Spatially Integrating Stakeholder Preferences for Wildlife Conservation and Ecosystem Services with Expert Opinions Using Public Participation Geographic Information Systems

by

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

Auburn, Alabama
May 5, 2013

Keywords: participatory, spatial, wildlife, ecosystem services

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Abstract

Due to changing trends in natural resource management, there is an increasing need to incorporate stakeholder opinions and preferences into the decision making process. Since much natural resource data is stored spatially in GIS databases, it is beneficial to capture this stakeholder information in the same format for overlay and analysis with scientific data, allowing the best informed decisions to be made. For this purpose, Public Participation Geographic Information Systems (PPGIS) was developed to spatially capture publicly identified places of importance and import them into a GIS database. However, there are still significant gaps in the PPGIS literature that need to be addressed to make this tool more useful for management purposes. This paper addresses some of these holes, demonstrating how PPGIS can be applied to wildlife management and conservation, for which PPGIS has not previously been used, and how the accuracy of PPGIS-identified places of ecosystem service provision can be identified and used to inform management decisions.

Acknowledgements

I would like to express my gratitude for the help and guidance provided by my major professor, Wayde Morse, and committee members, Luke Marzen and Christopher Anderson. I would also like to thank the United States Forest Service and the Mobile Bay National Estuary Program for generously providing the funding for this research. Additionally, I would like to thank my family and friends for their support throughout this process.

Table of Contents

List of Tables

List of Figures

List of Figures (continued)

Chapter 1: Introduction and Methods

Abstract

Changing philosophies and practices in natural resource management have led to the need to develop a more participatory approach to planning, incorporating stakeholder opinions and preferences into the decision making process. Additionally, much of the scientific data that is used in conjunction with these social data for decision making is stored spatially in GIS databases. Thus, it is beneficial to capture stakeholder opinions and preferences in the same format for efficient comparison. Public Participation Geographic Information Systems (PPGIS) was developed as a tool to allow participants to identify places of importance and management preferences on a map. PPGIS results can then be imported into a GIS database for spatial analysis. Despite the growing body of PPGIS literature, significant gaps remain. Further research needs to be conducted to demonstrate the applicability of this tool for the management of non-cultural services, such as wildlife and regulating ecosystem services. This thesis demonstrates how PPGIS can be used to inform wildlife management to aid in threatened species conservation, an application for which PPGIS has not previously been used. Additionally, this thesis lays out a method for testing the scientific accuracy of PPGIS results to determine how useful this stakeholder input is for management efforts in the domains of wildlife management and ecosystem service protection.

Introduction

In recent decades in the United States, a major shift in natural resource management philosophy has occurred, as members of the general public have voiced their discontent with traditional, expert-driven approaches to management (Smith & McDonough, 2001; Morse, 2012). Instead, stakeholders have called for collaborative practices in natural resource decision making, allowing them to participate in the planning process rather than simply being informed about current management strategies developed by a team of scientific experts. Consequently, there has been a corresponding shift within the field of natural resource management to move away from this expert-based approach and develop more participatory methods for resource management by including stakeholders and their opinions in the decision making process (Riley et al., 2002). This shift in philosophy has created the need for research on how best to incorporate these stakeholder preferences into the resource management process, necessitating the inclusion of social science methods in research on natural resource management. Fueling this trend is the fact that previous research has demonstrated that facilitating stakeholder participation in the decision making process often decreases conflict between stakeholders and managers, while also increasing public support for management efforts as a result of stakeholder empowerment and enhanced trust in management, as well as greater general public issue awareness (Treves et al., 2006; Schusler et al., 2003). All of these outcomes help to make the natural resource decision making process, as well as the implementation of those decisions, more efficient (Morse, 2012). Therefore, it has become important for resource managers to elicit stakeholder participation in the decision making process and incorporate their often diverse, and even conflicting, preferences into management plans (Riley et al., 2003).

However, since natural resource management focuses on overseeing discrete objects and features that are unevenly distributed across the landscape, there is an inherent need to incorporate a spatial aspect into this research (Swetnam et al., 2011). Since extensive spatial data are routinely collected on natural features and stored in Geographic Information Systems (GIS) databases, it is beneficial to capture and store stakeholder preferences in the same format to allow for easy overlay and analysis (Bengston et al., 2004; Theobald et al., 2005). This information also can play a critical role in reducing tensions involving natural resources, which often stem from conflicting stakeholder place meanings as much as from disputes over resource use (Cheng et al., 2003). Thus, spatial data on stakeholder landscape values and management preferences are crucial for identifying and mitigating those conflicts over natural resource use.

In order to introduce a spatial component into research on incorporating stakeholder preferences into natural resource management, researchers developed a tool called Public Participation Geographic Information Systems (PPGIS) in 1996 (Sieber, 2006). PPGIS was designed as a method to supplement the expert-driven practice of utilizing GIS data to inform natural resource management by allowing stakeholders to identify their personal management preferences, values, and opinions about places in a region on a map (Sieber, 2006). Since PPGIS allows participants to identify specific places in a landscape, it can account for the fact that participants can have different management preferences for different locations, unlike traditional survey methods, which often only capture general, non-spatially linked participant values and preferences (Brown, 2005). Additionally, PPGIS gives participants a greater role in the spatial identification of their preferences by allowing them to identify these preferences directly on a map.

While the focus of all PPGIS studies is allowing stakeholders to spatially identify their management preferences, opinions, and landscape values, researchers have experimented with different methods for best capturing this information. Following the example of Brown (2005), most PPGIS studies (e.g. Raymond et al., 2009; Nielsen-Pincus, 2011) have used points as the means for participants to identify places on the map. However, some PPGIS studies (e.g. Brown & Pullar, 2012; Lowery & Morse, in press) have asked participants to draw polygons on maps to identify places. There are tradeoffs to using each method. While fewer polygons are required to obtain significant results, it is cumbersome to use polygons in large general public surveys, for both the participants drawing on the map and for the researchers interpreting these drawn results (Brown & Pullar, 2012). Furthermore, researchers have also experimented with methods for conducting PPGIS surveys. PPGIS surveys have been implemented in personal settings, such as one on one interviews (Talen, 2000; Raymond et al., 2009) and focus groups (Lowery & Morse, in press), and using more widespread distribution methods, such as mail surveys (Brown, 2005; Nielsen-Pincus, 2011) and internet surveys (Brown et al., 2011; Pocewicz et al., 2012). Mail-based surveys are usually considered to be the most efficient strategy for capturing PPGIS data from a large sample of stakeholders, since they require much less time investment per response than interviews (Brown, 2005), but also report much higher response rates, and more places identified per response, than internet-based surveys (Pocewicz et al., 2012). Regardless of the method used to collect PPGIS data, the information is always stored in a GIS database, which provides the researcher with a multitude of avenues for spatial analysis on these data.

Despite their relatively recent development, PPGIS techniques have been incorporated into studies focusing on a diverse collection of disciplines, including city planning (Talen, 2000), landscape values (Brown et al., 2004; Brown, 2005; Beverly et al., 2008; Brown & Reed, 2009;

Zhu et al., 2010; Nielsen-Pincus, 2011; Sherrouse et al., 2011), sense of place (Brown & Raymond, 2007), ecosystem services (Raymond et al., 2009; Bryan et al., 2010; Brown et al., 2011), national park planning (Brown & Reed, 2009), recreation management (McIntyre et al., 2008), development preferences (Brown & Raymond, 2007), identification of natural and human induced threats to the environment (Raymond & Brown, 2011; Brown & Weber, 2011), and local knowledge about natural features (Alessa et al., 2008; Brown, 2012). PPGIS studies have been conducted worldwide, although they have been particularly concentrated in the United States and Australia, and in landscapes as different as urban neighborhoods in Dallas, TX (Talen, 2000) and Alaskan wilderness in the Prince William Sound region (Brown et al., 2004).

Wildlife

Nevertheless, there are still significant gaps in the PPGIS literature. Previous research has not examined how PPGIS methods can be used to incorporate stakeholder preferences into wildlife management. Therefore, PPGIS offers a new avenue for incorporating participatory planning into wildlife management, for which there is a distinct need. Due to the demands of stakeholders, there is increasing pressure on wildlife management to introduce more participatory planning strategies (Riley et al., 2002), thus opening the door for research into the human dimensions of wildlife management (Manfredo et al., 1998). Much research in this field has focused on understanding stakeholder values and opinions about wildlife (Manfredo, 2008), but there is a distinct need to incorporate a spatial component into this research, since much of the scientific data used to inform management decisions is stored spatially in GIS databases (Bengston et al., 2004; Theobald et al., 2005). Thus, it would be beneficial to store social data and preferences in the same way, allowing for easy overlay and analysis (Morse et al., 2009).

Previous studies have introduced a spatial element into research on the human dimensions of wildlife management by identifying the locations of human-wildlife conflicts to determine the locations of conflict hotspots and analyze whether stakeholder attitudes towards these species are significantly different in high conflict zones (Krester et al., 2009; Lowery et al., 2012). Furthermore, Hunter et al. (2003) used spatial data to determine where places with high biodiversity are threatened by residential development. Morzillo et al. (2007) attempted to introduce a spatial component into this field by surveying residents in several neighborhoods and then determining whether certain preferences for black bear recovery strategies clustered in specific geographic locations or neighborhoods by linking participants' responses with their home addresses. However, despite the contributions to the literature made by each of these studies, there are still significant gaps that need to be addressed to further aid research on the human dimensions of wildlife management through the incorporation of spatial data.

Particularly, it would benefit wildlife managers to not only know who values wildlife, but where they think this wildlife should be conserved. A study showing what places stakeholders think are important for wildlife conservation would provide managers with a wealth of information. This technique would allow managers to target specific places for conservation efforts, not simply satisfy groups of conservation-minded people. Additionally, a study allowing participants to identify where they think conservation efforts should be focused accounts for the fact that many participants may demonstrate both positive and negative attitudes towards conservation based upon the location of the efforts, a complexity that is often lost in traditional survey methods (Riley et al., 2002). Therefore, it would be beneficial for wildlife management to develop a tool that can spatially capture the values, preferences, and opinions of stakeholders about places pertaining to wildlife in a local region, which would allow participants to demonstrate different feelings for the same categories across the landscape, thus retaining this psychological complexity. The information gathered by such a study would help managers highlight areas of strong stakeholder support for wildlife conservation efforts, as well as areas of potential resource use conflict (Nielsen-Pincus, 2011).

Despite its great potential to benefit wildlife management, applications for introducing PPGIS into this field are lacking in the literature. While Brown and various collaborators have included a category for biological value (Brown & Reed, 2000), which they define as “areas valued because they provide places for a variety of plants, animals, and wildlife,” this category does little to inform management or conservation efforts for specific species due to its breadth and vagueness (Alessa et al., 2008, p. 28). Brown et al. (2004) noted this shortcoming, conceding that they were not able to ascertain “the specific biological features or attributes the respondents were mapping” when using the biological value category (p. 176). In an effort to refine the biological value category, Brown et al. (2004) replaced it with an item asking participants to identify places of biological diversity value. While this new category offers more specific insights for management purposes, it still presents a rather incomplete picture for managers. The data acquired from this category only highlight places that people think are important because they provide a variety of species (Brown et al., 2004). While biodiversity is a significant component of wildlife management and conservation, more information is needed to make the results applicable for wildlife management. For example, only assessing biodiversity does not tell managers which species participants think inhabit that area, or whether the majority of those species are plants or animals. Additionally, focusing solely on biodiversity would omit places that provide critical habitat for an endangered species and have high public support for conservation as a result, but have low overall biological diversity and could lead conservation efforts to focus on areas that provide habitat for a large number of common species instead. Therefore, in this study we asked participants to identify places that should be maintained as habitat for four charismatic local threatened and endangered species to demonstrate that PPGIS can be used as an effective tool for the management and conservation of particular species of wildlife.

To demonstrate the usefulness of PPGIS for wildlife management, we designed this study to facilitate the identification of important places for the conservation of specific threatened species by randomly selected stakeholders. For this purpose, we chose four locally threatened species or groups of species: Florida black bears (*Ursus americanus floridanus*), wading birds, West Indian manatees (*Trichechus manatus*), and sea turtles. We then used biological data to determine whether the general public participants could accurately identify suitable habitat for wildlife conservation, thus demonstrating that their contributions are meaningful for participatory planning efforts. We also used this study to determine how additional stakeholder preferences can be used to inform management by identifying the overlap of places where the public would like future development to be prohibited with places where they would like to see conservation, which should lead to additional support for conservation efforts. Similarly, we identified places where the public thinks future development is permissible with places where they think conservation efforts should be focused to identify potential conflict zones.

Ecosystem Services

There is also a need for additional PPGIS research to supplement studies on ecosystem services. Ecosystem services refer to any benefits provided by an ecosystem to humans, which are commonly grouped into four categories: cultural services, provisioning services, regulating services, and supporting services (Millennium Ecosystem Assessment, 2005). Cultural services are considered to be those benefits that humans derive from ecosystems that are not material in nature. These services include cultural, religious and spiritual, aesthetic, and educational benefits (Landell-Mills & Porras, 2002). Provisioning services are those that produce materials that humans can use for their benefit, such as food, fuel, and fresh water. Regulating services are those provided from the management of ecosystem functions, including water quality regulation, pollination, and carbon sequestration (Millennium Ecosystem Assessment, 2005). Supporting services do not benefit humans as directly, but are critical natural processes required for the other ecosystem services to be produced, such as nutrient cycling (Millennium Ecosystem Assessment, 2005). Much of the previous literature dealing with stakeholder identification and valuation of ecosystem services has taken an economic focus, developing formulas for quantifying the monetary value of the services provided or investigating the willingness to pay for particular services by consumers or stakeholders (e.g. Costanza et al., 1989; Daily et al., 2011). However, there is a need to develop alternate research techniques to quantify stakeholder valuation of ecosystem services in non-monetary terms since many ecosystem services, such as biodiversity, are difficult to quantify monetarily (Bryan et al., 2010; Kumar & Kumar, 2008). Since ecosystem services are provided by different places to different extents throughout the landscape (Hein et al., 2006; Swetnam et al., 2011; Maes et al., 2012), PPGIS has been introduced as a useful tool for incorporating a spatial element into research on stakeholder valuation of ecosystem services (Raymond et al., 2009). This tool is useful in natural resource management since it allows managers to identify places that stakeholders think are important for ecosystem service provisioning and focus conservation efforts on those places with the most public support, while also being able to assess stakeholder knowledge gaps about places of ecosystem service provisioning and focus outreach efforts on those topics (Swetnam et al., 2011; Don Carlos et al., 2009; Sherrouse et al., 2011).

A few previous PPGIS studies have focused on having participants identify places that provide ecosystem services (Raymond et al., 2009; Bryan et al., 2010; Brown et al., 2011). However, despite this previous research, critical gaps in the PPGIS literature on ecosystem services remain unaddressed. Importantly, previous studies have not definitively shown that general public stakeholders can spatially conceptualize ecosystem services and identify places that provide them on a map. In the study conducted by Raymond et al. (2009) and Bryan et al. (2010), PPGIS information was collected via one on one interviews with 56 stakeholders who were selected to participate in the study because they "were perceived to shape opinions and actions regarding the management of natural resources in the region" (Raymond et al., 2009, p. 1304). Thus, the participants in this study were likely more knowledgeable about natural resources and ecosystem services than the average member of the general public. Furthermore, the interview setting of this study allowed for a more qualitative approach, since participants "were asked to locate and describe places of value and threat," allowing participants to only choose to identify the services they found most important or were most comfortable locating (Raymond et al., 2009, p. 1305). This study showed that participants were knowledgeable about the locations of many more explicit ecosystem services. However, it did not demonstrate that randomly selected members of the general public could spatially identify places that provide specific ecosystem services. It also did not show that a more qualitative PPGIS study, in which participants are asked to identify places that provide pre-selected services on a map, would be effective. These concerns are important when examining whether PPGIS can be an effective tool for incorporating stakeholder preferences into ecosystem service management, since conducting one on one interviews often requires a considerable time investment and is not an efficient strategy for surveying a large sample population.

Brown et al. (2011) sought to address some of these issues by developing an internet-based PPGIS survey which could ask a large random sample of stakeholders to identify the places that they think provide specific ecosystem services. However, this study reported a considerably low response rate. Additionally, its results were skewed by the fact that participants could use an unlimited number of points to identify places that provide each service, so 12 percent of the respondents identified 50.9 percent of the total points (Brown et al., 2011). Thus, the opinions of the most engaged participants were overrepresented in the results. Therefore, we aimed to fill the gaps in the literature and build upon these previous studies by creating a mail-based PPGIS survey that would be sent to a random sample of the general public in which each service was assigned a fixed number of points. This method was designed to test whether a representative sample of the general public could spatially conceptualize and identify places that provide specific ecosystem services.

Furthermore, little previous research has examined the spatial accuracy of the features identified as being important by participants in PPGIS studies. In the context of PPGIS, “accuracy reflects how well the marker approaches the true spatial dimensions of the attribute being identified,” which “is influenced by a number of variables including the nature of the PPGIS attribute being mapped …, the quality of the mapping environment …, and respondent characteristics such as familiarity with the study landscape” (Brown, 2012, p. 290). When using PPGIS data to inform management decisions, it is important to understand the accuracy of that information to understand how it can best be used to inform decision making (Don Carlos et al., 2009; Lowery et al., 2012). Brown (2012) found high levels of participant accuracy when comparing PPGIS identification of places of native vegetation with land cover data in New Zealand. We sought to support these results by assessing the accuracy with which participants identified places that provide habitat for certain threatened species or provide specific watershed services. Understanding the accuracy of these PPGIS data is critical, since low accuracy in the results might indicate that PPGIS is not a good tool for capturing stakeholder preferences for use in natural resource management and would highlight the need for outreach efforts. Additionally, comparing the PPGIS results with scientific data allows us to determine whether members of the general public spatially conceptualize these items similarly to scientific experts to identify any potential disconnects (Kumar & Kumar, 2008).

Methods

Study Area

For this project, we selected a 4,607 square mile study area focused on Mobile Bay, which is located on the Gulf Coast of Alabama (Figure 1.1). This region includes nearly all of Baldwin and Mobile counties, Alabama. It also contains the entirety of Mobile Bay, which is 413 square miles, as well as several smaller bays, and virtually all of Alabama's coastline. Another prominent feature of this study area is the Mobile-Tensaw River Delta, which flows into Mobile Bay from the north and forms the second largest delta in the United States. Mobile Bay is also fed by many other smaller rivers and streams, and the region contains extensive wetlands. As a result of its unique location, the Mobile Bay region provides a wide range of ecosystem services, including many that are produced by its numerous and diverse range of watershed features. Additionally, Baldwin and Mobile counties provide habitat for a large assortment of federally listed threatened and endangered plants and animals, as well as a multitude of additional species that are protected by the state of Alabama (Alabama Natural Heritage Program, 2011).

In addition to the important, yet diverse natural characteristics of the region, the human impact on the region is also quite uneven. Mobile and Baldwin counties have a combined population of 599,294 (U.S. Census Bureau, 2010). Nonetheless, there are large undeveloped expanses within this study area. However, there are towns strewn throughout much of the region, particularly along the coast, several of which are of significant size. The largest city in the region is Mobile, which has a population of 194,924 in the city proper, and a metropolitan statistical area that is home to 412,992 people (U.S. Census Bureau, 2010). Additionally, this region is known throughout the Southeast as a recreation hub, due to its beach resorts, particularly in Gulf Shores and Orange Beach, and diversity of other recreation opportunities, ranging from sailing to hiking. Furthermore, Dauphin Island, which is a narrow barrier island off the coast of Mobile County in the Gulf of Mexico, is renowned as a birdwatching mecca, since it has the distinction of being the first land mass encountered by birds migrating north across the Gulf of Mexico, leading to tremendous species diversity and birdwatching opportunities during migration season.

However, there is also a considerable amount of industrial activity in this region, which has the potential to greatly impact these natural features and recreation opportunities, as the recent Deepwater Horizon oil spill in the Gulf of Mexico demonstrated. Water pollution, in particular, poses a significant threat to many key features of the area. Also, since it has become such a prime destination, development is a major concern. Thus, we chose this study area not only because it offers such an array of diverse ecosystems, threatened and endangers species, and recreation opportunities, but also because of the vulnerability of these features to human impacts, such as development and pollution.

Data Collection

During the spring of 2012, we developed a map-based survey, which we mailed to residents of Mobile and Baldwin counties over the course of the summer of 2012 (Appendix I). We purchased a random sample of addresses from these two counties from Survey Sampling International for this purpose (SSI, 2012). In this study, we tested two different mail-based survey methodologies. Both were modified from the four contact mailing design developed by Dillman et al. (2008). In the sample populations for each method, the number of surveys sent to residents of each county was proportional to that county's percentage of the combined total population, so 69 percent of the surveys were sent to residents of Mobile County and 31 percent were sent to residents of Baldwin County. However, residents were randomly selected for inclusion from within each county.

Following our first method, we mailed 2000 pre-notice letters to randomly selected residents of Baldwin and Mobile counties. These pre-notice letters described our study and informed recipients that they had been selected to participate in it. Then, we asked them to indicate whether they would or would not be willing to participate in the study on a provided form and return it via a pre-stamped envelope. We asked those who marked that they did not wish to participate in the study to answer a few brief demographic questions on the same form about their age, gender, race, income, and education so that we could identify non-respondent biases. Four weeks after we mailed out these pre-notice letters, we sent reminder postcards to those members of the sample from whom we had not yet received a response. Respondents who indicated that they did not wish to participate in the study were not contacted again. Those who indicated that they did want to participate were then mailed a survey packet containing a questionnaire, map of the Mobile Bay region, sticker sheet, and a second map of the region to keep as a token of our appreciation for completing the survey. Participants were asked to return their completed questionnaires and PPGIS mapping activities in pre-stamped envelopes, which were included in their survey packets. Two weeks after these survey packets were mailed out, we sent reminder postcards to those from whom we had not yet received responses. After an additional two weeks, we mailed final reminder letters to participants who had still not returned their survey packets.

Next, we tested a different mail-based survey approach on an additional 750 randomly selected residents of Baldwin and Mobile counties. Following this method, we also employed a four contact approach modeled on the one designed by Dillman et al. (2008). However, this time we mailed out pre-notice letters to the sample population describing our study and informing them that they had been selected to take part in it, but we did not ask them to return a form indicating whether or not they were willing to participate or provide any demographic information. Instead, we simply mailed out survey packets to the entire sample one week later. These survey packets included the same materials as the one that we used in the previous approach, except they did not include a complementary map. As an alternative, we promised to mail this map to members of this group once we received their completed responses. Then, as in the first method, we sent reminder postcards to those who had not returned their surveys after two weeks and sent final reminder letters to those who had still not returned their surveys after an additional two weeks.

Questionnaire

This survey was designed to identify which terrestrial and aquatic places in the Mobile Bay region stakeholders think provide important cultural services, watershed services, and threatened species habitat, as well as highlight places that threaten the region by emitting pollution and places that are or are not permissible for future development (Appendix I). The survey also sought to identify whether certain respondent characteristics, attitudes, or preferences influenced the spatial distribution of the places that they identified. Thus, stakeholders were mailed a survey packet including a questionnaire and PPGIS mapping activity to capture the data necessary for performing these analyses.

The first part of the questionnaire consisted of questions about the length of time that the participant has lived in the Mobile Bay region and asked the participants to indicate how knowledgeable about places in the region they believe themselves to be (Brown & Raymond, 2007). Additionally, the participants were asked to report their level of concern for the future of the Mobile Bay region (Brown & Raymond, 2007). These questions were designed to engage the participants and ease them into the survey, while allowing for analysis on whether their mapped results vary based on length of residence or knowledge of the area, which could serve as useful indicators for managers.

The second section of the questionnaire focused on participants' outdoor recreation activities in the region. In this section, participants were asked to rate the importance they place on a series of outdoor recreation activities and identify which activity they participated in on their most recent recreation trip within the study area. Participants were then asked to rank how important a series of recreation motivations were in their decision to participate in that activity (Moore & Driver, 2005; Manning, 2011).

The third component of the questionnaire concentrated on local natural resource management issues (Brown & Reed, 2009; Hall et al., 2009; Brown & Weber, 2011; Clement & Cheng, 2011; Raymond & Brown, 2011). Participants were asked to assess the degree to which they believe various topics, such as habitat destruction and overuse of upstream water, threaten wildlife and watershed services in the region. They were also asked to identify the degree to which they believe various development issues, including industrial development and urbanization, threaten the Mobile Bay region and to rate their satisfaction with a range of natural characteristics in the region.

The fourth section of this questionnaire was the PPGIS mapping exercise, in which we asked participants to identify a range of cultural values, places for wildlife habitat conservation, places of watershed service provisioning, pollution threats, and development preferences (Table 1.1) on a 24 x 36 in. full color map of the Mobile Bay region using a set of 0.25 in. stickers that were color coded to correspond to each item (Brown, 2005). The map of the study area on which participants were instructed to place the stickers was composed of a true color aerial photograph set at a scale of 1:150,000 which was acquired from the Bing Maps Aerial database in ArcGIS, as well as layers depicting cities, major roads, and the boundaries of lands that are protected on a state or federal level, which were displayed as references for participants to aid them in accurately placing their stickers. Subsequently, participants were asked to indicate how important each of the cultural values, places of watershed service provisioning, and wildlife habitat is to them on a seven point Likert scale (Pocewicz et al., 2012).

After completing the PPGIS mapping activity, the participants were asked to return to their questionnaire booklets and answer a range of demographic and socio-economic questions, which make up the fifth and final section of the questionnaire (Nielsen-Pincus, 2011; Sherrouse et al., 2011). This section asked participants to report their age, gender, race, marital status, education level, income level, employment status, and profession.

Mapped Items

As previously stated, participants were asked to complete a mapping exercise in which they placed sticker dots corresponding to 19 PPGIS items onto a map of the Mobile Bay region (Table 1.1). These 19 items were grouped into five conceptual categories: cultural values, watershed services, wildlife habitat, pollution threats, and development preferences. The first category was composed of four cultural values (economic/livelihood value, recreation/tourism value, historical value, and aesthetic value). These four values were initially developed by Brown and Reed (2000) as part of a set of 13 types of stakeholder landscape values. For this study, that set of values was condensed to four because certain values, such as subsistence value, were not deemed to be particularly relevant to this study area and others, such as spiritual value and therapeutic value, were shown by Nielsen-Pincus (2011) to be more abstract, and thus more difficult for participants to identify spatially and map using points. These four values represent cultural ecosystem services as defined by the Millennium Ecosystem Assessment (2005).

Ecosystem Service Choice

The second PPGIS category was composed of four watershed service values (fish nursery, storm protection, flood protection, and water quality protection), which were designed to assess the value that residents place on ecosystem services derived from water (Raymond et al., 2009), as well as to test their ability to spatially identify places that provide these important watershed services (Brown, 2012). Due to the prevalence of aquatic features in the Mobile Bay region, we decided to focus the ecosystem services that we chose to test for stakeholder spatial identification on services produced by watersheds. As previous research has demonstrated, watersheds provide a multitude of critical services to humans, such as water quality protection, carbon sequestration, habitat provisioning, flood protection, nutrient export, provisioning of fresh water, biodiversity support, recreation opportunities, erosion control, groundwater recharge, places of aesthetic value, fish nurseries, nutrient retention, storm buffering, and places of cultural significance (Zedler, 2003; National Research Council, 2004; Pattanayak, 2004; Millennium Ecosystem Assessment, 2005; Postel & Thompson, 2005; Zedler & Kercher, 2005; Turner et al., 2008; Peterson & Lowe, 2009; Wamsley et al., 2010; Engle, 2011).

From this list of important watershed services, we decided to choose four services for participant identification of places that provide them. Due to the fact that previous PPGIS studies have reported that participants had difficulty identifying places that provide overly technical, complex, and non-discrete ecosystem services (Raymond et al., 2009), we sought to avoid this problem by selecting watershed services that members of the general public could reasonably identify spatially with some degree of accuracy. Therefore, we selected four watershed services that are spatially explicit and regularly effect many residents of the Mobile Bay region. The services we chose are provided by large areas which are spread throughout the study area to avoid spatial biases. We also selected services that we felt were broad enough for general public participants to be able to comprehend them and spatially identify places that provide those services. Since cultural services were the focus of the previous section, and of previous PPGIS literature (e.g. Brown, 2005; McIntyre et al., 2008), the services that we selected were all regulatory services (Millennium Ecosystem Assessment, 2005). To fit these specific parameters, we selected fish nurseries, storm protection, flood protection, and water quality protection for this PPGIS study (Table 1.1).

Wildlife Species Choice

The third category was composed of four wildlife habitat values (black bears, manatees, sea turtles, and wading birds). For each of these, the participants were asked to identify places that they would like to see maintained for the conservation of that species. To understand how PPGIS could be applied to wildlife conservation for specific species, we decided to select local threatened and endangered species, since these are often targeted by conservation efforts and are also typically high in the public consciousness. Since Baldwin and Mobile counties are home to 99 federally listed threatened and endangered animal species, as well as a plethora of additional species that are protected by the state of Alabama because they are considered to be locally vulnerable, we developed additional selection criteria (Alabama Natural Heritage Program, 2011). From this extensive list, we sought to identify species that members of the general public would be familiar with to such an extent that they would be able to identify places that offer suitable habitat for that species with relatively high accuracy. Thus we chose relatively large, charismatic species from the list of threatened species present in the Mobile Bay region.

Furthermore, in addition to trying to select species which stakeholders would actually be able to spatially identify, we also attempted to prevent spatial biases with the species that we chose for this study. Therefore, only species that are present in both Mobile and Baldwin counties were selected. Moreover, we sought to pick species that would be particularly associated with each of the four prominent non-developed land cover classes found in the study area: forest, water, wetlands, and beaches. Thus, we selected Florida black bears (*Ursus* *americanus floridanus*) to represent forest land, West Indian manatees (*Trichechus manatus*) to represent water, wading birds to represent wetlands, and sea turtles to represent beaches. In order to prevent confusion and error from general public respondents, wading birds, including threatened species such as reddish egrets (*Egretta rufescens*) and wood storks (*Mycteria americana*), and sea turtles, such as green sea turtles (*Chelonia mydas*) and loggerhead sea turtles (*Caretta caretta*), were lumped together due to the considerable overlap of their ranges and required habitats, as well as their physical similarities and the high probability that general public respondents would have difficulty distinguishing specific species.

Pollution Threats and Development Preferences

Next, the participants were asked to identify places that are pollution threats to the region (Raymond & Brown, 2011). This category was split into places that threaten air quality and places that threaten water quality. Finally, the participants were asked to indicate places where future development should be prohibited and places where future residential development could occur with a well-designed plan (Brown & Raymond, 2007).

Data Analysis

First, the participant responses for each question in the questionnaires were entered into an online survey program called Qualtrics (2005). This program stored all of the questionnaire data and compiled it into spreadsheets for analysis. Additionally, it computed descriptive statistics, such as means, for each question.

We then digitized the results of the PPGIS mapping activity into a GIS database by employing the method of heads-up digitizing. Using this technique, we manually placed points on the GIS map to correspond directly to each sticker on the physical maps returned by the participants (Brown et al., 2004). The GIS map was displayed at a 1:1 size ratio with the physical maps throughout the digitization process to minimize digitization error (Brown et al., 2004). In this process, we took painstaking efforts to ensure that the digitized points matched the locations of the stickers as closely as possible. The points were assigned attribute values to identify which PPGIS item they represented. Each participant's points were stored in a separate GIS layer.

To identify places where specific participant-identified items clustered spatially, we performed a kernel density analysis. Kernel density calculation is a spatial statistical technique which "fits a smoothly curved surface (grid) over each point producing a circular area (kernel) of a certain bandwidth (or search radius)" (Brown & Weber, 2012, p. 9). When conducting this kernel density analysis, we followed the parameters set out by Brown and Pullar (2012) and used a grid cell size of 500 meters and a search radius of 3000 meters. Kernel density analysis allowed us to determine how participant-identified points for each mapped item clustered throughout the study area. Higher kernel densities represent greater levels of public support or consensus for that item, since this density level is generated by the fact that there are more participant-identified points in that vicinity (Brown & Weber, 2012). In order to compare kernel density results for various PPGIS items to one another, we standardized the kernel densities for each item by the number of points identified by respondents for that item (Brown & Pullar, 2012). Thus, the kernel density results were not influenced by the number of raw points used to identify the item. Then, following the convention established by Brown and Pullar (2012), we used a 0.67 kernel density threshold to identify "hotspots" for each PPGIS item. Hotspots are places with a significant level of participant support or agreement. The kernel density hotspots for each mapped item were then extracted for further spatial analysis through the process of reclassification.

To assess the accuracy of the publicly-identified hotspots for threatened species conservation, we overlaid the hotspots for each species with maps identifying habitat within the study area that is suitable for each species which were developed by the Alabama Gap Analysis Project (Silvano et al., 2007). The hotspot layer and GAP layer for each species were then combined to produce a new layer depicting hotspot areas that were within the extent of the suitable habitat, hotspot areas outside of the suitable habitat, and suitable habitat not included in hotspots. Thus, we were able to determine what percentage of the hotspots for each species was located in the necessary habitat for that species. We termed these areas of hotspot and habitat overlap "conservation targets."

We also identified kernel density hotspots for each of the watershed services using the same process. To assess the accuracy of those hotspots, we associated each service with the type of land cover that provides that service (Willemen et al., 2008). Fish nurseries are provided by wetlands and aquatic areas (Chambers, 1992; Zedler, 2003; Zedler & Kercher, 2005; Turner et al., 2008; Peterson & Lowe, 2009; Engle, 2011). Beaches and wetlands provide storm protection (Loder et al., 2009; Wamsley et al., 2010; Engle, 2011). Flood protection was considered to be provided by wetlands, forests, and stream channels (Zedler, 2003; Pattanayak, 2004; Postel & Thompson, 2005; Zedler & Kercher, 2005; Turner et al., 2008). Wetlands, forests, and streams all provide water quality protection (Zedler, 2003; Pattanayak, 2004; Postel & Thompson, 2005; Zedler & Kercher, 2005; Verhoeven et al., 2006; Turner et al., 2008; Engle, 2011). Then we performed a land cover classification of the study area. For enhanced accuracy, we used land cover data derived from Enhanced Thematic Mapper Plus (ETM+) satellite imagery provided by the Alabama GAP (Kleiner et al., 2007). The GAP had categorized the land cover of the region into 71 classes, thus highlighting numerous specific types of land cover. However, due to the more general nature of this study, we reclassified those into nine broader classes, corresponding to those developed by Anderson et al. (1976). We then were able to assess the accuracy of the participant-identified hotspots by clipping the land cover layer to the hotspots for each watershed service and then analyzing the land cover composition of those hotspot areas in the GIS attribute tables. As a result, we were able to identify what percentage of the hotspots fell on the correct land cover for that service.

In addition to assessing the accuracy of the kernel density hotspots, we also sought to determine how the hotspots for various PPGIS items interacted with one another, which could provide additional insights for management. First, to identify places that should be low hanging fruits for conservation efforts, we overlaid hotspots for places where participants think future development should be prohibited with the conservation targets for each species developed previously to highlight areas of overlap, which represent places where stakeholders are strongly in favor of conservation and strongly against development, which are compatible preferences. Additionally, we overlaid the hotspots for publicly-identified pollution threats with the conservation targets for each species and with the hotspots for fish nurseries and water quality protection to identify areas of overlap. These areas should also be the focus of conservation efforts, since stakeholders have recognized their importance for wildlife or watershed services and have recognized the pollution threats. Thus, there would likely be high public support for reducing pollution in those locations. Finally, we sought to identify areas of potential conflict over resource use. Therefore, we overlaid the wildlife conservation targets and watershed service hotspots with hotspots for places that stakeholders think are permissible for future development.

Areas of overlap represent stakeholder value conflicts, which present a challenge for management efforts.

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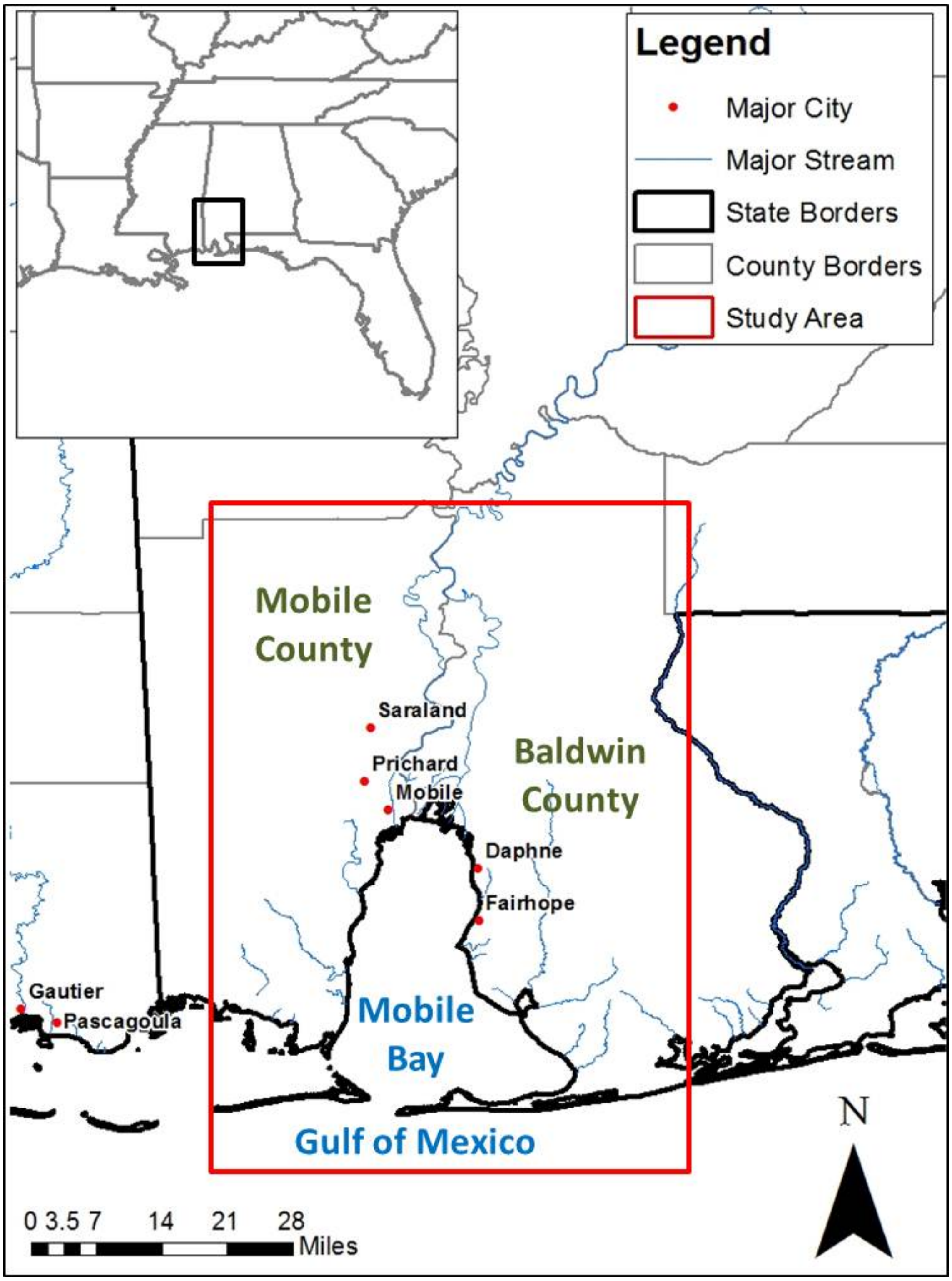
Table 1.1 – PPGIS Items

PPGIS Item	Definition
Economic/Livelihood	These places are important to me for the economic benefits they provide, such as timber, fisheries, or oil.
Recreation/Tourism	These places are important to me because they provide outdoor recreation or tourism opportunities.
Historic	These places are important to me because they are a significant part of human cultural legacy to me, others, and/ or the nation.
Aesthetic	These places are important to me for the attractive scenery, sights, smells, sounds, etc.
Fish Nursery	These places are important to me because they provide key habitat for juvenile fish to mature and support local fisheries.
Storm Protection	These places are important to me because they provide protection and buffering against the effects of hurricanes and storm surge.
Flood Protection	These places are important to me because they minimize flooding from rivers and streams.
Water Quality Protection	These places are important to me because they filter sediment and remove pollutants from water.
Black Bears	I would like to see these places maintained for the conservation of black bears.
Manatees	I would like to see these places maintained for the conservation of manatees.
Sea Turtles	I would like to see these places maintained for the conservation of sea turtles.
Wading Birds	I would like to see these places maintained for the conservation of wading birds (cranes, herons, egrets, etc.).
Air Pollution	Please indicate places that you believe threaten air quality.
Water Pollution	Please indicate places that you believe threaten water quality.
No Development	Please indicate places where you think any future development should be prohibited.
Residential Development	Please indicate places where you think residential development could occur with a well-designed plan.
Special Places	Use these dots to identify up to 3 of your special places. Please remember to write your reason why these places are special in the survey booklet.
Places You Dislike	Use these dots to identify up to 3 places that you dislike. Please remember to write your reason why you dislike these places in the survey booklet.
Most Recent Recreation Trip	Use this dot to identify the location of your most recent recreation trip in the Mobile Bay region.

Figure 1.1 – Study Area: Mobile Bay Region, Alabama



Chapter 2: Applying Public Participation Geographic Information Systems to Wildlife Management

Abstract

There is a growing trend within the field of wildlife management to incorporate public participation methods to increase efficiency and reduce tensions in the decision making process. However, there is a need to incorporate spatial data into these studies, since most biological and ecological data for planning purposes is stored spatially in Geographic Information Systems (GIS) databases. Previous studies in this field have not attempted to have stakeholders identify specific places on a map that they would like to see maintained for the conservation of particular local threatened and endangered species. This article presents a method for doing so by using Public Participation Geographic Information Systems (PPGIS). This information is useful for wildlife management since it allows for the comparison of public perceptions with expert opinions to identify places of agreement. Additionally, it shows how these data can be used to highlight publicly identified threats to wildlife conservation and places of potential conflict due to incompatible stakeholder landscape values.

Keywords: public participation GIS, spatial, wildlife, collaboration

Introduction

In the United States there is an ongoing shift in the way that the general public values wildlife, moving from a utilitarian outlook to a protection-oriented attitude (Manfredo et al., 1998). Additionally, the public has expressed dissatisfaction with management practices that are perceived as notifying them about the implementation of plans developed by experts rather than collaborating with stakeholders and allowing them to participate in the decision-making process (Smith & McDonough, 2001; Morse, 2012). As a result, there has been a movement within the field of wildlife management to shift from a top-down, expert driven approach to one that puts a greater emphasis on integrating stakeholder opinions with biological information, creating a need for the incorporation of social science methods into wildlife management (Riley et al., 2002). Allowing stakeholders to participate in wildlife management decisions has been shown to reduce tensions between local stakeholders and managers, while garnering greater public support for management plans through increased trust and empowerment and increasing the stakeholders' awareness of the management issues, which serve to increase the efficiency with which the plan can be implemented (Treves et al., 2006; Schusler et al., 2003; Morse, 2012). As a result of these trends, it has become increasingly important in wildlife management for stakeholders to be consulted on issues of wildlife conservation, and for their often diverse and even conflicting values and opinions to be addressed and sometimes incorporated into management plans (Riley et al., 2003). Furthermore, public support is beneficial in decision making on wildlife management issues, since wildlife is considered to be a publicly owned resource in the United States (Zinn et al., 1998).

However, there is a distinct need for the incorporation of spatial data into studies on the human dimensions of wildlife to better inform conservation and management decisions.

Incorporating spatial data is a growing trend in natural resource management, since “natural resource politics is as much a contest over place meanings as it is a competition among interest groups over scarce resources,” thus making it necessary for managers to be able to spatially identify the locations of these stakeholder values (Cheng et al., 2003, p. 87). It is particularly beneficial to capture and analyze these stakeholder place values spatially, since many of the tools used in wildlife and natural resource management are based upon Geographic Information Systems (GIS) spatial analysis (Bengston et al., 2004; Theobald et al., 2005). Thus, it would be helpful for resource managers to be able to capture social data and overlay these data in a GIS database with biological and ecological layers for direct comparisons, allowing social data to be more efficiently and completely integrated into management decisions.

Several studies (e.g. Krester et al., 2009; Lowery et al., 2012) have incorporated spatial information to identify the locations of human-wildlife conflicts, so that managers can understand where conflict hotspots are located and if human attitudes towards these animals are different in high conflict areas as opposed to areas where there is less conflict. Additionally, spatial data have been incorporated to identify places where residential development threatens areas with high levels of biodiversity (Hunter et al., 2003). While this literature has made important strides in incorporating spatial data into human dimensions of wildlife studies, there are still significant gaps in the ways in which spatial information has been used to inform wildlife management decisions. One particular area where incorporating spatial data could be extremely beneficial is in the realm of wildlife conservation. For example, Morzillo et al. (2007) examined how human opinions about black bear recovery strategies clustered based on location. This study developed clusters based on the home addresses of the participants, and thus analyzed whether people living in different neighborhoods had different opinions on black bear recovery strategies. Thus, they were able to identify places where conservation-minded people clustered. However, for a manager, it would be more beneficial to examine where in the landscape people think wildlife should be conserved. This type of data would be useful because it would allow stakeholders to identify specific places in the landscape where they are in favor of conservation. Identification of spatial preferences accounts for the fact that individuals may have both positive and negative attitudes towards conservation, depending on the location of the efforts (Riley et al., 2002). For example, a stakeholder might be in favor of managing for black bear conservation in one part of the region, but not in favor of these same practices in another location. Thus, it would be beneficial to develop a method for incorporating spatial social data into wildlife management that can allow for more respondent complexity, based on the fact that a person can have multiple, place-dependent attitudes towards wildlife conservation, since these data would enable managers to identify specific areas with strong public support for conservation and areas of likely conflict.

One way to spatially integrate public opinions and preferences into wildlife conservation, while allowing participants to indicate different management preferences for specific places, is to use a Public Participation Geographic Information Systems (PPGIS) survey. While PPGIS represents a new form of participatory planning in wildlife management, it was developed in the mid-1990's as a method to spatially capture participants' opinions, values, and preferences about places in a landscape and complement the often expert-driven approach of using GIS for resource management (Sieber, 2006). PPGIS studies allow participants to identify places in the landscape that are important to them and indicate opinions and management preferences towards specific places. Researchers have experimented with different methods for place identification, such as points (Brown, 2005) and polygons (Brown & Pullar, 2012), but all PPGIS studies are based around having participants identify specific places on a map that have a particular meaning to them. These results are then compiled into a GIS database for spatial analysis. The method of PPGIS implementation has ranged from one on one interviews (Talen, 2000) to mail-based surveys (Brown, 2005) to focus groups (Lowery & Morse, in press) to internet surveys (Pocewicz et al., 2012). Brown (2005) has argued that mail-based surveys using sticker dots corresponding to a range of values for place identification are the most effective way to capture the opinions of a large, representative sample of stakeholders. Pocewicz et al. (2012) have supported this argument after reporting much lower response rates for internet-based PPGIS surveys than mail-based PPGIS surveys when using a mixed methods survey design.

The breadth of applications for PPGIS projects is immense. PPGIS has been used to assess landscapes as diverse as urban neighborhoods (Talen, 2000) and Alaskan wilderness (Brown, 2005). Additionally, PPGIS has been used to collect data on a wide range of features within these landscapes, such as landscape values (Brown et al., 2004; Beverly et al., 2008; Brown & Reed, 2009; Zhu et al., 2010; Nielsen-Pincus, 2011; Sherrouse et al., 2011), development preferences (Brown & Raymond, 2007), ecosystem services (Raymond et al., 2009; Brown et al., 2011), identification of environmental threats and human impacts (Raymond & Brown, 2011; Brown & Weber, 2011), and stakeholder knowledge about local ecosystems (Brown, 2012).

However, little research has been conducted into determining how PPGIS methods can be used to inform wildlife management and conservation efforts. In several studies, Brown and his collaborators have included a category for places of biological value, which is defined as "areas valued because they provide places for a variety of plants, animals, and wildlife," but have noted that they "do not know the specific biological features or attributes the respondents were mapping," since this category was broad and did not ask participants to identify particular aspects of biological value, thus making the data rather vague for specific wildlife management applications (Alessa et al., 2008, p. 28; Brown et al., 2004, p. 176). In an attempt to focus on a more specific aspect of biological value, Brown et al. (2004) asked participants to identify places of biological diversity value. However, the biological diversity category only highlights places that people think are important because they “provide a variety” of species (Brown et al., 2004, p. 167). Thus, it does not capture all of the information that might be valuable for spatially integrating public opinions into a wildlife management plan. For example, a specific area might provide important habitat for a particular endangered species, while not being biologically diverse, and might have high public support for conservation as a result. Thus, for this study, the landscape values typology developed by Brown and Reed (2000) was adjusted to incorporate places that people think should be conserved as habitat for four charismatic local threatened and endangered species.

Research Questions

In this study, we wanted to understand which places stakeholders in the Mobile Bay region think are important for wildlife conservation. Additionally, we sought to determine whether the places that they identified actually provided suitable habitat for the conservation of those species. In order to do so, we selected four locally threatened species or groups of species, black bears, manatees, wading birds, and sea turtles. First, we sought to identify the locations of public preferences for wildlife conservation. Then, we tested these locations against biological data to determine whether the places identified by randomly selected members of the general public as being important for the conservation of particular species accurately identified places that are considered to be suitable habitat by scientific experts. This assessment provided insights into determining how PPGIS can be used as a tool for wildlife management. Additionally, we sought to identify areas of potential conflict due to competing stakeholder preferences for wildlife conservation and future residential development. Furthermore, we sought to identify additional factors that might support conservation efforts, such as publicly-identified pollution threats.

We expected that the participant-identified hotspots for black bears would fall primarily on forested areas. We also predicted that wading bird hotspots would mostly be located in coastal wetlands. Additionally, we expected that manatee hotspots would fall in marine areas adjacent to the coast. Furthermore, we predicted that sea turtle hotspots would be focused on Gulf Coast beaches, which represent the turtles' nesting sites. Finally, based upon research on PPGIS accuracy with land cover by Brown (2012), we expected that a high percentage of the participant-identified hotspot areas for each species would fall on places that are considered to be suitable habitat for that species.

Methods

Study Area

The study area that was chosen for this project was a 4,607 square mile (11,932 km^2) region centered around Mobile Bay, which is a large bay located along the Gulf Coast of Alabama (Figure 2.1). This area covers close to the entirety of both Mobile and Baldwin counties, Alabama. Baldwin and Mobile counties contain the entire coast of Mobile Bay, in addition to several smaller bays and all of Alabama's Gulf Coast. They also contain the Mobile-Tensaw River Delta, which is the second largest delta in the U.S. Additionally, the region includes Dauphin Island, located just off the coast in the Gulf of Mexico, which is renowned as a birdwatching hub due to its ideal location as the first land encountered by birds migrating north across the Gulf of Mexico. The human development of this landscape is extremely mixed, containing large undeveloped areas, as well as several sizeable urban areas, including Mobile, a city of 194,914 people, with a total of 412,992 people residing in the Mobile Metropolitan Statistical Area (U.S. Census Bureau, 2010). This study area was chosen due to its diversity of ecosystems, array of threatened and endangered species, inclusion of many prime recreation destinations, and vulnerability to human threats.

Species Choice

When setting out to choose the species or faunal groups to include in this study, we decided to focus on local threatened and endangered species, since these are commonly the target of conservation efforts. Baldwin and Mobile counties are home to a diversity of both federally listed threatened and endangered species, including 99 animal species, and numerous more that are recognized as being vulnerable and are protected by the state of Alabama (Alabama Natural Heritage Program, 2011). From this list, we selected relatively large, charismatic species that the general public would be easily able to identify and locate perceived conservation preferences for on a map. Additionally, we sought to avoid any spatial biases with our species selection. Thus, we only chose species that inhabit both counties. Additionally, we selected species to represent the four major non-developed types of land cover in the region: Florida black bears (*Ursus americanus floridanus*) for forest land, wading birds for wetlands, West-Indian manatees (*Trichechus manatus*) for water, and sea turtles for beaches. Wading birds, such as wood storks (*Mycteria americana*) and reddish egrets (*Egretta rufescens*), and sea turtles, such as loggerhead sea turtles (*Caretta caretta*) and green sea turtles (*Chelonia mydas*), were grouped together to avoid the possibility of general public respondents confusing similar species and due to the high overlap of their habitats and ranges. Maps of suitable habitat within the study area for each of these species were obtained from the Alabama Gap Analysis Project (GAP), which were developed to show the predicted range of each species within the state of Alabama (Silvano et al., 2007). These maps were developed by Silvano et al. (2007) using a combination of known species range data and a habitat association model, which accounted for the habitat requirements of each species, including land cover, elevation, hydrology, relation to adjacent land cover, and contiguousness of habitat.

Data Collection

In the summer of 2012 we developed a map-based survey, which was sent to 988 residents of Baldwin and Mobile counties (Appendix I). In order to most accurately represent the opinions of stakeholders in these two counties, the number of surveys sent to residents of each county was proportional to that county's percentage of the total population of the two counties. Thus, 69 percent of the surveys were sent to residents of Mobile County and 31 percent were sent to residents of Baldwin County. Residents were randomly selected from within each county, using addresses purchased from Survey Sampling International (SSI, 2012). The survey methodology followed a modified version of the four contact method developed by Dillman et al. (2008), employing a pre-notice letter informing the participant of his/her selection to take part in the study, the survey packet, a reminder postcard, and a final reminder letter.

The purpose of this survey was to identify which terrestrial and aquatic places stakeholders in the Mobile Bay region think are important for the conservation of specific threatened and endangered species and how those places interact with other management preferences and opinions. The questionnaires were composed of five parts including: 1) knowledge and use of the bay region, 2) identification of threats to the region, 3) a PPGIS mapping exercise to identify places that should be maintained for the conservation of specific threatened species; pollution threats; and development preferences, 4) ranking the importance of the mapped values, and 5) a series of questions to ascertain the participants' occupational, demographic, and socio-economic backgrounds.

In the PPGIS mapping exercise, participants were asked to identify places in the Mobile Bay region that are important to them because they provide a range of services, including places that should be maintained as habitat for the conservation of black bears, wading birds, manatees, and sea turtles (Table 2.1). Additionally, participants were asked to identify places that threaten the region through air or water pollution and places that they think should or should not be developed in the future. Participants identified the locations of these important places by placing 0.25 in. stickers that were color-coded to correspond to these components onto a 24 x 36 in. full color map of the Mobile Bay region (Brown, 2005). The map consisted of a true color aerial photograph of the region at a scale of 1:150,000, which was obtained from the Bing Maps Aerial database, with cities, major roads, and the boundaries of federally and state protected lands identified as references.

Data Analysis

The stickers used by respondents for the PPGIS mapping exercise were digitized as points in a GIS database, using the technique of "heads-up" digitizing, in which the researcher manually places points onto a map displayed on the computer screen to match those on the physical map as closely as possible (Brown et al., 2004). The size ratio of the physical map to its digital counterpart was set at 1:1 for the digitization process to minimize the potential for digitization error (Brown et al., 2004).

In order to determine where participant-identified important places for wildlife conservation, development preferences, and pollution threats clustered, we used a kernel density tool, which "fits a smoothly curved surface (grid) over each point producing a circular area (kernel) of a certain bandwidth (or search radius)" (Brown & Weber, 2012, p. 9). For the kernel density analysis, we used a grid cell size of 500 m and a search radius of 3000 m, following the recommendations of Brown and Pullar (2012). This process allowed us to identify where significant clustering of particular items occurred. Higher kernel densities indicate areas with greater levels of stakeholder consensus about that value, preference, or opinion (Brown & Weber, 2012). We then standardized the kernel densities so that they would not be influenced by the raw number of points and used a 0.67 kernel density threshold to identify "hotspots" for each mapped item (Brown & Pullar, 2012).

Subsequently, the ArcGIS reclassify tool was used to extract these kernel density hotspots for further analysis. First, participant identified conservation hotspots for each species were overlaid with maps of suitable habitat for that species produced by the Alabama GAP (Silvano et al., 2007). This information allowed us to determine where the hotspots overlapped with a scientific assessment of suitable habitat. The results allowed for an assessment of the accuracy of the publicly-identified hotspots, which was quantified based on the percentage of hotspot overlap with the suitable habitat. The areas of overlap between the hotspots and GAP habitat models were termed conservation targets and were then extracted for additional spatial analysis (Silvano et al., 2007).

These conservation targets were then overlaid with kernel density hotspots for places where stakeholders think future development should be prohibited. The areas of overlap represent places that should be low hanging fruits for conservation, since the public does not want them to be developed, in addition to wanting them to be maintained for wildlife conservation, and these preferences support each other. Then, we calculated the percentage of the total GAP defined suitable habitat for each species that was included in each conservation target to identify how much of each species' total habitat was identified by the conservation targets. Additionally, the conservation targets were overlaid with kernel density hotspots for publicly-identified pollution threats. The areas of overlap again represent low hanging fruits for conservation, since they represent areas that the public believe threaten the quality of their region and would like to see cleaned up and used for conservation. Finally, the conservation targets were overlaid with hotspots for places where stakeholders think future development is acceptable. The areas of overlap in this case represent places of potential conflict, since a significant number of stakeholders have expressed a desire for conservation in these areas and a significant number have expressed a desire for development, and these two preferences are not compatible.

Results and Discussion

Response

Nine hundred eighty-eight survey packets were mailed to residents of Baldwin and Mobile counties. Of these, 75 (7.59%) were returned as undeliverable by the U. S. Postal Service. A total of 274 responses (30.01%) were received, with 88.32% (n = 242) of those participating in the PPGIS mapping exercise. The survey responses overrepresented certain portions of the population of the study area, including males, Caucasians, people with higher levels of formal education, and people with higher levels of annual income. The 242 respondents who participated in the mapping exercise identified a total of 11,391 points for a range of landscape values, management preferences, and pollution threats. Results for selected items are presented in Table 2.1.

Kernel Density Results

The locations of the kernel density hotspots for each animal closely resembled our initial expectations (Figure 2.2). Sea turtle hotspots were found around the nesting sites located on the beaches of the Gulf Coast. Manatee hotspots emerged in coastal waters, generally near the mouths of streams. Wading bird hotspots were located primarily around coastal wetlands and offshore islands. However, the story was somewhat different for black bears. The black bear hotspots were primarily located in forested areas, as we expected. However, the points were widely dispersed throughout the northern half of the study area, and thus did not cluster to near the same extent as the other species, with only a few small areas reaching the kernel density threshold for being considered a hotspot, which was set at 0.67. Instead, there were large areas with lower kernel densities spread across the northern half of the study area. We believe that this result occurred because black bears have very different habitat requirements than the other species, since individuals require large home ranges, approaching 50 square miles in some cases, and live in low densities, rarely congregating (Moyer et al., 2007). Thus, bears are not associated with a single fixed place by the general public in the same way that other animals are, since wading birds congregate in specific wetlands and sea turtles have specific nesting sites on beaches. Therefore, these animals are associated with specific sites by the public, and places that they indicated in the PPGIS activity reflect this conclusion by clustering very densely around these locations. As a result, we heuristically developed a new kernel density threshold for identifying black bear hotspots, which we set at 0.33. The area included in the hotspots for each animal is shown in Table 2.2. The hotspots for each animal were then extracted for further analysis.

GAP Analysis

The kernel density hotspots provide an excellent preliminary analysis for determining locations where the highest levels of public support for conservation are focused. However, when analyzing these hotspots, it is important to include biological data to validate the public preferences, since it is necessary to be sure that the hotspots fall on areas that actually provide suitable habitat for that species (Lowery et al., 2012). Thus, these hotspots were overlaid with GAP identified suitable habitat. In order to assess the biological accuracy of these participant-identified conservation hotspots, we overlaid this data with GAP identified suitable habitat in our GIS database (Figures 2.3-2.6). We were thus able to identify areas where the hotspots and GAP habitat overlapped, which shows places that participants think should be conserved that fall within the suitable habitat for that species. This analysis also highlighted areas where the hotspots fell outside of the GAP identified suitable habitat. Additionally, comparing the hotspots to the GAP range shows that certain large areas of suitable habitat, such as non-coastal wetlands for wading birds, were not included in the hotspots (Figure 2.4). These areas represent potential outreach opportunities to better inform stakeholders about the importance of these places, in addition to coastal areas, for wading bird habitat (Don Carlos et al., 2009). The results show that participant-identified hotspots located suitable habitat with a high degree of spatial accuracy

(Table 2.3). The one outlier in these findings was sea turtles, for which only 60.06% of the points fell inside the GAP defined habitat. However, the GAP suitable range does not include beaches. While sea turtles do not actually inhabit beaches, they do lay their eggs there. As a result, beaches have been the targets of sea turtle conservation efforts worldwide. Thus, these nesting sites are often associated with sea turtle conservation by many people, and are protected as such. Therefore, we identified coastal beaches using the Land Cover Map of Ecological Systems for the State of Alabama, developed by the Alabama GAP, which distinguished 71 specific land cover classes using Enhanced Thematic Mapper Plus (ETM+) satellite imagery (Kleiner et al., 2007). We then added the beaches to the GAP defined sea turtle habitat in an attempt to account for public identification of these nesting sites. This adjustment brought the number of publicly identified points in suitable habitat up to 81.11 percent (n=528), which was in line with our findings for the other species. Additionally, a considerable amount of the error can be attributed to the fact that each sticker represented 0.275 square miles on the ground, and a 3000 meter search radius was used for creating the kernel densities, both of which ensured that small areas of unsuitable habitat in close proximity to suitable habitat were included in the hotspots, even though that might not have been the intent of the participants. Thus, the results demonstrate that the public identified suitable habitat for these species with high levels of accuracy. Additionally, the results show that the conservation targets highlighted relatively small percentages of the total GAP defined suitable habitat (Table 2.3). Thus, the large GAP identified suitable habitat that lies outside of the conservation targets presents numerous opportunities for outreach education efforts (Figures 2.3-2.6).

Compatibility Analysis

However, it is important to note that these conservation targets do not exist in a vacuum. Certain additional stakeholder values, preferences, and opinions can overlap these targets and should be considered. PPGIS can be a useful tool for identifying these interactions, which could lead to increased support or conflict over conservation efforts (Nielsen-Pincus, 2011). Thus, we sought to identify areas within the conservation targets, which were developed from the PPGIS hotspots and GAP data, where other stakeholder preferences and opinions might be compatible with conservation. Therefore, we overlaid kernel density hotspots for places that participants believed should not be developed in the future onto the conservation targets developed for each animal in the study to identify areas of overlap, which represent low hanging fruits for conservation, since the public would like to see these areas remain undeveloped and be used for conservation, which are compatible preferences (Figure 2.7). The results show that people actively support prohibiting future development on a sizeable area of these conservation targets (Table 2.4). Additionally, we overlaid publicly identified pollution threat hotspots onto the conservation targets to identify areas of overlap with the conservation targets, which represent places where stakeholders have increased environmental concern, and thus would support clean-up efforts, which would aid conservation in these locations (Figure 2.8). Table 2.4 demonstrates that the public views pollution as being a greater threat to black bear and manatee conservation targets than wading bird and sea turtle targets. In addition, we sought to identify areas in the conservation targets where other stakeholder preferences might conflict with conservation efforts. Thus, we overlaid hotspots for places that stakeholders believe are appropriate for future residential development onto the conservation targets to identify areas of overlap, which highlight places with conflicting stakeholder preferences (Figure 2.9). The results in Table 2.4

indicate that there were no areas of conflict between conservation targets and places for future residential development, which represents the ideal outcome for management.

Management Implications

Since public participation is becoming more important in the decision making process for wildlife management, it is becoming increasingly critical to develop and understand methods that improve the participatory process. This paper demonstrates that PPGIS, which has been used in many other facets of natural resource management, but not previously for wildlife, can be used as an effective tool for enhancing public participation in wildlife management. PPGIS can provide managers with spatial information about where large numbers of stakeholders would like to see specific conservation efforts focused, which can then be easily compared with other scientific data in a GIS database. Additionally, the results of this study, along with similar findings by Brown (2012) on participant identification of native vegetation in New Zealand, show that participants can identify suitable locations for conservation with a high level of accuracy, which makes the results valuable and useful for planning purposes. We recommend that areas where the hotspots and GAP range overlap, which we term “conservation targets,” be prioritized for conservation efforts, since they represent suitable habitat where there is significant public support for conservation efforts. Therefore, these areas represent a low hanging fruit for conservation efforts. Some portions of the conservation targets are already located on protected lands or are located on open water. However, those terrestrial sections that do not fall on protected areas can be targeted for acquisition, particularly those adjacent to protected areas.

Additionally, PPGIS offers the opportunity to examine the effects of additional social factors on conservation preferences, which can highlight locations with increased conservation opportunities or land use conflicts. First, we examined PPGIS items that should provide additional public support for conservation. Thus, we identified places where the conservation targets overlapped with publicly preferred hotspots for no development. This preference complements the desire for conservation on the areas of overlap, since stakeholders have indicated that they would like these areas to remain undeveloped and be used as habitat for the conservation of threatened species. Public identification of threats can also be used as a way to identify places with strong public support for wildlife conservation efforts. In this study, participants identified places that they believe threaten air and water quality through pollution. These pollution hotspots were then overlaid with the conservation targets to show places that people think should be maintained as habitat for the conservation of threatened species and are threatened by pollution. The identification of this threat again should complement conservation efforts, since people recognize that this pollution is threatening their region, and conservation efforts would help reduce this pollution. Thus, PPGIS offers the opportunity to easily factor other social preferences into wildlife management decisions to support conservation efforts.

PPGIS studies can also aid conservation efforts by identifying where other stakeholder values conflict with wildlife conservation targets at a certain location. To illustrate this point, we identified kernel density hotspots for places where people think future residential development is acceptable and overlaid these results with the conservation targets for each of the four species. The areas of overlap represent places of conflicting stakeholder values. Despite the fact that these places fall within the conservation targets that we previously identified, it might be prudent to prioritize conservation efforts on target areas that do not overlap with hotspots for other conflicting values, such as these development preferences, since this might result in conflict, which would divert resources away from conservation. While it is never possible to please every stakeholder, PPGIS offers a practical toolset for efficiently capturing and analyzing stakeholder management preferences, allowing managers to make informed decisions and understand tradeoffs.

Conclusions

The results of this study demonstrate that PPGIS can be an extremely useful tool for wildlife management and conservation. This tool allows for the minimization of conflict stemming from competing stakeholder values, allowing conservation efforts to focus on the most suitable and publicly supported locations that are also scientifically supported. However, there are numerous avenues for future research. As a follow up to this study, more research should be conducted on determining kernel density thresholds for PPGIS items that are not associated with fixed locations, such as the black bears in this study. Future research should determine whether or not it is appropriate to use lower kernel density thresholds to identify hotspots for these types of items. However, the bear results are not insignificant for management purposes. While the results do not show large hotspots, they show moderate kernel densities covering much larger areas. These results indicate that there is a significant degree of support for bear conservation, but the points are distributed across a wider area so they do not produce hotspots. Additionally, more research should be conducted to understand why participants identified specific locations for wildlife conservation to determine how outreach education efforts and media reports influence public conservation preferences. Ultimately, we believe that the use of this tool can greatly benefit wildlife management, and the data from this study is currently being used by the Mobile Bay National Estuary Program in the development of its regional management plans.

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Table 2.1 – Selected PPGIS Items and Results

PPGIS Item	Definition	Number of Dots Used	Percent of Available Dots Used by Participants
Black Bears	I would like to see these places maintained for the conservation of black bears.	530	43.80%
Manatees	I would like to see these places maintained for the conservation of manatees.	506	41.82%
Sea Turtles	I would like to see these places maintained for the conservation of sea turtles.	651	53.80%
Wading Birds	I would like to see these places maintained for the conservation of wading birds.	715	59.09%
Air Pollution	Please indicate places that you believe threaten air quality.	526	43.47%
Water Pollution	Please indicate places that you believe threaten water quality.	664	54.88%
No Development	Please indicate places where you think any future development should be prohibited.	665	54.96%
Residential Development	Please indicate places where you think residential development could occur with a well-designed plan.	485	40.08%

Table 2.2 – Areas of PPGIS Hotspots for Wildlife Conservation

Species	Hotspot Area (mi^2)
Black bears (0.67 threshold)	5.60 mi^2
Black bears (0.33 threshold)	240.64 mi^2
Wading birds	106.27 mi^2
Manatees	44.02 mi^2
Sea turtles	124.81 mi^2

Table 2.3 – PPGIS Accuracy Assessment for Wildlife Habitat

Species	Percent of PPGIS points in GAP habitat	Percent of hotspot within GAP habitat	Area of conservation target (mi^2)	Percent of total GAP habitat included in conservation target
Black bears	79.62%	86.28%	207.63 mi^2	10.59%
Wading birds	74.69%	78.39%	83.30 mi^2	5.49%
Manatees	80.83%	73.24%	32.24 mi^2	2.72%
Sea turtles	60.06%	68.20%	85.14 mi^2	9.35%

Table 2.4 – Public Preference Interactions with Conservation Targets

	Hotspot area (mi^2)	Area of overlap with conservation targets (mi^2)			
		Black bears	Wading birds	Manatees	Sea turtles
Development	7.24 mi^2	0 mi^2	0 mi^2	0 mi^2	0 mi^2
No development	70.95 mi^2	0 mi^2	19.02 mi^2	4.54 mi^2	33.20 mi^2
Pollution	166.22 mi^2	5.60 mi^2	4.73 mi^2	6.56 mi^2	0 mi^2

Figure 2.1 – Study Area: Mobile Bay, AL

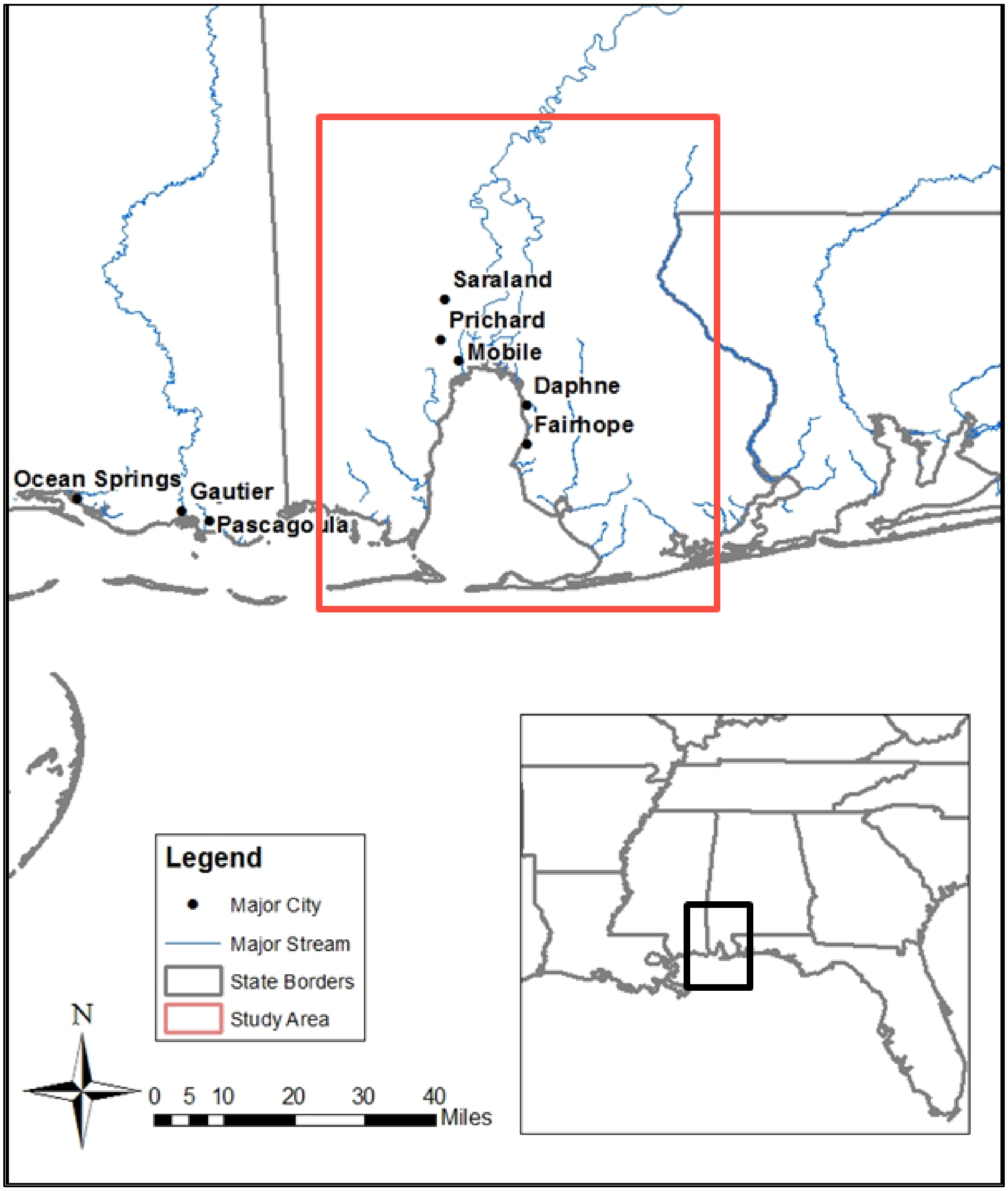


Figure 2.2 – Wildlife Kernel Density Hotspots

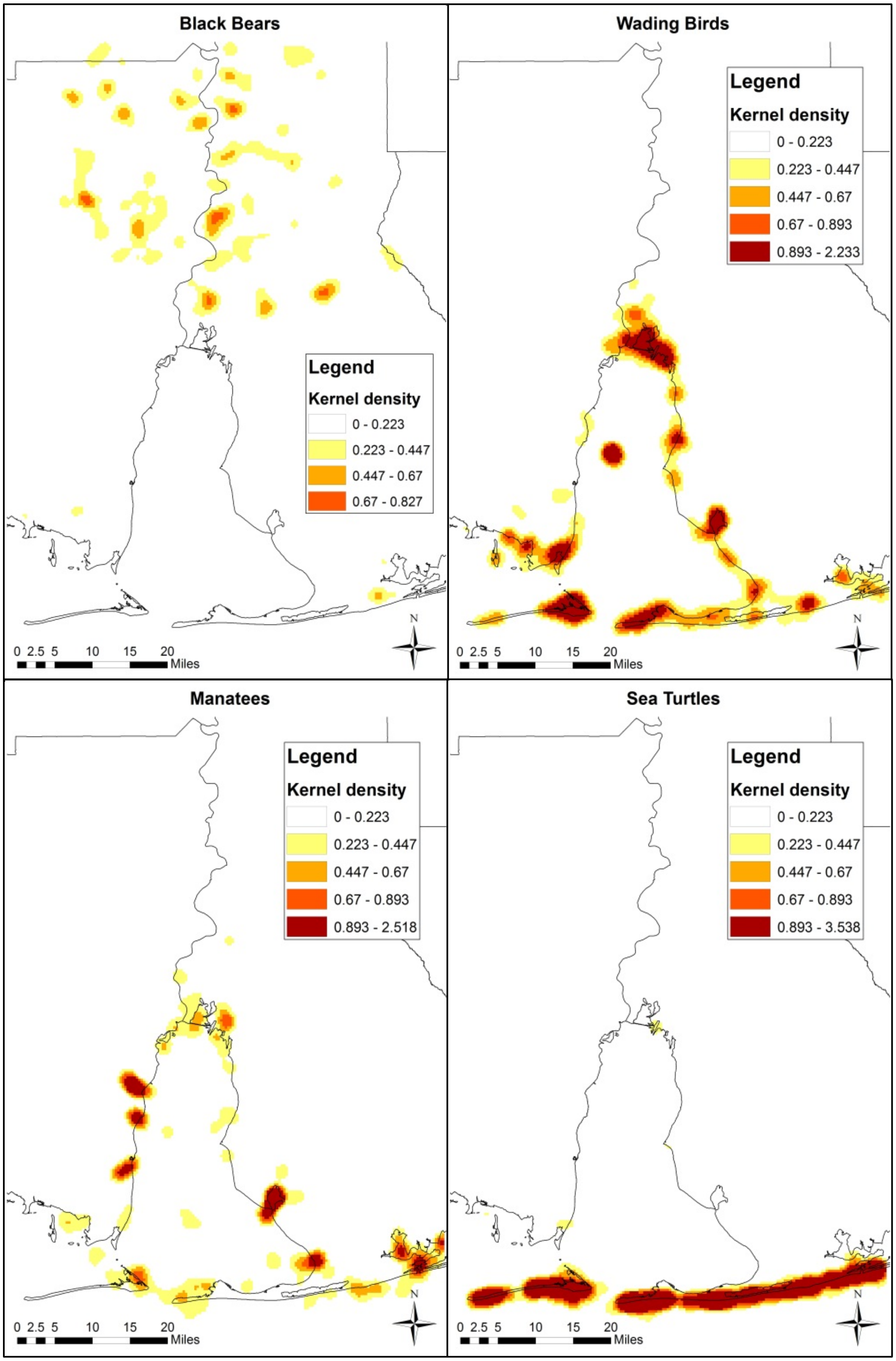


Figure 2.3 – Black Bear Conservation Targets

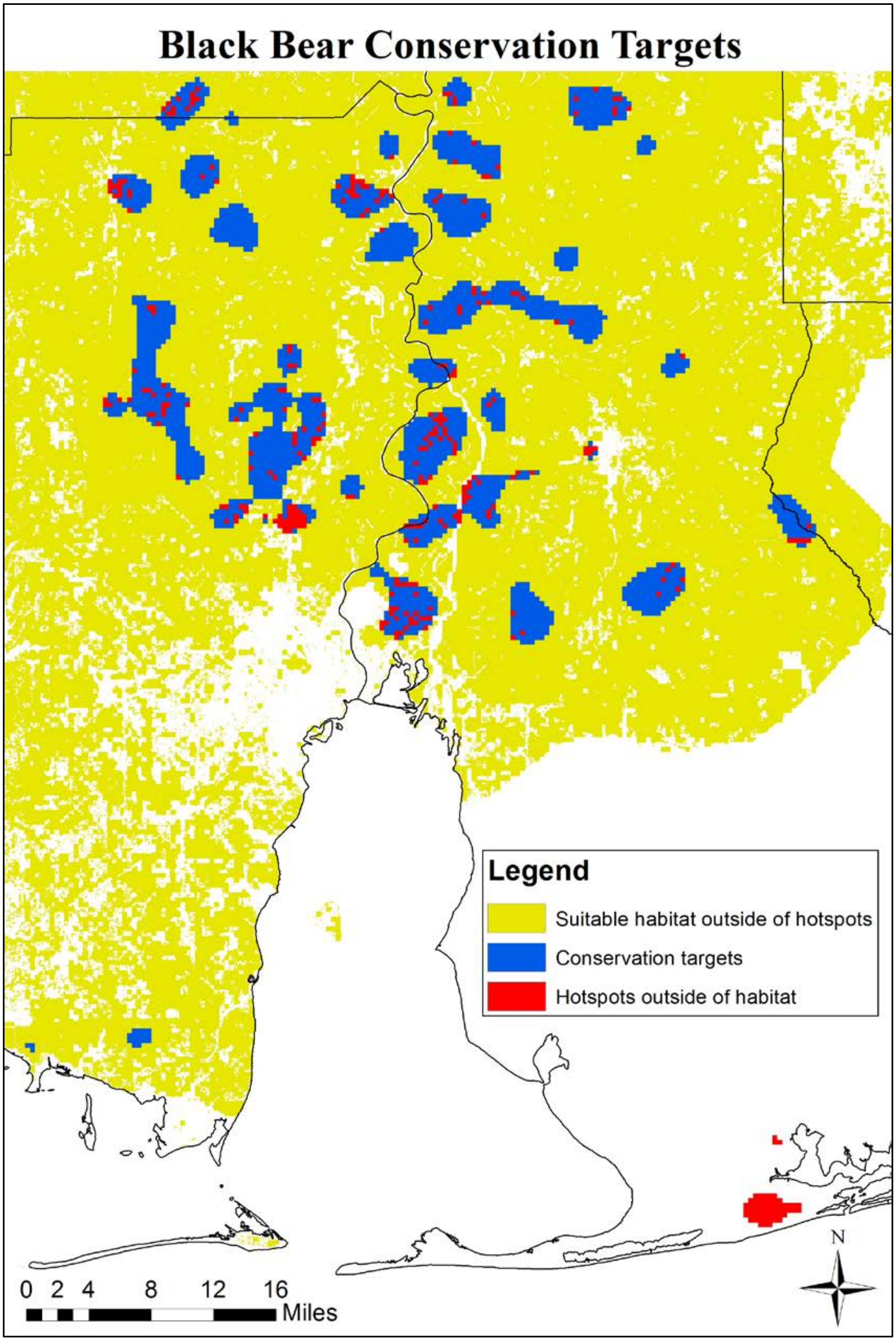


Figure 2.4 – Wading Bird Conservation Targets

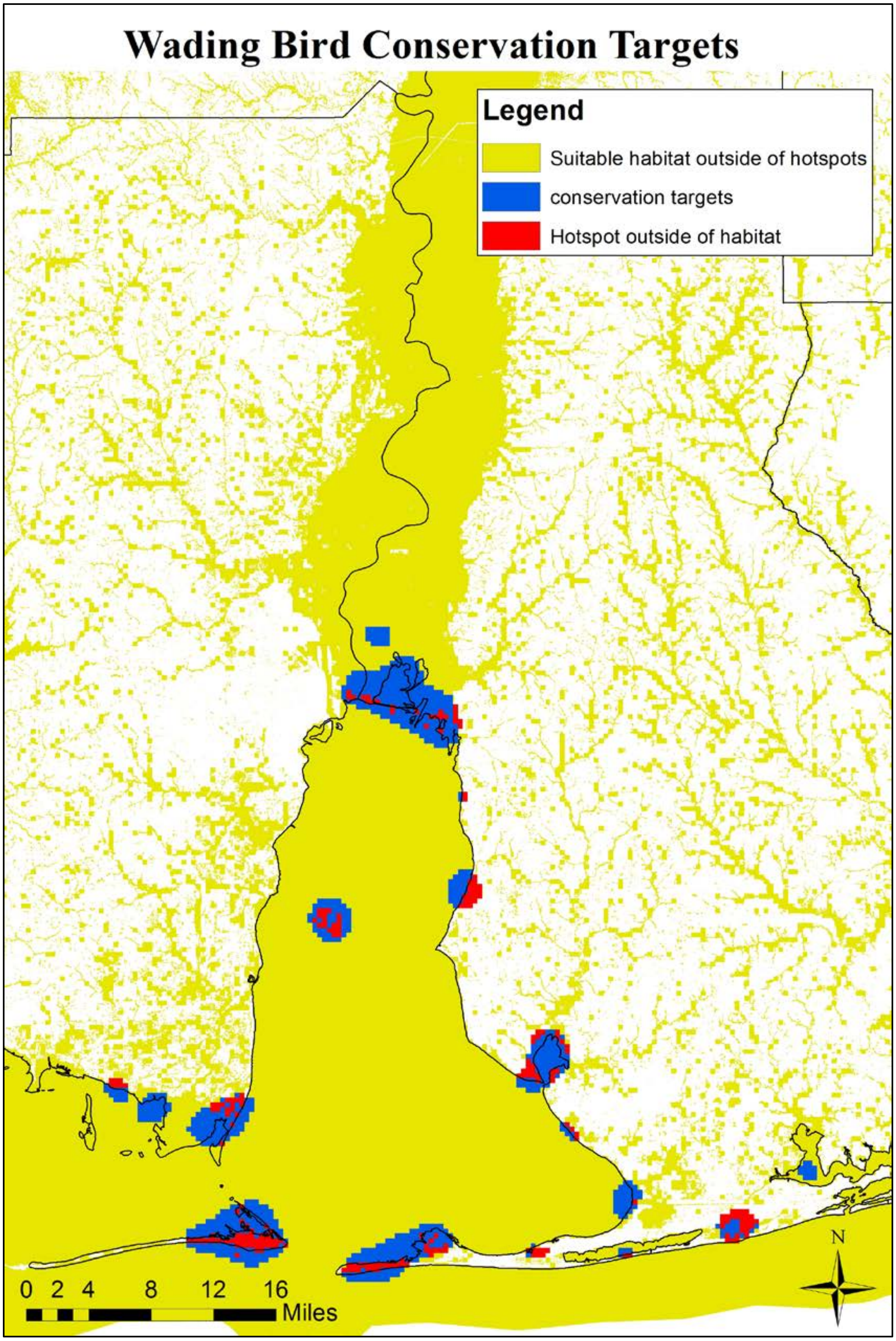


Figure 2.5 Manatee Conservation Targets

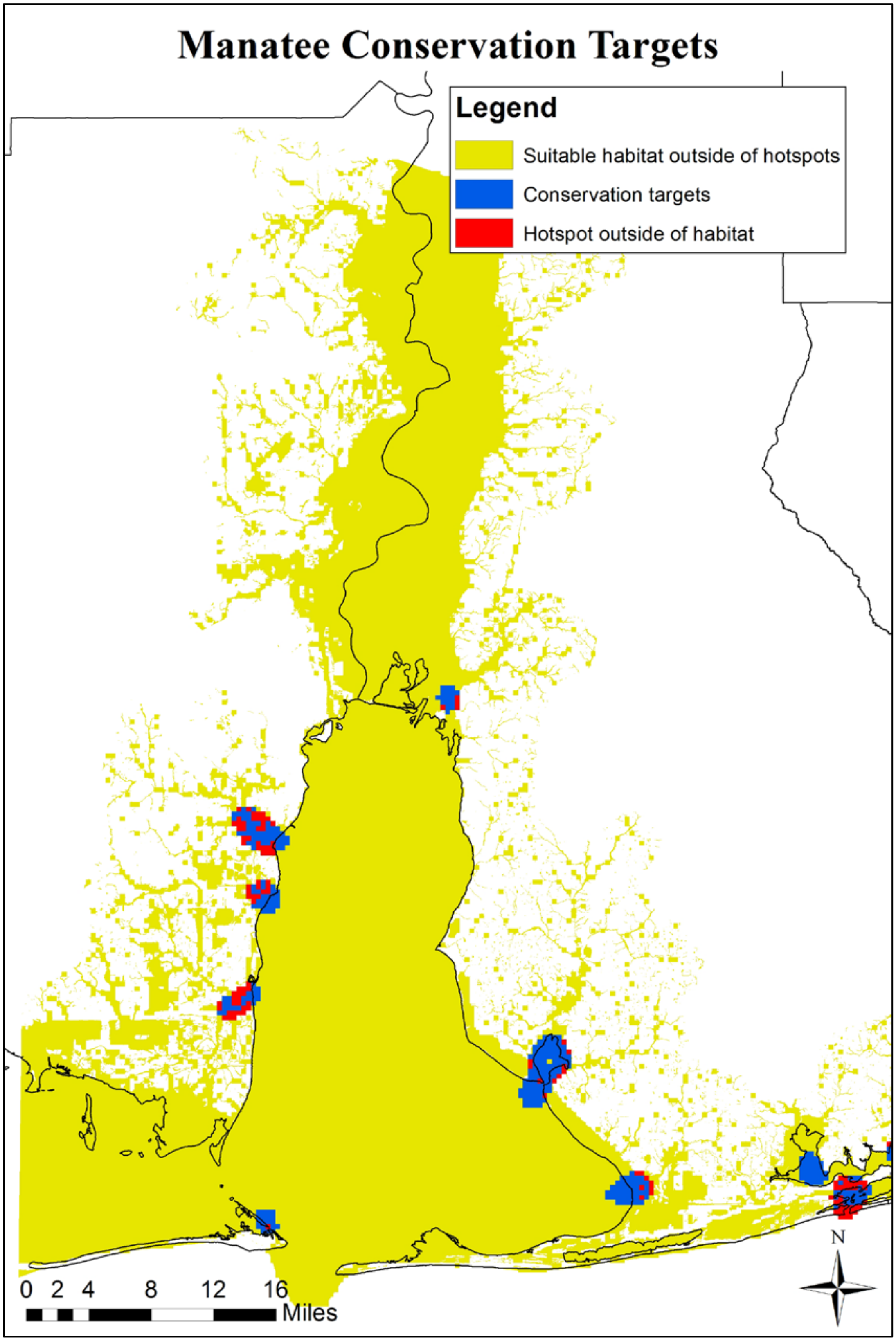


Figure 2.6 – Sea Turtle Conservation Targets

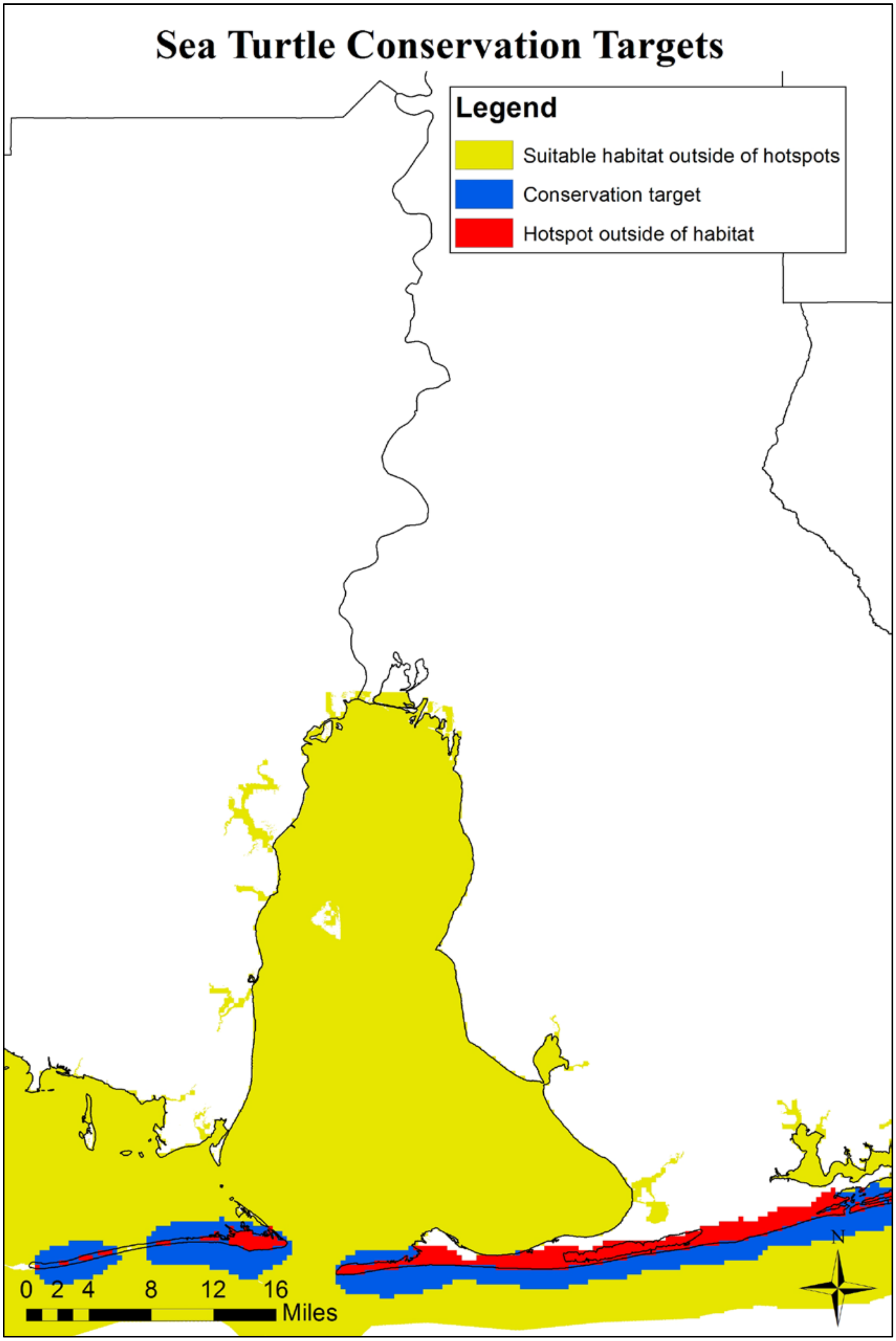


Figure 2.7 – Overlap of Public Preferences for No Future Development and Sea Turtle Conservation Targets

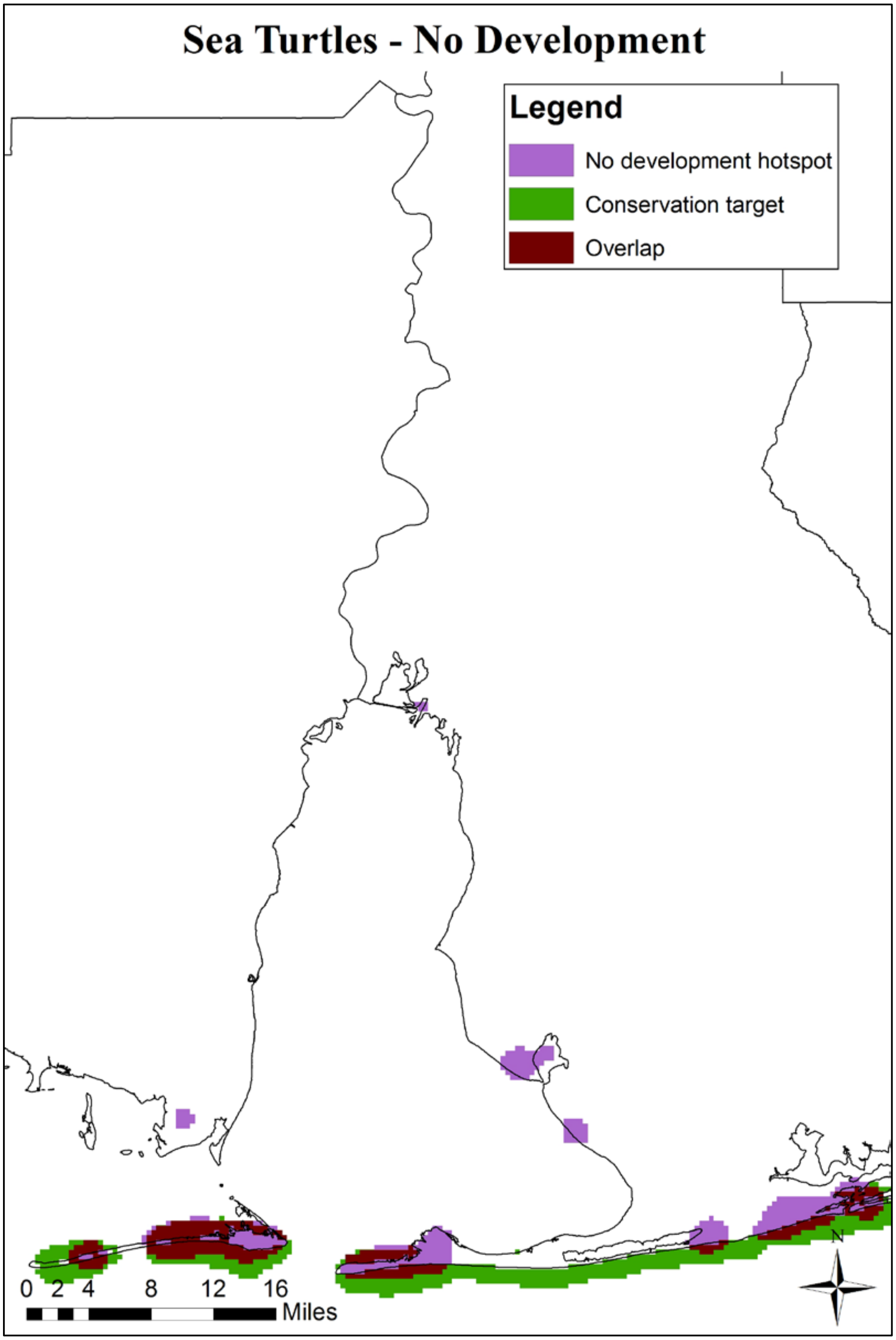


Figure 2.8 – Overlap of Publicly Identified Pollution Threats and Manatee Conservation Targets

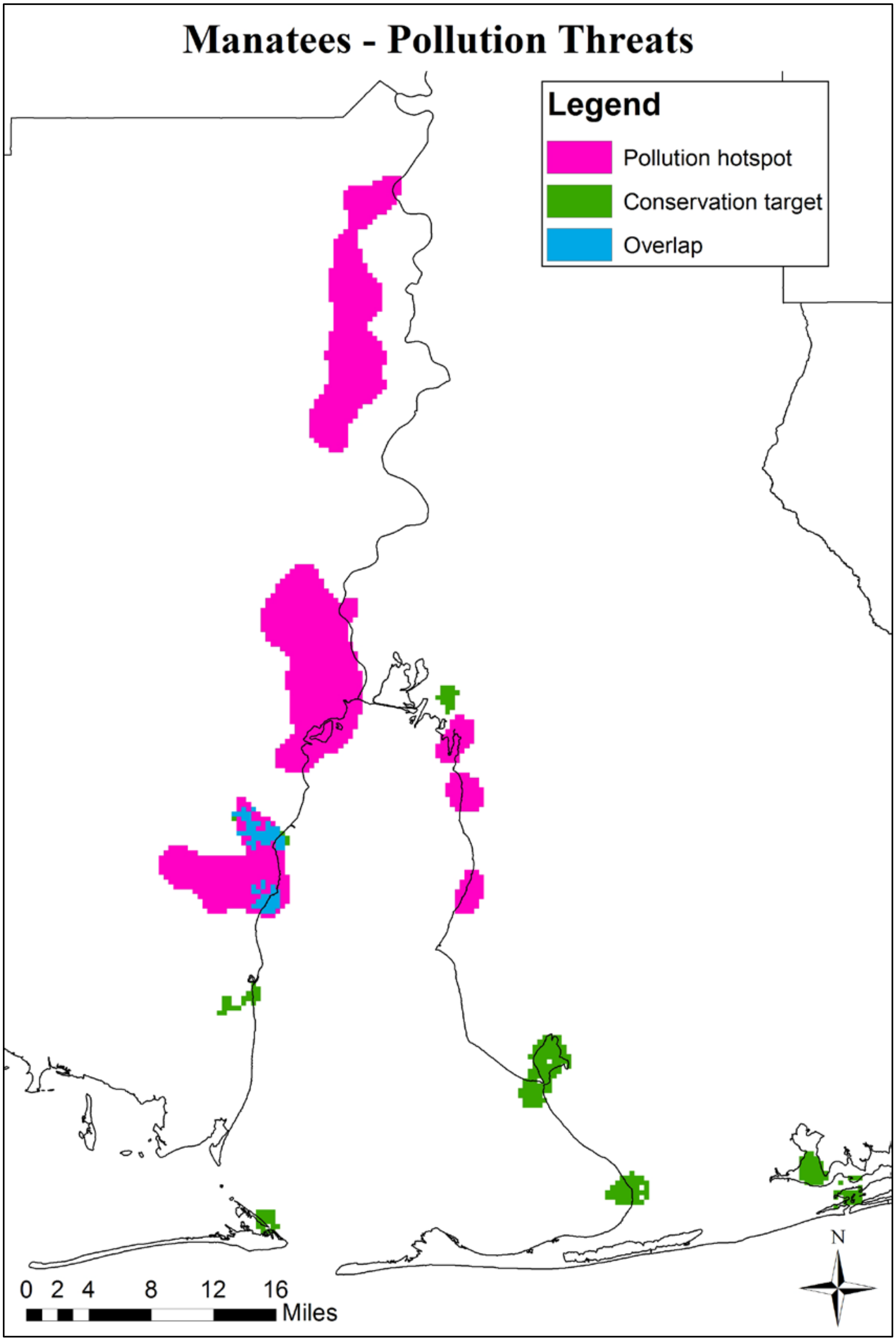
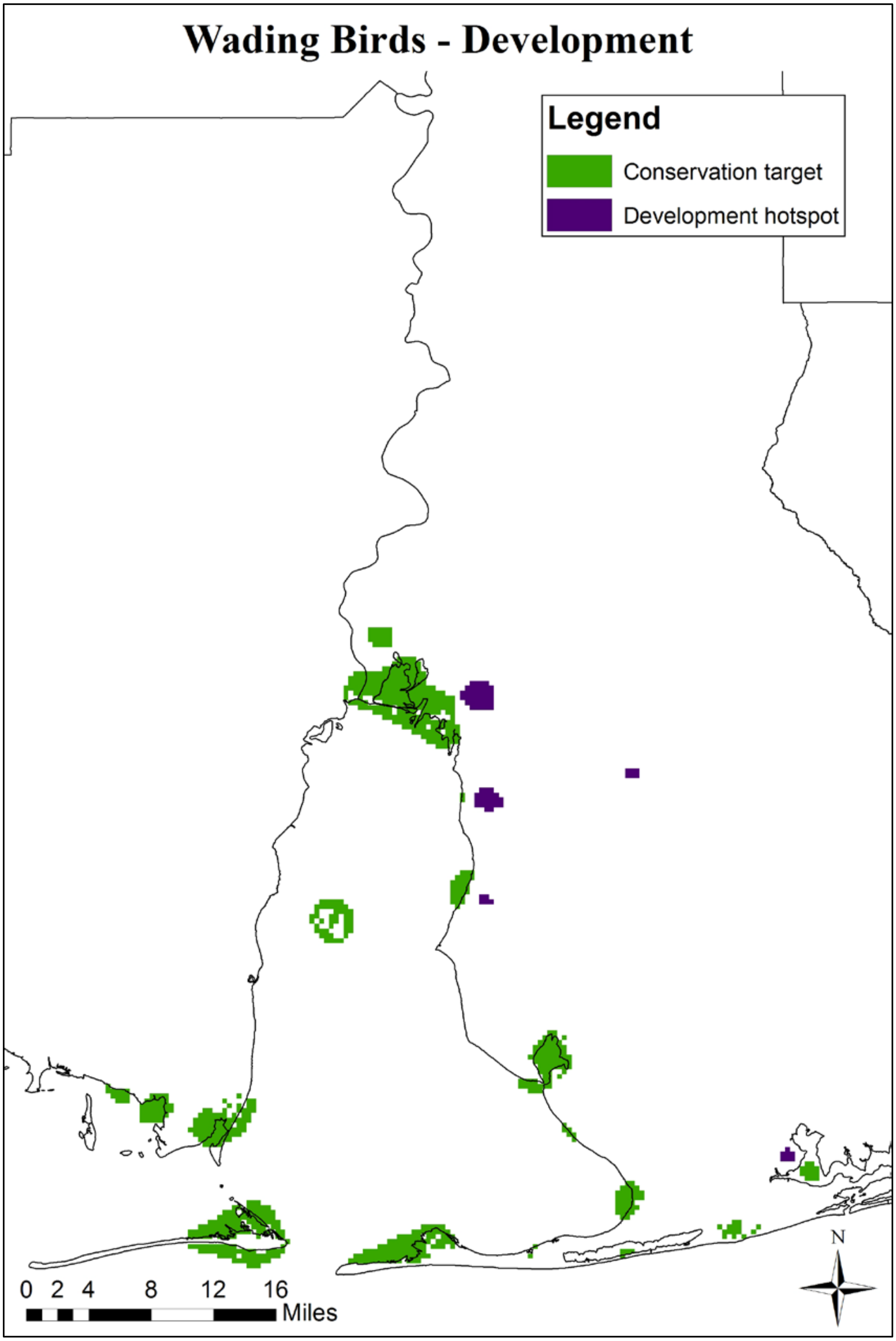


Figure 2.9 – Overlap of Public Development Preferences and Wading Bird Conservation Targets



Chapter 3: Using Public Participation Geographic Information Systems to Identify General Public Accuracy in Identifying Places of Ecosystem Provisioning

Abstract

As a result of changing trends within the field of natural resource management, there is a growing need to make the decision making process more participatory. Due to the fact that much of the scientific data that is used for natural resource planning is stored in Geographic Information Systems (GIS) databases for efficient analysis and comparison of different features, it would also be beneficial to store social data in the same way. Thus, Public Participation Geographic Information Systems (PPGIS) has been developed to spatially capture the landscape values, management preferences, and opinions of stakeholders. However, it is necessary to understand how accurate participants are in identifying places when using these data to inform management decisions. Previous studies have used PPGIS methods to elicit stakeholder identification of places that are important for ecosystem service provisioning, but none have analyzed the spatial accuracy of the identification of these places by a representative sample of the general public. This paper sets out to assess the accuracy of participant ecosystem service identification and demonstrate how this information can be useful for management purposes.

Keywords: Public Participation GIS, ecosystem services, collaboration, spatial

Introduction

Ecosystems produce a wide variety of beneficial commodities for humans, ranging from concrete products, such as food, to more esoteric services, such as spiritual value (Millennium Ecosystem Assessment, 2005). All of these benefits provided to humans by ecosystems are termed ecosystem services. Research into the human dimensions of ecosystem services has focused on the economic valuation of the services produced, as well as the markets for these services and the ecology behind these services to determine how much of a particular service a specific type of ecosystem can produce, and the monetary worth of that service (e.g. Costanza et al., 1989; National Research Council, 2004; Millennium Ecosystem Assessment, 2005; Daily et al., 2011; Engle, 2011). However, there is a distinct need to delineate these areas, since places of ecosystem service provisioning often vary across a landscape (Swetnam et al., 2011; Maes et al., 2012). Moreover, the extent of the area providing the ecosystem service must be defined spatially in order for any type of value to be assigned to it (Hein et al., 2006). Additionally, there is a need to understand the stakeholder values and opinions associated with specific ecosystem services, since stakeholders have begun pushing for inclusion in the natural resource management decision-making process, driving the introduction of more collaborative approaches to natural resource management (Bryan et al., 2010; Smith & McDonough, 2001; Kumar & Kumar, 2008). Previous research has demonstrated that eliciting stakeholder participation in management decisions frequently results in heightened public awareness about the issues, increased stakeholder support for the management decisions and trust in the managers to make fair decisions, and greater public support for the management outcomes as a result of their involvement in the process (Treves et al., 2006; Schusler et al., 2003; Morse, 2012).

It is beneficial to incorporate spatial data when integrating stakeholder opinions and preferences into natural resource management decisions, since it is important to understand the meanings of specific places to stakeholders because competing place meanings are often the source of natural resource conflicts (Cheng et al., 2003). Additionally, many aspects of natural resource management, particularly environmental data, are stored in Geographic Information Systems (GIS) databases for spatial analysis (Bengston et al., 2004; Theobald et al., 2005). Thus, it is advantageous for social data to be captured and stored using the same medium, allowing it to be easily overlaid upon other spatial data for spatial analysis (Morse et al., 2009). It is also important for managers to understand where the public thinks important places for ecosystem service provisioning are located because it allows them to focus protection efforts on certain areas where there is high public support and understanding, while also identifying gaps or important areas that the public did not identify or misidentified, which should be targets for outreach education efforts (Swetnam et al., 2011; Don Carlos et al., 2009; Sherrouse et al., 2011).

Places that the public think are important because they provide a specific ecosystem service can be efficiently identified spatially using Public Participation Geographic Information Systems (PPGIS). PPGIS is a tool that allows participants to identify important places and management preferences on a map, providing the opportunity for participatory decision making in the frequently expert led, technical field of GIS-based planning (Sieber, 2006). The purpose of PPGIS is to facilitate the identification by stakeholders of important places, opinions, and preferences on a map, which can then be imported into a GIS database for spatial analysis. Different tools for place identification, such as points (Brown, 2005) and polygons (Brown & Pullar, 2012) have been tested. Additionally, various approaches have been used to collect

PPGIS data. Some studies have used a more qualitative design, collecting PPGIS data through one on one interviews (Talen, 2000) or focus groups (Lowery & Morse, in press). Others have used more quantitative methods, such as mail-based surveys (Brown, 2005) or internet surveys (Pocewicz, et al. 2012). The quantitative methods allow the researcher to efficiently collect PPGIS data from a large representative sample of stakeholders. Pocewicz et al. (2012) recorded much higher response rates for mail-based PPGIS surveys than internet-based PPGIS surveys in a comparative study. However, regardless of the data collection method, PPGIS results are ultimately entered into a GIS database, allowing for spatial analysis.

PPGIS studies have been applied to a wide array of topics, ranging from landscape values (Brown, 2005; Beverly et al., 2008; Zhu et al., 2010; Nielsen-Pincus, 2011; Sherrouse et al., 2011) to knowledge about local ecosystems (Raymond et al., 2009; Bryan et al., 2010; Brown et al., 2011; Sherrouse et al., 2011; Brown, 2012) to the identification of threats and human impacts on the environment (Raymond & Brown, 2011; Brown & Weber, 2011) to development preferences (Brown & Raymond, 2007). Studies using PPGIS have ranged geographically from the United States (Brown & Reed, 2009) to Australia (Raymond et al., 2009), in landscapes as disparate as the Prince William Sound Region in Alaska (Brown et al., 2004) and neighborhoods in downtown Dallas, TX (Talen, 2000).

While a few previous studies (Raymond et al., 2009; Bryan et al., 2010; Brown et al., 2011) have used PPGIS methods to identify places that stakeholders think are important because they provide ecosystem services, there are still significant gaps in the literature. First, we aimed to determine whether or not a representative sample of the general public could spatially conceptualize these ecosystem services, and whether a mail-based PPGIS survey is an effective tool for capturing this information. Previously, Raymond et al. (2009) and Bryan et al. (2010), whose paper used the same data as Raymond et al. (2009), used a PPGIS method to capture stakeholder ecosystem service values. They conducted their study in the form of one-on-one interviews with 56 selected participants who “were perceived to shape opinions and actions regarding the management of natural resources in the region” (Raymond et al., 2009, p. 1304). While these participants might have represented the complete range of stakeholder opinions, they were likely more knowledgeable about natural resources and ecosystem services than the average member of the general public. Additionally, in the interview setting, the participants “were asked to locate and describe places of value and threat,” which makes the process more open-ended, rather than identifying places that they value for providing a specific service, which tests spatial knowledge about specific services (Raymond et al., 2009, p. 1305). Furthermore, the interview process requires a large time investment, making it difficult to capture responses from a large sample quickly and efficiently. Brown et al. (2011) sought to determine whether the values stakeholders associate with ecosystem services could be captured using a broader-based survey technique, so they developed an internet-based PPGIS survey that included a range of ecosystem services. However, this study suffered from low response rates, and the results were skewed by the fact that 12 percent of the respondents identified 50.9 percent of the places of ecosystem service value due to the fact that the number of points that a single participant could identify was not constrained (Brown et al., 2011). Thus, we sought to build upon this literature by developing a mail-based PPGIS survey with a fixed number of points that could be used to identify places for each ecosystem service, so that we could test whether a representative sample of the general public can conceptualize and identify places in the landscape that provide specific ecosystem services.

Additionally, previous studies have not assessed the scientific accuracy of the places that participants have identified as being important sources of specific ecosystem services to verify that these places actually provide the services that participants have identified. According to Brown (2012), "accuracy reflects how well the marker approaches the true spatial dimensions of the attribute being identified," and, in "PPGIS is influenced by a number of variables including the nature of the PPGIS attribute being mapped …, the quality of the mapping environment …, and respondent characteristics such as familiarity with the study landscape" (p. 290). It is important for managers using a PPGIS survey to capture stakeholder ecosystem service values to understand how accurate the data is before incorporating it into a management plan (Don Carlos et al., 2009; Lowery et al, 2012). Thus, we sought to determine the level of spatial accuracy with which participants could identify places that provide certain specific ecosystem services. A previous study assessing the accuracy of PPGIS identification of native vegetation in New Zealand found that participants can identify natural resource based PPGIS items with a high degree of spatial accuracy (Brown, 2012). Therefore, we predicted that participants in this study would be able to identify places that provide specific ecosystem services with a high level of spatial accuracy. These methods will allow us to assess whether members of the general public conceptualize places of ecosystem provisioning similarly to scientific experts (Kumar & Kumar, 2008).

The goal of this study was to determine whether spatial data identifying places that are important for providing ecosystem services collected from a randomly selected general public sample provide useful information for natural resource management. In consideration of the number of services to take into account, Raymond et al. (2009) asked their participants to explain the places of ecosystem service value that they identified using a typology including 40 specific ecosystem service categories. However, they noted that participants had difficulty identifying places that provide very specific, technical, and difficult to comprehend services. Thus, we chose four distinct ecosystem services for this study that likely impact the lives of stakeholders regularly and significantly, to facilitate their ability to spatially conceptualize these services. We determined that this subset of services would allow us to investigate the previously defined research gaps while avoiding asking participants to identify an unnecessarily large group of services, many of which, such as genetic resources and pollination, would be difficult for experts, let alone general public participants, to delineate spatially (Raymond et al., 2009).

Methods

Study Area

The Mobile Bay region, as defined by this study, is a 4,607 square mile area comprising nearly all of Baldwin and Mobile counties, Alabama (Figure 3.1). This region is focused on Mobile Bay, which is 413 square miles, and also contains the entirety of Alabama's Gulf Coast, which features several other smaller bays. Mobile Bay is fed by the Mobile and Tensaw rivers, in addition to numerous other smaller rivers and streams. The Mobile-Tensaw River Delta, located at the northern edge of Mobile Bay, is the second largest delta in the U.S. As a result, the region provides many important ecosystem services associated with water. Additionally, Mobile and Baldwin counties have a combined population of 599,294 (U.S. Census Bureau, 2010). However, it is unevenly distributed across the landscape, with much of the population clustered in a few urban areas, such as Mobile, in which 194,914 people reside (U.S. Census Bureau, 2010). This study area was chosen due to its variety and complexity of aquatic features, in addition to the fact that it includes several popular recreation destinations, is home to an array of threatened and endangered species, and is vulnerable to a range of human induced threats, particularly water pollution.

Ecosystem Service Choice

Since the study area was focused on a region that is dominated by aquatic ecosystems, we selected four ecosystem services that are all provided by watersheds to test stakeholders' ability to spatially identify places of ecosystem service provisioning. Wetlands and forested watersheds provide a wide array of important ecosystem services including habitat provisioning, biodiversity support, water quality protection, groundwater recharge, flood protection, nutrient retention, carbon sequestration, erosion control, nutrient export, storm buffering, provisioning of fresh water, recreation opportunities, places of cultural significance, fish nurseries, and places of aesthetic value (Zedler, 2003; Pattanayak, 2004; Millennium Ecosystem Assessment, 2005; Postel & Thompson, 2005; Zedler & Kercher, 2005; Turner et al., 2008; Peterson & Lowe, 2009; Wamsley et al., 2010; Engle, 2011).

While all of these services are important, we sought to select a subset that we felt participants would realistically be able to conceptualize and spatially identify with some degree of accuracy. Thus, we sought to avoid excessive or overlapping services by choosing four that routinely impact many Mobile Bay residents and are spatially explicit and sufficiently general for public understanding and identification. Additionally, we chose services that were provided by relatively large areas distributed throughout the region.

The four watershed services selected for public identification were fish nurseries, storm protection, flood protection, and water quality protection (for descriptions see Table 3.1). In this region, nearshore marine environments, coastal wetlands, and estuaries provide important habitat for juvenile saltwater fish to grow and mature, supporting the Gulf of Mexico's fisheries (Chambers, 1992; Zedler, 2003; Zedler & Kercher, 2005; Turner et al., 2008; Peterson & Lowe, 2009; Engle, 2011). Storm protection occurs when coastal wetlands, beaches, and barrier islands help to buffer against offshore storms, particularly hurricanes in this region, mitigating the damage to areas farther inland (Loder et al., 2009; Wamsley et al., 2010; Engle, 2011). Flood protection refers to the ability of inland stream channels, wetlands, and forested riparian buffers to retain stormwater and prevent potential flooding downstream (Zedler, 2003; Pattanayak, 2004; Postel & Thompson, 2005; Zedler & Kercher, 2005; Turner et al., 2008). Water quality protection denotes the removal of sediment, pollutants, and other objects from water. This service is provided particularly by riparian forests, wetlands, and streams, all of which help to filter unwanted materials out of the water through a combination of physical and biological processes (Zedler, 2003; Pattanayak, 2004; Postel & Thompson, 2005; Zedler & Kercher, 2005; Verhoeven et al., 2006; Turner et al., 2008; Engle, 2011).

Data Collection

In order to identify places that the public think are important for ecosystem service provisioning, we created a PPGIS-based survey, which was mailed to 988 randomly selected residents of Mobile and Baldwin counties in the summer of 2012. The addresses were purchased from Survey Sampling International (SSI, 2012). To reflect the population distribution of the two counties, 69 percent of the surveys were sent to residents of Mobile County and 31 percent were sent to residents of Baldwin County. We used a four contact approach adapted from the one created by Dillman et al. (2008) to distribute the survey. Members of the selected sample were first sent a pre-notice letter which notified them that they had been chosen to take part in the study. Two weeks later they were mailed the survey packet. After another two weeks, those who had not yet responded were mailed a reminder postcard. Those who had still not responded after an additional two weeks were sent a final reminder letter.

The survey was designed for participants to identify places in the Mobile Bay region that they think are important because they provide specific water-related ecosystem services and to pinpoint threats to these services (Appendix I). The surveys consisted of a PPGIS mapping activity and a questionnaire, which focused on the participants' knowledge of places in the region, recreation activities performed in the region, perceived regional threats, and demographic information. Additionally, the questionnaire asked participants to rate the importance of each of the four watershed services to themselves on a seven point Likert scale. The PPGIS mapping exercise requested that participants use a set of 0.25 in. stickers to identify places in the Mobile Bay region that they believe are important because they provide watershed services, such as fish nurseries, storm protection, flood protection, and water quality protection, as well as places that they think threaten the region because of water pollution (Table 3.1). Participants were asked to identify those locations by placing the stickers, which were color-coded to correspond to each service or threat, onto a 24 x 36 in. map of the study area (Brown, 2005). The basemap was a true color aerial photograph of the Mobile Bay region, acquired from the Bing Maps Aerial collection, which was displayed at a scale of 1:150,000. The map also displayed cities, major roads, and the boundaries of lands that are protected at the federal and state levels for participants to use as spatial references.

Data Analysis

We employed the technique of heads-up digitizing to enter the PPGIS mapping activity results into our GIS database (Brown et al., 2004). Following this technique, we digitized the stickers as points in the GIS database by manually locating those points and entering them on the digital version of the map to correspond as closely as possible to the locations of the stickers on the physical maps (Brown et al., 2004). For the digitization process, the GIS version of the map was set at a 1:1 size ratio to the physical survey maps to reduce the possibility of digitization error (Brown et al., 2004).

Kernel density analysis was then performed on these points using the ArcGIS Spatial Analyst extension to identify where participant-identified places of importance for watershed services and pollution threats. To calculate kernel density, the tool "fits a smoothly curved surface (grid) over each point producing a circular area (kernel) of a certain bandwidth (or search radius)" (Brown & Weber, 2012, p. 9). We used a 3000 meter search radius and a 500 meter grid cell size to calculate kernel densities for this study, based on the recommendations of Brown and Pullar (2012). The kernel density analysis shows where PPGIS items cluster on the map at significant densities, with higher densities representing greater levels of stakeholder agreement (Brown & Weber, 2012). For this study, we identified a 0.67 kernel density threshold for determining kernel density hotspots based on the recommendation of Brown and Pullar (2012).

Next, we classified the land cover of the study area, using data from the Land Cover Map of Ecological Systems for the State of Alabama provided by the Alabama Gap Analysis Project (Kleiner et al., 2007). The GAP land cover data was derived from Enhanced Thematic Mapper Plus (ETM+) satellite imagery. The land cover data featured subpixel accuracy and a maximum positional error of 30 meters (Kleiner et al., 2007). The features in this imagery were then grouped into 71 classes, which distinguished a large range of specific land cover types. We then grouped these land cover types into seven broader categories based upon the Anderson classification system: water, wetlands, beach (barren land), rangeland, agriculture, forest land, and developed land (Anderson et al., 1976). Based upon widely reported trends, we identified which land cover classes were important for providing each mapped ecosystem service (Willemen et al., 2008). Storm protection is provided by beaches and coastal wetlands (Loder et al., 2009; Wamsley et al., 2010; Engle, 2011). Important lands for flood protection were considered to be provided by riparian forests, wetlands, and stream channels (Zedler, 2003; Pattanayak, 2004; Postel & Thompson, 2005; Zedler & Kercher, 2005; Turner et al., 2008). Essential areas for water quality protection were considered to be provided by wetlands, forests, and streams (Zedler, 2003; Pattanayak, 2004; Postel & Thompson, 2005; Zedler & Kercher, 2005; Verhoeven et al., 2006; Turner et al., 2008; Engle, 2011). Important fish nurseries were defined as tidal aquatic or wetland areas (Chambers, 1992; Zedler, 2003; Zedler & Kercher, 2005; Turner et al., 2008; Peterson & Lowe, 2009; Engle, 2011).

The accuracy of the participant-identified ecosystem service hotspots was assessed by clipping the modified GAP land cover data to the extent of the hotspots for each watershed service (Kleiner et al., 2007). Thus, we identified the percentage of each land cover class contained by the PPGIS hotspots for each watershed service. We then compared these data with the previously determined land cover classes that we identified as actually providing each service to assess the percentage of the PPGIS hotspots that fell on places with the necessary land cover to provide that service. This process allowed us to identify the spatial accuracy of the PPGIS watershed service hotspots.

Furthermore, spatial analysis of PPGIS items was used not only to identify where individual items clustered on a map, but also how different items interacted with one another. In this study, we asked participants to identify places that they thought threaten water quality in the region through water pollution. We then identified water pollution hotspots using the kernel density analysis method described above. These hotspots were overlaid with the previously defined hotspots for water quality protection and fish nurseries to identify areas of overlap, which highlight places that are important for watershed service provisioning and stakeholders believe are also threatened by water pollution. Additionally, the water pollution hotspots were overlaid with a map of streams that have been listed as being polluted by Alabama's 2010 303(d) List, which catalogs water bodies that do not meet EPA water quality standards, which was acquired from the Alabama Department of Environmental Management. This overlay allowed the participant water pollution data to be compared with expert-derived water pollution assessments.

Results and Discussion

Response

We mailed survey packets to 988 randomly selected residents of Baldwin and Mobile counties to collect the data for this study. Seventy-five (7.6%) of these packets were marked as undeliverable and returned by the U.S. Postal Service. Two hundred seventy-four (30.01%) useable surveys were returned. Of those respondents who returned the survey, 88.3% (n=242) chose to participate in the PPGIS mapping activity, identifying a total of 11,391 points for a range of landscape values and management preferences, including places that provide ecosystem services and places that are water pollution threats. Selected results for mapped items can be found in Table 3.1. In our study, 31 percent of the respondents identified 50.6% of the PPGIS points. Thus, the point distribution in our study was not as influenced by a few individuals as previous studies (Brown et al., 2011). However, it should be noted that some portions of the sample population were overrepresented in the survey responses, such as Caucasians, males, those with higher annual income, and those with higher levels of formal education.

The number of points used by respondents to identify places that are important for the provisioning of each watershed service differed dramatically (Table 3.1). Participants identified 679 points for fish nurseries and 578 points for storm protection, but only 452 points for water quality protection and 319 points for flood protection. However, when respondents ranked the importance of each of these services on a seven point Likert scale, the mean scores were quite similar (Table 3.1). These results possibly indicate that many participants were more confident in their abilities to spatially identify places that provide fish nurseries and storm protection than places that provide flood protection or water quality protection. Alternatively, these results could also indicate that participants believed that there were fewer places that provide water quality and protection and flood protection in the study area.

Kernel Density Results

The areas of the hotspots identified for each service differed dramatically (Figure 3.2), similar to the number of points used by participants to identify each service, despite the fact that the kernel densities were standardized to account for some having more points than others (Brown & Pullar, 2012). The hotspot areas for each service can be found in Table 3.2. The two services that participants identified with more stickers, fish nurseries and storm buffering, had much larger hotspot areas than the other two services. Since this result occurred despite standardization of the kernel densities, it reinforces the idea that participants were better able to conceptualize and identify the spatial requirements for these services, and thus significant numbers of participants identified the same places as being important for the provisioning of these services. On the other hand, participants seemed to have more difficulty identifying places that provide water quality protection and flood protection. The areas of the hotspots for these two services, especially flood protection, were much smaller, indicating that the points were more spread out across the landscape, which represents the fact that there was much less public consensus about which specific places actually provide these services and likely a difficulty in understanding what types of places provide these services.

Accuracy Assessment

While the kernel density hotspots identified places that significant portions of the general public think are important for the provisioning of specific ecosystem services, more information is needed to make these results truly applicable for management purposes. These hotspots show where public agreement is high, but do not show how this support correlates to scientific assessment. Thus, it is important to understand to what extent these hotspots include places that actually provide the corresponding ecosystem service. This information allows for the assessment of the public's ability to spatially identify these places, and makes sure that managers incorporating social data for the prioritization of protection efforts are targeting the correct places (Lowery et al., 2012). Therefore, we analyzed the land cover of the hotspots, and how they correspond to land cover characteristics are necessary for the provisioning of each of these services (Figures 3.3-3.6). The land cover distribution of the hotspots for each service is presented in Table 3.3. The results show that a high percentage of the hotspot area fell on the correct land cover. These results show that members of the general public were able to identify the correct types of places that provide these watershed services with an extremely high level of accuracy, except in the case of storm protection. Furthermore, a substantial portion of the error in the accuracy assessment can be attributed to the fact that the stickers provided to the participants to identify these places on the map were 0.25 inches in diameter, meaning that they covered 0.275 square miles on the map, causing a loss in precision. Additionally, the kernel densities were created using a 3000 meter search radius, which resulted in some small areas that were not identified by the participants' stickers being lumped into the hotspots due to their close proximity to numerous identified points. These sources of error can partially account for the fact that the correct percentage for storm protection was so low, since participants were identifying a very narrow coastal strip, and it is visually clear that all of the hotspots are situated in the right general areas along the coast (Figure 3.4). The case of storm buffering illustrates the fact that certain imprecisions are inherent when working with PPGIS data, and it is important to analyze the data visually, in addition to using technical analyses, to determine its applicability, since the storm buffering hotspots highlighted the proper general areas, particularly barrier islands, on the map but demonstrated low land cover accuracy, illustrating an issue in scale when determining hotspot accuracy. Thus, additional analyses should be developed to supplement the use of land cover to determine the accuracy of PPGIS hotspots for ecosystem service provisioning.

In addition to assessing the accuracy of the publicly-identified hotspots with scientific data, incorporating the land cover data allows for the analysis of public knowledge gaps. This allows a researcher to determine that a disproportionately low amount of a certain land cover type that is important for the provisioning of an ecosystem service fell within the publicly-identified hotspots. Thus, the researcher can determine that there seems to a lack of public knowledge about the importance of that land cover type for the provisioning of that service, presenting an outreach opportunity for public education about that issue. For example, the low percentage of wetlands identified in the storm protection hotspots offers an opportunity for outreach efforts to teach residents about the importance of coastal wetlands for storm buffering.

Pollution Threats

PPGIS analysis also allows for the comparison of multiple publicly-identified items with one another. To demonstrate this comparison, we identified water pollution hotspots and overlaid them onto a map of the study area streams that are included in the Alabama 303(d) list of impaired and threatened waters (Figure 3.7). These hotspots had a strong correlation to the listed streams. However, it is also interesting to note that one hotspot was focused on Dog River, which is not listed in the 303(d) report. This information shows that many stakeholders believe that this watershed is polluted, which should inspire further scientific investigation into this issue. Personal communication has shown that local managers are aware of pollution issues, particularly with litter, in Dog River and are actively working to improve the situation. Additionally, many 303(d) listed impaired streams were not identified by the PPGIS water pollution hotspots. This result can be attributed to the fact that participants were only given five stickers with which to identify water pollution threats, so they had to prioritize their choices and could not identify every one of the numerous impaired streams in the region. Furthermore, participants also identified sources of water pollution via runoff, such as factories, that were not located directly on 303(d) listed streams, but were located within the watersheds of those impaired streams, as water pollution threats.

Additionally, hotspot mapping allows for the interactions between hotspots for different items to be analyzed. In this case, we chose to examine how water pollution might threaten the provisioning of watershed services. To do so, we examined where the water pollution hotspots overlapped with the hotspots identified by participants for fish nurseries and water quality protection, since water pollution would not affect the provisioning of storm protection or flood protection (Figures 3.8 & 3.9). The results from this analysis show that participants did not think that water pollution is a major threat to the places that they identified as being important for the provisioning of fish nurseries or water quality protection, since only 1.54 square miles of each of these watershed service hotspots overlapped with the water pollution hotspots. If a significant overlap of pollution threats and these watershed services were to occur, it would indicate a serious issue that management should investigate immediately. Additionally, the upstream adjacency of water pollution hotspots to watershed service hotspots should raise concern, since water would flow from the polluted areas into the watershed service hotspots. Our results showed a high amount of adjacency, but the water pollution hotspots were identify separate watersheds from the watershed service hotspots, so there was less cause for concern.

Management Implications

Incorporating public participation is a growing trend in natural resource management, and it is becoming a necessary component in many decision making processes. As a result, it is important for managers to understand which places stakeholders think are important for the provisioning of specific ecosystem services. This information allows management plans to be tailored to the values and opinions of stakeholders. Knowing where the public think important places for the provisioning of the services are located can aid in the decision to target certain places for conservation efforts, since public support for ecosystem preservation would likely be higher in places where they have recognized the benefits. Additionally, it is important to know if the general public does not hold high value for a particular service or has difficulty identifying places that provide it. These public knowledge gaps provide important opportunities for outreach efforts, where natural resource decision makers can educate stakeholders about the importance of certain ecosystem services and what kinds of places provide them, allowing for greater future public support for the protection of those services.

This paper set out to determine whether a general public PPGIS survey is a useful tool for natural resource management to identify places that stakeholders think are important for ecosystem provisioning. Despite the fact that participants identified considerably more places that provide certain watershed services than others, we believe that this study shows that PPGIS can be an important tool for managing for ecosystem services. First, it demonstrates that a representative sample of the general public is knowledgeable about places that provide specific ecosystem services in their local region and can spatially identify these places, which supports Raymond et al.'s (2009) conclusions that stakeholders can locate places that produce particular ecosystem services on a map. Additionally, it highlights stakeholder knowledge gaps, which present opportunities for outreach education efforts. Finally, since participants could identify places that provide some of these services with high levels of confidence and accuracy, these data can be used for planning purposes in deciding which places of ecosystem service provisioning would have more public support for protection efforts.

Conclusions

This study demonstrates that PPGIS can be a valuable tool for land management efforts that are focused on identifying and protecting places that provide important ecosystem services. It can not only provide valuable spatial information about which places stakeholders think are most important for the provisioning of these services, but can also help to identify services that the public has difficulty conceptualizing spatially and types of land cover that the public does not recognize provide certain services, both of which present important opportunities for outreach and education efforts. Future research needs to continue to determine which types of ecosystem services stakeholders have trouble identifying spatially. However, we believe that the ecosystem service data collected by PPGIS studies such as this one can be extremely beneficial for incorporating stakeholder preferences and perceptions into land management and developing a more participatory decision making process. As such, the data collected for this study are being used to inform regional planning efforts.

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Table 3.1 – Selected PPGIS Items and Results

Item	Definition	Number of Dots Used	Percent of Available Dots Used by Participants	Mean importance on 7-Point Likert Scale
Fish Nursery	These places are important to me because they provide key habitat for juvenile fish to mature and support local fisheries.	679	56.12%	5.58
Storm Protection	These places are important to me because they provide protection and buffering against the effects of hurricanes and storm surge.	578	47.77%	5.49
Flood Protection	These places are important to me because they minimize flooding from rivers and streams.	319	26.36%	4.98
Water Quality Protection	These places are important to me because they filter sediment and remove pollutants from water.	452	37.36%	6.17
Water Pollution	Please indicate places that you believe threaten water quality.	664	54.88%	Did not assess

Table 3.2 – Areas of PPGIS Hotspots for Watershed Services

Watershed Service	Hotspot Area (mi^2)
Fish Nursery	85.04 mi^2
Storm Protection	82.14 mi^2
Flood Protection	8.78 mi^2
Water Quality Protection	36.00 mi^2

Table 3.3 – Land Cover of Watershed Service Hotspots

(bold indicates correct land cover)

Land Cover	Flood Protection	Fish Nursery	Water Quality Protection	Storm Protection
Water	**41.75%**	**62.49%**	**52.51%**	70.37%
Wetlands	**39.57%**	**27.33%**	**31.79%**	**6.97%**
Barren (Beach)	0.00%	0.64%	0.09%	**9.81%**
Rangeland	0.00%	0.56%	0.01%	0.09%
Agriculture	0.00%	0.53%	0.00%	0.00%
Forest	**18.66%**	5.35%	**13.79%**	3.80%
Developed	0.02%	3.10%	1.81%	8.96%
Percent Correct	**99.98%**	**89.82%**	**98.09%**	**16.78%**

Figure 3.1 – Study Area: Mobile Bay Region, AL

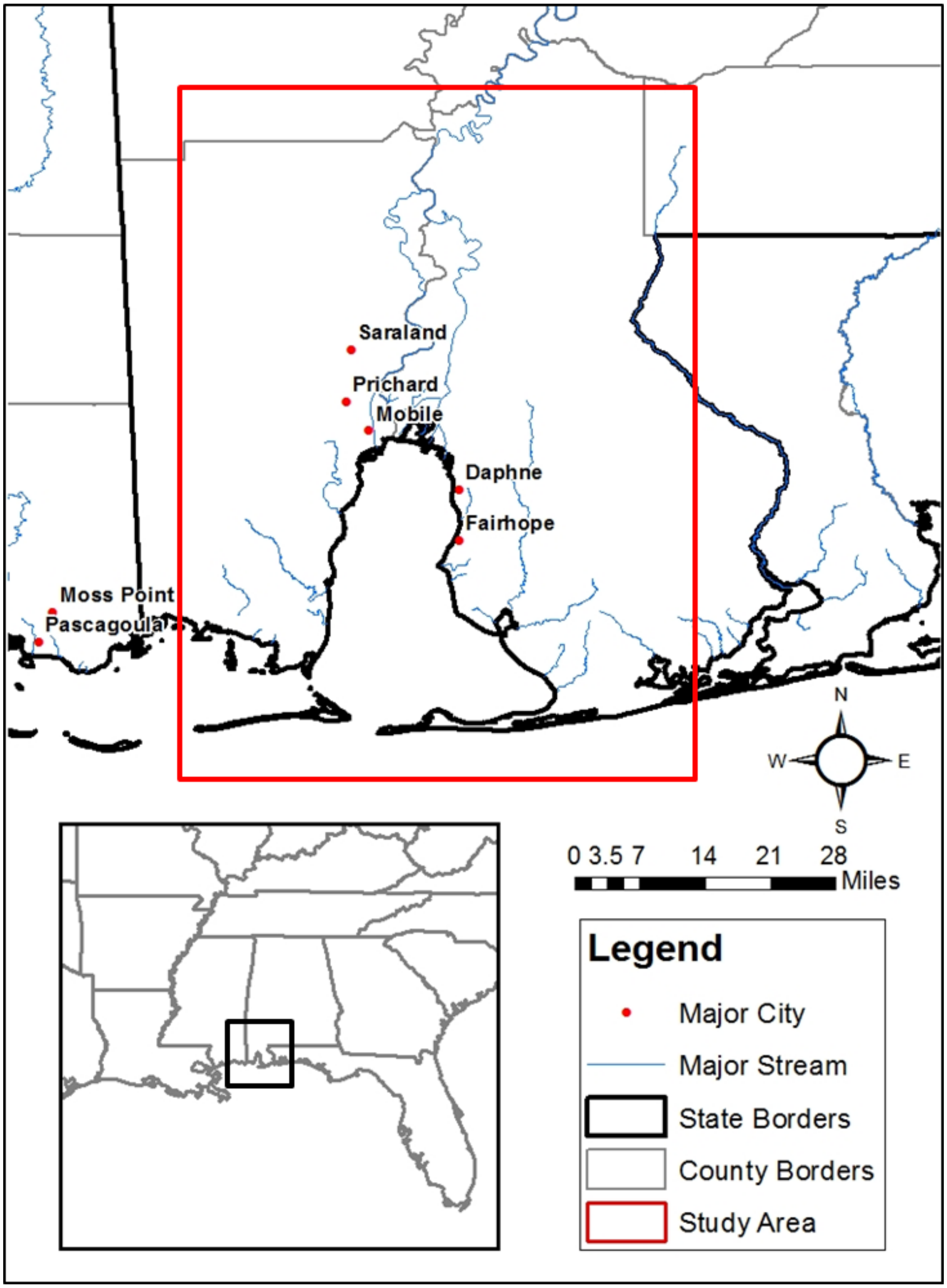


Figure 3.2 – Watershed Service Kernel Density Hotspots

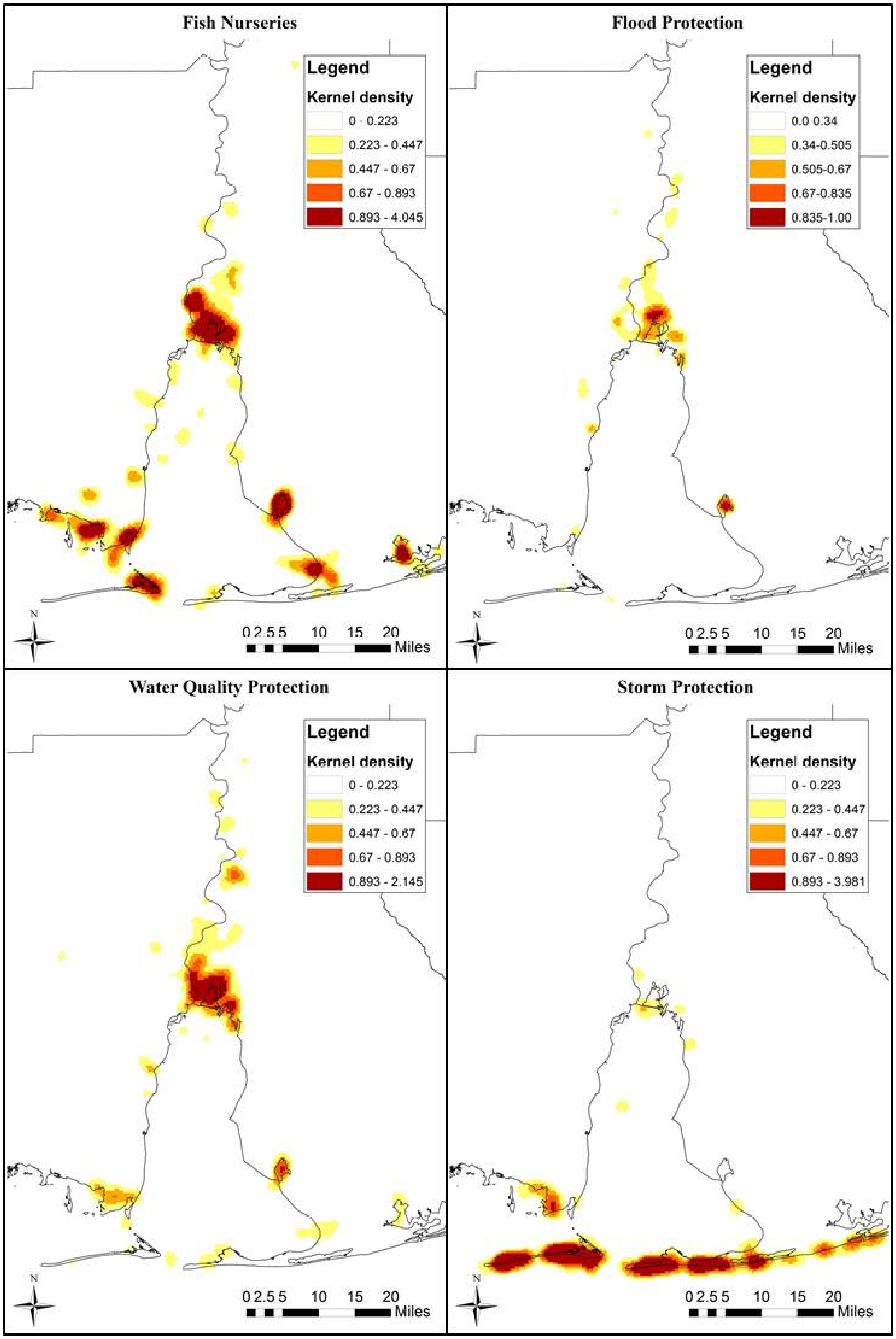


Figure 3.3 – Land Cover of Fish Nursery Hotspots

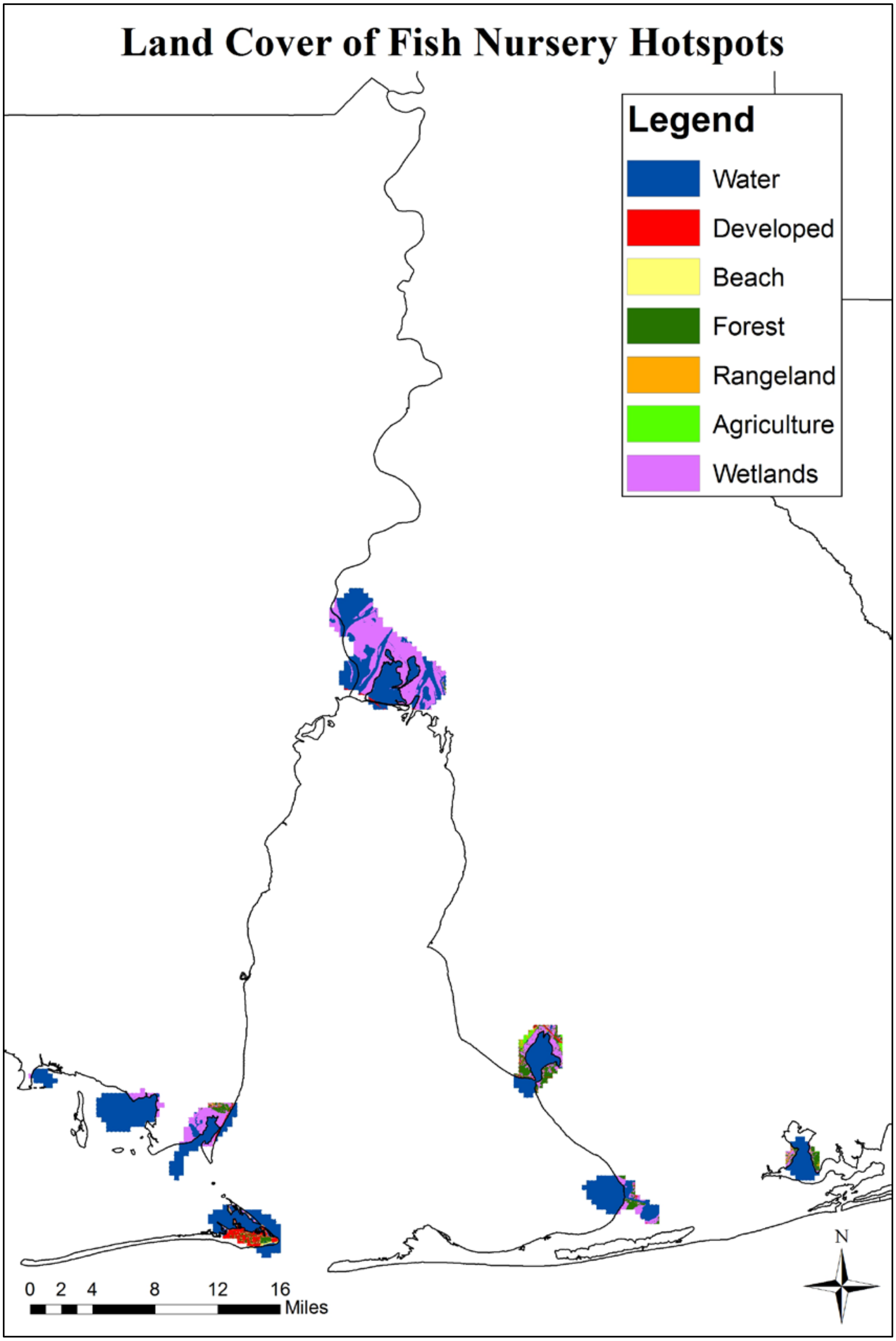


Figure 3.4 – Land Cover of Storm Protection Hotspots

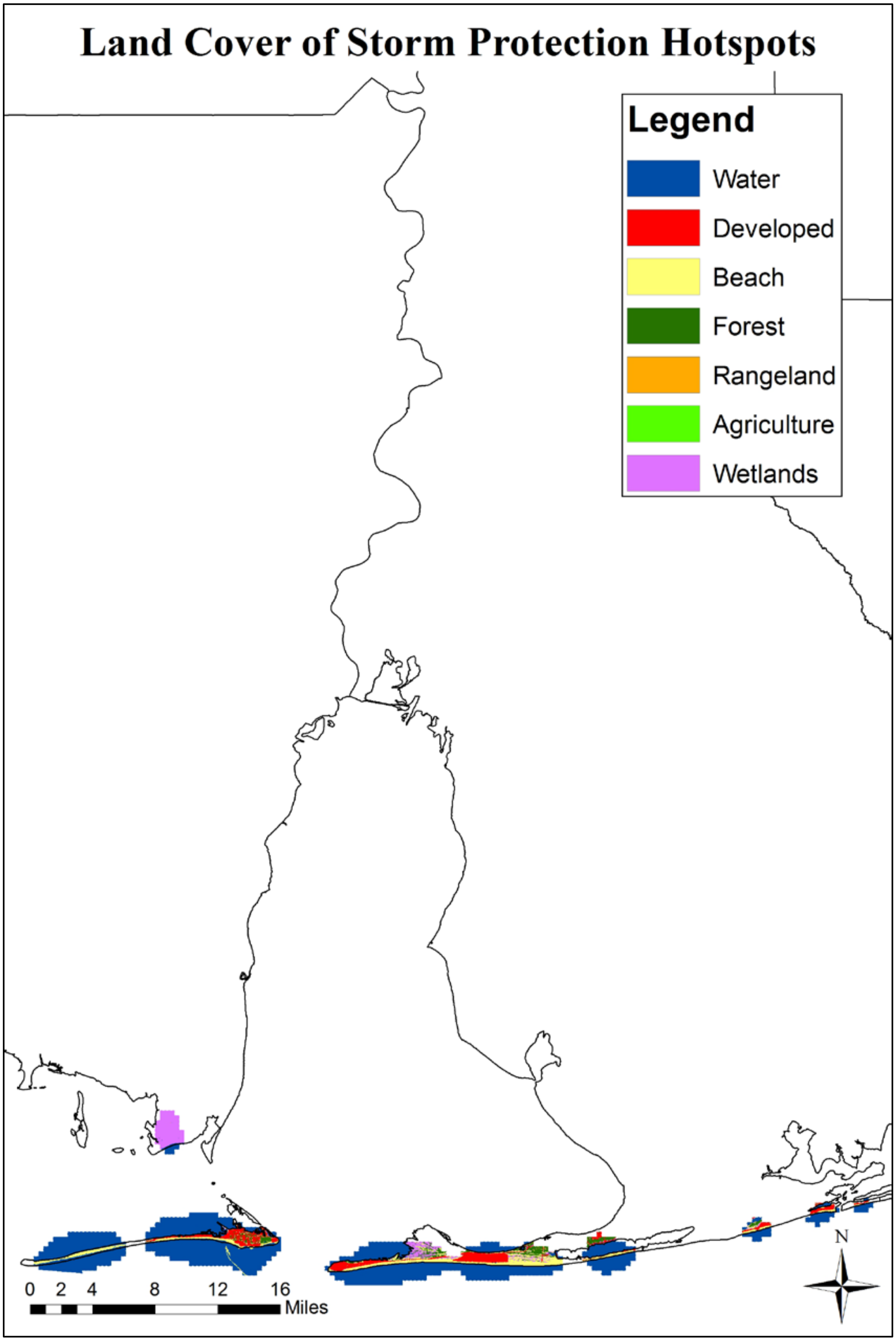


Figure 3.5 – Land Cover of Flood Protection Hotspots

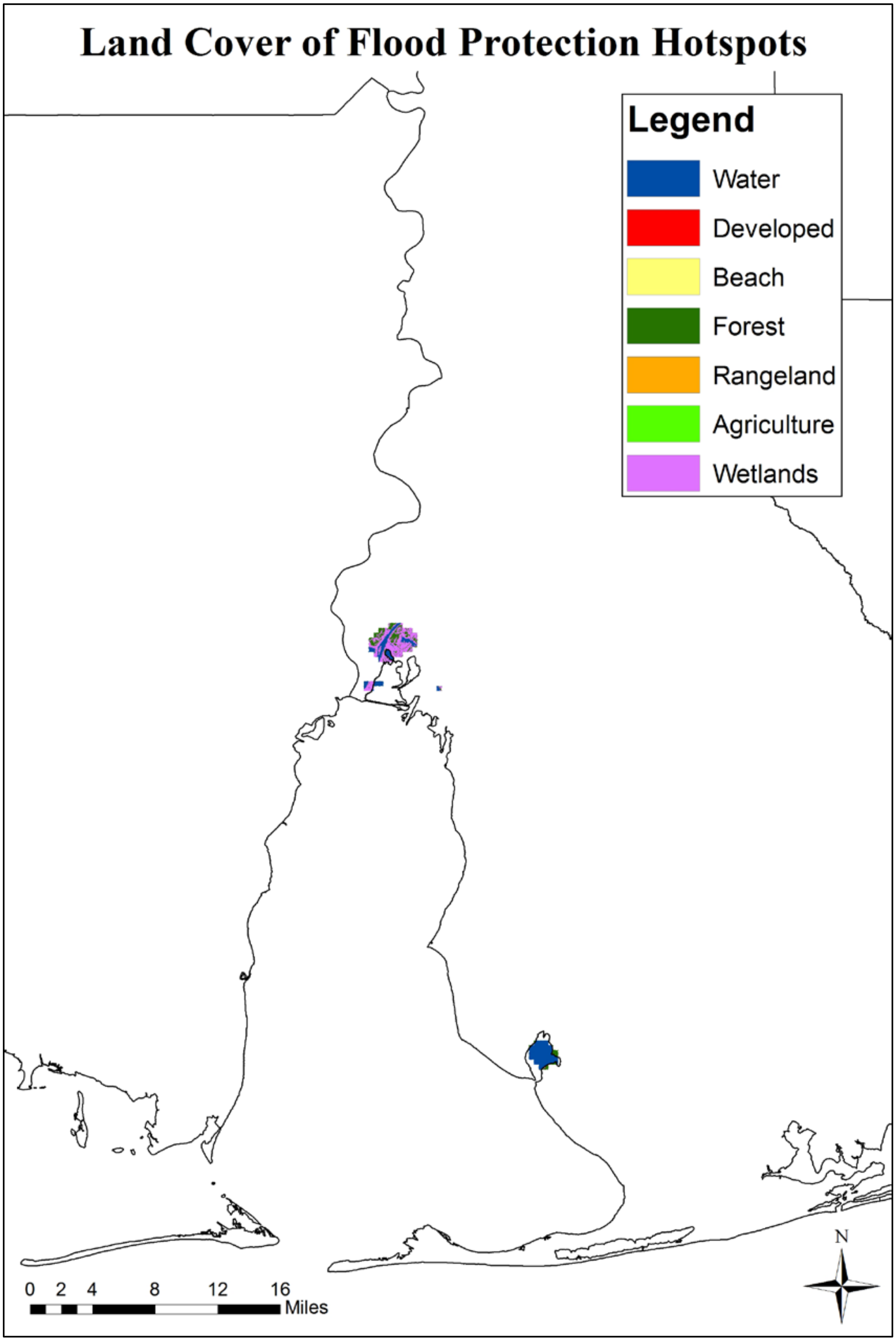


Figure 3.6 – Land Cover of Water Quality Protection Hotspots

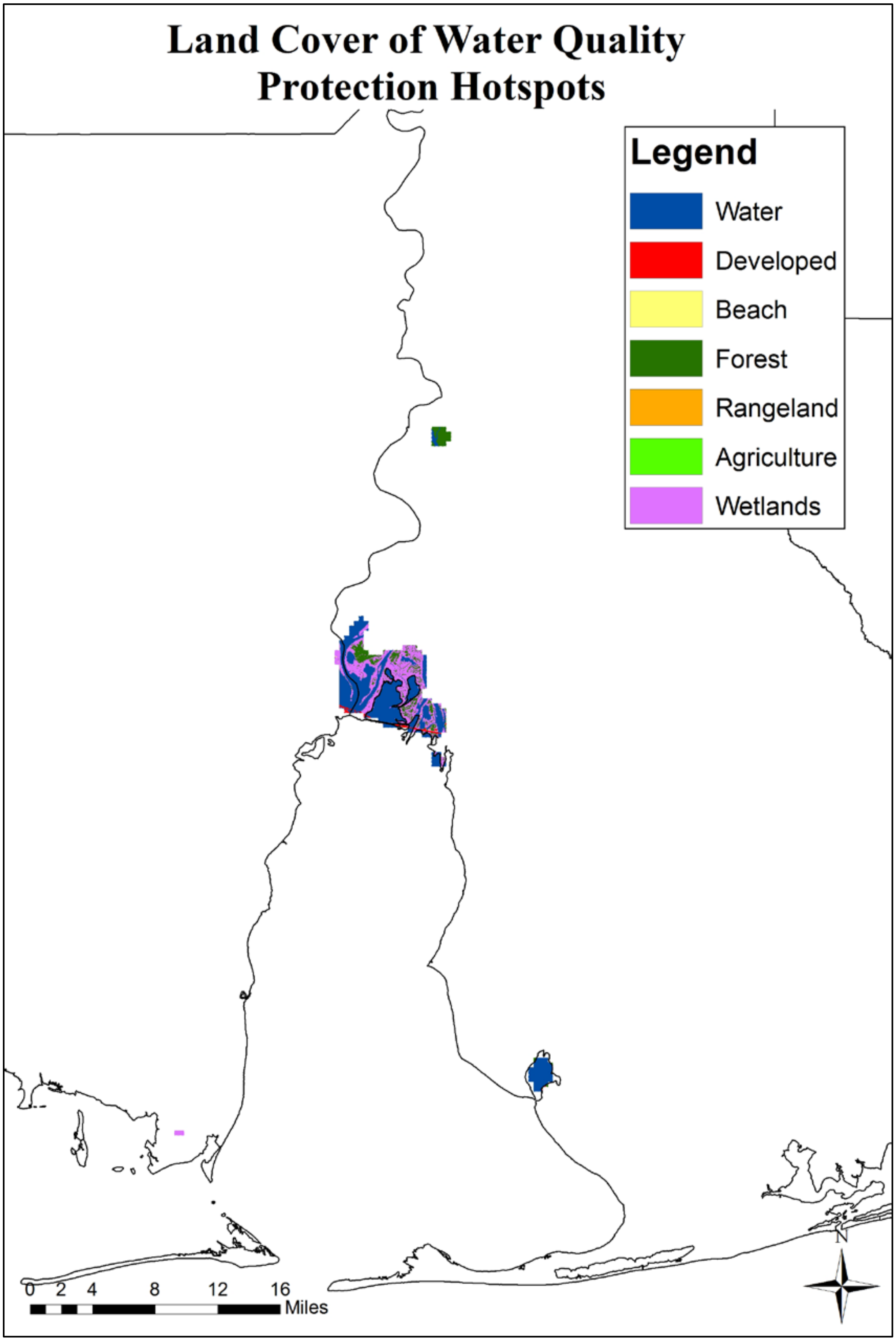


Figure 3.7 – Locations of Publicly Identified Water Pollution Hotspots and 303(d) Listed Impaired Streams

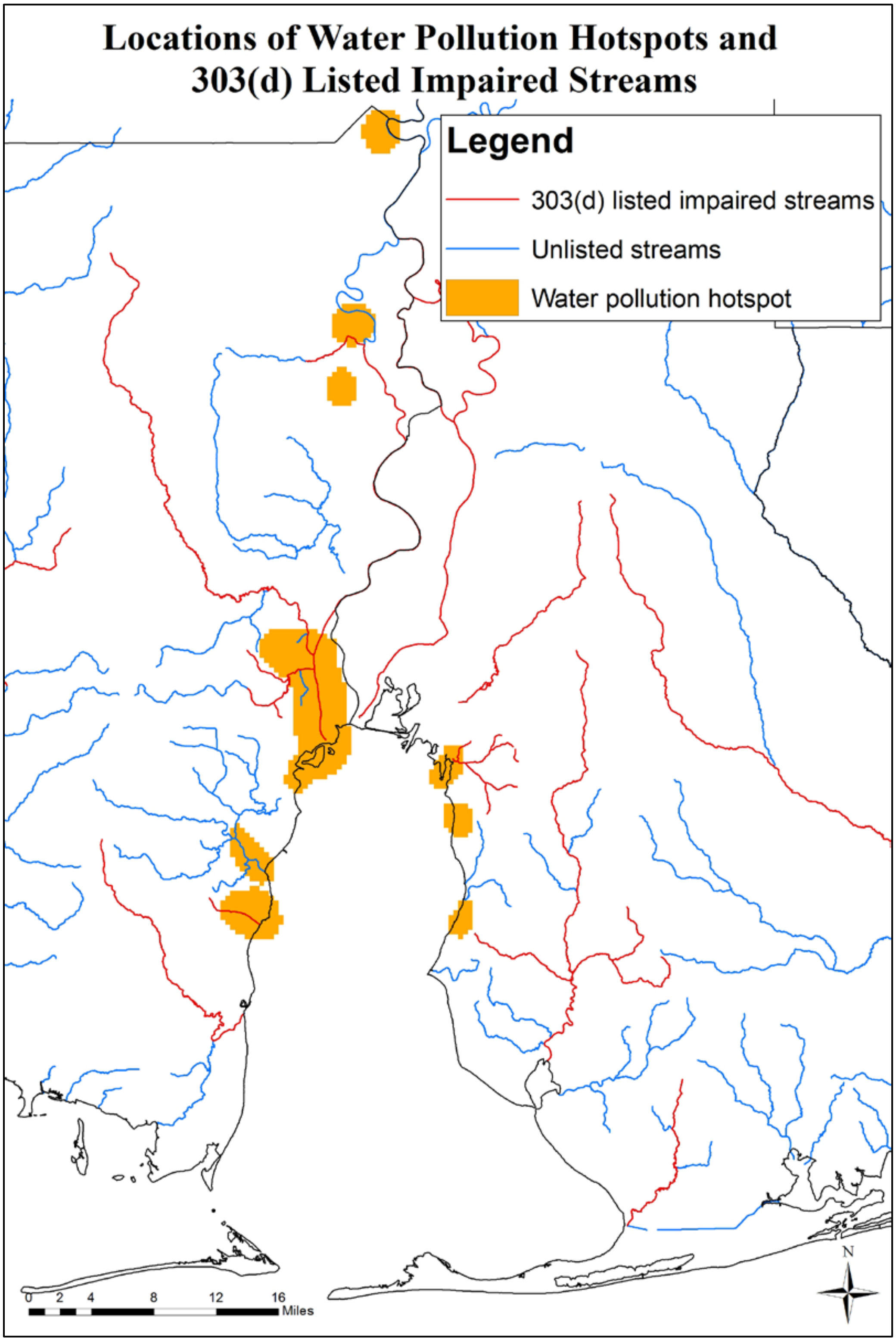


Figure 3.8 – Water Pollution Threat Overlap with Fish Nursery Hotspots

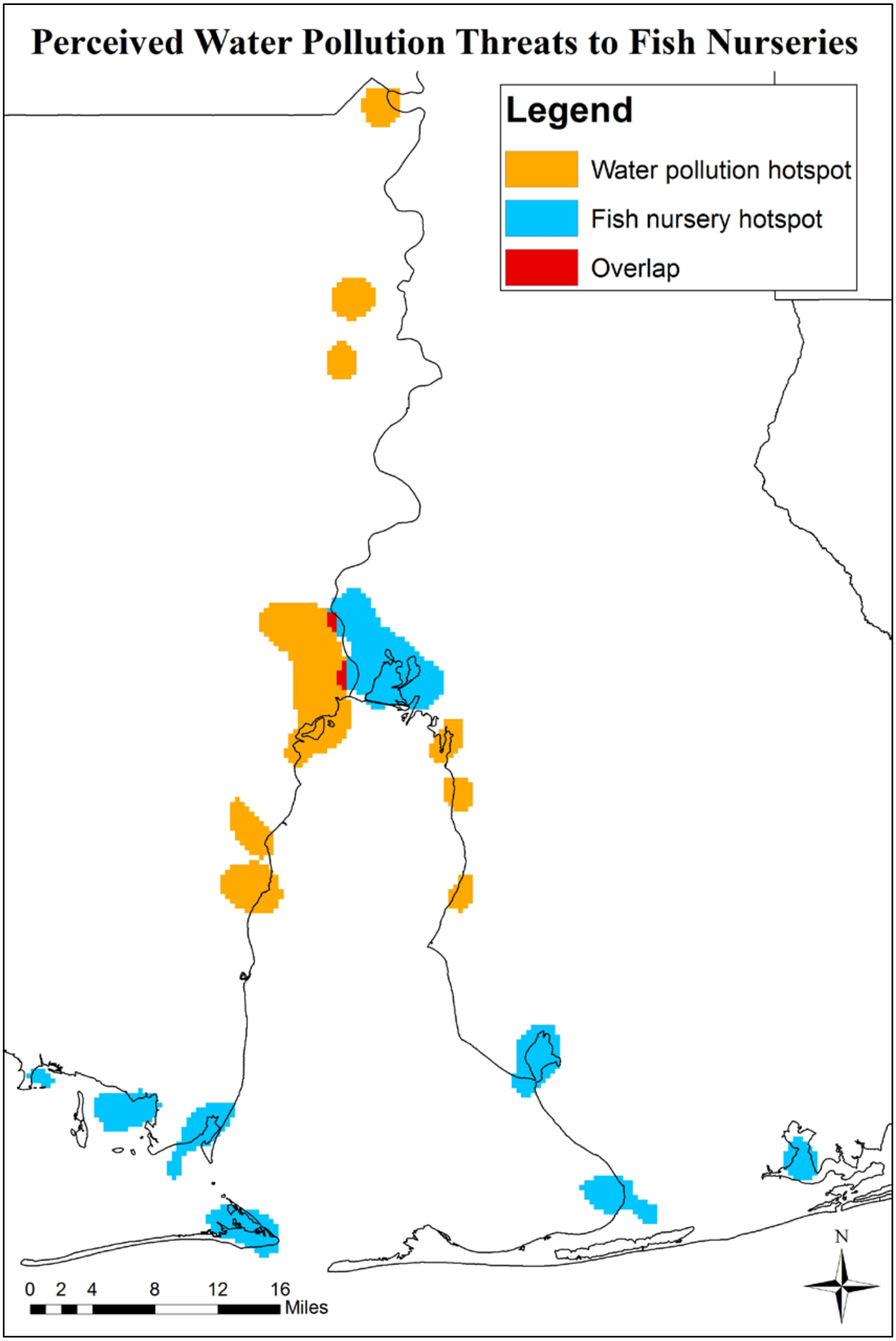
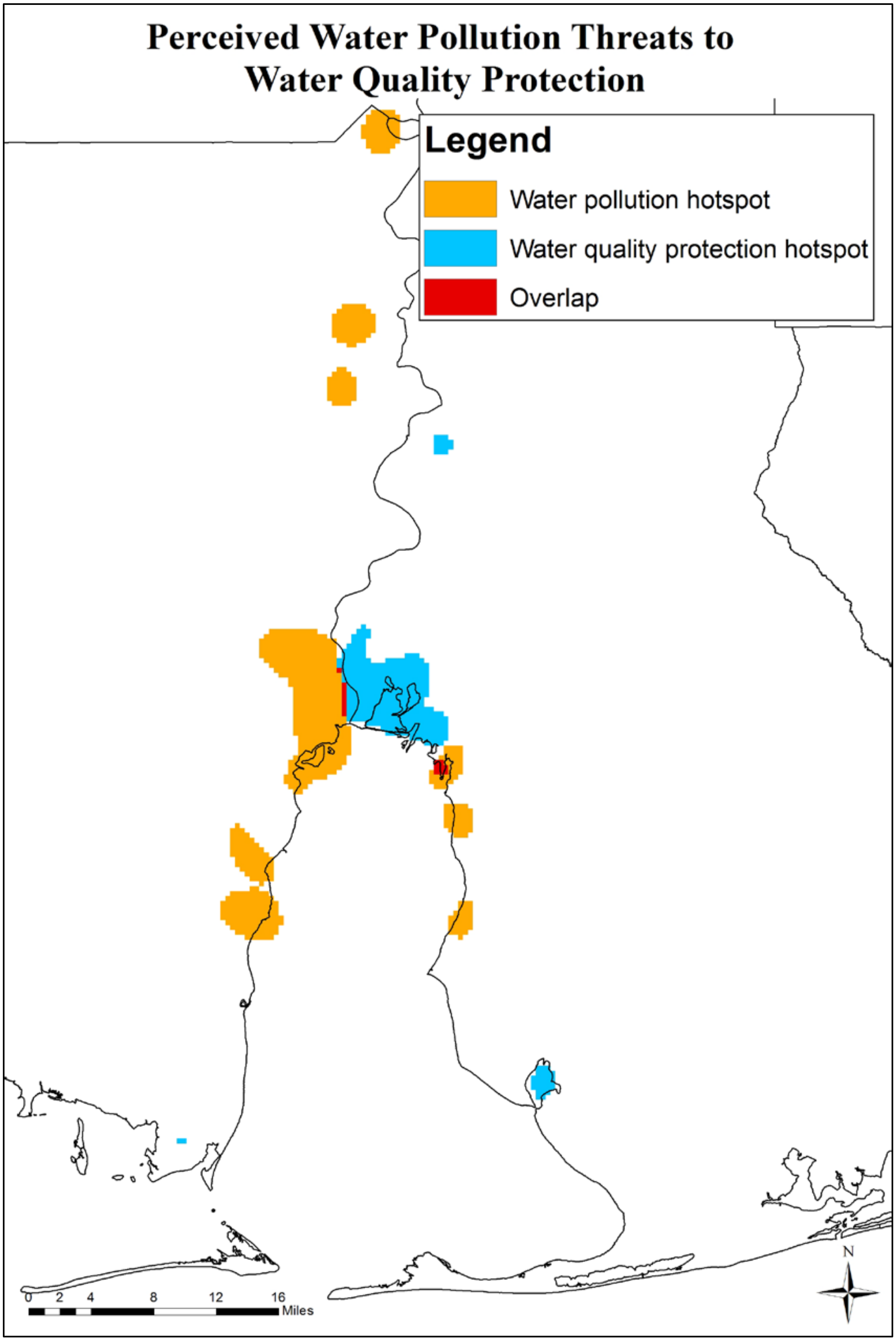
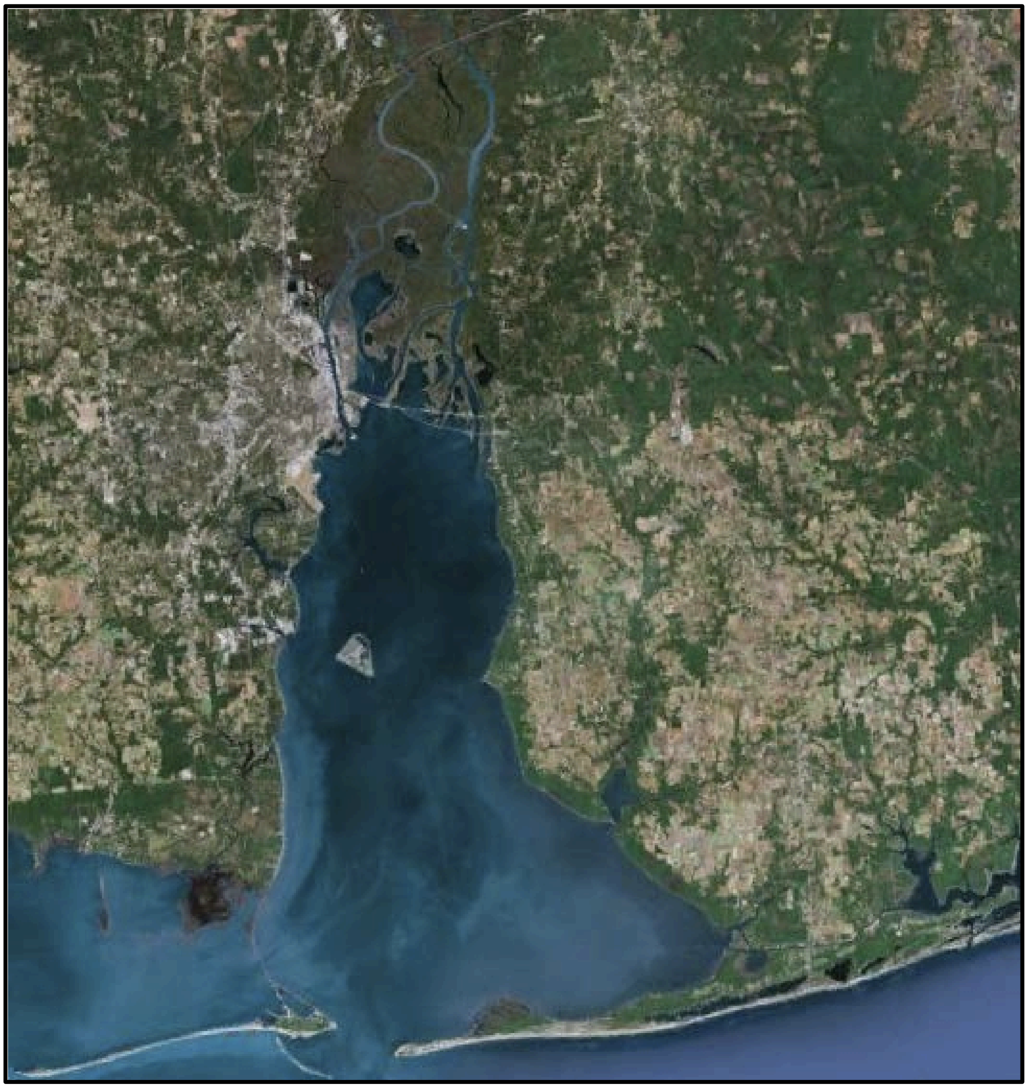


Figure 3.9 – Water Pollution Threat Overlap with Water Quality Protection Hotspots



Appendix I – Questionnaire

Mobile Bay Landscape Values Mapping Survey



A Study By
The School of Forestry and Wildlife Sciences
Auburn University

Greetings from Auburn University,

Thank you for taking our survey on Mobile Bay! As land managers and planners in the Mobile Bay region (Baldwin and Mobile counties, AL) seek to determine the best plans for the future management of the area, it is of great benefit to understand which types of places are valued by local residents and why.

The best way to learn about place values is to ask a diversity of people to share their thoughts and opinions. You are one of a few randomly selected residents of the Mobile Bay region who will be asked to complete this survey. The questions and mapping exercise should take about 20-30 minutes to complete. Your responses are voluntary and will be kept confidential. Your answers will never be associated with your name or your mailing address.

Your decision about whether or not to participate will not jeopardize your future relations with Auburn University or the School of Forestry and Wildlife Sciences. If you have any questions about this survey, please contact Dr. Wayde Morse by telephone at (334) 844-8086 or by email at valmaps@auburn.edu. If you have any questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by telephone at (334) 844-5966 or by email at hsubjec@auburn.edu.

By taking a few minutes to share your experiences, you will be helping us out a great deal. The information you share with us can be used to help determine the best management plan for the region. I hope that you enjoy completing this questionnaire. I look forward to receiving your responses.

Sincerely,

Wayde Morse

Dr. Wayde Morse
Assistant Professor and Researcher
School of Forestry and Wildlife Sciences
Auburn University

Survey topics include:

Outdoor Recreation	Wildlife Issues
Water Issues	Development Issues
Satisfaction with Mobile Bay	Mapping Landscape Values Activity

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO.

The Auburn University Institutional Review Board has approved this document for use from May 31, 2012 to May 30, 2013. Protocol #12-203 EX 1205.

Mobile Bay Use and Values

1. About how long have you lived in the Mobile Bay region? [ ] **Years**

2. How interested are you in the future of the Mobile Bay region?

1	2	3	4	5	6	7
Not at all interested			Somewhat interested			Very interested
○	○	○	○	○	○	○

3. How would you rate your knowledge of places in the Mobile Bay region?

1	2	3	4	5	6	7
Poor			Good			Excellent
○	○	○	○	○	○	○

Outdoor Recreation

4. How interested are you in participating in outdoor and nature recreation in the Mobile Bay region?

- ○ Not interested
- ○ Somewhat interested
- ○ Very interested

5. **How important to you is participating in each of the following activities <u>in the Mobile Bay region</u>?**

	1 Not important at all	2	3	4 Moderately important	5	6	7 Very important
Walking/Hiking	○	○	○	○	○	○	○
Bird Watching	○	○	○	○	○	○	○
Other Wildlife Watching	○	○	○	○	○	○	○
Boating/Sailing	○	○	○	○	○	○	○
Canoeing/Kayaking	○	○	○	○	○	○	○
Viewing Natural Scenery	○	○	○	○	○	○	○
Saltwater Fishing (Bay or Ocean)	○	○	○	○	○	○	○
Freshwater Fishing (River or Stream)	○	○	○	○	○	○	○
Camping	○	○	○	○	○	○	○
Hunting	○	○	○	○	○	○	○
Visiting Beach	○	○	○	○	○	○	○

6. **From the previous list of outdoor recreation activities, please indicate which activity you participated in <u>most recently</u> in the <u>Mobile Bay Region</u>.**

7. How important to you were each of the following reasons for participating in your <u>most recent</u> recreation activity <u>in the Mobile Bay region</u>?

	1 Not important at all	2	3	4 Moderately important	5	6	7 Very important
To learn about the history/culture of the area	○	○	○	○	○	○	○
To develop my personal/ spiritual values	○	○	○	○	○	○	○
To enjoy the sounds and smells of nature	○	○	○	○	○	○	○
To be with friends/family	○	○	○	○	○	○	○
To experience excitement/adventure	○	○	○	○	○	○	○
To get away from the usual demands of life	○	○	○	○	○	○	○
To explore the area and learn about nature	○	○	○	○	○	○	○
To be close to nature	○	○	○	○	○	○	○
To escape noise and crowds	○	○	○	○	○	○	○
To depend on/develop my skills and abilities	○	○	○	○	○	○	○
To promote my physical fitness/exercise	○	○	○	○	○	○	○
To enjoy the natural scenery	○	○	○	○	○	○	○
To observe wildlife	○	○	○	○	○	○	○
To be with others who enjoy the same things	○	○	○	○	○	○	○

Wildlife Issues

8. To what extent do you believe each of the following wildlife issues is or is not a threat <u>to the Mobile Bay region</u>?

	1 Not a threat at all	2	3	4 Moderate threat	5	6	7 Very extreme threat
Habitat destruction/fragmentation	○	○	○	○	○	○	○
Biodiversity loss	○	○	○	○	○	○	○
Species population decline	○	○	○	○	○	○	○
Invasive species	○	○	○	○	○	○	○
Nuisance bears	○	○	○	○	○	○	○
Overfishing/depletion of fisheries	○	○	○	○	○	○	○
Destruction of fish nurseries	○	○	○	○	○	○	○
Destruction of shellfish habitat	○	○	○	○	○	○	○

9. How important to you is the conservation of each of the following animals <u>in the Mobile Bay region</u>?

	1 Not at all important	2	3	4 Moderately important	5	6	7 Extremely important
Black bears	○	○	○	○	○	○	○
Manatees	○	○	○	○	○	○	○
Sea turtles	○	○	○	○	○	○	○
Wading birds (cranes, herons, egrets, etc.)	○	○	○	○	○	○	○

Water Issues

10. To what extent do you believe each of the following water issues is or is not a threat <u>to the Mobile Bay region</u>?

	1 Not a threat at all	2	3	4 Moderate threat	5	6	7 Very extreme threat
Overuse of upstream water	○	○	○	○	○	○	○
Inadequate river flow	○	○	○	○	○	○	○
River damming	○	○	○	○	○	○	○
Water pollution	○	○	○	○	○	○	○
Sediment in water	○	○	○	○	○	○	○
Excessive nutrients/ fertilizer in water	○	○	○	○	○	○	○
Erosion	○	○	○	○	○	○	○
Wetland drainage/destruction	○	○	○	○	○	○	○
Flooding from offshore storms	○	○	○	○	○	○	○
Flooding from rivers/ streams	○	○	○	○	○	○	○
Sea level rise	○	○	○	○	○	○	○
Litter/trash in water	○	○	○	○	○	○	○

Development Issues

11. To what extent do you believe each of the following industry and/or development issues is or is not a threat to the Mobile Bay region?

	1 Not a threat at all	2	3	4 Moderate threat	5	6	7 Very extreme threat
Air pollution	○	○	○	○	○	○	○
Oil industry	○	○	○	○	○	○	○
Industrial Shipping	○	○	○	○	○	○	○
River dredging	○	○	○	○	○	○	○
Commercial/industrial development	○	○	○	○	○	○	○
Residential development	○	○	○	○	○	○	○
Urbanization	○	○	○	○	○	○	○
Tourism	○	○	○	○	○	○	○
Too much environmental regulation	○	○	○	○	○	○	○

Satisfaction with the Mobile Bay Region

12. Rate your <u>level of satisfaction</u> with the following natural and developed characteristics of the Mobile Bay region.

	1 Extremely Dissatisfied	2	3	4 Neither Satisfied or Dissatisfied	5	6	7 Extremely Satisfied
Urban crowding	○	○	○	○	○	○	○
Recreational crowding	○	○	○	○	○	○	○
Number of places for recreation	○	○	○	○	○	○	○
Level of shore development	○	○	○	○	○	○	○
Natural scenery	○	○	○	○	○	○	○
Water quality	○	○	○	○	○	○	○
Air quality	○	○	○	○	○	○	○
Biodiversity	○	○	○	○	○	○	○
Preservation of ecosystems	○	○	○	○	○	○	○
Material needs (access to work, food, shelter, goods)	○	○	○	○	○	○	○
Access to healthcare	○	○	○	○	○	○	○
Security/personal safety	○	○	○	○	○	○	○
Social relations/cohesion/ trust/respect	○	○	○	○	○	○	○

Mapping Landscape Values Activity

13. **We will now work with one of the maps included in your packet. The other is yours to keep. Please find the enclosed map and sheet of sticker dots. There are 19 sets of dots that identify different values for places in the Mobile Bay region, such as recreation value or livelihood/economic value. Stick the dots on the map on places on both land and water that you think are important for these values.**
    ****After you have completed this activity, please return to this questionnaire to complete the final section of the survey.***

<u>The following is for the special places portion of the mapping activity:</u>

Please record the reasons that you consider each of your special places to be special in the boxes below.

Special Place 1

Name:

Reason:

Special Place 2

Name:

Reason:

Special Place 3

Name:

Reason:

Please record the reasons that you dislike each of the places you identified on the map in the boxes below.

Place I Dislike 1

Name:

Reason:

Place I Dislike 2

Name:

Reason:

Place I Dislike 3

Name:

Reason:

14. Of those characteristics you just mapped, how important to you are each of the landscape values?

	1 Not at all important	2	3	4 Moderately important	5	6	7 Extremely Important
Livelihood/Economic	○	○	○	○	○	○	○
Recreation	○	○	○	○	○	○	○
Historic	○	○	○	○	○	○	○
Aesthetic	○	○	○	○	○	○	○
Fish Nursery	○	○	○	○	○	○	○
Storm Protection	○	○	○	○	○	○	○
Upstream Flood Protection	○	○	○	○	○	○	○
Water Quality Protection	○	○	○	○	○	○	○
Black Bear Habitat	○	○	○	○	○	○	○
Manatee Habitat	○	○	○	○	○	○	○
Sea Turtle Habitat	○	○	○	○	○	○	○
Wading Bird Habitat	○	○	○	○	○	○	○

Demographic Information

For statistical purposes, we need to ask you a few demographic questions.

Please remember that the information you provide is confidential!

15. In what year were you born? [ ]

16. What is your gender?

- ○ Female
- ○ Male

17. Including yourself, how many people live in your house? [ ] **people**

18. Are you a student?

- ○ Yes
- ○ No

19. What is your highest degree or level of school completed?

- ○ Did not complete high school
- ○ High School Diploma or GED
- ○ Some college, but no degree
- ○ Other [ ]
- ○ Associate degree
- ○ Bachelor degree
- ○ Graduate or professional degree

20. Are you retired?

- ○ Yes
- ○ No

21. Are you currently employed?

- ○ Yes
- ○ No (*please skip to question #23*)

22. What kind of business or industry do you work in?
(Please select the single best match)

- ○ Management, business, and financial operations
- ○ Professional and related operations (doctor, nurse, lawyer, etc.)
- ○ Service occupations (cleaning, food, health, personal, protective, etc.)
- ○ Sales and related occupations
- ○ Office and administrative occupations
- ○ Farming and forestry occupations
- ○ Fishing and seafood industry (including supporting industry)
- ○ Construction
- ○ Oil and other extraction occupations (including supporting industry)
- ○ Installation, maintenance, and repair occupations
- ○ Production occupations (manufacturing)
- ○ Transportation and trucking
- ○ Other

23. How many hours do you work during a <u>typical week</u>?

- ○ Less than 10 hours
- ○ 21-40 hours
- ○ 11-20 hours
- ○ More than 40 hours

24. Do you speak a language other than English at home?

- ○ Yes
- ○ No

25. Are you of Hispanic, Latino or Spanish descent?

- ○ Yes **--If yes, from which country--**
- ○ No

26. What is your race?

- ○ American Indian
- ○ Asian
- ○ Black/African American
- ○ White/Caucasian
- ○ Other

27. What is your marital status?

- ○ Single
- ○ Divorced
- ○ Married
- ○ Widowed

28. Please check the box that corresponds to your household income for 2011.

- ○ Less than $14,999
- ○ $25,000- $34,999
- ○ $75,000- $99,999
- ○ $15,000 to $19,999
- ○ $35,000- $49,999
- ○ $100,000- $149,999
- ○ $20,000 to $24,999
- ○ $50,000- $74,999
- ○ $150,000 or more

THANK YOU FOR PARTICIPATING IN THIS STUDY!!

Please provide any additional comments here.