THE ROLE OF SCIENCE IN PUBLIC UNDERSTANDING OF ENVIRONMENTAL CONTROVERSIES: COGNITION, MEDIA, AND RESIDENT PERCEPTION IN COASTAL FLORIDA

By

J. STUART CARLTON

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2012

To Libby, who continues to believe in me despite all available evidence

ACKNOWLEDGMENTS

I would like to thank the members of my committee for guiding me through this process and helping become an interdisciplinary researcher and thinker. I also would like to thank my committee chair, Dr. Susan Jacobson, for being the best mentor imaginable. I would also like to acknowledge past mentors whose guidance continues to shape me, including Dr. Oliver Houck, Dr. Hank Bart, and Dr. Cecil Jennings.

I received financial assistance from Florida Sea Grant, Oregon Sea Grant, the University of Florida School for Natural Resources and Environment, and the University of Florida Department of Wildlife Ecology and Conservation. I received technical and logistical assistance from Dr. Joan Bradshaw, Cyndi Langin, Thomas Ruppert, Dr. Mike Spranger, Dara Wald, and a large contingent of undergraduates, family, and friends who helped me pilot test, code, and do all sorts of other little boring things that were necessary for getting these projects done. My mother-in-law, Marcia Gutridge, and her husband David provided valuable babysitting assistance; I'd be a year behind without them.

Most importantly, I would like to thank my mom, dad, and the rest of my family for getting me here and getting me through. Special thanks goes to Harper, who made sure that I had plenty of time for late-night brainstorming sessions, and Libby, who helped me recover from the aforementioned late-night brainstorming sessions.

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J. Stuart Carlton

August 2012

Chair: Susan K. Jacobson
Major: Interdisciplinary Ecology

Controversies hinder effective coastal management, impeding communication between scientists, managers, and the public. I examined the role of science in public understanding of coastal natural resource management controversies to advance the theory and practice of environmental communications. I conducted in-depth interviews with government administrators in Crystal River, Florida, comparing their cognitive models of climate-related environmental hazards to an expert model. The models differed substantially: nonexperts were less concerned about climate change than local issues such as water quality. However, many nonexpert concerns were climate-related. Refocusing communications on climate-related hazards should promote meaningful adaptation and mitigation while lessening controversy associated with the concept of climate change.

To evaluate media's role in controversy, I analyzed the content of 441 articles in five Florida newspapers covering three coastal management controversies: a gill-net fishing ban, reef fisheries management, and climate change. I studied the use of six frames—science, scientific uncertainty, conflict, economics, human interest, and

morality—and scientists' quotations. Conflict and economic frames dominated, appearing in a significant majority or plurality of articles by controversy. Science framing appeared in significantly less than 50% of articles by controversy. Discriminant function analysis classified 63.7% of articles using two axes: scientific uncertainty and conflict. Scientists were quoted 262 times versus 532 for non-scientists. The results suggest that only a small part of media coverage is science-based and mass media may not be the best channel for science communication.

To analyze coastal residents' climate-related risk perceptions, I surveyed 558 Florida undergraduates. Based on factor analyses, respondents were more concerned about risks to the physical environment (average concern 7.17/10) than risks to the economy (6.66) and biota (5.98). Regression analysis showed that environmental attitudes, gender, and politics were significant drivers of risk perception, implying that risk perception is less a function of careful thought than of individuals' cognitive and affective characteristics. Communicators should focus on salient risks to improve climate communication. These studies demonstrate that scientific information is a small component of how the public receives, processes, and perceives coastal environmental controversies, suggesting that successful outreach must address emotional content in addition to disseminating scientific facts.

CHAPTER 1
INTRODUCTION

As coastal populations grow and the climate changes, the pressures on coastal natural resources are likely to increase (Tobey et al. 2010). Additionally, both the likelihood of and consequences from environmental hazards are expected to increase in many coastal communities (IPCC 2012). However, coastal natural resource management is often hampered by political concerns, controversies over the validity of the relevant science, and poor communication. Additionally, scientists, resource managers, and other experts tend to approach coastal resource management issues differently from the lay public, relying more on analytical assessments of scenarios than more experiential, emotion-laden judgments. This can lead to poor communication between scientists, managers, and the public, which can contribute to distrust among the parties. By understanding how the public views controversial coastal resource management issues, outreach and communication personnel can improve communication and management actions, framing them in a more palatable manner for the public.

The three studies in this dissertation approach this problem from three different angles. The first study, “Comparing Models of Climate Change Risks Among Expert and Nonexpert Stakeholders”, uses a qualitative mental models approach to explore the differences in perception of climate change risks between expert and nonexpert stakeholders in Crystal River, Florida. Specifically, the study compares the “mental models” of policymakers and government technical staff to an expert model developed by Florida Sea Grant personnel.

The second study, “Media Coverage of Three Natural Resource Controversies in Florida: Generic Framing and the Role of Science”, analyzes newspaper coverage of three coastal natural resource controversies in Florida: the 1994 “net ban” constitutional amendment, an ongoing reef fishery management controversy, and climate change. The study compares the use of six different frames in each controversy: science, scientific uncertainty, conflict, economics, human interest, and morality. Additionally, the study analyzes the use of scientists as sources of information in coverage of the controversies.

The final study, “Climate Change and Coastal Environmental Risk Perception”, uses survey research to analyze coastal environmental risk perceptions among undergraduates at the University of Florida. The study also uses regression analysis to determine the extent to which cognitive and affective characteristics influence risk perception.

Together, these three studies reveal critical information about how the public receives information about and perceives coastal environmental and natural resource issues. Though the studies often raise as many questions as they answer, the work represents and important step toward improving outreach and communication in coastal communities.

CHAPTER 2
COMPARING MODELS OF CLIMATE CHANGE RISKS AMONG EXPERT AND NONEXPERT STAKEHOLDERS

Climate Change Inaction: The Importance of Qualitative Research

Climate change is a significant global risk that is predicted to be particularly devastating to coastal communities because of effects of sea-level rise, coastal flooding, and increased storm activity. Climate change will likely erode shorelines, raise estuarine salinity (IPCC 2007), and cause significant disruptions in marine fisheries (Cheung et al. 2009). Climate change might amplify other stresses to the coastal environment such as water pollution, habitat loss, and overuse of natural resources (Tobey 2010).

Despite the climate-related risks, many coastal communities are unprepared for either adapting to or mitigating the effects of climate change. A 2008 survey of coastal states, commonwealths, and territories in the US and Canada found that 84% of them do not have a completed sea-level rise adaptation plan, and 56% have yet to begin development of such a plan (CSO 2008). A lack of appropriate physical and socioeconomic data (CSO 2008) and competition over limited time and resources (Titus et al. 2009; Parkinson & McCue 2011) may hinder institutional response to climate change.

Inaction on climate change is not limited to state and local governments. In a recent survey of Oregon coast professionals, defined as those who work private or public sector jobs near the coast, less than half of respondents indicated that they were prepared to devote time or resources to climate change (Borberg et al. 2009).

The reasons for slow actions on climate change are manifold, and the result of individual and societal values, perceptions, processes, and power structures (Adger et

al. 2009). Climate change is complex, and remains a controversial topic among the public, despite a consensus among scientists (IPCC 2007; Leiserowitz et al. 2010). The public generally lacks knowledge of the existence, causes, and effects of climate change, which hinders action (Leiserowitz et al. 2010, Wolf and Moser 2011). Individuals have consistently displayed confusion about climate change, often conflating it with other environmental problems such as ozone depletion or air pollution (Bostrom et al. 1994; Bord et al. 1998; Leiserowitz et al. 2010). Public confusion may be exacerbated by inadequate media coverage, which may be subject to partisan influence (Dotson et al. 2012) or overinflate the importance of the climate change controversy in an attempt to provide journalistic balance (Boykoff 2007).

Incorrect or incomplete knowledge is not the only factor hindering public action on climate change. Psychological research has revealed several other challenges to action. First, climate change is a long-term threat without a cause attributable to specific actions, individuals, or institutions, and people tend to ignore those sorts of risks in favor of those that are more salient and immediate (Stern 1992; Moser and Dilling 2004; CRED 2009). The tendency to ignore climate change might be exacerbated by the fact that the majority of US citizens tend to view climate change as a hazard that will affect people who are either geographically or temporally distant from the present-day United States, making climate change less worthy of concern (Leiserowitz 2005). Scientists may have contributed to this “distant” view of climate change by defining global warming largely in future-oriented terms (Ungar 2000). Even if climate change is perceived as a threat, people may be slow to take adaptive or mitigating actions because of (correctly or incorrectly) perceived risks of taking such action (Gifford 2011).

Despite nearly 30 years of effort, climate change outreach and communication programs have not succeeded in spurring widespread public action on climate change (Wolf and Moser 2011). While some of the difficulty can be attributed to the intractability of climate change as a public issue, it has also been argued that climate change communication has been poorly designed for the task at hand. Moser and Dilling (2011) make a compelling case that climate outreach and communication has been unsuccessful because of four faulty, but common, assumptions made by communicators: (1) that the public does not act due to a lack of information and understanding, (2) that the public would be motivated to act by fear, (3) that describing climate change in scientific terms is the most persuasive way to frame the issue, and (4) that mass communication is the best medium for communicating about climate change. The manner in which climate change communication is presented can heavily influence public reaction to the information (Spence & Pidgeon 2010), and by addressing the faults behind these assumptions, coastal managers, policymakers, and climate communicators can design outreach and communication campaigns that are more likely to inspire public action.

Qualitative research is an important, often-overlooked component of designing education and outreach programs (Jacobson et al. 2006; Jacobson 2009). Qualitative research provides in-depth contextual information for understanding a system and can reveal important, potentially hidden concerns that might be missed in general quantitative studies (Patton 2002). Understanding the specific context of controversial topics like climate change can help managers, communicators, and policymakers frame management strategies, communications products, and policies to reflect the reality of

what audience perception *is* rather than a theoretical conception of what audience perception *should* be.

Mental Models

Analysis of cognitive, or “mental” models is a qualitative research approach that allows researchers to understand the psychological context of an issue (Morgan et al. 2002). Analyzing mental models reveals people’s understanding of the relationships among different aspects of an issue.

Mental models are simplified cognitive representations of a perceived situation (John-Laird 1983). Typically, people do not think of a piece of information or a situation in isolation, but as a part of a domain of knowledge with interweaving sets of relationships among concepts. These concepts and relationships are collectively called a "mental model,” which represents someone's thoughts and beliefs about how something works (CRED 2009). Mental models are a source for people’s expectations about how a system works (Wickens 1984), allowing people to make predictions about a system and take appropriate actions (Johnson-Laird 1983).

An individual's mental model is informed by that person's experiences, attitudes, and values (Gentner & Stevens 1983). Mental models are constructed through an iterative process in which an individual receives new information and filters it through their existing models. Since existing models are a starting point for understanding novel situations, people tend to reject information that conflicts with, and accept information that agrees with, their existing mental models, though new information can cause a mental model to shift over time (Morgan et al. 2002).

Mental model formation occurs on a personal level, based on an individual’s experiences and knowledge. This personal nature means that different people will have

different mental models informed by different experiences and knowledge. As a result, individuals' mental models may be basic or thorough, accurate or error-ridden (Norman 1983). When individuals interact, they use their contextually relevant mental models as a basis for the interaction. In teams of individuals, mental model compatibility is a critical component of team performance (Cannon-Bowers et al. 1993).

Because of the individual nature of mental model construction, experts and nonexperts tend to have different mental models for any given phenomenon (Bostrom et al. 1994). Experts' mental models tend to be much more thorough, rational, and accurate than nonexpert models, and experts may actually be able to "run" potential actions through their model to accurately predict the consequences of these actions (Klein 1989). The expert-nonexpert gap can hinder communication, as things that the experts consider relevant and important within a system may not be relevant or important in nonexperts' model of the situation, and vice versa (e.g., Zaksek and Arvai 2004). Climate change is an area in which an expert-nonexpert gap persists (Bostrom et al. 1994; Bord et al. 1998; Leiserowitz et al. 2010), which may contribute to the relative ineffectiveness of climate outreach.

One strategy for climate outreach and communication is to find noncontroversial ways to frame climate information (CRED 2009; Hardisty et al. 2010). A frame is the "central organizing idea or story line that provides meaning" (Gamson and Modigliani 1987: 143) to a message. Focusing on mental models allows researchers to find specific topics, areas, and concepts (i.e., "story lines") to emphasize in outreach and education that are climate-related but avoid the controversy often associated with climate change. A similar approach was used in a study of models of genetic disease

inheritance, which found that people tended to have one of three general mental models, a fact that, once validated, could be used to design educational materials to aid in genetic counseling sessions (Henderson & Maguire 2000).

A number of studies have explicitly compared expert models of a phenomenon to nonexpert mental models to understand the similarities and differences between the ways experts and nonexperts view a system. For example, researchers studied expert and nonexpert models of chemical hazards (Cox et al. 2003, Niewöhner et al. 2004). By juxtaposing the models, the researchers were able to reveal information gaps, including areas where users were not appropriately concerned with proper chemical safety (Cox et al. 2003). This information was used in developing workplace communications, and the mental models were found to be an important part of improving such communications (Niewöhner et al. 2004). This approach has been applied to understand how experts' and nonexperts' models differ in other systems, such as the risks of radon (Bostrom et al. 1992) and risks from flash floods (Wagner 2007), among others.

A mental models approach was used to compare expert and nonexpert views of climate change (Bostrom et al. 1994; Read et al. 1994). Researchers compared the mental models of adults in the Pittsburgh, PA area and found that people were concerned about climate change but were confused about many aspects of climate change, such as the difference between climate and weather. Additionally, respondents were not necessarily aware of regulatory actions being taken (Bostrom et al. 1994). A subsequent survey showed that misunderstandings such as these were relatively

common, and that people tended to confuse good environmental practices with specific strategies to prevent climate change (Read et al. 1994).

There have been several other studies of mental models of climate change. One study using a modified mental models approach found that highly educated adults—graduate students at MIT—had mental models of climate change that implicitly violated the law of conservation of matter (Sterman and Booth Sweeney 2007; Sterman 2008). A different study focused solely on experts to develop a “meta-influence” diagram representing the expert respondents’ consensus assessment of the risks of climate change. The results of the study described three conceptualizations of climate-related danger: human influence upon the climate system, impacts upon natural and human communities, and threats posed to the status quo by the costs and difficulty of mitigation measures (Lowe and Lorenzoni 2007).

While these prior studies provide valuable information about public perception of climate change, they have focused on students (Sterman 2007), experts (Lowe and Lorenzoni 2007) or members of the public (Bostrom et al. 1994) in inland areas. This study expands on prior work by comparing mental models of coastal environmental hazards of government administrators in a coastal Florida community to a more general, expert model of the effects of climate change developed by Florida Sea Grant extension specialists. We focus on environmental hazards generally, rather than climate change specifically, to attempt to find more "hooks", or common beliefs among experts and nonexperts, for use in developing climate policy, outreach and communication. In doing so, we hope to achieve the practical goal of enabling better outreach while increasing

our understanding of how the threat of climate change relates to other environmental hazards in nonexperts' cognitive models.

Research Question

How do county government administrators' mental models of coastal hazards overlap with an expert model of climate change hazards?

Methods

Study Site: Crystal River, Florida

Crystal River is a city of approximately 3300 people (U.S. Census Bureau 2010) located on the Gulf coast in north-central Florida near an eponymous river. The Crystal River-King's Bay area is known for clear, spring-fed waters, a sizable ecotourism industry, and has become a winter haven for the endangered West Indian manatee (*Trichechus manatus*). Crystal River is part of Citrus County, which has approximately 140,000 residents.

Mental Models Interviews

Semi-structured, open-ended "mental models" interviews were conducted with 8 government administrators in Crystal River and Citrus County, Florida. While confidentiality agreements prevent the reporting of the specific names and job titles of the interview subjects, the respondents included 4 of the 12 administrators at or above the Assistant County Administrator level (up to and including County Commissioners) and 4 of the 26 administrators within relevant county departments (public works, water resources, etc.), for a total of 8 of the 38 (21%) of the highest administrators in the county. Previous mental models studies have shown that a small number of interviews is usually sufficient to identify most widely held beliefs about the system (Morgan et al. 2002). Thus, this purposive sample should capture much of the diversity of people

contributing to policy decisions and should be large enough to reveal many, though not all, of the relevant beliefs.

An interview guide was developed based on an "expert model" created and provided by cooperative extension personnel and scientists at Florida Sea Grant (Figure 2-1). The authors of this study did not participate in the creation of the expert model. Since the goal of the study was to compare the models and not assess their validity, and the expert model represented the understanding of the extension specialists, no effort was made to verify the expert model for accuracy or validity. The interview guide was pilot tested with 6 members of the public unassociated with the study and minor revisions were made to question clarity.

The questions in mental model interviews are intentionally vague, allowing respondents to free-associate among concepts with minimal direction from the interviewer (Morgan et al. 2002). Interviews for this study, which focused on environmental risks in the city of Crystal River, began with a general question: "What comes to mind when you think of living in Crystal River, especially as it relates to the natural environment?" After exhausting the response to this question, follow-up prompts were asked, such as “Anything else?” After the introductory question and follow-up, a slightly more directed question was asked: "Are there any hazards or dangers associated with the natural environment in Crystal River?" This question was followed by general prompts for more information (e.g., "what else can you tell me about hazard x?", "can you explain hazard x?", "what causes hazard x?", etc.) or for additional hazards (e.g., "are there more environment-related hazards that come to mind?").

Once the topics raised by the general questions were exhausted, directed questions were asked to ensure that 4 major areas from the expert model (climate change, sea-level rise, storm surge, and coastal erosion) were covered in the interview. The directed questions were followed up in a similar manner to the general questions. Interviews were recorded, transcribed, and made anonymous for coding and analysis.

Constructing the Models

Interview transcripts were coded for three types of information: environmental risks, causes of environmental risks, and effects of environmental risks. Each individual risk, cause, or effect was considered a "node" in the mental model, and nodes that were explicitly connected in the interviews were joined with “links” in the model (Morgan et al. 2002). Only risks, causes, or effects that were explicitly mentioned by the respondent were included in the models. Causes could be mentioned either before or after effects, but the nodes were only connected if there was a direct cause-effect relationship mentioned.

The individual mental models were melded with the expert model to create a combined model. This model was based on the expert model and was created to assess how respondent perceptions of coastal environmental hazards matched the expert model of climate change hazards. To create the combined model, each node and link on the expert model was marked with the number of interviewees (i.e., up to 8) who had the node in their mental model of coastal environmental hazards. Additionally, any risk, cause, or effect that wasn’t on the expert model but was connected to existing nodes on the expert model was added as a node to the combined diagram. When possible, similar concepts were combined into a single node to aid in interpretation. The combined model gives a visual sense of the overlap and discrepancy between the

expert model and nonexpert mental models. All model diagrams were created using OmniGraffle Pro 5 (The Omni Group, Seattle, Washington).

Results

The results are presented in an ordered adapted from suggestions made by Morgan et al. (2002), with two sample mental models presented before the combined model with expert and nonexpert nodes.

Nonexpert Mental Models

The first sample mental model came from a high-level county administrator and consisted of 29 nodes with 35 links (Figure 2-2). Fourteen of the nodes “mapped” (i.e., fit within an existing node) onto the expert model: climate change, sea-level rise, coastal erosion, drought, aquifer drawdown, severe weather extremes, hurricanes and non-hurricane storm events (mapped to “increased storm intensity” on the expert model), storm surge, coastal flooding, property & infrastructure damage (mapped to “increased damage to public infrastructure” & “loss of private property”), human life endangerment, reduced ecotourism, and economic harm. Fifteen of the nodes did not map to the expert model: God, natural cycles, coal power, and greenhouse gases as causes of climate change (N.B. the expert model didn’t include any causes of climate change); melting ice caps; terrestrial vegetation changes; water quality reduction in Crystal River/King’s Bay; manatee population increases, manatee waste, development, septic tanks, fertilizer use, and aquatic vegetation changes as a cause of water quality reduction; and property value declines and increasing insurance rates as a cause of economic harm.

The second sample mental model came from a departmental administrator who works in a natural resource-related department (Figure 2-3). The model comprised 37 nodes with 49 links. Seventeen nodes mapped onto the expert model: climate change,

sea-level rise, coastal erosion, severe weather extremes, drought, hurricanes and non-hurricane storm events (mapped to “increased storm intensity”), storm surge, coastal flooding, aquifer drawdown (mapped to “decreased surface water available”), property and infrastructure damage, human life endangerment, loss of coastline, saltwater intrusion, fish population declines (mapped to “damage to local fishing economy”), reduced ecotourism and aquatic recreation, and economic harm. Twenty nodes did not map to the expert model: greenhouse gases as a cause of climate change; terrestrial vegetation changes and natural limestone loss as a cause of coastal erosion; lack of swamp buffers as a cause of property and infrastructure damage; crystal River/King’s Bay water quality reduction; manatee population increases, aquatic vegetation changes, boat traffic, septic tanks, increases in aquatic nitrate levels, fertilizer use, nutrification, algae blooms, and shoreline hardening as causes of water quality reduction; increases in aquatic parasites, human health problems, invasive aquatic plants, and loss of native plants as an effect of water quality reduction, and property value declines and increasing insurance rates as causes of economic harm.

Comparing the Nonexpert and Expert Models

Including the four discussion guide topics, 24 nodes on the expert model also appeared in one or more of the nonexpert mental models (Figure 2-4). These nodes were mentioned by an average of 4.83(SD=2.52) respondents. The nodes included increasing climatic variability, increased water temperature/CO2 levels, increased rates of sea-level rise, longer dry periods, increased storm intensity (note: any storm or hurricane nodes were mapped to this node), increased coastal flooding, increased coastal erosion, saltwater intrusion, decreased surface water availability, increased storm surge (all storm surge nodes mapped to this node), loss of public & private

beaches, change in invertebrate distributions, need to develop potable water, increased damage to public infrastructure, loss of private property, loss of life, loss of tourism dollars, damage to local fishing economy, public armoring, loss or residential property, loss of business property, private armoring, increased costs to the public, and decreased quality of life. The most frequent of the nodes common to both models are described below.

Increased storm intensity and storm surge: Hurricanes and other storms were a primary concern of respondents, both in terms of wind damage and storm surge, as described in this quote from a high-ranking elected official:

> The Sheriff's Office, who handles emergency management for Citrus County, put out their annual hurricane guide a couple years ago, and the cover of that was a picture of this building with a storm surge about five feet above it. (With) that really major storm surge, like a Category 4, Category 5 storm, this whole town goes under water… we can't stop the storm surge. Even though we're seven miles removed from The Gulf, it's all flat. There's nothing to really stop high water, other than the seven miles. We would have very significant difficulty if we got that kind of a storm surge.

Loss of private property: Respondents were concerned about property and infrastructure damage to homes and businesses, particularly from hurricanes and other storm events:

> A storm surge [from a] Category 2 (hurricane) is gonna wipe out a huge percentage of the homes...the [new homes] that are up on pilings ten feet above sea level, probably will survive, but we'll have huge infrastructure disruption. The coastal roads will be wiped out.

Loss of tourism dollars: Respondents were concerned about water quality and other environmental issues causing a reduction in ecotourism, such as in this quote:

> [A]s the water quality declines, we may lose some of that tourist base, and there's nothing to step up and replace that. And that's a clean industry. And since we have retirees, we don't have a good diverse economic base at this time, [loss of ecotourism] is a real concern to everybody. We'd like to keep that, because that's a clean industry.

Increased costs to the public: Any mention of economic harm to individuals or the local economy was coded to this node. Respondents were concerned about a general degradation to the economy resulting from reduced ecotourism, severe hurricane or storm damage, and property value declines, as illustrated in this quote from a department-level administrator:

> At some point in time, either through man's actions such as regulation and controls or through environmental degradation, the ecotourism is going to start to drop off. And that's a major component in this economy.

Seven nodes were only raised by nonexperts but still fit within the expert model classification scheme of “general impacts”, “specific physical impacts”, and “potential socioeconomic impacts”. These seven nodes were mentioned by an average of 6.86 (SD=1.68) respondents each. The nodes included: water quality loss in Crystal River/King’s Bay, manatee population changes, terrestrial vegetation changes, aquatic vegetation changes, the spread of invasive aquatic plants, increased insurance rates, and decreased property values. The most commonly mentioned of these are described below.

Reduced water quality in Crystal River/King's Bay: Respondents expressed concern over water quality in Crystal River, King's Bay, and nearby springs, either due to a loss of water clarity or other problems:

> For anybody who has been here for a fairly reasonable amount of time, it's obviously degraded significantly from what they were used to, or what they remember. And that's a major concern within this community… visibility is poor. The bottom has gotten a lot of sedimentation.

Property value declines: Many respondents expressed concern over current and future property value declines, especially as resulting from the effects of water quality reduction, such as in this quote from a department-level administrator:

> [W]hen that river was gin clear, and the water was crystal blue [waterfront properties] would be a jewel. And now, when [the Crystal River] is just green, pea green, it's just a regular river, and [the property is] not as valuable.

Aquatic vegetation changes: Aquatic vegetation (including algae and algal blooms) was a concern for many respondents, especially as related to water quality. Often, respondents were concerned about the relationship between aquatic vegetation and manatees, as stated by a county-level administrator:

> I know that when we think about manatees, they're a wonderful thing to look at, and they're a big attraction, but what are they doing about the natural grasses that they're eating, that clean and filter the water? You can't grow it back fast enough. They did a replanting in (a nearby spring), and after eight or nine months the (manatees) knocked it down and ate it, so there wasn't enough time to get a natural replanting growth back in there.

Terrestrial vegetation changes: Respondents were concerned with changes in terrestrial vegetation from sea-level rise and climate change:

> We are seeing vegetation that has a low salinity tolerance dying off, and many of those are canopy-type trees. And so, we're seeing that vegetation shift. When those trees die off, they in turn present opportunities for invasive species like Brazilian Pepper to come in.

Increased insurance rates: Respondents were concerned about increased property insurance rates, particularly in response to flooding or hurricane risks:

> Oh, Yes. I mean, not only is (flooding) a problem…when it gets into homes and causes damage…look at the insurance industry. The insurance industry for the most part won't even write policies anymore in Florida…I can tell you this, if you live west of (US Route) 19, your chances of getting a policy are slim to none and you're gonna pay through the nose.

Discussion

The interwoven sets of causes and effects that make up a mental model can contain relationships that are explicit and direct or implicit and indirect. By comparing nonexpert mental models of environmental hazards to an expert model of climate

change, this study showed how considering the relationships between the models allows communicators and policymakers to find areas of commonality in otherwise controversial topics. The results suggest that a path to effective climate outreach and communication may lie in focusing on non-controversial areas that may be only indirectly related to climate.

When comparing the models, the combined nonexpert models did not map perfectly onto the expert model, which is typical for mental models studies (e.g., Bostrom et al. 1994; Cox et al. 2003; Niewöhner et al. 2004). Most of the climate change impacts that were common between the models were related to hurricanes, property damage, and economic concerns. The nonexperts' ecological concerns didn't overlap well with the expert model: four of the nonexperts' five ecological concerns were related to water quality in Crystal River and King's Bay and a different group of four of five were absent in the expert model. Many of these ecological concerns revolved around local issues, such as Crystal River and King's Bay's flora and fauna and especially manatee populations. The higher frequency of the unique nonexpert nodes (averaging 6.86 mentions per node) than the "combined" nodes (averaging 4.83 mentions per node) supports prior research showing that people in the US tend to view climate change as less salient than other environmental concerns (Leiserowitz 2005).

Implications for Climate Change Communication and Outreach

While the combined expert/nonexpert model doesn't represent any one person's mental model, it does give a general sense of the understandings of a diversity of people who contribute to policy decisions in Crystal River. The combined model illustrates the compatible parts of the expert and nonexpert models, which prior research has shown to be a critical component of groups working well together

(Cannon-Bowers et al. 1993). Focusing on these compatible parts reveals a number of potential points of entry for successful climate change outreach and communication despite the substantial differences between the expert and nonexpert models.

Prior research has indicated that people tend to ignore threats that are distant, general, or not caused by specific, identifiable actions (Stern 1992; Moser and Dilling 2004; CRED 2009). Climate outreach and communication should focus instead on some of the specific, local concerns that people are psychologically more inclined to act upon. The nonexpert model reveals that many of these concerns, such as water quality and hurricane preparedness, are *simultaneously related to climate change*, allowing managers and outreach personnel to tie climate change outreach to other, more salient topics. Involving stakeholders to create collaborative, cultural models of risk, as opposed to a one-way, technical model, can improve risk communication (Cox 2006). Focusing on locally salient issues found by comparing mental models to expert models can be an important form of collaborative risk definition and communication.

The nonexpert models have other implications for climate change education and outreach. The nonexpert models revealed information that would not necessarily be apparent to distant researchers or communicators, or be a part of the more general expert model, which was designed to be applicable throughout Florida. While some of the nodes may seem obvious after the fact, there is a danger in making assumptions. For example, water quality, which was one of the most common and important nodes raised by the nonexperts, was a minor focus in the expert model, yet at a local level is a consistent source of concern and action. Additionally, hazards that might have initially seemed important to external sources were not necessarily so in the local mental

models. For example, the risks associated with fish population declines did not seem salient or important to respondents compared to other hazards. This was a somewhat surprising result, as Crystal River is a coastal community with an active fishing industry. Because it is impractical for communicators and policymakers to have detailed knowledge of every community, it is important to incorporate local qualitative research when working with communities.

Implications for Mental Models Research

Much of the research using mental models has focused on aiding communication related to a single risk phenomenon, such as radon exposure (Bostrom et al. 1992), chemical hazards (Cox et al. 2003, Niewöhner et al. 2004), or flash floods (Wagner 2007). Even the early work on climate change mental models (Bostrom et al. 1994; Read et al. 1994) had a fairly narrow focus on specific climate change phenomena.

This study took a different approach, expanding beyond the hazards of climate change and into related environmental hazards and mapping respondents' models of these hazards to an expert model. By examining the broader context of the relationship between the risks of climate change and other risks, new connections were revealed and the number of potentially relevant nodes was expanded. Studying mental models enables more effective outreach and communication by helping communicators identify, as Kaplan (2000) termed it, multiply desirable solutions. A mental models approach should be useful in other situations involving controversial phenomena when, as with climate change, there is significant disagreement about even the most basic concepts.

Limitations

This study has several limitations. As qualitative research with a small number of individuals in one coastal community in Florida, the specific results cannot be

generalized. Additionally, the difference in the process of creating the expert model and creating the nonexpert models may have contributed to some of the discrepancies between the models. The nonexpert models were created from a single interview with each respondent, and likely do not contain all of the information known by the subject about climate change and other coastal environmental hazards. Additionally, some detail in the nonexpert models may have been lost as specific concepts were combined into general nodes.

However, I believe that the models created in these interviews are a reasonable representation of the aspects of coastal environmental hazards that were most salient to the respondents. While the similarities and differences between the expert and nonexpert models might not be canonical, they are instructive, and point to the critical importance of on-the-ground research when designing effective outreach and policy.

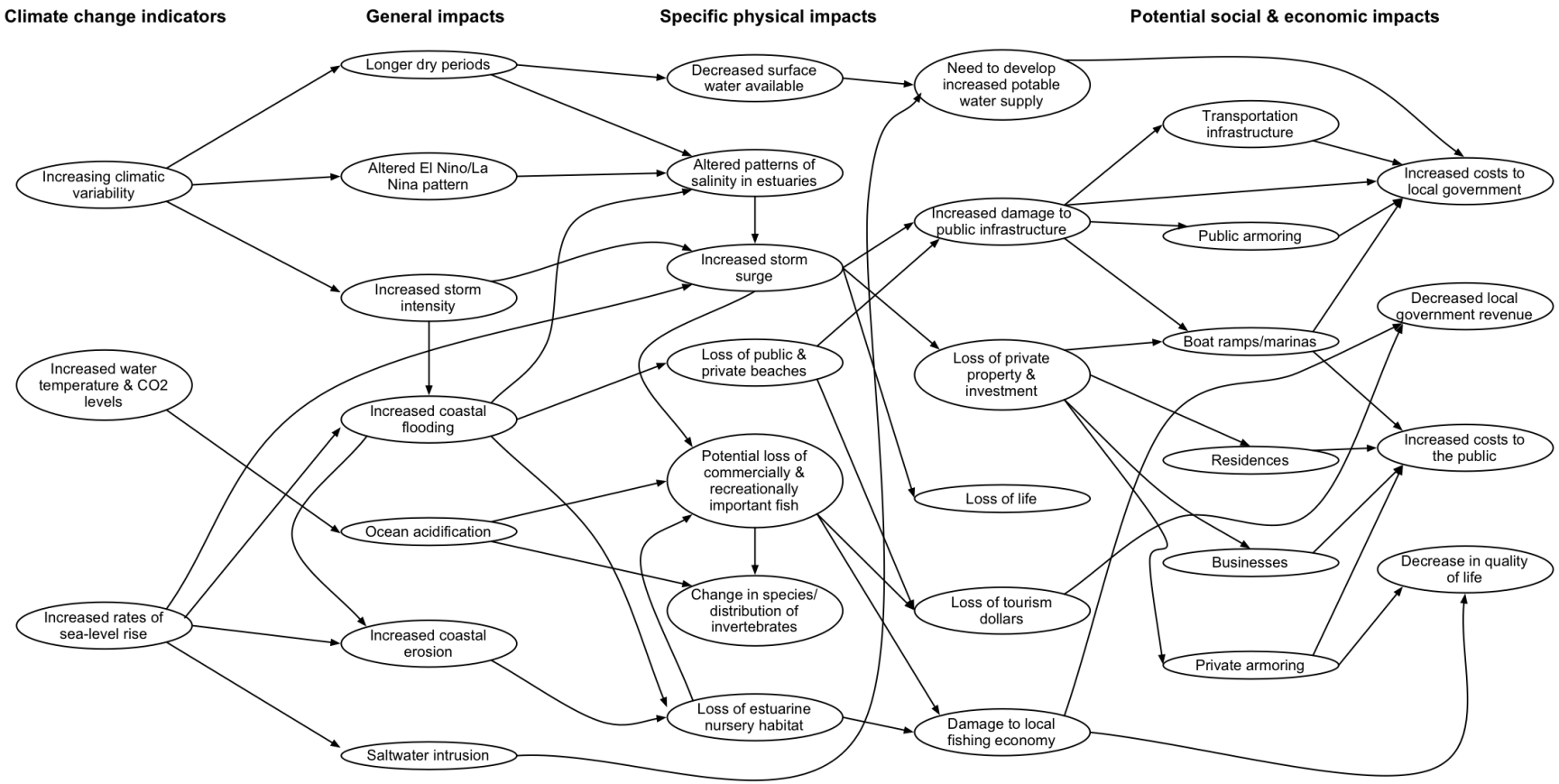

Figure 2-1. Climate change expert model, developed by Florida Sea Grant outreach personnel. Arrows indicate a causal or influential relationship.

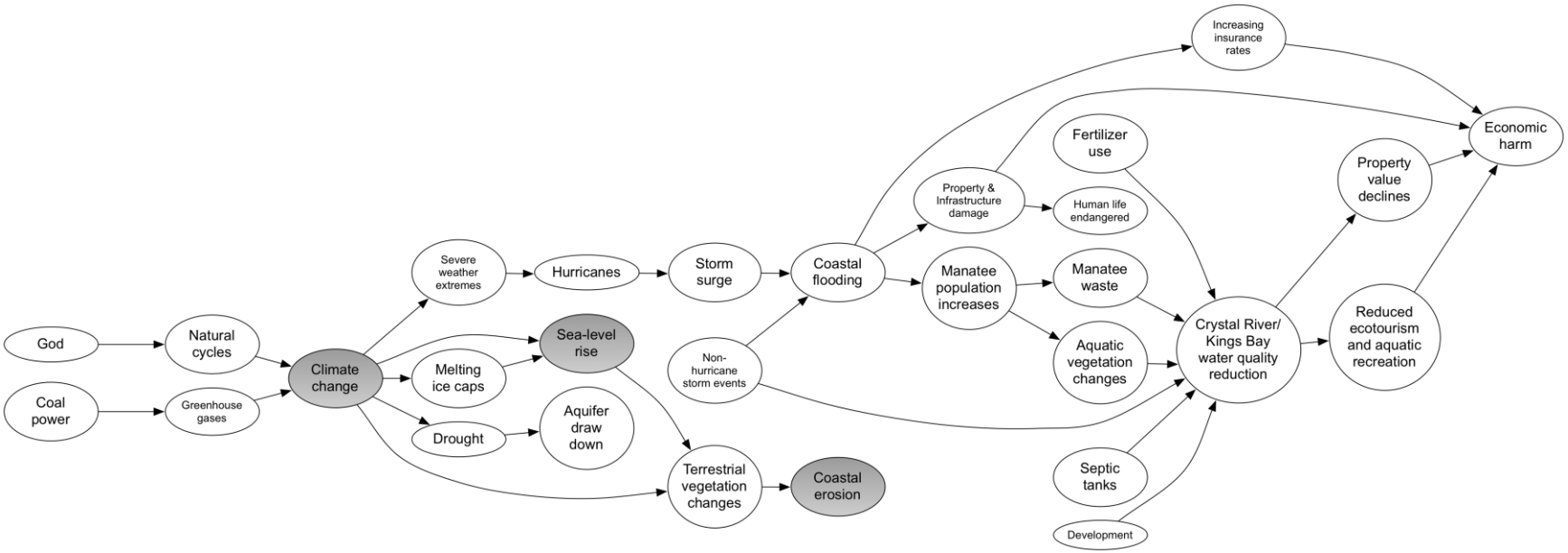

Figure 2-2. Sample high-level administrator mental model of climate change and coastal environmental hazards in Crystal River, Florida. NOTE: Shaded nodes were raised by the interviewer and not otherwise by the respondent.

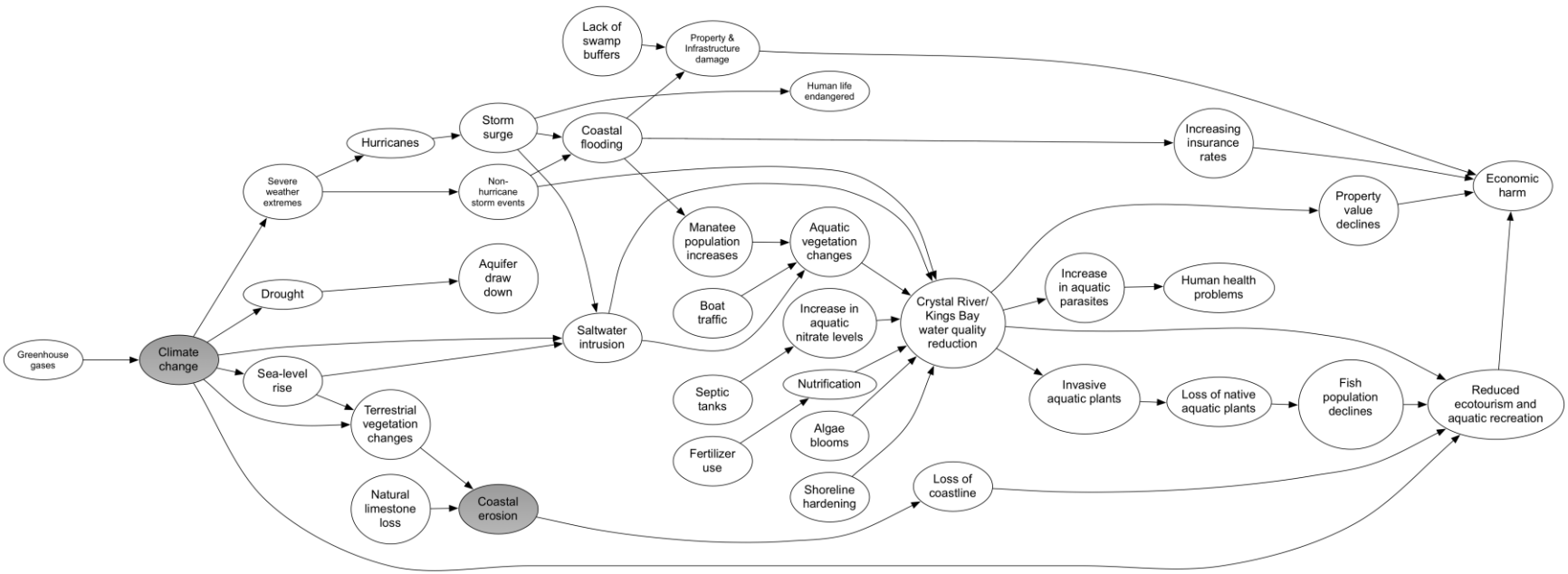

Figure 2-3. Sample department-level administrator mental model of climate change and coastal environmental hazards in Crystal River, Florida. NOTE: Shaded nodes were raised by the interviewer and not otherwise by the respondent.

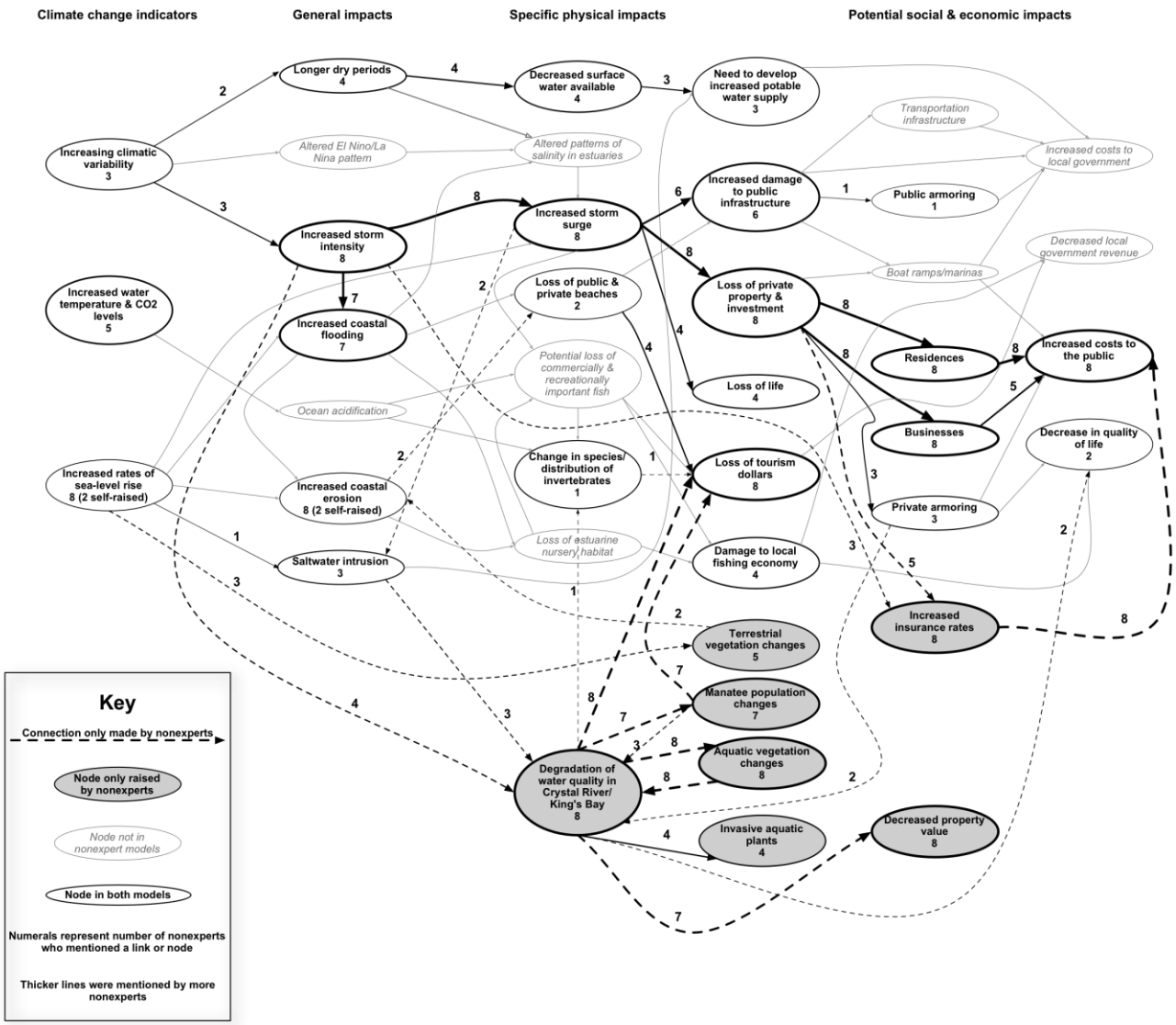

Figure 2-4. Expert model of climate change hazards in Crystal River, Florida with nonexpert nodes added.

CHAPTER 3
MEDIA COVERAGE OF THREE NATURAL RESOURCE CONTROVERSIES IN FLORIDA: GENERIC FRAMING AND THE ROLE OF SCIENCE

Media Effects and Environmental Controversies

Environmental and natural resources controversies are often complex, technical, and difficult for the public to fully understand (Weible 2007). Given this inherent complexity and the public's tendency to seek only minimal amounts of information about any new issue (Fiske and Taylor 1991), intermediaries such as media are critical sources of public information related to these types of controversies (Lee 2004). This study analyzes media coverage of three natural resource management-related controversies in Florida: a 1994 net fishing ban, an ongoing controversy over reef fish management, and climate change.

Mass media serve as more than a simple information provider. Decades of research have shown that the amount and type of media coverage an issue receives can influence public perception of the issue (Bryant and Oliver 2009). Three separate, but related, media effects that have been studied are the agenda-setting, priming, and framing effects (Scheufele and Tewksbury 2007). Agenda-setting occurs when the amount of media coverage an issue receives influences the importance of that issue in the public's mind (McCombs and Shaw 1972). Media "priming" occurs when "news content suggests to news audiences that they ought to use specific issues as benchmarks for evaluating the performance of leaders and governments" (Scheufele and Tewksbury 2007:11).

Framing, the framework of this study, is an aspect of media coverage that can influence the audience's attitudes toward an issue. A frame is a "central organizing idea for the news content that supplies a context and suggests what the issue is through the

use of selection, emphasis, exclusion, and elaboration" (Tankard 2001: 100–101). Journalists' selection of frames is influenced by many factors, including news values such as conflict, timeliness, or novelty, socially salient themes, the presence of recognizable personalities (Price and Tewksbury 1997), and organizational pressures (Gans 1979). The frames chosen can serve one of several implicit functions: defining causes, diagnosing causes, making moral judgments, or suggesting remedies (Entman 1993).

Framing is related to agenda-setting in that frames can either explicitly or implicitly suggest causality or responsibility for the events described in the article (Maher 2001). The implied causality can alter the manner in which the audience perceives an issue (McCombs and Estrada 1997). These "framing effects" can influence how an audience defines and judges problems and actors while changing audience perception of potential solutions to the problems (Entman 1993). While framing theory is still developing (for a review, see Tewksbury and Scheufele 2009) there have been numerous studies analyzing how different issues have been framed.

Frame analysis is a way to study the potential influence of media coverage on an audience. Researchers analyzing the use of frames can reveal patterns of news coverage, compare the way issues are covered, and, in cases of controversial issues, determine if any particular stakeholder group or viewpoint dominates media coverage of the controversy (Miller and Riechert 2001; Siemer et al. 2007).

Media as an Information Source for Environmental Issues

Environmental and natural resources issues tend to be unobtrusive (Eyal et al. 1981). An unobtrusive issue is one in which individuals have "little personal contact and for which they rely on media as the primary, and sometimes, only source of information"

(Ader 1995: 300). The public often relies on mass media for information on unobtrusive issues, which may strengthen media effects associated with them (Zucker 1978; Atwater et al. 1985; Lee 2004). Understanding how unobtrusive issues are framed and the influence of that framing on public perception, therefore, may be particularly important.

For example, media coverage has been an important source of information about climate change (Wilson 1995; Nisbet 2009). However, the role of media coverage of climate change has been controversial, as studies have shown that coverage may be influenced by politics (Carvalho 2007; Dirikx & Gelders 2010; Dotson et al. 2012). Additionally, journalistic norms such as balance (i.e., presenting both sides of an issue) and news values such as relevance, controversy, or proximity may cause media to give undue weight to climate skepticism even as the scientific evidence for anthropomorphic climate change grows (Boykoff 2007). The potential effects of this coverage are great, because media act as critical validators of science, especially in cases of controversy (Gamson 1999).

Frame analysis of mass media coverage of the environment, fish and wildlife, and natural resources issues is a burgeoning field. In wildlife-related issues, many recent studies have concentrated on the media's effect on risk and risk perceptions related to human-wildlife conflict, often focusing on a single species or several closely related species. These studies have found that media coverage can contribute to public knowledge about and perceptions of a number of species, including cougars (Wolch et al. 1997; Jacobson et al. 2012), black bears (Corbett 1992; Gore et al. 2005; Siemer et al. 2007), and cormorants (Muter et al. 2009), among others.

These prior studies of both environmental and wildlife issues typically have focused on risks or frames that are specific to the individual being studied. Such a focus is informative in aggregate. However, there are also cross-issue, “generic” frames inherent in nearly every news story (De Vreese 2005). Generic frames have been variously defined depending on the focus of a given study. For example, strategic framing, which is news framing that focuses the mechanics of winning and losing political battles, has been found to be a consistent feature of political and policymaking news (Cappella and Jamieson 1997). While strategic framing isn’t generic to *all* news coverage, it is generic to these broad issues. Other generic frames are generic to most, if not all, news coverage. One proposed list of generic frames includes conflict, economic consequences, human interest, morality, and attribution of responsibility (Semetko and Valkenburg 2000; De Vreese 2005). Studying the use of generic frames across issues may enable researchers to compare media coverage more easily, potentially enabling theory development and complementing studies of issue-specific framing. Additionally, understanding how generic frames are related to the use of a science frame could inform the issue and background d research that is an essential part of developing an education or communication campaign (Jacobson 2009).

Media as Battleground for Claims-Makers

Given the power of media and the fact that journalists often must rely on outside sources for information, claims-makers, defined as “individuals or groups making assertions or grievances and claims with respect to some putative conditions” (Spector and Kitsuse 1977: 75, quoted in Trumbo 1996), are often an important aspect of news coverage of an issue. Claims-making in media stories often takes the form of direct quotations from sources (Trumbo 1996); the sources who are selected are considered

successful claims-makers. Successful claims-making can promote a certain problem definition for a given issue, potentially altering the operating environment for risk communication campaigns (Gore and Knuth 2009).

Government sources, including scientists, often play a critical role in media coverage of wildlife. Corbett (1992) studied wildlife stories in Minnesota and found that a significant majority of the sources cited were bureaucratic (government employees, scientists, or educators). While Corbett's sample focused on wildlife news generally, rather than specific controversies, it included stories about wildlife-related controversies. Jacobson et al. (2012) found a similar reliance on government sources, including scientists, in media coverage of Florida panther.

The use of sources may change over time or with the tenor of the coverage. Trumbo (1996) studied the use of sources in national newspaper coverage of climate change and found that the relative number of scientists quoted decreased as the issue became more politicized. Wolch et al. (1997) implied, though did not measure, a similar phenomenon in coverage of mountain lions in the *Los Angeles Times*, finding that as coverage of mountain lions grew increasingly negative, stakeholders on both sides of the cougar management controversy used the opportunity to promote their viewpoint through claims-making in news stories. Though Wolch et al. did not report specific numbers, their findings indicate a potential mechanism by which scientists decrease as a source of quotes: as more groups compete for attention, journalists may try to incorporate more points of view, subsequently reducing the attention paid to scientists.

Research Questions and Hypothesis

This study analyzes the use of generic frames and science frames in three coastal resource management controversies to see if there are common themes among them.

Additionally, this study is interested in the use of scientists as sources in media coverage of the controversies, as the prevalence of scientists as claims-makers might influence future decisions about science and risk communication in controversial systems. Based on the research reviewed above, this study asks the following research question and tests the following hypothesis:

- RQ1: How were the three controversies framed in terms of science frames and generic frames?
- RQ2: To what extent are scientists used as sources and does the prevalence of scientist sources vary by frame?
- H1: Scientists will be a minority of total sources quoted in each of the three controversies.

About the Coastal Resource Management Controversies

The three controversies were chosen for their relatively extensive media coverage, their statewide relevance, and their representativeness of the different types of coastal natural resource controversies.

There is a consistent tension between recreational and commercial fishers in Florida's fishery management (Martin 1997; Smith 2006). The tension has manifested itself in several large controversies over the years. The first controversy of interest in this study is the 1994 voter referendum to amend the Florida constitution to ban the use of gill nets and other entanglement nets in Florida waters. While putatively about saving mullet populations (*Mugil spp.*) from overfishing and reducing bycatch of other fishes, including popular sportfish such as spotted sea trout (*Cynoscian nebulosus*), there was little scientific evidence that an action as drastic as banning nets was necessary to accomplish these goals. However, net ban proponents were able to rally citizens under the call to "Save Our Sealife", reframing the issue from a resource allocation problem

into an environmental problem. As a result, the net ban passed with 74% of the vote. In the time since the net ban, mullet populations have rebounded slightly while many former mullet fishers were put out of work (Adams et al. 2000).

Reef fishery management, particularly in the grouper and snapper fisheries, is a current management controversy in Florida. Red grouper and red snapper are heavily fished by both recreational and commercial fishers, and the populations may be severely overfished (Coleman et al. 2004). However, the population dynamics of grouper and snapper are extraordinarily complex, and often under fire from both recreational and commercial fishers. The technical difficulty of determining population size, a management scheme with different rules in federal and state waters, and attitude and value differences between commercial and recreational fishers have led to a management controversy, threatening both the fishery and the legitimacy of the management regime (Smith 2006; Cowan et al. 2010).

The third coastal controversy of interest is climate change. Climate change is a significant global risk that may be particularly devastating to coastal areas due to the effects of sea-level rise and increased storm activity. Climate change is likely to cause increased flooding, erosion, and changes in salinity levels (IPCC 2007), potentially amplifying other coastal stresses such was water pollution and overuse of resources, as well (Tobey et al. 2010).

Methods

Content analysis is a “research technique for the objective, systematic, and quantitative description of the manifest content of communication” (Berelson 1952: 147). This study used content analysis to characterize the frames used in newspaper

coverage of the net ban amendment, the reef fish management controversy, and the controversy surrounding climate change.

Sample

A different sample of at least two years was selected for each controversy. The samples were chosen to balance efficiency with thoroughness while capturing a high-leverage, salient time for each controversy. For the net ban, the sample consisted of a census of net-ban-related news items and features published between March 1, 1992 (roughly when the public movement to ban the nets began) and November 8, 1994 (the date of the vote) in four newspapers: the *Miami Herald* (average 2012 Monday–Friday circulation: 160,988; this and other circulation figures from the Audit Bureau of Circulations 2012), *Orlando Sentinel* (173,576), *St. Petersburg Times* (since renamed the *Tampa Bay Times*, 299,497), and *Tampa Tribune* (144,510). The sample was found by searching for the terms “net ban” or “gill net” in the Access World News and Factiva electronic databases. Articles that were not related to the net ban controversy were eliminated from the sample.

The reef fish management sample consisted of a census of news items and features published between June 1, 2004 and December 31, 2010 in five newspapers: the *Florida Times Union* (average 2012 daily circulation: 98,580), the *Miami Herald*, the *Orlando Sentinel*, the *Sarasota Herald Tribune* (79,845), and the *St. Petersburg Times*. The beginning date for this sample was selected to coincide with the introduction of Reef Fish Amendment 22, establishing a rebuilding plan for red snapper. The end date for this sample was chosen because it approximated the present date when the sample was chosen and coincided with the passage of new, more restrictive snapper regulations in mid-2010. Articles were found by searching for either “grouper” or

“snapper” in the appropriate electronic databases. Articles that were not related to management of the reef fish populations were eliminated from the sample.

For climate change, a “constructed weeks” sample was taken. A constructed week is a sample in which all of the relevant articles are taken from one randomly selected Sunday, one randomly selected Monday, one randomly selected Tuesday, etc., per year. Prior research suggested that two constructed weeks per year can be sufficient to represent a newspaper’s overall content (Lacey et al., 2001). However, since this project was concerned with a specific issue, a larger sample of 10 constructed weeks per year was selected for each year from 2006 to 2008 from the same five newspapers as the reef management sample. Ten weeks per year is approximately 20% of the issues in any given year. 2006 was selected because it was the year in which *An Inconvenient Truth* was released in the United States, spurring public interest in climate change (Boykoff 2007), and 2008 was selected as end date because it coincided with the end of a US Presidential election, which may have precipitated additional climate coverage. Articles were selected by searching for the terms “climate change” or “global warming” in the appropriate databases as described above.

Letters, editorials, and opinion pieces were not sampled for any of the three controversies because the goal was to characterize the frames that a reader might find in putatively neutral coverage.

Each individual article was coded as a distinct coding unit. Articles from all three controversies were coded for the presence or absence of two issue-specific frames, science and scientific uncertainty, and four generic frames, as identified and operationalized by Semetko and Valkenburg (2000). The science and scientific

uncertainty frames were operationalized based on a pilot study of related articles from different newspapers. The frames were operationalized as follows:

Science: A science frame was present if the article mentioned science or scientific studies as a way of explaining a phenomenon.

Scientific uncertainty: A scientific uncertainty frame was present if the article described the science related to an issue as uncertain, wrong, incomplete, or invalid.

Conflict: A conflict frame was present if the article reflected disagreement between parties, individuals, or groups, or if one individual or group reproached another, or if opposing sides of a problem or issue were referred to.

Economic consequences: An economic consequences frame was present if the article mentioned costs associated with a course of action, the (positive or negative) economic consequences of pursuing a course of action, or financial gains or losses.

Human interest: A human interest frame was present if the story provided a human example or placed a human face on an issue, employed adjectives or personal vignettes that generate feelings of outrage, caring, empathy, or compassion, or focused on the private or personal lives of the actors.

Morality: A morality frame was present if the story contained an overt moral message, referred specifically to morality, God, or other religious tenets, or offered specific social prescriptions about how to behave.

A fifth frame, attribution of responsibility, was dropped from the analysis for insufficient inter-coder reliability.

Additionally, the number of sources quoted was recorded for each article. Sources were classified as either lay, science, interest group, or government. Government workers identified as scientists were classified as scientists.

The articles were coded by the author in two readings. During the first reading, the author acquired a general sense of the article's content and tone while coding basic descriptive information about the article (author, article type, word count, and newspaper). The second reading was used to identify the frames used. A subsample of 15% of the articles (rounded to the nearest article) was coded by a second coder for the purpose of establishing intercoder reliability. Following Krippendorff (2004) and Siemer et al. (2007), Scott's Pi (Scott 1955) was used to calculate intercoder reliability and variables with a Pi under 0.7 were dropped from the analysis.

Statistical analyses were performed with SPSS version 20. Results were considered statistically significant at a=0.05. Intercoder reliability was good-to-excellent for all variables, with Scott's Pi ranging from 0.75 to 0.92.

Data Analysis

Each frame was scored as present or absent in each article. A binomial test was used to determine if frames were more or less likely to be present than expected by random chance (i.e., 50% chance of being present, 50% chance of being absent) for each controversy. Cochran's Q, a nonparametric test that compares multiple treatments with binary outcomes (Conover 1998), was used to determine which frames were most likely to appear by controversy, or were most "dominant".

A discriminant function analysis was performed to determine if the presence of the frames could be used to predict which controversy a story covered. The discriminant function analysis was validated using a leave-one-out cross validation and assessed

using the proportional chance criterion, which assumes a random classification of articles to groups based on groups' proportion in the sample (Sanchez 1974). All articles were included in the analysis.

The association between the science frame and other frames was assessed using the phi coefficient, which measures the degree of association between two binary variables and is interpreted similarly to the Pearson correlation coefficient. Associations between the number of scientists and the frames, stratified by issue, were measured using a point-biserial correlations.

Results

Sample

The final sample consisted of 441 articles: 89 about the net ban, 108 about the reef fishery, and 244 about climate change.

Framing

The presence and absence data for the frames varied by controversy (Table 3-1). The conflict frame was present in significantly more than 50% of articles about the net ban and reef fishery; the economic frame was present in significantly more than 50% of articles about the reef fishery and significantly less than 50% of articles about climate change. The human interest frame was present significantly less than 50% of the time in all three controversies; the science frame was present significantly less than 50% of the time in net ban and climate change articles. Morality was present in significantly fewer than 50% of articles about all three controversies; scientific uncertainty was present in significantly fewer than 50% of articles about the net ban and climate change.

The dominant frames differed somewhat by controversy (Table 3-2). For all three controversies, the conflict frame was the most dominant frame. The conflict frame was

in its own Q-group in the net ban and fishery articles, and grouped with (i.e., was similarly dominant as) the economic frame, human interest frame, and science frame in climate change coverage. For the net ban, the least dominant frames were science, morality, and uncertainty. For the reef fishery, the morality frame was least dominant. For climate change, the morality and uncertainty frames were least dominant.

Differentiating Controversies

Two discriminant functions were calculated, both of which were statistically significant (Table 3-3). The first discriminant dimension was strongly positively weighted by the uncertainty frame, slightly positively weighted by the science, conflict, economic, and morality frames, and negatively weighted by the human interest frame. The canonical correlation for dimension one was 0.44 (chi-sq=168.53, 12 df, $p<0.001$). The second discriminant dimension was strongly positively weighted by the conflict frame, positively weighted by the human interest frame, and negatively weighted by the uncertainty, morality, science, and economic frames. The canonical correlation for dimension two was 0.39 (chi-sq=73.05, 5 df, $p<0.001$).

These results indicate that the first dimension reflected a scientific uncertainty/lack-of-uncertainty axis and the second dimension represented a conflict/lack-of-conflict. The group centroids for functions (1,2) were (–0.14, 0.84) for the net ban, (0.86, –0.11) for the reef fishery, and (–0.33, –0.26) for climate change.

The discriminant functions correctly classified 63.7% of the original cases. A leave-one-out cross-validation correctly classified 61.0% of the cases, indicating a good fit. Classifying the articles based on the discriminant functions results in a 56.5% improvement over randomly assigning articles to groups using the proportional chance criterion, which would expect to classify 40.7% of articles correctly.

Frames Associated with the Science Frame

The analysis revealed few significant associations between the science frame and other frames (Table 3-4). There were no significant associations between the science frame and any other frames in net ban coverage. In reef fishery coverage, there was a weak positive association between the science frame and the uncertainty, conflict, and economic frames. In coverage of climate change, there was a weak negative association between the science frame and the economic, conflict, and morality frames.

Use of Scientists as Sources

Scientists made up a minority of sources quoted. A total of 31 science sources were quoted in articles related to the net ban, averaging 0.35 sources per article. This compares to 163 non-scientists quoted, an average of 1.83 per article. The reef fishery had similar results: a total of 39 science sources were quoted, averaging 0.36 per article, compared to 177 non-scientist sources, averaging 1.64 per article. In coverage of climate change, a total of 192 science sources were quoted, an average of 0.79 per article, compared to 340 non-scientist sources, an average of 1.39 per article. These results support Hypothesis 1, that scientists would be a minority of quoted sources.

There were few correlations between the number of scientists quoted and the various frames (Table 3-5). The science frame was significantly positively correlated with number of scientists quoted in all three controversies. Scientific uncertainty was significantly positively correlated with the number of scientists quoted the net band and reef fishery, but not climate change. There were no other patterns of significant correlations between scientists quoted and frame across controversies.

Discussion

Mass media framing of can have a strong influence on public understanding of unobtrusive issues such as coastal resource management controversies (Atwater et al. 1985; Lee 2004). The use of different sources can influence public perception as well, as successful claims-makers can help define how the public understands a problem and influence the operating environment for communications campaigns (Gore and Knuth 2009). This study characterized the generic and science frame use three controversies and found that, while there was considerable variation in framing among the controversies, there were also common themes. Additionally, this study found that scientists were rarely used as sources compared to other types of claims-makers. The implications of the findings are discussed below.

Science and Generic Framing

The first research question asked how the controversies were framed in terms of science frames and generic frames. The results showed that the most common frames in all three controversies were conflict and economic consequences. The prevalence of these frames suggests that, across issues, journalists found conflict and economics to be either the most newsworthy or most important aspects of the controversies. The science frame was comparatively uncommon, appearing in significantly fewer than half of the articles about climate change and the net ban and approximately half of the reef fishery articles. The relative scarcity of science framing indicates that either science was not perceived as newsworthy, important, or interesting as other aspects of the controversies. However, the fact that the science frame, and to a lesser extent the scientific uncertainty frame, was consistently used in each controversy suggests that they might be generic frames for coverage of natural resource management

controversies, just as strategic framing is generic to political news coverage (Cappella and Jamieson 1997).

Despite a large overlap in the use of frames, the overall framing was different for each controversy. For example, while conflict was the dominant frame in all three controversies, the relative frequency of the conflict frame varied. The conflict frame appeared in nearly every story about the net ban compared to less than half of the stories about climate change. In fact, the gap between the prevalence of the conflict frame and the next most common frame (which was economic consequences in all three controversies) differed greatly among the controversies, as well. Media coverage of the net ban was much more dominated by the conflict frame than was coverage of either the reef fishery or climate change. The other frames were similarly unevenly used in the different controversies.

The differences among controversies are also reflected in the multiple comparison measures, which showed that climate change coverage was framed much more widely than the other controversies. There was no significant difference in the prevalence of the top four frames in climate change, and there were only 3 Q groups with an average of 2.67 members in each group. This contrasts the findings for both the net ban and reef fishery controversies, which each had 4 Q groups and averaged 1.5 members per group. In other words, climate change had a much greater “framing diversity”, giving equal weight to more frames, than did the coverage of the other controversies.

Turning to the use of the science frame, there was no consistent association between the science frame and the other frames across controversies. For example, the science frame was highly significantly correlated with economic consequences in both

the reef fishery and climate change controversies, but insignificantly correlated with the economic consequences frame in the net ban. The lack of consistent associations suggests that the use of the science frame might be story or issue-specific rather than predictable across issues.

The 63.7% article classification success rate in the discriminant function analysis indicates that the two axes, interpreted as scientific uncertainty and conflict, were good-but-imperfect separators of the controversies. The differing coverage of the controversies may be because of intrinsic differences between them or may simply be a function of the issue attention cycle, as described by Trumbo (1996). Trumbo found that, as climate change matured as an issue, media coverage of it changed, too. Each of the three controversies had different time horizons (several years for the net ban, several decades for climate change, and in between for the reef fishery), and differences in where they were in the maturation cycle may explain some of the differences in the way they were covered.

The fisheries issues' scores on the discriminant functions reflected the popular understanding of the controversies. The net ban had relatively high levels of the conflict function compared to the other controversies and was relatively neutral on the scientific uncertainty function. This finding fits the narrative of the net ban (Martin 1997; Adams et al. 2000) that despite being a fisheries management controversy, science and management was overwhelmed in the public discourse by conflict. Similarly, the reef fishery scored higher in the scientific uncertainty function than did the other conflicts. This finding confirms the popular narrative of the reef fishery controversy, in which the quality and use of science has come under repeated public criticism (Tomalin 2005).

Coverage of climate change scored slightly negatively for each function, indicating a relative lack of conflict and scientific uncertainty. This finding is initially surprising, given that climate change is a controversial political issue. However, Boykoff (2007) noted that the use of false balance, defined as the giving of undue coverage to a minority position like climate skepticism, has declined in climate change coverage in recent years as the scientific consensus has strengthened. These results affirm Boykoff's finding. Additionally, the fact that this analysis left out opinion pieces and editorials probably lessened the prevalence of climate uncertainty.

The advantage of analyzing media use of generic frames is in the potential for theory building (De Vreese 2005). These findings suggest that the two axes of the discriminant function analysis, conflict vs. lack of conflict and scientific uncertainty vs. lack of uncertainty, may be a starting point for building theories about coverage of natural resource controversies. There is reason to believe that the two axes might be informative in other controversies. For example, conflict has been shown to be an important part of media coverage in several prior studies, such as Muter et al.'s (2009) cormorant study and Wolch et al.'s (1997) study of mountain lions. However, since the presence of a generic conflict frame was not specifically discussed in those studies, and scientific uncertainty did not appear to be a significant part of the controversies, this classification scheme must be deemed preliminary and in need of further study.

Science Frame and Scientists as Sources

The second research question asked about the extent to which scientists were used as sources and how the prevalence of scientist sources varied by frame. This study found that scientists were the minority of sources quoted, as predicted by Hypothesis 1. This finding contrasts those of Corbett (1992) and Jacobson et al. (2012),

who reported that scientist and government sources were the most frequently quoted sources in their systems. The discrepancy is likely explained a prior study that showed that politicized or controversial issues tend to quote scientists less often than other types of sources (Trumbo 1996). The difference between “scientist” and “scientist and government” sources may have contributed to the difference, as well, though it’s notable that in this study, there were very few government sources quoted who weren’t also scientists.

A potential causal mechanism for the relative lack of scientist quotes in controversial issues is that highly controversial or politicized issues are more likely to attract claims-makers on multiple sides of the issue, giving journalists a larger pool of sources competing for attention. This idea is supported by Wolch et al.’s (1997) finding that, as mountain lions became more controversial, more claims-makers arose, attempting to use mountain lions as a lever to make larger political points.

Other than the science frame, there was no consistent association between frames use and the number of scientists quoted. This finding suggests that, across controversies, scientists are only quoted incidentally with other frames and it may be difficult for scientists to get quoted among the increased competition among claims-makers.

Practical Implications

These findings illustrate how difficult it is for outreach and communication personnel to use mass media as a method for communicating with stakeholders. The lack of consistent framing across issues means that science communicators might not be able to find “hooks” that work for all issues. For example, an issue that is primarily covered in terms of conflict might require different communication than an issue

primarily covered in terms of economics. The relative scarcity of science framing and scientists quoted means that the public might perceive the science related to an issue as less important than other aspects of the issue. Science may be diluted by other coverage, especially as issues become controversial and other potential claims-makers compete for attention. The findings underscore the importance of carefully planning media campaigns to maximize the few opportunities for science coverage in controversial issues while simultaneously looking outside of the media for additional chances to interact with stakeholders (Fazio et al. 2001; Jacobson 2009).

Future Studies

As a first attempt to use generic frames to analyze coverage, this study raises more questions than it answers. Most notably, the frames in this study need to be analyzed across more controversies to see what patterns emerge. The discriminant function analysis needs to be repeated, as well, to see if the classification scheme holds. Finding a consistent, straightforward way to classify controversies might be extremely useful for outreach and communication, allowing communicators to better target their outreach.

It's not clear from this study how much science coverage is "enough" science coverage. Does the audience receive the appropriate information if the science frame is used a minority of the time? This is a question that could be answered via experimental or survey work, and the answer could greatly inform communication strategy. If the amount of science coverage were inadequate for agency or outreach goals, then agencies or institutions interested in outreach would need to attempt to find other ways of reaching the public.

Finally, the diversity of frame use across controversy merits further investigation. Diversity of generic frame use could be measured across additional controversies, perhaps using indices from the ecological literature such as the Shannon-Weaver index. It's possible that framing diversity affects reader comprehension of or attitudes toward an issue. Regardless of whether these extensions prove fruitful, this study underscores De Vreese's (2005) point about the suitability of generic frames for theory-building.

Limitations

There are several limitations to this study. The first is that the conclusions, while theoretically and statistically sound, are based on studying three controversies in one state. It's possible that idiosyncratic aspects about these specific controversies, or about Florida, generally, might limit the generalizability of the findings. Additionally, issues change over time, and this study only analyzes a snapshot of the coverage of the reef fishery and climate change. Coverage of these issues may change, too, and the framing with it. Finally, the media analyzed, news stories published in newspapers, are only a part of the total media coverage of the issues. Other media influence public perceptions as well and may have been framed differently.

Table 3-1. Percent present and absent frames by controversy.

Frame	Controversy	Present (%)	Absent (%)
Conflict	Net Ban	91.0	9.0[c]
	Reef Fishery	74.1	25.9[c]
	Climate Change	46.7	53.3
Economic Consequences	Net Ban	56.2	43.8
	Reef Fishery	59.3	40.7[a]
	Climate Change	44.3	55.7[a]
Human Interest	Net Ban	40.4	59.6[a]
	Reef Fishery	33.3	66.7[c]
	Climate Change	32.8	67.2[c]
Science	Net Ban	27.0	73.0[c]
	Reef Fishery	52.8	47.2
	Climate Change	39.3	60.7[c]
Morality	Net Ban	14.6	85.4[c]
	Reef Fishery	19.4	80.6[c]
	Climate Change	18.0	82.0[c]
Scientific Uncertainty	Net Ban	14.6	85.4[c]
	Reef Fishery	49.1	50.9
	Climate Change	8.2	91.8[c]

Note: Superscripts indicate significant presence or absence beyond a binomial 50% random chance (a=p<0.05, b=p<0.01, c=p<0.001). Net ban N=89, reef fishery n=108, climate change n=244.

Table 3-2. Frames in Cochran's Q groups by relative dominance for each controversy.

Controversy	Frame	Group(s)
Net Ban	Conflict	A
	Economic Consequences	B
	Human Interest	C
	Science	D
	Morality	D
	Scientific Uncertainty	D
Reef Fishery	Conflict	A
	Economic Consequences	B
	Human Interest	C
	Science	B
	Morality	D
	Scientific Uncertainty	B
Climate Change	Conflict	A
	Economic Consequences	A
	Human Interest	A, B
	Science	A
	Morality	B, C
	Scientific Uncertainty	C

Note: A-grouped frames are more prevalent than B-grouped frames, etc.

Table 3-3. Standardized dimension coefficients for the discriminant function analysis.

Frame	Dimension 1	Dimension 2
Conflict	0.08	1.08
Scientific Uncertainty	0.95	-0.33
Human Interest	-0.27	0.22
Morality	0.04	-0.29
Economic Consequences	0.07	-0.23
Science	0.12	-0.26

Table 3-4. Association between the science frames and other frames, as measured by the phi coefficient, stratified by controversy.

Frame	Net Ban	Reef Fishery	Climate Change
Scientific Uncertainty	0.11	0.48[c]	0.04
Conflict	0.19	0.37[c]	-0.20[b]
Economic Consequences	0.08	0.35[c]	-0.31[c]
Human Interest	0.02	0.12	0.08
Morality	-0.11	0.23[a]	-0.20[b]

Note: Superscripts indicate statistical significance: a=p<0.05, b=p<0.01, c=p<0.001.

Table 3-5. Point-biserial correlation between the number of scientists quoted and frame presence, stratified by controversy.

Frame	Net Ban	Reef Fishery	Climate Change
Conflict	0.05	0.19[a]	–0.20[b]
Economic Consequences	0.02	0.13	–0.23[c]
Human Interest	0.15	0.17	–0.11
Morality	0.25[b]	0.10	–0.24[c]
Scientific Uncertainty	0.30[a]	0.19[a]	0.03
Science	0.35[c]	0.31[c]	0.77[c]

Note: Superscripts indicate statistical significance: a=p<0.05, b=p<0.01, c=p<0.001.

CHAPTER 4
CLIMATE CHANGE AND COASTAL ENVIRONMENTAL RISK PERCEPTIONS

Climate Risk Perceptions

Climate change will likely have a dramatic and disproportionate effect on coastal regions, exacerbating existing coastal environmental risks, including flooding, shoreline erosion, and habitat change, among other effects (IPCC 2007). Despite the potential impact of climate change and related environmental risks, climate outreach and communication has been ineffective (Wolf and Moser 2011). Risk perceptions are an important influence of the political context of policymaking (Slovic 1999; Leiserowitz 2006); understanding risk perceptions can be a key part of improving risk communication (Slovic 1987; Keller et al. 2006). However, our knowledge of climate-related risk perception is still developing and there is substantial work to be done to clarify public perception of climate change risks.

Surveys have shown that about 55% of Americans say they are "somewhat" or "very" worried about climate change and about 45% say they are "not very" or "not at all" worried (Leiserowitz et al. 2010). Climate change risk perceptions in the United States are influenced by a lack of accurate climate knowledge (Leiserowitz et al. 2010; Wolf and Moser 2011). However, climate change knowledge is negatively associated with perceived responsibility for climate change, perhaps because more informed people recognize the political will and collective action required to alter the course of climate change (Kellstedt et al. 2008).

Part of the reason for the relative lack of climate concern is that climate-related risks are perceived as affecting people who are temporally or geographically distant from the present-day United States (Leiserowitz 2005). Long-term threats to distant

people are often under-valued compared to more immediate and salient threats (Stern 1992; CRED 2009). These factors conspire to minimize the perceived threat from climate change, which may partially explain why climate change is not a primary concern to many people in the United States.

However, climate change is not necessarily a specific risk itself as much as a driver and catalyst of other risks. These effects may be particularly noted in coastal communities, where climate change may exacerbate sea-level rise, heavy precipitation events (IPCC SREX 2012), marine fishery declines (Cheung et al. 2009), water pollution, and habitat loss (Tobey 2010). Specific coastal environmental risks may be more salient to coastal residents than general climate change risks, even if the environmental risks are climate-related (Carlton and Jacobson, unpublished data). Thus, understanding coastal environmental risk perceptions and what drives those perceptions offers important insight to risk communicators about specific coastal risks while also helping to clarify influences on general climate change risk perceptions.

This study uses survey research to analyze perception of coastal environmental risks that are likely to be directly affected or exacerbated by climate change in Florida. The study is based on a conceptual model of risk perception (Figure 1) developed from prior research into the determinants of environmental risk perception, described below.

Determinants of Risk Perception

Early research on risk perception largely focused on rational-choice models of risk, which presumed that individuals considered risks in an analytical manner, mentally calculating the odds and desirability of different risk outcomes and using those calculations as the basis for their risk perception (Lowenstein et al. 2001; Slovic et al. 2001; Leiserowitz 2006). Rational-choice models imply that people make judgments

about risks using their brain's analytic processing system, the logical, deliberative system that encodes information in terms of words, numbers, and symbols (Epstein 1994; Lowenstein et al. 2001; Leiserowitz 2006). However, there is ample evidence that the rational-choice model does not explain people's risk perceptions particularly well (Slovic et al. 2002). For example, studies that analyze risk perception from a purely cognitive, rational standpoint often find that laypeople have little understanding of the drivers, probabilities, and consequences required to rationally assess a specific risk. This is especially notable in "mental models" studies of risk perceptions (e.g., Bostrom et al. 1994; Read et al. 1994; Carlton and Jacobson unpublished data), which often reveal incomplete or inaccurate layperson understanding of risk.

Instead of analytical, rational processing of risk, laypeople often process risks using their experiential processing system, which is affective and holistic and tends to encode information in terms of metaphors, stories, and images. Experiential processing is typically non-rational, leading to emotion-, value-, and affect-driven decisions and attitudes (Epstein 1994; Lowenstein et al. 2001; Slovic et al. 2001). In other words, laypeople are often reactive when perceiving risks. As a result, experts and laypeople tend to think of risks in entirely different manners, which may be a significant factor in the relative ineffectiveness of many risk communications, particularly about complex topics such as climate change (Moser and Dilling 2011).

Practically speaking, laypeople's experiential risk processing means that risk perception generally, and environmental risk perception specifically, is primarily a function of the characteristics of the individuals perceiving the risks and only secondarily a function of the characteristics of the risks themselves (Sjöberg 2000; Skimak and

Dietz 2006). Additionally, the risk-specific factors that influence risk perception, such as the voluntariness of the risk, the public's familiarity with the risk, perception of risk control, and the morality of the risk, tend to do so by influencing the public's sense of "outrage" over a risk rather than a dry calculation of the probabilities and consequences of a risk (Sandman 1987).

While the precise drivers of risk perception may vary by system, there are several personal characteristics that often have been found to be important components of risk perception.

Social trust: One primary influence of environmental risk perception appears to be social trust. In this context, social trust is a measure of the trust that an individual has in government agencies to manage a risk (Siegrist et al. 2000). Individuals with higher levels of social trust often perceive less risk than do individuals with lower levels of social trust. For example, trust was a primary factor in public risk perception of a hypothetical Superfund waste site (Bord and O'Connor 1992). Similarly, social trust was an important factor in risk perceptions associated with the proposed nuclear waste repository in Yucca Mountain (Flynn et al. 1992). The effects of social trust on risk perception go beyond waste issues: social trust has also been shown to affect risk perceptions of pesticides, nuclear power, artificial sweetener (Siegrist et al. 2000), and prescribed burning (Vaske et al. 2007). While social trust has been found to be a significant component of risk perception in many studies, the finding is not unanimous: Sjöberg (1998) found that social trust was not a significant factor in nuclear waste risk perception in Sweden.

These prior studies of social trust and risk perceptions have been in systems with a direct, obvious connection between the risk and the government agency responsible for managing the risk. Since climate change is such a broad risk likely to have effects on diverse parts of the environment and economy (IPCC 2007), climate-related coastal environmental risks do not necessarily have such a clear-cut connection. For example, it might not be obvious to laypeople which agency at which level of government is responsible for managing problems associated with drought or other, broad impacts.

Environmental attitudes: People's environmental attitudes have been shown to affect their environmental risk perceptions. The New Ecological Paradigm (NEP; Dunlap et al. 2000) scale and its predecessor, the New Environmental Paradigm (Dunlap et al. 1978) have become the most commonly used measures of environmental attitudes (Hawcroft and Milfont 2010). The NEP has been used in models of environmental values (Stern and Dietz 1994), models of environmental behavior (Stern et al. 1995), and in contingent valuation studies (Kotchen and Reiling 2000, Cooper et al. 2004). Several studies have shown that higher levels of environmental concern as rated by the NEP are associated with greater risk perceptions across a variety of ecological risks (Slimak and Dietz 2006), including climate change (Kellstedt et al. 2008).

However, there is some controversy over what the NEP actually measures. The paper announcing the revised NEP suggested that the scale might measure five facets of an ecological worldview and that care should be exercised in treating the NEP as a single variable (Dunlap et al. 2000). Some studies have treated the NEP as a unidimensional scale of environmental concern (e.g., Cooper et al. 2004; Slimak and Dietz 2006; Kellstedt et al. 2008). Other studies have explicitly analyzed the

dimensionality of the NEP (through factor analysis, structural equation modeling, and similar techniques) with inconsistent results (e.g., Shephard et al. 2009; Amburgey and Thoman 2012; Wu 2012).

Risk salience: Another set of factors that can influence environmental risk perceptions can be loosely termed risk salience. Generally, risk salience is made up of two components: relevant prior experience and proximity to the risk.

Relevant prior experience can directly influence risk perceptions. This was the case with the Chernobyl disaster, which increased the perceived risk of nuclear technology in Sweden, with the most-affected people perceiving the greatest risk from nuclear power (Drottz-Sjoberg and Sjoberg 1990). In another study, experience with air pollution affected individual's climate change risk perception, though experience with flood did not (Whitmarsh 2008), a discrepancy that may be in part due to differing environmental values. There is evidence that hurricanes may trigger climate risk perceptions, such as the increase in climate concern after hurricane Katrina in 2005 (Boykoff). Prior experience may influence risk perceptions because of the availability heuristic: people who have suffered from an environmental disaster may be more likely to recall that event when considering related environmental risks, increasing their risk perceptions (Keller et al. 2006).

Similarly, actual or perceived (Giordano et al. 2011) proximity to a potential risk has been shown to affect risk perception, though this finding is not universal. Closeness to potential terrorist targets was associated with risk perceptions in a study in Michigan (Woods et al. 2008). However, closeness to a major 1998 wildfire event in Florida did not change beliefs about prescribed burning (Jacobson et al. 2001). Sometimes the

effects of proximity to an event differ by demographic group. For example, a November, 2001 national survey found that living within 100 miles of the World Trade Center (site of the September, 2001 terrorist attacks) increased terror risk perceptions, but only in a few demographic groups: men, adults, whites, and Republicans (Fischoff et al. 2003). The effects of proximity on risk perception may be influenced by perceived benefits associated with the risk: those living closest to chemical manufacturing facilities in Houston perceived less risk from and had greater support for the chemical production industry, possibly because of the perceived economic benefits from the industry (Heath et al. 1998). Similarly, those living in the counties closest to the proposed Yucca Mountain repository perceived less risk from the site than those who lived farther away (Kunreuther et al. 1990), although that difference may have been explained by demographic patterns.

Demographic factors: Researchers have found several potential demographic influences of environmental risk perception. Of specific interest to this study of undergraduate students are political affiliation and gender. Political affiliation may amplify or attenuate risk perceptions depending on the system being studied (Slovic 1999; Leiserowitz 2006 offers a specific environmental example). In addition, gender is an important component of risk: dozens of studies (`reviewed in Slovic 1999) have shown that females tend to perceive risks as greater than males do.

Research Questions

This study analyzes coastal environmental risk perceptions among Florida undergraduate students to address the following research questions:

- RQ1: How do Florida college students perceive climate-change-related coastal risks?

- RQ2: What factors influence perceptions of risk?

Methods

In this study, risk perceptions were assessed and were used as a dependent variable in a regression analysis with several independent variables in a model (Figure 4-1) derived from the general model described above: social trust, environmental attitudes, familiarity with relevant keystone events, proximity to the coast, political affiliation, and gender. The survey population consisted of 762 undergraduate students in two large, introductory classes at the University of Florida. The operationalization, measurement, and analysis of the variables is described below.

Risk Perceptions

Respondents were asked to rate their level of concern about 17 coastal environmental risks (Table 4-1). The risks were selected based on a model generated by Florida Sea Grant and a series of in-depth key informant interviews with policymakers and technical staff in the coastal community of Crystal River, Florida (Carlton and Jacobson, unpublished data; Jacobson et al. 2012). Two of the risks (sea-level rise and coastal erosion) were chosen because of their general applicability to Florida. The remainder were among the most commonly mentioned during the interviews.

Respondents rated the risk items using the most-least rating method, a technique that has been found to be an efficient way of avoiding end-piling when rating lists of items (McCarty and Shrum 2000). Specifically, respondents were first presented with the list of risks that they would be asked to rate and were asked to choose which of the items is of most concern to them and which item is of least concern to them. Respondents were then asked to rate each of the items on a 10-point scale, with 1

meaning "not at all concerned" and 10 meaning "strongly concerned". A principal component analysis with varimax rotation was performed on the risk questions to reduce the variables into interpretable components. Factor scores were obtained using the regression method and were retained for use in later analyses. Retaining factor scores is superior to simply averaging the variables for each factor because factor scores optimally weight the observed variables for analysis (Stevens 1986).

Social Trust

Social trust was measured using several questions based on those developed by Vaske and Bright (2007). The questions were designed to assess respondents' trust of "Florida government officials" to effectively manage coastal environmental risks. Respondents were asked "I trust Florida government officials to: (1) effectively manage coastal environmental risks, (2) provide the best available information on coastal environmental risks, (3) provide me with enough information to decide what actions I should take regarding coastal environmental risks, (4) provide me with truthful information about coastal environmental risks, (5) provide me with timely information about coastal environmental risks". Responses were given on a 5-point Likert scale as above. As an additional indicator of social trust, respondents were asked "taking everything into consideration, how would you grade Florida government officials for handling coastal environmental risks?" Responses were given as a grade ranging from A to F.

Environmental Attitudes

The 15-question New Ecological Paradigm scale (Dunlap et al. 2000) was used measure environmental attitudes. In accordance with Dunlop et al.'s suggestions, a

principal components analysis was performed to assess the dimensionality of the scale before use in the regression model.

Risk Salience

The 2004 hurricane season, in which 4 different hurricanes (Charlie, Frances, Ivan, and Jeanne) made landfall in Florida, was used as a key prior coastal environmental risk event. Respondents were asked whether they lived in Florida during the 2004 hurricane season and the extent to which they were affected by the 2004 hurricanes, measured on a 1–10 scale from “not at all affected” to “extremely negatively affected.” Respondents who were not Florida residents in 2004 were assigned a score of 1. To assess general proximity to the coast, respondents were asked how far their permanent residence was from the coast: 1 mile or closer, 2–5 miles, 6–10 miles, 11–25 miles, or 26+ miles.

Demographic Variables

Respondents were asked to identify their political affiliation on a 7-point scale from "Strong Democrat" to "Strong Republican", with "Independent" as the middle value. Respondents also were asked their gender and age, though age was omitted from the analysis because the vast majority (94.3%) of respondents were between the ages of 18 and 22 years old.

Survey Administration and Data Analysis

Prior to administration, a pilot test was performed to refine the instrument. Twenty-three University of Florida undergraduates of similar demographics to the target population and 6 adults took the survey during the pilot test. Their feedback was incorporated prior to administrating the survey, causing us to revise the wording on the social trust questions and several of the risk perception questions.

The survey was administered electronically via SurveyMonkey to 762 students in two general education undergraduate classes at the University of Florida. Respondents were given electronic pre-notification and several in-class reminders about the survey.

Results

Response Rate

A total of 558 completed surveys were received for a 73.2% response rate. A nonresponse check showed that the gender ratio of respondents was similar to the gender ratio of nonrespondents. Additionally, the gender ratio and political affiliations were similar between the two classes surveyed. As a result, no post-hoc weighting was applied.

Risk Perceptions

The average score for the risk items was 6.75 on a scale of 1–10. Respondents were most concerned (i.e., a score of over 7 on a 1-10 scale) about drinking water loss (M=7.81, SD=2.20), beach loss (M=7.40, SD=2.03), property damage from hurricanes (M=7.34, SD=2.17), water contamination from septic tanks (M=7.31, SD=2.08), increasing drought (M=7.21, SD=2.04), and climate change (M=7.13, SD=2.20). Respondents were least concerned (i.e., a score of less than 6 on a 1-10 scale) about land plant loss (M=5.91, SD=2.20), aquatic plant loss (M=5.77, SD=2.26), invasive plants (M=5.54, SD=2.34), and tourism declines (M=5.36, SD=2.54) (Table 4-1).

For the risk data, three principal components explaining 65.29% of the variance were retained based on evaluation of a scree plot. The components were interpreted as physical environment risks (M=7.17, SD=1.79), economic risks (M=6.66, SD=1.55), and biological risks (M=5.98, SD=1.88). All three components had acceptable internal consistency (Table 4-1). Three variables loaded highly on two or more components and

were therefore dropped from the analysis (Stevens 1986): septic tank contamination, storm surge, and coastal erosion.

Social trust

The social trust indicators had high internal consistency (alpha = 0.81), and were averaged into a social trust index. The average social trust index score was 3.09 (SD = 0.78) out of 5, representing a moderate level of trust in Florida government officials to manage coastal risks.

Environmental Attitudes

The 15-item New Ecological Paradigm (NEP) scale had strong internal consistency (alpha = 0.80). The average NEP score was 3.44 on a 5-point scale, indicating mild-to-moderate pro-environmental attitudes among respondents. To address the concerns about dimensionality, a principal components analysis was performed. Thirteen of the 15 components loaded highly (≥0.40) on the first unrotated factor, so in keeping with Dunlap et al.'s (2000) suggestion, the NEP was treated as a unidimensional scale.

Demographics

The majority of respondents (58.6%) were female. The average respondent was slightly Republican, rating themselves 3.98 (SD=1.62) on the 7-point political affiliation scale. Most (93%) respondents have lived in Florida for at least the last 5 years.

Regression Model

Each of the retained risk factor components (physical environment risks, economic risks, and biological risks) was used as a dependent variable in a separate multiple regression analysis (Table 4-2). The independent variables included social trust, the New Ecological Paradigm (NEP) scale, the extent to which respondents were affected

by the 2004 hurricanes, the distance of respondents' permanent residence from the coast, respondents' political affiliation, and respondents' gender. All three regression models were significant at the $p<0.001$ level, and visual inspection of residual plots suggested a normal residual variance structure.

The NEP score was the biggest predictor of physical risk perception ($B=0.57$, $p<0.001$), with respondents expressing greater environmental concern also perceiving greater risk. Gender also was a significant predictor of physical risk perception ($B=0.20$, $p<0.05$), with females perceiving greater risk than males. Political affiliation significantly predicted physical risk perception ($B=–0.13$, $p<0.001$), with more Democrat-leaning respondents perceiving greater risk.

Gender was the largest predictor of economic risk perception ($B=0.26$, $p<0.05$), with females again perceiving greater risk than males. NEP score was also a significant predictor ($B=–0.20$, $p<0.05$), with people who expressed less ecological concern perceiving greater economic risk. Political affiliation also predicted economic risk perception ($B=0.12$, $p<0.001$), with more Republican respondents perceiving greater economic risk.

NEP score was the only significant predictor of biological risk perception ($B=0.37$, $p<0.001$): those who had greater environmental concern perceived greater risk.

Discussion

Individuals' cognitive and affective characteristics often influence their environmental risk perceptions as much as or more than the characteristics of the risks themselves (Slimak and Dietz 2006). This study analyzed risk perceptions in undergraduates at the University of Florida and found that, though many proposed cognitive and affective variables did not influence risk perceptions, people's

environmental risk perceptions were strongly influenced by attitudinal factors such as environmental attitudes and political affiliation.

Risk Perceptions

The first research question identified specific risk perceptions. In general, respondents were concerned about all 17 risks: each item's average rating was above the midpoint on the concern scale. This may in part result from the potential for a survey priming effect. Practically, many of the highest concerns—half of those rated above 7 on the 10-point scale—were related to drinking water: drinking water loss, water contamination, and drought. The public concern for water quality and quantity is unsurprising in a coastal state like Florida.

There are apparent similarities among some of the most highly rated risks. Both the water risks and property damage from hurricanes, which together are 4 of the 6 hazards that rated over 7, might be considered more immediate, personal threats to the respondents, especially compared to the items of least concern, including tourism declines, spread of invasive species, and aquatic and terrestrial plant population declines. This difference is also found in the general categories of risk identified by the factor analysis: respondents were more concerned about risks related to the physical environment and property than they were risks to the local flora and fauna. The ordering of concern for the different risk categories, and roughly the individual risk items, reflects prior research that individuals perceive salient, local, and more immediate risks of more concern than risks that are less personal (Stern 1992; CRED 2009).

However, the connection between risk immediacy and risk perception was uneven. Climate change, generally considered by Americans to be a long-term risk that will affect others (CRED 2009), was the sixth-highest rated risk, averaging 7.12 on the 10-

point scale. This finding reflects prior nationwide surveys in which most Americans indicate they are “somewhat” or “very” concerned about climate change (Leiserowitz 2010).

Practically, the risk perception results illustrate specific concerns of Florida residents, suggesting “hot” areas in which climate communicators might focus their efforts in an attempt to achieve better results. Focusing a climate change message to the physical environment or water supply risks, for example, might improve message salience for coastal residents, helping to improve ineffective climate-related outreach (Wolf and Moser 2011).

Influences on Risk Perception

The second research question was concerned with which factors influence risk perception. The regression analysis revealed that risk perceptions were most influenced by respondents’ environmental attitudes as measured by the New Ecological Paradigm, their gender, and their political affiliation.

Environmental attitudes: Environmental attitudes were, in aggregate, the largest determinant of risk perception. Pro-environmental attitudes (i.e., higher NEP scores) were positively associated with greater physical and biological risk perception, and negatively associated with greater economic risk perception. These findings affirm prior research showing that environmental risk perception is related to environmental attitudes (Slimak and Dietz 2006; Kellstedt et al. 2008). Additionally, these findings go beyond prior research by showing that specific environmental risk perceptions, in addition to concerns about general risks like global warming, are influenced by environmental attitudes.

The fact that the categories of risk were differently influenced by environmental attitudes illustrates the wide-ranging effects of climate change. Even those who are not environmentally concerned (i.e., have a low NEP score) showed concern about some climate-related hazards. These findings suggest an opportunity for climate outreach and personnel to find common ground with those who might not heed a climate change message and provide a starting point for the background and audience research that's a critical part of any communication campaign (Jacobson 2009).

Political affiliation: Political affiliation was an important driver of risk perception for both physical environmental risks, where more Democrat-leaning respondents perceived greater risks, and economic risks, where more Republican-leaning respondents perceived greater risks. Prior research has shown that Republican-leaning individuals tend to perceive climate risks as lower (Leiserowitz 2005). These findings add nuance by showing that while Republican affiliation is negatively associated with the risks of climate change to the physical environment, Republican affiliation is associated with greater concern for property- and economy-related risks of climate change. The challenge for risk managers is to either make the connection between the different risks and climate change or find adaptive or mitigative strategies that appeal to these concerns.

Social trust: Social trust was not a significant predictor of risk perception in any of the risk categories. This lack of predictive power is this model contrasts with prior research about the influence of social trust on risk perceptions related to a variety of risks, including nuclear waste repositories (Flynn et al. 1992); Superfund waste sites (Bord and O’Connor 1992); pesticides, nuclear power, and artificial sweeteners (Siegrist

et al. 2000); and prescribed burning (Vaske et al. 2008). While prior research has shown that students may already have developed social trust (Sjöberg 1998), the process of social trust formation requires further examination, which may help clarify these results.

Other studies also have found that social trust is not a factor in risk perception (Sjoberg 1998). Siegrist et al. offer a potential explanation for the discrepancy: “the explanation power of trust depends on how it is operationalized. An unspecified measure of social trust (e.g., general social trust in government in all situations) might well explain much less variance” (Siegrist et al. 2000: 259). This study, after pilot testing, referred to specific definitions of trust (i.e., government management of coastal risks, government provision of information about coastal risks, etc.) and a relatively general definition of government (“Florida government officials”). This illustrates a difficulty in relating social trust to climate-risk perception. Climate-related risks differ from risks related to, for example, prescribed burning or artificial sweeteners in that climate-related risks are inherently multifactorial and are not clearly the responsibility of any particular local or federal government agency. Given this fact, it is possible that no specific operationalization of social trust would explain the variance in risk perception across the diversity of climate-related risks.

Risk salience: Neither prior experience with hurricanes nor distance of residence from the coast were significant predictors of risk perception in any of the three categories. The lack of predictive power for respondents’ experience with risks, in this case the 2004 hurricanes, contrasts with some previous work (e.g., nuclear power studied by Drottz-Sjöberg and Sjöberg 1990; air pollution studied Whitmarsh 2008), but

not all (e.g., flood experience studied Whitmarsh 2008). There are several possible explanations for this discrepancy. One is that the 2004 hurricanes are not an appropriate prior event, either because hurricanes are such a concern throughout Florida that even those who were not affected by the 2004 hurricanes are still worried about hurricanes generally, reducing the predictive power of the 2004 events. Similarly, enough time may have passed that the 2004 hurricanes are no longer cognitively "available" (Keller et al. 2006) to trigger climate-related risk perceptions. Finally, climate change encompasses many types of risk, so hurricanes might not cause an availability heuristic effect beyond hurricane-related risks.

The irrelevance of proximity as a determinant of risk perception is somewhat surprising given that several recent studies found proximity to be important (Woods et al. 2008; Giordano et al. 2011). One potential explanation is that the coast may be similarly salient for residents throughout the state of Florida, given the state's famed beaches and ocean destinations. A similar study of coastal environmental risk perceptions in a state with less coastline might yield different results.

This study built on prior, general studies of climate risk perception by analyzing perceptions of specific, climate-related coastal environmental risks. It is one of the first papers to look at specific climate-related risks rather than taking a more general approach. The findings showed that climate-related coastal environmental risks are diverse, and may be difficult to analyze as a monolithic unit. Categorizing the risks, in this case physical environmental risks, economic risks, and biological risks, allowed for a more nuanced analysis and understanding of the various drivers of risk perception. By

focusing on the most salient categories, in this case physical environmental risks, risk managers might design more effective communications.

Factors such as environmental attitudes or political affiliation were significant predictors of risk perception, supporting the notion that people tend to perceive risk experientially rather than analytically. The fact that people often do not consider risks analytically is important information for risk communicators as it serves as a reminder that simply providing accurate information about risks is not enough (Wolf and Moser 2011).

Limitations

There are several limitations to the study. First, the respondents were college students, so these findings may not generalize to the population as a whole. Second, although the identified risks are believed to be generally applicable to many Florida communities, the risks might be irrelevant or confusing to some of the respondents, affecting their responses.

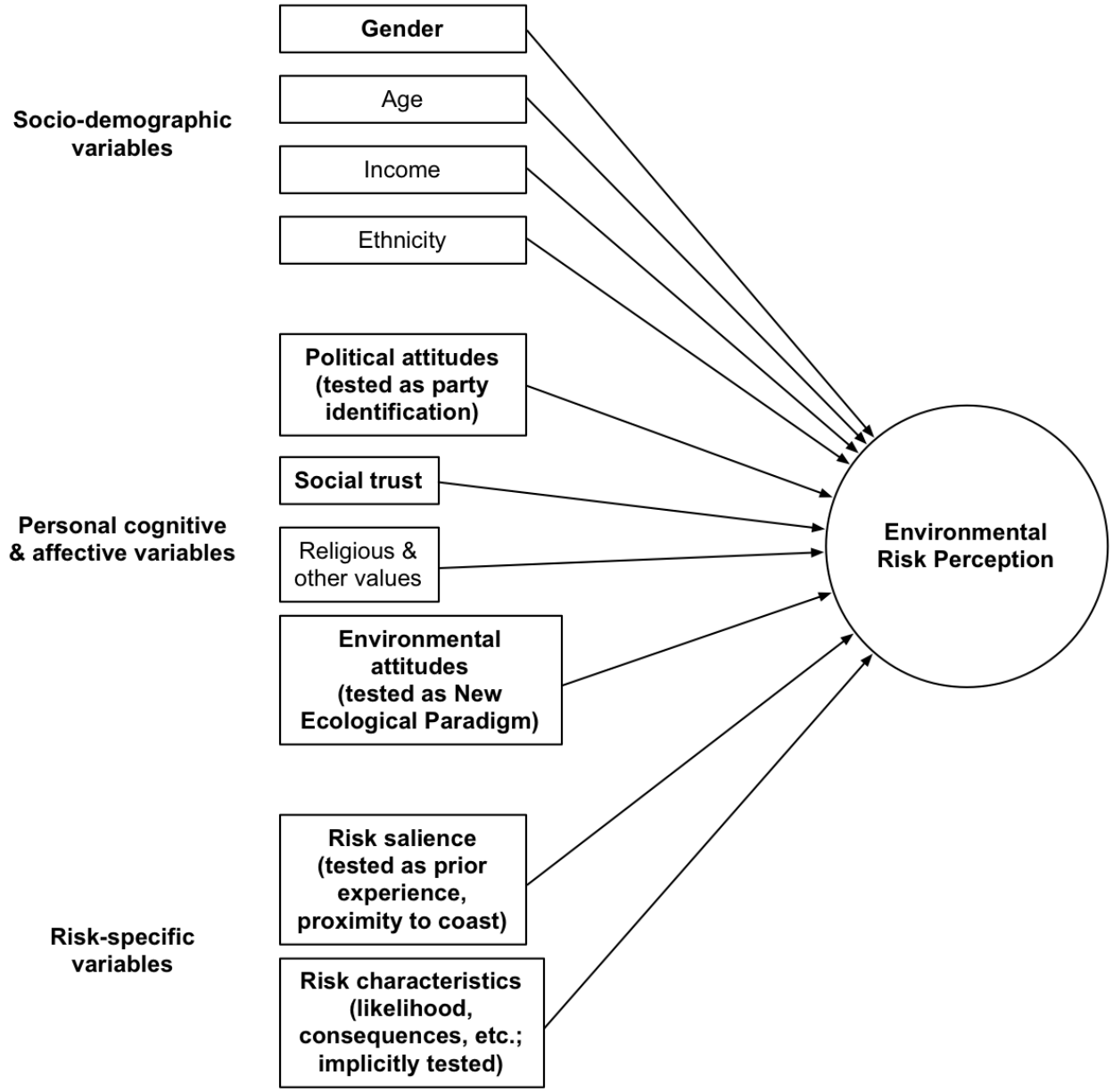

Figure 4-1. Conceptual model of coastal environmental risk perception. Items in **bold** were tested in the regression analysis.

Table 4-1. Risk items divided into scales based on a principal components analysis.

Risk item	Mean	SD	Factor loading
Physical environment risks	*7.17*	*1.79*	*0.89*
Drinking water loss	7.81	2.20	0.78
Drought	7.21	2.03	0.82
Climate change	7.12	2.20	0.87
Extreme temperatures	6.92	2.12	0.83
Sea-level rise	6.83	2.17	0.74
Economic risks	*6.66*	*1.55*	*0.71*
Beach loss	7.41	2.02	0.48
Property damage from hurricanes	7.34	2.17	0.57
Property insurance increases	6.72	2.16	0.85
Property value declines	6.48	2.30	0.88
Tourism declines	5.36	2.54	0.50
Biological risks	*5.98*	*1.88*	*0.86*
Fish population declines	6.72	2.11	0.65
Land plant population declines	5.91	2.20	0.91
Aquatic plant population declines	5.77	2.26	0.92
Spread of invasive plant species	5.54	2.34	0.75
Risks dropped from analysis			
Contamination from septic tanks	7.31	2.08	
Storm surge	6.98	2.05	
Coastal erosion	6.76	1.99	

Table 4-2. Multiple regression models by risk category with risk perception as the dependent variable.

Independent variable	Model 1: Physical environment risk	Model 2: Economic risk	Model 3: Biological risk
Social Trust	0.06	0.12	–0.1
New Ecological Paradigm	0.57[c]	–0.20[a]	0.37[c]
2004 Hurricane effects	0.03	0.01	–0.01
Proximity	0.01	–0.04	–0.06
Political affiliation	–0.13[c]	0.12[c]	0.04
Gender (dcv)	0.20[a]	0.26[a]	–0.074
Adjusted r2	0.22	0.20	0.21
N	491	491	491

Note: Superscripts indicate statistical significance: a=p<0.05, c=p<0.001.

CHAPTER 5
CONCLUSION

The three studies in this dissertation took different approaches to understanding how the public receives, processes, and perceives information about controversial coastal environmental and natural resource issues. The findings expand on prior practical and theoretical work and suggest ways to improve outreach, communication, and policymaking on these difficult issues.

The mental models study built on prior mental models work and found that there were substantial differences in the way that experts and nonexperts perceived climate change-related hazards. The results also showed that there are a number of less controversial, climate-related topics that climate outreach, communication, and policymaking personnel can focus on to achieve their goals while avoiding some of the public climate change controversy. This difference is critical to consider in the development of outreach, communication, and policy.

The content analysis used generic and science frame analysis to reveal that newspaper coverage of coastal natural resource management controversies, which is a critical source of public knowledge about the controversial topics, focuses largely on conflict and economics at the expense of scientific knowledge. This finding illustrates the difficulty in using mass media for outreach and communication, as the message might be diluted by other concerns. Additionally, education, outreach, and communication personnel need to carefully analyze each issue to tailor their programs appropriately, because media coverage may vary drastically by issue.

Finally, the coastal risks survey built on prior, general studies of climate risk perception by analyzing perceptions of specific, climate-related coastal environmental

risks. The findings showed that climate-related coastal environmental risks are diverse, and may be difficult to analyze as a monolithic unit. Categorizing the risks as physical environmental risks, economic risks, and biological risks, allowed for a more nuanced analysis and understanding of the various drivers of risk perception. Survey respondents were primarily concerned about risks to the physical environment, especially the water supply, followed by risks to the economy and risks to the biological components of the environment. The findings also revealed that factors such as environmental attitudes or political affiliation were significant predictors of risk perception, supporting the notion that people tend to perceive risk experientially rather than analytically. The fact that people often do not consider risks analytically is important information for risk communicators as it serves as a reminder that simply providing accurate information about risks is insufficient for changing behavior.

Together, these three studies illustrate the challenge of expert-nonexpert communication. Experts and nonexperts think about issues differently, often use different communication channels, and evaluate risks differently. As coastal environmental issues become more pressing, the ability to successfully overcome these difficulties becomes more important. The work in this dissertation is a significant theoretical and practical step in that process.

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BIOGRAPHICAL SKETCH

J. Stuart Carlton was born and raised in New Orleans, Louisiana, where he graduated with a B.A. in English from Tulane University in 2001. He earned an M.S. in Fisheries Biology from the University of Georgia in 2004. After receiving his M.S., Stuart worked as a marine biologist for the Florida Fish and Wildlife Conservation Commission and a science teacher for Fitzgerald Middle School in Largo, Florida. He entered the Interdisciplinary Ecology Ph.D. program at the University of Florida in 2007. Upon completion of his Ph.D., he will pursue a career in academics. Stuart has been married to his wife, Libby, since 2010, and they recently had a daughter, Harper, who has been Stuart's companion for much of the dissertation writing process.