Total	57	100
Don’t Know	43	Do not know enough about the management of the desert tortoise to give a letter grade

The following questions ask about the sources from which you obtain information about the desert tortoise.

1. About how often have you obtained information about the desert tortoise from ***each*** of the following sources?

	Never	Once	Twice	3 times	4 times	5 or more times	
Scale:	0	1	2	3	4	5	Mean
A. Newspapers, magazines, books	43	9	16	12	4	17	1.77
B. Radio	85	8	5	0	8	2	0.30
C. Television news	70	10	10	6	1	4	0.72
D. Other television programs (e.g., Discovery Channel, PBS)	42	17	15	10	6	11	1.54
E. State agency brochures	64	16	6	5	5	3	0.80
F. Federal agency brochures	73	9	9	5	3	2	0.64
G. State agency websites	87	7	3	2	0	2	0.28
H. Federal agency websites	88	6	3	1	0	2	0.27
I. Other internet websites	79	8	5	6	0	1	0.46
J. Conservation groups	68	11	13	1	4	4	0.73
K. Off-highway vehicle groups	61	11	8	8	7	6	1.06
L. Outdoor videos and / or DVD's	86	5	4	2	3	1	0.34
M. Federal or state employees	77	5	10	2	1	5	0.59
N. Friends / family members, word of mouth	47	9	11	15	5	14	1.65

2 From the list of information sources in Question 1 (above), please state the ***one*** **main source** from which you would ***prefer*** to obtain information regarding the desert tortoise. **(*Write only ONE LETTER*)**

	Percent
D. Other television programs (e.g., Discovery Channel, PBS)	31
A. Newspapers, magazines, books	15
K. Off-highway vehicle groups	11
E. State agency brochures	8
C. Television news	6
F. Federal agency brochures	6
N. Friends / family members, word of mouth	5
G. State agency websites	4
H. Federal agency websites	4
J. Conservation groups	4
I. Other internet websites	3
L. Outdoor videos and / or DVD's	1
M. Federal or state employees	1
B. Radio	0

Finally, we would like to ask you a few questions about yourself to help us understand the different characteristics of respondents and to allow us to compare your answers with those of other respondents. Your answers are totally confidential.

1. Are you a member of any environmental or wildlife groups (e.g., Sierra Club, Ducks Unlimited)?

92% No
8 Yes If yes, which groups?

Environmental Groups	Number of respondents
Sierra Club	15
Ducks Unlimited	8
Elk Foundation	8
MDHCA	8
Blue Ribbon Coalition	7
Quails Unlimited	5
Living Desert	4
Desert Wildlife	4
Defenders of Wildlife	2
MRA	3
World Wildlife Federation	2
Desert Tortoise Club	2
National Wildlife Society	1
Fly Fishers	1

2. Are you a member of any off-highway vehicle groups (e.g., Blue Ribbon Coalition, California Association of 4-Wheel Drive Clubs)?

85% No
15 Yes If yes, which groups?

Off-highway vehicle groups	Number of respondents
American Motorcycle Association	45
CORVA	31
American Sand Association	26
4 x 4 Club	9
SCTA	9
Dunes	6
4WD	5
Honda Riders Club	4

3. Do you own any of the following types of vehicles? (***Check ALL that apply***)

Type of vehicle	Percent
Off-highway motorcycle	37
ATV	41
Dune buggy / rail	14
4 wheel drive vehicle	44
Other	4

Total Number of Vehicles Owned	Number of Respondents	Percent
0	302	30
1	320	32
2	161	16
3	148	14
4	81	8

Number of Vehicles Owned	Number of Respondents	Percent
None	302	30
1 or more	709	70

4. Have you ever driven an off-highway vehicle in the California desert?

	Percent
No	31
Yes	69

5. Have you hunted in the California desert in the last 5 years?

	Percent
No	90
Yes	10

6. Are you?

Sex	Percent
Female	51
Male	49

7. What is your age?

Age	Percent
18 to 29	20
30 to 39	24
40 to 49	24
50 to 59	15
60 to 69	10
70+	7
Mean age	43.46

8. Do you live within the California desert?

Desert residence	Percent
No	26
Yes	74

9. In which county do you currently live?

County of Residence	Number of Respondents	Percent
Imperial	16	2
Kern	65	6
Los Angeles	140	14
Riverside	120	12
San Bernardino	669	66

10. How would you describe **your current** residence or community?

Size of community	Percent
Large city with 250,000 or more people	14
City with 100,000 to 249,999 people	41
City with 50,000 to 99,999 people	16
Small city with 25,000 to 49,999 people	12
Town with 10,000 to 24,999 people	9
Town with 5,000 to 9,999 people	2
Small town / village with less than 5,000 people	4
A farm or rural area	2

11. What is the **highest** level of education that **you** have achieved?

Education	Percent
Less than high school diploma	3
High school diploma or GED	24
2-year associates degree or trade school	39
4-year college degree (e.g., bachelors)	20
Advanced degree beyond 4-year degree (e.g., masters, Ph.D., medical doctor)	14

12. In what ethnic group would you place yourself?

Ethnicity	Percent
Hispanic or Latino	33
Not Hispanic or Latino	67

13. In what race would you place yourself? **(*Check ONE or more*)**

Race	Percent
American Indian or Alaska Native	3
Asian	5
Black or African American	4
Native Hawaiian / other Pacific Islander	7
White	81

14. What is your approximate annual household income before taxes?

Income	Percent
Less than $10,000	2
$10,000 to $29,999	6
$30,000 to $49,999	18
$50,000 to $69,999	11
$70,000 to $89,999	21
$90,000 to $109,999	18
$110,000 to $129,999	9
$130,000 to $149,999	8
$150,000 to $199,999	2
$200,000 to $249,999	2
more than $250,000	3

Appendix B

Data Weighting Methodology

To reflect the actual population of individuals living in the five counties included in this study, the sample was weighted by U.S. Census 2000 data (U.S. Census Bureau, 2000). Four weighting variables were used:

1. county (Imperial, Kern, Los Angeles, Riverside, San Bernardino)
2. ethnicity (Hispanic vs. Non-Hispanic)
3. sex (male vs. female)
4. age (18-29, 30-39, 40-49, 50-59, 60-69, 70+)

The combination of these four variables and their associated levels resulted in 120 cells (i.e., 5 counties * 2 levels of ethnicity * 2 levels of sex * 6 age categories = 120). The population size (N) and population percent for these 120 cells were based on Census 2000 data. The percent of the sample in these cells was based on the survey data. Weights were calculated using the formula:

$$\text{Weight} = \frac{\text{Population \%}}{\text{Sample \%}}$$

Sampling weights for Imperial County

County	Population	Category	Hispanic Population	% Hispanic Population	% Hispanic Sample	Hispanic Weight
Imperial						
Total Population	142361					
% 18 and over	0.686					
Total Population 18+	97660					
		Male 18-29	10108	0.104		
		Male 30-39	8173	0.084		
		Male 40-49	6603	0.068	0.025	2.704
		Male 50-59	3410	0.035		
		Male 60-69	2319	0.024	0.15	0.158
		Male 70+	2332	0.024		
		Female 18-29	8721	0.089		
		Female 30-39	7714	0.079		
		Female 40-49	7098	0.073	0.225	0.323
		Female 50-59	3962	0.041	0.175	0.232
		Female 60-69	2870	0.029		
		Female70+	2860	0.029		
			Non-Hispanic Population	% Non-Hispanic Population	% Non-Hispanic Sample	Non-Hispanic Weight
		Male 18-29	3700	0.038		
		Male 30-39	4249	0.044		
		Male 40-49	3751	0.038		
		Male 50-59	2635	0.027	0.075	0.360
		Male 60-69	1866	0.019	0.05	0.382
		Male 70+	2300	0.024		
		Female 18-29	1749	0.018		
		Female 30-39	2133	0.022		
		Female 40-49	2471	0.025	0.125	0.202
		Female 50-59	2225	0.023	0.05	0.456
		Female 60-69	1763	0.018	0.075	0.241
		Female70+	2603	0.027	0.05	0.533

Sampling weights for Kern County

County	Population	Category	Hispanic Population	% Hispanic Population	% Hispanic Sample	Hispanic Weight
Kern						
Total Population	661645					
% 18 and over	0.681					
Total Population 18+	450580					
		Male 18-29	30973	0.069		
		Male 30-39	21961	0.049	0.013	3.749
		Male 40-49	14727	0.033	0.039	0.838
		Male 50-59	7009	0.016	0.184	0.085
		Male 60-69	3629	0.008	0.132	0.061
		Male 70+	2744	0.006	0.026	0.234
		Female 18-29	24571	0.055		
		Female 30-39	18194	0.040		
		Female 40-49	13082	0.029	0.026	1.117
		Female 50-59	6849	0.015	0.026	0.585
		Female 60-69	3771	0.008	0.013	0.644
		Female70+	3228	0.007		
			Non-Hispanic Population	% Non-Hispanic Population	% Non-Hispanic Sample	Non-Hispanic Weight
		Male 18-29	30462	0.068	0.013	5.200
		Male 30-39	31681	0.070	0.013	5.409
		Male 40-49	33780	0.075	0.053	1.415
		Male 50-59	23260	0.052	0.211	0.245
		Male 60-69	15088	0.033	0.105	0.319
		Male 70+	15619	0.035	0.053	0.654
		Female 18-29	27357	0.061		
		Female 30-39	28452	0.063	0.026	2.429
		Female 40-49	31574	0.070	0.026	2.695
		Female 50-59	23357	0.052	0.026	1.994
		Female 60-69	16507	0.037	0.013	2.818
		Female70+	22391	0.050		

Sampling weights for Los Angeles County

County	Population	Category	Hispanic Population	% Hispanic Population	% Hispanic Sample	Hispanic Weight
Los Angeles						
Total Population	9519338					
% 18 and over	0.72					
Total Population 18+	6853923					
		Male 18-29	497436	0.073		
		Male 30-39	381063	0.056		
		Male 40-49	240208	0.035	0.08	0.438
		Male 50-59	124242	0.018	0.08	0.227
		Male 60-69	63889	0.009	0.046	0.203
		Male 70+	47390	0.007	0.011	0.629
		Female 18-29	453768	0.066		
		Female 30-39	350024	0.051	0.023	2.220
		Female 40-49	248998	0.036	0.063	0.577
		Female 50-59	142325	0.021	0.063	0.330
		Female 60-69	81887	0.012	0.04	0.299
		Female70+	76004	0.011	0.011	1.008
			Non-Hispanic Population	% Non-Hispanic Population	% Non-Hispanic Sample	Non-Hispanic Weight
		Male 18-29	398852	0.058		
		Male 30-39	428731	0.063	0.006	10.425
		Male 40-49	426507	0.062	0.126	0.494
		Male 50-59	312646	0.046	0.166	0.275
		Male 60-69	197587	0.029	0.097	0.297
		Male 70+	218633	0.032	0.006	5.316
		Female 18-29	409632	0.060		
		Female 30-39	433097	0.063	0.023	2.747
		Female 40-49	436025	0.064	0.063	1.010
		Female 50-59	334372	0.049	0.046	1.061
		Female 60-69	221576	0.032	0.023	1.406
		Female70+	326470	0.048	0.029	1.643

Sampling weights for Riverside County

County	Population	Category	Hispanic Population	% Hispanic Population	% Hispanic Sample	Hispanic Weight
Riverside						
Total Population	1545387					
% 18 and over	0.697					
Total Population 18+	1077135					
		Male 18-29	60910	0.057		
		Male 30-39	48766	0.045	0.008	5.659
		Male 40-49	32208	0.030		
		Male 50-59	15380	0.014	0.076	0.188
		Male 60-69	8411	0.008	0.051	0.153
		Male 70+	6386	0.006	0.017	0.349
		Female 18-29	54506	0.051	0.008	6.325
		Female 30-39	44109	0.041	0.059	0.694
		Female 40-49	30283	0.028	0.059	0.477
		Female 50-59	15718	0.015	0.051	0.286
		Female 60-69	9619	0.009	0.051	0.175
		Female70+	8299	0.008	0.008	0.963
			Non-Hispanic Population	% Non-Hispanic Population	% Non-Hispanic Sample	Non-Hispanic Weight
		Male 18-29	61529	0.057		
		Male 30-39	68930	0.064	0.017	3.764
		Male 40-49	76201	0.071	0.034	2.081
		Male 50-59	54106	0.050	0.076	0.661
		Male 60-69	41694	0.039	0.11	0.352
		Male 70+	55138	0.051	0.025	2.048
		Female 18-29	61067	0.057	0.025	2.268
		Female 30-39	71057	0.066	0.008	8.246
		Female 40-49	75702	0.070	0.22	0.319
		Female 50-59	56214	0.052	0.034	1.535
		Female 60-69	46631	0.043	0.042	1.031
		Female70+	73832	0.069	0.017	4.032

Sampling weights for San Bernardino County

County	Population	Category	Hispanic Population	% Hispanic Population	% Hispanic Sample	Hispanic Weight
San Bernardino						
Total Population	1709434					
% 18 and over	0.677					
Total Population 18+	1157287					
		Male 18-29	71871	0.062	0.023	2.700
		Male 30-39	55711	0.048	0.027	1.783
		Male 40-49	38600	0.033	0.045	0.741
		Male 50-59	18964	0.016	0.042	0.390
		Male 60-69	9450	0.008	0.025	0.327
		Male 70+	7094	0.006		
		Female 18-29	65623	0.057	0.02	2.835
		Female 30-39	53291	0.046	0.048	0.959
		Female 40-49	38129	0.033	0.045	0.732
		Female 50-59	19706	0.017	0.038	0.448
		Female 60-69	11436	0.010	0.025	0.395
		Female70+	10050	0.009	0.015	0.579
			Non-Hispanic Population	% Non-Hispanic Population	% Non-Hispanic Sample	Non-Hispanic Weight
		Male 18-29	80993	0.070	0.037	1.891
		Male 30-39	75968	0.066	0.055	1.194
		Male 40-49	83455	0.072	0.08	0.901
		Male 50-59	58634	0.051	0.116	0.437
		Male 60-69	34983	0.030	0.103	0.293
		Male 70+	34769	0.030	0.01	3.004
		Female 18-29	75071	0.065	0.037	1.753
		Female 30-39	79301	0.069	0.037	1.852
		Female 40-49	86123	0.074	0.07	1.063
		Female 50-59	59006	0.051	0.045	1.133
		Female 60-69	37863	0.033	0.06	0.545
		Female70+	51296	0.044		

Appendix C

OHV owners vs. Non-OHV owners

Across all respondents (*n* = 1011), 709 owned an OHV and 625 of these individuals participated in OHV desert-related recreation activities (Table C1). Among the 302 individuals who did not own an OHV, 284 did not participate in desert recreation activities with an off-highway vehicle.

This appendix compares those respondents who owned on OHV and participated in desert-related recreation activities with their vehicle (*n* = 625) and individuals who did not own an OHV and did not participate in desert recreation activities with a vehicle (*n* = 248).

Table C1. Participation in OHV desert activities by OHV ownership

	OHV Ownership [1]		
Participation in OHV desert activities	No	Yes	Total
No	248	84	332
Yes	54	625	679
Total	302	709	1011

1. Cell entries are n's

Table C2. Prior experience by OHV ownership and participation

	OHV Ownership/Participation [1]				
Prior recreation experience	No	Yes	*F*-value	*p*-value	eta
Average days recreating in Mojave Desert [2]	10.52	34.96	37.86	< .001	.223
Familiarity with the Mojave Desert [3]	4.42	5.70	49.78	< .001	.233
Average days recreating in other desert areas [2]	15.20	19.77	0.95	.331	.039

1. Cell entries are means
2. Variable coded from fill-in-the-blank responses.
3. Variable coded on a 9-point scale ranging from (1) not at all familiar to (9) extremely familiar.

Table C3. Specific knowledge indicators by OHV ownership and participation

	OHV Ownership/Participation				
	No (%)	Yes (%)	χ^2	*p*-value	Cramer's *V*
The desert tortoise is the California state reptile			5.33	.070	.077
Correct	30	32			
Incorrect	8	12			
Unsure	62	56			
Desert tortoises hibernate from October through February			14.88	.001	.127
Correct	42	56			
Incorrect	0	1			
Unsure	58	44			
Desert tortoises may live to 100 years or longer			46.32	< .001	.236
Correct	1	3			
Incorrect	58	78			
Unsure	41	18			
Adult desert tortoises are typically longer than 20 inches			78.21	< .001	.279
Correct	46	34			
Incorrect	9	37			
Unsure	45	29			
Desert tortoises spend only a small percent of their time in their burrows			13.64	.001	.121
Correct	31	32			
Incorrect	11	20			
Unsure	58	48			
Desert tortoises do not need water to survive			82.51	< .001	.314
Correct	8	19			
Incorrect	40	60			
Unsure	52	21			
Desert tortoises eat mainly plants such as grasses and flowers			17.85	< .001	.145
Correct	62	74			
Incorrect	1	3			
Unsure	37	23			
The summer sun can kill an unsheltered desert tortoise within an hour			27.93	< .001	.177
Correct	23	30			
Incorrect	12	24			
Unsure	65	46			
Desert tortoises build up most of their fat and water reserves during the spring			16.14	< .001	.135
Correct	33	48			
Incorrect	1	1			
Unsure	66	51			
Desert tortoises may be active any time of the year following a rainfall			24.39	< .001	.154
Correct	36	26			
Incorrect	2	11			
Unsure	62	63			
Overall knowledge score			1.74	.419	.046
Low	32	35			
Medium	47	42			
High	21	23			

Table C4. Awareness of and encounters with the desert tortoise by OHV ownership and participation

	OHV Ownership/Participation				
	No (%)	Yes (%)	χ^2	*p*-value	Cramer's *V*
Prior to receiving this survey, had you ever heard of the desert tortoise?			41.89	< .001	.233
No	12	2			
Yes	87	98			
Unsure	1	0			
Have you ever seen a desert tortoise in the wild?			37.15	< .001	.206
No	54	40			
Yes	43	60			
Unsure	3	0			
Do you know anyone who has picked up a desert tortoise in the wild?			34.00	< .001	.188
No	87	69			
Yes	13	31			
Unsure	0	0			
Do you know anyone who has taken a desert tortoise from the wild?			19.52	< .001	.134
No	89	85			
Yes	9	6			
Unsure	2	9			
Do you know anyone who has adopted a wild desert tortoise as a pet?			44.63	< .001	.2132
No	84	62			
Yes	16	37			
Unsure	0	1			
Do you know anyone who has released a pet desert tortoise into the wild?			7.81	.020	.074
No	97	96			
Yes	3	2			
Unsure	0	2			

Table C5. Perceived threats by OHV ownership and participation

Perceived threats [1]	OHV Ownership/Participation No	OHV Ownership/Participation Yes	*F*-value	*p*-value	Eta
Human [2]	4.65	4.07	20.94	< .001	.164
Nature [2]	4.70	4.68	0.01	.907	.004
Other animals [2]	4.39	4.49	0.71	.401	.030
Habitat loss [2]	5.55	4.94	21.27	< .001	.162
Pesticides or other toxic chemicals [3]	5.49	4.69	21.73	< .001	.172
Disease [3]	5.23	5.05	1.60	.206	.048

1. Variables coded on 7-point scales ranging from (1) not at all a threat to (7) extreme threat. Cell entries are means.
2. Composite variables constructed from the items shown in body of report).
3. Single-item variable.

Table C6. One main threat to desert tortoise populations by OHV ownership and participation

One main perceived threat	OHV Ownership/Participation No (%)	OHV Ownership/Participation Yes (%)
Habitat loss due to human development	53	34
Off-highway vehicles unintentionally disturbing tortoises	13	5
Drought	9	5
Pesticides or other toxic chemicals	7	2
Disease	6	5
Being eaten by ravens	5	25
Road kill due to tortoises attempting to cross roads	2	5
Cattle / sheep grazing	2	0
Collecting by humans	1	4
Competition for habitat with other wildlife	1	1
Habitat loss due to agriculture	1	1
Hunting	1	1
Lack of nutritional food	0	6
Military training in the desert	0	3
Being eaten by feral dogs	0	1
Hikers unintentionally disturbing tortoises	0	1

$\chi^2 = 156.49$, $p < .001$, Cramer's $V = .385$

Table C7. Awareness of Endangered Species Act (ESA) and desert tortoise declines by OHV ownership and participation

	OHV Ownership/Participation				
	No (%)	Yes (%)	χ^2	*p*-value	Cramer's *V*
Heard of ESA prior to this survey			4.00	.135	.069
Yes	78	84			
No	16	11			
Unsure	6	5			
The number of desert tortoises have declined dramatically in recent years			35.36	< .001	.191
Agree	42	53			
Neither	56	37			
Disagree	2	10			

Table C8. Support for management actions by OHV ownership and participation

	OHV Ownership/Participation [1]				
	No	Yes	*F*-value	*p*-value	eta
Do you support or oppose [2]					
The Endangered Species Act	1.60	0.74	31.41	< .001	.189
Efforts to recover the desert tortoise	1.90	1.13	32.83	< .001	.193
Beliefs about management actions [3]					
The government should do more to protect desert tortoise populations	0.95	0.39	17.10	< .001	.139
Land managers are doing everything they can to save the desert tortoise	-0.64	-0.29	12.42	< .001	.119
Laws protecting the desert tortoise are too strict	-0.82	-0.06	37.47	< .001	.203

1. Cells entries are means.
2. Variables coded on 7-point scales ranging from (-3) strongly oppose to (+3) strongly support.
3. Variables coded on 7-point scales ranging from (-3) strongly disagree to (+3) strongly agree.

Table C9. Attitudes toward endangered species and desert tortoises by OHV ownership and participation

	OHV Ownership/Participation				
Attitude [1]	No	Yes	*F*-value	*p*-value	eta
attitude towards *all endangered species*	1.79	1.36	12.12	.001	.118
attitude towards recovery efforts to save *all endangered species*	1.64	1.05	18.12	< .001	.143
attitude towards the *desert tortoise*	2.04	1.42	26.90	< .001	.175
attitude towards recovery efforts to save the desert tortoise	2.06	1.10	52.02	< .001	.239

1 Variables coded on 7-point scales ranging from (-3) extremely negative to (+3) extremely positive. Cell entries are means.

Table C10. Acceptability of management actions by OHV ownership and participation

How acceptable is it for federal / state agencies to: [1]	OHV Ownership/Participation				
	No	Yes	*F*-value	*p*-value	eta
take no action to protect the desert tortoise	-1.88	-0.97	38.90	< .001	.207
vaccinate desert tortoises to control disease	0.93	0.40	14.04	< .001	.126
enhance native vegetation food sources for the desert tortoise	0.81	1.10	4.62	.032	.073
fence roads to reduce road kills of desert tortoises	0.66	0.15	10.04	.002	.107
eliminate *ravens* that threaten juvenile desert tortoises	-0.45	-0.23	1.85	.175	.046
eliminate *feral dogs* that threaten desert tortoises	0.30	0.21	0.41	.524	.022
purchase private land to slow human development in desert tortoise habitat	0.46	0.32	0.79	.376	.030
limit *new human development* in desert tortoise habitat	0.59	0.51	0.26	.607	.017
limit *military training maneuvers* in some areas of desert tortoise habitat	0.37	0.18	1.44	.231	.041
ban *cattle / sheep grazing* in some areas of desert tortoise habitat	0.49	-0.03	12.03	.001	.117
limit *agricultural uses* in some areas of desert tortoise habitat	0.71	0.17	16.81	< .001	.138
ban *hunting* in some areas of desert tortoise habitat	1.16	-0.05	50.94	< .001	.235
limit the number of *hikers* in some areas of desert tortoise habitat	0.49	-1.16	130.95	< .001	.363
ban *hikers* in some areas of desert tortoise habitat	-0.33	-1.46	60.62	< .001	.255
limit number of *off-highway vehicles* in some areas of desert tortoise habitat	1.58	-0.90	226.16	< .001	.454
ban *off-highway vehicles* in some areas of desert tortoise habitat	1.24	-1.20	205.91	< .001	.437
ban *dual sport rides* in some areas of desert tortoise habitat	1.30	-1.04	195.86	< .001	.429
enact seasonal closures to all human activity	0.59	-1.05	87.41	< .001	.302

1. Variables coded on 7-point scales ranging from (-3) highly unacceptable to (+3) highly acceptable. Cell entries are means

Table C11. Sources of information by OHV ownership and participation

Information Source [1]	OHV Ownership/Participation No	Yes	*F*-value	*p*-value	eta
Traditional media [2]	0.74	1.19	33.21	< .001	.192
Brochures [3]	0.27	0.84	38.72	< .001	.206
Websites [4]	0.17	0.38	12.63	< .001	.120
Conservation groups [5]	0.83	0.72	1.07	.301	.035
Off-highway vehicle groups [5]	0.12	1.59	163.70	< .001	.398
Outdoor videos and / or DVD's [5]	0.06	0.42	27.92	< .001	.176
Federal or state employees [5]	0.45	0.65	4.46	.035	.071
Friends / family members, word of mouth [5]	0.93	2.04	65.36	< .001	.264

1. Variables coded on 6-point scales: (0) never, (1) once, (2) twice, (3) 3 times, (4) 4 times, and (5) 5 or more times. Cell entries are means.
2. Composite variable constructed from the average of newspapers, magazines, books, radio, and television.
3. Composite variable constructed from the average of state and federal agency brochures.
4. Composite variable constructed from the average of state, federal and other internet websites.
5. Single-item variable.

Table C12. Preferred main source for obtaining desert tortoise information by OHV ownership and participation

Preferred main source of information	OHV Ownership/Participation No (%)	Yes (%)
Television programs (e.g., Discovery Channel, PBS)	37	22
Conservation groups	13	1
Television news	9	6
Newspapers, magazines, books	7	17
Federal agency websites	6	3
Federal agency brochures	5	6
Friends / family members, word of mouth	4	7
State agency brochures	3	9
Other internet websites	3	4
Radio	1	0
Off-highway vehicle groups	0	18
State agency websites	0	5
Outdoor videos and / or DVD's	0	0
Federal or state employees	0	2

$\chi^2 = 242.55$, $p < .001$, Cramer's $V = .490$.

Table C13. Agency trust and believability of information by OHV ownership and participation

	OHV Ownership/Participation [1]				
	No	Yes	*F*-value	*p*-value	eta
Trust federal / state agencies [2]	0.04	-0.01	0.17	.684	.014
Believability of information [3]	5.82	5.71	0.55	.458	.027

1. Cell entries are means.
2. Composite variable constructed from the trust items listed in body of report.
3. Composite variable constructed from the believability items listed in body of report.

Table C14. Overall evaluation of government management of the desert tortoise by OHV ownership and participation

	OHV Ownership/Participation				
	No (%)	Yes (%)	χ^2 or *F*	*p*-value	Effect Size
Provided a letter grade			38.77	< .001	.212
No – do not know enough to give a letter grade	58	35			
Yes	42	65			
Letter grade			16.01	.003	.169
A	9	9			
B	39	45			
C	36	36			
D	0	4			
F	16	6			
Grade point average [1]	2.29	2.47	2.39	.123	.068

1. Variable coded on a 5-point scale: (0) F, (1) D, (2) C, (3) B, and (4) A. Cell entries are means.

Table C15. Beliefs about endangered species and desert tortoises by OHV ownership and participation

	OHV Ownership/Participation [1]				
Belief concepts [2]	No	Yes	*F*-value	*p*-value	Eta
OHV's are unfairly blamed for harming desert tortoises	-0.90	1.33	263.54	< .001	.482
Anthropocentric basic beliefs	-1.46	-0.68	38.98	< .001	.207
Biocentric basic beliefs	0.29	0.14	1.67	.197	.044
Awareness of consequences	1.01	1.17	1.92	.166	.047
Ascription of responsibility	0.82	0.50	6.21	.013	.084
Behavioral intentions	1.49	-0.12	123.13	< .001	.352

1. Cell entries are means
2. Belief concepts constructed from the items in body of report.

Table C16. Demographics by OHV ownership and participation

Demographics	OHV Ownership/Participation No (%)	Yes (%)	χ^2	*p*-value	Cramer's *V*
Sex			57.57	< .001	.255
Male	68	40			
Female	32	60			
Age			68.84	< .001	.284
18 – 29	30	16			
30 – 39	15	28			
40 – 49	14	28			
50 – 59	15	15			
60 – 69	14	9			
70+	12	3			
Mean age	44.56	42.50			
Education			132.88	< .001	.368
Less than high school diploma	3	1			
High school or GED	4	32			
2 year associate degree or trade school	35	42			
4 year college degree (bachelors)	31	15			
Advanced degree beyond 4 year degree	27	10			
Income			153.03	< .001	.389
Less than $10,000	3	0			
$10,000 to $29,999	12	1			
$30,000 to $49,999	23	17			
$50,000 to $69,999	16	9			
$70,000 to $89,999	21	22			
$90,000 to $109,999	16	18			
$110,000 to $129,999	8	10			
$130,000 to $149,999	0	13			
$150,000 to $199,999	0	3			
$200,000 to $249,999	1	3			
More than $250,000	0	4			
Ethnicity			5.63	.018	.081
Hispanic or Latino	39	30			
Not Hispanic or Latino	61	70			
Race			25.12	< .001	.180
American Indian or Alaska Native	5	2			
Asian	10	3			
Black or African American	4	4			
Native Hawaiian / other Pacific Islander	6	7			
White	75	84			

Table C17. Place of residence by OHV ownership and participation

	OHV Ownership/Participation				
Place of residence	No (%)	Yes (%)	χ^2	*p*-value	Cramer's *V*
Do you live within the California desert?			1.17	.280	.036
No	21	25			
Yes	79	75			
County of residence			12.57	.014	.114
Imperial	0	2			
Kern	9	6			
Los Angeles	8	14			
Riverside	13	11			
San Bernardino	70	67			
Size of community			34.99	< .001	.170
Large city (250,000+ people)	12	14			
City (100,000 to 249,999 people)	46	39			
City (10,000 to 99,999 people)	13	16			
Small city (25,000 to 49,999 people)	18	11			
Town (10,000 to 24,999 people)	7	8			
Town (5,000 to 9,999 people)	0	3			
Small town / village (< 5,000 people)	4	5			
A farm or rural area	0	3			

Table C18. Organizational membership by OHV ownership and participation

	OHV Ownership/Participation				
Organizational membership	No (%)	Yes (%)	χ^2	*p*-value	Cramer's *V*
Environmental or wildlife groups			0.58	.448	.025
No	93	91			
Yes	7	9			
Off-Highway vehicle groups			103.98	< .001	.276
No	100	78			
Yes	0	22			

Appendix D

California Desert Residents

This appendix compares respondents who live in the California desert (74%) against those who do not live in the desert (26%).

Table D1. California desert residence

Live in the California Desert	Number of Respondents	Percent of Respondents
No	261	26
Yes	750	74
Total	1011	100

Table D2. Prior experience by California desert residence

	Live in the California Desert [1]				
Prior recreation experience	No	Yes	*F*-value	*p*-value	eta
Average days recreating in Mojave Desert [2]	10.39	34.09	35.16	< .001	.201
Familiarity with the Mojave Desert [3]	4.60	5.39	18.72	< .001	.135
Average days recreating in other desert areas [2]	6.15	23.14	15.20	< .001	.144

1. Cell entries are means.
2. Variable coded from fill-in-the-blank responses.
3. Variable coded on a 9-point scale ranging from (1) not at all familiar to (9) extremely familiar.

Table D3. Specific knowledge indicators by California desert residence

	Live in the California Desert				
	No (%)	Yes (%)	χ^2	*p*-value	Cramer's *V*
The desert tortoise is the California state reptile			3.04	.219	.053
Correct	34	34			
Incorrect	7	10			
Unsure	59	56			
Desert tortoises hibernate from October through February			21.02	< .001	.141
Correct	38	53			
Incorrect	0	0			
Unsure	62	47			
Desert tortoises may live to 100 years or longer			2.73	.256	.052
Correct	3	3			
Incorrect	67	72			
Unsure	30	25			
Adult desert tortoises are typically longer than 20 inches			11.10	.004	.103
Correct	28	40			
Incorrect	31	27			
Unsure	41	34			
Desert tortoises spend only a small percent of their time in their burrows			68.15	< .001	.253
Correct	14	36			
Incorrect	13	19			
Unsure	73	45			
Desert tortoises do not need water to survive			25.23	< .001	.117
Correct	8	17			
Incorrect	58	56			
Unsure	34	27			
Desert tortoises eat mainly plants such as grasses and flowers			4.70	.095	.069
Correct	65	72			
Incorrect	3	2			
Unsure	32	26			
The summer sun can kill an unsheltered desert tortoise within an hour			30.81	< .001	.173
Correct	21	30			
Incorrect	14	24			
Unsure	65	46			
Desert tortoises build up most of their fat and water reserves during the spring			20.30	< .001	.137
Correct	31	44			
Incorrect	1	3			
Unsure	68	53			
Desert tortoises may be active any time of the year following a rainfall			20.82	< .001	.140
Correct	17	30			
Incorrect	7	9			
Unsure	76	61			
Overall knowledge score			49.42	< .001	.218
Low	47	30			
Medium	45	44			
High	8	26			

Table D4. Awareness of and encounters with the desert tortoise by California desert residence

	Live in the California Desert				
	No (%)	Yes (%)	χ^2	*p*-value	Cramer's *V*
Prior to receiving this survey, had you ever heard of the desert tortoise?			3.88	.144	.064
No	6	4			
Yes	94	96			
Unsure	0	0			
Have you ever seen a desert tortoise in the wild?			45.93	< .001	.204
No	62	39			
Yes	38	59			
Unsure	0	2			
Do you know anyone who has picked up a desert tortoise in the wild?			21.09	< .001	.148
No	77	75			
Yes	20	25			
Unsure	3	0			
Do you know anyone who has taken a desert tortoise from the wild?			19.19	< .001	.128
No	94	84			
Yes	2	8			
Unsure	4	8			
Do you know anyone who has adopted a wild desert tortoise as a pet?			117.93	< .001	.306
No	92	63			
Yes	5	36			
Unsure	3	1			
Do you know anyone who has released a pet desert tortoise into the wild?			11.91	.003	.108
No	94	93			
Yes	2	5			
Unsure	4	2			

Table D5. Perceived threats by California desert residence

Perceived threats [1]	Live in the California Desert		*F*-value	*p*-value	eta
	No	Yes			
Human [2]	4.34	4.20	1.05	.306	.034
Nature [2]	4.51	4.71	2.18	.140	.050
Other animals [2]	4.24	4.44	2.56	.110	.053
Habitat loss [2]	4.97	5.08	0.63	.429	.026
Pesticides or other toxic chemicals [3]	4.46	5.03	11.39	.001	.116
Disease [3]	4.57	5.23	22.69	< .001	.165

1. Variables coded on 7-point scales ranging from (1) not at all a threat to (7) extreme threat. Cell entries are means.
2. Composite variables constructed from the items shown in body of report.
3. Single-item variable.

Table D6. One main threat to desert tortoise populations by California desert residence

One main perceived threat	Live in the California Desert	
	No (%)	Yes (%)
Habitat loss due to human development	45	41
Off-highway vehicles unintentionally disturbing tortoises	11	5
Being eaten by ravens	7	20
Drought	7	5
Military training in the desert	7	0
Collecting by humans	6	4
Disease	4	4
Being eaten by feral dogs	4	2
Competition for habitat with other wildlife	3	0
Pesticides or other toxic chemicals	2	6
Road kill due to tortoises attempting to cross roads	2	5
Habitat loss due to agriculture	2	1
Cattle / sheep grazing	1	1
Hunting	1	0
Lack of nutritional food	0	5
Hikers unintentionally disturbing tortoises	0	0

$\chi^2 = 140.93$, $p < .001$, Cramer's $V = .361$

Table D7. Awareness of Endangered Species Act (ESA) and desert tortoise declines by California desert residence

	Live in the California Desert				
	No (%)	Yes (%)	χ^2	*p*-value	Cramer's *V*
Heard of ESA prior to this survey			17.03	< .001	.124
Yes	88	77			
No	5	8			
Unsure	7	15			
The number of desert tortoises have declined dramatically in recent years			5.38	.068	.069
Agree	52	51			
Neither	44	41			
Disagree	4	8			

Table D8. Support for management actions by California desert residence

	Live in the California Desert [1]				
	No	Yes	*F*-value	*p*-value	eta
Do you support or oppose [2]					
The Endangered Species Act	0.86	1.19	5.24	.022	.073
Efforts to recover the desert tortoise	1.07	1.58	15.94	< .001	.126
Beliefs about management actions [3]					
The government should do more to protect desert tortoise populations	0.37	0.82	11.94	.001	.108
Land managers are doing everything they can to save the desert tortoise	-0.47	-0.40	0.60	.438	.024
Laws protecting the desert tortoise are too strict	0.40	-0.44	16.01	< .001	.125

1. Cell entries are means.
2. Variables coded on 7-point scales ranging from (-3) strongly oppose to (+3) strongly support.
3. Variables coded on 7-point scales ranging from (-3) strongly disagree to (+3) strongly agree.

Table D9. Attitudes toward endangered species and desert tortoises by California desert residence

	Live in the California Desert [1]				
Attitude [2]	No	Yes	*F*-value	*p*-value	eta
attitude towards *all endangered species*	1.13	1.66	21.31	< .001	.144
attitude towards recovery efforts to save *all endangered species*	0.83	1.43	21.95	< .001	.146
attitude towards the *desert tortoise*	1.00	1.87	64.27	< .001	.247
attitude towards recovery efforts to save the desert tortoise	1.00	1.60	23.38	< .001	.151

1. Cell entries are means.
2. Variables coded on 7-point scales ranging from (-3) extremely negative to (+3) extremely positive.

Table D10. Acceptability of management actions by California desert residence

How acceptable is it for federal / state agencies to: [2]	Live in the California Desert [1]				
	No	Yes	*F*-value	*p*-value	Eta
take no action to protect the desert tortoise	-1.09	-1.39	4.55	.033	.067
vaccinate desert tortoises to control disease	0.40	0.63	2.73	.099	.052
enhance native vegetation food sources for the desert tortoise	0.86	1.09	2.75	.098	.052
fence roads to reduce road kills of desert tortoises	-0.09	0.48	13.47	< .001	.115
eliminate *ravens* that threaten juvenile desert tortoises	-0.72	-0.12	14.28	< .001	.118
eliminate *feral dogs* that threaten desert tortoises	-0.27	0.41	23.27	< .001	.150
purchase private land to slow human development in desert tortoise habitat	0.24	0.48	2.50	.114	.050
limit *new human development* in desert tortoise habitat	1.99	2.09	0.61	.434	.025
limit *military training maneuvers* in some areas of desert tortoise habitat	0.24	0.33	0.36	.546	.019
ban *cattle / sheep grazing* in some areas of desert tortoise habitat	0.24	0.13	0.70	.404	.026
limit *agricultural uses* in some areas of desert tortoise habitat	0.29	0.46	1.68	.195	.041
ban *hunting* in some areas of desert tortoise habitat	0.38	0.43	0.07	.787	.009
limit the number of *hikers* in some areas of desert tortoise habitat	-0.42	-0.55	0.85	.357	.029
ban *hikers* in some areas of desert tortoise habitat	-1.02	-0.93	0.32	.570	.018
limit number of *off-highway vehicles* in some areas of desert tortoise habitat	-0.08	-0.01	0.19	.662	.014
ban *off-highway vehicles* in some areas of desert tortoise habitat	-0.42	-0.28	0.59	.441	.024
ban *dual sport rides* in some areas of desert tortoise habitat	-0.31	-0.10	1.36	.244	.037
enact seasonal closures to all human activity	-0.59	-0.43	0.86	.354	.029

1. Cell entries are means.
2. Variables coded on 7-point scales ranging from (-3) highly unacceptable to (+3) highly acceptable.

Table D11. Sources of information by California desert residence

Information Source [1]	Live in the California Desert				
	No	Yes	*F*-value	*p*-value	eta
Traditional media [2]	1.04	1.09	0.44	.507	.021
Brochures [3]	0.59	0.77	4.16	.042	.064
Websites [4]	0.34	0.34	0.01	.936	.003
Conservation groups [5]	0.85	0.69	3.10	.079	.055
Off-highway vehicle groups [5]	1.09	1.05	0.11	.740	.010
Outdoor videos and / or DVD's [5]	0.26	0.36	1.96	.162	.044
Federal or state employees [5]	0.36	0.67	12.00	.001	.108
Friends / family members, word of mouth [5]	1.33	1.76	10.78	.001	.103

1. Variables coded on 6-point scales: (0) never, (1) once, (2) twice, (3) 3 times, (4) 4 times, and (5) 5 or more times. Cell entries are means.
2. Composite variable constructed from the average of newspapers, magazines, books, radio, and television.
3. Composite variable constructed from the average of state and federal agency brochures.
4. Composite variable constructed from the average of state, federal and other internet websites.
5. Single-item variable.

Table D12. Preferred main source for obtaining desert tortoise information by California desert residence

Preferred main source of information	Live in the California Desert	
	No (%)	Yes (%)
Television programs (e.g., Discovery Channel, PBS)	42	25
Off-highway vehicle groups	17	9
State agency websites	10	2
State agency brochures	6	8
Federal agency brochures	5	6
Federal agency websites	5	3
Newspapers, magazines, books	4	17
Other internet websites	4	3
Television news	3	7
Conservation groups	3	4
Friends / family members, word of mouth	1	6
Radio	1	0
Outdoor videos and / or DVD's	0	1
Federal or state employees	0	2

$\chi^2 = 154.83$, $p < .001$, Cramer's $V = .372$.

Table D13. Agency trust and believability of information by California desert residence

	Live in the California Desert [1]				
	No	Yes	*F*-value	*p*-value	eta
Trust federal / state agencies [2]	0.10	0.18	0.40	.529	.020
Believability of information [3]	1.67	1.92	0.05	.829	.007

1. Cell entries are means.
2. Composite variable constructed from the trust items listed in body of report.
3. Composite variable constructed from the believability items listed in body of report.

Table D14. Overall evaluation of government management of the desert tortoise by California desert residence

	Live in the California Desert				
	No (%)	Yes (%)	χ^2 or *F*	*p*-value	Effect Size
Provided a letter grade			4.26	.039	.065
No – do not know enough to give a letter grade	49	42			
Yes	51	58			
Letter grade			2.10	.718	.059
A	13	11			
B	47	43			
C	32	35			
D	3	3			
F	5	8			
Grade point average [1]	2.58	2.45	1.77	.184	.056

1. Variable coded on a 5-point scale: (0) F, (1) D, (2) C, (3) B, and (4) A. Cell entries are means.

Table D15. Beliefs about endangered species and desert tortoises by California desert residence

	Live in the California Desert [1]				
Belief concepts [2]	No	Yes	*F*-value	*p*-value	Eta
OHVs are unfairly blamed for harming desert tortoises	0.56	0.53	0.05	.828	.007
Anthropocentric basic beliefs	-0.82	-1.05	4.13	.042	.064
Biocentric basic beliefs	0.08	0.16	0.49	.482	.022
Awareness of consequences	1.02	1.15	1.16	.282	.034
Ascription of responsibility	0.29	0.73	12.01	.001	.108
Behavioral intentions	0.34	0.53	1.56	.212	.039

1. Cell entries are means.
2. Belief concepts constructed from the items listed in body of report.

Table D16. Demographics by California desert residence

Demographics	Live in the California Desert: No (%)	Live in the California Desert: Yes (%)	χ^2	*p*-value	Cramer's *V*
Sex			2.09	.149	.045
Male	53	48			
Female	47	52			
Age			65.06	< .001	.248
18 – 29	10	23			
30 – 39	19	26			
40 – 49	35	20			
50 – 59	22	13			
60 – 69	11	9			
70+	2	9			
Mean age	45.43	42.78			
Education			44.79	< .001	.212
Less than high school diploma	1	4			
High school or GED	22	25			
2 year associate degree or trade school	28	42			
4 year college degree (bachelors)	32	15			
Advanced degree beyond 4 year degree	17	14			
Income			93.20	< .001	.296
Less than $10,000	0	2			
$10,000 to $29,999	1	8			
$30,000 to $49,999	11	20			
$50,000 to $69,999	10	11			
$70,000 to $89,999	22	21			
$90,000 to $109,999	24	16			
$110,000 to $129,999	13	7			
$130,000 to $149,999	5	9			
$150,000 to $199,999	7	1			
$200,000 to $249,999	3	2			
More than $250,000	4	2			
Ethnicity			0.09	.769	.009
Hispanic or Latino	33	34			
Not Hispanic or Latino	67	66			
Race			8.75	.068	.096
American Indian or Alaska Native	5	2			
Asian	5	5			
Black or African American	6	4			
Native Hawaiian / other Pacific Islander	5	7			
White	79	82			

Table D17. Place of residence by California desert residence

Place of residence	Live in the California Desert: No (%)	Live in the California Desert: Yes (%)	χ^2	*p*-value	Cramer's *V*
County of residence			148.61	< .001	.339
Imperial	0	2			
Kern	0	9			
Los Angeles	5	17			
Riverside	2	16			
San Bernardino	93	57			
Size of community			107.86	< .001	.286
Large city (250,000+ people)	16	13			
City (100,000 to 249,999 people)	53	37			
City (10,000 to 99,999 people)	23	14			
Small city (25,000 to 49,999 people)	3	15			
Town (10,000 to 24,999 people)	3	11			
Town (5,000 to 9,999 people)	0	2			
Small town / village (< 5,000 people)	0	6			
A farm or rural area	3	2			

Table D18. Organizational membership by California desert residence

Organizational membership	Live in the California Desert: No (%)	Live in the California Desert: Yes (%)	χ^2	*p*-value	Cramer's *V*
Environmental or wildlife groups			9.64	.002	.091
No	96	91			
Yes	4	9			
Off-Highway vehicle groups			9.35	.002	.099
No	79	87			
Yes	21	13			