VALUING THE INVALUABLE: AN INVESTIGATION OF OUTDOOR RECREATION BEHAVIOR, PERCEIVED VALUES OF ECOSYSTEM SERVICES, AND BIOPHYSICAL CONDITIONS ON CHANNEL ISLANDS NATIONAL PARK

A Dissertation

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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May 2014

Major Subject: Recreation, Park, and Tourism Sciences

ABSTRACT

Impacts on parks and protected areas are modifying ecosystems that provide benefits to sustain human health and well-being. Compelling evidence of ecological and economic values has been gathered to better understand the implications of these changing social-ecological conditions; however, social values have received considerably less attention. There is a strong need to integrate disciplinary perspectives on the value concept and illustrate the *full* value of nature experienced through outdoor recreation activities. My dissertation drew from theoretical frameworks in psychology, economics, and ecology to better understand the multiple values of Channel Islands National Park (CINP), California, U.S. Specifically, I examined "held" value orientations, "assigned" values of ecosystem services, and ecological values of the CINP. In first of three papers, I tested the value-belief-norm (VBN) theory of environmentalism to determine the psychological processes driving low-impact behavior among outdoor recreationists. I observed that behavioral engagement was more strongly related to biospheric-altruistic held values than egoistic concerns. Also, moral norm activation was a direct antecedent to behaviors that minimized the spread of invasive species, degradation of archeological artifacts, and overfishing in marine protected areas. In the second paper, I investigated how environmental worldview shaped the spatial dynamics of assigned values for ecosystem services on Santa Cruz Island within the CINP. Using Public Participation Geographic Information Systems methods, I found that held value orientations (i.e., biocentrism, anthropocentrism) manifested different

values ascribed to marine and terrestrial environments. In the third paper, I compared assigned biodiversity values to spatially-explicit measures of ecosystem structure and function using a Social Values for Ecosystem Services (SolVES) mapping application and Maximum Entropy modeling. My results showed that distance to features relevant for park management, carbon sequestration, species richness, elevation, vegetation density, and several categories of land cover predicted the locations and intensity of preferences for biodiversity on Santa Cruz.

DEDICATION

For my loving family, without whom this dissertation would not be possible.

ACKNOWLEDGEMENTS

There are countless people that deserve my gratitude for supporting this research and my graduate experience at Texas A&M more broadly. First and foremost, Gerard Kyle is absolutely the best mentor I could have hoped for in a doctoral program and words cannot express how grateful I am for all he has taught me through direct instruction and by example. I especially appreciate his respect for theory, humility as an individual and endless encouragement throughout my academic journey. The lessons I have learned from our interactions will be guiding principles for the rest of my career. I also owe a debt of gratitude to Steve Sutton for his thought-provoking questions, helpful observations and willingness to freely share his expertise. Steve's sincere support and mentoring have greatly contributed to the development of my research and I look forward to us building an even stronger collaborative relationship and friendship in the coming years. Amanda Stronza has been a role model and source of inspiration for me. Her knowledge, passion and success as a woman are exemplar, and I am thankful for her patience and ability to nurture ideas. Finally, I feel very fortunate to have had an opportunity to learn from Christian Brannstrom's experience and scholarship. His sage advice and guidance on navigating human-environment interactions provided a foundation for my dissertation and greatly contributed to my doctoral education.

My dissertation research was made possible by numerous individuals. I would like to thank Russell Galipeau, Kate Faulker and Yvonne Menard with the National Park Service for providing administrative support and offering helpful feedback as I developed my ideas. Dustin Green, Travis Peters and Michael Patillo enthusiastically assisted with data collection that improved the quality of my work and leisure experiences at the Channel Islands. I would also like to thank several people that assisted with preliminary research that laid the groundwork for my dissertation. Thanks are extended to Renae Tobin at James Cook University (JCU) for her support during two field seasons in northeast Queensland and positive attitude that made the experience a real joy. I greatly appreciate the analyses and data entry performed by Melinda Barnes, Parker Batt and Jennifer Hageman, as well as managers of the Great Barrier Reef Marine Park Authority, Queensland Parks and Wildlife Service and Aransas National Wildlife Refuge for dedicating time to participate in my preliminary research. Financial support from the Human Dimensions of Natural Resources (HDNR) Laboratory, Fishing and Fisheries Research Center at JCU, Thomas G. Villo Fellowship in Marine Recreation Management, and Jake Hershey Fellowship in Natural Resource Conservation made these projects possible. Also, Bob Manning, Debbie Chavez, Dave White, Laura Anderson, and Bill Valliere are mentors that have been instrumental in my professional development. Thank you for always believing in me!

There are a number of institutions and affiliated individuals worthy of acknowledgement for supporting my growth as a young scholar. The George Wright Society on Parks, Protected Areas and Cultural Sites provided formative experiences for me to expand my academic passion about protected areas research and management. I've learned a great deal from the Board of Directors and feel extremely fortunate for the opportunity to be inspired by such a dynamic group of people. I am also indebted to the current and former members of the Human Dimensions of Natural Resources Laboratory. This was a wonderful environment in which to foster camaraderie and ideas that I will carry with me for the duration of my career. My labmates truly made a world of difference in my research and personal well-being. The Applied Biodiversity Sciences program and Department of Recreation, Parks, and Tourism Sciences at Texas A&M have also shaped my thinking and provided an environment conducive to learning, growth and problem solving. I'm thankful for the friendships that have sustained and inspired me through involvement in these organizations.

Most importantly, my family is deserving of endless degrees of thanks and appreciation. My mother, Sandra Guest van Riper has imbued my world with beauty and never fails to give me hope when there is none in sight. Her wisdom is a point of inspiration that has enabled me to pursue my dreams. Similarly, I cannot thank enough my father, mentor and close friend Charles van Riper. There is no doubt in my mind that I am the luckiest daughter in the entire world! I would not have achieved my life goal of completing a Ph.D. without his encouragement and guidance. I have also benefited and learned a great deal from my siblings. Kale's devotion and strength, Jacque's leadership and beauty, and Kim's wisdom and unconditional love continue to demonstrate the finest qualities that I am so fortunate to have observed in my life. Finally, I owe a great deal of gratitude to my companion, Madrugada, whom I appreciate beyond words. I am and always will be eternally grateful for my loving family.

NOMENCLATURE

VBN	Value-Belief-Norm Theory
NAM	Norm-Activation Model
NEP	New Ecological Paradigm scale
AC	Awareness of Consequences
AR	Ascription of Responsibility
PN	Personal Norms
PEB	Pro-Environmental Behavior
CINP	Channel Islands National Park
SCI	Santa Cruz Island
NPS	National Park Service
TNC	The Nature Conservancy
NOAA	National Oceanic and Atmospheric Administration
SolVES	Social Values for Ecosystem Services
MaxEnt	Maximum Entropy Modeling
SVI	Social Value Index
ES	Ecosystem Services
MEA	Millennium Ecosystem Assessment
SES	Social-Ecological System
PPGIS	Public Participation Geographic Information Systems

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1. INTRODUCTION

1.1. Human Impacts

How can management agencies in the United States most effectively minimize human-caused impacts to benefit and promote environmental sustainability? This question underpins widespread concerns about the use and protection of natural resources (Chapin et al., 2009; Steffen et al., 2004; Turner et al., 1990). Efforts to maintain stable and productive ecosystems alongside human well-being are of critical importance, especially in the context of coastal and marine protected areas (Halpern et al., 2008; Pauly et al., 2002; Worm et al., 2006). Various environmental pressures such as habitat fragmentation and the loss of top predators (Hansen & DeFries, 2006), intrusions from invasive species (Didham et al., 2005), air and water pollution (Orr et al., 2005), and global climate change (Loarie et al., 2009) are occurring from local to globe scales at accelerating and unprecedented rates. In response to the cumulative impacts emerging from these sources, ecosystem-based management and marine spatial planning tools have offered promising solutions for solving environmental problems across spatial and temporal scales (Cogan et al., 2009; McLeod & Leslie, 2009; Norse, 2010). Within this arena, a substantive body of past work has effectively worked toward enhancing the resilience and capacity of human and natural systems in the face of change (Holling, 2001; Hughes et al., 2003; Ostrom, 2009; Turner et al., 2007; Walker & Salt, 2006).

1.2. Ecosystem Service Values

Human impacts on parks and protected areas warrant consideration because these places provide a variety of goods and services to human populations, including recreation activities, food, flood control, and waste detoxification (Adger et al., 2005; Holmlund & Hammer, 1999). These "ecosystem services" (ES) are defined as the characteristics and functional processes of environments that provide benefits to sustain and fulfill human life (Daily, 1997). The ES concept is increasingly used to rationalize resource protection and determine the extent to which human well-being depends on the flow, valuation, and provision of benefits from ecosystems to human communities (Carpenter et al., 2006). This view differs from neoclassical economic goals of maximizing consumer surplus via consumption as the ultimate desirable end, though still assumes that rationally deduced moral guidelines shape behavior (Daly & Farley, 2010). Use of ES for conservation has been hotly debated, in part because forcing resources of arguably infinite quality into market systems can misrepresent the meanings of places (Brockington & Duffy, 2010), risk limiting the protection of less charismatic resources (McCauley, 2006), and elicit unstable evaluations (i.e., "preference reversals") (Slovic, 1995). However, ES's sustain linkages with the SES concept (Reyers et al., 2013), are relatively defensible in political arenas (Daily et al., 2009), and have become the defining frame of conservation particularly in coastal and marine environments (Granek et al., 2010).

The United Nation's Millennium Ecosystem Assessment (MEA) (2005) is the predominant ES framework and it includes four categories: 1) provisioning (e.g., goods that have a direct benefit to people such as fresh water); 2) regulating (e.g., ecosystem functions such as climate regulation); 3) cultural (e.g., factors like recreational experiences that indirectly benefit society); and 4) supporting services (e.g., aspects of a functioning ecosystem such as soil formation). This classification system has been widely adopted to measure and conceptualize ES and has offered important insights on tradeoffs made among competing elements of a SES (Nelson et al., 2009). It has been especially useful to meld concepts from the fields of ecology and economics (Turner & Daily, 2008); however, a growing body of research indicates that non-material benefits people derive from ecosystems have not been traditionally well-represented in environmental planning and management (Chan et al., 2012a; Daniel et al., 2010; Klain & Chan, 2012; Wallen, 2013) despite being deemed a priority in SES research. If less tangible and indirect benefits of ecosystems continue to be sidelined in decision-making, resource allocation efforts may lead to politically divisive outcomes that can thwart environmental policy-making (Endter-Wada et al., 1998; Stamieszkin et al., 2009).

The long-term success of the conservation movement relies on a strong understanding of ES values and thus places humans at the heart of effective conservation strategies (Larson, 2009; Armitage et al., 2009; Berkes, 2006; Folke et al., 2005; Williams et al., 2013). Increasingly, a broad array of interests (current and potential) affected by resource and recreation management activities are being recognized by the global conservation community, and if these interests are not given due consideration in decision-making, governance regimes may become inconsistent with public interests and render policy outcomes unsuccessful (Ban et al., 2003; Pollnac et al., 2010). Much remains to be learned about how to effectively manage natural systems linked to diverse ES values expressed by stakeholder groups (Hunt et al., 2013). Though, promising advances have been made to help protected area managers develop strategies for fostering stewardship and framing information in an appealing way for diverse constituencies (Monroe, 2003). More specifically, investigations of values for ecosystem services have brought intangible concepts into relief and assisted in understanding the factors that shape outdoor recreation behavior and indicate support for or opposition to conservation initiatives (Schultz, 2011).

The study of value has been advanced by scholars in an array disciplines such as political science (Sabatier, 1988), philosophy (Callicott, 1984; Norton & Hannon, 1996), anthropology (Satterfield, 2001; West, 2006), and history (Cronon, 1991). However, this dissertation is primarily concerned with three value concepts understood from different disciplinary perspectives. First, this dissertation draws from the field of psychology to offer a perspective on "held values," which are the ideals and basic cognitions that facilitate preferences and underlie attitudes and behavior (Rokeach, 1973). Examples of held values include equality, freedom, and wisdom. Secondly, through an ecological economics lens, this dissertation examines "assigned values" defined as the qualities associated with places, including material and non-material benefits that can be derived from ecosystems (MEA, 2005). Finally, building on concepts in ecology, this dissertation investigates the biophysical properties of an environment that sustains the delivery of ES for outdoor recreationists. These three bodies of literature are integrated to article *multiple* values of nature, create space for discourse over the role of values in management of outdoor recreation behavior, and reflect the diversity of values nested within the social and ecological dynamics of protected areas.

1.3. Social-Ecological Systems Framework

A social-ecological system (SES) framework is a promising tool for organizing and designing research that cuts across disciplinary boundaries. A SES is a network of people, organizations, resources, and institutions that evolve together over space and time. The attributes of a SES interact within a multi-tiered complex system that requires research questions to transcend the boundaries of natural and social science disciplines (Berkes et al., 2003; Collins et al., 2011; Liu et al., 2007; Machlis et al., 1997; Ostrom, 2009; Perry et al., 2011). Multiple biophysical (e.g., biotic and abiotic conditions, ecological processes and functions) and social forces (e.g., socioeconomics, behavior, regulations), as well as the interactions and feedbacks among these variables shape the phenomenon of environmental change and underpin the sustainability of ecosystems, economies, and human well-being. As such, the most pressing environmental problems are often the most complex and resistant to solutions developed using individual disciplinary lenses (Ostrom, 2009). The SES framework has become a widely accepted, powerful tool that responds to these challenges by drawing together perspectives from multiple fields of study, organizing attributes that characterize complex systems, and recognizing the various factors that affect the capacity of environments to sustain current and future generations.

One example that illustrates how a SES framework can be applied in conservation research relates to overfishing in marine reserves. To understand the current state, past trends, and potential effects of resource extraction on ecosystems, the biophysical conditions of a given marine community would need to be identified, along with functions such as such as productivity, key links in the food web, wildlife habitat, and diversity (Odum, 1976). External pressures including climate variability and technological change also influence human use and access to marine resources and may warrant consideration in research guided by a SES framework (Walker & Salt, 2006). Using Ostrom's (2007) parlance, these "resource systems" and "units" operate alongside "governance systems" and "users" such as stakeholders affected by restrictions on human use, administrative players that operate at different management scales (e.g., local, regional, national), industry pressures, and relations among these individuals. These "social" variables operate at multiple nested scales. To fully capture the changing dynamics of a SES, many of the aforementioned attributes should be simultaneously integrated into the decision-making process. This example shows how one might begin to identify variables in a SES and ultimately maintain the functionality of a complex system surrounding resource extraction in a marine environment.

Extensive theoretical and empirical research has indicated that individuals and groups faced with problems such as overfishing or other forms of human impact work together to sustain SESs over space and time (Ostrom, 2000). Much progress has been made to demonstrate that communities voluntarily unite to achieve the benefits of collective action and co-manage resources to reduce environmental pressures (Armitage et al., 2009; Berkes, 2006; Heyman, 2011; McClanahan et al., 2007). However, past work under the purview of a SES framework has not fully explained *why* individuals perform behavior. Specifically, the psychological factors that shape decision-making (beyond conforming to norms and expectations of reciprocity) have been largely overlooked in SES research. There is a strong need for studies of "internal processes" (e.g., held value orientations, belief structures) to unveil the intricacies of human behaviors that drive the users, and in turn, governance systems of a SES (Schultz, 2011). Therefore, this dissertation aims to integrate concepts from psychology and the study of ecosystem services into the SES literature to provide theoretical insights on the factors that shape behavior among outdoor recreationists, as well as offer applied outcomes that help to minimize environmental impacts on parks and protected areas.

1.4. Study Objectives

My dissertation confronts the challenges of environmental change in an interdisciplinary investigation of the multiple values of nature. A SES framework is used to tie together the ideas of held value orientations reported by outdoor recreationists, assigned values of ecosystem services, and biophysical conditions occurring across the land and seascapes of my study area. Specifically, this work was guided by the following objectives: 1) determine how held values and other psychological processes drive reported behavior relevant to the Channel Islands National Park ecoregion, 2) examine the similarities and differences between held and assigned values reported by outdoor recreationists on Santa Cruz Island, and 3) explore how perceived biodiversity assigned values relate to biophysical conditions across terrestrial and aquatic environments. Sections 2, 3, and 4 address these three overarching objectives; however, each of these Sections is structured around subsets of research questions presented later in the dissertation.

1.5. Dissertation Structure and Contributions

This document is organized into three major Sections that respectively draw from conceptual frameworks in psychology, ecological economics, and ecology to enhance outdoor recreation and leisure experiences while minimizing human impact on a protected area. The next Section examines the psychological processes driving engagement in outdoor recreation behavior that minimizes the spread of invasive species, degradation of archeological artifacts, and overfishing in marine protected areas that surround the Channel Islands. This study was the first latent variable structural equation model of the *full* value-belief-norm (VBN) theory of environmentalism. The results presented help to minimize the so-called, "value-action gap" and account for a high degree of variance in reported behavior. Section 3 explores the spatial dynamics of various tangible and intangible values of ES provided to two survey subgroups of outdoor recreationists defined by biocentric and anthropocentric worldviews. The subgroups' value assignments were compared to operationalize a conceptual model of the differences between held and assigned values that have been referenced in past research but not empirically analyzed. This portion of the dissertation shows that held values give rise to spatially-anchored assigned values that help to determine resource and recreation management priorities. Section 4 examines the relationship between perceived biodiversity values and eight indicators of ecological value among outdoor recreationists with low and high self-reported knowledge of the Channel Islands. These results show how correlates of behavior (e.g., self-reported knowledge) shape public understandings of biodiversity and the spatially-explicit relationship among variables in a SES. Finally, the conclusion summarizes the research findings presented in this dissertation and provides suggestions for future research.

2. UNDERSTANDING THE INTERNAL PROCESSES OF BEHAVIORAL ENGAGEMENT IN A NATIONAL PARK: A LATENT VARIABLE PATH ANALYSIS OF THE VALUE-BELIEF-NORM THEORY*

2.1. Overview

Theoretical advances in research on the antecedents of recreation behavior have offered promising explanations for why people choose to undertake environmentally-friendly action. This investigation provides further insight on the psychological processes driving self-reported behavioral engagement among visitors to Channel Islands National Park in the United States. I used latent variable structural equation modeling to test the hypothesized structure stipulated by the value-belief-norm (VBN) theory of environmentalism. Biospheric-altruistic values geared toward non-human species and concern for other people positively predicted environmental worldview and pro-environmental behavior, whereas egoistic values negatively influenced moral norm activation. Consistent with previous research, findings also showed that belief structures and personal moral norms gave rise to behaviors reported by visitors to the park.

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2.2. Introduction

Over the past four decades, social psychological theories have advanced knowledge of human behaviors that benefit and promote environmental sustainability. Investigations of attitude-behavior correspondence have gained particular traction in the context of natural resources management given their potential for guiding intervention strategies that influence biological diversity and human well-being (Schultz, 2011). A stronger understanding of the psychological factors that lead people to care more or less about the environment can inform conservation efforts via insight on stakeholder responses to policy change, technological advancements, and outreach activities (Heberlein, 2012). Although much progress has been made to explain the (dis)association between internal processes – values, beliefs, norms – and behavioral engagement, more remains to be understood about how to translate these variables into action. A substantive body of work has established only weak linkages between environmental attitudes and reported engagement (Bamberg & Möser, 2007; Oskamp & Schultz, 2005; Vining & Ebreo, 2002), indicating a need for additional research to examine the theoretical relations among antecedent variables, and in turn, identify the facets of cognition and affect that can be targeted to effectively shape behavior that minimizes environmental degradation (De Groot & Steg, 2009; Joireman, Lasane, Bennett, Richards, & Solaimani, 2001).

Past research has indicated there are several ways to capture the variance in behavioral predictions. Psychometrically, refinements in model measurement have provided more accurate assessments of attitude-behavior congruence (Fishbein & Ajzen, 1975; Kaiser & Gutscher, 2003). That is, behavioral models typically reliant on linear combinations of observed measures can be improved with more precise statistical techniques such as latent variable modeling (Kaiser, Hubner, & Bogner, 2005; Oreg & Katz-Gerro, 2006). Compatibility among measures is another methodological consideration (Ajzen & Fishbein, 2005). Studies have shown that general attitudes coupled with general behaviors carry positive, moderate correlations (Tarrant & Cordell, 1997), whereas specific attitudes and specific behaviors yield stronger associations and more accurate predictions (Oskamp & Schultz, 2005). In addition to maintaining similar levels of specificity in item measurement, the wording of survey items warrants careful consideration to improve the reliability of measures. Shared method variance exaggerates the strength of associations between behavior and antecedent variables owing to similarities in item appearance rather than actual similarities among constructs (Kaiser, Schultz, & Scheuthle, 2007). Thus, potential method effects should be minimized to effectively determine the explanatory power of models predicting behavior.

In this study I examine the psychological factors that energize self-reported recreation behaviors benefiting the environment of Channel Islands National Park located in the southwestern United States. Building on a well-established literature, I test the value-belief-norm (VBN) theory of environmentalism (Stern & Dietz, 1994; Stern, Dietz, Abel, Guagnano, & Kalof, 1999), which suggests that overt responses to feelings of moral obligation can be expected when positively influenced by values beyond self-interest and belief structures. Using latent variable modeling techniques, I examine the integrity of measurement (i.e., reliability and validity) and relations among variables stipulated in this model to determine how internal processes shape behavior performed by outdoor recreationists. In the following subsections, I review VBN theory and the processes driving behavior that it hypothesizes. The final subsection summarizes my study objectives.

2.3. Literature Review

2.3.1. Engagement in Pro-Environmental Behavior

I define behavior as an intent-oriented action performed as a function of internal processes (Stern, 2000). In the context of environmentalism, behaviors are further considered to be efforts that "minimize the negative impact of one's actions on the natural and built world" (Kollmuss & Agyeman, 2002, p. 240), and can be broadly investigated under the rubric of "pro-environmental behavior" (PEB) that is socially motivated (e.g., Heberlein, 1972) rather than strictly a function of self-interest (e.g., Ajzen, 1978). There are a number of ways to organize measures of pro-environmental behavior. Stern (2000) posited that actions beneficial for the environment relate to either "private sphere" (e.g., purchasing clean energy products for a household) or "public sphere" activities (e.g., supporting environmental policies that ultimately shape the context in which choices are made) that directly and indirectly contribute to environmental change, respectively. These two forms of behaviors do not measure *actual* engagement but can be assessed using measures of self-reported activities and/or intentions as proxies.

Studies of intent-oriented pro-environmental behaviors have spanned multiple topics. Several research examples include studies of: (a) curbside, central location, and public recycling (Guagnano, Stern, & Dietz, 1995; Porter, Leeming, & Dwyer, 1995; Schultz, Oskamp, & Mainieri, 1995), (b) littering (Cialdini, Reno, & Kallgren, 1990; Heberlein, 1972), and (c) support for environmental protection (Guagnano, 1995; Halpenny, 2010; Stern, Dietz, & Black, 1985). In this literature, the relationship between antecedents and reported engagement has been examined across environmental problems and research contexts (Poortinga, Steg, & Vlek, 2004). Multiple factors external to an individual (e.g., persuasion, regulations, incentives) have influenced the strength of this relationship by constraining and/or promoting individual actions (Stern, 2000). As such, investigating a range of behaviors that can achieve conservation objectives in different settings will lend insight on the capacity of places such as protected areas to inspire and educate stakeholders.

2.3.2. Personal Norms and Beliefs

As an extension of Schwartz's (1977) norm-activation model (NAM), the VBN theory (Stern et al., 1999) hypothesizes that reported behavioral engagement is shaped by personal norms. Although norm construction is learned from social interaction, decisions about whether or not to engage are processed at the individual level on the bases of cognition and affect. Sanctions from other people also influence personal norms by generating temporary feelings of moral obligation that reinforce sources of pressure external to the individual (Cialdini, 2003; Heberlein, 1977). Consequently, conformity with a particular personal norm can be supported by pride, security, or self-esteem, whereas rejection of that norm may result in responses such as guilt and worry (Schwartz, 1973). For example, in response to normative pressures an individual may feel inclined to undertake a pro-environmental behavior such as disposing of waste that may lead to unintended environmental consequences. In this case, negative sanctions may create dissonance if opposing actions (e.g., littering) are displayed, thus, activating a response.

To influence pro-environmental behavior, personal norms can be activated or deactivated by two related belief structures including ascription of responsibility and awareness of consequences (Schwartz, 1968, 1977). Both of these constructs are considered cognitive preconditions to moral norm activation according to the "causal chain" posited by the NAM and VBN models. The original propositions of these models assume that awareness is necessary for an individual to recognize the importance of their contributions to avert negative consequences for non-human species and other human beings, which in turn are expressed by feelings of moral obligation (Schwartz, 1977). For example, an individual may deny responsibility to find trash and/or recycling receptacles to throw away food, because s/he assumes that a sufficient number of other people are engaging in this activity (Bamberg & Schmidt, 2003) or because the potential contribution is thought to be negligible (Montada & Kals, 2000). Similarly, if this individual were unfamiliar with environmental impacts that would arise if s/he did not throw away food that may cause the spread non-native plants and/or habituate animals, then the associated response to norms would be negated. In other words, pro-environmental behavior that is consistent with normative pressures will likely be performed when an individual feels responsible for and is aware of consequences that can arise from action and/or inaction.

2.3.3. Environmental Worldviews

According to the VBN theory, measures of norms and beliefs are preceded by a construct that reflects environmental worldviews and/or general beliefs about the perceived relationship between people and the environment. Worldviews are more general than norms, in that they encompass broader dispositions that are not specific to one particular area (Stern, Dietz, & Guagnano, 1995). This construct is represented by the New Ecological Paradigm (NEP) scale (Dunlap & Van Liere, 1978; Dunlap, Van Liere, Mertig, & Jones, 2000), which has received considerable attention over the past several decades. The NEP scale is theoretically related to principles about living in harmony with or having mastery over natural and social worlds (Schwartz, 1994, 1999). That is, NEP worldviews are situated along a continuum anchored by biocentric beliefs oriented toward environmental protection and anthropocentric beliefs geared toward people taking precedent over nature (Hawcroft & Milfont, 2010; Schultz & Zelezny, 1999). Previous research has demonstrated that the NEP scale is a reliable and valid measure of environmental worldview (Dunlap, 2008) and that it is a strong predictor of pro-environmental behavior (Dunlap et al., 2000).

The NEP scale has appeared in a variety of forms over the history of its use. The original scale contained 12 survey items that tapped three facets of belief structure, including the balance of nature, limits to growth, and human rights to rule over the rest of nature (Dunlap & Van Liere, 1978). The scale was later revised to include a more balanced number of positively and negatively worded survey items, and limit outdated language (Dunlap et al., 2000). There are numerous interpretations of the NEP scale's dimensionality, in that past research has identified up to five different facets of human-environment relations (Amburgey & Thoman, 2012; Hunter & Rinner, 2004; Nooney, Woodrum, Hoban, & Clifford, 2003). A six-item scale has also been used in past research (Knight, 2008; Pierce, Steger, Steel, & Lovrich, 1992), which includes an equal number of survey items representing the three facets of the original NEP scale and serves as a relatively parsimonious model of environmental worldview (Milfont & Duckitt, 2004). The abbreviated, six-item NEP scale was used in the present study.

2.3.4. Environmental Values

Belief structure and feelings of moral obligation are affected by value systems that serve as guiding principles in life and define people's relationships with the physical world (Stern et al., 1999). Empirical measures of value have been characterized as desirable end states and enduring beliefs (Rokeach, 1973) that transcend specific situations and shape reported behavior (Schwartz & Bilsky, 1994). Previous research has measured values that range from ecocentrism to anthropocentrism (Vaske & Donnelly, 1999), drawn ties between concepts of value and measures of environmental concern (Schultz, 2001), and theorized about the genetic roots of value orientations (Kellert & Wilson, 1993). Consistent among these conceptualizations is the suggestion that values are stable cognitive structures that form early in life, arise from acculturation, and remain relatively immutable over short periods (Dietz, Fitzgerald, & Shwom, 2005).

The base of the VBN model is centered on values that explain environmentalism, which are represented to varying degrees in all individuals. Past research has suggested there are three tenets of environmental value (Stern et al., 1999; Stern, Dietz, & Kalof, 1993). First, biospheric values are centered on non-human species and the biosphere. Environmental protection carries relative weight in decision-making among individuals that embody this value. Altruism constitutes a second value for individuals concerned about human welfare. Finally, egoistic values are related to self-interest, in that individuals who wish to achieve this endpoint act favorably toward environmental preservation if they believe their personal well-being is threatened, and act unfavorably if there are high (figurative) individual costs.

Although a tripartite conceptualization of environmental values has been well-established in past research (Stern et al., 1999) the dimensionality of this construct has been operationalized in different ways (e.g., Steg, Perlaviciute, van der Werff, & Lurvink, 2014). For example, Stern and Dietz (1994) posited that morality played equally important roles in the activation of biospheric and altruistic values on the basis of ethical considerations for non-human species (Leopold, 1970) and other people (Heberlein, 1977). This logic and past empirical findings have supported a two-dimensional structure of values whereby biospheric and altruistic principles form a single category (Norlund & Garvill, 2002; Schultz et al., 2005; Stern & Dietz, 1994). This conceptualization – namely, that of "biospheric-altruistic" and "egoistic" orientations – aligns with past research that has categorized values on axes of motivation (Schwartz, 1994). In this light, biospheric-altruistic values fall into a higher order category of self transcendence whereby the well-being of humanity *and* the environment take precedent over or are equal to self consideration. Egoistic values on the other hand are encompassed by a broader category of self-enhancement motivations primarily concerned with authority and power. Biospheric-altruistic and egoistic values are expected to positively and negatively influence environmentalism, and in turn, feelings of moral obligation that antecede pro-environmental behavior (Karp, 1996; Norlund & Garvill, 2002; Stern, Kalof, Dietz, & Guagnano, 1995).

2.4. Current Study

The purpose of this study was to explore the psychological processes underlying pro-environmental behavior as hypothesized by Stern et al.'s (1999) VBN theory. Through the use of structural equation modeling, I tested whether reported behavior would be performed when an individual felt they ought to take action (PN), believed they could make a difference / others were not performing needed behaviors (AR), considered environmental conditions to be problematic (AC), and positively or negatively evaluated human-environment interactions (NEP) in response to the attitude objects of non-human species (biospheric-altruistic value) and individual interests (egoistic value) (see Figure 1). I identified linkages among various constructs in the VBN model according to past research that has suggested values lead to worldviews, flow through AC and AR, and then predict PN as a direct antecedent to PEB. I based the hypothesized paths in my model on the notion that feelings of moral obligation result from environmental values and worldviews (Dietz et al., 2005; Dunlap et al., 2000; Stern, Kalof, et al., 1995). Thus, I did not test for relationships among all antecedent variables, rather, only those supported in past research (de Groot & Steg, 2009).

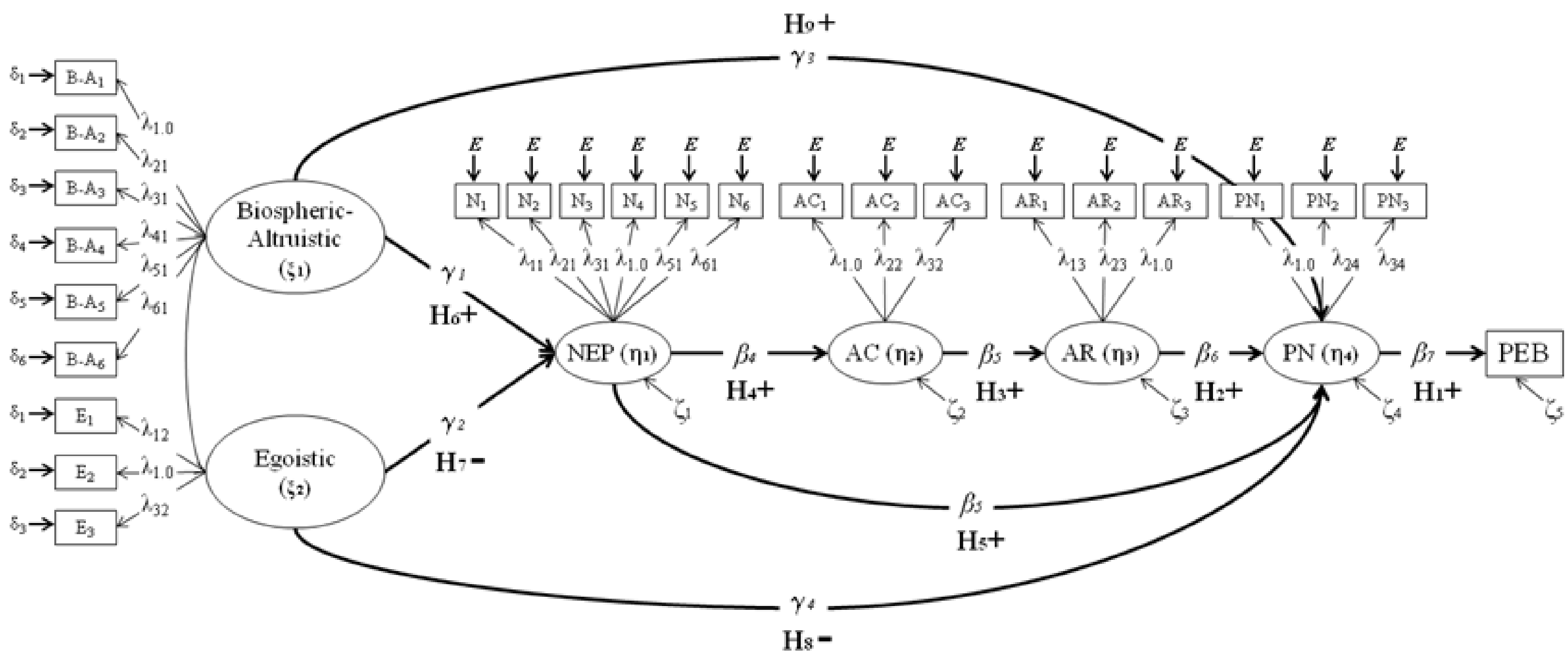

Figure 1. Hypothesized model of the theoretical relations among factors that lead to engagement in pro-environmental behavior.

2.5. Methods

2.5.1. Study Context

This research was conducted within an ecoregion including two (Anacapa and Santa Cruz) of five protected islands and surrounding waters in Channel Islands National Park (CINP), located approximately 15 miles off the coast of southern California. The CINP ecoregion is an ecologically defined area that plays an important role in the provision of recreational opportunities, in that these two CINP islands accommodate the highest levels of visitation within the park. The islands can be viewed from the mainland, and although they are proximate to densely populated southern California including 22 million inhabitants from metropolitan areas such as Los Angeles and San Diego, their isolated location provides suitable habitat for over 2,000 species of marine and terrestrial organisms. Many organisms found within the park are listed as threatened or endangered by the U.S. Fish and Wildlife Service and found nowhere else on earth (NPS, 2006). The United States National Park Service (NPS), The Nature Conservancy, and National Oceanic Atmospheric Administration, as well as other organizations actively manage, restore, and monitor the recovery of organisms within the park in response to pressures such as invasive species, habitat destruction, and predation (Davis, 2005).

Various activities within the CINP ecoregion contribute to local economies by drawing tourists to this region, support human well-being through the provision of recreational activities, and increase knowledge of resources that are protected by the park. Visitor activities are permitted on the eastern portion of Santa Cruz Island and

East Anacapa are managed by the NPS, whereas other portions of the islands are owned by organizations such as TNC and are reserved for scientific research and environmental preservation. Many visitors become familiar with Channel Islands National Park through outlets such as the Channel Islands Harbor in Ventura, CA that offers shops, restaurants, dive centers, boat charters and yacht clubs, as well as whale watching and opportunities for fishing in the Santa Barbara Channel. Of the 300,000 people that annually visit the park's mainland educational center – the Robert J. Lagomarsino Visitor Center located within the Harbor – only 10% go to the islands. The visitors that go to the islands use public transportation provided by an external contractor that works in cooperation with the NPS. The cost of visiting Anacapa or Santa Cruz islands for an afternoon is $59 for one adult. A ticket for camping is $79 per adult plus a $15 fee to reserve a campsite for one night.

Although the majority of on-site visitors can be identified through their use of public transportation, there are several other important modes of activity within the CINP ecoregion such as private boating, consumptive activities (e.g., lobster diving, spear fishing), and diving operations (LaFranchi & Pendleton, 2008). Kayaking is also a popular activity that is purchased and coordinated through external contractors. Water-based activities are spread across nearly 100 miles of coastline surrounding the two islands. Commercial fisheries and the energy industry also maintain a presence outside of the park's marine reserve networks, primarily in the Santa Barbara Channel that lies adjacent to this ecoregion. Aboriginal populations (Chumash Native Americans) and scientists that undertake investigations spanning the natural and social sciences further reflect the breadth of human use accommodated on the islands.

2.5.2. Data Collection and Sampling Design

Data were collected via an on-site self-administered survey during a time period (June-August, 2012) selected to reflect visitation during the high use season (see Appendix A). Potential respondents over the age of 18 were approached at random by trained survey administrators and asked to participate in the study. For groups, the individual with the most recent birthday completed the survey to minimize potential group leader bias (Battaglia, Link, Frankel, Osborn, & Mokdad, 2008). The survey schedule was stratified by day of the week to obtain a representative sample of visitors to the CINP ecoregion that accessed the islands and adjacent waters using public transportation during the time period of the study (Bernard, 2000). Segments of the park's constituency such as private boaters were not necessarily included in the sample due to challenges surrounding access to the entire coastline of the island. Using ASUS Transformer TF3000T tablets and offline software (DroidSurvey, version 1.4.1), English versions of the survey were administered at multiple locations, though primarily on Santa Cruz Island to reflect the flow of visitation and owing to difficulties transporting the survey team between the two islands. Decisions about data collection and the sampling design were made in consultation with NPS staff and were informed by preliminary on-site visits to the park in August, 2011 and April, 2012. Contact logs were used to monitor response rates and calculate potential non-response bias, none of which were detected on the bases on gender (χ^2 = 0.07) and group size (t = -0.92, df = 373) (see Appendix B). In total, this sampling method yielded 359 completed surveys and a response rate of 95%.

2.5.3. Survey Sample

The gender distribution of survey respondents was nearly equal with 48% male and 52% female. The majority (84%) was White and well-educated with 76% reporting having obtained at least a four-year college degree. Half of the survey sample earned over $100,000 before taxes on an annual basis. The average age was 43.3 (*SD*=14.3) and number of people per household was 2.9 (*SD*=1.3). Respondents did not report extensive previous experience at the park, in that most (80%) had visited only one island and over half (61%) were visiting for the first time. The average group size was 6.7 (*Median*=4, *SD*=11.8) and respondents engaged in various activities such as hiking (39%), kayaking (15%), and camping (15%).

2.5.4. Survey Measures

Scales for the constructs of pro-environmental behavior, personal norms, ascription of responsibility, and awareness of consequences were created to represent NPS managers' primary concerns about sustainable use of resources within the CINP, including: 1) the spread of non-native plants and animals, 2) impacts on cultural resources such as archaeological sites and historic structures, and 3) degradation of natural resources within marine protected areas. These concerns were identified in consultation with park staff through discussions and preliminary data collection. The reliability estimates (Cronbach's alpha) of scaled items ranged from .66 to .88 (Cortina, 1983). All factor loadings exceeded .40 (Hair, Anderson, Tatham, & Black, 1998).

2.5.4.1. Engagement in Pro-Environmental Behavior

This study examined intent-oriented actions that Stern (2000) termed public-sphere behaviors. Nine survey items presented on a dichotomous (yes/no) scale were included in the survey questionnaire to measure reported engagement over the previous 12 months (see Table 1). Given that no standard measure of pro-environmental behavior existed, the survey items developed for this study reflected the three issues of greatest management concern noted above, including invasive species, damage to cultural resources, and marine impacts. Although select respondents may not have had opportunities to engage in activities that required use and/or ownership of equipment, all self-reported behavioral items reflected park-specific issues (Halpenny, 2010) and were considered plausible by managers of the CINP. Other considerations that guided the creation of items included the range of potential behaviors and congruence between internal processes and subsequent actions (Norlund & Garvill, 2002; Oskamp & Schultz, 2005; Steg, Dreijerink, & Abrahamse, 2005; Stern, et al., 1999; van Riper, Kyle, Sutton, Yoon, & Tobin, 2013). A composite score was created on the basis of a summation of all reported behaviors performed by survey respondents in the previous year.

Table 1. Scaled items measuring reported behavior.

		Percent
Pro-environmental Behavior (summative score (SD))		*4.79 (2.23)*
PEB_1	Volunteer at Channel Islands National Park to remove non-native species	7.7
PEB_2	Support and/or accept policies that protect the marine environment	62.3
PEB_3	Clean equipment (e.g., wash hulls of boats, shake tents, pick seeds from shoe laces) to prevent the spread of exotic species	32.6
PEB_4	Use boot scraping stations to prevent the spread of non-native plants	22.9
PEB_5	Read a newsletter, magazine or other publication about the human history of Channel Islands National Park	52.9
PEB_6	Support the reintroduction of native species (e.g., Island Fox) on Channel Islands National Park	63.9
PEB_7	Properly dispose of waste (e.g., apple cores) that may cause the spread of non-native plants	83.9
PEB_8	Support policies that protect historic and cultural resources	75.2
PEB_9	Encourage other visitors to not disturb archeological artifacts on Channel Islands National Park	77.7

Note. Respondents could check all that applied so column total may not equal 100%.

2.5.4.2. Personal Norms and Beliefs

Multiple item scales were used to measure personal norms, ascription of responsibility, and awareness of consequences, all of which were comprised of three survey items about invasive species, cultural resource impacts, and environmental degradation in the marine environment. These constructs reflected feelings of moral obligation, perceived responsibility for negative consequences, and the extent to which these impacts were occurring on the CINP (see Table 2). Personal norms and ascription of responsibility were measured on five point Likert-type scales ranging from "Strongly Disagree" to "Strongly Agree." Both norms ($\alpha = .68$) and responsibility ($\alpha = .68$) maintained acceptable internal consistency (Cortina, 1983). Awareness of consequences was measured along a five point Likert-type scale that ranged from "Not at all a Problem" to "A Very Serious Problem" ($\alpha = .85$).

2.5.4.3. Environmental Worldviews

Environmental worldviews were measured using Dunlap et al.'s (2000) six-item, abbreviated NEP scale (see Table 2). Survey respondents were asked to indicate their level of agreement on a five-point scale ranging from 1 "Strongly Disagree" to 5 "Strongly Agree." Given that dimensionality of the NEP remains contested (Amburgey & Thoman, 2012; Hunter & Rinner, 2004; Noe & Hammitt, 1992; Nooney et al., 2003), analyses were performed inductively beginning with a principal components analysis (PCA) (tests conducted in SPSS version 21). Results from the PCA using varimax rotation illustrated that all survey items loaded on a single factor that accounted for 43.72% of variance in the sample data. A single dimensional conceptualization of the NEP aligns with past work suggesting environmental worldviews are situated along a continuum ranging from high to low degrees of environmentalism (Dunlap & Van Liere, 1978; Dunlap et al., 2000; Hawcroft & Milfont, 2010; Schultz, 2001).

2.5.4.4. Environmental Values

I drew the environmental value survey items from Schwartz's (1994) Value Inventory Scale to represent two dimensions that were conceptually and empirically supported in past research (Norlund & Garvill, 2002; Schultz et al., 2005; Stern & Dietz, 1994). These dimensions reflected biospheric-altruistic (items BA_1-BA_6) and egoistic values (items E_1-E_3). Respondents were asked to report the extent to which value types were viewed as guiding principles in life. My response scale ranged from 0 "Not at all Important" to 7 "Of Supreme Importance" and provided an option (-1) for participants to indicate they were opposed to the value (Schwartz, 1994). All data were included in the analysis, in that the scale was re-coded to range from 1 to 9.

Table 2. Scaled items measuring factors that lead to engagement in pro-environmental behavior.

		λ	***M***	***SD***
Personal Norms[1] *α = .662*			*4.40*	*0.64*
PN_1	I feel morally obliged to minimize human impact on marine resources within the CHIS	.678	4.31	0.86
PN_2	I would feel guilty if I were responsible for the spread of non-native plants across the CHIS	.660	4.39	0.86
PN_3	I feel a sense of personal obligation to not damage historic structures on CHIS, regardless of what others do	.586	4.54	7.81
Ascription of Responsibility[1] *α = .744*			*3.59*	*0.93*
AR_1	I feel jointly responsible for the spread of non-native species	.504	3.31	1.28
AR_2	I feel jointly responsible for damage to cultural resources	.554	3.35	1.18
AR_3	I am jointly responsible for environmental impacts to marine life	.774	4.06	1.03
Awareness of Consequences[2] *α = .850*			*3.96*	*1.05*
AC_1	The spread of non-native plants and animals on CHIS	.759	4.05	1.17
AC_2	Damage to cultural resources including historic structures and archaeological artifacts on CHIS	.768	3.70	1.25
AC_3	Human impact on the marine environment on CHIS	.907	4.11	1.18
New Ecological Paradigm[1] *α = .764*			*3.95*	*0.71*
NEP_1	We are approaching the limit of the number of people the earth can support	.487	3.76	1.09
NEP_2	When humans interfere with nature if often produces disastrous consequences	.580	4.03	0.97
NEP_3	Plants and animals have as much right as humans to exist	.697	4.11	1.06
NEP_4	The earth is like a spaceship with very limited room and resources	.618	3.74	1.01
NEP_5	The balance of nature is very delicate and easy to upset	.588	4.02	0.95
NEP_6	Humans were meant to rule over the rest of nature*	.618	3.90	1.20

Table 2. Continued

		λ	*M*	*SD*
Biospheric-altruistic[3] *α = .875*			*7.32*	*1.35*
$B\text{-}A_1$	Unity with nature: fitting into nature	.794	7.21	1.80
$B\text{-}A_2$	Protecting the environment: preserving nature	.861	7.60	1.51
$B\text{-}A_3$	A world of beauty: beauty of nature and the arts	.762	7.55	1.53
$B\text{-}A_4$	A world at peace: free of war and conflict	.695	7.34	1.90
$B\text{-}A_5$	Equality: equal opportunity for all	.651	7.21	1.83
$B\text{-}A_6$	Social justice: correcting injustice, care for others	.644	7.14	1.84
Egoistic[3] *α = .666*			*4.88*	*1.57*
E_1	Authority: the right to lead or command	.576	5.08	2.13
E_2	Social power: control over others, dominance	.934	3.77	2.20
E_3	Influential: having an impact on people and events	.428	6.05	2.04

[1]Mean scores are on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).
[2]Mean scores are on a scale ranging from 1 (Not at all a Problem) to 5 (A Very Serious Problem).
[3]Mean scores are on a scale including 1 (Opposed to my Values) and ranging from 2 (Not at all Important) to 9 (Of Supreme Importance).
*Reverse coded survey items

2.6. Results

I used structural equation modeling to test the measurement properties of scales along with the hypothesized relations among the antecedents of pro-environmental behaviors (PEB) (Anderson & Gerbing, 1988) using Mplus version 7 (Muthén & Muthén, 2012) (see Figure 2). I accounted for missing data (16% MCAR) using a full information maximum likelihood procedure in Mplus and analyzed a positive definite covariance matrix using a maximum likelihood estimation procedure. Model fit was assessed using a χ^2 value, though given this statistic's sensitivity to sample sizes larger than 200 (Kline, 2011) other fit statistics were referenced, including the root mean square error (RMSEA) ≤ 0.07 (Steiger, 2007), comparative fit index (CFI) ≥ 0.90 (Bentler, 1990), and standardized root mean square residual (SRMR) ≤ 0.07 (Hu & Bentler, 1999).

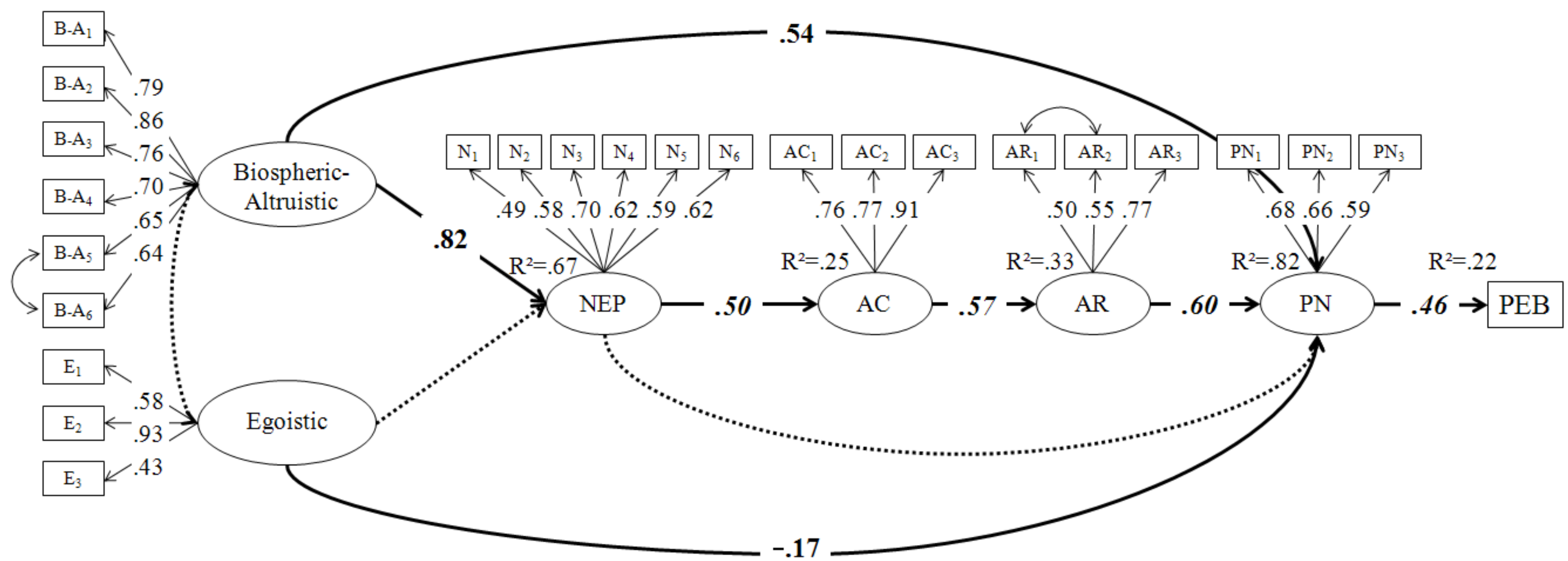

Figure 2. Results from a latent variable path analysis of the value-belief-norm theory of environmentalism. Dotted lines indicate non-significant relationships.

Table 3. Summary of fit indices that examined the hypothesized factor structures among variables predicting pro-environmental behavior.

	X^2	df	RMSEA	CFI	SRMR
Measurement Model	424.391	235	0.048	0.930	0.057
Structural Model	506.621	264	0.051	0.912	0.071

My measurement model adequately fit the data and provided a basis to determine the construct validity and reliability of the survey measures. Given adequate fit of the measurement model to the sample data (χ^2 =424.39; *df*=24; RMSEA=0.05; CFI=0.93; SRMR=0.06), estimation of a structural model was warranted to determine the predictive validity of the latent constructs. Results supported the hypothesized relationships (χ^2=506.62, *df*=264; RMSEA=0.05; CFI=0.91; SRMR=0.07) (see Table 3). Modification indices indicated that model fit could be significantly improved by permitting covariance between two sets of error terms falling within similar dimensions (T_5 with T_6; AR_1 with AR_2) ($\Delta\chi^2$ = 83.76; Δdf = 2). The model was respecified under the assumption that error among the items could be attributed to method-related effects in the sample data (Byrne, Shavelson, & Muthén, 1989). That is, the items I allowed to covary had common sources of error rooted in measurement concerns such as similar language among survey items.

Consistent with H_1, H_2, H_3, and H_4, I found positive, direct effects of PN on PEB (β = 0.46, t = 8.28), AR on PN (β = 0.60, t = 7.08), AC on AR (β = 0.71, t = 8.44), and NEP on AC (β = 0.50, t = 9.51) (see Table 4). In other words, as general belief structures representing an environmental worldview were rated more favorably, respondents reported heightened awareness of environmental problems, ascribed responsibility to take action, and moral inclinations that in turn led to actions undertaken in the previous year. H_5, examining the direct effect of NEP on PN, was rejected (β = 0.26, t = 1.93). As predicted, tests of H_6 confirmed that biospheric-altruistic value orientations increased the likelihood that respondents would positively evaluate human-environment interactions (γ = .82, t = 23.91). Egoistic values had no influence on NEP (H_7; γ = -.10, t = -1.64). However, as hypothesized in H_8, egoism had a negative direct effect on PN (γ = -.17, t = -2.81). The expected pattern of relations emerged between biospheric-altruistic values and PN (H9) (γ = .54, t = 8.07). Overall, the correlations among variables supported the direction of effects postulated by the VBN model.

Table 4. Estimates of the final structural model of the value-belief-norm theory of environmentalism.

Dependent variables	Predictors	γ	β	SE	t-value	R^2
PEB	PN		.46	.06	8.28	.22
PN	AR		.60	.09	7.08	.82
AR	AC		.57	.07	8.44	.33
AC	NEP		.50	.05	9.51	.25
PN	NEP		.26	.14	1.92[a]	
NEP	Biospheric-altruistic	.82		.03	23.91	.67
NEP	Egoistic	-.10		.06	-1.64[a]	
PN	Biospheric-altruistic	.54		.07	8.07	
PN	Egoistic	-.17		.06	-2.81	

[a] non-significant values at $p \leq 0.05$

2.7. Discussion

Based on the tenets proposed by Stern et al.'s (1999) VBN theory, I tested a latent variable structural equation model of the psychological antecedents to pro-environmental behavior within the Channel Islands National Park ecoregion. I observed support for this framework's potential to combine theoretical understandings of moral norm activation (Schwartz, 1977), belief structures (Dunlap et al., 2000), and environmental values (Schwartz, 1994). My data suggest that attitude-behavior correspondence in the context of this research can be understood on the basis of internal processes girding intent-oriented behaviors that benefit the environment.

My research results indicated a clear pattern of effects that can be referenced to "improve" outdoor recreationists' decisions about minimizing environmental impact on the CINP. As predicted, reported behaviors related to management concerns were most likely to occur when expressions of norms that obligated action and/or inaction were activated. Specifically, personal moral norms were directly increased by the extent to which respondents considered biospheric-altruistic values to be guiding principles in life and felt responsible for minimizing environmental change. On the other hand, higher levels of egoistic value decreased the likelihood that normative pressures would lead to reported behavioral engagement. I also found that internal attribution of responsibility was positively predicted by respondents' awareness of impacts on natural and cultural resources, which was positively associated with environmental concerns that emerged from biospheric-altruistic values geared toward non-human species and other people.

2.7.1. Engagement in Pro-Environmental Behavior

In this study I responded to a call for research to be conducted across a range of behaviors that directly and indirectly affect environmental quality (Poortinga et al., 2004). Individual's decisions to undertake actions relevant to the CINP ecoregion were conceptualized as public sphere behaviors that held potential to shape policies and management practices, consequently influencing broad drivers of environmental change (Stern, 2000). My model carried moderate predictive power, in that personal norms accounted for 22% variance in the self-reported behavioral indicator. These findings align with past research showing that sets of VBN variables capture between 19% and 35% sample variance depending on the type of pro-environmental behavior examined (Stern et al., 1999). Emergent patterns may be attributable to the diversity and ease of performing different actions. It could be that some activities (e.g., volunteering at the park) were too costly and/or worked in conjunction with external factors (e.g., average income, state of residence) whereas others (e.g., supporting decisions about marine reserve design) may have been relatively common yet relevant to the CINP. Overall, correlations between reported behaviors and my measures of internal processes reflected the importance of natural areas for generating feelings of environmentalism. Future research should continue to distinguish among forms of pro-environmental behaviors, and particularly in natural areas, develop context-specific measures that reflect management concerns about ecological and socio-cultural integrity (Halpenny, 2010; Ramkissoon, Smith, & Weiler, 2012).

2.7.2. Personal Norms and Beliefs

Activated personal norms were experienced as feelings of moral obligation that played important roles in the performance of PEB (Heberlein, 2012). A total of 82%

variance in personal norms was accounted for by direct effects from ascription of responsibility and biospheric-altruistic values. The correlations I observed in these data were supported by past research (Norlund & Garvill, 2002; Stern et al., 1999) and the proportion of explained variance in my model was comparatively high. Steg et al. (2005), for instance, found that the preceding VBN variables – values, environmental worldviews, awareness, and responsibility – accounted for 49% variance in personal norms. Additionally, Bamberg and Möser (2007) conducted a meta-analysis across 46 independent studies of pro-environmental behavior and showed that four variables including awareness and responsibility accounted for 58% variance in personal norms. Past research suggests that models of self-reported behavior are influenced by multiple internal factors such as knowledge, motivations, and attitudes (Kollmuss & Agyeman, 2002), as well as circumstances external to an individual including infrastructure, economic pressures, and institutions (Guagnano et al., 1995; Steg & Vlek, 2009; Turaga, Howarth & Borsuk, 2010). Although I did not incorporate measures of these internal and external factors, my findings illustrate that ascribed responsibility and biospheric-altruistic values carry potential for anticipating norm construction that likely stems behaviors reflective of CINP management concerns.

Consistent with propositions from the norm activation model, as survey respondents expressed higher levels of awareness that resource conditions were under threat and were willing to assume individual responsibility to prevent impacts, they felt obliged to engage in pro-environmental behavior. This portion of my model illustrated moderate predictive power of awareness leading to responsibility (33% variance) and

NEP leading to awareness (25% variance), despite different levels of specificity between my norm activation model variables and the preceding measures of environmental worldview and value orientation that are more cognitively stable (Dietz et al., 2005). My findings align with Stern et al. (1999) who reported a relatively high R^2 value of .48 for the awareness construct using the same predictors. However, these authors excluded measures of ascribed responsibility from their analysis, as have several others testing adaptations of the VBN model (e.g., Norlund & Garvill, 2002; Raymond, Brown, & Robinson, 2011). Although important contributions have been made using VBN as a guide, future research should be inclusive of ascribed responsibility because this construct represents an important piece of the social psychological puzzle surrounding behavioral engagement (Schwartz, 1977). A wealth of past research has shown that feelings of responsibility are conceptually distinct from other behavioral antecedents, and that individuals will not likely act in accordance with norms if they do not recognize the problems incurred from environmental degradation *and* take it upon themselves to seek a solution (Black, Stern, & Elworth, 1985; De Groot & Steg, 2009; de Ruyter & Wetzels, 2000). Future research including considerations of responsibility will also dovetail with and maintain possibilities for comparisons across research guided by the NAM and VBN models.

2.7.3. Environmental Worldviews

In line with the VBN theory, I argue that personal norms, ascribed responsibility, and awareness of consequences are preceded by more general beliefs that can be assessed using the six-item NEP scale (Dunlap et al., 2000). Within the CINP ecoregion, I found that biocentric-oriented survey respondents with high NEP scores were more likely to assume responsibility, recognize impacts incurred from inaction, and report engagement in pro-environmental behavior (Poortinga et al., 2004; Wynveen, Kyle, & Sutton, in press). High levels of variance accounted for in NEP by biospheric-altruistic values (67% in the current study) have also been reported in previous research (Steg et al., 2005). These results confirm that broad conceptualizations of human-environment interactions are cognitive preconditions to norm activation and can be seen as a link between underlying value systems and belief structures such as awareness of consequences and ascribed responsibility (Stern et al., 1995).

2.7.4. Environmental Values

Environmental values were represented by two dimensions that reflected humanistic tendencies (biospheric-altruistic value) and aspects of self-interest (egoistic value). This conceptualization of variables is supported by past research (Karp, 1996; Norlund & Garvill, 2002; Schultz & Zelezny, 1999; Schwartz, 1994; Stern & Dietz, 1994). Study results illustrate that altruism toward non-human species and other people are indistinguishable bases for the factors that drive pro-environmental behavior. This finding suggests that consequences for the environment and people give equal traction to the performance of individual reported behaviors. Much of the current environmental rhetoric (e.g., "ecosystem services" (Millennium Ecosystem Assessment, 2005)) justifies environmental protection by focusing relatively more attention on ramifications for people. To move environmentalism into a moral realm, my research suggests that problems need to be framed in a way that blends ethical considerations of impacts on the environment *and* the resultant effects for society.

2.7.5. Limitations and Opportunities for Future Research

Much can be gleaned from the sequence of behavioral antecedents examined in this study, though several limitations warrant consideration. First, with regard to the chain of causality implied by the VBN theory, my use of cross sectional data allows me only to falsify hypotheses derived from the theory. My use of structural equation modeling examines the congruence between the predicted variance-covariance matrix (Σ) and the sample (S) variance-covariance, where the structure of Σ is derived from theory. The resulting fit indices provide insight on the degree of congruence and the plausibility of the hypothesized model and theory. These findings imply that the tenets of the VBN theory are plausible despite my use of cross-sectional data (Bollen, 1989; Kline, 2011). Ultimately, however, the tenability of the theory will emerge over time through testing with an array of research designs that include experimentation and the collection of longitudinal data.

The observed patterns in my data might also be attributable to the setting in which my research was conducted. Survey respondents that visited the park via public transportation were presented with multiple opportunities for learning about environmental management challenges. On-site interpretation (e.g., educational exhibits) largely facilitated by the NPS and volunteer-led tours shaped the visitor experience in a particular way and likely increased knowledge and awareness of management concerns (Powell & Ham, 2008). The intensity of interpretation along with visitor characteristics and the nature of the site (Hughes & Morrison-Saunders, 2005) may have caused temporarily heightened levels of awareness that conditioned visitors to be concerned with specific kinds of impacts while visiting the park. However, the pronounced biospheric-altruistic values were reported by respondents indicated stable and positive environmental orientations that would be unlikely to change outside of the park context. Along similar lines, past research has showed that interpretive programs may not contribute to 'authentic' experiences as much as other factors such as learning about customs and values, interacting with locals, and preserving cultural resources (Budruk et al., 2008). Although on-site interpretation likely shaped visitors' experiences in different ways, this test of the VBN model using data drawn from a specific locale offered a critical examination of the tenability of the theory (and its hypotheses) and helped to define the boundaries of its propositions (Kyle et al, 2004a; Kyle et al, 2004b).

Broader representation of the CINP constituency and American public would provide a stronger basis for generalizing research findings. Although I offer a perspective on the predictive relations among factors that lead to reported behavioral engagement among on-site visitors, decision-makers should take caution when applying these results to frame widespread interventions. Multiple interest groups, not all of which were represented in the sampling design, have a stake in CINP resource management activities. For example, access to the CINP waters is almost exclusively maintained by a relatively small but important group of private boaters. Past research suggests the individuals that pursue water-based activities are residents of Santa Barbara and Ventura Counties, fall within a socio-economic bracket amenable to expensive storage and maintenance fees of vessels, and maintain commitment to visiting the islands given the need for crossing ten miles of open ocean to visit the park (LaFranchi & Pendleton, 2008). This stakeholder group may have different environmental orientations and preferences than on-site visitors given their different socio-demographic traits (Oskamp & Schultz, 2005) and proximity the park (Yoon, Kyle, van Riper, & Sutton, 2013). To better understand the tendencies of the entire CINP constituency, future research should cross-validate my findings and explore other segments of the survey population.

The conclusions drawn from this study could have been drawn using alternate methodological and theoretical frames. Advances in social psychology have established several promising avenues for predicting individual human behavior. For example, under assumptions of rationality, the theory of planned behavior (TPB) (Ajzen, 1985) could have guided this investigation and provided valuable insights on behavioral intentions and tendencies. Although this approach may have accounted for relatively high levels of explained variance via measures of intention (Kaiser et al., 2005), the inclusion of personal moral norms in the current study (as opposed to a focus on self interest) showed strong predictive power across the antecedents of pro-environmental behavior. In response to an expressed need for research to consider the predictive power of multiple theoretical frames (Bamberg & Möser, 2007), results from my latent variable model can be more easily considered alongside TPB-related research findings. That is, this Section in my dissertation moves beyond the aggregated measures of antecedents often tested in VBN models and considers unobserved relations among variables. Thus, this study accounts for measurement error that may otherwise go undetected (Kaiser et al., 2007).

2.7.6. Implications for Behavior Change

I share implications emanating from this research to illustrate how managers and policymakers can activate behaviors that are beneficial for the CINP ecoregion. This information can guide intervention strategies that promote biological diversity and carries potential to be well-received by stakeholders in the context of industrialized nations (Cole & Yung, 2010; Hobbs, Hallett, Ehlrich, & Mooney; Marris, 2011). The theoretical underpinnings of my model suggest that less stable determinants of environmentalism can be more easily influenced to yield behavior change that aligns with environmental management goals and objectives (Dietz et al., 2005). These data indicate that environmental management agencies will see more immediate results from outreach efforts that target variables farther down the "causal chain," namely variables within the NAM. That is, rather than attempting to tap values or worldviews, the most effective means for promoting pro-environmental behavior is via personal norms (Heberlein, 2012). On-site education and outreach efforts should be maintained and/or implemented to stimulate responses to environmental consequences and prevent responsibility denial by activating feelings of moral obligation among the environmentally conscious and affluent people that visit the CINP ecoregion. Decision-makers should also focus their efforts on preventing the deactivation of norms that create behavioral regularities and drive individual expectations about visitor experiences in parks and protected areas.

My research results provide guidance for on-site management interventions. Specifically, public land managers that oversee areas such as the CINP can consider adopting three approaches outlined by Heberlein (2012). First, “technological” changes to the biophysical world may involve creating more durable structures that are less susceptible to deterioration, which would effectively circumvent changes to behaviors such damaging historic artifacts on the CINP. Second, “structural” management tactics may involve expanding marine reserve networks or other policies that impose regulations on resource extraction. Finally, “cognitive” changes require decision-makers to have knowledge of attitudes, and on the CINP, may involve interpretive signage or educational messages about how to properly dispose of waste that exacerbates biological invasions. Cognitive solutions are most common and require understandings of the internal processes highlighted in this study. However, this tactic will fail if implemented alone (McGuire, 1986). Technological, structural, and cognitive fixes are complementary approaches to shaping behavior, and should be carefully executed and combined with other techniques to equip decision-makers with the tools for designing outreach strategies informed by visitor behavioral patterns.

2.8. Conclusions

Social psychological scholarship has provided insightful explanations of why internal processes do or do not give rise to behavioral engagement. This latent variable path analysis of the full VBN theory of environmentalism further advances theoretical understandings of the configuration and measurement properties of variables in this model. Investigations of small but important self-reported, context-specific behaviors performed by park visitors and the relations among antecedents to engagement will help to sustain special places such as the CINP that protect biologically diversity, contribute to local economies, and support human well-being. The implications from my research also guide management interventions that aim to encourage pro-environmental behavior in economically-developed nations.

3. CAPTURING MULTIPLE VALUES OF ECOSYSTEM SERVICES SHAPED BY ENVIRONMENTAL WORLDVIEW: A SPATIAL ANALYSIS

3.1. Overview

Two related approaches to valuing nature have been advanced in past research including the study of ecosystem services and psychological investigations of the factors that shape behavior. Stronger integration of the insights that emerge from these two lines of enquiry can more effectively sustain ecosystems, economies, and human well-being. Drawing on survey data collected from outdoor recreationists on Santa Cruz Island within Channel Islands National Park, U.S., this study blends these two research approaches to examine a range of tangible and intangible values of ecosystem services provided to stakeholders with differing biocentric and anthropocentric worldviews. I used Public Participation Geographic Information System methods to collect survey data and a Social Values for Ecosystem Services mapping application to spatially analyze a range of values assigned to terrestrial and aquatic ecosystems in the park. My results showed that preferences for the provision of biological diversity, recreation, and scientific-based values of ecosystem services varied across a spatial gradient. I also observed differences that emerged from a comparison between outdoor recreationists defined by their worldviews. The implications emanating from this investigation aim to support environmental management decision-making in the context of protected areas.

3.2. Introduction

How can we better articulate and understand multiple values of nature? This question has attracted considerable research attention in the social and behavioral sciences. Previous investigations have indicated that tangible and, at times, monetized values of nature can maintain traction in political arenas and create meaningful opportunities to examine tradeoffs among competing "ecosystem services," defined as the direct and indirect benefits (e.g., clean air, flood control, timber, recreation) that nature provides to people (Costanza et al., 1997; Daily, 1997; de Groot et al., 2002; MEA, 2005). Although compelling evidence of ecological and economic values has been gathered to demonstrate the implications of changing social-ecological conditions, a growing body of research has called for broader conceptions of value encompassing ethical imperatives and expressions of the nonmaterial qualities of nature (Chan et al., 2012a; Cordell et al., 2005; Daniel et al., 2012; Martín-López et al., 2012; Raymond et al., 2009). Specifically, insights on behavioral antecedents (e.g., value orientations, worldviews, belief structures) are rarely incorporated in the study of ecosystem services despite their ability to help explain why valuation occurs and reveal the complexities of human behavior that benefits the environment (Kumar & Kumar, 2008; Turaga et al., 2010).

In this Section of my dissertation, I call for stronger integration among disciplines that espouse value-related concepts to enhance recreation experiences, minimize impacts on the environment, and help ensure that policy outcomes are not rendered unsuccessful. Information about psychological processes can be harnessed to better understand external (e.g., markets) and internal factors (e.g., dispositions) that confound decision-making (Guagnano et al., 1995), as well as complement a well-established bridge between economics and ecology. Multiple values – especially those extending beyond the assumptions of rational choice theory – influence the implementation process and carry potential to ensure science is successfully incorporated in management activities (Knight et al., 2008; Pressman & Wildavsky, 1984). Social science scholarship must establish a more inclusive approach to integrating concepts from psychology, economics, and ecology to enhance resource and recreation management decisions about the allocation of goods and services. Given broader representation of multiple values in decision-making, agencies will be better positioned to: (a) negotiate consensus-based outcomes and create space for trust in scientific expertise (Brown, 2009); (b) ensure more equitable and transparent decisions (Bridge & Perreault, 2009); and (c) encourage greater compliance with rules and regulations among the individuals most affected by policy change (Ban et al., 2013; McCook et al., 2010; Sutton & Tobin, 2009).

Past research has called attention to tiers of the value concept that range from core belief structures processed on an individual basis to more reflective and interactive place-based values (Brown, 1984; Manning et al., 1999; McIntyre et al., 2008; Sabatier, 1988; Schroeder, 2013). Extending this line of enquiry, I empirically analyzed two different forms of value across spatial scales to reveal variation in outdoor recreation interests that may otherwise be marginalized in environmental planning and management. Specifically, I investigated “held” environmental value orientations that ranged from biocentric (i.e., nature-based) to anthropocentric (i.e., human-based) worldviews and “assigned” values of ecosystem services that were mapped by survey respondents guided by Public Participation Geographic Information Systems (PPGIS) methods. I also used a Social Values for Ecosystem Services (SolVES) analysis tool (Sherrouse et al., 2011) to spatially analyze assigned value patterns reported by subgroups with differing worldviews, and in turn, identify high priority locations within the terrestrial and aquatic ecosystems of the study area. Thus, the purpose of this Section of my dissertation was to determine how worldviews gave rise to different preferences for tangible and intangible values of ecosystem services across spatial scales. In the following subsections I elaborate on the definition of value, review methods for examining this concept, and situate this investigation in the context of parks and protected areas. Finally, I present the research objectives that guided this study of outdoor recreationists visiting Channel Islands National Park.

3.3. Literature Review

3.3.1. Conceptualizing Value

My conceptualization of value is adapted from research that distinguishes between held and assigned values (Brown, 1984). A held value is defined as “an enduring belief that a particular mode of conduct or that a particular end-state of existence is personally and socially preferable” (Rokeach, 1973, p550). This form of value reflects the most basic elements of cognition that facilitate preferences and induce action. For example, Norlund & Garvill (2002) tested a path analysis of held values and other factors that shaped behavior reported by a sample of Swedish residents. In this study, held values were correlated with beliefs and norms that anteceded action. The authors examined the general and environmental held values of self enhancement and anthropocentrism (i.e., concern for individual interests and human welfare), as well as self transcendence and biocentrism (i.e., concern for all life forms beyond the self). Along similar lines, other scholars have argued that held values play a significant role in attitude formation and influence less stable psychological processes such as place-based preferences for resource conditions (De Groot & Steg, 2010; Schultz & Zelezny, 1999).

Assigned values are defined as the perceived qualities of an environment that provide material and nonmaterial benefits to people (Bengston & Xu, 1995; Rolston, 1988; Zube, 1987). Investigations of assigned value have shown that these place-based preferences can be mapped using GIS and rated in relation to one another (Seymour et al., 2010). As such, tradeoffs among competing assigned values of ecosystem services can be examined across spatial scales. Past research has related assigned value typologies to categories of the Millennium Ecosystem Assessment (2005) to further solidify the linkage between assigned values research – often explored under the rubric of PPGIS methods – and the ecosystem services literature (Brown, 2013; Brown et al., 2012). For example, Sherrouse et al. (2011) linked a series of spatially-anchored assigned values of ecosystem services to a suite of biophysical metrics (e.g., distance to roads, elevation) that reflected natural resource conditions in Colorado's Pike and San Isabel National Forests. van Riper et al. (2012) also mapped a suite of material and nonmaterial assigned values of places on Hinchinbrook Island National Park, Australia.

These past studies have demonstrated that qualities ascribed to an environment can be mapped across a spatial gradient and conceptualized as distinct processes from held environmental value orientations that encompass biocentric and anthropocentric worldviews.

A rich theoretical foundation underpins the argument that there are multiple values of nature. More specifically, a class of social psychological theories that guide the study of environmental attitudes provides a formal basis to show that held values shape attitudes and less stable psychological processes such as assigned values, which in turn influence human behavior (Dietz et al., 2005; Schwartz, 1992). For example, Stern et al. (1999) developed the value belief norm theory, which indicated that overt responses to feelings of moral obligation could be expected when positively influenced by values beyond self-interest and belief structures such as environmental worldview. Vaske & Donnelly (1999) also tested a series of psychologial processes organized into a cognitive hierarchy model that predicted behavioral intentions reported by Colorado residents. Literature in political science (e.g., Sabatier, 2007) and environmental ethics (e.g., Callicott, 1984) offer parallel arguments about the need for pluralism in the study of value (Wallen, 2013). For example, the advocacy coalition framework of policy change developed by Sabatier (1988) argued that individual decision-making was typically a function of multiple sources of information including shared beliefs and external events. From the aforementioned lines of research, a multifaceted conceptualization of value can be rationalized whereby broad, core belief structures lead to more specific, malleable preferences for policy outcomes.

My understanding of held and assigned values is depicted in Figure 3, which flows from bottom to top. Held values and similar orientations spanning anthropocentrism and biocentrism provide a foundation on which people base their decisions and interpret the world around them. Drawing on a spectrum of held values, an individual moves through an arena whereby he or she experiences nature. This is a relational realm linking held and assigned values and reflecting gestalt feelings that emerge from human-environment interactions (Schroeder, 2013). At the top of this diagram lies a typology of assigned values reflecting preferences for features detected in an environment. The relative perceived importance of these assigned values is more immutable than a spectrum of held values (Dietz et al., 2005). In support of this heuristic, past research has shown that held values shape attitudes toward management of protected areas (Borrie et al., 2002; Tanner et al., 2008). For example, Manning et al. (1999) developed a suite of held values and measures of ethical disposition to predict Vermont residents' attitudes toward management of Green Mountain National Forest. McIntyre et al. (2008) also posited held values were abstract concepts that could be contrasted against place-based measures of assigned values. Results from this latter study identified particular locales that were mapped across a working landscape. These results illustrate the importance of how assigned values can be depicted in spatial analyses, and in turn, integrated into environmental planning and management.

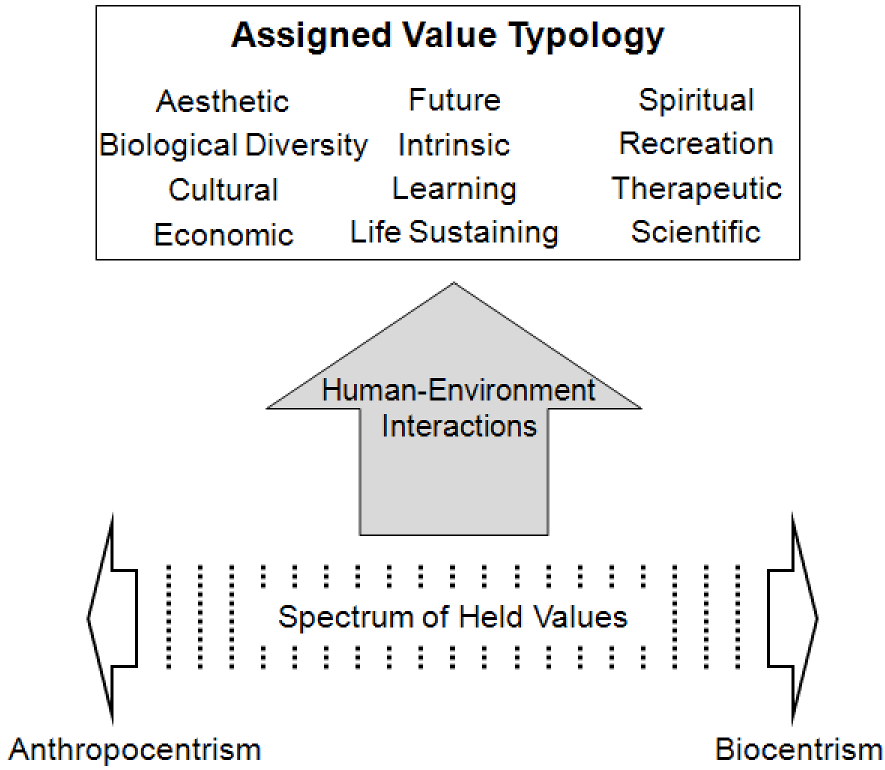

Figure 3. Conceptual framework of the relationship between "held" environmental values represented by a continuum ranging from anthropocentrism to biocentrism and 12 different types of "assigned" values of ecosystem services. (Adapted from Brown, 1984.)

3.3.2. Navigating Value Methodology

Held values are underlying orientations that drive reported behavior, similar to the ideas reflected in the New Ecological Paradigm (NEP) scale (Dunlap & Van Liere, 1978; Dunlap et al., 2000). The NEP measures nature-based, 'primitive' beliefs that reflect an individual's fundamental priorities about human-environment interactions (Oskamp & Schultz, 2005). The NEP scale indicates potential endorsement of an environmental worldview and is comprised of statements about living in harmony with (i.e., biocentrism) or having mastery over nature (i.e., anthropocentrism) (Schultz &

Zelezny, 1999; Schwartz, 1994). The dimensionality of this construct has been contested (Ambergey & Thoman, 2012), though a large body of research has relied on a two-dimensional framework to suggest underlying belief systems predispose people to act in support or opposition of policy change (Milfont & Duckitt, 2004; Nooney et al., 2003; Wynveen et al., in press). Use of the NEP as a reflection of held value is a departure from the "Rokeachean" tradition (i.e., Rokeach, 1973); however, the NEP can be considered a proxy because this belief structure operates on a similar cognitive plane as held environmental values (Norlund & Garvill, 2002) and is more resistant to change than less stable place-based preferences such as assigned values (Dietz et al., 2005).

Multiple classification systems have been proposed in past research to characterize assigned values (Bengston & Xu, 1995; Brown & Reed, 2012; Harmon & Putney, 2003; Rolston, 1988; Tarrant et al., 2003). One typology that has spawned a substantive body of PPGIS research was developed by Brown & Reed (2000). These authors identified 13 conceptually distinct categories adapted from past research to reflect why areas in the Chugach National Forest were valued. Other scholars have used similar methods to elicit preferences for assigned values of ecosystem services and spatially analyze the locations of points assigned to places by survey respondents using GIS techniques (Sherrouse et al., 2011, 2014). Specifically, past research has developed value mapping methods whereby survey respondents are presented with a typology of various landscape qualities (see Table 5) and asked to situate those qualities across a geographic locale. The assignment of aesthetic value, for instance, indicates that the respondent enjoys the sites and scenery of a setting in relation to other place-based services. This PPGIS research thread has prioritized management decisions and engaged stakeholders in participatory mapping exercises to identify focal areas ("hotspots" or "coldspots") that carry meaning and importance (Alessa et al., 2008; Brown & Raymond, 2007; Nielsen-Pincus, 2011; Sherrouse et al., 2011).

Table 5. Definitions of assigned value types that reflect the tangible and intangible qualities of nature.

Value Type	Description
Aesthetic	I value Channel Islands National Park for the attractive scenery, sights, sounds, or smells
Biological Diversity	I value Channel Islands National Park because it provides for a variety of plants, wildlife, marine life, and other living organisms
Cultural	I value Channel Islands National Park because it preserves historic places and archaeological sites that reflect human history of the island
Economic	I value Channel Islands National Park because it provides fisheries, recreation, or tourism opportunities that provide economic benefits
Future Value	I value Channel Islands National Park because it allows future generations to experience this place
Intrinsic	I value Channel Islands National Park in and of itself for its existence
Learning	I value Channel Islands National Park because I can learn about natural and cultural resources
Life Sustaining	I value Channel Islands National Park because it helps produce, preserve, clean, and renew air, soil, and water
Spiritual	I value Channel Islands National Park because it is spiritually significant to me
Recreation	I value Channel Islands National Park because it provides a place for my favorite outdoor recreation activities.
Therapeutic	I value Channel Islands National Park because it makes me feel better, physically and/or mentally
Scientific	I value Channel Islands National Park because it provides an opportunity for scientific observation or experimentation

3.3.3. Contextualizing Value

Investigations of value, including those elicited via PPGIS methods, require careful consideration in parks and protected areas (PAs). Particularly within the U.S., PAs are often touted as "priceless" locales that provide valuable resources for future generations and that serve as symbols of American heritage (NPS, 2012). On a global scale, PAs preserve biological diversity including ecosystems, habitats, and at-risk species, and they cover 15% of terrestrial and 10% of aquatic global environments (CBD, 2008). These contexts inherently embody multiple forms of value including: (a) economic benefits of tourism activities (Eagles, 2002); (b) restorative experiences that contribute to human well-being and quality of life (Kaplan, 1995; Manning, 2011); and (c) resources that sustain and support local livelihoods (Naughton-Treves et al., 2005; Robbins et al., 2009). Moreover, PAs are fascinating laboratories to examine a range of values, because they elicit positive associations with nature (e.g., sublimity, open spaces, quiet environments) (Harmon & Putney, 2003) alongside negative sentiments such as potential feelings of intimidation (Plieninger et al., 2013) or histories of resident displacement (Spence, 1999). As dynamic and changing environments inevitably shaped by human activities (Mascia & Pailler, 2011), PA managers and policymakers are increasingly challenged to reconcile competing assigned values and ethical orientations toward human-environment interactions (Manning et al., 1999).

In response to these intellectual, methodological, and contextual challenges, I conducted this research on Santa Cruz Island, which is the largest (96.53 square miles) of five islands within Channel Islands National Park (CINP) located approximately 20 miles off the coast of southern California (see Figure 4). The National Park Service (NPS) and The Nature Conservancy (TNC) jointly manage 24% and 76% of Santa Cruz, respectively. Among other agencies, the NPS and the National Oceanic and Atmospheric Administration (NOAA) oversee waters surrounding the island, which are partially protected within a marine reserve network (Davis, 2005). Santa Cruz Island has a Mediterranean climate, is largely covered by grassland plant communities, and is characterized by dramatic viewsheds including bluffs, sea caves, and occasional sandy beaches along the coastline. An interior mountain range reaches 2,450 feet while giant kelp forests flourish in nearshore waters providing habitat for an abundance of marine life. Similar to Ecuador's Galapagos Islands, the CINP harbors endemic species such as the Island Fox (*Urocyon littoralis*) and Island Scrub Jay (*Aphelocoma insularis*). The islands have been occupied by humans for approximately 13,000 years, throughout which time indigenous communities (i.e., Chumash Native Americans), ranching operations, recreational activities, and scientific research have shaped its biophysical condition (Gherini, 2005). Currently, outdoor recreation activities within the CINP amount to approximately 30,000 annual visits and 60,000 to adjacent waters (NPS, 2013).

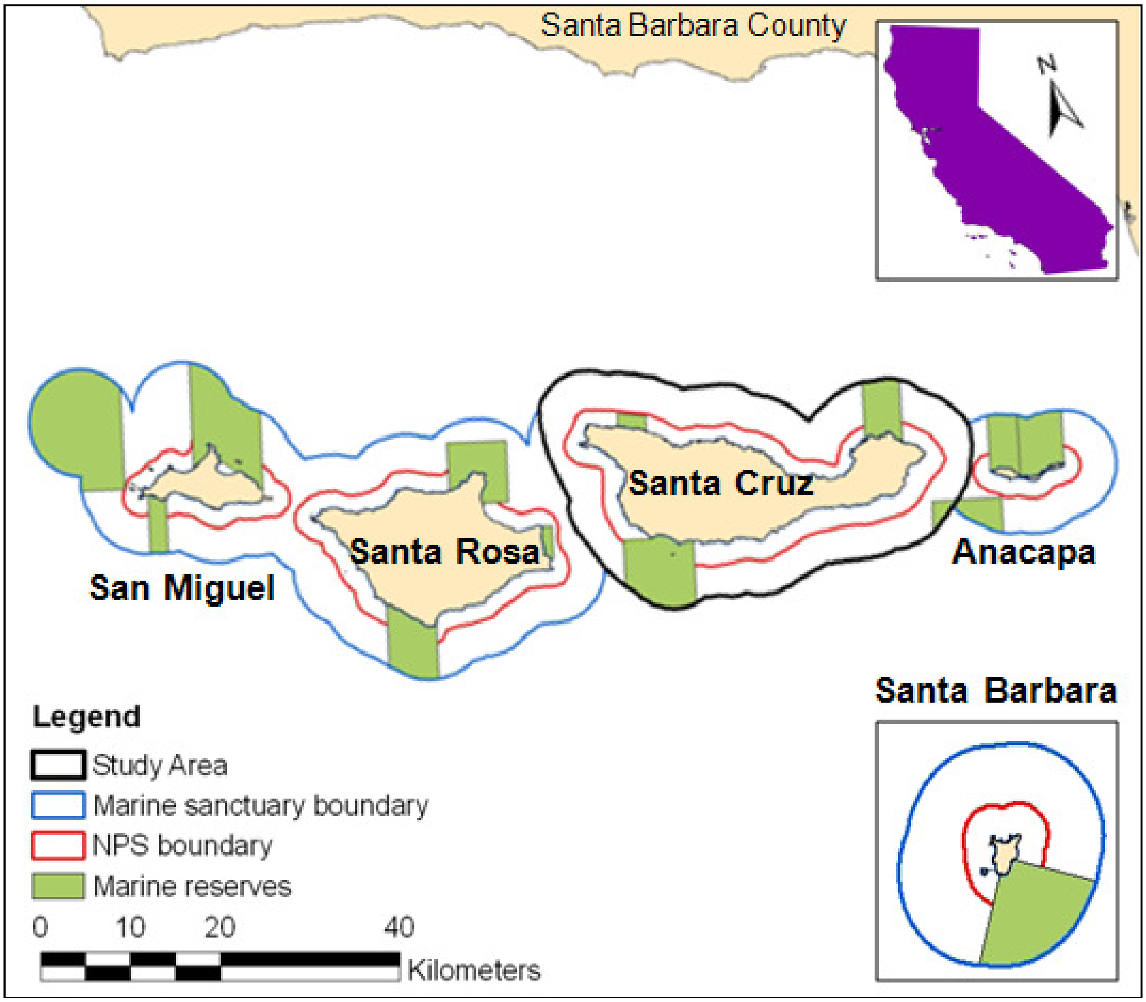

Figure 4. Map of the Santa Cruz Island within Channel Islands National Park.

3.3.4. Research Objectives

This Section in my dissertation explores issues related to the conceptualization and measurement of value-related concepts reported by outdoor recreationists on Santa Cruz Island within the CINP. Specifically, I mapped a range of tangible and intangible assigned values reported by two survey subgroups defined by their held environmental value orientations. My results offer a perspective on how spatially-anchored assigned values of ecosystem services are shaped by biocentric and anthropocentric worldviews.

Three objectives guided this research: (a) identify subgroups within a sample of outdoor recreationists on the basis of environmental worldview, (b) examine the relative perceived importance and spatial distribution of 12 assigned values of ecosystem services, and (c) determine the spatial relationships between environmental worldview and assigned values across the land and seascapes of Santa Cruz Island.

3.4. Methods

3.4.1. Data Collection

On-site self-administered surveys were distributed to a random sample of adult visitors by a team of trained administrators (see Appendix C). My survey schedule was stratified by day of the week and time of the day; data were collected in the mornings and afternoons of 28 weekdays and 14 weekend days June-August, 2012. I randomly selected respondents at pre-defined time intervals, and in groups, selected individuals with the most recent birthday (Battaglia et al., 2008). My survey station was located near Scorpion Ranch in the northeast portion of the island. I collected data using ASUS Transformer TF3000T tablets and Droid Survey (version 1.4.1) off-line software (Davis et al., 2012) and recorded all on-site encounters using contact logs to estimate response bias on the bases of gender (χ^2=0.065) and group size (t=1.256, df=335). In total, 344 people were asked to participate in the survey, 323 of whom agreed, resulting in a response rate of 94%. For spatial analyses, I used survey data from respondents that completed both steps in the participatory mapping exercise described later in this Section.

3.4.2. Measuring and Analyzing Environmental Worldview

I measured environmental worldview using an abbreviated 10-item version of the revised NEP scale (Dunlap et al., 2000). I based my configuration of survey items on previous research that has employed an equal number of positively and negatively-worded statements to represent each hypothesized facet of the NEP (Hall & Moran, 2006; Hawcroft & Milfont, 2010; Milfont & Duckitt, 2004). These items were measured using a Likert scale that ranged from 1="strongly disagree" to 5="strongly agree" (see Table 6). Missing observations (19.7% MCAR) were replaced using LISREL's (version 8.80) multiple imputation procedure in an extension program called PRELIS. Given the prevalence of a two-dimensional NEP model supported in past research (e.g., Milfont & Duckitt, 2004), I hypothesized that held environmental value orientations would be represented by biocentric and anthropocentric worldviews. To verify this two-dimensional conceptualization, I used confirmatory factor analysis, relied on a maximum likelihood estimation procedure, and analyzed data with a positive definite covariance matrix. The hypothesized factor structure illustrated adequate fit to the data: χ^2=109.990, df=33 ($p \leq 0.01$) (Kline, 2011); RMSEA=0.089 (Steiger, 2007), CFI=0.915 (Bentler, 1990); SRMR=0.47 (Hu & Bentler, 1999). All factor loadings exceeded .30 and a reliability analysis (Cronbach's alpha) illustrated internal consistency among five positively-worded items reflecting biocentrism (α=.706) and five negatively-worded items reflecting anthropocentrism (α=.763) (Nunnally, 1978).

Table 6. Factor loadings, mean values, standard deviations, and internal consistency among survey items in an abbreviated version of the new ecological paradigm scale.

	Factor Loading	**Mean**	**SD**
Biocentrism (α = .706)			
We are approaching the limit to the number of people the earth can support	.550	3.58	1.16
When humans interfere with nature if often produces disastrous consequences	.663	3.86	0.93
Plants and animals have as much right as humans to exist	.497	4.22	0.90
Despite our special abilities humans are still subject to the laws of nature	.341	4.40	0.68
If we continue on our current course, we will soon experience a major ecological catastrophe	.774	3.81	0.99
Anthropocentrism (α = .763)			
Humans have the right to modify the natural environment to suit their needs[1]	.498	3.67	0.98
Human ingenuity will ensure that we do not make the earth unlivable	.506	3.24	1.10
The earth has plenty of natural resources if we just learn how to develop them	.476	2.94	1.16
The balance of nature is strong enough to cope with the impacts of modern industrial nations	.692	3.72	1.06
The so-called "ecological crisis" facing humankind has been greatly exaggerated[1]	.786	3.88	1.08

[1]Survey items allowed to covary

Note. Measured on a Likert scale where 1 = "strongly disagree" and 5 = "strongly agree"

To segment respondents into subgroups I performed a K-means cluster analysis (SPSS version 21.0). For this procedure, I entered all NEP survey items into the analysis and considered multiple cluster solutions in terms of the: (a) proportion of respondents in each cluster; (b) significant differences illustrated by Analysis of Variance testing; and (c) results from validation analyses using socio-demographic and trip characteristics (Hair & Black, 2000). Ultimately, I selected a two-cluster solution and created a cluster membership variable to segment respondents into subgroups on the basis of their environmental worldviews. Table 7 includes survey respondents' evaluations of NEP items and a series of questions that were used to define the two subgroups of outdoor recreationists.

3.4.3. Measuring and Analyzing Assigned Value

I collected data on the perceived importance and spatial locations of assigned value during a mapping exercise that involved two tasks. First, I asked respondents to allocate 100 "preference points" across 12 categories of tangible and intangible values so that their point allocation totaled 100. These categories were drawn from past research (Brown & Reed, 2000) and modified in consultation with NPS staff. Specifically, modifications were made to the wording of most categories, "cultural" was integrated with "historic," "subsistence" was removed, and "scientific" was added to the typology originally proposed by Brown & Reed (2000). Preference points rather than dollar values were used during the mapping exercise because the typology included categories (e.g., "spiritual," "cultural") that, if framed in monetary terms, may have eclipsed actual estimations of perceived value. The second step in this exercise involved situating these values on a 34'' by 13'' map of the study context created by the National Geographic Society (http://travel.nationalgeographic.com/), which was displayed at the survey station. I asked respondents to identify places on the map that they believed embodied assigned values selected in the first step of the exercise. Survey administrators recorded information and verified accurate entries on the tablets. The mapping exercise occurred after the self-administered portion of my survey, given that it was an interactive process between the administrator and respondent.

Survey data were analyzed using a SolVES (Version 2.0) GIS mapping application developed by the U.S. Geological Survey (Sherrouse et al., 2011) that interfaced with Maximum Entropy (MaxEnt) modeling software (Phillips et al., 2006). All locations to which respondents assigned values were digitized in an ArcGIS geodatabase under a point feature class (n=2,245). The total number of preference points associated with each assigned value in the typology was linked to the digitized points using a unique identifier. Next, weighted kernel density surface layers were generated for each assigned value category (Alessa et al., 2008; Silverman, 1986) and then normalized, transformed, and standardized on a 10-point value index using SolVES (Sherrouse et al., 2014). The maximum value index for each assigned value category was multiplied by a logistic surface layer generated in MaxEnt, which employed a machine learning program to estimate the probability distribution of points given the constraints imposed by a suite of explanatory environmental variables (i.e., "biophysical metrics"). Using point data reflecting the distribution and intensity of valued landscapes as well as the continuous and categorical biophysical metrics selected for analysis, logistics surface layers were generated in MaxEnt to indicate the probability, on a cell by cell basis, that survey respondents would associate assigned values with places in the study area.

Building on past PPGIS research, five biophysical metrics analyzed in MaxEnt were selected for this study owing to their potential to shape the perceived qualities of places (Brown, 2013; Brown & Brabyn, 2012; Sherrouse et al., 2011). The first metric was an elevation layer acquired from the U.S. Geological Survey's National Elevation Dataset (http://nationalmap.gov/elevation.html). Secondly, I used a 16-class categorical land cover layer drawn from the National Land Cover Database 2006 (Fry et al., 2011). The third, fourth, and fifth metrics were distance to management infrastructure including trail systems and interpretive centers on Santa Cruz, distance to marine reserves, and distance to the coastline. I used the Euclidean Distance tool in the Spatial Analyst extension of ArcGIS to create the third, fourth, and fifth landscape metrics. All layers were treated as 50m resolution rasters and results were generated at an output cell size of 500m. The final value index maps created using SolVES and MaxEnt reflected the suitability of different places for providing values of ecosystem services within the constraints imposed by the five biophysical metrics (see Sherrouse et al., 2014). With these layers, I evaluated the dispersion, clustering, and randomness of assigned value points using completely spatially random hypothesis testing, which estimated average nearest neighbor statistics (Brown et al., 2002).

Table 7. Profile of the pooled sample and two subgroups defined by environmental worldview.

	Pooled Sample	**Neutral-NEP Subgroup**	**Strong-NEP Subgroup**	
Gender (%)				
Male	58.6	69.4	52.4	χ^2 = 8.25*
Female	41.4	30.6	47.6	
Age				
Years (*M, SD*)	43.53 (14.83)	41.4 (14.78)	44.74 (14.75)	*t*=-1.87

Table 7. Continued

	Pooled Sample	Neutral-NEP Subgroup	Strong-NEP Subgroup	
Education (%)				
Less than high school	1.3	1.9	1.1	χ^2=3.99
High school graduate	7.7	11.1	5.8	
Vocational / trade school certificate	4.0	3.7	4.2	
Two-year college degree	10.1	8.3	11.1	
Four-year college degree	35.7	32.4	37.6	
Graduate degree	41.1	42.6	40.2	
Income (%)				
< $50,000	15.0	14.3	15.3	χ^2=0.39
$50,000 - $99,999	32.3	32.4	32.2	
$100,000 - $149,999	25.3	26.7	24.6	
$150,000 - $199,999	13.2	13.3	13.1	
≥ $200,000	14.2	13.3	14.8	
Ethnicity (%)				
Hispanic	10.1	11.1	9.5	χ^2=0.19
Race (%)				
White	86.8	81.5	89.9	χ^2=4.24*
Asian	6.4	9.3	4.8	
Black or African American	1.0	1.9	0.5	
Native Hawaiian or other Pacific Islander	-	-	-	
American Indian or Alaska Native	2.0	0.9	2.7	
Household size				
People (*M, SD*)	2.93 (1.42)	3.19 (1.43)	2.78 (1.39)	*t*=2.46*
New Ecological Paradigm				
Biocentrism[1] (*M, SD*)	3.97 (.64)	3.38 (.52)	4.32 (.41)	*t*=17.39*
Anthropocentrism[2] (*M, SD*)	2.51 (.77)	3.23 (.57)	2.10 (.53)	*t*=-17.12*

[1]Agreement with survey items on a five-point Likert scale reflected a biocentric worldview.
[2]Agreement with survey items on a five-point Likert scale reflected an anthropocentric worldview.
*$p \leq .05$.

3.5. Results

In response to the first objective, I identified subgroups of outdoor recreationists on the basis of their environmental worldviews. The first subgroup, *Neutral NEP,* represented 36.4% (n=108) of the sample and was comprised of respondents that reported nearly equal agreement with survey items reflecting biocentrism (*M*=3.38, *SD*=.52) and anthropocentrism (*M*=3.23, *SD*=.57). Respondents in the second subgroup, *Strong NEP,* represented 63.6% (n=189) of the sample and took a relatively pronounced stance toward environmental issues indicated by high levels of agreement with statements about biocentrism (*M*=4.32, *SD*=.41) and strong disagreement with statements about anthropocentrism (*M*=2.10, *SD*=.53). According to results from independent samples t-tests, there were more White females reporting a smaller household in the *Strong NEP* subgroup compared to respondents in the *Neutral NEP* subgroup. Age, income, ethnicity, and previous experience did not vary. Survey items measuring biocentrism (t=17.39, $p \leq .001$) and anthropocentrism (t= -17.12, $p \leq .001$) were perceived differently.

Table 8. Preference point allocation and nearest neighbor statistics for 12 values that outdoor recreationists assigned to places on Santa Cruz Island.

	Pooled Sample			**Neutral NEP Subgroup**			**Strong NEP Subgroup**		
	N	*R-Ratio*	*Z-score*	*N*	*R-Ratio*	*Z-score*	*N*	*R-Ratio*	*Z-score*
Aesthetic	510	.21	-34.15	157	.21	-18.98	278	.29	-22.57
Biological Diversity	535	.47	-23.67	110	.39	-12.29	306	.57	-14.34
Cultural	97	.24	-14.35	40	.44	-6.79	46	.37	-8.18
Economic	20	.99	-0.08	7	.10	-4.54	9	1.33	1.91
Future	119	.38	-12.85	34	.28	-8.05	76	.49	-8.44
Intrinsic	102	.33	-12.95	40	.45	-6.70	57	.31	-9.92

Table 8. Continued

	Pooled Sample			Neutral NEP Subgroup			Strong NEP Subgroup		
	N	*R-Ratio*	*Z-score*	*N*	*R-Ratio*	*Z-score*	*N*	*R-Ratio*	*Z-score*
Learning	246	.11	-26.58	57	.05	-13.68	149	.14	-20.18
Life Sustaining	53	.43	-8.02	21	.46	-4.76	24	.49	-4.83
Spiritual	101	.25	-14.51	38	.24	-9.01	50	.27	-9.90
Recreation	428	.22	-30.98	156	.16	-20.07	213	.31	-19.37
Therapeutic	161	.34	-16.08	54	.13	-12.21	89	.45	-9.97
Scientific	259	.50	-15.24	39	46	-6.43	161	.53	-11.51

Note. Spatial statistics included the observed versus expected distance between points (R ratio) and the number of standard deviations from the mean (Z score).

As articulated by my second objective to examine the point density and distribution of assigned value, I evaluated how outdoor recreationists allocated 100 preference points across the value typology. This phase in the analysis allowed me to determine why survey respondents thought the CINP was important. Aesthetic, recreation, learning, biological diversity, and scientific qualities were assigned the greatest number of preference points, suggesting the park was most valued for these purposes. I also found that all categories in the typology except economic value formed statistically significant spatial clusters. That is, nearest neighborhood statistics indicated that the digitized points identifying which areas carried assigned value grouped together in several places across my study area (see Table 8). This procedure allowed me to determine areas of value abundance on Santa Cruz Island and in adjacent waters.

Table 9. Independent samples t-test results and descriptive statistics for assigned values.

	Neutral-NEP Subgroup (n = 108)		**Strong-NEP Subgroup** (n = 189)		**95% CI for Mean Difference**		
	M	*SD*	*M*	*SD*		*t*	*df*
Aesthetic[1]	18.36	18.67	16.32	15.11	-2.12, 6.19	0.97	187
Biological Diversity	13.04	14.05	17.97	15.18	-8.44, -1.42	-2.77*	295
Cultural	5.10	7.27	5.19	7.07	-1.78, 1.61	-0.10	295
Economic[1]	2.52	5.27	1.55	4.11	-0.21, 2.15	1.62	179
Future	6.70	9.26	9.16	10.80	-4.90, 0.02	-1.99*	295
Intrinsic	6.95	11.34	6.81	10.20	1.28, -2.38	0.11	295
Learning	7.78	12.43	8.68	11.09	1.40, -3.65	-0.64	295
Life Sustaining	5.46	11.39	5.87	10.38	-2.97, 2.14	-3.20	295
Spiritual	3.69	7.07	3.24	6.14	-1.10, 1.98	0.56	294
Recreation[1]	15.24	15.75	11.16	10.87	0.70, 7.45	2.38*	166
Therapeutic	5.67	10.26	5.60	8.19	-2.07, 2.20	0.60	294
Scientific	5.72	8.66	10.13	10.35	-6.73, -2.09	-3.74*	294

[1]Equal variances not assumed.
*$p \leq .05$.

Next, I compared value allocations between subgroups using an independent samples t-test (see Table 9). Among the five most important assigned values identified in response to my second objective, three were preferred to significantly different degrees by the two survey subgroups: (a) biological diversity, (b) recreation, and (c) scientific. I further examined these three assigned value categories to satisfy the third objective of analyzing the relationship between environmental worldview and assigned values. The *Neutral NEP* subgroup believed the park embodied more recreational qualities than the second subgroup, *Strong NEP*, which was comprised of individuals that reported higher ratings of biological diversity and scientific-based values. The final value index maps generated using SolVES and MaxEnt graphically illustrated how these three assigned values were perceived differently by the two subgroups. I found different spatial distributions of assigned value points, suggesting that held environmental values manifested different assigned value patterns (see Figure 5). Specifically, assigned values were spread across a larger geographic area by respondents in the *Strong NEP* subgroup. These individuals ascribed biological diversity, recreation, and scientific values of ecosystem services to the eastern portion of the island where visitor activities were facilitated by the NPS, as well as the TNC side of the island where public use was prohibited.

3.6. Discussion

In this investigation I attempted to disentangle the conceptual and empirical relationships between environmental worldview and assigned values of ecosystem services within the context of a U.S. protected area. The results of this study attest to the importance of distinguishing between held and assigned values across spatial scales, thus making tiers of the value concept more legible for future research and management. First, I identified two subgroups of outdoor recreationists on the basis of anthropocentric and biocentric worldviews. Secondly, using PPGIS methods I observed that respondents in these subgroups preferred 12 tangible and intangible assigned values to differing degrees and situated these values across my study area. Finally, using a SolVES modeling application I spatially analyzed assigned values of ecosystem services in relation to five biophysical metrics. I found heterogeneity in outdoor recreationists'

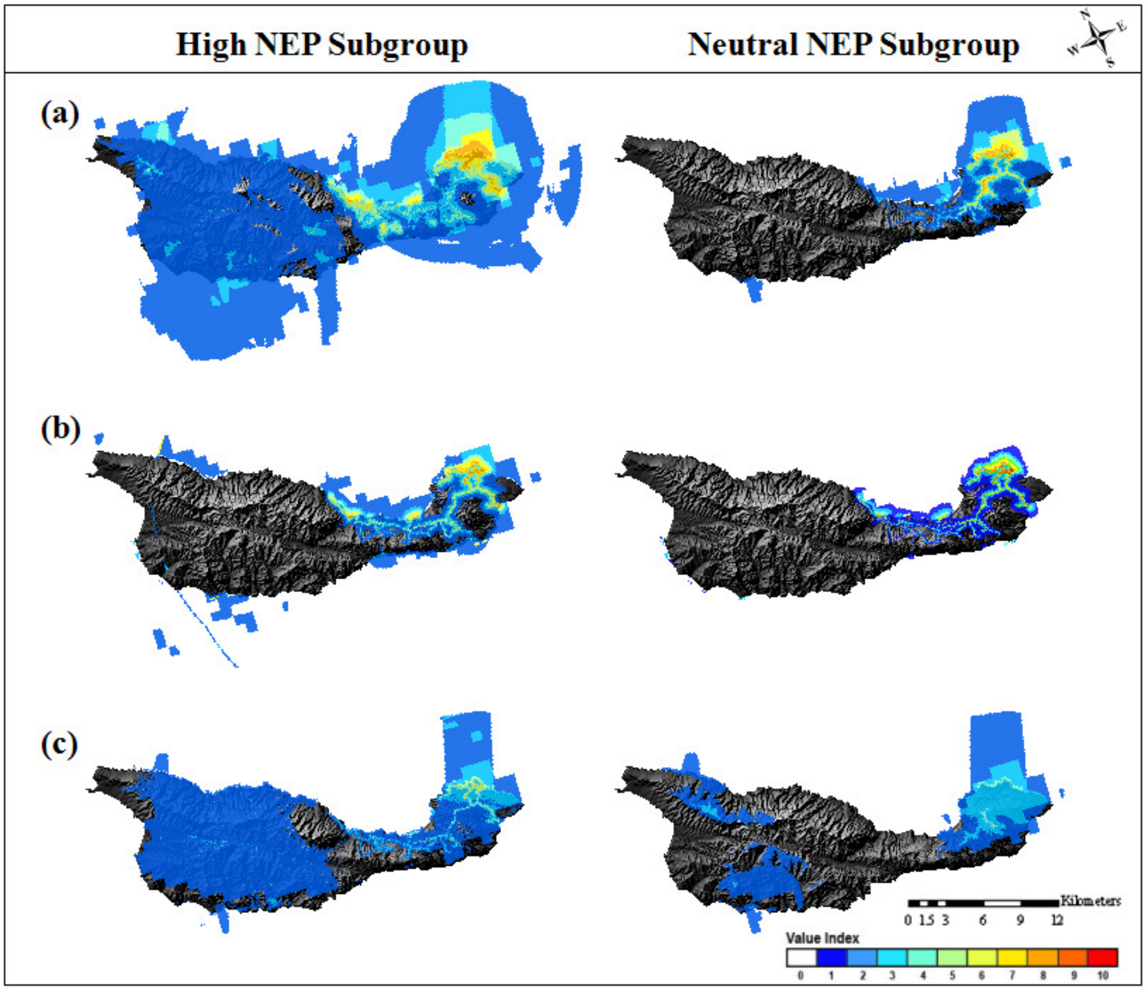

Figure 5. Spatial distribution of (a) biological diversity, (b) recreation, and (c) scientific assigned values of Santa Cruz Island in Channel Islands National Park. Results are presented for two subgroups that reported neutral and high degrees of environmentalism. The intensity of values assigned to places by the two subgroups ranged from 1 (blue) to 10 (red) on a value index.

interests, in that reported preferences for ecosystem services and the spatial dynamics of those preferences varied between the *Neutral NEP* and *Strong NEP* subgroups. This study extended previous arguments about the hierarchical relations among facets of the value concept (Brown, 1984; Manning et al., 1999; McIntyre et al., 2008; Sabatier, 1988; Schroeder, 2013), and provided empirical evidence that held environmental values were distinct from less stable place-based values that ultimately shape behavior reported by outdoor recreationists.

My psychological measure of worldview was relatively resistant to change and indicated the extent to which respondents subscribed to environmentalism. Drawing on a two-dimensional conceptualization of the NEP scale (Milfont & Duckitt, 2004), I observed that outdoor recreationists on Santa Cruz Island either viewed people and nature on equal terms or thought that nature had rights to exist irrespective of human use. Given the pronounced stances that emerged, my results indicated that park visitors endorsed an environmental worldview. In line with past research, these respondents reported high levels of previous experience and were well-educated (Oskamp & Schultz, 2005). Outreach efforts that call attention to conservation and preservation of natural resources will likely be well received by these individuals. Although value positions such as those reflected by the NEP scale are helpful to predict support for policy change, these tendencies are not easily manipulated by resource and recreation managers (Stern, 2000). That is, agencies will see more immediate results from their efforts to shape behavior if they target less stable beliefs such as awareness of changing environmental conditions (e.g., communicating about the consequences of not properly dispose of waste that cause the spread of invasive species) and moral normative concerns (e.g., designing interpretative programs to show that low impact behaviors are typically performed *and* expected by visitors) (Cialdini, 2003).

My application of PPGIS to examine assigned values of ecosystem services showed there were myriad reasons why the CINP was considered important to outdoor recreationists. Many of these reasons reflected the fundamental properties of nature (e.g., aesthetics, sublime landscapes, cultural resource preservation) that inspired the protected area movement in the U.S. and subsequently in other countries (Nash, 1995). The diversity and power of these values illustrate a need for the provision of multiple services to foster stewardship, protect key resources, and sustain local economies. Although tangible and intangible values can be difficult to define and reconcile with conservation goals and objectives (English & Lee, 2004), participatory mapping offers a method for capturing a range of values people place on the physical world (Carver et al., 2009; Klain & Chan, 2012) and understanding how values change over space and time (Carpenter et al., 2009). In line with this proposition, I contend that outdoor recreationists ascribed multiple, complex values to Santa Cruz Island as a reflection of the broader social, economic, and political system that likely governed value assignments. That is, values of ecosystem services and the worldviews expressed by respondents were likely a function of multiple factors outside of the park context. My findings support the use of PPGIS as a tool for explicitly documenting the changing values of places.

The perceived benefits of nature can be considered in relative terms when evaluating preferences for social values of ecosystem services among survey respondents that report different worldviews. Resource management is a value laden process that involves tradeoffs in decision-making and also requires information about potential compromises park visitors are willing to make among competing conditions (Lawson & Manning, 2001; van Riper et al., 2011a). To this end, my results showed what was *most* important to outdoor recreationists according to the relative ordering of assigned value categories in a typology adapted from Brown and Reed (2000). Perceived biological diversity, for example, was one of the most important value types whereas economics was the least important, suggesting that respondents may be willing to tolerate limitations on access and/or economic development to ensure protection of the various plants, wildlife, marine life, and other living organisms in the park. Although U.S. protected areas make important contributions to local and national economies, it could be that respondents in my sample viewed Santa Cruz as a relatively "invaluable" place that was not primarily important for monetary benefits and/or resource extraction (Runte, 1997).

This research helps to foster an interdisciplinary understanding of how values are formed in relation to on-the-ground conditions of Santa Cruz Island and its surrounding waters. Through the use of SolVES and MaxEnt modeling I generated value surface layers and identified suitable areas for ecosystem service provision on the basis of a social-biophysical data comparison. Drawing on five explanatory landscape metrics, I extended past research that has prioritized management decisions about particular geographic locales (McIntyre et al., 2008; Seymour et al., 2010) and worked toward bridging "the contemporary chasm separating biophysical and social science research" (Ostrom, 2007, p15186). Although I identified high priority settings according to value abundance, a variety of configurations can be referenced to direct attention toward places of managerial concern. For example, previous studies have argued that the diversity, rarity, and risk of assigned values can be gleaned from mapping results (Bryan et al., 2010). In a slightly different lexicon, past research has posited that richness, diversity, and vulnerability of values also indicate areas that can foster an appreciation of the physical world (Brown, 2013). Integration of spatially-explicit information (e.g., constraints imposed from biophysical metrics) alongside measures of reported preferences (e.g., value mapping survey data) will ultimately enhance human well-being and help to sustain ecological communities (Beeco & Brown, 2013; D'Antonio et al., 2013; Palomo et al., 2014; St. Martin & Hall-Arber, 2008).

3.6.1. Research and Management Considerations

To more effectively reach the CINP constituency, interpretation and outreach can be tailored toward subgroups of outdoor recreationists in the survey population. Individuals in the *Neutral NEP* subgroup can be targeted on the basis of their inclination to support human use within the park. That is, this subgroup placed relative importance on the recreation assigned value category suggesting these individuals relied on interaction with park resources to recognize values carried by an environment. To garner widespread support for environmental protection, individuals in the *Neutral NEP* subgroup should be made aware of important places, especially areas where visitor use may be prohibited due to human impacts, restoration, or scientific activities. By contrast, respondents in the *High NEP* subgroup situated values across a broader region including the western portion of Santa Cruz Island managed by TNC and inaccessible to the public. This subgroup valued areas that did not provide direct, tangible benefits in terms of outdoor recreation, indicating that ethical arguments about the intrinsic values of nature beyond utilitarian interests would likely resonate with these individuals (McCauley, 2006; Rolston & Coufal, 1991). Considering the range of value positions expressed by survey respondents, my findings shed light on different and potentially shifting public viewpoints about protection and use of natural resources (Tarrant et al., 2003).

I investigated value concepts among respondents that were predisposed to support environmental protection, because they sought out nature-based experiences. That is, considering the financeable obligation and time commitment to visit the park by crossing at least ten miles of open ocean, the sample was comprised of a specifically defined stakeholder group. Although my results are informative for managers that aim to engage with outdoor recreationists, educational strategies should be carefully formulated owing to the extent to which the sample is generalizable to broader publics. Managers of the CINP should consider the interests of residents that engage in private boating or water-based, consumptive activities in the case of policy change, because these individuals may express varied spatially-anchored values of ecosystem services (LaFranchi & Pendleton, 2008; van Riper et al., 2012). My results, however, reflected multiple values that were mapped across a spatial gradient by a relatively diverse sample of park visitors. If future protected area management and research strives to accommodate a range of value positions in decision-making, there will be a greater likelihood of public acceptance of and compliance with policy outcomes (Ban et al., 2013), as well as reduced potential for conflicts over competing forms of human use (Steel et al., 1994).

4. TOWARD AN INTEGRATED UNDERSTANDING OF NON-MATERIAL VALUES AND ECOLOGICAL PROCESSES IN A NATIONAL PARK

4.1. Overview

Non-monetary values of nature play a central role in the long-term success of conservation initiatives. However, despite much effort, many non-material values remain implicit in decisions about management of protected areas. Using on-site intercept survey data collected from outdoor recreationists and a Social Values for Ecosystem Services mapping application that interfaced with Maximum Entropy modeling, I examined the social and ecological values of Santa Cruz Island within Channel Islands National Park located off the coast of southern California. I examined multiple non-monetary values of nature that illustrated why the park was considered important. I focused particular attention on the spatial dynamics of a single value reflecting perceived biodiversity that was mapped by outdoor recreationists and analyzed in relation to eight indicators of ecological health including distance to several features relevant for park management, carbon storage, species richness, elevation, vegetation density, and categories of marine and terrestrial land cover. According to the distribution and density of points assigned to places thought to embody biodiversity value, I identified high and low priority settings across marine and terrestrial ecosystems in the park. I also found different spatial patterns in a comparison between two subgroups defined by their self-reported knowledge of the Channel Islands. My segmentation accounted for preference heterogeneity and indicated that respondents with greater understandings of the protected area would be more likely to associate non-material value with areas on Santa Cruz that were not experienced first-hand. I offer insights on the spatial dynamics of social and ecological data to advance theoretical understanding of the factors that shape recreation behavior and to bring non-material values such as perceived biodiversity to the fore in protected area planning and management.

4.2. Introduction

There is growing recognition that successful conservation initiatives are integrally linked to the consideration of multiple values society ascribes to the environment (Ban et al., 2013; Chan et al., 2012a, 2012b; Daniel et al., 2012; Satterfield et al., 2013). Particularly over the past decade, a burgeoning literature guided by a social-ecological systems (SES) framework has bridged the social and natural sciences to more fully reflect values expressed by stakeholders such as outdoor recreationists alongside measures of ecological processes, economic sustainability, and the interactions among these dimensions (Berkes et al., 2003; Collins et al., 2011; Liu et al., 2007; Ostrom, 2009). Within a sustainable SES, people, organizations, resources, and institutions evolve together over space and time and require that research questions transcend the boundaries of academic disciplines (Carpenter et al., 2009). However, despite widespread effort, the conservation movement continues to struggle in its quest for tackling ‘messy’ socio-political issues that underpin the most important and inherently complex resource and recreation management challenges (MEA, 2005).

Social science investigations of the non-monetary values of nature are urgently needed to bring intangible concepts into relief and provide insight on the psychological processes driving behaviors that contribute to environmental change (Schultz, 2011). If considered in the initial stages of planning and management, explicit consideration of stakeholder preferences will decrease the likelihood that governance regimes become inconsistent with public interests and render policy outcomes unsuccessful (Knight et al., 2006; Pollnac et al., 2012; Pressey, 2004).

Promising advances in Geographic Information System (GIS) techniques have helped researchers spatially integrate social and ecological data to more effectively determine resource and recreation management priorities (Villa et al., 2014; Hein et al., 2006; St. Martin & Hall-Arber, 2008). Particularly within coastal and marine environments, a substantive body of past work has examined stakeholder interests across spatial and temporal scales to shed light on the transactional relationships among variables within a SES framework (Cogan et al., 2009; Klain & Chan, 2012; McLeod & Leslie, 2009; Pollnac et al., 2010). One method that has proven particularly useful for eliciting and spatially analyzing stakeholder values in relation to the physical world is known as Public Participation GIS (PPGIS) (Sieber, 2006). This technique has varied applications such as mapping values that characterize local communities' in-depth expressions of place meanings (Carver et al., 2009), consulting stakeholders during regional environmental planning efforts (Brown, 2012), and framing potential conflicts between science and policy (Cutts et al., 2011). The non-material value of "perceived biodiversity" has been particularly important in a substantive minority of PPGIS studies.

For example, Alessa et al. (2008) found that perceived biodiversity values ascribed to the Kenai Peninsula, Alaska correlated with measures of net primary productivity for three of six communities surveyed. Also under a PPGIS methodological frame, Bryan et al. (2011) mapped a suite of social values elicited through interviews with residents in the Southern Australia Murray-Darling Basin and identified different conservation strategies on the basis of social and ecological value configurations. These papers signal a growing interest in PPGIS owing to its ability to blend diverse forms of data such as perceived and on-ground measures of biodiversity.

Past PPGIS research has advanced theoretical understandings of the spatial dynamics of SESs and provided empirical evidence for identifying high and low priority settings (Sherrouse et al., 2011). Progress has also been made to demonstrate that communities voluntarily unite to reduce environmental pressures and preserve the non-material values of nature (Armitage et al., 2009; Berkes, 2006; Heyman, 2011; McClanahan et al., 2007). However, few studies have examined how correlates of behavior (e.g., socio-demographics, attitudes, knowledge) shape the emergent relations among SES variables that can be mapped using PPGIS methods. Specifically, psychological factors that shape decision-making – beyond norms and expectations of reciprocity – have been largely overlooked in SES research despite their ability to explain *why* individuals act in particular ways. One psychological factor, self-reported knowledge, propels human behavior because an understanding of the environment is necessary for an individual to opt for minimum impact activities (Olli et al., 2001). Knowledge can unveil the intricacies of behavioral engagement and explain why people work together to sustain SESs over space and time (Ostrom, 2000). Moreover, a greater understanding of a constituency's knowledge base sheds light on the efficacy of existing education programs and provides insight on how to frame communications in a way that fosters environmental stewardship (Ardoin et al., 2013; Bustam et al., 2012; Mascia et al., 2003; Monroe, 2003).

I investigated the non-material values of nature and spatially analyzed perceived biodiversity in relation to measures of ecosystem structure and function on Santa Cruz Island among outdoor recreationist defined by their self-reported knowledge of Channel Islands National Park. First, I determined why the Channel Islands were considered important to outdoor recreationists. I then focused specifically on the spatial dynamics of perceived biodiversity to identify high and low priority settings across the land and seascapes of Santa Cruz. Next, I examined the relationship between perceived biodiversity and eight indicators of ecological health. Finally, I investigated the spatial relationships between social and ecological data for segments of respondents defined by self-reported knowledge of the park. This paper creates space for discourse over the role of non-material values in protected area management and provides insight on the effect of outdoor recreationists' self-reported knowledge on the spatial dynamics of a SES.

4.3. Methods

4.3.1. Study Area

This study was conducted on Santa Cruz Island, which is the largest (25,000ha) of eight California Islands situated 19-25 miles off the coast of southern California.

Santa Cruz has a Mediterranean climate and mountainous terrain reaching an elevation of 747m. The islands were formed through volcanic activity and may never have been connected to mainland California. The landforms of Santa Cruz include a central valley, canyons, and year-round streams, as well as a 77-mile coastline of cliffs, giant sea caves, sandy beaches, and tidepools. The Nature Conservancy (TNC) and the U.S. National Park Service (NPS) oversee 76% and 24% of the island, respectively, and cooperatively manage a number of endemic organisms across a range of taxa including birds, fish, invertebrates, mammals, and reptiles (van Riper et al., 1990). The island provides habitat for an abundance of terrestrial organisms including the charismatic Island Scrub Jay (*Aphelocoma insularis*) and Island Fox (*Urocyon littoralis*), as well as the native Bald Eagle that has been reintroduced from extinction (*Haliaeetus leucocephalus*). Santa Cruz is surrounded by the Channel Islands National Marine Sanctuary that protects a biologically diverse marine environment managed by multiple organizations with layered jurisdiction (Davis, 2005). The National Oceanic and Atmospheric Administration, California Fish and Game Commission, National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Coast Guard, and NPS are responsible for overseeing the sanctuary and its marine reserve network (NOAA, 2007).

Environmental conditions on Santa Cruz have been shaped by human activities over time and are currently enjoyed by a diversity of stakeholder groups that engage in consumptive and non-consumptive activities (LaFranchi & Pendleton, 2008). The rich history of human occupation on the California Islands ranges from indigenous groups such as the Chumash Native Americans that maintained a presence 8,500 years ago, through Mexican settlers (mid-1500's-1800s), to private landowners that ran sheep ranching operations and cultivated the land for approximately 150 years (Torben et al., 2005). These activities greatly altered the landscape of Santa Cruz via the introduction of non-native plant species and feral grazing animals such as sheep and pigs that have been removed since 2006 (Faulkner & Kessler, 2011). Visitor activities are permitted on the eastern portion Santa Cruz managed by the NPS, whereas the western side of the island is privately owned by TNC and reserved for scientific research and environmental preservation. Landing permits are available for use of the coastline and adjacent marine resources. Commercial and recreational fishers, recreational boaters and divers, maritime shipping, and researchers utilize the waters surrounding the island.

4.3.2. Survey Administration and Design

On-site survey data were collected from adult outdoor recreationists that visited Santa Cruz June-August, 2012 using NPS concessionaire boats (n=323; response rate 94%). Visitors were approached on the island by trained survey administrators at pre-defined time intervals. The study sampling frame was stratified by day of the week and time of day to ensure an equal likelihood of sampling respondents during the study period (Dillman, 2007). Surveys were administered using ASUS Transformer TF3000T tablets and Droid Survey (version 1.4.1) off-line software owing to the possibility of increasing response rates, enjoyment of park visitors, and cost efficiency (Davis et al., 2012). All encounters were recorded in contact logs, including descriptive information in the case of non-response to calculate potential sampling bias on the bases of gender

(χ^2=0.065) and group size (t=1.256, df=335). In the on-site survey, self-reported knowledge was measured by one item on a Likert scale (1 = "Very Low" to 5 = "Very High"). A median split (Median = 3) was performed to divide the sample into *Low Knowledge* (40%) and *High Knowledge* (60%) subgroups.

During the survey, the administrator and respondent engaged in a participatory mapping exercise whereby visitors allocated 100 "preference points" across a value typology adapted from past research (Brown & Reed, 2000; Cole et al., 2013) and tailored to the study context in consultation with NPS staff. Specifically, modifications were made to the wording of most categories, "cultural" was integrated with "historic," "subsistence" was removed, and "scientific" was added to the typology originally proposed by Brown and Reed (2000). The intensity of visitors' preferences for 12 non-material values reflected why the park was considered important. Following the division of preference points, respondents were asked to locate up to five areas that embodied these non-material values on a 34'' by 13'' map of the California Channel Islands created by the National Geographic Society and displayed at the survey station. The map of Santa Cruz Island had an approximate scale of 1:50,000 and served as a visual basis for dialogue about areas of importance within the park. Although 12 categories were examined during the mapping exercise, perceived biodiversity value points were spatially analyzed because there were more locations ascribed biodiversity than any other category and the relative importance of this value type was high (see Table 10). Also, biodiversity is a priority for agencies that oversee the Channel Islands and has been the sole focus of past PPGIS research (e.g., Brown et al., 2004).

Table 10. Value typology presented to survey respondents during mapping exercise, the number of locations that the pooled sample associated with each value category, and maximum social value index (SVI) scores.

	Point Assignments	*Maximum SVI*
Biological Diversity. I value Channel Islands National Park because it provides for a variety of plants, wildlife, marine life, and other living organisms	535	6.9
Aesthetic. I value Channel Islands National Park for the attractive scenery, sights, sounds, or smells	510	9.7
Recreation. I value Channel Islands National Park because it provides a place for my favorite outdoor recreation activities	428	7.7
Scientific. I value Channel Islands National Park because it provides an opportunity for scientific observation or experimentation	259	3.0
Learning. I value Channel Islands National Park because I can learn about natural and cultural resources	246	8.0
Therapeutic. I value Channel Islands National Park because it makes me feel better, physically and/or mentally	161	3.0
Future. I value Channel Islands National Park because it allows future generations to experience this place	119	4.0
Intrinsic. I value Channel Islands National Park in and of itself for its existence	102	2.8
Spiritual. I value Channel Islands National Park because it is spiritually significant to me	101	1.9
Cultural. I value Channel Islands National Park because it preserves historic places and archaeological sites that reflect human history of the island	97	4.0
Life Sustaining. I value Channel Islands National Park because it helps produce, preserve, clean, and renew air, soil, and water	53	1.9
Economic. I value Channel Islands National Park because it provides fisheries, recreation, or tourism opportunities that provide economic benefits	20	0.9

Note. The Social Value Index (SVI) score reflected the magnitude of difference among preference points allocated across the value categories. It ranged from 1-10, where 10 indicated greater relative importance of a category.

4.3.3. Spatial Analyses

Social and ecological spatial data were analyzed using a GIS mapping application developed by the U.S. Geological Survey called "Social Values for Ecosystem Services" (SolVES, Version 2.0) (Sherrouse et al., 2011, 2014). All locations to which respondents assigned values were digitized in an ArcGIS geodatabase as a point feature class (n = 2,245). Point data were analyzed owing to the capacity of the sample to accurately depict value distributions (Brown & Pullar, 2012; Phillips et al., 2006). The SolVES application created standardized 10-point Social Value Index (SVI) scores for all categories of non-material value according to their relative ratings. For further analysis of biodiversity value, SVI scores were generated for the *Low Knowledge* and *High Knowledge* subgroups. The total number of preference points allocated among the categories was linked to the digitized points using a unique identifier and then mapped across the study area. The dispersion, clustering, and randomness of all digitized points were evaluated using Completely Spatially Random (CSR) hypothesis testing, which estimated average nearest neighbor statistics (Alessa et al., 2008).

Table 11. Description and sources of environmental variables.

Environmental Variable	Description	Source
Distance to Infrastructure	Distance between perceived biodiversity value points and infrastructure that facilitated recreational activities, including trails, educational centers, boat ramps, and harbors.	Derived from the U.S. National Park Service spatial data
Distance to Viewshed	Distance between perceived biodiversity value points and areas on SCI within view of the coastline.	Derived from the U.S. National Park Service spatial data

Table 11. Continued

Environmental Variable	Description	Source
Distance to MPAs	Distance between perceived biodiversity value points and Marine Protected Areas surrounding SCI, including two Marine Reserves and one Marine Conservation Area.	Derived from the U.S. National Park Service spatial data
Carbon Storage	Extent to which soil and vegetation on SCI capture and store atmospheric carbon dioxide. Data are in 30 x 30 meter spatial resolution and were generated in 2000.	USDA Soil Survey Geographic (SSURGO) Database and National Biomass and Carbon Dataset
Species Richness	Total species richness across six taxonomic groups: 1) birds, 2) fish, 3) invertebrates, 4) mammals (terrestrial and marine); and 5) reptiles.	National Oceanic and Atmospheric Administration's Office of Response and Restoration
Elevation	Raster elevation data of Santa Cruz Island generated in 2007.	U.S. Geological Survey's National Elevation Dataset
Terrestrial Vegetation	Vegetation density of predominant plant life (conifers, hardwoods and shrubs) on Santa Cruz Island in 2007.	Derived from The Nature Conservancy spatial data
Marine and Terrestrial Land Cover	A 16-class NLCD-2006 classification scheme, including one additional category of marine vegetation cover that was added to the original layer to indicate giant kelp forest extents and eelgrass beds detected in surveys conducted from 1982-2009. All data were processed at a spatial resolution of 50 meters.	National Land Cover Database (NLCD-2006) and National Oceanic and Atmospheric Administration's Office of Response and Restoration

I identified eight environmental variables owing to their ability to reflect ecologically meaningful information and potential to contribute to the perceived biological importance of places (see Table 11). Building on past PPGIS research

(Brown, 2013; Loerzel, 2013; Sherrouse et al., 2011; van Riper et al., 2012), the first three variables were distance to features relevant for visitor use in the park, including management infrastructure, marine reserves, and viewshed created using tools available in the Spatial Analyst extension of ArcGIS. Next, measures of soil and vegetation carbon storage were combined to indicate tons of carbon stored per square meter across the island. A species richness layer was created to reflect range data for 25 species and indicate diversity within five taxonomic groups of organisms sensitive to environmental impacts (see Table 12). A digital elevation model was used and vegetation density was estimated whereby average values within six vegetation categories developed in past research (1=>60%; 2=40-60%; 3=25-40%; 4=10-25%; 5=2-10%; and 6=N/A) (Cohen et al., 2009) were reclassified into an index. The original categories were created on the basis of plot and transect data, ground sampling, and verification fieldwork, while the polygons of vegetation types were delineated from aerial and multispectral imagery.

I also drew on categorical data to examine relationships between perceived biodiversity value and underlying resource conditions. I extended past work that has compared spatially-anchored measures of human perception to land cover and land use change (Brown, 2013; Palomo et al., 2014; Nahuelhual et al., 2013). Specifically, I used a 16-class categorical layer drawn from the National Land Cover Database (NLCD-2006) (Fry et al., 2011). There were 13 of 16 NLCD categories represented on Santa Cruz and I added one category to represent predominant marine vegetation (i.e., presence of kelp forests and eelgrass). Spatial representations of predictor variables and non-material biodiversity values reported by the pooled sample and two subgroups were generated at an output cell size of 50m. Graphical representations of the eight ecological indicators included in this Section of my dissertation are listed in Appendix D.

Table 12. Animal species incorporated into species richness metric (source: NOAA Environmental Sensitivity Index maps for Southern California, 2010).

Taxon	Common name	Scientific name
Birds (1989-2009)	Ashy storm petrel	*Oceanodroma homochroa*
	Bald eagle	*Haliaeetus leucocephalus*
	Black oystercatcher	*Haematopus bachmani*
	Brandt's cormorant	*Phalacrocorax penicillatus*
	Brown pelican	*Pelecanus occidentalis*
	Western gull	*Larus occidentalis*
	Western snowy plover	*Charadrius alexandrines nivosus*
	Xantu's murrelet	*Synthliboramphus hypoleucus*
Fish (2000-2009)	California grunion	*Leuresthes tenuis*
	Rocky intertidal fish	-
Invertebrates (1977-2009)	Black abalone	*Haliotis cracherodii*
	Pink abalone	*Haliotis corrugate*
	Pismo clam	*Tivela stultorum*
	Red abalone	*Haliotis rufescens*
Terrestrial mammals (1990-2009)	Santa Cruz Island fox	*Urocyon littoralis santacruzae*
Marine mammals (1998-2010)	Baird's beaked whale	*Berardius bairdii*
	Blue whale	*Balaenoptera musculus*
	California sea lion	*Zalophus californianus*
	Fin whale	*Balaenoptera physalus*
	Humpback whale	*Megaptera novaeangliae*
	North Pacific right whale	*Eubalaena japonica*
	Pacific harbor seal	*Phoca vitulina richardii*
	Sperm whale	*Physeter macrocephapus*
Reptiles (2001-2009)	Leatherback sea turtle	*Dermochelys coriacea*
	Loggerhead sea turtle	*Caretta caretta*

4.3.4. Integrating Social and Ecological Data

I examined the relationship between social and ecological data with SolVES 2.0, which interfaced with Maximum Entropy (MaxEnt) Modeling (Elith et al., 2011; Phillips et al., 2006). MaxEnt is a machine-learning program that estimates the probability distribution of species occurrence according to presence (not absence) data in relation to explanatory environmental variables. This program has varied applications ranging from projections of climate change scenarios (Martínez-Meyer et al., 2004; Wiens et al., 2009) to eco-cultural niche modeling of known archaeological sites (Banks et al., 2011). Of interest in the present study, however, is MaxEnt's ability to identify valued locations on the basis of point data collected via PPGIS methods and a configuration of environmental variables. The fitted models produced in MaxEnt are spatial predictions of places most likely to support non-material values. For example, if a respondent ascribed biodiversity value to a particular place owing to landscape features such as forests or open bodies of water. Drawing on the relationship between known point assignments and these kinds of underlying environmental conditions, MaxEnt would identify other locations likely to be valued for biodiversity within a spatially-defined region.

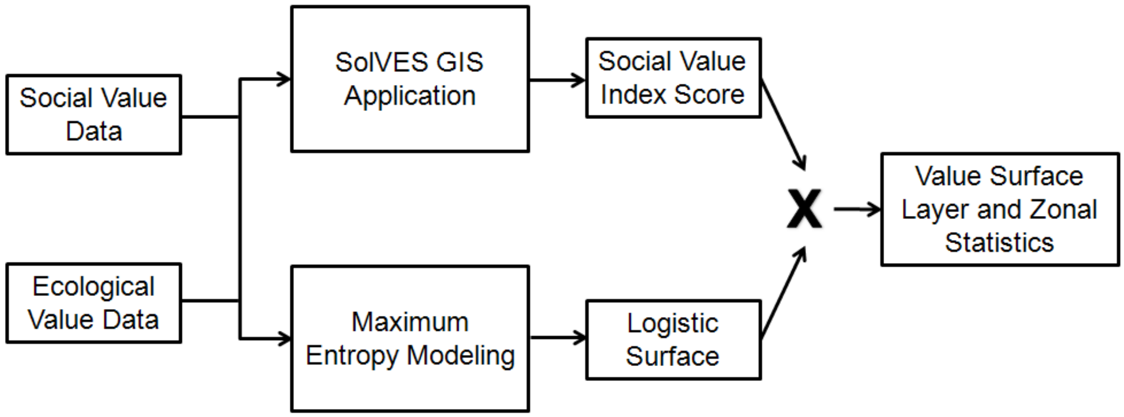

Figure 6. Schematic of steps in SolVES-MaxEnt modeling process. (Adapted from Sherrouse et al., 2014.)

To graphically illustrate the series of steps taken to analyze my spatial data, Figure 6 shows that social value data were entered into the SolVES GIS application, which created a social value index (SVI) score indicating the relative intensity of preference points allocated among the 12 categories in the typology. Ecological value data were also analyzed by MaxEnt to create a logistic surface layer according to the presence of social value points and the underlying environment. The next step in the sequence involved multiplying the SVI score by the logistic surface layer to scale the score to the maximum value that SolVES calculated from the survey data. This procedure yielded a value surface layer that highlights locations likely to be valued and the intensity of preferences for non-material values. I used this layer to generate zonal statistics that characterized the strength and direction of relations between social and ecological data. For the purpose of this Section of my dissertation, I estimated zonal statistics such as mean values and “majority” or dominant values for the continuous and categorical environmental variables, respectively, and biodiversity value was the only social value type that was spatially analyzed.

To evaluate the predictive performance of MaxEnt models estimated for the *Low Knowledge* and *High Knowledge* subgroups of outdoor recreationists, "training" and "testing" data were required (Phillips et al., 2006). Training data indicated the presence of a perceived biodiversity value point and testing data indicated presence and absence of these points. Given that testing data were not available, MaxEnt randomly partitioned my data into these two categories to create quasi independent datasets for fitting and evaluating my models. Area Under the Curve (AUC) statistics were calculated in MaxEnt to reflect the total area under the receiver-operating characteristic plot (ROC) (Fielding & Bell, 1997). To determine whether the models fit the sample data, I followed Swets (1988): AUC $\geq$ 0.90 = good; AUC $\geq$ 0.70 = useful; and AUC $\leq$ 0.70 = poor fitting model.

4.4. Results

A total of 323 respondents completed the on-site survey (response rate=94%), 297 of whom mapped non-material values across the land and seascapes of Santa Cruz Island. Analyses of socio-demographic variables indicated that most (86.8%) respondents were White, few (10.1%) were of Hispanic ethnicity, and the majority (76.8%) reported having obtained at least a four-year college degree. Approximately half (52.7%) earned at least $100,000 on an annual basis. There were more males (58.6%) than females (41.4%) and the average age was 43.53 years (*SD*=14.83). Just over half (65.3%) were visiting the park for the first time, 11.4% had visited previously, and the remainder had visited between 3 and 150 times. Using data available from the US Census (2012), I compared the sample to residents in Santa Barbara County and California and found similarities in terms of race and people per household. However, my sample was comprised of more educated and wealthier individuals than nearby residents.

Results revealed that the Channel Islands were valued for a multitude of reasons. Aesthetics, learning, recreation, and biodiversity were assigned the greatest number of preference points within the typology, thus indicating why outdoor recreationists thought the park was important. In my spatial analysis of the biodiversity value category, I found that respondents assigned points to numerous locations that were not randomly distributed across the study area. That is, average nearest neighbor tests showed spatial clustering along the coastline and within marine protected area boundaries according to R-values and Z-scores (see Table 13). The pooled sample reported average knowledge of the park (M=2.77, SD=1.11), whereas more pronounced differences emerged for the *Low Knowledge* (M=1.65, SD=.48) and *High Knowledge* (M=3.53, SD=.69) subgroups. The corresponding SVI scores for these two subgroups' ratings of the biodiversity value category were 6 and 10 suggesting respondents in the *Low Knowledge* subgroup felt the park was less important in terms of biodiversity than respondents in the *High Knowledge* subgroup.

Table 13. Mean and standard deviation of self-reported knowledge and nearest neighbor statistics for two subgroups and the pooled sample including R-values (observed versus expected distance between points) and Z-scores (number of standard deviations from the mean).

	Knowledge[1] *M (SD)*	*R-value*	*Z-score*
Pooled Sample	2.77 (1.11)	.506	-19.26
Low Knowledge	1.65 (.48)	.483	-11.50
High Knowledge	3.53 (.69)	.569	-13.84

[1]Knowledge was measured on a five-point Likert scale ranging from 1 (Low Knowledge) to 5 (High Knowledge)

Next, I examined the relationships between eight indicators of ecological health and non-material biodiversity values using SolVES and MaxEnt modeling. Good fitting models to the training data were found for the pooled sample (AUC=0.919), *Low Knowledge* (AUC=0.941), and *High Knowledge* (AUC=0.914) subgroups. These models had useful predictive capacities given corresponding AUC values (0.880, 0.971, and 0.880) on the test data (Swets, 1988). Varied directional relations emerged in the comparison between environmental variables and the SVI score reflecting the pooled sample's evaluation of biodiversity value (see Figure 7). Specifically, the intensity of preferences for biodiversity decreased as (a) distance to infrastructure, viewshed, and marine protected areas increased; (b) greater numbers of species and vegetation density were encountered; and (c) at areas of higher elevation. Conversely, as carbon sequestration increased, so too did biodiversity values. Analyses of categorical data showed that value points were associated with locations where the majority of land cover was classified as marine vegetation, open water, evergreen forest, shrub/scrub, and grassland/herbaceous.

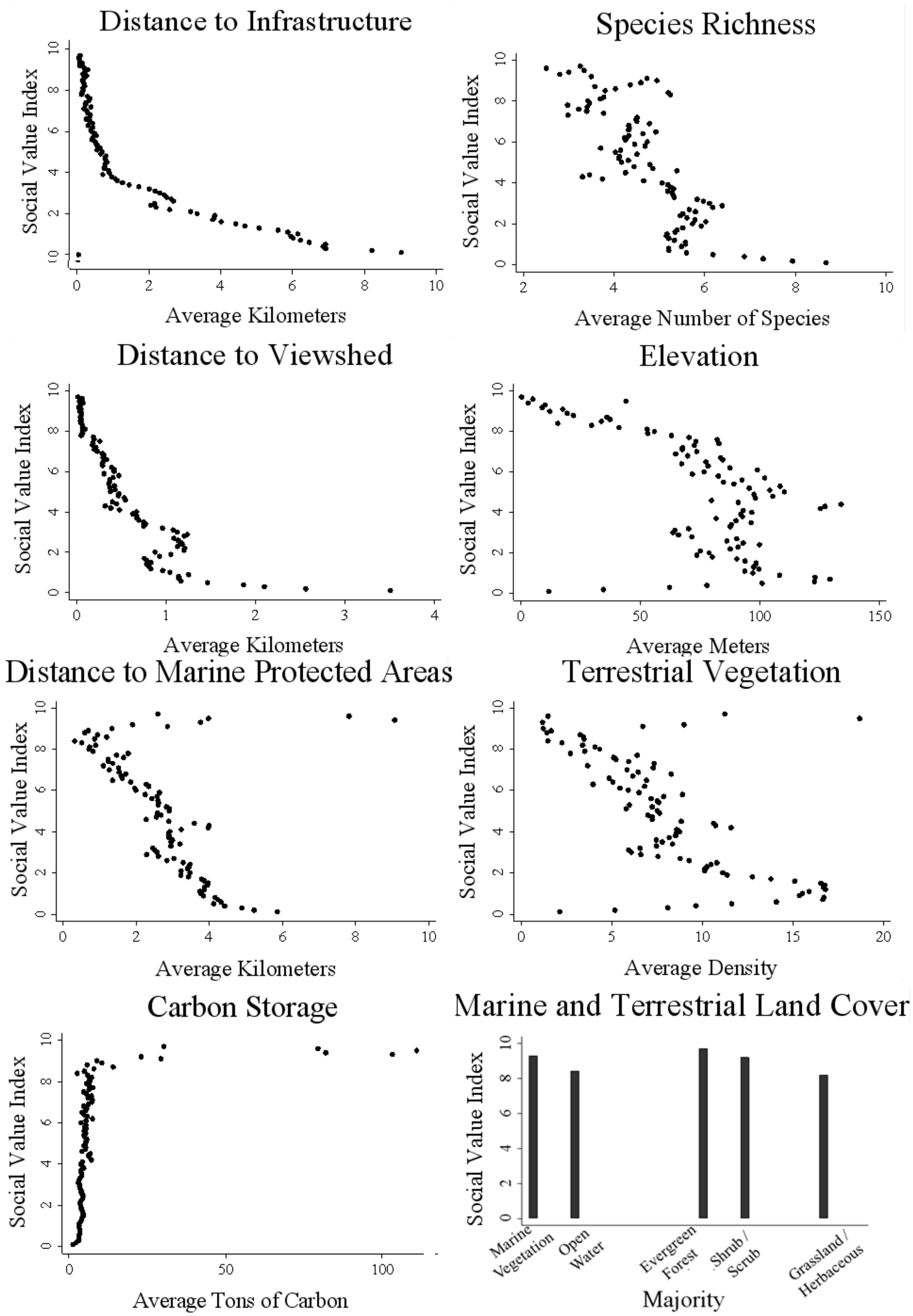

Figure 7. Zonal statistics for pooled sample showing the relationships between social value index scores displayed on the x-axis and eight environmental variables displayed on the y-axis.

Table 14. Mean values and standard deviations of zonal statistics, indicators of significant differences estimated using independent samples t-tests. Pearson correlation coefficients and percent contributions indicating each continuous variable's relative influence on the spatial projection of biodiversity value point distributions are also presented.

	Low Knowledge Subgroup			**High Knowledge Subgroup**		
	M(SD)	*r*	*Percent Contribution*	*M(SD)*	*r*	*Percent Contribution*
Distance to Infrastructure	1.76 (1.93)[a]	-.78*	49.701	2.94 (3.05)[a]	-.89*	47.060
Distance to Viewshed	0.43 (0.40)[b]	-.75*	15.861	0.62 (0.59)[b]	-.81*	14.812
Distance to MPAs	2.15 (1.60)	-.78*	20.840	2.46 (1.25)	-.78*	24.006
Carbon Storage	8.84 (11.18)[c]	.45*	0.740	4.13 (3.08)[c]	.45*	0.286
Species Richness	4.14 (0.97)[d]	.03	3.891	5.08 (1.34)[d]	-.62*	3.468
Elevation	87.51 (52.57)[e]	-.81*	4.913	72.05 (31.06)[e]	-.23*	3.559
Terrestrial Vegetation	9.47 (7.07)[f]	-.77*	0.637	6.25 (3.59)[f]	-.56*	0.898
Marine and Terrestrial Land Cover	-	-	3.417	-	-	5.913

* p-value ≤ 0.05
Note. Like superscripts indicate significant differences at $p \leq 0.05$.

As indicated by the percent contributions of each environmental variable, distance to management infrastructure, distance to viewshed, and distance to MPAs were the most effective whereas carbon storage was the least effective predictor variable (see Table 14). The two subgroups' preferences for biodiversity values on Santa Cruz were affected by the eight environmental variables similarly according to the directions of

Pearson correlation coefficients; however, results from independent samples t-tests indicated that the degree of each environmental variable's influence on biodiversity values varied. Specifically, differences were found for six of seven continuous variables including distance to infrastructure (t=-2.979, df=156), distance to viewshed (t=-2.412, df=153), carbon storage (t=3.948, df=156), species richness (t=-5.092, df=150), elevation (t=2.056, df=82.53), and terrestrial vegetation (t=3.263, df=76). These results indicate heterogeneity on the basis of self-reported knowledge, in that eight environmental variables contributed in different ways to preferences for biodiversity values reported by outdoor recreationists in the *Low Knowledge* and *High Knowledge* subgroups.

For the pooled sample, an abundance of biodiversity value points was assigned to the northeast corner of the island. Transportation, camping, and interpretation occurred within this region, indicating this area is an existing priority for management of visitor activities. Value points were also concentrated along trail systems, which likely aligned with the provision of opportunities for recreation and visitor use patterns. Additionally, areas along the coastline and within MPA boundaries embodied perceived *and* on-ground biological diversity (Davis, 2005). For the two subgroups, differences emerged in the assignment of points and the configuration of underlying environmental variables that supported non-material biodiversity values (see Figure 8). Respondents in the *Low Knowledge* subgroup (graph b) assigned points across a smaller geographic gradient that covered the eastern side of Santa Cruz and that was accessible to the public. Conversely, the *High Knowledge* subgroup (graph c) associated biodiversity with a larger space encompassing the eastern *and* the western portion of the island where public use was prohibited. These findings suggest that self-reported knowledge generated distinct spatial distributions of non-material biodiversity values. It could be that respondents in the *High Knowledge* subgroup assigned points to the TNC-side of Santa Cruz, because they were more familiar and had learned about the importance of this region through previous experience (Hammitt & McDonald, 1983; Schreyer et al., 1984). Although respondents likely obtained knowledge from multiple sources, a significantly higher number of previous visits were reported by the *High Knowledge* ($M = 7.51$, $SD = 20.09$) and *Low Knowledge* ($M = 1.01$, $SD = 0.69$) subgroups (*t-stat* = -4.316, df = 178).

4.5. Discussion

Santa Cruz Island supports the provision of multiple non-material values and ecosystem processes that sustain and fulfill human life through outdoor recreation activities within Channel Islands National Park. I mapped a single value reflecting perceived biodiversity across the study area and analyzed these point data in relation to ecological values spanning marine and terrestrial environments. I also compared between *Low Knowledge* and *High Knowledge* subgroups to determine how self-reported knowledge as a correlate of behavior (Olli et al., 2001) affected the spatial dynamics of a social-ecological system. I hope to elevate the visibility of values that are easily sidelined in decision-making yet play critical roles in public acceptance of policy change (Ban et al., 2013; Herzon & Mikk, 2007; Stern, 2000), ethical considerations in the allocation of goods and services (Chan et al., 2012b; Luck et al., 2012), and reduced potential for conflicts over competing forms of human use (Steel et al., 1994).

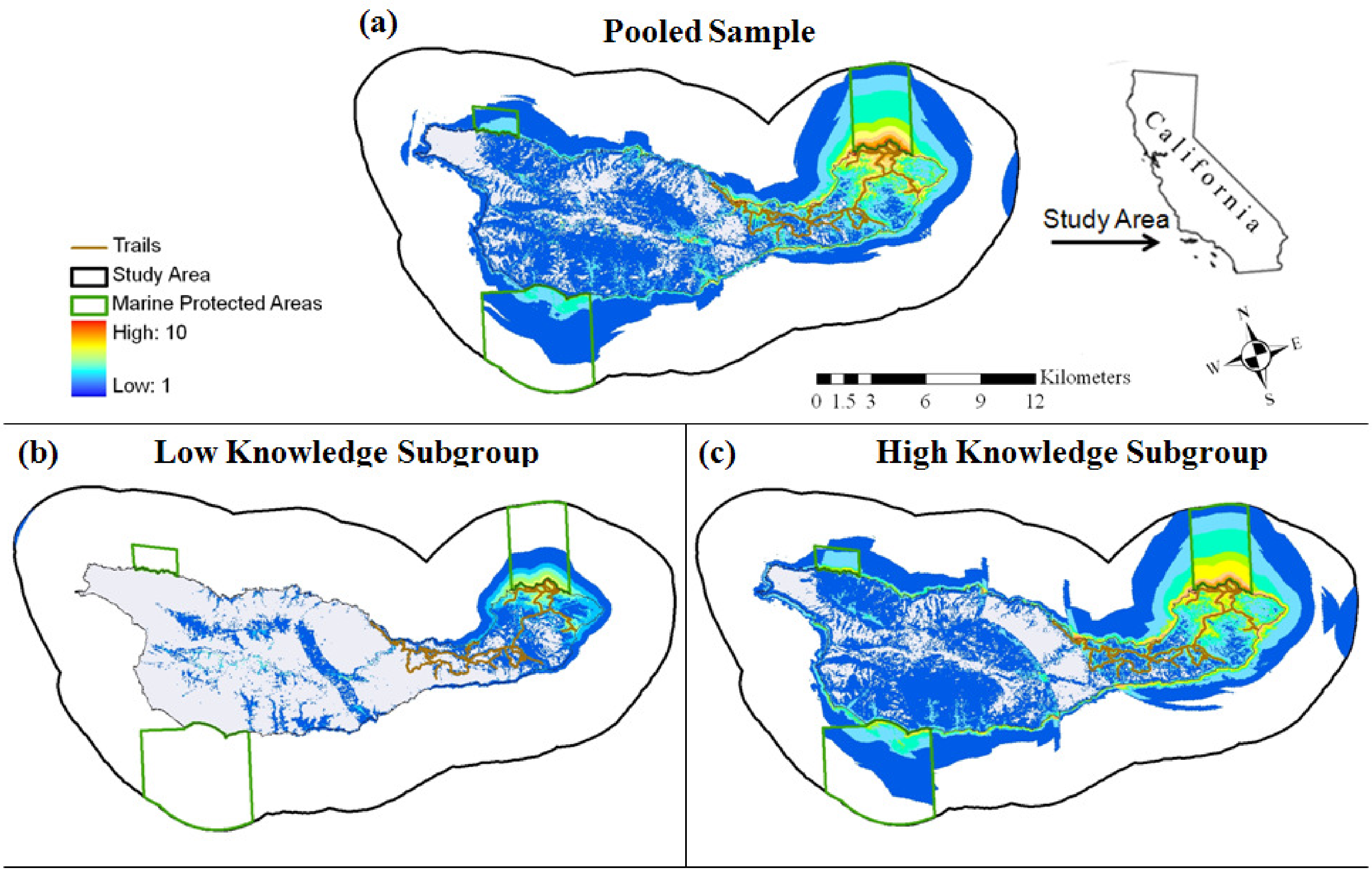

Figure 8. Distribution of perceived biodiversity value for the pooled sample and two subgroups defined by self-reported knowledge of Channel Islands National Park.

My research results offer a roadmap for prioritizing decisions and directing managerial attention toward high and low priority settings according survey data modeled alongside ecosystem processes on Santa Cruz. Extending past research, I identified "hotspots," or in other words, areas of spatial convergence that supported social and ecological values (Alessa et al., 2008; Bryan et al., 2011; Clement & Cheng, 2011). Areas of value abundance require caution owing to their capacity to support high quality experiences as well as potential for social conflict. In my social-ecological data comparison, I found that respondents were not attuned to on-ground biodiversity (e.g., species richness, vegetation density). This finding supports past research suggesting the general public is unfamiliar with the diversity of species encountered (Dallimer et al., 2012; Holl et al., 1995; Lindemann-Matthies & Bose, 2008; Matthies & Bose, 2008) and unable to distinguish between healthy versus degraded environments (Hammitt & Cole, 1998; White et al., 2001, 2008). As such, it may behoove managers to target "coldspots" where on-ground biodiversity is not within the public eye (van Riper et al., 2012). Raising awareness of regions that harbor the many plant and animal species found on Santa Cruz may help to generate a broader appreciation of landscape aesthetics (Han, 2007) and support psychological restoration from nature (Dallimer et al., 2014; Kaplan & Kaplan, 1989). Other natural features that evoked responses from outdoor recreationists included evergreen forests and open water (Brown & Brabyn, 2012), as well as the shrub/scrub and grassland/herbaceous categories of the NLCD-2006 layer.

SolVES and MaxEnt were powerful tools for investigating the relationships between social and ecological data. They enabled me to identify landscape qualities that were valued by a sample of outdoor recreationists that visited Santa Cruz Island. Consistent with past research (e.g., Sherrouse et al., 2014; Loerzel, 2013), my metrics representing distance to several features on the island effectively predicted value assignments. In other words, the areas on which respondents placed high biodiversity value tended to be closer to MPAs, infrastructure, and the coastline viewshed, which will allow decision-makers to anticipate geographically-explicit values and formulate place-based conservation strategies that afford greater consideration to the meanings of places (Adger et al., 2011; van Riper et al., 2011b). It could be that respondents detected the importance of biological resource conditions in these areas because park staff and volunteers imparted knowledge on visitors near infrastructure, and both MPAs and the aesthetics of the Santa Cruz coastline are often featured in NPS and NOAA communications. This information can help agencies more effectively gauge the efficacy of current interpretation that expresses diverse values of place, in turn supporting a less regulatory and more inclusive decision-making process that has been emerging in environmental management over the past several decades (Mason, 2007).

I empirically analyzed the effect of self-reported knowledge on social-ecological data to reveal variation that may have otherwise gone undetected. I found differences between subgroups, suggesting that an individual's understanding of the protected area changed the way s/he placed biodiversity values on Santa Cruz Island. Respondents in the *High Knowledge* subgroup assigned biodiversity values across a larger spatial gradient that covered the privately owned, western portion of the island that was not experienced during the on-site visit. Conversely, the *Low Knowledge* subgroup valued a smaller geographic area evidenced by values that were concentrated primarily on the eastern side of Santa Cruz. These findings suggest value assignments were manifested at different geographic scales depending on individual knowledge. Indeed, small-scale locales are likely to be valued due to personal experience and specific features whereas large-scale places are known in a different way – through recreational experiences and scientific analyses (Cheng & Daniels, 2003). Santa Cruz was valued through direct experience; however, extending this line of enquiry, I contend that knowledge can supersede first-hand experience as evidenced by values placed on the western side of Santa Cruz by respondents in the *High Knowledge* subgroup. This segment of outdoor recreationists can be targeted by management agencies given their propensity adopt minimum-impact behaviors (Blake, 1999; Kollmuss & Agyman, 2002) and the likelihood they will engage in activities such as volunteering at the park, learning about management challenges, and/or supporting environmental policies (van Riper & Kyle, 2014).

4.6. Limitations and Areas for Future Research

Broad support for conservation must be predicated on well-informed management decisions, and although the present study contributes to this end, my findings should be interpreted with several limitations and areas for subsequent investigation in mind. Firstly, data for this study were drawn from a value mapping exercise that involved the allocation of preference points across a typology. Biodiversity was one of 12 categories presented to survey respondents to reflect the reasons why the park carried value. Although past research has established that this category as an indicator of the importance of places (Brown et al., 2004), visitors evaluated and weighed biodiversity against other qualities such as aesthetics, economics, and recreation. If biodiversity was the sole focus of the mapping exercise, different observations may have emerged. Similarly, if respondents were not presented with a typology developed on an *a priori* basis, but instead asked to express their opinions with minimal influence from outside sources, respondents' reflections may have varied from the findings reported herein. These issues carry important considerations for the external validity of my study findings.

Survey respondents were advised to identify up to five locations that embodied biodiversity value, which may have affected the emergent patterns in my analysis of spatially-anchored perceived biodiversity values. For example, one respondent may have identified a single location (e.g., campground) that they thought was biologically diverse, whereas another respondent may have associated biodiversity with a larger area (e.g., trail system) and consequently spread several points across this region. The multiple values assigned by the second respondent could be interpreted via kernel density analysis to indicate stronger preferences; however, the two respondents may have equally valued these areas at different scales. Past research has called attention to a related phenomenon from the effects of "intensive mappers," whereby significantly more locations are identified by select respondents (Brown et al., 2012). However, the PPGIS mapping results reported in this Section of my dissertation were not likely affected by intensive mappers, because respondents assigned an equally high and low number of points across categories that reflected the perceived benefits they derived from nature.

One methodological challenge emerged when survey respondents ascribed value to moving targets within the park. A number of visitors associated biodiversity value with mobile organisms such as the Santa Cruz Island Fox. The points assigned to places by respondents were spatially fixed in response to an encounter; however, the valued objects were not. Additional research should be conducted on the reasons why places are assigned values at different spatial scales during mapping exercises (Brown & Pullar, 2012; Jorgensen, 2010; Klain & Chan, 2012). Similar scale-related challenges were faced in the analysis of spatial data when the distribution of organisms – particularly in the marine environment – spanned large geographic regions. Greater specificity in range data would increase the accuracy of spatial models such as those estimated for this research. Give rapid advances in GIS technology, the measurement and analysis of non-material values alongside ecological processes in protected areas warrant attention in future research.

5. CONCLUSION

In this dissertation, I investigated multiple values of nature to enrich outdoor recreation experiences and determine how best to minimize human-caused impacts on protected areas. Research on value-related concepts spans disciplines such as psychology, economics, and ecology; however, relatively narrow conceptualizations of this idea have dominated resource and recreation management decision-making. Although hopeful advancements are being made to bridge these academic disciplines, more remains to be learned about the internal processes girding behaviors that benefit the environment and contribute to human well-being. Thus, my dissertation research aimed to strengthen the integration of disciplines that espouse value-related concepts to offer a more complete understanding of outdoor recreation behavior, the valuation process, and biophysical conditions that support the long-term success of conservation policies and practice.

Drawing on multiple variables represented in a SES framework, I reached into offered a perspective on how to value an invaluable place – Channel Islands National Park. More specifically, I showed that tiers of the value concept could be referenced to more clearly articulate the importance of nature. First, I tested the relationships postulated by the VBN theory in a national park to show that held values and other psychological processes could lend insight on the factors that drive outdoor recreationists' reported behaviors. Second, I operationalized a held versus assigned values conceptual model to help prioritize decision-making and determine tradeoffs made among competing assigned values for ecosystem services. Finally, I investigated the spatial dynamics of social and ecological data to show that biophysical conditions on Santa Cruz Island supported an array of values for human and biological communities.

5.1. Theoretical Implications and Applied Outcomes

There are a number of theoretical implications emanating from my dissertation research. For example, the VBN theory of environmentalism (Stern et al., 1999) provided guidance to better understand how value orientations and other psychological processes energized outdoor recreation behavior. Given a pronounced need to clarify the presence and ordering of variables that antecede decisions to engage in environmentally-friendly actions (Bamberg & Möser, 2007; Oskamp & Schultz, 2005), the results I presented in Section 2 supported the use of VBN as a framework for understanding behavioral tendencies. Held values, represented by egoistic and biospheric-altruistic orientations, gave rise to a chain of variables that predicted behavior. Specifically, these orientations led to worldviews, awareness of consequences, ascribed responsibility, and personal norms, which in turn activated actions that would have minimal impact on the CINP. My findings supported theoretical arguments about the stability of values and are further helpful for directing managerial attention toward determinants of environmentalism that are more easily influenced by outreach activities (Dietz et al., 2005). Also, given that few previous studies have tested and evaluated the *full* VBN theory (Steg et al., 2005), I examined the measurement properties of the VBN model in a latent variable structural equation model.

The framework tested in Section 3 of my dissertation provided a basis for future research to distinguish between held and assigned values. Building on past work that has called attention to different forms of the value concept – ranging from core belief structures to more reflective and interactive place-based values (Brown, 1984; Sabatier, 1988) – my results showed empirical distinctions between environmental worldview (i.e., a proxy for held values) and assigned values of ecosystem services. Although previous PPGIS studies have referenced differences between value concepts (e.g., Brown, 2005; McIntyre et al., 2008), these relationships are still not fully understood. This is a rich area for future research to support management that aims to account for potential degradation and/or enhancement of non-material values. Integrating and analyzing different concepts of value reflects why places are (or are not) considered important and reveals variation in stakeholder interests that may otherwise be marginalized in environmental planning and management.

In Section 3 and 4, I coupled measures of non-material values with several environmental variables to advance understanding of select elements within a SES framework (Collins et al., 2011; Ostrom, 2007). Moving beyond considerations of ecological data alone, I engaged with the concept of ecosystem services (MEA, 2005) and showed how measures of socio-political drivers such as environmental worldview (Dunlap et al., 2012) and self-reported knowledge (Olli et al., 2001) were spatially manifested in settings of high conservation concern. This research approach explicitly integrated concepts from psychology and the study of ES into the SES literature. Particularly in the Section 4, several elements from the biophysical and social sides of a

SES equation were characterized and evaluated in relation to one another (Chan et al., 2012b). Although a number of facets of the SES framework were omitted from the study design owing to limitations on time and resources, social and ecological data were effectively measured to contribute to spatial planning and management activities relevant to the Channel Islands (Halpern et al., 2008; McLeod & Leslie, 2009). Additionally, through the use of PPGIS methods, I systematically measured a range of values that reflected the benefits provided to people by ecosystems.

A range of management options emerged from my doctoral dissertation research. First, the relative ordering of assigned values included in the value typology I adapted from past research (Brown & Reed, 2000) revealed the expressed importance of the CINP. That is, the park was most valued for aesthetic, recreation, learning, biological diversity, and scientific purposes. Second, the locations of places that embodied these values were identified to direct managerial attention toward important natural and cultural resources protected by a number of management agencies such as NPS, TNC, and NOAA. Using PPGIS methods, spatially-explicit information about perceived value abundance can help to prioritize efforts toward places deemed important by stakeholders and sensitive by management agencies. Third, I provided fodder for making tradeoffs among competing preferences for levels of use and development. With knowledge of why the park is considered important, organizations that oversee these special places can align public perceptions with their goals and directives, work toward ensuring policy outcomes address diverse stakeholder interests, and be better equipped to galvanize broad support for decision-making (Ban et al., 2013; Healy et al., 2012).

5.2. Closing Remarks

It is becoming increasingly evident that coastal and marine protected areas need to be understood, analyzed, and managed in a way that incorporates social, economic, and ecological information across spatial scales. "Social" landscapes that reflect measures of human perception and value have traditionally been overlooked in conservation policy and practice yet provide substantial opportunities for achieving management objectives that support human well-being and environmental protection. Specifically, the integration of psychological factors that shape behavior must be harnessed to complement knowledge and reveal factors that confound decisions affecting resource use and access. This dissertation aimed to fill these missing conceptual and cartographic layers and broaden the potential for social science research to be considered in resource and recreation management decision-making. Stronger integration between social and natural science disciplines will ultimately help to reflect the complexities of human-environment interactions and more effectively articulate the diverse values of nature.

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APPENDIX A: SURVEY QUESTIONNAIRE ABOUT VISITOR BEHAVIOR

HDNR HUMAN DIMENSIONS OF NATURAL RESOURCES DEPARTMENT OF RECREATION, PARK & TOURISM SCIENCES

TEXAS A&M UNIVERSITY

Channel Islands National Park Visitor Survey, 2012

ID____________

Date __________

Location_______

Texas A&M University is conducting a survey to learn more about recreationists at Channel Islands National Park. This information will be used to better serve the public. You are one of a small number of people chosen for this study, so your opinions are important to us. All information will be kept strictly confidential and your response is voluntary. No action may be taken against you for refusing to supply the information requested. Please read each question carefully and save any additional comments for the final page. This survey will take 10-15 minutes to complete.

SECTION 1 of 5: TRIP CHARACTERISTICS

1. How many people (including you) are in your personal group today?

   Total number of people: ________ Adults: ________ Children: ________

2. How would you describe your personal group? (*please ✓ one*)

   ❑ Traveling alone ❑ Friends ❑ Organized group
   ❑ Family ❑ Family and friends

3. How long are you staying in the park during your visit? (*please ✓ one box & fill in blank)*

   ❑ Day use only:
   → How many hours **today?** __________ hours
   ❑ Overnight use:
   → How many **nights** are you staying? __________ nights

4a. Do you expect to return to Channel Islands National Park on other trips in <u>the next 12 months</u>? (*please ✓one*)

   ❑ Yes➲*please skip to question 5* ❑ No

b. If you do not expect to return, please explain why not: ____

5a. How many times have you visited Channel Islands National Park? ___________

b. How many of the Channel Islands have you visited or do you plan to visit? ___________

c. Was Channel Islands National Park your primary destination? ___________

6. Are you aware that the boundary of Channel Islands National Park extends to one nautical mile offshore? (*please ✓one*)

   ❑ Yes ❑ No

7a. Which of the following activities have you participated in during your visit? (*please ✓all that apply*)

   ❑ Hiking ❑ Camping ❑ Recreational fishing
   ❑ Boating ❑ Diving/Snorkeling ❑ Sailing
   ❑ Kayaking ❑ Birding ❑ Viewing marine wildlife
   ❑ Experiencing nature ❑ Taking photographs ❑ Viewing island wildlife
   ❑ Attending programs ❑ Commercial fishing ❑ Other (*please specify)*

   ____

b. From the above list, which would you identify as your primary activity? ________________

8. What, if any, changes would you recommend park managers to make in recreational opportunities at the Channel Islands?

____
____
____

SECTION 2 of 5: ENVIRONMENTAL AWARENESS

9a. We'd like to better understand your awareness of the consequences associated with changing environmental conditions at Channel Islands National Park. How familiar are you with these issues? If you learned about these issues during your visit, please specify where.

	Not at all a familiar		Somewhat familiar		Very familiar	Where did you learn about these issues during your visit (if applicable)
The spread of non-native plants and animals	1	2	3	4	5	
Reintroduction of native species	1	2	3	4	5	
Damage to cultural resources including historic structures and archaeological artifacts	1	2	3	4	5	
Human impact on the marine environment	1	2	3	4	5	

b. How much of a problem to do you think these issues are for you and your family?

	Not at all a Problem		Somewhat of a Problem		A Very Serious Problem
The spread of non-native plants and animals	1	2	3	4	5
Reintroduction of native species	1	2	3	4	5
Damage to cultural resources including historic structures and archaeological artifacts	1	2	3	4	5
Human impact on the marine environment	1	2	3	4	5

c. How much of a problem to do you think these issues are for Channel Islands National Park?

	Not at all a Problem		Somewhat of a Problem		A Very Serious Problem
The spread of non-native plants and animals	1	2	3	4	5
Reintroduction of native species	1	2	3	4	5
Damage to cultural resources including historic structures and archaeological artifacts	1	2	3	4	5
Human impact on the marine environment	1	2	3	4	5

d. How much of a problem to do you think these issues are for other species of plants and animals?

	Not at all a Problem		Somewhat of a Problem		A Very Serious Problem
The spread of non-native plants and animals	1	2	3	4	5
Reintroduction of native species	1	2	3	4	5
Damage to cultural resources including historic structures and archaeological artifacts	1	2	3	4	5
Human impact on the marine environment	1	2	3	4	5

SECTION 3 of 5: ENVIRONMENTAL BEHAVIOR

10. Please rate the extent to which you agree or disagree with the following statements about how you evaluate activities, environments, and management proposals. (Circle one number.)

	Strongly Disagree		Neutral		Strongly Agree
I would feel guilty if I were responsible for the spread of non-native plants across the Channel Islands National Park	1	2	3	4	5
I feel a personal obligation to do whatever I can to support the reintroduction of native animals at Channel Islands National Park	1	2	3	4	5
Managers of Channel Islands National Park should exert pressure to prevent the spread of non-native plants and animals	1	2	3	4	5
I feel morally obliged to minimize human impact on marine resources within Channel Islands National Park	1	2	3	4	5
People like me should do whatever they can to prevent damage to historic structures on Channel Islands National Park	1	2	3	4	5
Managers of Channel Islands National Park should take strong action to reintroduce native vegetation	1	2	3	4	5
Managers of have a responsibility to prevent damage to archaeological artifacts	1	2	3	4	5
I feel a sense of personal obligation to not damage historic structures on the Channel Islands National Park, regardless of what others do	1	2	3	4	5
Not only is the National Park Service responsible for minimizing damage to historic structures, but me too	1	2	3	4	5
I feel jointly responsible for damage to cultural resources	1	2	3	4	5
The impact I have on cultural resources is negligible	1	2	3	4	5
I am jointly responsible for environmental impacts to marine life	1	2	3	4	5
I feel jointly responsible for the spread of non-native species	1	2	3	4	5
The impact I have on the reintroduction of native species is negligible	1	2	3	4	5

11. There are many ways you can help to minimize impacts on natural and cultural resources. Which of the following actions have you undertaken in the previous 12 months to reduce your impact on Channel Islands National Park? (Please circle one response.)

	Action taken in previous 12 months	
Volunteer at Channel Islands National Park to remove non-native species	Yes	No
Read a newsletter, magazine or other publication about the human history of the Channel Islands National Park	Yes	No
Clean equipment (e.g., wash hulls of boats, shake tents, pick seeds from shoe laces) to prevent the spread of exotic species	Yes	No
Use boot scraping stations to prevent the spread of non-native plants	Yes	No
Support and/or accept policies that protect the marine environment	Yes	No
Support the reintroduction of native species (e.g., island foxes) on Channel Islands National Park	Yes	No
Properly dispose of waste (e.g., apple cores) that may cause the spread of non-native plants	Yes	No
Support policies that protect historic and cultural resources	Yes	No
Encourage other visitors to not disturb archeological artifacts on the Channel Islands National Park	Yes	No

12. There are many ways you can help to minimize impacts on natural and cultural resources. Which of the following actions do you intend to undertake the next 12 months to reduce your impact on Channel Islands National Park? (Please circle one response.)

	Action taken in next 12 months	
Volunteer at Channel Islands National Park to remove non-native species	Yes	No
Read a newsletter, magazine or other publication about the human history of the Channel Islands National Park	Yes	No
Clean equipment (e.g., wash hulls of boats, shake tents, pick seeds from shoe laces) to prevent the spread of exotic species	Yes	No
Use boot scraping stations to prevent the spread of non-native plants	Yes	No
Support and/or accept policies that protect the marine environment	Yes	No
Support the reintroduction of native species (e.g., island foxes) on Channel Islands National Park	Yes	No
Properly dispose of waste (e.g., apple cores) that may cause the spread of non-native plants	Yes	No
Support policies that protect historic and cultural resources	Yes	No
Encourage other visitors to not disturb archeological artifacts on the Channel Islands National Park	Yes	No

SECTION 4 of 5: VALUE SYSTEMS

13. These questions examine your value systems. Please rate the extent to which these values are considered important as guiding principles in your life. (Circle one number.)

	Opposed to my values	Not at all Important			Important		Very Important		Of supreme Importance
Unity with nature: fitting into nature	-1	0	1	2	3	4	5	6	7
Authority: the right to lead or command	-1	0	1	2	3	4	5	6	7
Protecting the environment: preserving nature	-1	0	1	2	3	4	5	6	7
Social power: control over others, dominance	-1	0	1	2	3	4	5	6	7
A world at peace: free of war and conflict	-1	0	1	2	3	4	5	6	7
Preventing pollution: protecting natural resources	-1	0	1	2	3	4	5	6	7
Wealth: material possessions, money	-1	0	1	2	3	4	5	6	7
Equality: equal opportunity for all	-1	0	1	2	3	4	5	6	7
Respecting the earth: live in harmony with other species	-1	0	1	2	3	4	5	6	7
Social justice: correcting injustice, care for others	-1	0	1	2	3	4	5	6	7
Influential: having an impact on people and events	-1	0	1	2	3	4	5	6	7
Helpful: working for the welfare of others	-1	0	1	2	3	4	5	6	7
Loyal: faithful to my friends, group	-1	0	1	2	3	4	5	6	7
A world of beauty: beauty of nature and the arts	-1	0	1	2	3	4	5	6	7

14. These questions measure environmentalism and your view of the relationship between people and nature. Please rate the extent to which the following statements describe your view of the world. (Circle one number.)

	Strongly Disagree		Neutral		Strongly Agree
We are approaching the limit of the number of people the earth can support	1	2	3	4	5
Humans have the right to modify the natural environment to suit their needs	1	2	3	4	5
When humans interfere with nature it often produces disastrous consequences	1	2	3	4	5
Human ingenuity will ensure that we do not make the earth unlivable	1	2	3	4	5
Humans are severely abusing the environment	1	2	3	4	5
The earth has plenty of natural resources if we just learn how to develop them	1	2	3	4	5
Plants and animals have as much right as humans to exist	1	2	3	4	5

The balance of nature is strong enough to cope with the impacts of modern industrial nations	1	2	3	4	5
Despite our special abilities humans are still subject to the laws of nature	1	2	3	4	5
The so-called "ecological crisis" facing humankind has been greatly exaggerated	1	2	3	4	5
The earth is like a spaceship with very limited room and resources	1	2	3	4	5
Humans were meant to rule over the rest of nature	1	2	3	4	5
The balance of nature is very delicate and easy to upset	1	2	3	4	5
Humans will eventually learn enough about how nature works to be able to control it	1	2	3	4	5
If we continue on our current course, we will soon experience a major ecological catastrophe	1	2	3	4	5

SECTION 5 of 5: SOCIO-DEMOGRAPHICS

15. Are you …?

- ❑ Male
- ❑ Female

16. In what year were you born? _______________

17. What is your home zip code? ______________

18a. Do you consider yourself to be Hispanic, Latino or Latina?

- ❑ Yes
- ❑ No

b. With which racial group(s) do you identify? (*please ✓one or more*)

- ❑ American Indian or Alaska Native
- ❑ Asian
- ❑ White
- ❑ Black or African American
- ❑ Native Hawaiian or other Pacific Islander
- ❑ Other ____________________________________

19. What is the highest level of formal education you have completed? (*please ✓one*)

- ❑ Less than high school
- ❑ High school graduate
- ❑ Vocational/trade school certificate
- ❑ Two-year college degree
- ❑ Four-year college degree
- ❑ Graduate degree

20. How many people live in your household (including you)? Number of people: __________

21. Would you mind telling me your household's TOTAL approximate annual income from all sources before tax? (*please ✓one*)

- ❑ Less than $20,000
- ❑ $20,000 - $49,999
- ❑ $50,000 - $99,999
- ❑ $100,000 - $149,999
- ❑ $150,000 - $199,999
- ❑ Greater than $200,000

Thank you for helping us with this important survey. If there is anything else you would like to tell us, please do so in the space below.

Institutional Review Board Approval: 2012-1095
Expiration Date: May 2013

Person Collecting and Analyzing Data: Carena J. van Riper
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Department of Recreation, Park & Tourism Sciences
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Phone: 979-862-3068
Email: cvanripe@tamu.edu

APPENDIX B: ON-SITE CONTACT LOG

CONTACT & FRONT-END INTERVIEW FORM

DATES: _____/_____/_____ INTERVIEWER: ______________________ WEATHER ______________________ SAMPLING SITE: ____________________

				Group Type						
Time	Refusal	Survey ID #	Group Size	Family	Friends	Family / Friends	Other	Gender	# of Children present	Comments: explain reason for refusal

APPENDIX C: SURVEY QUESTIONNAIRE ABOUT VALUES

Channel Islands National Park Visitor Survey, 2012

ID____________

Date __________

Location_______

Texas A&M University is conducting a survey to learn more about recreationists at Channel Islands National Park. This information will be used to better serve the public. You are one of a small number of people chosen for this study, so your opinions are important to us. All information will be kept strictly confidential and your response is voluntary. No action may be taken against you for refusing to supply the information requested. Please read each question carefully and save any additional comments for the final page. This survey will take 10-15 minutes to complete.

SECTION 1 of 5: TRIP CHARACTERISTICS

1. How many people (including you) are in your personal group today?

   Total number of people: ________ Adults: ________ Children: ________

2. How would you describe your personal group? (*please ✓ one*)

   - ❑ Traveling alone
   - ❑ Family
   - ❑ Friends
   - ❑ Family and friends
   - ❑ Organized group

3. How long are you staying in the park during your visit? (*please ✓ one box & fill in blank)*

   - ❑ Day use only:
     → How many hours **today?** ________ hours
   - ❑ Overnight use:
     → How many **nights** are you staying? ________ nights

4a. Do you expect to return to Channel Islands National Park on other trips in the next 12 months? (*please ✓one*)

   - ❑ Yes➲*please skip to question 5*
   - ❑ No

b. If you do not expect to return, please explain why not: ________________________________

5a. How many times have you visited Channel Islands National Park? ___________

b. How many of the Channel Islands have you visited or do you plan to visit? ___________

c. Was Channel Islands National Park your primary destination? ___________

6. Are you aware that the boundary of Channel Islands National Park extends to one nautical mile offshore? (*please ✓one*)

   - ❑ Yes
   - ❑ No

7. How would you rate your knowledge of Channel Islands National Park? (*please ✓one*)

   - ❑ Very low
   - ❑ Somewhat low
   - ❑ Average
   - ❑ High
   - ❑ Very high

8a. Which of the following activities have you participated in during your visit? (*please ✓all that apply*)

   - ❑ Hiking
   - ❑ Boating
   - ❑ Kayaking
   - ❑ Experiencing nature
   - ❑ Attending programs
   - ❑ Camping
   - ❑ Diving/Snorkeling
   - ❑ Birding
   - ❑ Taking photographs
   - ❑ Commercial fishing
   - ❑ Recreational fishing
   - ❑ Sailing
   - ❑ Viewing marine wildlife
   - ❑ Viewing island wildlife
   - ❑ Other (*please specify)* ________________

b. From the above list, which would you identify as your primary activity? ________________

9. What, if any, changes would you recommend park managers to make in recreational opportunities at the Channel Islands?

____
____
____

SECTION 2 of 5: ENVIRONMENTAL VALUES

10. The following statements describe a range of potential feelings you could associate with Channel Islands National Park. Please indicate your level of agreement with the statements below. (Circle one number.)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I feel Channel Islands National Park is part of me	1	2	3	4	5
I identify strongly with Channel Islands National Park	1	2	3	4	5
Visiting this place says a lot about who I am	1	2	3	4	5
Channel Islands National Park means a lot to me	1	2	3	4	5
I have a strong emotional bond to Channel Islands National Park	1	2	3	4	5
I feel a strong sense of belonging to Channel Islands National Park	1	2	3	4	5
I am happiest when I visit Channel Islands National Park	1	2	3	4	5
I get more satisfaction out of visiting this place than any other	1	2	3	4	5
I wouldn't substitute any other area for doing the types of things I do here	1	2	3	4	5
The things I do at Channel Islands National Park I would enjoy doing just as much at a similar site	1	2	3	4	5
Channel Islands National Park is the best place for what I like to do	1	2	3	4	5
I will (do) bring my children to this place	1	2	3	4	5
My friends/family would be disappointed if I were to start visiting other settings and facilities	1	2	3	4	5
I have a special connection to Channel Islands National Park and the people who use it	1	2	3	4	5
I associate special people with Channel Islands National Park	1	2	3	4	5

11. Please use the space below to describe why Channel Islands National Park is important to you.

____
____
____
____
____
____

12. These questions measure environmentalism and your view of the relationship between people and nature. Please rate the extent to which the following statements describe your view of the world. (Circle one number.)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
We are approaching the limit of the number of people the earth can support	1	2	3	4	5
Humans have the right to modify the natural environment to suit their needs	1	2	3	4	5
When humans interfere with nature it often produces disastrous consequences	1	2	3	4	5
Human ingenuity will ensure that we do not make the earth unlivable	1	2	3	4	5
Humans are severely abusing the environment	1	2	3	4	5
The earth has plenty of natural resources if we just learn how to develop them	1	2	3	4	5
Plants and animals have as much right as humans to exist	1	2	3	4	5
The balance of nature is strong enough to cope with the impacts of modern industrial nations	1	2	3	4	5
Despite our special abilities humans are still subject to the laws of nature	1	2	3	4	5
The so-called "ecological crisis" facing humankind has been greatly exaggerated	1	2	3	4	5
The earth is like a spaceship with very limited room and resources	1	2	3	4	5
Humans were meant to rule over the rest of nature	1	2	3	4	5
The balance of nature is very delicate and easy to upset	1	2	3	4	5
Humans will eventually learn enough about how nature works to be able to control it	1	2	3	4	5
If we continue on our current course, we will soon experience a major ecological catastrophe	1	2	3	4	5

SECTION 3 of 5: SOCIO-DEMOGRAPHICS

14. Are you …?

- ❑ Male
- ❑ Female

15. In what year were you born? _______________

16. What is your home zip code? ______________

17a. Do you consider yourself to be Hispanic, Latino or Latina?

- ❑ Yes
- ❑ No

b. With which racial group(s) do you identify? (*please ✓ one or more*)

- ❑ American Indian or Alaska Native
- ❑ Asian
- ❑ White
- ❑ Black or African American
- ❑ Native Hawaiian or other Pacific Islander
- ❑ Other ____________________________

18. What is the highest level of formal education you have completed? (*please ✓ one*)

- ❑ Less than high school
- ❑ High school graduate
- ❑ Vocational/trade school certificate
- ❑ Two-year college degree
- ❑ Four-year college degree
- ❑ Graduate degree

19. How many people live in your household (including you)?

Number of people: __________

20. Would you mind telling us your household's TOTAL approximate annual income from all sources before tax? (*please ✓ one*)

- ❑ Less than $20,000
- ❑ $20,000 - $49,999
- ❑ $50,000 - $99,999
- ❑ $100,000 - $149,999
- ❑ $150,000 - $199,999
- ❑ greater than $200,000

SECTION 4 of 5: WHAT YOU VALUE

Now for something different! This final section examines the values you associate with Channel Islands National Park. Imagine you could distribute 100 preference points to ensure Channel Islands National Park keeps its existing value. Please allocate 100 points among the 12 values listed on the next page in a way that expresses why you think this place is important.

Please divvy up your 100 preference points and refer to the map on display for definitions of each value.

_____ **Aesthetic value (A).** I value Channel Islands National Park for the attractive scenery, sights, sounds, or smells.

_____ **Biological Diversity Value (B).** I value Channel Islands National Park because it provides for a variety of plants, wildlife, marine life, and other living organisms.

_____ **Cultural Value (C).** I value Channel Islands National Park because it preserves historic places and archaeological sites that reflect human history of the islands.

_____ **Economic Value (E).** I value Channel Islands National Park because it provides fisheries, recreation, or tourism opportunities that provide economic benefits.

_____ **Future Value (F).** I value Channel Islands National Park because it allows future generations to experience this \ place.

_____ **Intrinsic Value (I).** I value Channel Islands National Park in and of itself for its existence.

_____ **Learning Value (L).** I value Channel Islands National Park because I can learn about natural and cultural resources.

_____ **Life Sustaining Value (LS).** I value Channel Islands National Park because it helps produce, preserve, clean, and renew air, soil, and water.

_____ **Recreation Value (R).** I value Channel Islands National Park because it provides a place for my favorite outdoor recreation activities.

_____ **Spiritual Value (S).** I value Channel Islands National Park because it is spiritually significant to me.

_____ **Therapeutic Value (T).** I value Channel Islands National Park because it makes me feel better, physically and/or mentally.

_____ **Scientific Value (Sci).** I value Channel Islands National Park because it provides an opportunity for scientific observation or experimentation.

100 Preference Point Allocation

SECTION 4 of 5: WHAT YOU VALUE

Now for something different! This final section examines the values you associate with Channel Islands National Park. Imagine you could distribute 100 preference points to ensure Channel Islands National Park keeps its existing value. Please allocate 100 points among the 12 values listed on the next page in a way that expresses why you think this place is important.

Please divvy up your 100 preference points and refer to the map on display for definitions of each value.

_____ **Aesthetic value (A).** I value Channel Islands National Park for the attractive scenery, sights, sounds, or smells.

_____ **Biological Diversity Value (B).** I value Channel Islands National Park because it provides for a variety of plants, wildlife, marine life, and other living organisms.

_____ **Cultural Value (C).** I value Channel Islands National Park because it preserves historic places and archaeological sites that reflect human history of the islands.

_____ **Economic Value (E).** I value Channel Islands National Park because it provides fisheries, recreation, or tourism opportunities that provide economic benefits.

_____ **Future Value (F).** I value Channel Islands National Park because it allows future generations to experience this \ place.

_____ **Intrinsic Value (I).** I value Channel Islands National Park in and of itself for its existence.

_____ **Learning Value (L).** I value Channel Islands National Park because I can learn about natural and cultural resources.

_____ **Life Sustaining Value (LS).** I value Channel Islands National Park because it helps produce, preserve, clean, and renew air, soil, and water.

_____ **Recreation Value (R).** I value Channel Islands National Park because it provides a place for my favorite outdoor recreation activities.

_____ **Spiritual Value (S).** I value Channel Islands National Park because it is spiritually significant to me.

_____ **Therapeutic Value (T).** I value Channel Islands National Park because it makes me feel better, physically and/or mentally.

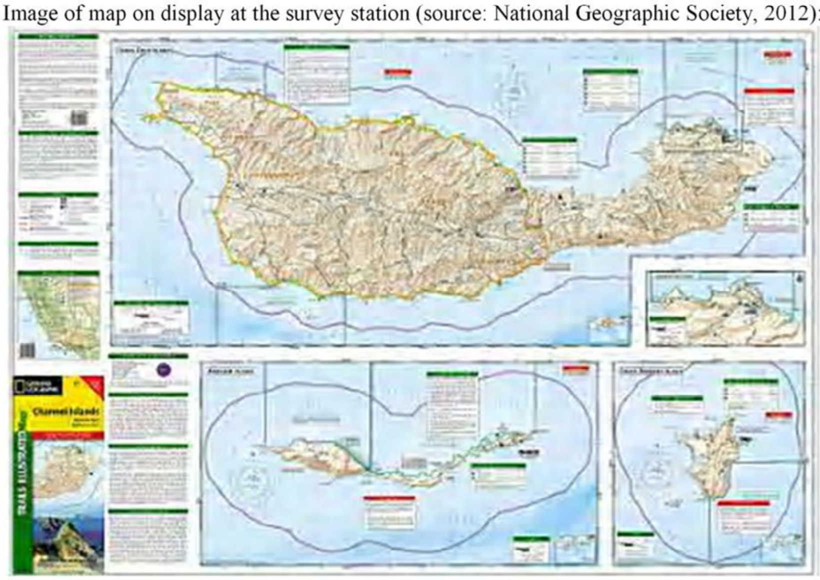
_____ **Scientific Value (Sci).** I value Channel Islands National Park because it provides an opportunity for scientific observation or experimentation.

100 Preference Point Allocation

SECTION 5 of 5: VALUE ALLOCATION

The final step in this exercise involves you showing us specific places that reflect the values you selected in the previous exercise. First, approach the displayed map of Channel Islands National Park and return your tablet to the survey administrator. Next, indicate which places on the map you feel embody values. Please refer to the value abbreviations listed in the lower right hand corner of the map to identify which values you associate with each area. You can point to as many or as few places as you would like.

Image of map on display at the survey station (source: National Geographic Society, 2012):

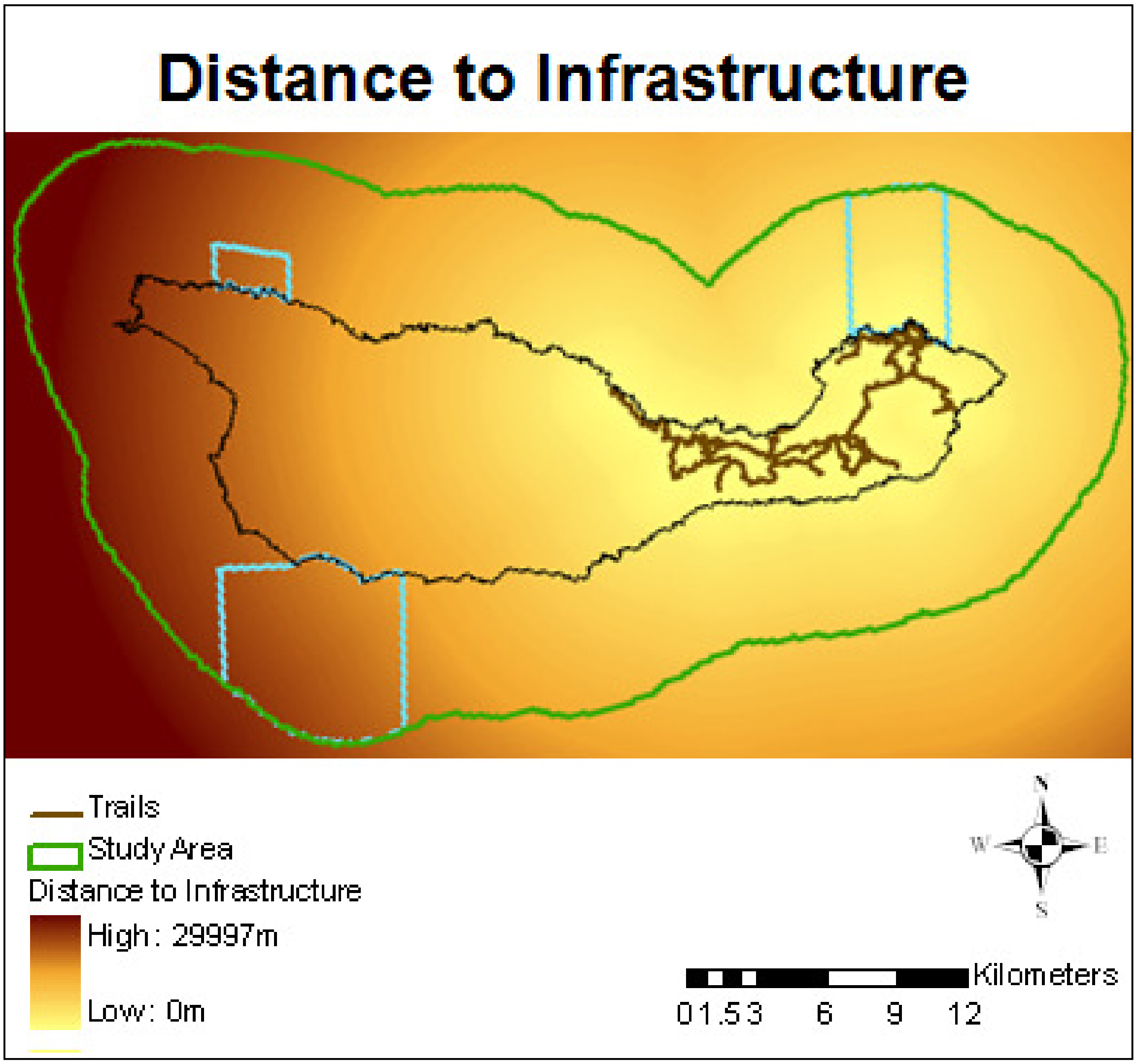


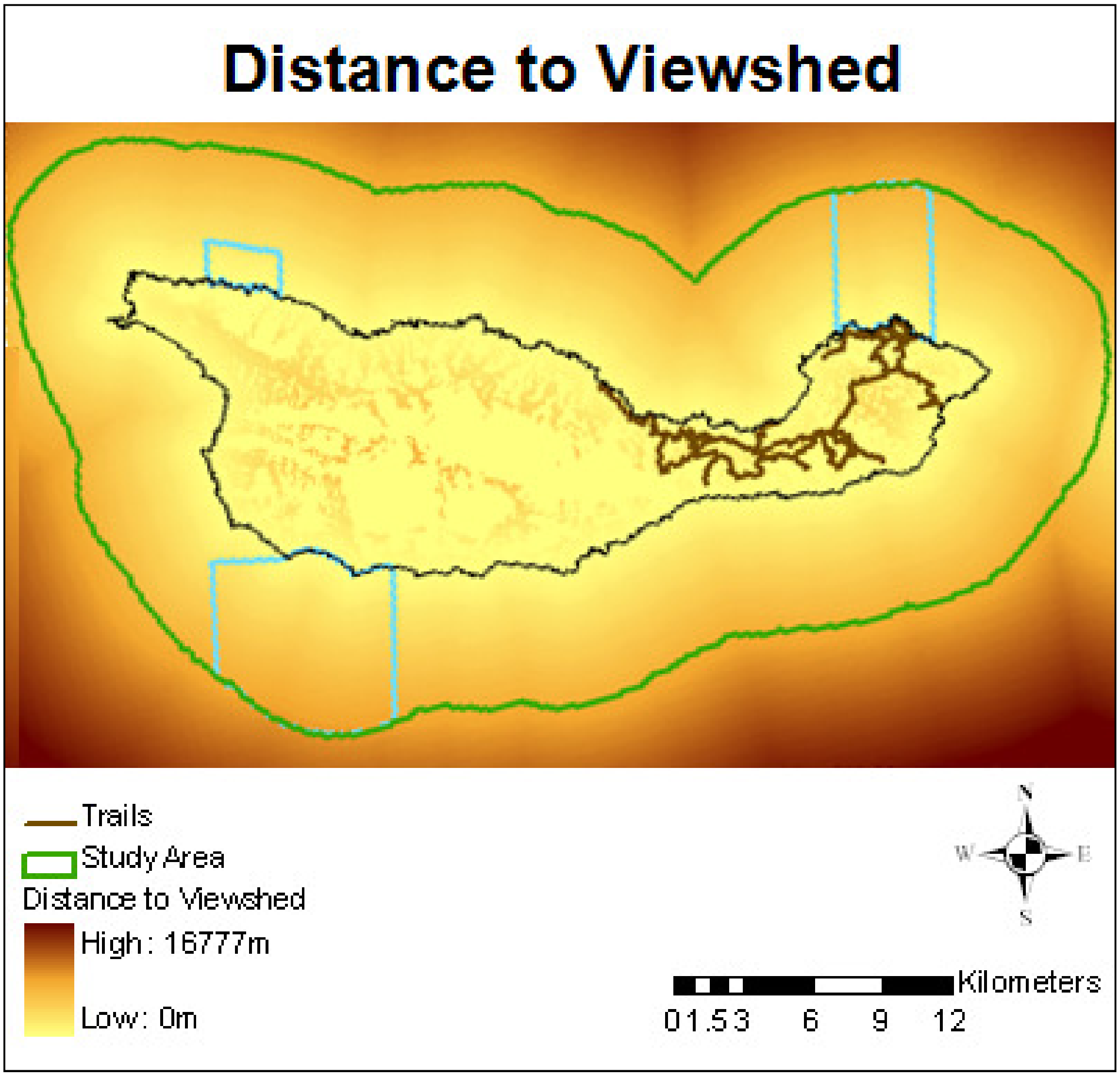
Thank you for helping us with this important survey! If there is anything else you would like to tell us, please do so in the space below.

Institutional Review Board Approval: 2012-0195
Expiration Date: May 2013

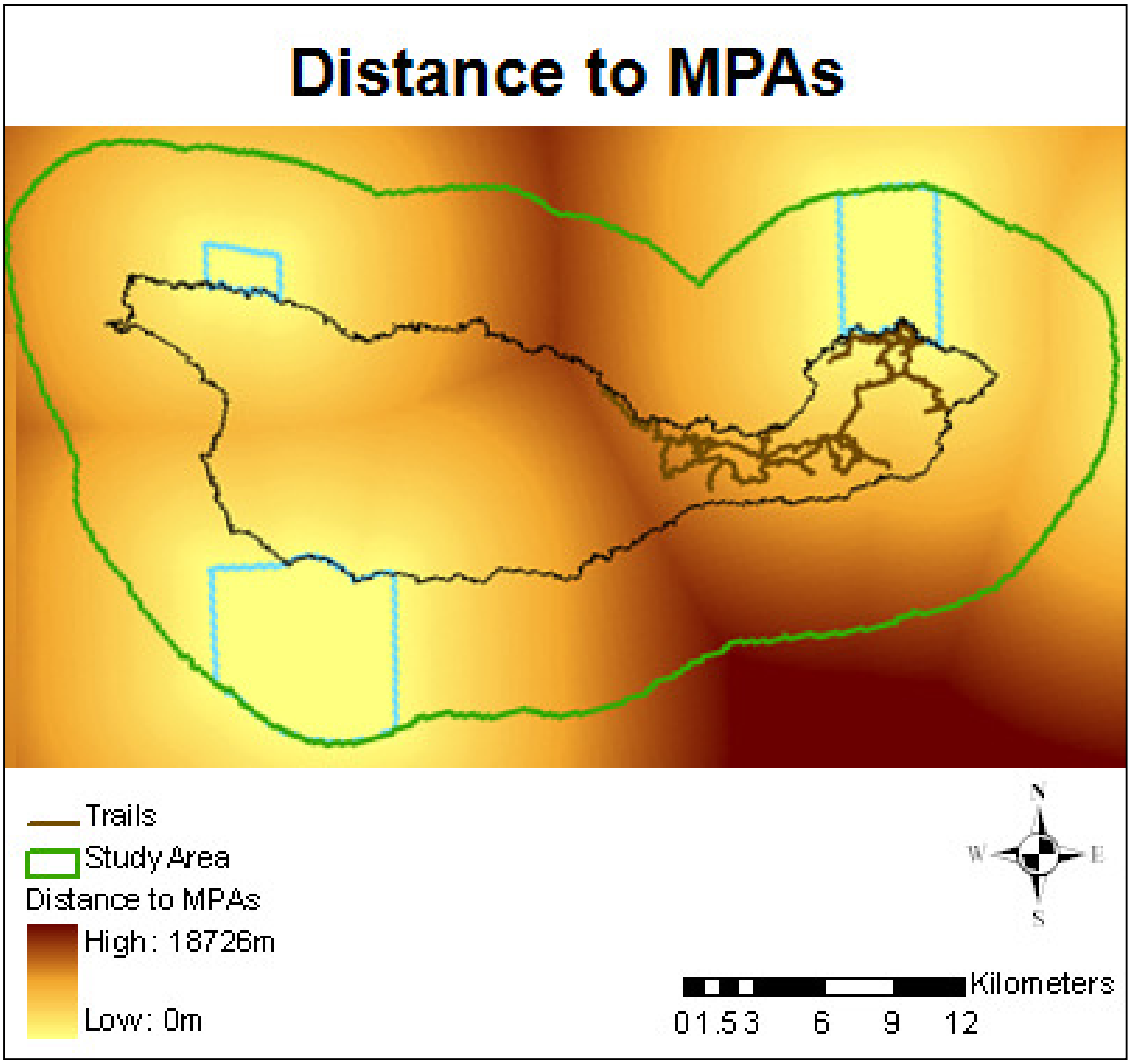
Person Collecting and Analyzing Data: Carena J. van Riper
Human Dimensions of Natural Resources Laboratory
Department of Recreation, Park & Tourism Sciences
Texas A&M University
2261 TAMU
College Station, TX, USA 77843-2261
Phone: 979-862-3068
Email: cvanripe@tamu.edu

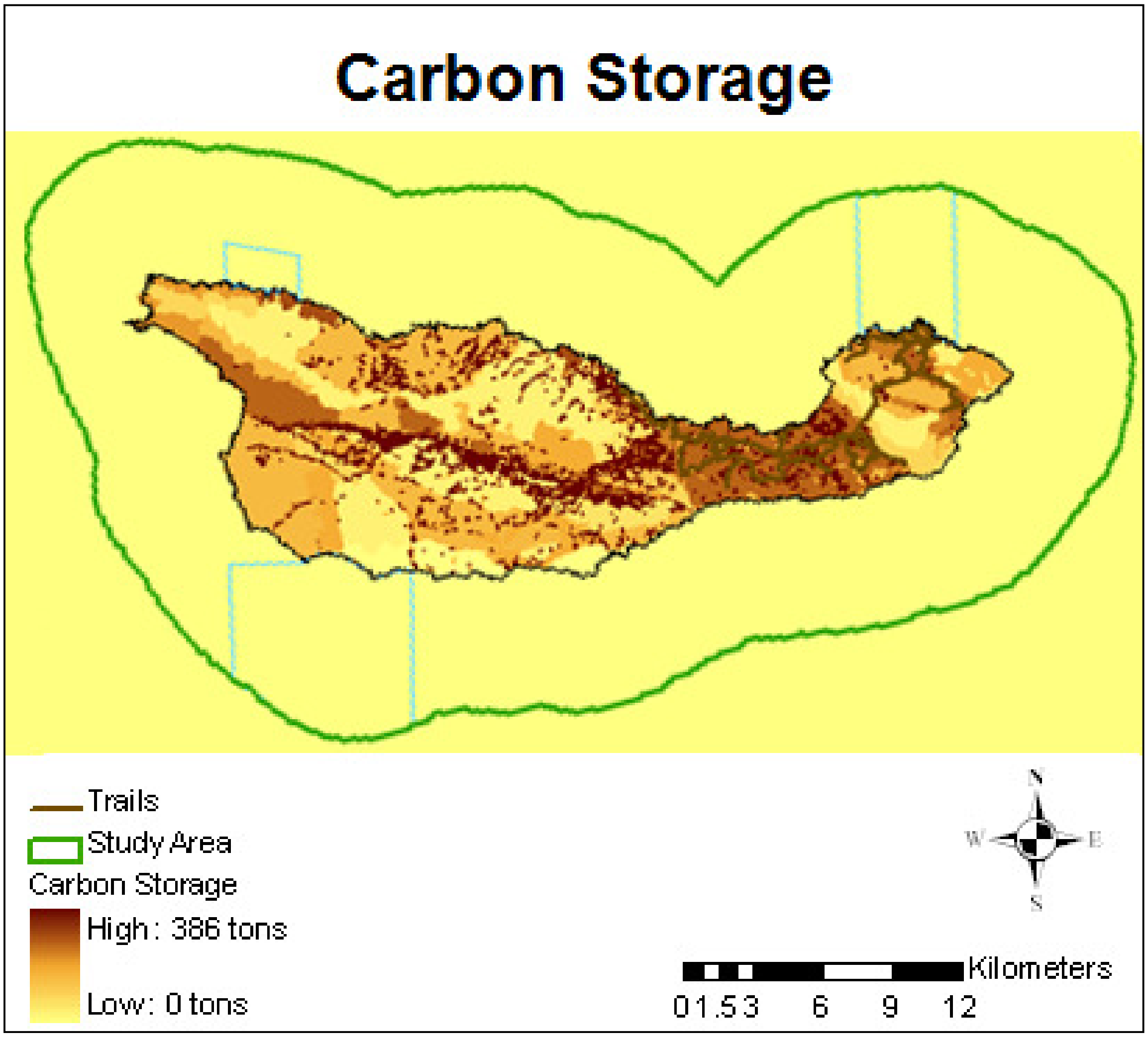
APPENDIX D: ENVIRONMENTAL VARIABLES

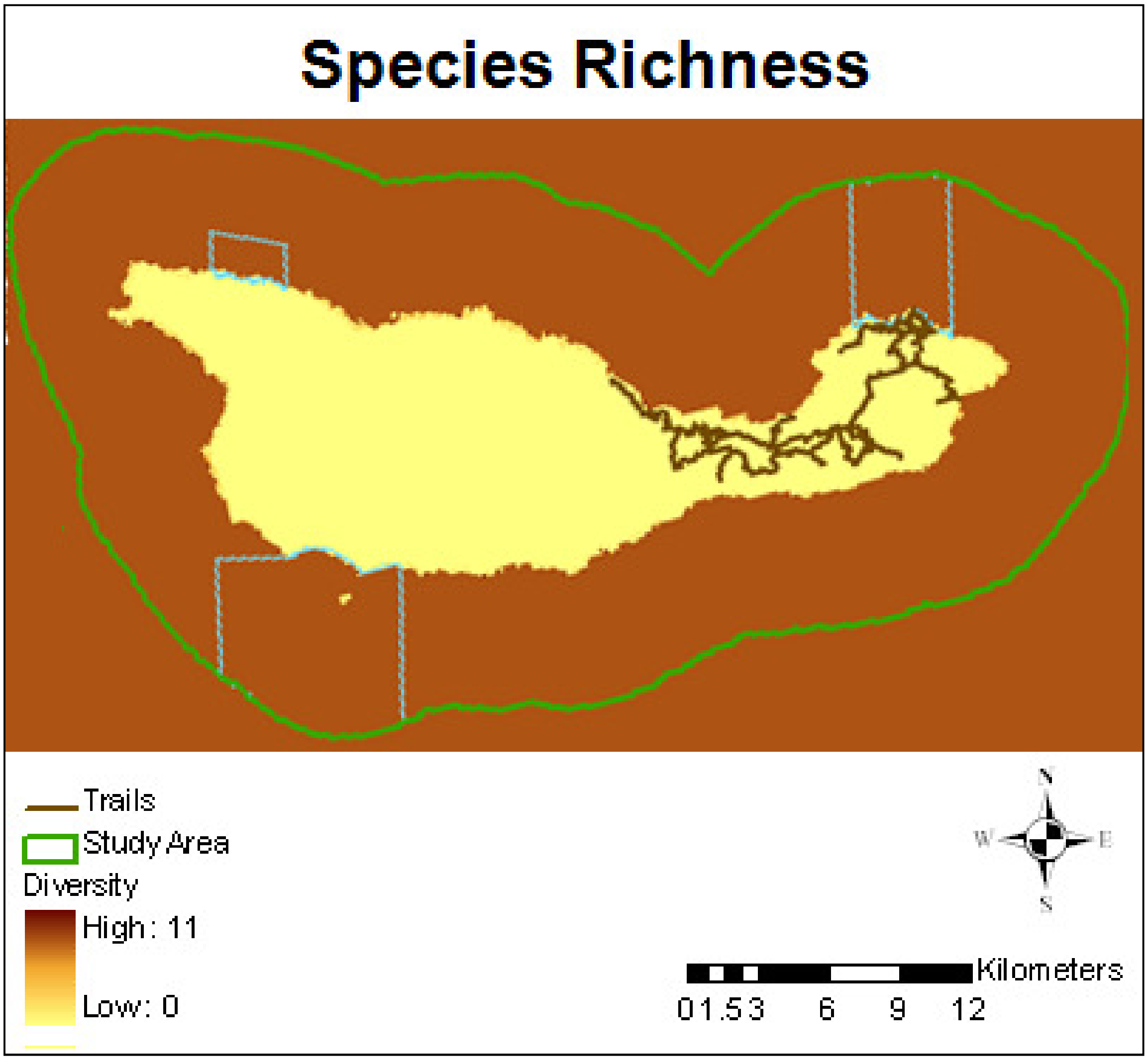


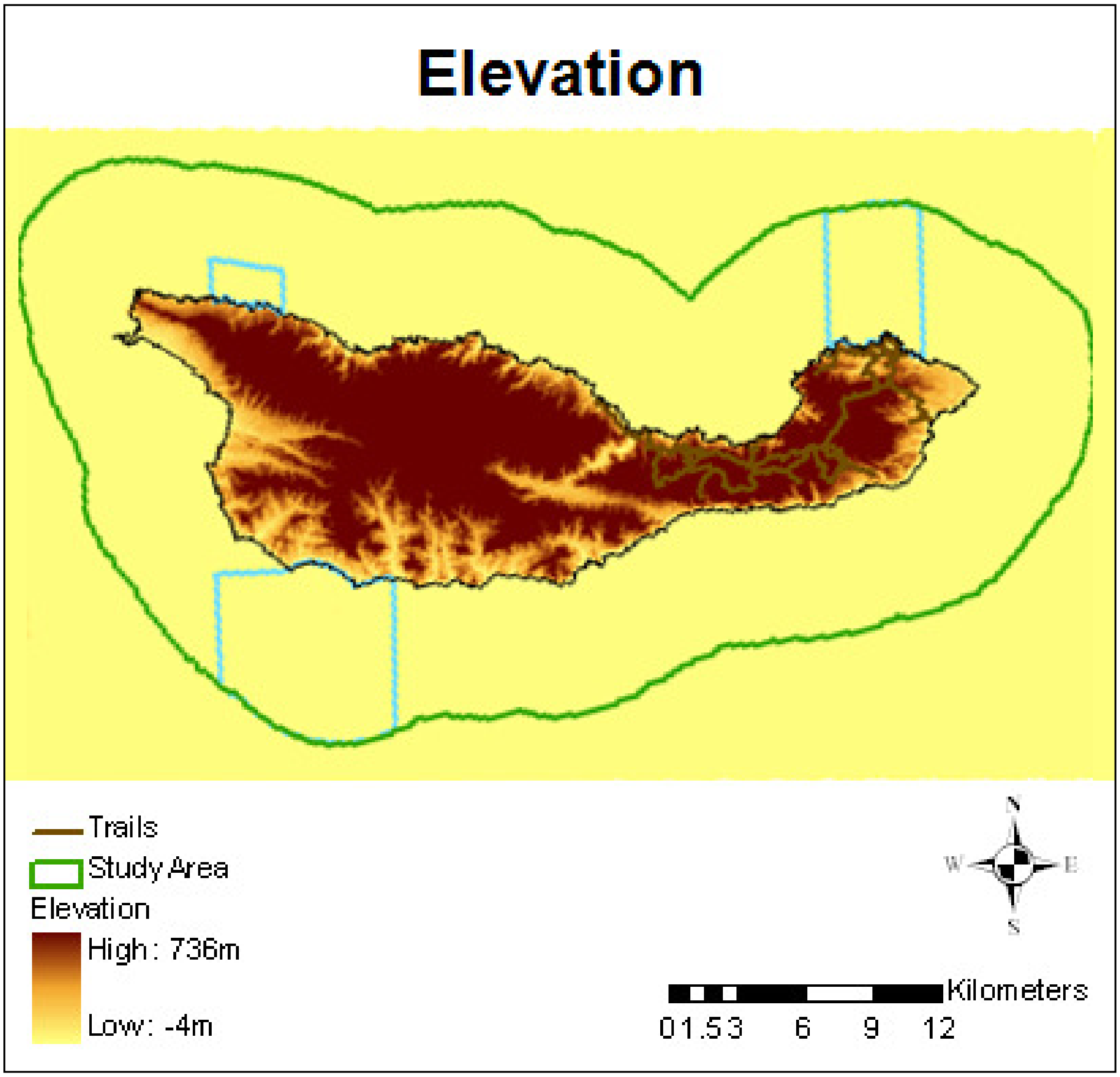


Distance to Viewshed
Trails
Study Area
Distance to Viewshed
High : 16777m
Low : 0m
N
W
E
S
Kilometers
0 1.5 3 6 9 12

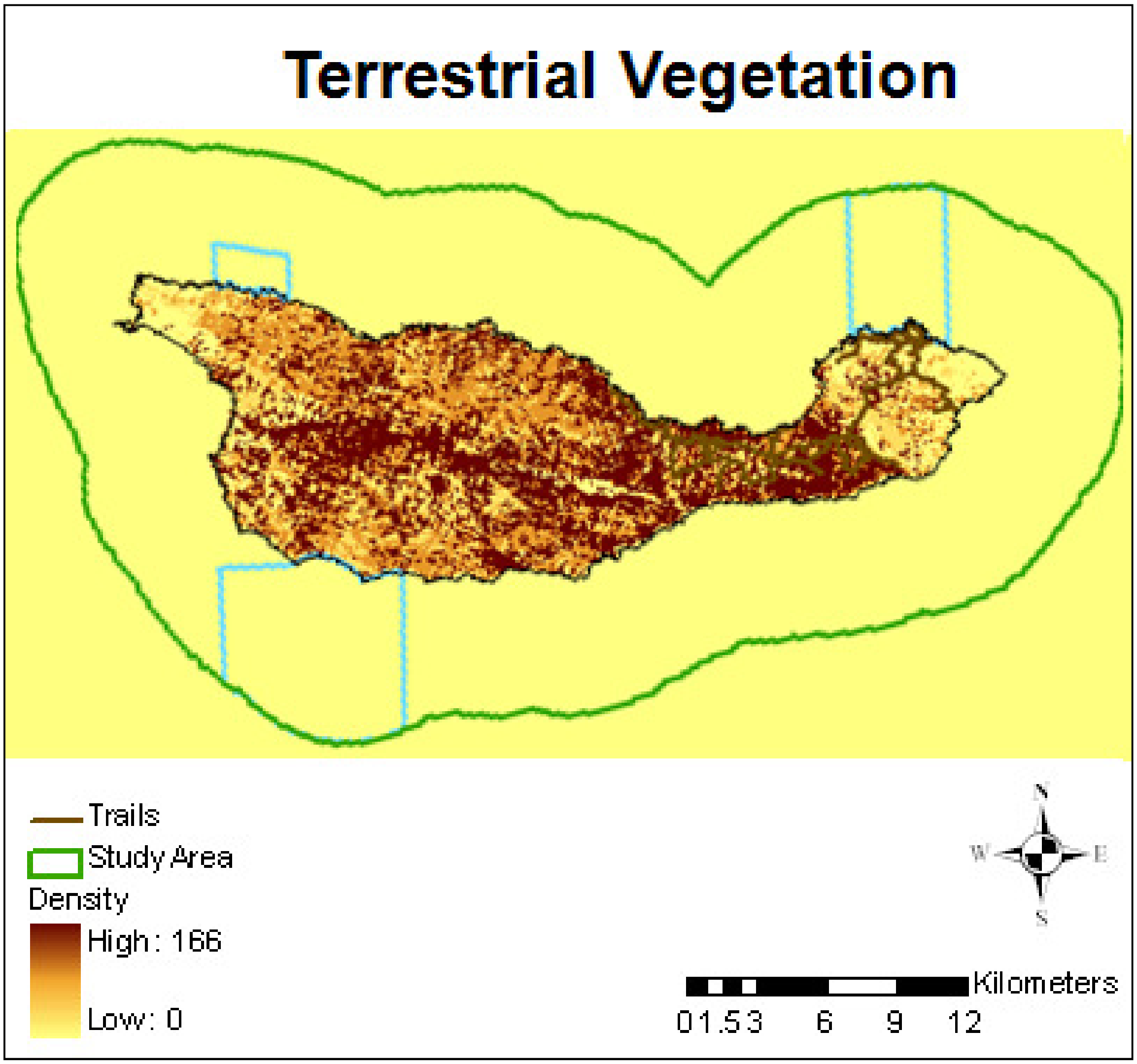

Distance to MPAs
Trails
Study Area
Distance to MPAs
High : 18726m
Low : 0m
N
W
E
S
Kilometers
0 1.5 3 6 9 12

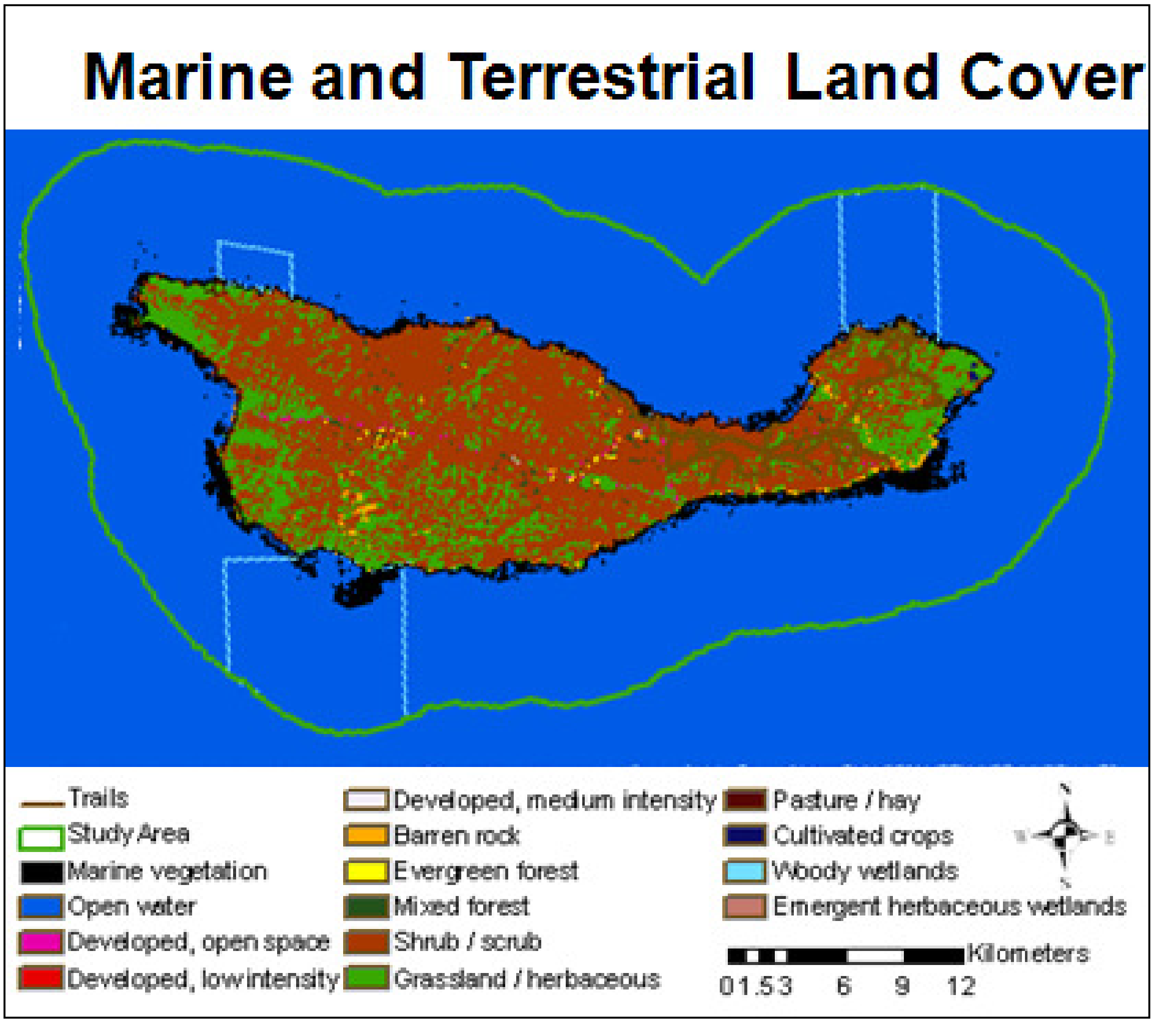

Carbon Storage
Trails
Study Area
Carbon Storage
High : 386 tons
Low : 0 tons
Kilometers
0 1.5 3 6 9 12
N
W
E
S


Species Richness
Trails
Study Area
Diversity
High : 11
Low : 0
N
W
E
S
Kilometers
0 1.5 3 6 9 12



Elevation
Trails
Study Area
Elevation
High : 736m
Low : -4m
N
W
E
S
Kilometers
0 1.5 3 6 9 12


Terrestrial Vegetation
Trails
Study Area
Density
High : 166
Low : 0
N
W
E
S
Kilometers
0 1.5 3 6 9 12


Marine and Terrestrial Land Cover
Trails
Study Area
Marine vegetation
Open water
Developed, open space
Developed, low intensity
Developed, medium intensity
Barren rock
Evergreen forest
Mixed forest
Shrub / scrub
Grassland / herbaceous
Pasture / hay
Cultivated crops
Woody wetlands
Emergent herbaceous wetlands
Kilometers
0 1.5 3 6 9 12