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Key Biscayne residents' uses of and views on island-wide and regional coastal and marine resources

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Acknowledgments

This project was completed as part of a contract with the Key Biscayne Community Foundation contract to characterize Key Biscayne residents' uses of and views concerning regional resources. First and foremost, I would like to acknowledge Melissa McCaughan White, the foundation's director whose indefatigable efforts made the project possible. I would also like to acknowledge Bob Molinari, who served as a mentor and guide, shepherding the project from its infancy to fruition. Both Melissa and Bob and staff at the foundation and village did all the hard work to get the survey off the ground, send out the emails, and monitor the survey process.

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Finally, I would like to thank all the folks who took time from their busy days to complete a detailed and encompassing survey. It was their participation that made this effort as successful as it turned out. Thank you.

I. Executive Summary

The study conducted an Internet-based survey of Key Biscayne residents on their uses of the region's resources, views on resource conditions and trends, rating of local, regional, and global stressor, attitudes concerning management priorities, and willingness to in citizen scientist research and monitoring program. The results, which were based on 735 returns, identified respondents as long-term residents (average time on the island was 6-10 years) of whom the majority lived on the island on a year-round basis. While the sample was over-represented by females, most other demographic results were similar to those of the island's 2010 US Census population.

Respondents' participation rates varied by resource and activity, and beach visitation (94%), green space use (90%), trail use (77%), and fishing (71%) leading all uses. By contrast, only 54% of the respondents participated in boating and 39% in diving and snorkeling. Frequency of use, or how often (per month) residents participated in an activity or accessed a resource, was related directly to the participation. Thus, the most frequently used resources were beaches, green spaces, and trails. Many activities were based on multiple use, such that residents participated in ancillary uses while conducting a primary activity. More than half of the residents who visited beaches, for instance, participated in walking/jogging, swimming, sunbathing, and nature watching while at the beach. These multiple uses suggest strong linkages across uses and activities. Uses were also discretely organized on or around the island, and preferences tended to be dependent on distance from home, especially for land-based activities (such as beach, green space, and trail use). Marine use was in part dependent on the nature of the activity, such that fishing was located mainly eastward off Key Biscayne, boating was concentrated off the western, southern, and eastern coasts, and diving and snorkeling was undertaken mainly off beaches.

Residents' knowledge of and views concerning resources were mostly based on their level of engagement with the resource, such that most residents felt that they were knowledgeable about beaches and the least felt that they were knowledgeable about fisheries. Residents were also least willing to provide their views on resource conditions for most resources, with the notable exception of beaches, because high percentages felt that they did not have enough information to provide answers. Overall, however, residents believed that beaches were in the best condition of all resources, and that water quality was in the worst condition.

Respondents were very concerned about a number of stressors that they believed were affecting the island's resources, of which pollution (77%), sewage (65%), and development (64%) led all stressors. However, several other stressors, including tourism (61%), beach nourishment (60%), and climate change (50%), were cited by half or more of the respondents as important stressors as well. These results showed that residents hold a complex view of how multiple stressors may work together and over time to affect the quality and concentration of resources.

To address stressors and conserve Key Biscayne's resources, residents ranked increased and improved environmental education as the top priority. However, residents also felt that other approaches, including restricted access to protect vulnerable or over-exploited resources and improved existing management, should be used in tandem to achieve conservation goals. The respondents were not in favor of carrying capacity as an approach, and most did not prioritize implementing visitor load limits to local beaches.

Finally, there was considerable support for participation in the Citizen Scientist Program. Almost half of the respondents agreed to serve as a citizen scientist with 70% in favor of participating in beaches and with water quality and over half with sea turtles; fewer respondents agreed to work in less familiar, mainly marine fields or resources, such as corals, nearshore areas, and fisheries. It is expected as the Citizen Scientist Program increases the island's knowledge base on marine science and research, the residents' interest to work in the marine environment will likely increase.

II. Introduction

Key Biscayne is the southernmost barrier island on South Florida's east coast (Srinivas and Taylor, 1996), extending approximately five miles in length and varying between one and two miles in width. Separated by a causeway from the highly urbanized, metropolitan Miami-Dade County, the island, along with the adjacent Virginia Key, contain a small resident population and a variety of coastal and marine resources.

Key Biscayne's population resides primarily in the central part of the island in the Village of Key Biscayne. Encompassing 787 acres, the village's 12,637 residents (US Census, 2013) live ensconced between two protected areas: the 808-acre, county owned Crandon Park on the northern end of the island and the 400-acre Bill Baggs-Cape Florida State Park on the southern end of the island (Blank, 1996). Historic Virginia Key Beach Park, located on the southern tip of Virginia Key, is the other main protected area. Together, the two islands contain a variety of popular recreational areas, including a 4.3-mile beach system in Key Biscayne, two beaches in Virginia Key (a half-mile beach on Historic Virginia Key Beach Park and the thin two-mile strip of Hobie Beach, created as a result of the Rickenbacker Causeway construction), green and trail areas for biking and walking, the aforementioned county and state parks (and a county-operated marina), fishing spots, and nearshore snorkel and dive locations. Key Biscayne and Virginia Key are further renowned for premier sporting events, including annual tennis and golf tournaments on Key Biscayne, the Miami Seaquarium and coastal and marine academic and research facilities on Virginia Key, and the keys' relaxed setting in the heart of a highly urbanized landscape.

Much of the islands' attraction is derived from the diverse coastal and marine resources that have been protected over Key Biscayne's history. Commencing with the donation of 808.8 acres of the northern section of Key Biscayne by the Matheson family in 1940 to Dade County to create Crandon Park, added to by the State of Florida's 1996 purchase of 400 acres leading to the 1967 opening of the Bill Baggs Cape Florida State Park (Blank, 1996), and culminating in the Village of Key Biscayne efforts in designating and updating green spaces within the village boundaries (Village of Key Biscayne, 2013), Key Biscayne has effectively protected much of its natural heritage from development and construction activities. Presently, residential areas comprise only a third of the island; the rest of Key Biscayne is managed largely for recreational activities and resource protection.

Although the island has taken several measures to conserve its coastal and marine resources, its natural areas remain highly vulnerable to a variety of local and regional stressors. The island's southern beaches, comprising a 2.5-mile stretch from the Village of Key Biscayne to Bill Baggs Cape Florida State Park, are considered critically eroded (and are currently under a nourishment project) by the State of Forida's Bureau of Beaches and Coastal Systems (DEP, 2012), and many of the beaches on both Key Biscayne and Virginia Key have been periodically

nourished (DEP, 2012; Srinivas and Taylor, 1996). Coastal and marine habitats such as red and black mangroves found along the islands' coastal fringes and sea grasses, nearshore soft and hardbottom areas, and patch reefs enjoy varying levels of protection. Miami-Dade County has delegated authority to manage mangrove protection under the 1996 Florida Mangrove Trimming Act (FS 403.9321-403.9333), and the protected area status over a majority of Key Biscayne prevents adverse activities (ex., sedimentation resulting from development) in intertidal and subtidal areas. Nevertheless, these resources remain vulnerable to regional activities such as dredging, point and nonpoint sources of pollution, and fishing, among others. Miami-Dade County, like much of South Florida, has experienced a construction boom in the past decade. While pollution abatement and prevention measures have been enacted, coastal pollution emanating from point and nonpoint sources remains a concern for the region (NPS, 2011; Shivlani et al., 2010). Other regional activities, such as periodic dredging and projects such as the Port of Miami expansion dredging operation (ACOE, 2011), have the potential to impact the island's coastal and marine resources. Also, both commercial and recreational fishing have considerable impacts on the region's fin fish and invertebrate fisheries. Biscayne Bay and environs host a variety of commercial fisheries, including a bait shrimp fleet, blue crab, stone crab, and spiny lobster trap fisheries, and a hook and line, fin fish sector (Shivlani and Villanueva, 2007; EDAW, 2005). The fin fish sector, and in particular reef fish, experiences extensive pressure from both the commercial but especially the recreational sector, such that the fin fish fisheries are considered to be serially overfished (NPS, 2011; Ault et al., 2001).

To engage Key Biscayne residents in the management and conservation of the island's resources, as well as to raise awareness and appreciation of the diverse habitats, green spaces, and resources, the Key Biscayne Community Foundation (hereafter 'foundation') partnered with the village of Key Biscayne, the Knight Foundation, and the Rosenstiel School of Marine and Atmospheric Science at the University of Miami, to create a Citizen Scientist Program (KBCF, 2013; Miami Herald, 2013). As part of the initiative, the foundation and its partners also conducted a resident resource use and attitudes project. The project, conducted using an online survey distributed to Key Biscayne residents, addressed the following objectives:

- A determination of the residents' uses of the Key Biscayne and Virginia Key resources and habitats, including frequency of use;
- An understanding of residents' views on resource conditions;
- An assessment of residents' priorities on resource protection and conservation;
- An evaluation of support for resident participation in the Citizen Scientist Program.

III. Methodology

The research team developed and administered an online survey instrument to determine residents' uses of and views on Key Biscayne and Virginia Key coastal and marine resources. The approach adopted consisted of census sampling, where the entire island population was provided access to the survey via email. Additional efforts and follow-up reminders were utilized following established mail and Internet survey methodology (Dillman, Alreck and Settle). A novel aspect of the survey methodology was the inclusion of online maps that were used to determine use profiles and frequencies (see description of the Geographical Information Systems methodology in Appendix 1).

Over the first month of the project, the foundation met with researchers from the University of Miami to discuss the project objectives and to develop themes for the survey instrument. It was decided over that period that because the foundation could access a large percentage of the Key Biscayne resident population via an email database, the survey would be self-administered and conducted via the Internet. The foundation identified Qualtrics (www.qualtrics.com) as a suitable Internet survey firm, the research team agreed to use the firm after perusing its capabilities, especially as related to its online mapping tool.

In month two, the research team finalized the following six themes:

- Theme 1: Demography of island residents
- Theme 2: Uses
    - Subtheme 2a: Beach use and activities
    - Subtheme 2b: Fishing use, species, and type of fishing activities
    - Subtheme 2c: Boating use and activities
    - Subtheme 2d: Diving and snorkeling use and activities
    - Subtheme 2e: Green spaces use and activities
- Theme 3: Use conflicts
- Theme 4: Knowledge and perceptions on resources and resource conditions
- Theme 5: Stressors and management priorities
- Theme 6: Citizen Scientist Program

Within these themes, the research team developed a list of questions that were added to the online survey, and the research team decided upon the best format for each question (ex., multiple choice, ranked, or open-ended formats). The research team sought to achieve a balance between the survey time and the information collected, and it selected questions within each theme (from a larger bank of questions) based on their overall value to the project objectives.

Once the online survey was complete, members of the research team conducted the survey, checking to make certain that the questions were comprehensible and formats selected were suitable, that the time required to finish the survey was reasonable, and that the results were stored on the survey website securely and could be accessed for data analysis and reporting.

Over the third month, the research team conducted a pilot survey session, which involved sending the hyperlink to the survey location to researchers at the University of Miami and Key Biscayne residents. Respondents were selected based on their ability to provide feedback on the technical and logistical aspects of the survey, including on whether the survey questions addressed all relevant use and management issues, the ease of answering questions, and the length of the survey, among others. The research team was particularly interested in whether respondents could identify use areas on the online maps, and if these data could be successfully transferred into a GIS database. A total of 23 respondents completed the pilot survey, the results of which the research team used to update the online survey instrument into its final version. Two versions of the final survey were created, in English and Spanish, and both were made available online.

The research team conducted the full survey session, open to the Key Biscayne resident population, over the fourth and fifth months of the project. The foundation sent out the hyperlink to the 8,000 emails of island residents with the following introduction:

The Key Biscayne Community Foundation (KBCF) is a non-governmental, not-for-profit organization which is developing a Citizen Scientist Program to assist with the preservation of the natural resources of Key Biscayne. The program will work with a group of 'Citizen Scientists' to address the various challenges to the maintenance of the environmental riches of the Island Paradise.

This survey has been developed to determine your uses of the island, your views on the condition of the island's resources and how you believe that those resources should be managed.

This information will provide background knowledge for our Citizen Scientists and other Key Biscayne residents to evaluate actions planned for the island. Thus, we strongly encourage you to complete the survey so that we can produce a successful program for maintaining the natural resources of our Island Paradise.

To learn more about the island's resources and the Citizen Scientist Program, please visit the program's website, which is accessible via: http://www.keyscience.org

Thank you.

Respondents were afforded the opportunity to complete the survey in either English or Spanish, and the survey session was left open for a total of eight weeks. At the end of the fourth week, the foundation sent a reminder to the entire email list, requesting that residents participate in the survey effort. Finally, at the end of the eighth week, the research team closed the survey, marking the end of the full survey session.

Finally, over months six and seven, the research team completed data analysis and reporting. Two types of data analyses were completed, of which the first involved generating summary statistics for the main findings, and the second utilized Geographic Information Systems (GIS) to determine total use and frequency of use profiles and to generate use maps. The methodology utilized to create these maps is described in Appendix I.

IV. Results

Overall, 735 Key Biscayne residents responded to the online survey. Based on an email population of 8,000, the response rate corresponded to 9.2%. Of the 735 returns, 89.8% were completed in English and the remaining 10.2% were completed in Spanish. It should be noted that the Hispanic/Latin population of Key Biscayne is much higher than the percentage of respondents who completed the survey in Spanish, as supported by 62% of those who completed the survey in English identifying themselves as Hispanic/Latino.

The rest of the survey results are presented under each theme as listed in the previous section. Analyses other than summary statistics are discussed where relevant.

a. Theme 1: Demography of island residents

Over two-thirds (69.1%; n = 423) of the residents who participated in the survey were female, which is higher than the 53.6% reported for the village in the 2010 US Census; thus, it is clear that females were over-sampled in the survey.

With respect to age groups, the average age of the respondents was slightly older than 31-40 years (mean = 3.30, where 1 = under 18 years old and 6 = over 60 years old; SD = 1.00; n = 669). The less than 18-year-old group represented the highest percentage of respondents (31.5%), followed by residents in the 41-50 year age group (22.0%) (see Figure 1). Both the 31-40 year old age group and over 60 years age group represented 16% of the sample. These results were very similar to those reported by the 2010 US Census, in which individuals less than 18 years old and those older than 65 years old comprised 28.2% and 17.4% of the village's total population, respectively. It should be noted also that the foundation, along with its village partners, made a concerted effort to recruit participation among students, and that likely increased the overall response rate within that group. The 18-30 year old age group that reported the lowest response rate was represented by two age groups in the 2010 US Census (20-24 years old and 25-34 years old), and the 20-24 year old group in the Census represented only 2.9% of the village's population; this is a similar statistic to the 3.2% of the survey sample that represented the 18-30 year old age group.

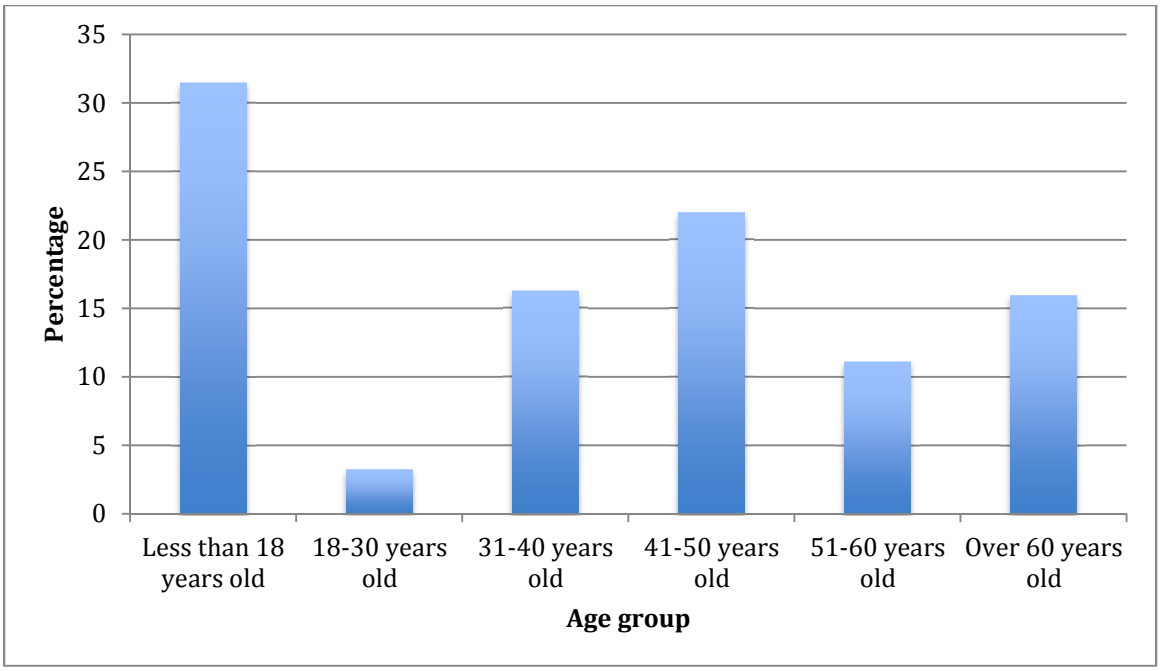

Figure 1: Key Biscayne resident age groups

The respondents represented a very highly educated sample, of which 36% (n = 671) had completed some postgraduate studies. When only those age groups above 18 year old were considered (as this group would clearly not have had the opportunity yet to enter university), a majority of the sample (51.7%; n = 462)) reported having completed some postgraduate studies, with 38.3% having completed a bachelor's degree (see Figure 2). Thus, nine out of ten, or 90%, of the Key residents surveyed had at least completed their college studies. This was higher than the 2007-2011 US Census data for Key Biscayne residents, which showed that among persons of 25 years of age or older, 75.2% held a bachelor's degree or higher.

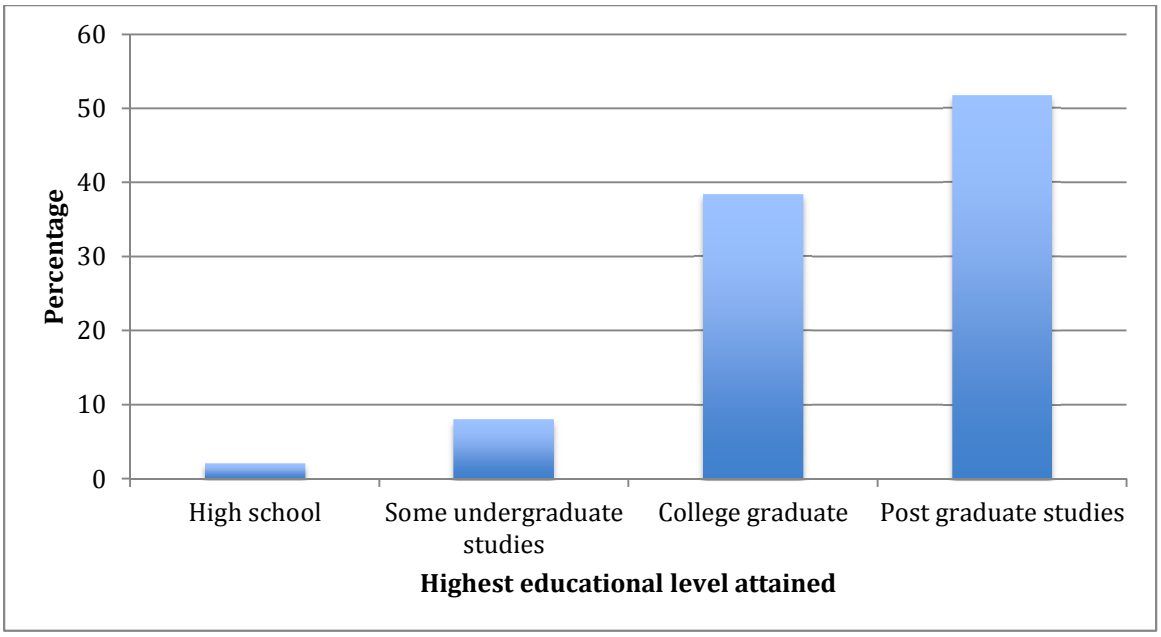

Figure 2: Key Biscayne residents' educational attainment (for residents older than 18 years)

Just under two thirds (64.9%; n = 676) of those surveyed identified themselves as being of Hispanic/Latino origin. This is congruent with the 2010 US Census data, which reported that 61.6% of the Key's residents identified themselves as Hispanic/Latino. While not queried, the results also demonstrate a high level of bilingual fluency. This is determined because a majority of the respondents who completed the survey in English (61.6%; n = 612) identified themselves as Hispanic/Latino.

Survey respondents had lived in Key Biscayne for an average of just under 6-10 years (mean = 3.83, where 1 = less than one year and 6 = over 10 years; SD = 1.57; n = 592), and a majority (93.4%) had lived on the island for at least over a year (see Firure 3). Longest-term residents, or those who had lived in Key Biscayne for over 20 years, comprised 21.6% of the sample, but at least 20% stated having lived on the island for between 1-5 years, 6-10 years, and 11-15 years. If those respondents who were less than 18 years were not considered (due to their lifespan not having covered the entire period of the query), then the average time lived on the island was slighter higher (mean = 3.92, where 1 = less than one year and 6 = over 10 years, SD = 1.74; n = 454) than the average amount of time lived on the island by the entire sample. The results showed that most of the residents were not transient or had not recently arrived, suggesting that residents' responses on resource use and resource conditions were based on a sample that could thus provide well-informed answers.

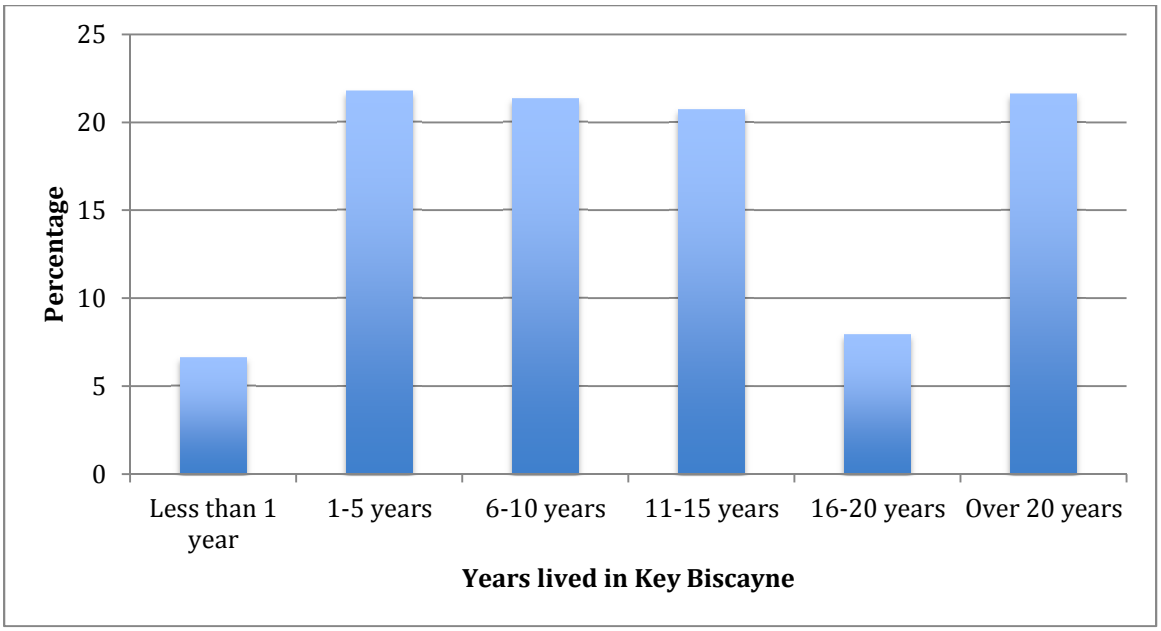

Figure 3: Key Biscayne residents' number of years lived on the island

Almost 80% (n = 656) of the residents surveyed stated that they lived on the island on a full-time basis (see Figure 4). Another 12.5% lived between 7-11 months out of a year, and less than 10% lived in Key Biscayne for six months or less per year. Coupled with the results showing the amount of time the sample had lived on the island, the year-round residency for a majority of respondents suggest that the sample was comprised mainly of residents who were likely knowledgeable about the island's resources (in that they had the opportunity, due to their long tenure and year-round residency to experience the resources and changes in resource conditions.

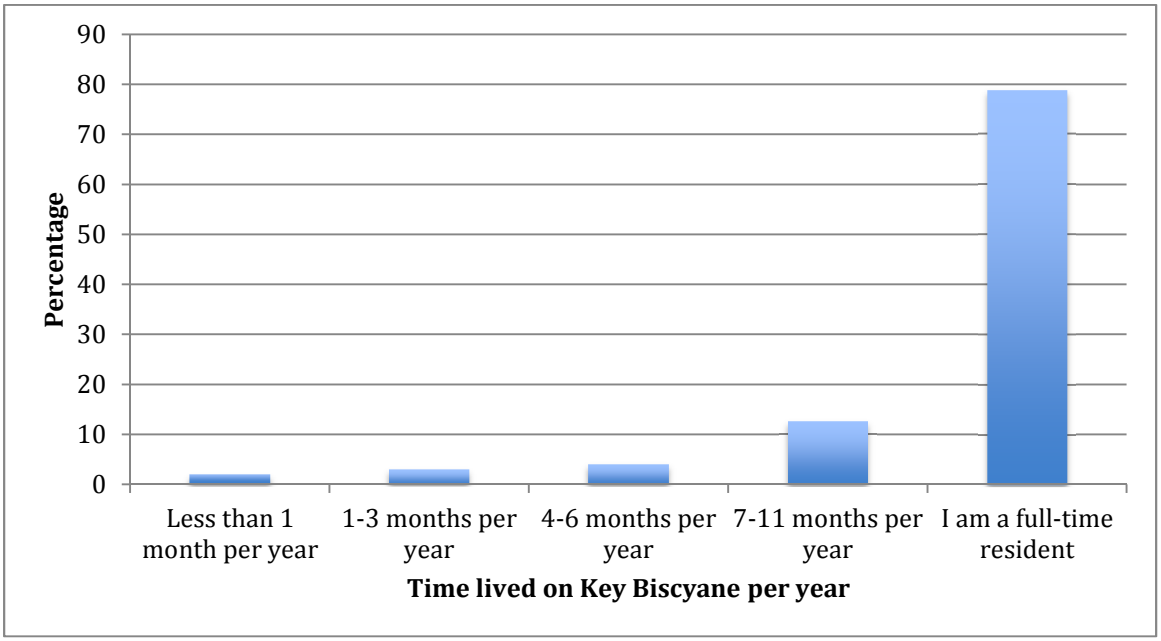

Figure 4: Key Biscayne residents' time spent on the island per year

b. Theme 2: Uses

The results from the theme concerning uses are divided into the five main use types reported by the sample, consisting of beach visitation, boating, fishing, diving and snorkeling, and the use of green spaces.

i. Subtheme 2a: Beach use and activities

Beaches are among the most important recreational sites on both Key Biscayne and Virginia Key and serve as high use centers for resident and visitor populations (Shivlani et al., 2003). The survey showed that almost all respondents (94.1%; n = 661) reported using one or more beaches.

Beach visitation peaked at 2-3 times per month, as reported by 27.9% of the respondents (n = 621). Just under two-thirds of sample (66.3%) visited one or more Key Biscayne and Virginia Key beaches at least 2-3 times per month. As the frequency rate increased, the percentage of respondents decreased, such that just over 5% visited beaches on a daily basis. By contrast, almost a fifth (19.5%) of Key Biscayne residents visited beaches less than once a month, showing the considerable variation in beach visitation profiles.

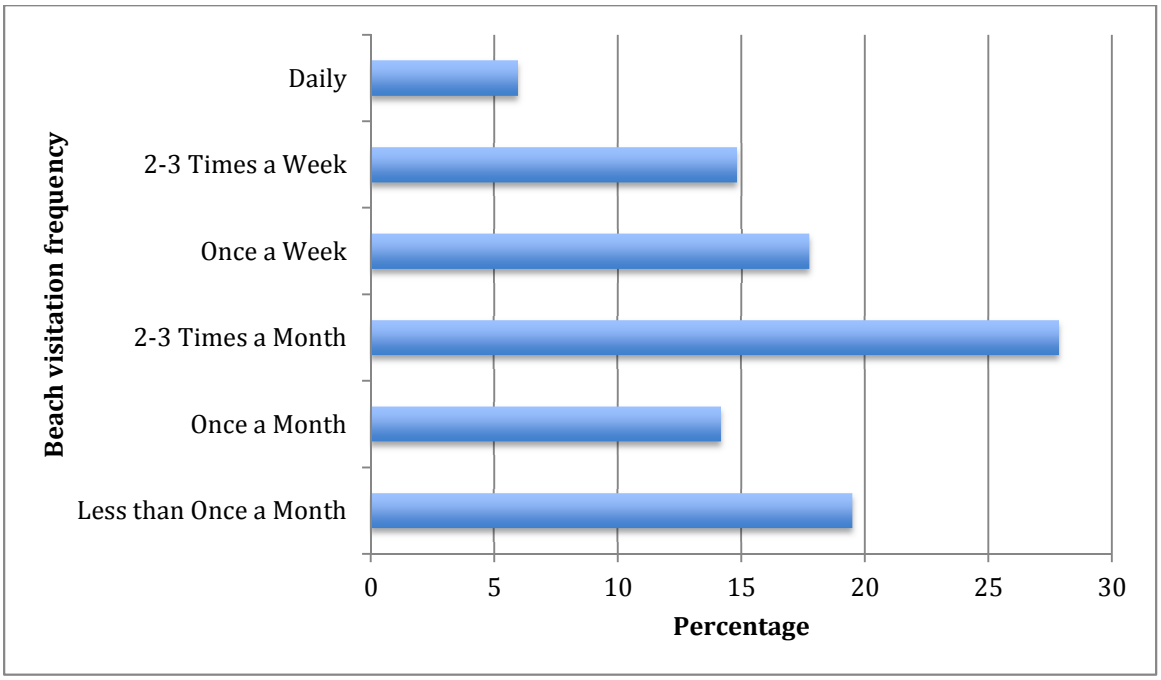

Figure 5: Key Biscayne residents' beach visitation rates

When asked about beach-based activities, almost 85% (n = 615) of the respondents stated that they either walk or jog on the beach. Swimming and sunbathing were the next most popular activities, identified by 76.4% and 64.2% of the sample, respectively (see Figure 6). Also popular was watching nature, such as bird watching (46% participation rate), showing that almost half of the sample considered beaches as important, natural sites. Among specialized, water-based

activities, snorkeling (30.1%) was the most popular, followed by paddle boarding (21.1%). By contrast, the only extractive activity (although it is acknowledged that fishing does include the catch-and-release option) conducted on beaches, fishing, was conducted by less than a fifth of the respondents (17.7%). This may be because of the lack of productive fishing areas near beaches and the conflict presented by fishing in such areas (especially with swimmers and surfers).

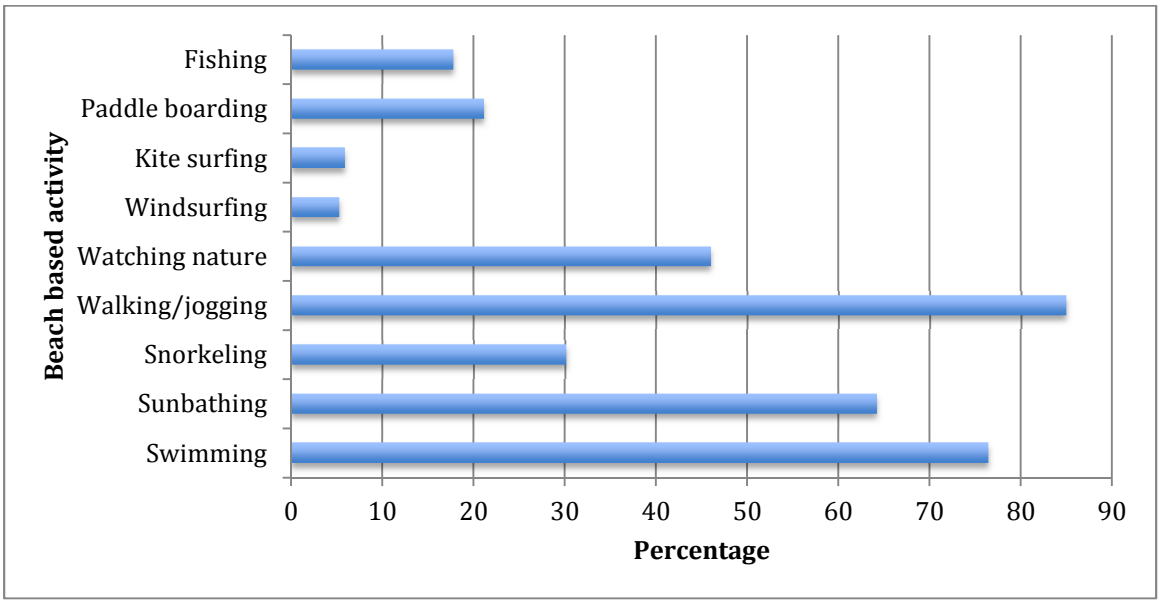

Figure 6: Key Biscayne residents' beach activities

Respondents selected the beaches they visited, and based on their frequency of visits, the research team calculated the total number of visits per beach per month[1]. It should be noted that frequency of use per beach is relative and is best applied in comparing across beaches. As shown in Figure 7, residents frequented Key Biscayne Beach more often than they did any of the other beaches on the two islands. The 2,626 monthly visits to Key Biscayne Beach accounted for 35% (n = 7,513) of all monthly visits reported by the sample. The next most heavily visited beach was Bill Baggs Beach, which attracted 27.3% of all monthly beach visits. Along with Crandon Park Beach, which attracted 24.5% of all monthly beach visits, the three Key Biscayne beaches accounted for 86.7% of all monthly beach visits by Key Biscayne residents. While respondents did use beaches on the adjacent Virginia Key, they did so less frequently. Virginia Key Beach was slightly more popular than Hobie Beach,

[1] To obtain frequency of visits per beach, the research team assumed that the each respondent visited each beach the respondent listed at the rate at which the respondent identified. To standardize frequencies, the research team used the following conversion to determined monthly visit totals: daily = 30 visits; 2-3 times per week = 12 visits; once a week = 4 visits; 2-3 times a month = 3 visits; once a month = 1 visits; and less than once a month = 0.5 visits. Then, the research team added the number of visits per beach that the respondent identified, yielding the frequency of visits per beach for the respondent. This frequency of visits for each respondent was summed for the sample, providing the total number of visits per beach per month. The same approach was used to determine fishing and snorkeling and diving trips per month.

attracting 7.2% of total monthly beach visits, compared to 6.0% at Hobie Beach. These results are consistent with a previous study conducted on three Key Biscayne and Virginia Key beaches (Shivlani et al., 2003), in which Key Biscayne residents reported visiting Key Biscayne beaches more frequently than Virginia Key beaches (with the notable exception being dog owners, who used Hobie Beach more frequently than other area beaches).

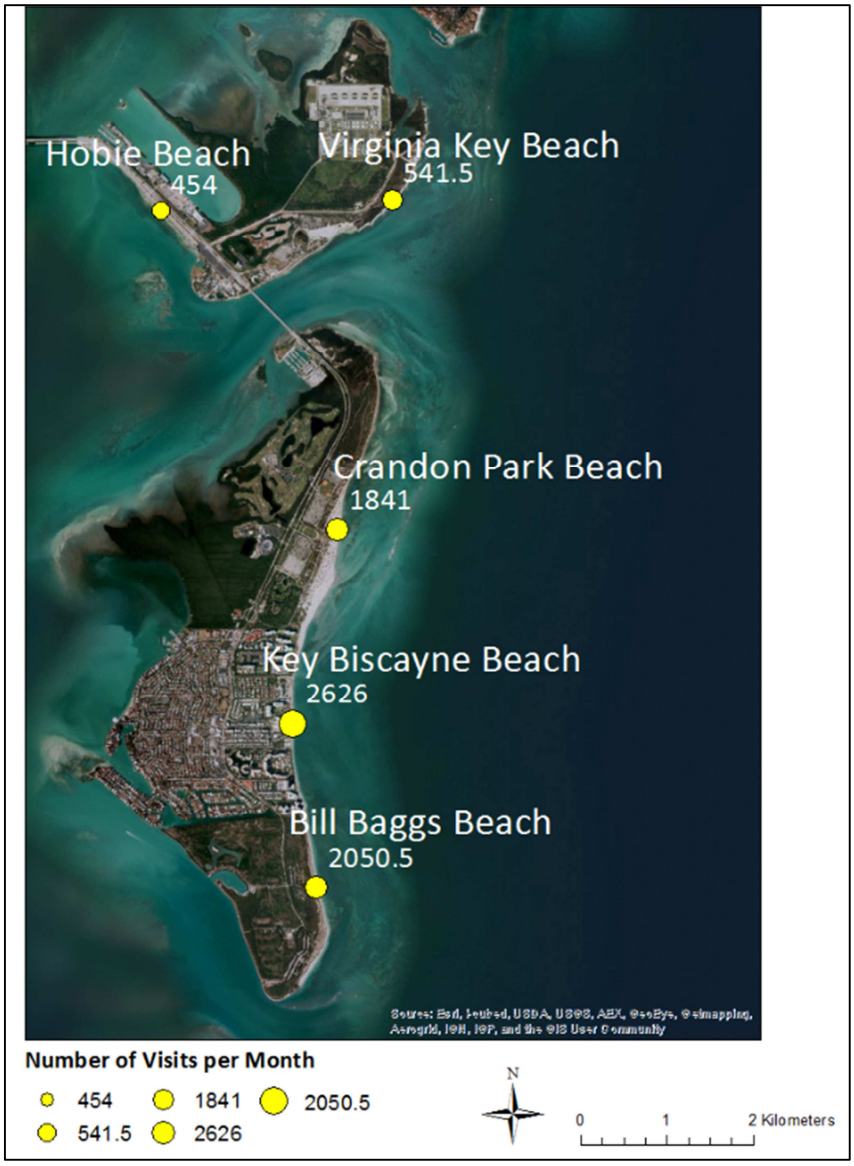

Figure 7: Monthly beach visitation by Key Biscayne residents

When asked about the beach that they **most** often visit, respondents overwhelmingly selected Key Biscayne Beach (82.3%; n = 601). Another 10% of the respondents selected Crandon Park Beach, and 5.7% selected Bill Baggs Beach. The beaches on Virginia Key were the least frequently listed as the most popular options, with Virginia Key Beach selected by 1.5% of the residents and Hobie Beach by less than 0.5% of the residents.

The main reason by over four fifths of the sample selected Key Biscayne Beach is likely due to the proximity of the beach. In fact, close to 90% (86.7%; n = 592) of the residents surveyed identified distance from home as the primary reason for beach selection (see Figure 8). Less important were factors such as crowding (22.8%) and cleanliness (20.8%), but it must also be stated that the latter two factors do not denote existing beach conditions. It could very well be that Key Biscayne Beach provides all three amenities – a shorter distance, less crowding, and cleanliness – but that respondents identified distance as the main reason for site selection. Swimming conditions were the least important factor, as only 12.8% selected it as the main reason they selected a beach. But, this could have occurred due to similar swimming conditions at least along the three beaches in Key Biscayne, thereby rendering it a less important factor than distance from home.

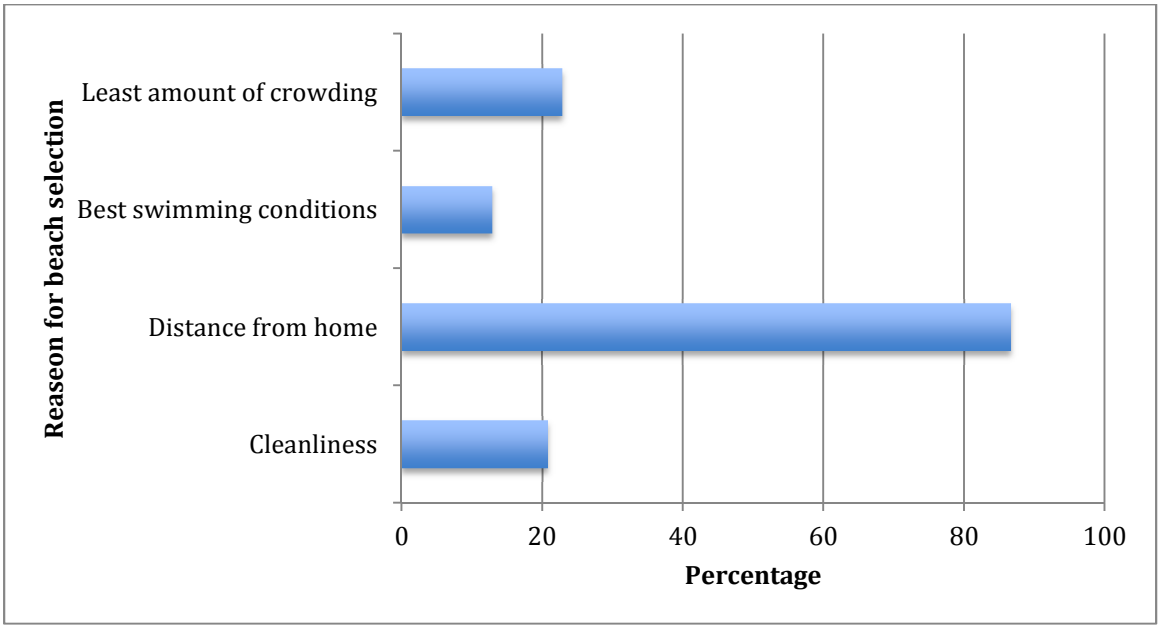

Figure 8: Key Biscayne residents' main reason for beach selection

ii. Subtheme 2b: Fishing use, species, and type of fishing activities

The second use subtheme concerned fishing activities off Key Biscayne and Virginia Key.

Recreational fishing has been characterized for the South Florida region using federal fishery management intercept surveys (MRFSS and MRIP programs) and regional studies (Shivlani and Villanueva, 2007). However, until the present effort, little was known about this important activity off Key Biscayne and Virginia Key. The survey showed that over a third of those interviewed, or 71.3% (n = 641), reported fishing in the region.

In terms of fishing mode, 49.4% (n = 182) of the respondents reported fishing off a boat as their primary fishing activity; by contrast, only 15.4% fished from the shoreline. Over a third, or 35.2%, fished from both a vessel and the shoreline. These activities demonstrate that while the primary mode of fishery access is via vessels, a sizable segment of the Key's anglers do participate in both shoreline and vessel-based fishing.

Key Biscayne residents did not report fishing on a regular basis, as measured by frequency of use (see Figure 9). A majority (46.7%; n = 182) fished less than once a month, and another 27.5% fished once a month. Taken together, almost two-thirds fished once a month or less. There was a smaller group of residents (10.4%) who fished at least once a week, suggesting that while fishing is not an important activity for a majority of the island's residents, it is likely among the most important activities for a segment of the population.

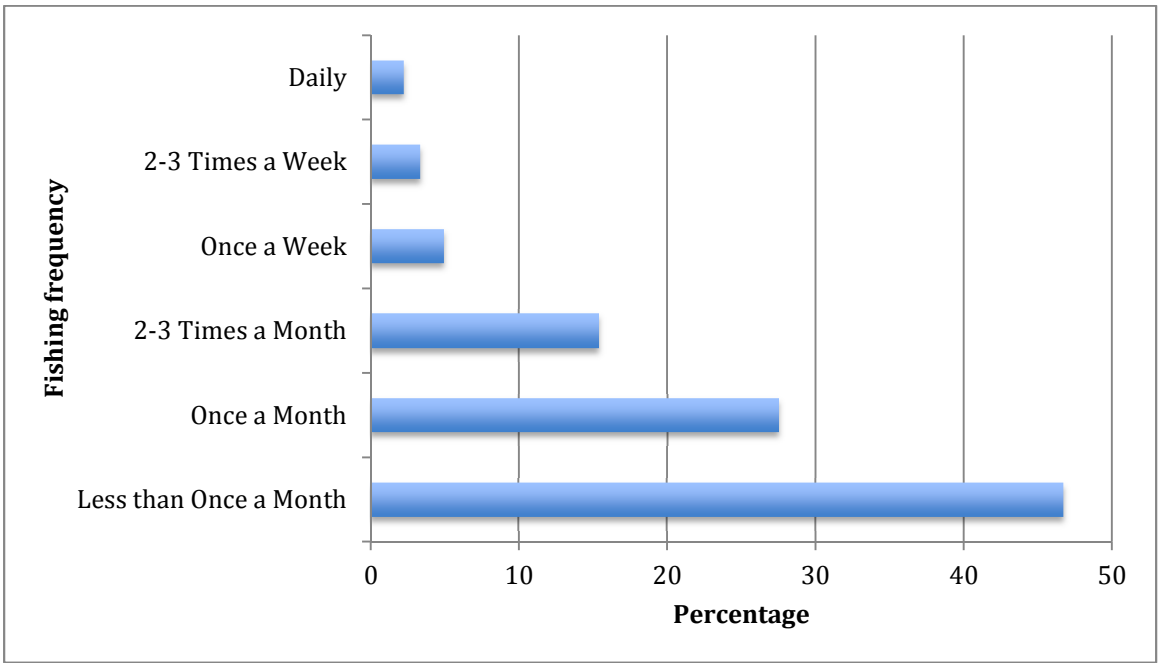

Figure 9: Key Biscayne residents' fishing participation rates

Over half of the respondents who reported fishing as an activity, or 57.4% (n = 305), participated in hook and line fishing (see Figure 10). In-water fishing activities, either practiced using SCUBA gear or by free diving, were less important; however, it should be noted that 18.0% and 13.4% participated in lobster diving and spearfishing, respectively. Only a small percentage of respondents caught shrimp by net (6.2%) or collected tropical fish (4.6%). Thus, angling is the most important fishing activity practiced by Key Biscayne residents, while almost a fifth participates in lobster diving.

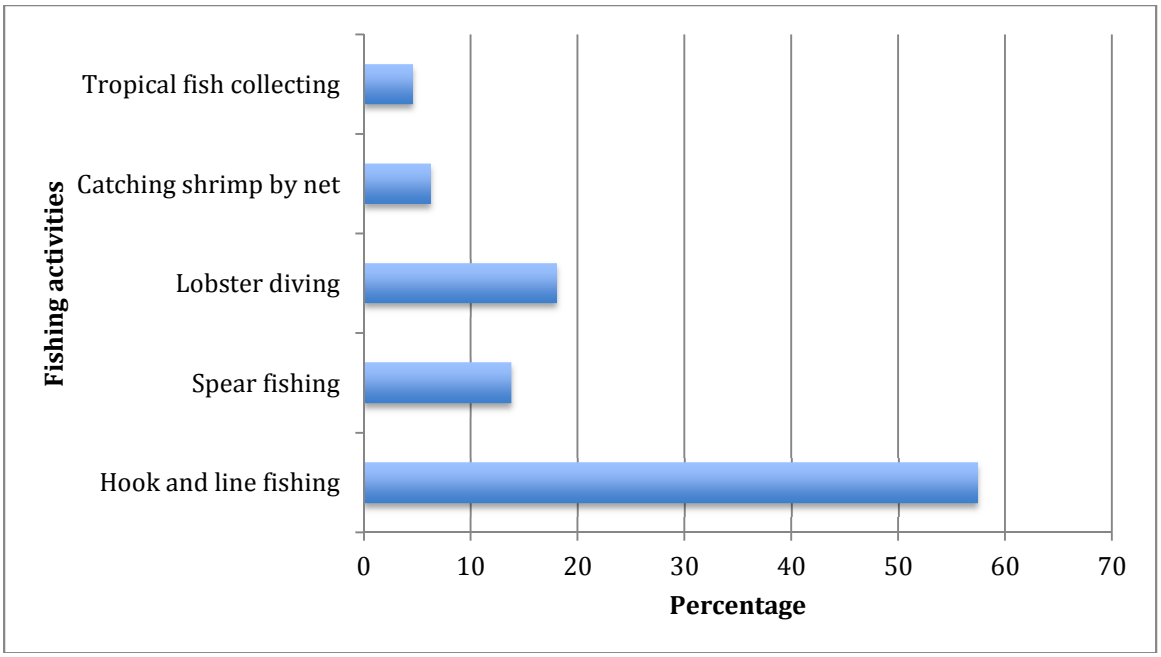

Figure 10: Key Biscayne residents' fishing activities

Respondents provided information on their fishing areas off and around Key Biscayne and Virginia Key (see Figure 11). The most heavily fished area was the area designated as "offshore Key Biscayne", which was identified as the deep water area east off Key Biscayne and Virginia Key. While the area was not identified on the map provided via bathymetry (i.e., depth), the map did identify features used to differentiate the nearshore area off the two islands and the offshore area to the east. With the exception of discrete areas off eastern Key Biscayne and Virginia, use was less intensive in nearshore areas than it was in offshore areas. These discrete areas were located exclusively on the eastern sides of each island, consisting of fishing spots located off Bill Baggs Beach, the Village of Key Biscayne, Crandon Park Beach, and Virginia Key Beach. The western side of the islands, including Biscayne Bay, was less popular for fishing activities than was the eastern side. Fishing activities peaked west from Key Biscayne, and effort was relatively low (compared to the eastern side) from Hobie Beach south to Cape Florida. Interesting, fishing use on either side of the Village of Key Biscayne was limited compared to other areas, due likely to a combination of fishing access, the lack of good fishing sites, and conflicts with other uses (namely beach visitation). But the low fishing effort on the western side relative to the higher fishing effort on the eastern side suggests a definite use preference, which may be related to specific species abundance (ex., offshore pelagics on the eastern side versus nearshore species on the western side).

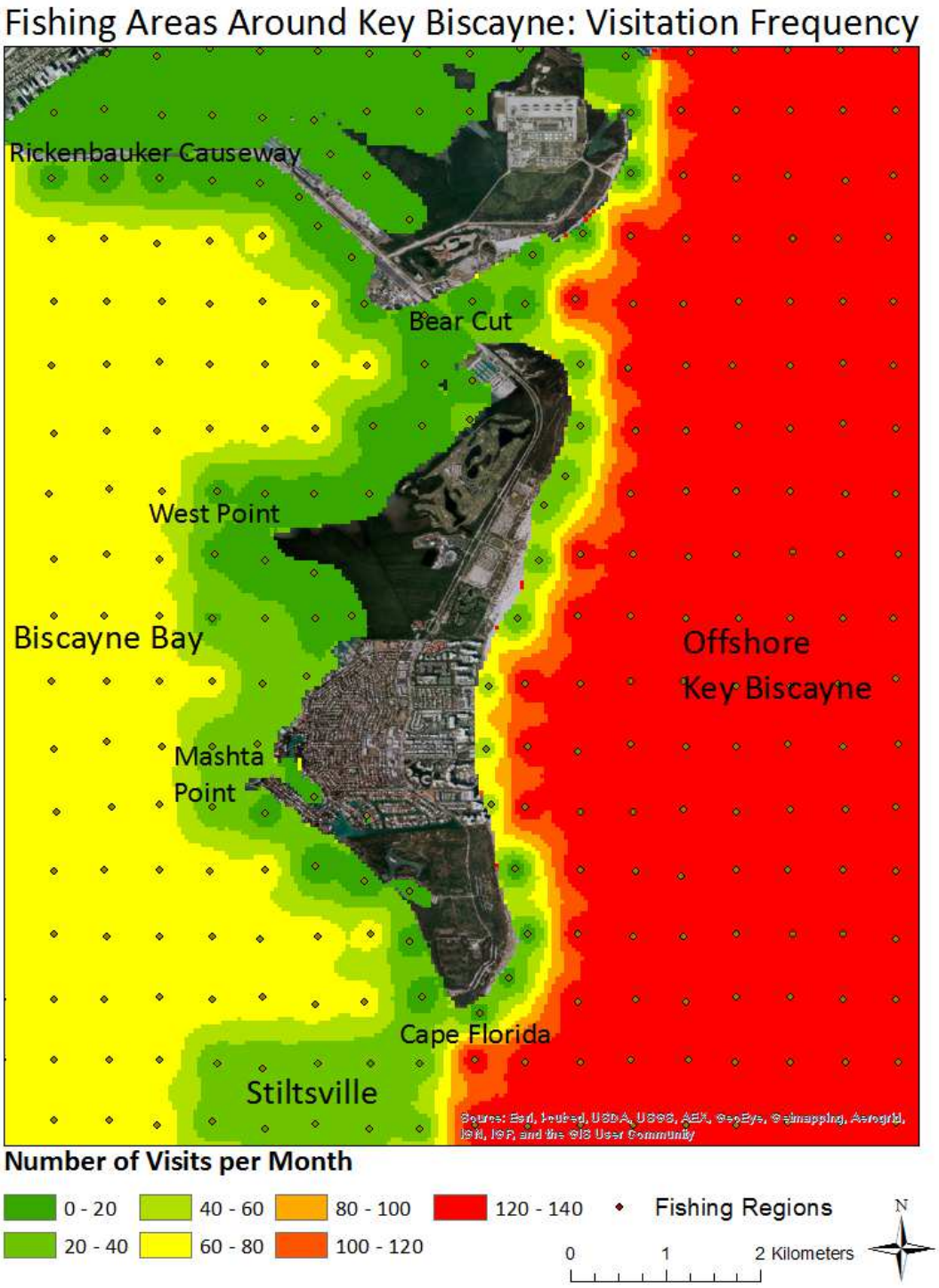

Figure 11: Monthly fishing trips by Key Biscayne residents

The top species targeted by residents on fishing trips belong to the snapper/grouper complex (see Figure 12), which almost 85% (n = 165) of the respondents reported fishing. It should be noted that this does not mean that fishing trips targeting such species were successful, and that the results instead

demonstrate the most sought after species or species complexes. The next most important group of species targeted were offshore pelagics (35.8% reporting fishing for these species), such as dolphin, grouper, and wahoo, which were likely fished in the eastern offshore area, followed by coastal pelagics like king and Spanish mackerels (29.1%), and spiny lobster (27.9%). Less than 20% of the respondents fished for the other species, including sharks, stone crab, and shrimp.

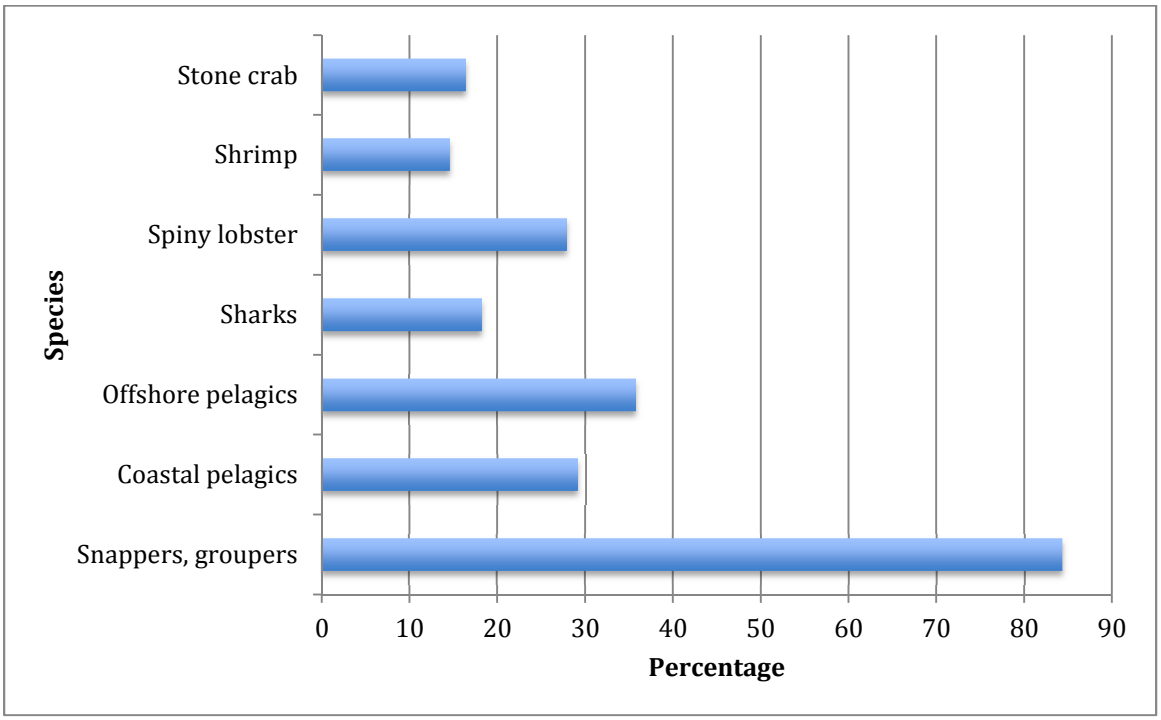

Figure 12: Species targeted on fishing trips by Key Biscayne residents

iii. Subtheme 2c: Boating use and activities

The third use subtheme concerned boating use and activities around Key Biscayne and Virginia Key.

Boating is among the most popular water-based activities in South Florida. In 2012, the Department of Highway Safety and Motor Vehicles listed 60,572 registered vessels in Miami-Dade County (DHSMV, 2012), representing 6% of all registered vessels in the State of Florida. Pleasure, or recreational, vessels represented 95.9% of all registered vessels in the county. By virtue of its island nature, Key Biscayne offers numerous access points for boating purposes. These include a public boat ramp off Crandon Park Marina, private boat slips on the several marinas on Virginia Key and Key Biscayne, and private docks. Also, those using canoes and kayaks can access Biscayne Bay and the Atlantic Ocean via the beaches and other access areas. Studies evaluating boating use in the region have been limited to research conducted by the University of Miami Boating Research Center, a four-county study on boater use and perceptions on coral reefs (Shivlani and Villanueva, 2007), and overflight studies on boating use patterns.

Over half of the residents in the survey, or 54.3% (n= 637), stated that they access the bay or ocean via a powerboat, kayak, or canoe. Among the most commonly used vessel types were powerboats, which almost 61% (n = 276) of the respondents used, followed by kayaks (17.2%) and sailboats (7.9%) (see Figure 13). By contrast, jetskis (4.5%) and canoes (0.7%) were the least popular vessels among residents.

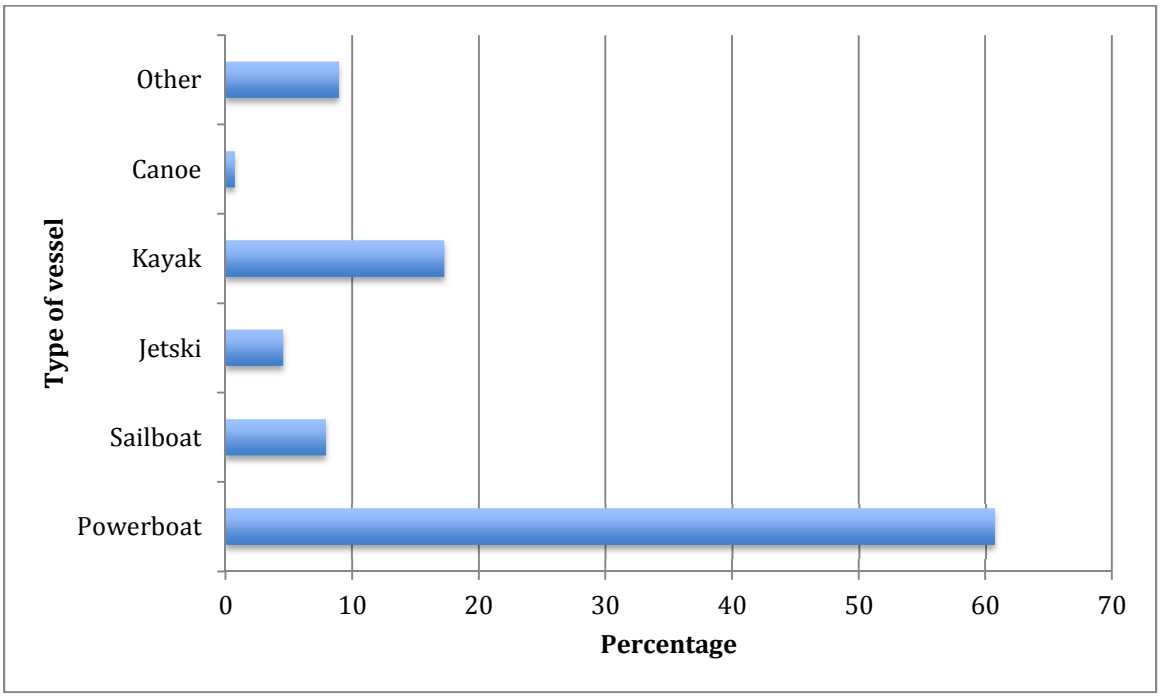

Figure 13: Vessel types used by Key Biscayne residents

In terms of use frequencies (see Figure 14), over a third (37.3%; n = 290) reported taking less than one boating trip per month. Another 21.7% took one boating trip per month, and 29.0% took 2-3 boating trips per month. Just over 12% took weekly boating trips, with 8.6% taking one trip per week. Boating, like fishing, is an important activity for a small percentage of the Key Biscayne population that participates in the activity on a weekly basis.

As shown in Figure 15, boating-based activity rates varied considerably. Residents who took boating trips most often participated in swimming (80%; n = 275), cruising (70.2%), anchoring (52%), and diving and snorkeling (51.8%) while boating. Other boating-based activities that were taken by less than half the respondents included fishing (44.4%), regatta (39.6%), water skiing (28%), and rafting with other boats (26.5%). Boating thus represents a multiple-use activity, via which resident boaters conduct many of the other activities described in this report.

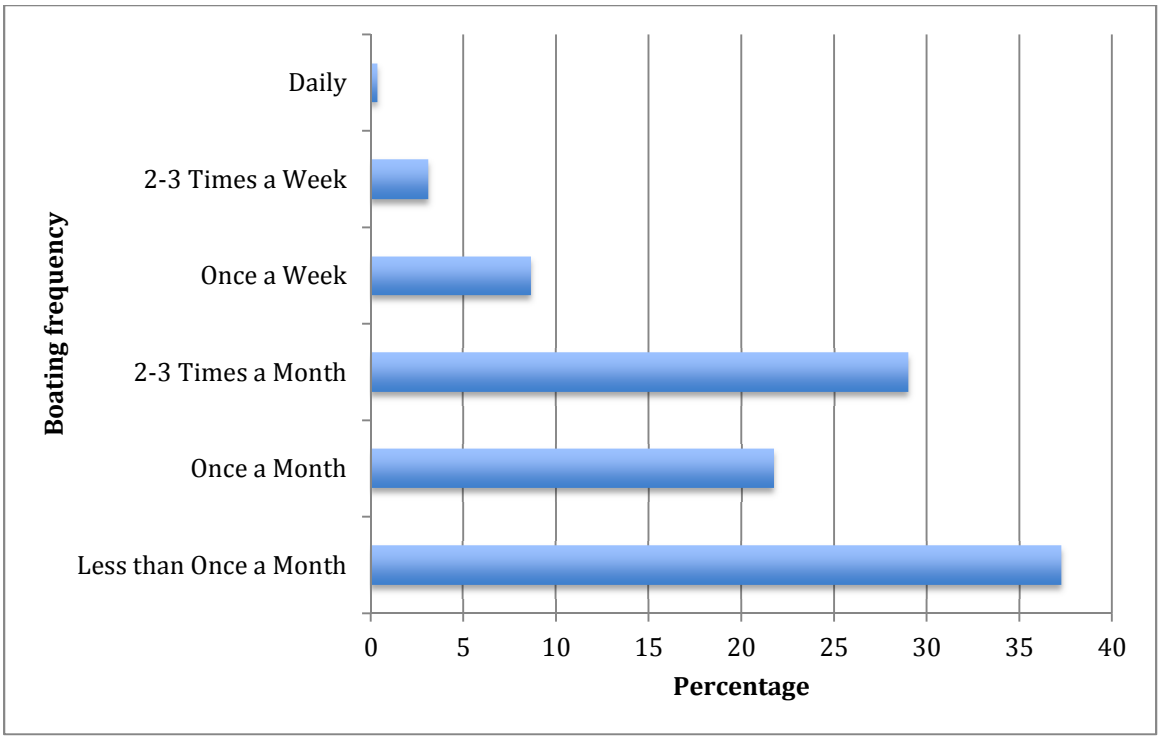

Figure 14: Key Biscayne residents' boating rates

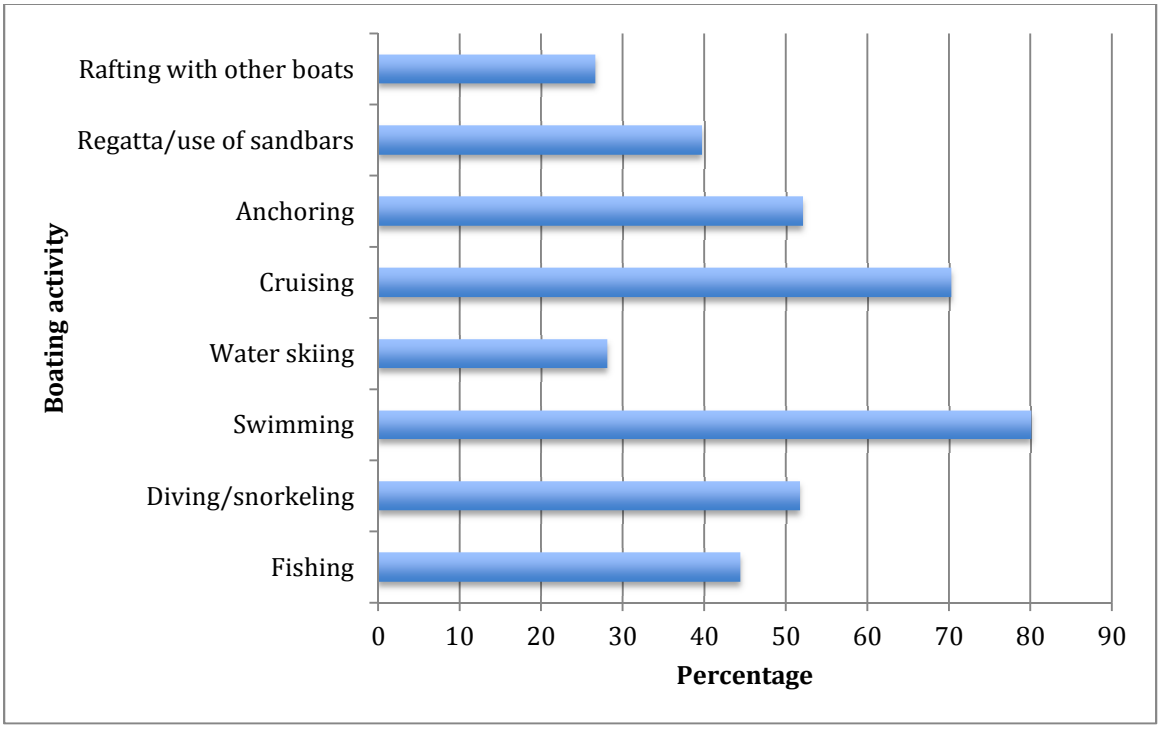

Figure 15: Boating-based activities by Key Biscayne residents

Figure 16 demonstrates the monthly boating frequencies/trips were highest in the eastern offshore Key Biscayne and western nearshore Biscayne Bay areas. Boaters did use many of the nearshore areas around Key Biscayne, especially around the southwestern area of Stiltville, off the northwestern part of Bill Baggs Park, and the area north of Mashta Point; however, use was relatively low around the islands compared to the rest of the region, suggesting that residents generally boat further away from the islands (and thereby conduct the various activities associated with boating at higher rates further away from the islands).

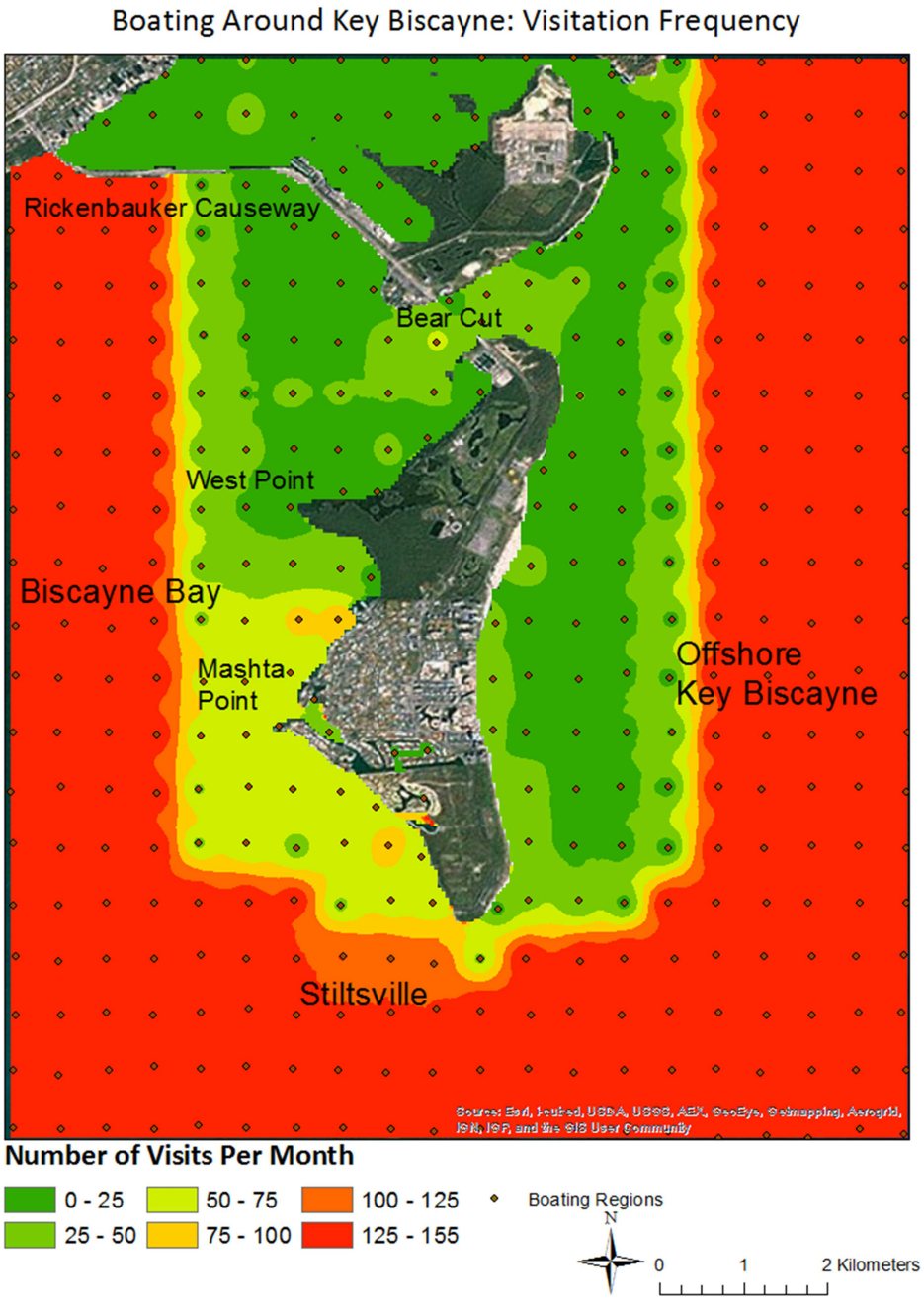

Figure 16: Monthly boating trips by Key Biscayne residents

iv. Subtheme 2d: Diving and snorkeling use and activities

The fourth use subtheme concerned diving and snorkeling activities off Key Biscayne and Virginia Key.

Diving and snorkeling are important uses around Southeast Florida, especially in the upper Florida Reef Tract that extends from Miami-Dade County to Martin County (DEP, 2004) and the various artificial reefs that have been placed off the coast (Shivlani and Villanueva, 2007). Johns et al. (2001) reported that visitors and residents spent 3.25 million person-days diving and snorkeling off Miami-Dade County in 2000-01. There are many popular dive and snorkel sites located off Key Biscayne and Virginia Key, including seagrass, soft bottom, and hard bottom areas located off the shoreline from beaches and other access points, nearshore natural and artificial reefs, and the Florida Reef Tract located further offshore, extending in a north-south direction in the Atlantic Ocean.

Over 39% (n = 617) of Key Biscayne residents stated that they either dive or snorkel off Key Biscayne and Virginia Key. Among those who reported diving and snorkeling, only 19.5% (n = 236) stated that they participate in lobster diving or spearfishing. These results demonstrated that unlike beach visitation, fishing, or boating, all of which had participation rates of 50% or higher, less than half of the respondents participated in diving and snorkeling. Also, consumptive/extractive activities accounted for less than a fifth of all respondents, suggesting that most Key Biscayne residents did not fish while participating in diving and snorkeling activities.

In terms of frequency of use, diving and snorkeling – much like other activities in which Key Biscayne residents participated – was undertaken most frequently by those who dived or snorkeled less than once a month (64.2%; n = 243) (see Figure 17). Overall, 83.1% took one or fewer dive or snorkel trips per month. Only 5.3% dived or snorkeled more once a week or more.

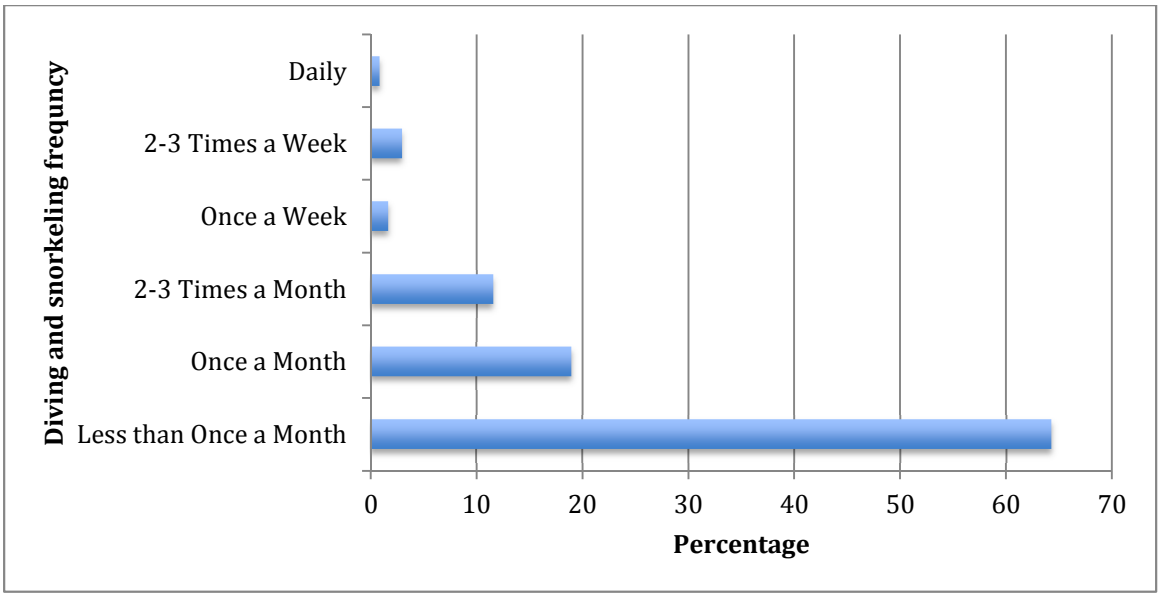

Figure 17: Key Biscayne residents' diving and snorkeling rates

In terms of dive and snorkel areas used, the highest number of monthly trips was focused on two areas off Key Biscayne Beach (see Figure 18). Both areas are located very close to the shoreline and likely attract a large number of snorkelers (as opposed to divers). By contrast, offshore areas, including popular dive sites situated on the Florida Reef Tract, were less popular and attracted among the lowest monthly trip totals. From the figure, it is clear that the most residents participate in diving and snorkeling (mainly the latter) in conjunction with beach visitation. In fact, 30% of residents who reported visiting beaches participate regularly in snorkeling. Although a smaller percentage visit deeper reef sites as a conjunction of boating trips (it should be noted over half of the residents who reported boating undertook diving and snorkeling activities), such trips are less frequent when compared to shore-based, snorkel trips.

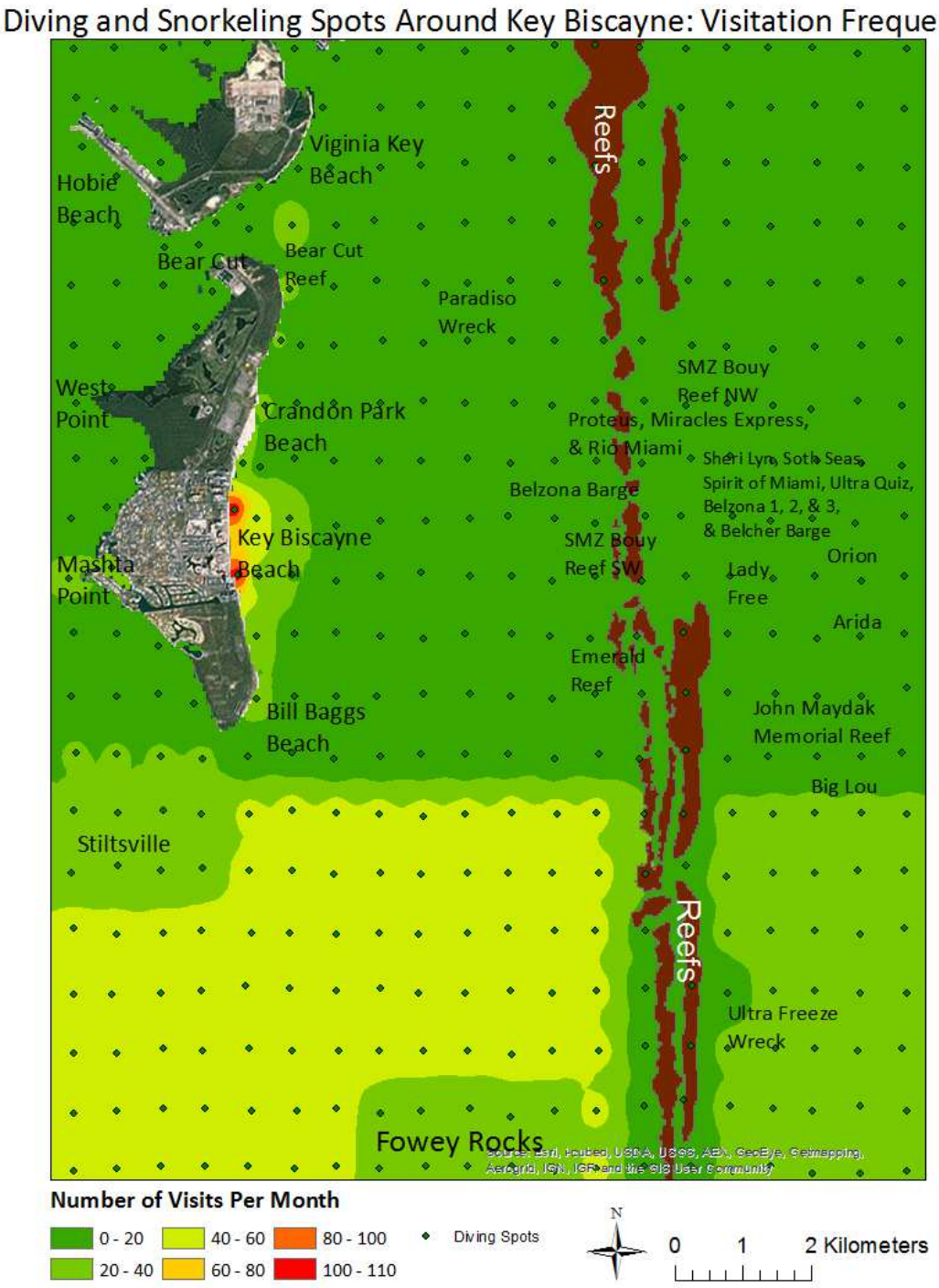

Figure 18: Monthly dive and snorkel trips by Key Biscayne residents

v. Subtheme 2e: Green spaces use and activities

The fourth use subtheme concerned green spaces use activities in Key Biscayne and Virginia Key.

There are several green spaces in Key Biscayne and Virginia Key that have been designated over the past few decades at the village, city, county, and state levels. The largest of these green spaces is the county-owned Crandon Park, an 808-acre green space located on the northern end of Key Biscayne that encompasses a variety of coastal and marine habitats, marina, public beaches, and other facilities. Located at the southern end of Key Biscayne is the 400-acre Bill Baggs-Cape Florida State Park, a green space that is maintained mostly in a natural state while allowing for recreational uses. Also on the island, the Village of Key Biscayne manages a village green, which is open to variety of recreational uses. Finally, Virginia Key contains the Historic Virginia Key Beach Park, an 8.5-acre coastal area and beach that is managed by the City of Miami (VKBT, 2009). Together, these areas comprise the islands' green spaces.

Almost 90% (n = 607) of the residents stated that they used one or more of the green spaces. Rates of visitation were very high, as shown in Figure 19. Over 31% (n = 547) used the green spaces between 2-3 times a week, and almost two thirds (64%) used the green spaces at least once a week. By contrast, only 10.8% of the respondents stated using the green spaces less than once a month. Along with the beaches, green spaces represented the most popular use of Key Biscayne and Virginia Key resources. The high level and rate of use is likely related to the green spaces' accessibility, as compared to other activities that may require equipment, time, and even expertise (ex. diving).

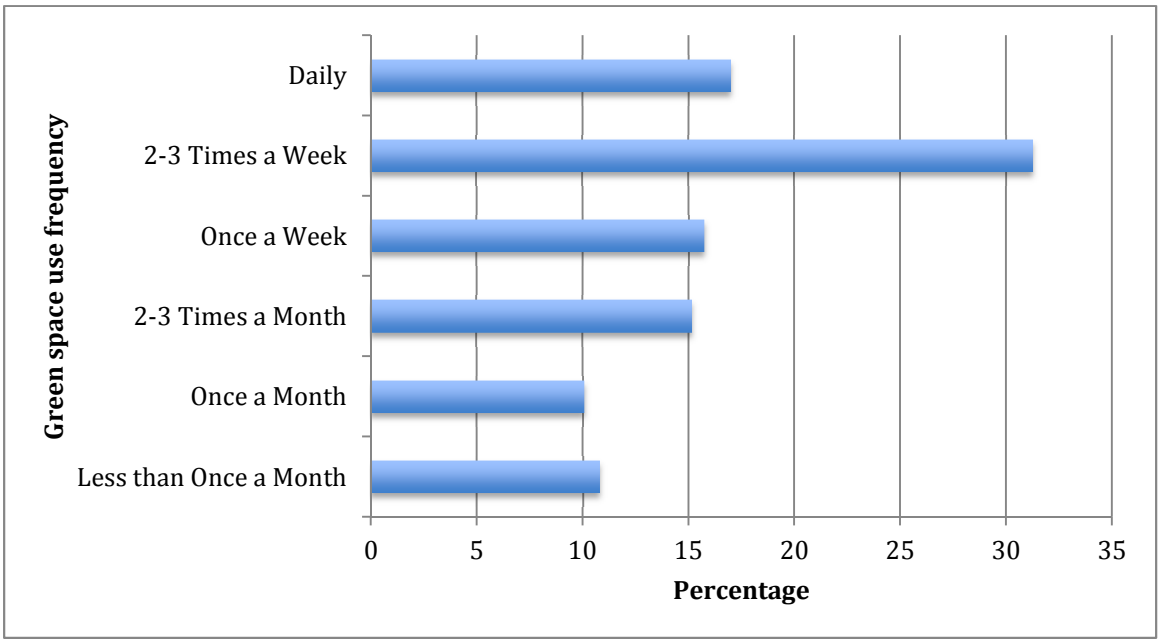

Figure 19: Key Biscayne residents' green space use rates

When asked about which green spaces they most often visited, residents selected the Key Biscayne Village Green over the other three green spaces (see Figure 20). Out of the 9,709 monthly visits reported by the residents, over a third, or 36.7%, were taken to the Key Biscayne Village Green. Crandon Park Green Space accounted

for 26.8% of all monthly visits, followed by Bill Baggs Park Green Space (25.6%), and Virginia Key Park Green Space (10.9%). Much like with beach visitation, for which Key Biscayne beaches accounted for almost 90% of the monthly total, green space visitation was also dominated by Key Biscayne locations (over the Virginia Key Green Space), likely due to a combination of distance and amenities.

Figure 20: Monthly green space visits by Key Biscayne residents

Residents also provided information on their use of bicycle and hiking trails on the islands, which were identified as the Crandon Park trails, Village of Key Biscayne bike path, and the Bill Baggs Park trails. Over 77% (n = 605) used one or more of these trails. The rate of use (see Figure 21) of the trails varied considerably, suggesting that different segments of the island's population used the trails more and less frequently. No rate of use, for example, exceeded 25%. The most popular

rate of use was 2-3 times month, as reported by 22.2% (n = 473) of the sample. However, a very similar percentage (21.7%) used the trails 2-3 times a week (or at four times the rate of the previous respondents). Fewest respondents (9.7%) used the trails on a daily basis, but in terms of all activities, the daily use percentage was second only to the percentage of residents who used green spaces on a daily basis

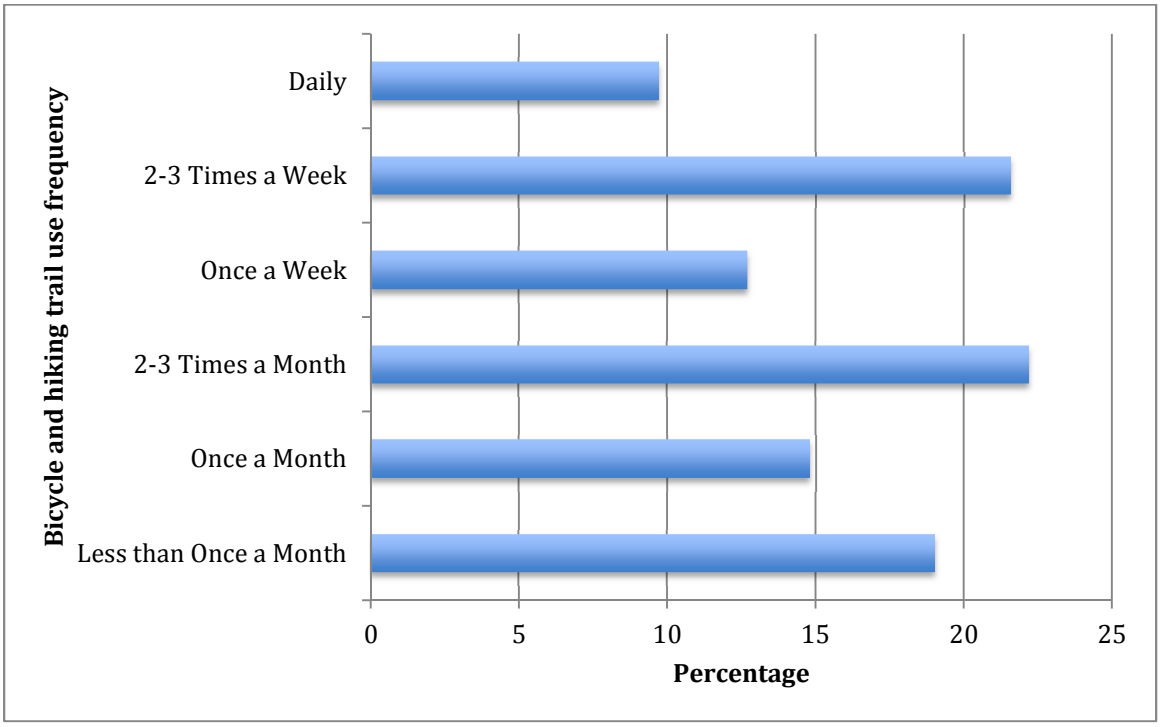

Figure 21: Key Biscayne residents' trail use rate

Of the three trail locations, Crandon Park trails were used most frequently (80.8%; n = 463); however, the other two trails were also used very frequently. Over three quarters of the respondents (78%) used the Village of Key Biscayne bike path, and just under a third (64.6%) used the Bill Baggs Park trails. When asked to compare the trail locations, however, respondents selected the Village of Key Biscayne bike path as their most frequently used trail (45.2%; n = 456). Crandon Park trails were the second more frequently used location (34.3%), followed by Bill Baggs Park trails (20.4%). Thus, although all trails were used by a large majority of the residents, the results suggest that distance may play a role in the trails that are most often used, which in this case favors the centrally located Key Biscayne bike path.

c. Theme 3: Use conflicts

Use conflicts may profoundly impact stakeholder resource access and influence stakeholders' perceptions on both resource conditions and trends (see, for instance, Shivlani and Estevanez (2011) for an evaluation of use conflicts on Southeast Florida coral reefs). In a densely populated area such as Southeast Florida, crowding,

limited resource availability, declining resource quality, and a negative use experience can affect use patterns and resource access. This has led resource agencies to consider measures to address user satisfaction and to determine ways by which to improve the resource use experience (NPS, 2011; Leeworthy and Wiley, 1996).

In this study, residents were asked whether they had experienced any type of use conflict on Key Biscayne or Virginia Key and, if so, the area/nature of the use conflict. Only 29.4% (n = 605) of the residents reported having experienced a use conflict on either island, suggesting that a majority of the residents either perceived the region as still allowing for space (i.e., lack of congestion, minimal crowding, etc.) for most activities or believed that the users exercised common courtesy and best management practices to avoid use conflicts.

In terms of conflict areas or locations, most respondents (62.7%; n = 169) identified bike paths, followed by beaches (56.2%) (see Figure 22). All other conflict areas or locations were identified by less than half of the respondents, indicating that water-based sites, such as speed zones, sandbars, and underwater sites, presented few conflicts. Interestingly, while bike paths were listed as the main conflict area, fewer respondents identified trails as presenting a conflict. This may be due to the recent accidents that have occurred on bike paths, where vehicles have to share the road with bicycles, compared to trails, where vehicles are obviously not permitted. Also, the results demonstrated that those activities that exhibited among the highest rates of use were the same ones that had the highest rates of conflicts.

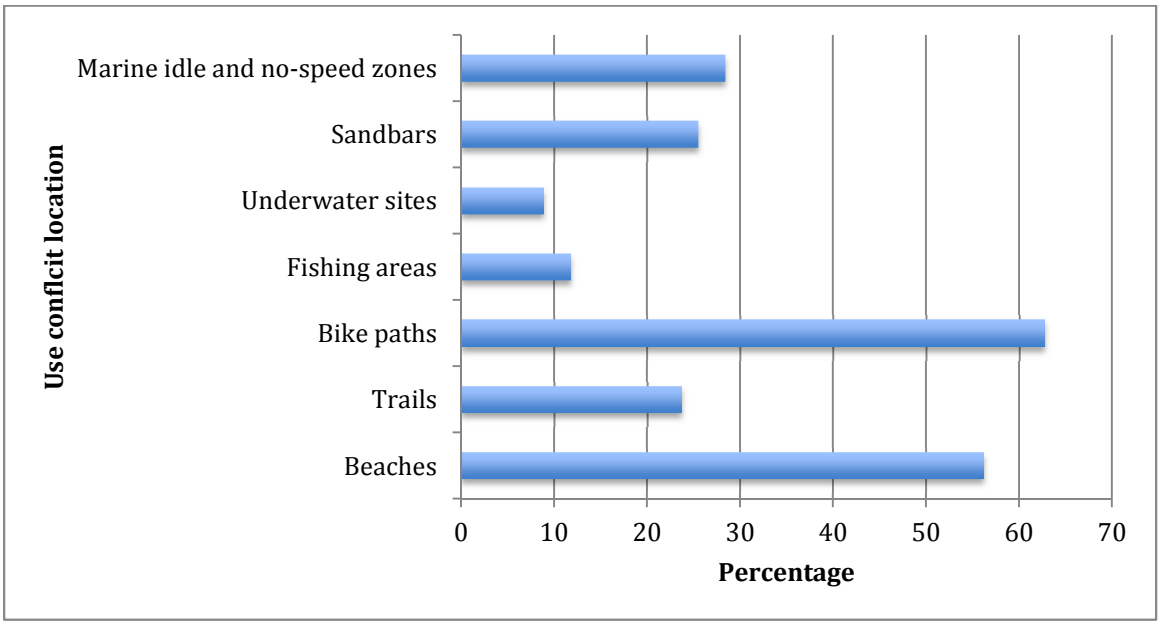

Figure 22: Key Biscayne residents' views on use conflicts by location/area

d. Theme 4: Knowledge and perceptions on resources and resource conditions

Following previous work done in the region with stakeholders on their knowledge of and perceptions concerning resources (Shivlani and Estevanez, 2011; Shivlani et al., 2008; Shivlani and Villanueva, 2007), the survey sought to evaluate residents' knowledge on resources and their views on resource conditions.

As shown in Table 1, residents felt that they were most knowledgeable about beaches (mean = 2.12, where 1 = very knowledgeable and 5 = not knowledgeable at all) and least knowledgeable about fisheries (mean = 3.38). While 69.5% of the respondents felt that they were either very knowledgeable or somewhat knowledgeable about beaches (sum of columns titled "1" and "2"), less than half felt the same about the remaining resources. For certain resources, such as corals and fisheries, a majority believed that they were either not very knowledgeable or knowledgeable at all (sum of columns titled "4" and "5"). These results suggested that residents perceived their knowledge base being limited mainly to the resources which they encountered most frequently (i.e., beaches), and that residents had less knowledge about resources located partly or wholly in the marine environment. Fisheries best exemplify this, a resource which a majority felt that they had knowledge about but an activity (fishing) in which 71% of the residents participated. The results also demonstrate a willingness on the part of residents to admit a lack of awareness over the region's resources, which is important when considering the appropriate education and awareness measures.

		Very knowledgeable ←-----→ Not knowledgeable at all					
Resource	Sample	1	2	3	4	5	Sample mean
1. Beaches	n = 603	37.8	28.7	19.9	10.6	3.0	2.12 (SD = 1.12)
2. Mangroves	n = 598	18.2	23.6	18.6	26.9	12.7	2.92 (SD = 1.32)
3. Sea grasses	n = 595	12.4	18.7	19.3	31.9	17.7	3.24 (SD = 1.29)
4. Corals	n = 588	12.8	15.8	21.4	29.9	20.1	3.29 (SD = 1.30)
5. Sea turtles	n = 592	18.6	22.1	21.3	27.4	10.6	2.89 (SD = 1.29)
6. Fisheries	n = 592	12.5	13.5	19.4	33.1	21.5	3.38 (SD = 1.30)
7. Water quality	n = 597	16.9	24.0	21.6	27.0	10.5	2.90 (SD = 1.27)

Table 1: Key Biscayne residents' knowledge of resources

Residents rated resources based on their present condition, where 1 meant that the resource is in excellent condition and 5 meant that the resource is in very poor

condition (see Table 2). Residents were allowed to state whether they did not have enough information to answer the question. The resource that a majority of respondents (63.6%) felt was in excellent or very good condition (sum of columns titled "1" and "2") was beaches. None of the other resources was rated as highly, mainly due to the fact that a minimum of 20% or higher of residents felt that they did not have enough information to rate the other resources. Thus, while 37.6% and 38% stated that water quality and sea turtles were in excellent or very good condition, respectively, over a fifth of the respondents could not provide a rating for either due to a lack of information. When the "don't know" responses were removed to determine the mean ratings for each resource, mangroves (mean = 2.19, where 1 = excellent condition and 5 = very poor condition) were ranked above all other resources, including beaches, but all resources were ranked as being at least between fair and very good condition. Thus, respondents who provided resource ratings did not rank any resource as being in poor to very poor condition. These results suggest two main findings. The first is that a large percentage of residents perceive that they information on many of the region's resource conditions. While the lack of information is low for beaches (among the most popular resources, in terms of use frequencies), it is much higher for sea turtles, sea grasses, corals, and fisheries, for which between a third to almost half of the residents perceive as having insufficient information to provide a rating. The second finding is that for the segment of the resident population that did provide a rating for the resources, the view held is that all resources are in fair to good condition. By these residents' perceptions, the region's coastal and marine areas are doing either well (ex., mangroves, beaches, and sea turtles) or are least not in poor condition (ex., sea grasses, fisheries, water quality, and corals). These findings are important in that they provide a baseline (of both the amount of information held and trends perceived by the resident community) on perceived resource conditions that can be compared with a baseline of biophysical conditions to determine where there are convergences between the two baselines and where residents' views do not match the biophysical information.

Excellent ←-----→ Very poor

Resource	Sample	1	2	3	4	5	Don't know	Sample mean
1. Beaches	n = 593	22.1	41.5	23.6	5.6	3.0	4.2	2.23 (SD = 0.97) n = 568
2. Mangroves	n = 590	12.5	36.6	20.0	2.0	0.1	28.1	2.19 (SD = 0.79) n = 424
3. Sea grasses	n = 588	6.8	25.7	23.5	7.8	1.9	34.4	2.58 (SD = 0.93) n = 386
4. Corals	n = 588	9.5	12.8	19.9	11.6	4.6	41.7	2.81 (SD = 1.16) n = 343
5. Sea turtles	n = 587	14.8	23.2	20.3	6.1	2.7	32.9	2.39 (SD = 1.05) n = 394
6. Fisheries	n = 583	9.3	16.0	18.5	4.8	2.9	48.5	2.54 (SD = 1.07) n = 300
7. Water quality	n = 591	11.5	26.1	24.4	10.8	6.9	20.3	2.69 (SD = 1.14) n = 471

Table 2: Key Biscayne residents' resource rankings

Residents also provided their views on which resource they considered to be in the **best** condition and which resource they considered to be in the **worst** condition. Figure 23 shows that over half of the respondents (n = 586) felt that beaches were in the best condition; this finding was expected, as beaches were most highly rated resource. By contrast, only 16.2% (n = 543) argued that beaches were in the worst condition of any resource. Other than beaches, only mangroves had a higher best condition rating than a worst condition rating, where 21.3% felt that mangroves were in the best condition and only 5.9% felt that they were in the worst condition. All other resources had higher worst condition percentages than best condition percentages, with water quality leading all resources in highest worst condition percentage (28.4%). In comparing best to worst condition percentages, it was determined that there were considerable differences between resources in terms of the magnitude of the ranking. For instance, 3.2 times as many respondents believed that beaches were in the best condition compared to the worst condition. Similarly, 3.6 times as many respondents felt that mangroves were in the best condition compared to the worst condition. By contrast, almost 10 times as many respondents believed that corals were in the worst condition compared to the best condition. By comparing the differences between the percentages of best and worst conditions, it was determined that corals and water quality were most often identified as the

resources in the worst condition, while beaches and mangroves were most often identified as the resources in the best condition. The differences in percentages were less drastic for the other resources, suggesting an equivocation or split across the sample. Thus, for resources such as sea turtles and fisheries, just as many residents considered them as the resources in the best condition as they did as the resources in the worst condition. As stated above, these views should provide useful information in comparing residents' perceptions with the biophysical information and prove useful in establishing targeted management and outreach and education efforts.

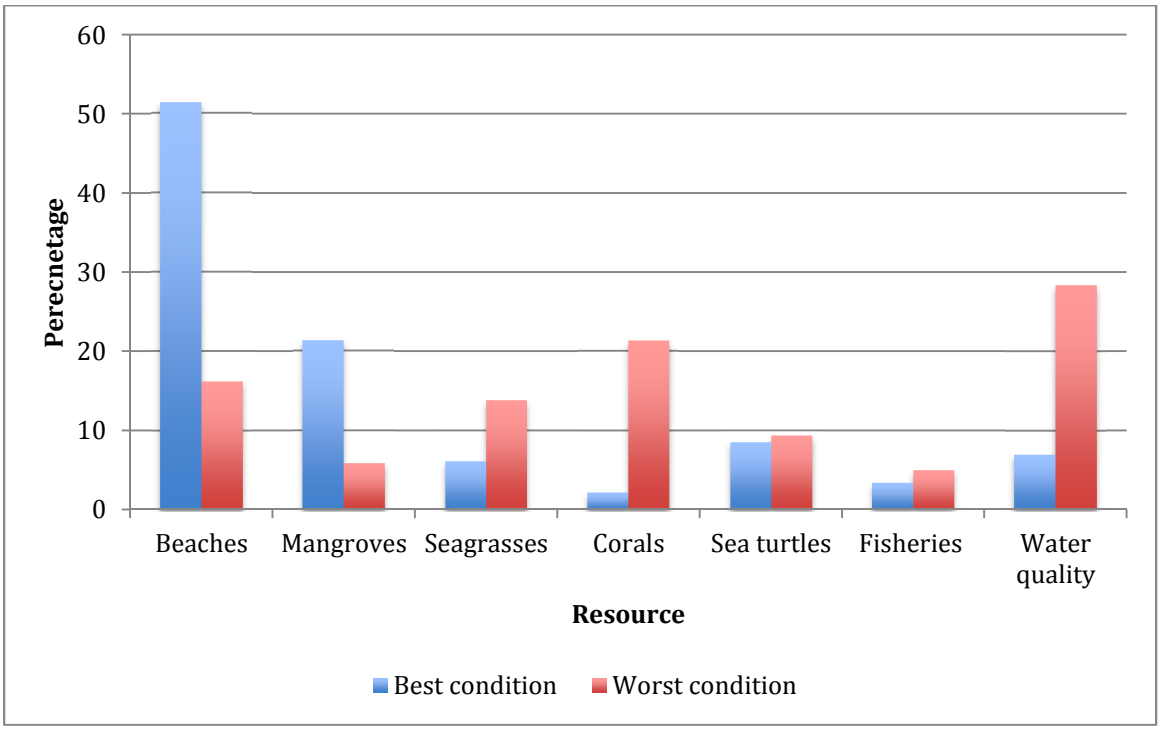

Figure 23: Key Biscayne residents' views on best and worst resources

e. Theme 5: Stressors and management priorities

As conducted in previous studies with stakeholders concerning stressors to the Southeast Florida coastal and marine environment (Shivlani and Estevanez, 2011; Shivlani and Villanueva, 2007; Shivlani, 2006) and preferred management priorities (Shivlani and Estevanez, 2011), this study surveyed Key Biscayne residents on their views on what activities or suite of activities work as stressors on the region's coastal and marine resources and environment, and which management options should be prioritized to counter stressors. Particular emphasis was placed on how both existing and emerging management approaches could be applied, without concern for how these would be implemented (ex., which level of government would be responsible for implementation).

Table 3 shows the impacts that residents perceived various stressors have on the region's resources. Overall, pollution and solid waste led all stressors, in terms of its perceived impact; over three quarters of the respondents, or 76.8%, agreed that pollution and solid waste had a major or moderate impact (sum of columns titled "1" and "2") on Key Biscayne's resources. Also, sewage (which was listed separately from pollution) was considered a major stressor, listed as having major or moderate impacts by 65% of the respondents. Another 64% stated that development had major or moderate impacts on resources. Over half or more of the respondents identified tourism (61.3%), beach nourishment (60.3%), and climate change (50.4%) as stressors. Only overfishing, Port of Miami dredging, and boating were listed by less than half the respondents as having significant impacts on resources; however, it should be noted that for these stressors, a fifth or more of the respondents stated that they did not have enough information to determine the impact of the stressor. In fact, when the means of each stressor were determined (by removing the "don't know" answers, almost all of the impacts were considered to have at least some impact on Key Biscayne resources (mean < 3.0, where 1 = major impact and 4 = no impact). This shows that residents held a nuanced view of stressors and understood stressors to have synergistic and even cumulative impacts. For instance, residents ranked development, pollution, and sewage as major stressors, suggesting that they felt that these stressors develop in conjunction to each other and contributed to cumulative impacts.

Major impact ←→ No impact

Stressor	Sample	1	2	3	4	Don't know	Sample mean
1. Pollution, solid waste	n = 581	49.1	27.7	12.4	2.9	7.9	1.67 (SD = 0.83) n = 535
2. Overfishing	n = 560	18.2	21.6	23.4	8.6	28.2	2.31 (SD = 0.98) n = 402
3. Development	n = 572	46.0	28.0	11.7	4.3	10.0	1.71 (SD = 0.87) n = 515
4. Tourism	n = 563	24.9	36.4	23.4	8.5	6.8	2.17 (SD = 0.93) n = 525
5. Sewage	n = 569	40.6	24.4	14.6	3.9	16.7	1.95 (SD = 13) n = 501
6. Port of Miami dredging	n = 564	27.0	20.2	15.4	5.7	31.7	2.00 (SD = 0.98) n = 385
7. Boating	n = 565	11.5	26.1	24.4	10.8	20.3	2.29 (SD = 0.96) n = 501
8. Climate change	n = 564	23.8	26.8	25.2	10.1	14.2	2.25 (SD = 0.99) n = 484
9. Beach nourishment	n = 572	33.9	26.4	14.0	6.3	19.4	1.91 (SD = 0.95) n = 461

Table 3: Key Biscayne residents' views on resource stressors

When asked about how to best to prioritize a series of management approaches to conserve region's resources, residents felt that increased environmental education should have the highest priority (65.7%) over other approaches (see Table 4). Over half of the respondents also assigned a high priority for restricting fishing access to certain areas to improve fisheries (57.8%), restricting seasonal access to beaches where sea turtle nesting occurs (55.4%), and improving existing enforcement (54.1%). Fewer respondents assigned a high priority for setting up restricted mangrove access areas (43.8%), perhaps due to the sample's view that mangroves are a healthy resource. Almost all proposed management measures received strong levels of support, being ranked as between high and medium priorities, with the notable exception of setting daily visitor limits on beaches. Only a quarter of the residents believed that this was a high priority, and it was the only management approach that had a high (40%) low priority ranking. The results demonstrate that

residents are in favor of a variety of management approaches to improve the condition of regional resources, including spatial and temporal area closures (such as coastal and marine protected areas for protected species and fisheries protection), regulatory approaches that call for better signage and improved enforcement, and interpretative approaches that involve greater education and awareness and involve the citizenry in resource monitoring.

Approach	Sample	Priority			Sample mean
		High	Medium	Low	
1. Resident-based resource monitoring program	n = 555	44.0	45.2	10.8	1.67 (SD = 0.66)
2. Increased environmental education	n = 566	65.7	27.6	6.7	1.41 (SD = 0.61)
3. Sea turtle nesting season restricted access	n = 565	55.4	32.7	11.9	1.56 (SD = 070)
4. Fishing area restricted access	n = 562	57.8	33.1	9.1	1.51 (SD = 0.66)
5. Mangrove area restricted access	n = 557	43.8	41.3	14.9	1.71 (SD = 0.71)
6. Beach visitor daily limits	n = 559	25.2	35.1	39.7	2.14 (SD = 0.79)
7. Improve existing enforcement	n = 556	54.1	35.8	10.1	1.56 (SD = 0.67)
8. Better land and water signage	n = 557	49.4	38.8	11.8	1.62 (SD = 0.69)
9. Exotic plant removal	n = 550	32.3	42.1	25.6	1.93 (SD = 0.76)

Table 4: Key Biscayne residents' management priorities for regional resources

f. Theme 6: Citizen Scientist Program

The survey informed residents of the Citizen Scientist Program, and it directed each respondent to the program's website. So, the respondents were made well aware of the program's objectives and its call for the residents' participation in the program as "Citizen Scientists". When asked if they would agree to participate in the program, 48.5% (n = 582) stated that they would. Most were interested in working with beaches and water quality (70.5%) and sea turtle research (56.4%) (see Figure 24). Less than a third were interested in the other areas, including corals (27.7%), nearshore areas (26.3%), mangroves (23.3%), and fish and fisheries (21.6%). Interest in beaches and water quality are likely a result of the residents' familiarity with the resource; as previously stated, beach visitation was among the most popular activities listed by those who took the survey. Similarly, sea turtles, which are most often sighted on beaches during the nesting season may present an area in which the residents are both interested and with which they are familiar. The other

areas, such as fisheries, corals, and sea grasses, are wholly marine and may thus feel less accessible. With the CSP, however, residents could be educated on the ease with which to access these resources, and these percentages may in turn shift more in favor of subtidal over intertidal or wholly terrestrial resources and activities.

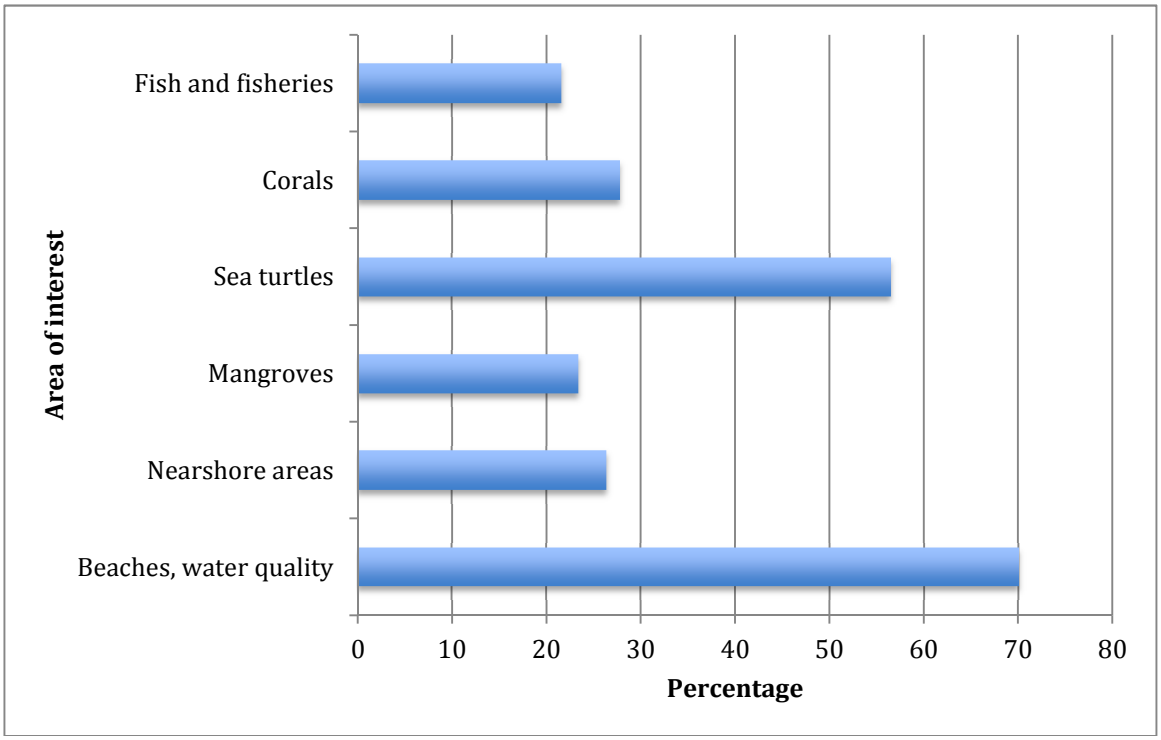

Figure 24: Key Biscayne residents' area of interest for participation in the Citizen Scientist Program

V. Discussion

The resident survey effort led to the characterization of the Key Biscayne resident population, in terms of its uses of Key Biscayne and Virginia Key resources, residents' knowledge of the region's coastal and marine resources, the concerns shared by residents on the various stressors that affect the quantity and quality of the resources, and the residents' views on management priorities and willingness to participate in the Citizen Scientist Program. These results can serve as a baseline against which to periodically measure changes in use frequencies and patterns, the resident knowledge base on resource conditions, and residents' willingness to engage in local, community-based, research and monitoring activities.

Several aspects of the survey approach and results are examined in more detail, as a means to understand the overall effectiveness of the adopted approach, the ability of the survey to obtain wide-ranging, representative, and useful results, and the importance of the findings for resource management and conservation.

a. The overall efficacy of the survey approach

The survey approach, as described in the methodology (see section II), adopted technology to reach a well-educated and sophisticated audience. The use of Internet surveys remains an emerging field (Dillman), but its use proved to excellent effect in this effort, as measured by the high response rates and completed surveys. While there were a few residents who were unable to complete their surveys (and efforts were made to accommodate these individuals), a large majority accessed and filled out the survey remotely (i.e., over the Internet) and over their machines. The effort was also greatly aided by the fact that the survey program used was administered via a third party website that builds, maintains, and supports online surveys. **It is recommended that future survey efforts take advantage of this user-friendly, versatile technology to conduct similar exercises.**

b. Understanding uses, use dynamics, and areas of uses via Geographical Information Systems (GIS)

The survey was able to determine the different uses of natural resources on Key Biscayne and Virginia Keys, assess use frequencies and areas of use, and to map uses via GIS. Users were asked to provide use information by confirming whether they participated in a particular use type (ex., beach visitation, fishing, etc.), providing how often they participated in that use, identifying the ancillary activities associated with that use, and finally locating their areas of use. This stepwise approach to obtaining multiple aspects of use information provided multiple layers of data (spatial and non-spatial data) that were used to create a use and activity baseline. The approach, for example, was instrumental in determining the overall percentage of residents who use Key Biscayne and Virginia Key beaches, their rates of use (which were expressed on a monthly basis in the report but which could be estimated for longer time intervals), participation rates in beach activities, rates of use by individual beach, and most frequently used beach. **It is recommended that other studies conducted via the CSP or other initiatives strongly consider using a compatible spatial platform to build on the existing data layers; this will provide a means by which Increase the knowledge base across various disciplines.**

c. A hierarchy of resources, as determined by use profiles

The results demonstrated that a majority of Key Biscayne residents conducted certain activities, such as beach visitation and green space and trail use, on a very frequent basis. By contrast, fewer residents participated in other activities, such as boating and diving and snorkeling, and did so on a less frequent basis. This is to be expected, as use for an overall population is related to a number of factors, including access and facility. Beaches and green spaces and trails are among the most accessible of resources, and residents tended to use the sites based on location. So, residents were more likely to use Key Biscayne Beach and the Key Biscayne bike trail than they were other beaches and trails. While part of this may have been related to resource quality, at least in the case of beaches, almost 87% of the respondents stated that distance from home played a role in selecting the beach they most frequently. Also, it must be noted that beach visitation for residents was

related to various other uses, making beach visitation a multiple use activity. The most important of these uses was walking/jogging, in which 85% of the residents participated; this makes much of beach visitation similar to trail use. Less accessible activities that required gear (ex., fishing gear, dive gear, vessels) involve a greater time and effort commitment; some of these activities are also more strongly affected by external factors, such as weather, sea state, etc., than are more accessible activities. Accordingly, the results showed that diving and snorkeling was the least popular activity, both in terms of total participation and frequency rates. Even when residents did participate in diving and snorkeling, they did so most frequently in areas located directly off beaches, suggesting that much of the diving and snorkeling use may have in fact been related to beach visitation. The overall hierarchy of uses determined by the study is as follows:

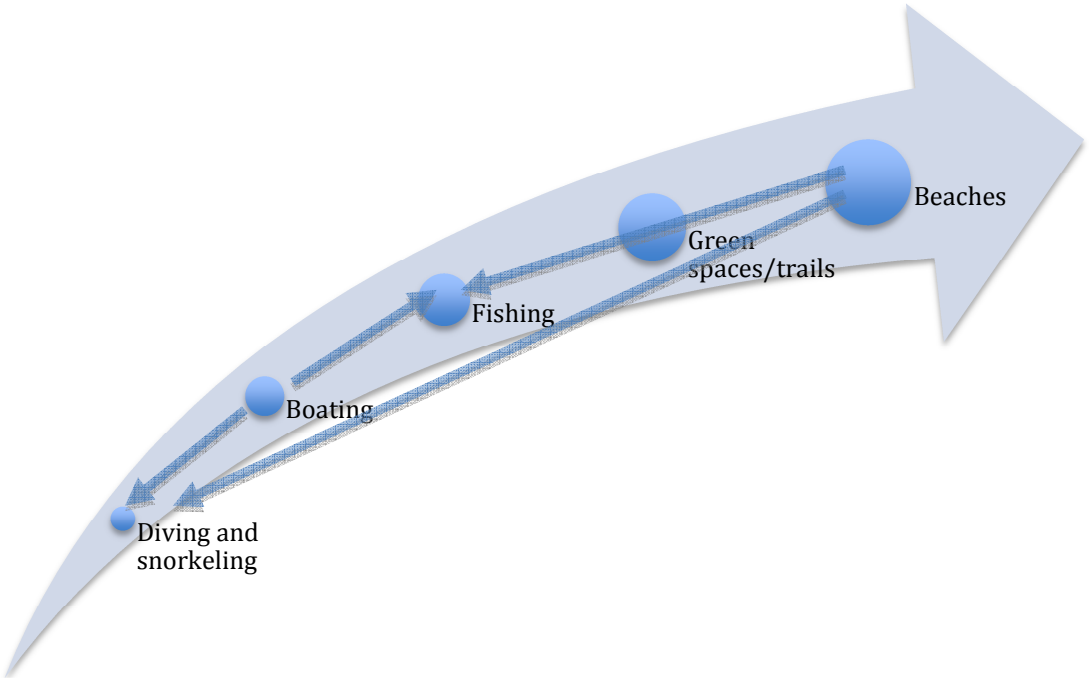

Figure 25: Hierarchy of Key Biscayne resident uses

Figure 25 shows how frequently residents used particular resources or participated in certain activities. As indicated by the figure, there were many connections between activities, such that there is less a hierarchy of uses as there is a hierarchical network of uses. Boating, for instance, by itself was not as important an activity as was beach visitation, as only 54% of the respondents participated in boating. But, 52% of the boaters undertook diving and snorkeling activities and 44% participated in fishing, showing that roughly half of the Key Biscayne boaters were divers and snorkelers and fishermen. **It is recommended that outreach and education, communications, and management approaches should be developed to target multiple-activity users to maximize the population that can be reached and to lower cost associated with broadcasting approaches.**

d. Local (resident) ecological knowledge and gaps

Local ecological knowledge (LEK) represents a wealth of non-scientific, user-based knowledge about the regional environment and resources and trends in resource conditions (Yli-Pelkonen and Kohl, 2005) that can be used to increase scientific knowledge, develop meaningful and effective management measures, and to set up user-based management, monitoring, and reporting programs. As shown from the results, the Key Biscayne residents who participated in the study mostly lived on the island on a year-round basis, had lived in Key Biscayne for an average of 6-10 years, and three quarters held a bachelor's degree or higher. These characteristics denote a well-educated, long-term community that engages regularly with one or more of the region's resources via activities such as beach visitation, biking, walking, swimming, snorkeling, boating, and fishing, among others. Thus, the island's residents can provide important LEK that could be used to further ongoing or proposed research and management activities or which can be used to set up resident-based monitoring activities (i.e., the Citizen Scientist Program).

But, it should be noted that the residents' LEK is in part limited to certain resources and activities due to the differential use frequencies across activities. This limitation was most often reported by the residents themselves, as measured by the large percentages of "don't know" responses recorded for trends in resource conditions such as mangroves, sea turtles, corals, and fisheries. Residents felt that they were most knowledgeable about intertidal and terrestrial resources, likely a result of the more limited engagement with subtidal resources.

Another limitation to using LEK is the divergence in residents' views versus those that are reported in the scientific or technical literature. A good example of this is the condition of beaches, which almost two thirds of the respondents listed as being excellent or very good. A 2012 DEP study reported that 2.5 miles of beach in southern Key Biscayne, that is presently undergoing a nourishment project, is critically eroded. It is not expected that residents would identify a critically eroded beach, and the divergence is presented here to show that unless educated on the matter, LEK may not always match scientific knowledge. **It is recommended that the Citizen Scientist Program should utilize Key Biscayne resident LEK to obtain knowledge and to develop programs that maximize data gathering (ex., using those activities in which residents most frequently engage and can via which can easily collect data); however, it is cautioned that the Citizen Scientific Program should use education and training to ensure that the information collected can be "exported" to or combined in scientific projects, monitoring programs, etc.**

e. Nuanced views on stressors

Residents hold sophisticated and nuanced views on resource stressors, as demonstrated by the survey results. This is exemplified by the residents' views that development, pollution, and sewage are all major stressors. This finding demonstrated that the respondents perceive stressors as being synergistic, where two or more stressors can amplify impacts on resources, and that stressors can

likely not be isolated in an urban, dynamic environment. The finding also showed that residents understand that stressors are cumulative, in that that impacts are made worse by each additional stressor, over time, and across space. But, it was also determined that there were certain stressors for which a large percentage (20% or higher) of the residents did not have enough information to provide their views. This was the case for the current Port of Miami expansion dredging project, overfishing, and vessel-based impacts. These findings show some of the gaps that exist in stakeholder knowledge and can be used as a means by which to devise basic and applied programs to improve the knowledge base. **It is recommended that the Citizen Scientist Program, via its website or lecture series, consider developing web-based primers, updates, or alerts and lectures and seminars, to educate the Key Biscayne community on resource conditions and stressors.**

f. Priorities for management

There is a strong consensus that the top priority to conserve the region's resources should be environmental education and outreach. Overall, most other initiatives, ranging from interpretation, regulation, and enforcement, had significant support as well; this was particularly important when considering restricted access, which residents prioritized as an approach. While it could be argued that because no argued that support was strong because no particular area was identified and that lines on a map may generate a not-in-my-backyard (NIMBY) response, it should be noted that the measures to restrict access did identify resources (ex., mangroves) and activities (i.e., fishing). If not much else, the findings represent a willingness on the part of the resident community to protect the islands' resources, and the findings should be used to generate support for such measures if the measures will lead to better resource conditions. **It is recommended that residents should be engaged in developing priority measures for management, best management practices, and education such that calls for local or extra-local management measures are developed using a bottom-up (and thus a more locally acceptable) approach. It is also recommended that the Citizen Scientist Program should develop a robust environmental education component that can be used to meet the priority needs identified in the results.**

VI. Conclusions

The Key Biscayne resident survey, conducted using an Internet-based survey sent to 8,000 residents via email, led to the completion of 735 responses. The responses represented a tenured, well-educated, and engaged population that participates in a number of resource-based activities, of which beach use, green space use, and trail use dominated all other uses. A smaller yet significant portion of the population participate in fishing, boating, and diving and snorkeling off Key Biscayne and Virginia Key. The results demonstrated also that the residents are well informed about the local environment and share concerns about its future. This was best reflected in the management priorities selected by the respondents and the fact that almost half of those interviewed were willing to participate as citizen scientists. This

support suggests that a community-based research and monitoring program will provide long-term benefits for the community and its coastal and marine resources.

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Appendix 1: Key Biscayne Resident Survey GIS Mapping Methods

- **Creating a Map For the Survey Using ArcMap 10.1**
  - Open a new map document, and import a basemap (used World Imagery from ESRI, can be downloaded for free from the internet)
  - Zoom to desired distance on the map, and change view to layout view
  - Create a grid around the data frame by right clicking on the data frame and creating a grid in the properties menu. Each grid cell will be used to reference the lat/lon of each region created from the Qualtrics survey software.
  - Any text you may want to add to your map can be done in the layout view as well.
  - Save the file, and choose to export the map. You can export the map under the file tab. Save as a tiff file.
  - Use this process to make as many maps as you need. For this project some of the maps were used for multiple survey questions. However, I saved each file according to survey question. For example, for this project, a single map was used for boating activities and fishing around Key Biscayne. When the map was finished it was saved as Key Biscayne Boating Survey, and a tiff image was exported and saved with the same name. The same file was then saved again as Key Biscayne Fishing Survey, and another tiff image was exported and saved with the same name. Doing this helps to separate your results and avoid confusion later on in the analysis process.

- **Creating Regions in Qualtrics**
  - From the Qualtrics website choose the survey you want to edit.
  - For survey questions requiring a map, import your previously saved tiff image of the map you want to use.
  - Select to add a region, and shape it according to your desired specifications. For this project the grid cell was used as an outline to define regions. For bigger regions that took up more than one grid space you can make a larger square or custom shaped polygon. Make sure to label regions accordingly. Each region is created in numeric order, 1, 2, 3… For more specific regions you can give them a name (ex. Key Biscayne Beach). Make sure to note which grid cells each region occupies, you will use the lat/lon of these grid cells to map your results. To help print a copy of the map that you can use to mark on later.
  - Finish and save all maps you add.

- **Gathering lat/lon data**

- Open up your saved map document in ArcMap. Have a printed copy of the Qualtrics survey map to reference regions to grid cells. It may help to outline each region on the paper copy of the map and label them accordingly if you haven't made note of which grid cells each region occupies.
- While keeping ArcMap running open an excel workbook to record your lat/lon. Create a separate sheet for each survey map you created. In this case a sheet was created for Beaches, Fishing, Boating, Diving/Snorkeling, and Green Spaces.
- For each sheet create three columns. The first will be titled REGION, the second and third will be titled LAT and LON, accordingly.
- Under the REGION column enter the name of each region in your survey map. For regions that occupy more than one grid cell enter them according to the number of grid cells they occupy. That is if a region takes up 10 grid spaces enter the name for that region ten times. This is done because the center of each grid cell will be used as a discrete data point. Bigger regions take up more grid cells and will have multiple data points.
- In ArcMap use the identity button, a blue button with the letter "i" in the middle, to click in the middle of each grid cell. This will give you the information for that discrete location. You may have to change the location to display in decimal degrees, however. Once you have the location displayed in decimal degrees copy and paste the lat/lon into your excel workbook. Repeat this step for each region for each map
- For a grid cell that has more than one region in it, record the lat/lon for each region. Instead of clicking in the middle of the grid cell, click within the boundary of each region in the grid cell, and record that data under the appropriate region in your excel workbook.

- **Adding Survey Results to your Excel Workbook**
  - Go to the Qualtrics website to obtain the survey results. Click on the survey you want to get results from. Click the View Results tab and select to Download Data. Click on the downloadable file and open the raw data in a excel workbook.
  - Starting with cell A3 each row will contain the raw data for each survey response. Each subsequent row represents a separate respondent. In the first ROW, each COLUMN will be labeled by question number (ex. Q1, etc.). Some questions will have multiple parts, and they will be labeled as such: Q43_1, Q43_2, etc. The ROW under this will have text for each question, so you know what question is being asked.

- Find the questions you wish to obtain results for, and copy and paste their column into anther excel file for manipulation. Make sure to have a different sheet for each survey question (ex. Beaches, Fishing, etc.) For this survey data was gathered for two types of questions:
    - Questions asking which beaches, greenspaces, fishing regions, etc. you use (ex. Q41_4 Please click on all the beaches that you visit in Key Biscayne/Virginia Key. -Hobie Beach, Q41_5 Please click on all the beaches that you visit in Key Biscayne/Virginia Key. -Virginia Key Beach, etc.) These types of questions refer to the survey map you created, and each region will have its own COLUMN with data. Data in these COLUMNs will either be a 1, 2, or 3. 1 stands for DISLIKE, 2 for NEUTRAL, and 3 for LIKE. Since values of one and three are recorded from clicking a region in the survey map, they were both treated as an intentional LIKE by the respondent.
    - Questions on visitation frequency (ex. How many times a month do you visit Beaches around Key Biscayne?). Data in these COLUMNs are displayed as 1, 2, 3, 4, 5, or 6. 1 stood for less than once a month, 2 for once a month, 3 for 2-3 times a month, 4 for once a week, 5 for 2-3 times a week, and 6 for daily.
- Once you have the data copied into the appropriate workbook sheet you can begin to manipulate the data for mapping.
    - Locate the column on visitation frequency. You will need to change some values for mapping purposes. Answers displayed as a 1 (less than once a month) need to be changed to .5. Answers displayed as 2, 5, and 6 need to be changed to 1, 12, and 30 respectively. These values translate to the number of days the respondent visits the region (ex. For 2-3 times a week, they will visit the region 12 times in a month). Changing these values can be done with the find and replace command in excel (CTRL F).
    - Next highlight all cells containing data on which region each respondent visits. Remember these values should be a 1, 2, or 3. Using the find and replace command change all 2s to 0s and all 3s to 1s. This makes the data easier to manage. For each COLUMN containing these cells scroll to the first empty cell at the bottom of the data table and use this to calculate the SUM for the COLUMN. This will create a new row that you should label as TOTAL. This SUM will show you how many respondents visit each given region. Once every COLUMN has been calculated copy this data and paste it into your original

excel file with region name and lat/lon of each region. Make sure to hit PASTE SPECIAL: VALUE. This data can then be transposed into its own COLUMN in the data sheet labeled USERS.

- Finally you need to calculate the visitation frequency for each location. Go back to the excel file where the number of USERS was calculated. The cells containing data on the regions the respondent visited needs to be multiplied by the number of times a month they visit the region. You do this by clicking on the first cell containing this data in the COLUMN and multiplying it by the cell in the same ROW that is for visitation frequency. This will multiply the value by .5, 1, 3, 4, 15, or 30. The results will show in the cell, and you can copy this cell to apply the same formula for the remaining cells in the COLUMN. After this you will notice the value in the last row labeled TOTAL will increase drastically. Repeat this process for each COLUMN, and copy and paste it into the original excel workbook in the exact same manner as you did at the end of the previous step. Label the resulting COLUMN VISTS.
- Make sure to repeat these steps for each survey question map

- Format each sheet in your final excel document so that the font size and color are all the same, and the alignment in each cell is the same. Make sure to have 6 decimal places for the LAT LON COLUMNS and two decimal places for the VISITS COLUMN.
- Save your final product.

- **Mapping Results in ArcMap**
  - Open the map you desire to work with in ArcMap (ex. Key Biscayne Survey Fishing Map). Once open go to File Import Data, choose XY data, and browse for your saved final excel file with all your necessary data. Choose the appropriate sheet for the map (ex. Fishing). Make sure the X field is Lon and Y filed is Lat, and leave the Z field empty. Before hitting ok, change the coordinate system to WGS 1984. Do this by hitting edit, selecting the folder Geographic Coordinate System, then the World folder, and selecting WGS 1984. Click ok, and you data will be displayed as points on the map.
  - In the table of contents window on the left of the screen, right click on your data, and choose to export the data. Choose a meaningful name to title it and save it in an appropriate folder. This will save your data as a shapefile. When asked to add the data as a layer select YES. In the layer window you can delete the original data, and use your exported data shapefile for mapping.

- There are multiple ways to display your data in the map. For this project, data was displayed in two manners either as discrete points of various size that increase with larger values or the data was used to create an interpolation map. The discrete point method was used for Beaches and Greenspaces since you just want to see data for separate regions in the map and compare values. To display fishing, boating, and diving trends an interpolation map was created to calculate data values across the whole map regardless if there was a data point there or not. This method predicts values for none sampled locations across your study site based on values of surrounding data points, and creates a raster layer from this data.
- Displaying Data with Discrete Data Points
    - In the table of contents window double click on your data shapefile, and choose the SYMBOLOGY tab when the PROPERTIES window pops up.
    - On the left of this window will be a box titled SHOW. In this box choose to show data as QUANTITIES and as GRADUATED SYMBOLS.
    - Next, in the FIELDS box click on the drop down tab for VALUE and choose the data field you wish to map (ex. USERS).
    - Finally, you can choose an appropriate number of classes and class breaks and edit your symbols as you wish.
    - Once your data is displayed you can go into Layout View and add the finishing touches to your map: title, legend, compass rose, and scale. This can be down by selecting the INSERT tab from the main toolbar, and choosing to insert any of these features.
    - You can also add text to your data points in the layout view to better display the values being measured.
- Displaying Data in an Interpolation Map
    - To turn your data points into a raster layer that shows data values for the whole study site interpolation can be used. What interpolation does is calculate values of non-sampled locations based on data contained in the surrounding data points. There are a few interpolation methods that do this, but inverse distance weighting was used for this project.
    - This method works great across a continuous study site; however, for this project there are several land bodies that divide the water bodies in the study site. You need to create a polyline barrier for these land bodies, or else the interpolation will interpolate across them as if they were not there and seriously alter the data in your map. To do this:

- ❖ In the data view use the DRAW toolbar to create a polygon for your land barriers. If the DRAW toolbar is not displayed, click on the CUSTOMIZE tab, choose TOOLBARS and, choose DRAW.
- ❖ Draw a ruff polygon for your land body. After this "first draft" polygon is created you can edit your vertices to better outline your land bodies. This can be done in the DRAW toolbar as well.
- ❖ If you create multiple polygons you can union them. Make sure they are all selected, click on the DRAW drop down tab, choose GRAPHIC OPERATIONS, and click on UNION.
- ❖ Finally in the DRAW drop down tab choose to CONVERT GRAPHICS to FEATURES and save your file and imported it as a layer.
- ❖ Once you have your polygon saved as a layer you must convert it to a polyline. First select CONVERSION TOOLS from the arctoolbox window, choose the TO RASTER toolbox, use the FEATURE TO RASTER tool, and save and import the layer. Next convert from a raster to a polyline by selecting the FROM RASTER toolbox and the RASTER TO POLYLINE tool, and save and import. This will create the polyline you will use as a barrier for your interpolation.

- To create your interpolation surface choose the SPATIAL ANALYST tool box in the arctoolbox window, choose the INTERPOLATION toolbox, and choose IDW. IDW is used, because you can use a barrier in your interpolation process.
- Once in the window for IDW choose your data shapefile from the drop down menu for the INPUT POINT FEATURES. In the Z VALUE FIELD drop down menu choose the data you want to map (ex. USERS). For the OUTPUT RASTER, choose the correct folder to save the data and name your file. Scroll to the bottom of the window and select your barrier polyline from the drop down menu for INPUT BARRIER POLYLINE. Next, choose the ENVIRONMENTS tabs at the bottom of the window, and make sure that your OUTPUT COORDINATES and PROCESSING EXTENT are selected to be the same as your input data. Finally, click OK and OK, and the IDW will start. It may take a while for it to process.
- To further edit your IDW raster, you can double click on it in the TABLE OF CONTENTS window and change the

SYMBOLOGY. You can display the IDW with discrete classes with set class breaks or as a smooth surface.

- Finally, in the layout view, you can add title, legend, compass rose, and scale bar.