Characterizing Participation in Non-Commercial Fishing and other Shore-based Recreational Activities on St. Croix, U.S. Virgin Islands

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Characterizing Participation in Non-Commercial Fishing and other Shore-based Recreational Activities on St. Croix, U.S. Virgin Islands

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Executive Summary

Executive Summary

Non-commercial fishing, which includes recreational and subsistence fishing activity, is part of the culture and heritage of the U.S. Virgin Islands (USVI). Residents of USVI fish for enjoyment, to gather food, to bond with others, as well as for gifting and other traditional activities. According to a 2010 report, recreational fishing contributed an estimated 25 million dollars to the economy per year. Though there is evidence that reef fish assemblages in the USVI have changed over time in part due to fishing pressure (both commercial and non-commercial fishing), reporting of catch is currently required only for the commercial fishing sector. Thus, little is known about the non-commercial fishing community and how their fishing activity may impact the stocks of regional fisheries. This study characterizes the community of shore-based, non-commercial fishers on the island of St. Croix, USVI in terms of their fishing patterns over space and time and to the extent possible, their demographic and socioeconomic characteristics. The results and lessons learned from this study can inform future survey efforts of non-commercial fishers in the USVI.

ST. CROIX, AN IDEAL STUDY AREA FOR NON-COMMERCIAL FISHING

For as long as people have been known to live on St. Croix, they have fished. St. Croix has approximately 80 miles of shoreline, much of which is sandy and rocky beaches amenable to fishing and other shore-based recreational activities. The coastal and marine environment around the island is home to coral reefs, salt ponds, mangrove forests and seagrass beds which host a variety of fish and other marine life. There is anecdotal evidence that non-commercial fishing activity on St. Croix is a significant traditional, cultural activity; however, there is no license or registration requirement to identify and monitor the size and characteristics of the non-commercial fishing community or to track any potential ecological impacts of fishing. Previous research suggested that participation rates for non-commercial fishing (shore-based and boat-based fishing) were higher on St. Croix than the other U.S. Virgin Islands. In addition, territorial managers believed that residents of St. Croix were more likely to rely on fishing for subsistence and personal-use, when compared to residents of St. Thomas or St. John. For these reasons, St. Croix was chosen as the island of study for this project.

PROJECT COMPONENTS AND GOALS

Though the research goals of the study initially included calculating catch and effort, the low number of fishers encountered during the interview portion of the study made calculations of catch and effort less useful. This provided an opportunity to adjust the data collection method mid-study by incorporating lessons learned from the first part of the research project. For the second phase of the study, the amount of time spent in the field to count shore-based activities was increased and the interview portion was terminated. These changes prioritized counting and describing spatial and temporal patterns of fishers and people engaged in other recreational activities along the shoreline of St. Croix.

The study addressed four goals through the different components. The Interview Component gathered data to address two goals: 1) to calculate and describe fishing catch and effort and 2) to profile shore-based non-commercial fishers in terms of demographic characteristics, fishing patterns and subsistence fishing activity. Count Components 1 and 2 gathered information on spatiotemporal patterns and participation in fishing and other shore-based recreational activities. Finally, the three components together served to accomplish an overarching goal: to field test use of a roving study design for collecting information on non-commercial fishing in the USVI via site counts and interviews.

Executive Summary

FISHER INTERVIEWS

Information on fishers' demographics and fishing behavior can inform the design of future surveys of non-commercial fishers. Some highlights from the interviews follow: The majority of fishers interviewed were male and born on St. Croix, and the average age was 47 years old. About half of survey respondents indicated that they were unemployed and/or had a monthly income of less than one thousand dollars. Regarding fishing behavior, most fishers were fishing from a sandy or rocky beach when interviewed. The most frequently used fishing gear was a handline, and fishers spent an average of four hours fishing each trip. Two-thirds of those interviewed indicated that the primary reason that they fish is for food, although most fishers reported that less than ten percent of their household's food came from non-commercial fishing. Significantly, however, for one out of ten fishers interviewed, fishing comprised at least 50 percent of their household's food, indicating a high dependence on fishing amongst the survey respondents. A complete profile of the shore-based fishers interviewed during the study is presented in Section 4 of the report.

PATTERNS OF SHORE-BASED FISHING AND OTHER SHORE-BASED ACTIVITIES

An analysis of information collected during Count Components 1 and 2 revealed patterns of fishing and other shore-based recreational activity patterns over space and time. The shoreline of St. Croix was divided into approximately one-mile long segments and then grouped into units. Three of these units were most frequented by fishers during both Count Components: an area that includes Frederiksted Pier, a segment of waterfront in Christiansted that contains Altona Lagoon, and Molasses Dock. Molasses Dock and Frederiksted Pier had higher ratios of fishers to people engaged in other shore-based recreational activities than the unit in Christiansted. The waterfront area in Christiansted was used by fishers as well as people engaged in other shore-based recreational activities such as observing, swimming and walking, and had one of the highest rates of participation in shore-based activities over all. For both count periods, one was more likely to encounter fishers on weekdays from 3:00 p.m. to 9:00 p.m.

People engaged in other shore-based recreational activities were observed more frequently than shore-based fishers over the course of the study period, in almost every area of the island included in the study. People watching others the from the shore (observing), walking, swimming, sunbathing, camping and snorkeling were the most common activities documented during the entire study period (Count Components 1 and 2). Camping and snorkeling were more common during Count Component 1 than 2, while sunbathing was more common during Count Component 2. In general, shoreline areas near the population centers of Christiansted and Frederiksted exhibited higher numbers of people engaged in shore-based recreational activities than more remote areas of the island, with Cane Bay beach and Salt River estuary being two notable exceptions. Detailed results describing patterns of fishing and other shore-based activities can be found in Sections 5 and 6 of the full report.

REFINING A METHODOLOGY FOR COLLECTING INFORMATION ON SHORE-BASED FISHING

An overarching goal of this project was to test a roving survey methodology (Interview Component) along with independent counts of people engaged in fishing and other shore-based activities (Count Components). Due to low numbers of fishers encountered during the Interview component, the interviews were discontinued, while the count component went through a process of refinement. Challenges to conducting a roving survey on St. Croix included: difficulty accessing certain shoreline units or progressing along the shore due to physical barriers or dangerous conditions; inclement weather; security concerns for field staff; and staffing issues related to cost of labor and scheduling conflicts. Expanding the count component allowed for an increase in the temporal coverage of count assignments to make sure that the entire three-hour sampling period was covered for each assignment.

The information gathered in this study on fishing patterns, behaviors and demographics can be used to design future studies. Key fishing locations, days and times spent fishing, and dependence on fishing activities were noted in this study. Gathering information on shore-based activity patterns could be made more efficient by the use of technology such as remote sensing. Digital surveys could be employed to reduce the amount of labor required to process paperwork. Finally, employing a full-time survey staff is advised to reduce scheduling conflicts and ensure proper coverage of sampling units, as well as to increase the safety of field staff.

FINDINGS

Fishing participation estimates documented in this study indicate that shore-based non-commercial fishing on St. Croix is not a high participation activity. The number of fishers using the shoreline at any given time is relatively low compared with the other types of shore-based users. This possibility should be further tested using site-specific collections. Regardless, from the standpoint of investing in data collections that will yield the most useful data for understanding non-commercial fishing in the USVI, there may be other collections that prove a better value. For example, researchers may direct limited research funds to on-site surveys of boat-based, non-commercial fishing or charter fishing, or opt to invest in household surveys. To better characterize and profile this fishing subgroup, a priority investment of limited research funds would be to conduct a household survey with a sample size adequate to parse out the shore-based fishers from other fisher subgroups (e.g., boat-based). Such a survey would be invaluable at providing a current, valid and reliable estimate of the population of shore-based non-commercial fishers, which is presently lacking. Such a survey could be used to collect information on subsistence reliance as well as the temporal and spatial patterns of fishing activity, in terms of fisher behavior, that could then be used to refine sampling designs and data collection protocols for roving or access point surveys.

Introduction

Introduction

This report summarizes findings of research conducted on St. Croix, U.S. Virgin Islands (USVI) from December 1, 2013 through October 31, 2014. The focus of the study was shore-based non-commercial fishing. The project was executed in three data collection components covering two periods:

- Interview Component—December 2013 – July 2014
- Count Component 1—December 2013 – July 2014
- Count Component 2—August 2014 – October 2014

This report is organized into seven sections. Section 1 provides information on the project background and rationale, as well as summarizes the current state of knowledge specific to non-commercial, shore-based fishing on St. Croix. Section 2 relates important contextual information about the study site and period, in terms of the social and economic conditions of the island, as well as its climate and geography. Section 3 provides information about the research methods for each of the project components. Research findings are organized by project component in Sections 4, 5, and 6. Finally, project conclusions and recommendations for future research are provided in Section 7. Supporting tables and other project documentation are provided in the appendices.

Section 1
Project Background and Literature Review

Project Background and Literature Review

1.1. PROJECT BACKGROUND

Figure 1.1. A fisher on St. Croix uses a handline to fish near Cane Bay beach. Photo: NOAA NOS/NCCOS

Non-commercial fishing, which includes recreational (personal-use) and subsistence fishing activity, is a part of the culture and heritage of the USVI. Residents of the USVI fish for enjoyment, to gather food, to bond with others, as well as for gifting and other traditional activities (Toller, O'Sullivan and Gomez 2005; van Beukering et al. 2011)(Figure 1.1). However, little is known about the USVI's non-commercial fishing community in terms of the number of fishers in the general population, their demographic and socioeconomic characteristics, or how their fishing activities may impact regional fisheries. The only continuous fishery data collections in the USVI gather data on commercial fishing, highly migratory species, and fishing tournaments. Given evidence that reef fish assemblages in the jurisdiction have changed over time due in part to fishing pressure (Beets and Rogers 2000), there is interest in better understanding the differential influence of fishing pressure from the non-commercial and commercial fishing sectors.

An impediment to collecting valid and reliable information on non-commercial fishing in the USVI is the lack of a sampling frame for fishers (Beets and Rogers 2000; Munoz et al. 2012). A frame is a complete list of units in a population, such as non-commercial fishers, from which to draw a scientific sample, which is necessary to generalize research findings to the focal population. Currently, the USVI does not have a license or registration requirement for non-commercial fishing in territorial waters. Without a program requiring non-commercial fisher registration, there is no way to easily identify and conduct surveys of the population of non-commercial fishers. Thus, sampling of non-commercial fishers can be prohibitively expensive because it requires a resident household survey, necessitating a large sample size in order to reach the recreational fishing population. An intercept survey approach may make generalizing to the broader recreational fishing population problematic. Other challenges cited by fishery resource managers to successfully execute data collections on non-commercial fishing in the USVI include: difficulty recruiting and retaining field staff, lack of adequate information to increase sampling efficiency, difficulty achieving adequate survey coverage of accessible shoreline (particularly on St. Croix) and safety concerns for field staff during field surveys (especially in darkness) (Munoz et al. 2012). The lack of a registration frame combined with practical and logistical challenges associated with field approaches has made research of non-commercial fishing in the USVI difficult.

Given the challenges mentioned above, it is not surprising that there is little information available to describe non-commercial fishing activity in the USVI. This persistent gap in information hinders the sustainable management of fisheries. Without basic data describing the non-commercial fishery and its participants, it is not possible to develop required fishery management plans or to confidently set annual catch limits for the fishery. With comprehensive knowledge about the dynamics of total fishing pressure and the relationship to fish populations, resource managers could "reduce fishing impacts on critical stocks that most directly affect the health and resilience of the reef ecosystem" (The Territory of the United States Virgin Islands and NOAA Coral Reef Conservation Program 2010). Territorial fishery managers documented a need to "obtain necessary information on fishing effort in U.S. coral reef ecosystems by measuring fishing intensity, fishing mortality, frequency, area coverage, community dependence, etc. to inform management activities" (The Territory of the United States Virgin Islands and NOAA Coral Reef Conservation Program 2010). The present study was designed to help close some existing informational gaps for shore-based non-commercial fishing, specifically. The research goals of this study were to:

1. Field test use of a roving study design for collecting information on non-commercial fishing in the USVI via site surveys and direct interviews;
2. Gather data needed to calculate fishing effort and catch, as well as to provide catch characteristics;
3. Gather data needed to profile shore-based non-commercial fishers, in terms of demographic characteristics, fishing behavior and subsistence reliance; and
4. Document the spatial distribution of participation in shore-based fishing and other shore-based recreational activities.

This study was executed on the island of St. Croix, USVI. St. Croix was chosen for three primary reasons. First, resource managers consulted during project development indicated that non-commercial fishing was a significant traditional, cultural activity on St. Croix. Second, anecdotal evidence and previous research suggested that participation rates for non-commercial fishing (shore-based and boat-based fishing) were higher on St. Croix than on the other U.S. Virgin Islands (Valdés-Pizzini et al. 2010; van Beukering et al. 2011). Finally, territorial managers believed that residents of St. Croix were more likely to rely on fishing for subsistence and personal use, when compared to residents of St. Thomas or St. John (Coles, W., pers. comm.; Pemberton, R., pers. comm.).

1.2. NON-COMMERCIAL FISHING ON ST. CROIX

Recreational fishing, including boat-based, shore-based and sport fishing, is an important cultural and economic activity in the USVI, contributing an estimated $25 million annually to the economy (Valdés-Pizzini et al. 2010). Shore-based fishing has been estimated to be the most popular mode of non-commercial fishing in the USVI, though with a lesser economic contribution than boat-based recreational fishing or sport fishing (Valdés-Pizzini et al. 2010). On St. Croix, in the 1990s, an estimated 9% to 11% of St. Croix residents fished recreationally, not including charter boat fishers (Jennings 1992; Mateo 2004). Shore-based fishing is believed to be more common on St. Croix than St. Thomas or St. John (Adams et al. 1996), although the amount of participation may vary year by year (Osborn and Lowther 2002).

The real or perceived popularity of shore-based fishing on the island is likely related to accessibility. The shoreline of St. Croix can be readily accessed across much of the island, making opportunities for shore-based fishing greater than on the other U.S. Virgin islands. Additionally, traditional forms of non-commercial fishing, namely handlining and the use of nets or seines, require little specialized equipment, making this mode of fishing easy for people to engage in regardless of income level (Figure 1.2).

Figure 1.2. Fishers use handlines to fish at the end of Frederiksted Pier. Photo: NOAA NOS/NCCOS

Project Background and Literature Review

Several studies have characterized the behavior, effort, and harvest patterns of non-commercial fishers on St. Croix. Relying on interview data gathered from 1982 to 1994, Adams et al. (1996) suggested that the greatest fishing effort on St. Croix occurred near population centers, and that the majority of the island's fishers fished from the shoreline or Frederiksted Pier. The authors speculated that the choice of fishing location was more likely related to convenience as opposed to the probability of catch (Adams et al. 1996). The area with the most documented fishing effort was on the west of end of the island near Frederiksted. Mateo, Gomez, Uwate et al. (2000) found that most shoreline fishing on the island occurred primarily at Molasses Dock and Frederiksted Pier. A survey of activities within the boundaries of East End Marine Park found that most shore-based fishing activity occurred on the south shore in Boiler Bay, Great Pond Bay, Robin Bay, Rod Bay, Turner Hole and Yellow Cliff Bay (Geographic Consulting 2010)(Figure 1.3).

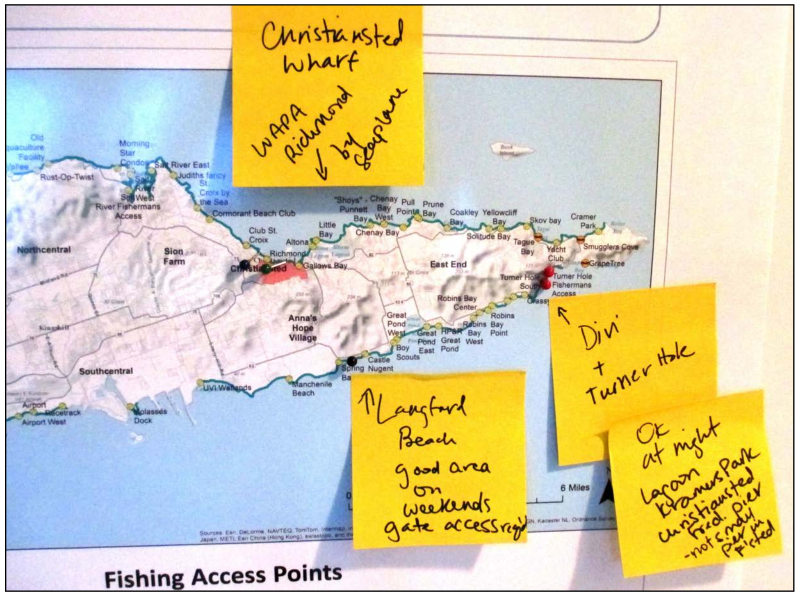


Figure 1.3. Community members marked common shore-based fishing sites on a map of St. Croix during a public meeting prior to the sampling phase of the study. Photo: NOAA NOS/NCCOS

In terms of timing, Mateo et al. (2000) found that per hour shore-based fishing effort on St. Croix varied by time of day and day type, meaning weekends versus weekdays. On weekdays, researchers found more effort in the evening hours (5:00 – 8:00 p.m.). On weekends, effort was more dispersed across the fishing day, but more intense during the afternoon (2:00 – 5:00 p.m.) and evening hours (Mateo et al. 2000).

Estimates of the total annual catch by recreational fishers on St. Croix, inclusive of catch from both boat and shore-based fishing, ranged from 23,039 to 35,225 pounds for the period 1995 to 1999 (Hinds Unlimited 2003; Mateo 2004; Mateo et al. 2000). In the middle to late 1990s, fifty-two species of finfish were documented as catch by shore-based fishers on St. Croix, with squirrelfish (*Holocentrus* spp.), French grunt (*Haemulon flavolineatum*) and bar jacks (*Caranx ruber*) as the most common (Mateo et al. 2000)(Figure 1.4). In the USVI, generally most of the fish caught by non-commercial fishers are consumed locally.

Figure 1.4. Squirrelfish (a), French grunts (b), and bar jacks (c) were found to be some of the most commonly landed species by shore-based fishers on St. Croix (Mateo et al.). Photo: NOAA Photo library/ Flickry

Section 2
Research Context

2.1. INTRODUCTION

Awareness of the context for the present study is important for several reasons. First, as a culturally and socially mediated practice, non-commercial fishing on St. Croix will necessarily be influenced by the social, cultural, and economic context of the island. Fishing practices, behaviors, and subsistence reliance may each be correlated with any number of social, economic, or other characteristics of the island or its population. Second, with closure of the Hovensa oil refinery in February of 2012, the island's previous primary private sector employer, there is evidence that the social and economic profile of the community was altered substantially just prior to this study, which was December 2013 to October 2014 (SygmaPCS 2014). Thus, findings from this research may be anomalous when compared to past or future data collections. Finally, one of the goals of this study was to field test methodological approaches to data collection on the island; therefore, contextual information pertaining to more practical considerations relevant to fieldwork will be useful to future researchers, such as crime and security, weather patterns, landscape and topography.

2.2. SOCIO-DEMOGRAPHIC

As of 2012, 50,225 people resided on St. Croix (DeGannes, Mills and Hall 2014). Of this population, forty-seven percent reported being native to the island (DeGannes, Mills and Hall 2014). This means that just over half of St. Croix's population immigrated to the island. Forty percent of these immigrants reported coming from Caribbean nations (Figure 2.1). The diverse origins of St. Croix's present day population likely means that there are a variety of culturally-mediated views and behaviors related to fishing and other uses of St. Croix's shoreline and marine resources.

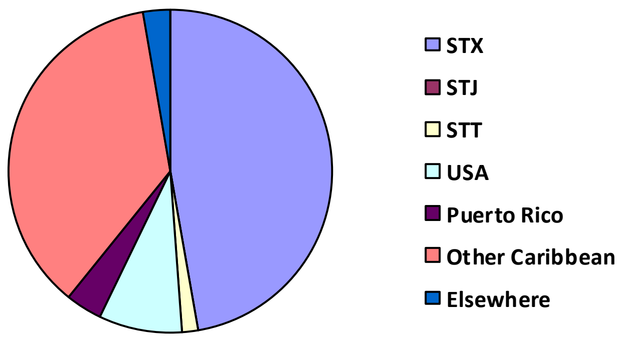


Figure 2.1. Population by place of birth, 2012.
Source: Virgin Islands Community Survey, Eastern Caribbean Center. University of the Virgin Islands.

The population of St. Croix has been declining since the 2000 decennial census. From 2000 to 2010, the population declined by five percent, decreasing from 53,234 to 50,601 people (U.S. Census Bureau 2003; U.S. Census Bureau 2014). On the island, the sub-districts with the highest rates of decline during this period were Frederiksted (-17.9%) and Northcentral (-13.6%), which is located mid-island west of Christiansted and east of Frederiksted (U.S. Census Bureau 2014). A population decline was again documented for the island in 2012: from 2010 to 2012, the population declined by approximately one percent. This emigration of St. Croix's population is possibly related to the economic challenges faced by most residents on the island (SygmaPCS 2014).

2.3. ECONOMIC

On St. Croix, as with other small island communities, employment and economic opportunity are limited. St. Thomas and St. John support a thriving tourism economy, primarily due to the cruise ship industry. Although the tourism sector contributes to St. Croix's local economy, its scale is not that of the other islands (Vinow.com 2015). Other employment sectors important to St. Croix are retail trade, accommodation and food services, and health care and social assistance (Figure 2.2). Unlike St. Thomas and St. John, St. Croix largely maintained an industrial economy since the 1960s, exporting sugar, rum, aluminum and refined petroleum (Figure 2.3). The volume of exports overall in the USVI has declined since 2007, although exports of rum increased from 2012-2013 (Hamano and Osman 2014).

In 2012 (the most recent data available for St. Croix) the median household income was $34,580, four percent less than the median household income in 2010, and 26% of the population was in poverty (SygmaPCS 2014).

Research Context

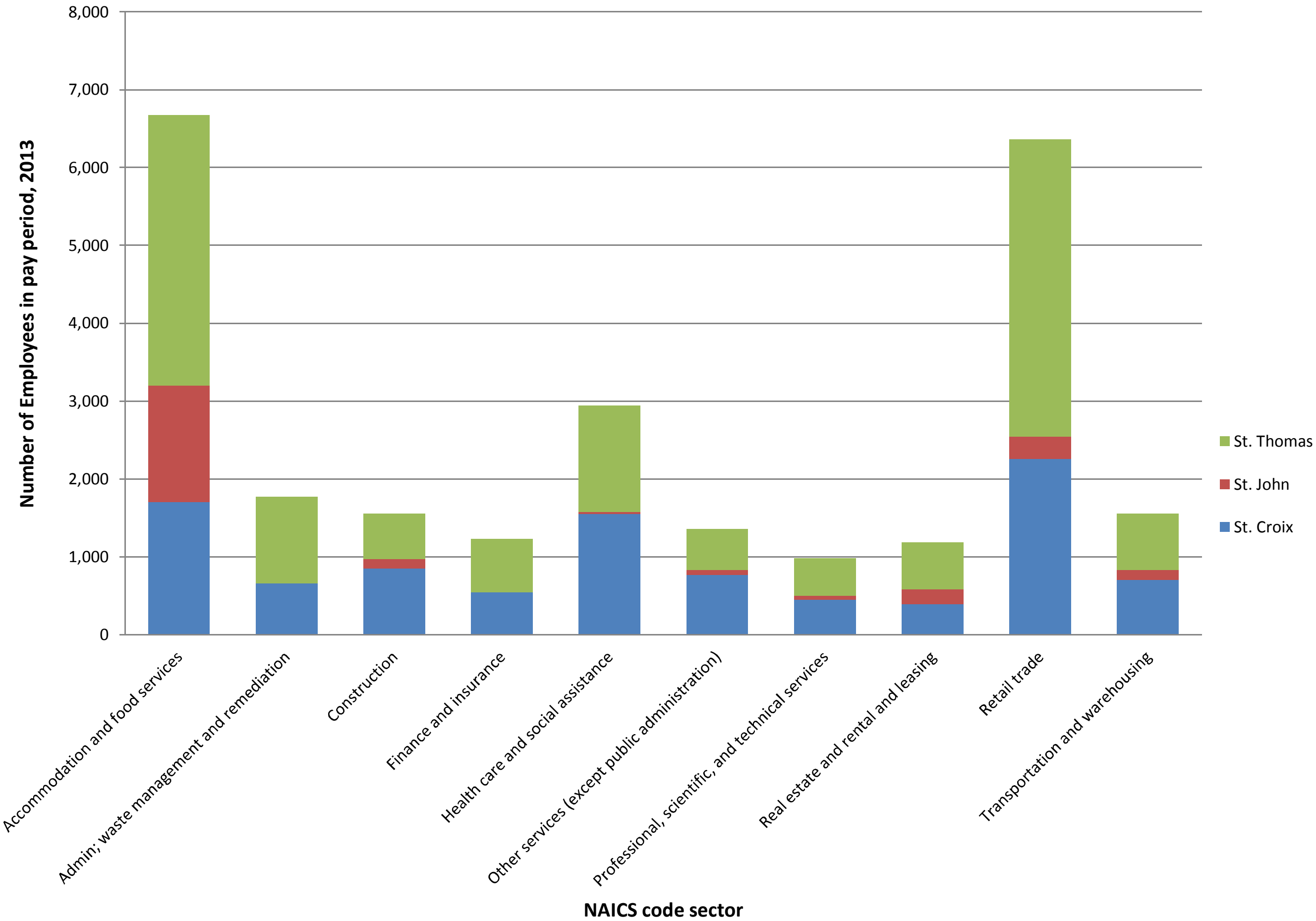


Figure 2.2. Employment by occupational sector (top 10) in the U.S. Virgin Islands, 2013. Source: U.S. Census Bureau, American Factfinder.

At the same time, generally the cost of living is consistently higher in the USVI than in the mainland of the U.S. because most consumables must be imported. Reliance on welfare assistance programs, such as the Supplemental Nutrition Assistance Program (SNAP), is common. In FY 2012, from October 2011 to September of 2012, some 27 percent of St. Croix's population received SNAP benefits. The number of people receiving SNAP benefits has increased steadily since FY 2011 (October 2010 to September 2011). However, it is difficult to calculate rates of participation as yearly population estimates for St. Croix are not currently available through 2014.

In 2012, St. Croix's economy was negatively impacted by the closure of the Hovensa oil refinery, which was the largest employer on the island. After the closure of Hovensa (Table 2.1), the unemployment rate for St. Croix spiked. Although the unemployment rate has since declined, it remains above that of the U.S. and above the rate prior to the Hovensa closure.

Figure 2.3. Today, rum is one of the main exports from St. Croix, and an important part of the economy of the island. Photo: NOAA NCCOS.

Table 2.1. Number of people participating in SNAP on St. Croix as of January, 2011-2014.

Such a change in the economy of St. Croix could have influenced participation rates for non-commercial fishing. One scenario is that the Hovensa closure led to increased participation in non-commercial fishing, as individuals tried to meet the protein needs of households in the absence of paid employment. Alternatively, a second scenario is that as the population declined through emigration, there are simply fewer people on the island to participate in non-commercial fishing. Recent baseline data on non-commercial fishing participation for the island are not available. Thus, there are no data for post-closure comparisons; however, this contextual note for the island is important.

2.4. CRIME

During project development, security concerns were voiced by researchers who had previously conducted creel and intercept studies in some locations and during evening hours on St. Croix (Pemberton, R., pers. comm.; Tobias, W., pers. comm.). When deploying field staff to remote areas of the island or to survey at dusk or in darkness, understanding the state of crime on St. Croix became important. The USVI generally has a high rate of crime. In 2012, the homicide rate exceeded the average homicide rate in the U.S. by a factor of 10, and was one of the highest homicide rates in the world (Mattei 2013). Robbery, burglary, and larceny were on the rise in 2013, potentially due to the poor economy (Kane 2014) (Figure 2.4).

Figure 2.4. The high rates of crime on St. Croix make security an issue of concern for field staff. Photos: NOAA NCCOS.

On St. Croix, during part of the study period (2013-2014), the island saw a downward trend in violent crime, despite the flagging economy and rising unemployment rates (Table 2.2). The number of known incidents of violent crime decreased from 457 in 2012 to 350 in 2013. For 2012, the per capita rate for violent crime on St. Croix was nine known offenses per 1,000 people. Thus, security risk remained a concern for field staff working on the island. The trend in property crime on the island fluctuated from 2010 to 2013. There was an uptick in property crime from 2011 to 2012 (the year the oil refinery Hovensa closed), specifically burglary and theft of motor vehicles. However, incidence of property crime declined again for 2013 (Table 2.3).

Table 2.2. Unemployment rates in St. Croix, USVI compared to the United States as a whole from 2011-2015.

	St. Croix, USVI*		United States**
Year	Unemployment Rate (June)	Annual Average Unemployment Rate	Unemployment Rate (June)
2011	9.9	9.8	9.1
2012	15.1	13.9	8.2
2013	14.8	15.1	7.5
2014	14.6	13.9	6.1
2015	13.1	_	5.3

Source: *Virgin Islands Department of Labor unemployment insurance claims data and the current employment statistics monthly survey of establishments. Prepared by VIDOL Bureau of Labor Statistics. **United Stated Department of Labor, Bureau of Labor Statistics.

Table 2.3. Offenses known to law enforcement: St. Croix, USVI 2010-2013. Source: Uniform Crime Reports, Table 11, 2010-2013.

	Violent crime	Murder and non-negligent manslaughter	Forcible rape	Robbery	Aggravated assault	Property crime	Burglary	Larceny theft	Motor vehicle theft
2010	573	29	21	118	405	1,385	585	659	141
2011	593	27	20	114	432	1,280	545	633	102
2012	457	24	21	101	311	1,387	634	629	124
2013	350	18	17	103	212	1,248	571	563	114

Research Context

2.5. CLIMATE AND NATURAL FEATURES

Though located in the tropics, St. Croix has a subtropical climate due to cooler seas and easterly trade winds that lower the humidity. Daily temperatures in the USVI average between 77-82°F with little seasonal variation. Average rainfall precipitation levels in St. Croix are less the 49 inches of rain per year, generally increasing across the island from east to west (Chakroff 2010) (Figure 2.5).

Figure 2.5. The amount of rainfall on St. Croix varies depending on the time of year and location across the island. The northwest part of the island (left image) receives the largest amount of rainfall, and is home to a subtropical moist forest, while the east end of the island (right image) is much more arid and has species characteristic of a subtropical dry forest (Chakroff 2010). Photo source: NOAA NCCOS.

However, during the study period (December 2013 – October 2014), rainfall averages for the rainy season were abnormally high, particularly during the months of November and December of 2013. Figure 2.6 shows a comparison of the historical monthly average precipitation compared to the study period.

Although the rainy season is short (from September through November), the island is vulnerable to hurricanes. Hurricanes Hugo in 1989 and Marilyn in 1995 were the most recent to directly hit the island (Valdés-Pizzini et al., 2010). In the last fifty years, St. Croix has been impacted by 12 major hurricanes, as well as many tropical storms. The island has also been subjected to earthquakes, droughts, floods and tsunamis.

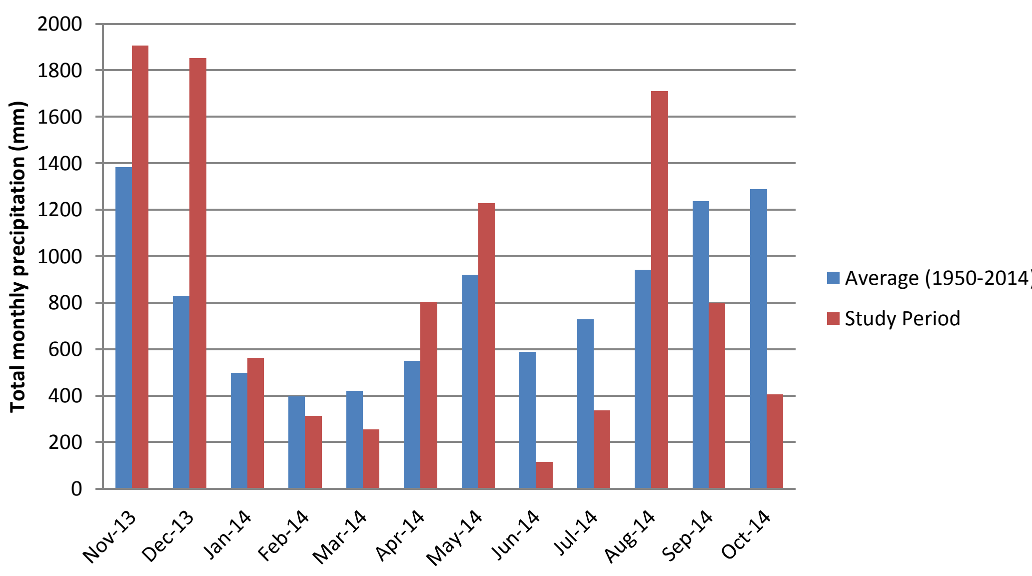


Figure 2.6. Average of total monthly precipitation (mm) by month on St. Croix. Average total precipitation for the month (1950-2014) is compared with the average precipitation for the month of the study period (November 2013 – October 2014) (NOAA 2014).

The coastal and marine environment around the island is diverse, home to coral reefs, salt ponds, and mangrove forests. Common benthic habitat features around the island include coral reef, hardbottom and seagrass (Figure 2.7) (Kendall et al. 2001). This type of underwater topography supports a variety of fauna including sharks and sea turtles, reef fish, wahoo and tuna, the presence of which create fishing and SCUBA diving opportunities. St. Croix's narrower shelf limits the fishery to a smaller harvesting area for reef fish than the surrounding islands, but also brings their pelagic fishery closer to shore (Feingold 2014).

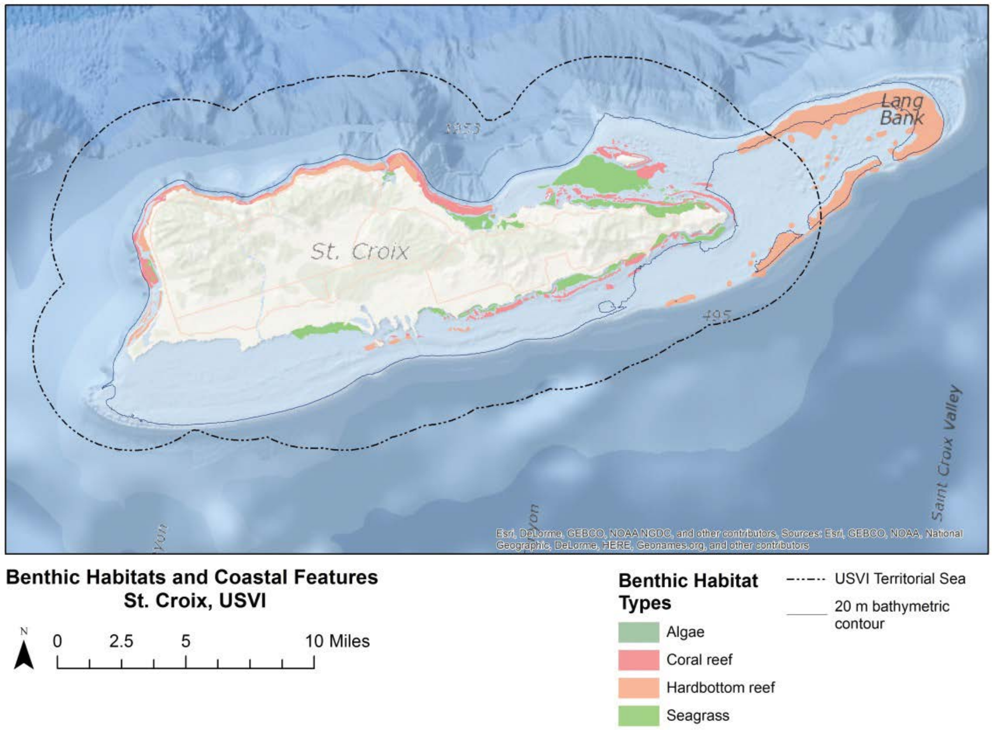


Figure 2.7. Benthic habitats and coastal features of St. Croix.

In addition to a variety of man-made structures, including a pier, docks/marinas, a boardwalk and a jetty, there are a number of natural shoreline types on St. Croix, ranging from sandy beaches to sheer cliffs. The Environmental Sensitivity Index (ESI) provides a characterization of shoreline habitats in part based on the substrate, grain size, tidal elevation and geological origin of the shoreline to assess shoreline sensitivity to potential oil spills (ESI 2001). Shoreline habitats described by the ESI include mangroves, fine-to-medium grain sandy beaches, and riprap, among others. Certain shoreline habitat types may be more attractive to shore-based fishers. Figure 2.8 illustrates eight shoreline types where fishers might be encountered.

Figure 2.8. Eight shoreline types found on St. Croix: Certain shoreline types may be more amenable to shore-based fishing than others. This figure depicts shoreline types encountered on St. Croix: a) man-made pier, b) man-made dock, c) man-made jetty/groin, d) sandy beach, e) rocky beach, f) rocky pavement, g) rocky point, and h) man-made boardwalk. Source: NOAA NCCOS

Ease of access to the shoreline on St. Croix varies across the island. While there are official and unofficial access points in many locations, some stretches of shoreline do not have access points at all or access points that are not easily accessible. In terms of convenience, access in some instances might require extensive walking, a horse, or a four wheel drive vehicle. Once the shoreline is reached, some coastal areas are challenging to traverse because of the shoreline type. For example, shoreline characterized by steep banks, rocky outcroppings, or mangroves (Figure 2.9) were not easily or, in some cases, safely walked by field staff. These locations would likely be challenging for fishers as well. Finally, access to the shoreline in some areas was limited because of proximate private property. Such areas required permission from landowners to be included in the present study. Presumably, these access points would not be readily accessible to the general population of fishers without similar permissions.

Figure 2.9. Access to the shoreline for fishing may be inhibited by human and natural barriers, including fences, thick mangroves or roads that require 4WD/ off road vehicles. Source: NOAA NCCOS

A final contextual note for a portion of the study period, from late August through October of 2014, was a seaweed stranding event (Figure 2.10). According to field staff, some beaches on the island had more than 75 feet of *Sargassum* seaweed extending from the shoreline out to sea. Based on observational notes from field staff, this event limited the ability of shore-based fishers to cast a line from the shore. Additionally, the presence and smell of the seaweed repelled swimmers and other shore-based users.

Figure 2.10. In August - October of 2014, a seaweed stranding event impacted many beaches on St. Croix. Source: NOAA NCCOS

Section 3
Research Methods

This study was divided into three distinct data collection components: Interview, Count 1 and Count 2. The Interview Component of this study involved gathering data on catch, fisher behavior, and socioeconomic information from shore-based, non-commercial fishers. Count Component 1 (hereafter "Count 1") and Count Component 2 (hereafter "Count 2") were designed to collect data needed to estimate fishing participation. Sampling strategy and on-site protocols for the three study components varied slightly. These variations are noted.

3.2. STUDY POPULATION

The population universe for this study included any person on St. Croix who engaged in shore-based, non-commercial fishing from December 1, 2013 to November 30, 2014. In the USVI, non-commercial fishers are only required to secure permits for harvest in a few locations under particular circumstances. On St. Croix, a permit for recreational harvest of shrimp is required for Altona Lagoon and Great Pond (DPNR 2012). Other than these permitting requirements, no license or permit is needed for non-commercial fishing. Because fishing licenses or registration is not required, the total number of fishers in the potential respondent universe for St. Croix was not known.

The actual number of non-commercial fishers on St. Croix has not been quantified to date. However, estimates have been published. On St. Croix, an estimated 10.8% of St. Croix residents fished recreationally, not including charter boat fishers (Jennings 1992). Based on a household survey conducted from December 1998 to July 1999, Ivan Mateo (2004) estimated the total number of recreational anglers on St. Croix to be 3,294, or approximately 6% of the population based on the 2000 decennial census. Approximately 1,976 of the 3,294 recreational anglers fished exclusively from the shore on St. Croix, while an estimated 691 anglers fished both from the shore and a boat (Mateo 2004). Thus, per 1999 estimates, a population of 2,667 shore-based, non-commercial fishers was assumed for St. Croix.

In caveat, according to the U.S. Census Bureau, total population on St. Croix declined by 4.9 percent, from 53,234 to 50,601, between 2000 and 2010. Much of this population reduction occurred in the Frederiksted and Northcentral sub-districts, which are reportedly areas of high fishing pressure by non-commercial fishers. Impact of this change in population may have reduced shore-based recreational fishing pressure on St. Croix to a greater extent than estimated here.

3.3. SAMPLING FRAME

Telephone or mail surveys are generally used to document fishing effort, fisher behavior and other characteristics of recreational fishers. Intercept creel surveys are generally used to collect information on recreational catch. However, neither of these methodological approaches was particularly suited to St. Croix. St. Croix poses a challenging sampling context for shore-based, non-commercial fishing because, first, in the absence of a program for registration of non-commercial fishers, there is no readily available sample frame to conduct telephone or mail surveys. Second, while there are known points of access along the shoreline, the shoreline may be accessed across its length. There are only a few places on St. Croix where fishers are legally prohibited or physically impeded from accessing the shoreline. This open shoreline makes an access-point intercept survey largely impractical for the island. Consequently, researchers for this study opted to use a roving survey approach to conduct interviews with fishers, along with independent fisher counts to document fishing effort.

Roving surveys are ideally suited to locations where fishers may access a body of water from many different points along the shoreline (Malvestuto, Davies and Shelton 1978). For a roving survey, field staff persons walk along a predetermined length of shoreline and interview fishers that are encountered along the way (Figure 3.1). When a fisher is encountered, he or she is recruited for an interview and their catch examined. To collect information on fishing effort or participation, progressive fisher counts were conducted independent of the survey component of the study to document the number of fishers engaged in fishing along the shoreline.

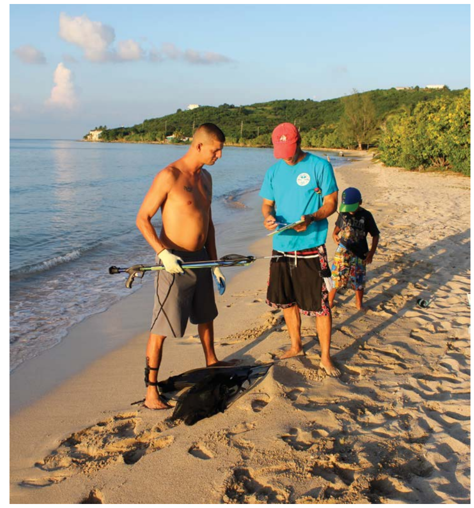


Figure 3.1. A NOAA staff member interviews a spear fisherman. Source: NOAA NCCOS.

The sampling frame employed for roving surveys is spatiotemporal, meaning that the selection of sampling units is based on space or area, as well as day and time of the fishing day. Related to space, the sampling frame includes all shoreline that could be used for fishing, which is divided into sub-areas (Pollock 1994).

For this study, a multi-stage stratified cluster sampling design was used with 'day' as the primary sampling unit (PSU). For the period of interest, the PSU was stratified by weekday and weekend/holiday. The secondary sampling unit (SSU) was defined as the combination of time period and shoreline area, described in additional detail below. For the time period, hours within the fishing day, defined as 6:00 a.m. to 9:00 p.m., were stratified into five, three-hour time periods.

Spatially, the shoreline of St. Croix was divided into sub-areas termed "shoreline units." Shoreline units (SUs) were created by dividing the linear shoreline of interest into roughly one mile segments, beginning at the west edge of the coastal industrial complex, located on the south shore of the island, and continuing around the island to the eastern most boundary of the property formerly owned by Hovensa (Figure 3.2). Adjustments to the lengths of segments were made to facilitate logistics and improve fieldwork. Using the Environmental Sensitivity Index (ESI) geospatial data layer for St. Croix, shoreline where fishing is prohibited was identified and excluded from the study.

Each shoreline segment was assigned a relative pressure code from 1 to 10, with 10 representing high anticipated fishing pressure and 1 representing low anticipated fishing pressure. Pressure codes were assigned based on information from previous research (Mateo et al. 2000). Once a pressure code was assigned, shoreline segments were clustered into shoreline units based on the following criteria:

- Shoreline segments with pressure codes of 8, 9 or 10 were not clustered with other segments. Two exceptions to this rule were made to ensure that all of the Sandy Point National Wildlife Refuge fell into two shoreline units and to keep all shoreline units composed of contiguous segments.
- Shoreline segments with a ranking of 7 or less were clustered with up to two additional segments.
- Segments with a ranking of 3 or less were clustered with a site ranked 4 to 7. This was to ensure that each cluster contained at least one segment with a moderate fishing pressure code.
- To minimize driving time for the surveyor across island, clusters of segments were located on the same shore of the island (i.e., north, south, east or west).

This clustering resulted in 38 shoreline units. In April 2014, field staff identified shoreline units requiring boundary adjustments. Shoreline Units 9 and 10 were adjusted to expand SU 9 to include both sides of Frederiksted Pier. This adjustment slightly increased the amount of shoreline in Unit 9 and decreased the amount of shoreline in Unit 10. SU 38 was adjusted to include a small stretch of publicly accessible beach to the east of the dock which previously was omitted.

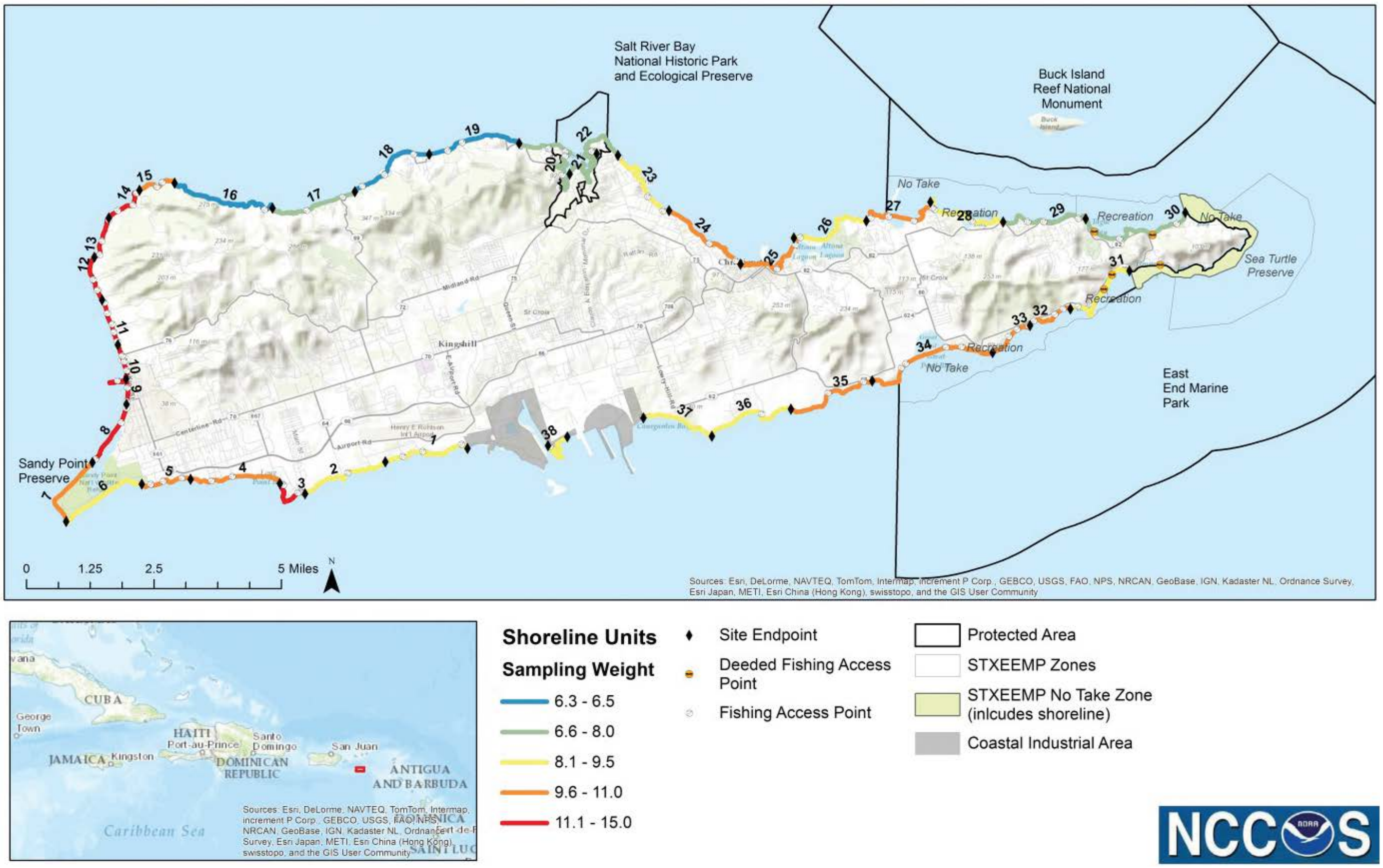


Figure 3.2. Map of shoreline units and sampling weights implemented in study. Areas excluded from the study design include a no-take fishing area along a section of the shoreline of the St. Croix East End Marine Park (STXEEMP) and a coastal industrial area.

3.4. WEIGHTING OF SAMPLING UNITS

In roving surveys, sampling effort should be emphasized on the times and sub-areas that are likely to have the most fishing pressure (Pollock 1994). Therefore, secondary sampling units (SSUs) for this study were weighted for selection purposes. Using information from previous studies (Adams et al. 2000; Mateo et al. 2000) and input from territorial fishery managers, researchers adjusted the total sampling weight of the SSU to increase the likelihood of selecting assignments during times and in locations where higher numbers of fishers might be expected. The mentioned adjustments for the Interview and Count 1 components are described below, and in greater detail in Appendix A:

- Shoreline units having a high ranking for fishing pressure, a larger number of fishing access points, and a shorter distance to a population center (i.e., Christiansted or Frederiksted) were adjusted up to increase the probability of selection and;
- Time periods expected to have high fishing pressure were adjusted up to increase the probability of selection (Mateo et al., 2004).

Based on findings from Count 1, shore-based fishing on the island of St. Croix was anticipated to be a low pressure activity or rare event. Using information gained from Count 1, researchers properly adjusted the total sampling weight of the sampling units for Count 2 to increase the likelihood of selecting sampling units during times and in locations where higher numbers of fishers might be expected. Count 2 selection probabilities for sampling units were adjusted up based on:

- Shoreline units within proximity to a population center;

- Shoreline units with a higher proportion of total fisher encounters per shoreline unit (based on Count 1);
- Time periods with a higher proportion of total fisher encounters (based on Count 1) and;
- Qualitative feedback from field staff and territorial fishery managers regarding shoreline units with high anticipated fishing pressure.

The total sampling weight for each sampling unit for all study components was calculated by summing the rating for each of these factors. The probability of selection of each SSU was proportional to the total sampling weight. As a result, sampling units with larger total sampling weights had a larger likelihood of selection compared to sampling units with smaller total sampling weights.

3.5. SAMPLE SELECTION AND SIZE

Sample selection was accomplished using a multi-stage stratified cluster sampling design. Within the period of interest, the primary sampling units (PSUs), meaning days, were stratified by month. The PSUs were selected at random without replacement within each month. For the Interview Component and Count 1, PSUs were also stratified by day type, meaning weekdays versus weekend/holidays. For each month, 50% of all available weekdays were sampled and 50% of available weekends/holidays. The secondary sampling units (SSUs), a combination of shoreline unit and time period, were then selected using sampling proportional to size (total sampling weight).

For Count 2, the number of sampling units drawn was bounded by the remaining duration of the data collection period, in combination with limited staff availability. Sampling units were selected at random without replacement using sampling proportional to a measure of pressure for every day of the remaining study period. A fixed number of one sampling unit was selected for each day. Due to limitations of labor available to complete assignments, weekend days/holidays were not over sampled for this component.

PROC SURVEYSELECT DATA and PPS, SAS Version 9.4, was used to select the sample for this analysis. For the Interview Component of this study (December 2013 – July 2014), a total of 127 sampling units was drawn randomly without replacement. Three scheduled survey assignments were not completed due to the non-availability of field staff. For Count 1 (December 2013 – July 2014), which ran concurrently with the Interview Component, a total of 127 sampling units was drawn randomly without replacement. One scheduled count assignment was not completed due to the non-availability of field staff. The incomplete assignments were deemed random. Adjustment procedures (i.e., weight adjustment) were used to account for missing data for Count 1.

For Count 2 (August 2014 – October 2014), a total of 91 sampling units was randomly drawn without replacement. Five scheduled count assignments were not completed; three of these incomplete assignments were the result of random events: a rain event, staff illness and staff failure to complete the assignment. The remaining two missed assignments were not completed due to crime and high security risk. SU 5, which is located on the southwest end of the island, was ranked as a high security risk area for the project. The area is remote and unpopulated, and it is historically known by locals for having a high incidence of criminal activity. This area was surveyed without incident for Count 1, with the exception of one assignment plagued by aggressive dogs. However, on August 26, 2014, police escorted field staff off of this site due to the presence of armed men fleeing from a suspected robbery.

The aborted assignment was deleted from the dataset and a remaining assignment scheduled on SU 5 was dropped from the sample. Because the presence of criminal activity in the region impacts the number of fishers

who would use this
missing-at-random.

3.6. ON-SITE PROTOCOLS

For all survey and count assignments, starting points, “North/East” or “South/West,” were predetermined by randomly assigning the direction of the survey or count for sampling unit. For example, a “North/East” starting point meant that field staff began at the northern point for shoreline units oriented north to south, or at the eastern point for shoreline units oriented east to west. Using a GPS unit, field staff identified the predetermined starting point for the shoreline unit. For purposes of this report, the terms “survey” or “surveyor(s)” are used in reference to the interview component of the project, while the terms “count” or “counter(s)” refers to the count components, specifically.

While on assignment, surveyors used an on-site protocol designed to conduct interviews with fishers encountered, as well as to evaluate any catch. Surveyors covered the entire spatial unit within the allotted three-hour period, but did not remain at the site after expiration of the period waiting for additional fishers to arrive. For the Interview Component, the surveyors moved across the sampling unit at a normal pace, conducted interviews and examined available catch until:

1. the three-hour period expired, or
2. the entire shoreline unit had been covered and all interviews had been conducted.

This protocol assumed that the surveyor: a) would encounter fishers for most sampling units and b) that the time required for traversing shoreline units could vary based on shoreline length, terrain, and weather conditions. The on-site survey protocol assumed that the surveyor could traverse completely any given sampling unit within the three-hour period and that a substantial portion of the time period would be required to complete assignments where fishers were encountered.

Previous research findings and anecdotal information indicated that fishing pressure on St. Croix was not intense for shore-based, non-commercial fishing, except at certain locations (e.g., Frederiksted Pier) and on holidays (e.g., Easter) (Adams et al., 1996; Mateo et al., 2000; Pemberton, pers. comm.). Consequently, researchers opted to complete a census of fishers per sampling unit, unless the number of fishers exceeded 17 persons upon inspection. Seventeen was chosen because researchers estimated that the presence of more than 16 visible fishers would result in difficulties completing assignments, spatially or temporally, based on an estimated 10 minute interview completion time. For sampling units with 17 or more fishers present, the surveyors systematically sub-sampled fishers for inclusion by selecting every k^{th} fisher using the following procedure:

- Number of fishers visibly present is approximately 17 to 37 = Interview every 2nd fisher
- Number of fishers visibly present is approximately 37 or more = Interview every 3rd fisher

During the period of interest for the Interview Component, implementation of the sub-sampling protocol was not required.

Once field staff encountered and recruited a shore-based non-commercial fisher into the study, he or she conducted the interview and evaluated any catch possessed by the fisher. Evaluation protocols for evaluation of catch are found in Appendix B.

Research Methods

Counters recorded the number of people per sampling unit who were fishing or engaged in other shore-based activities along the shoreline (Figure 3.3). Counters recorded the number of persons engaged in:

- Fishing/Harvest
- Walking
- Observing/Watching
- Sunbathing
- Swimming/Wading
- Soaking
- Snorkeling (not fishing)
- SCUBA Diving (not fishing)
- Camping
- Kayaking, Canoeing, Paddle Boarding (not fishing)
- Use of Personal Watercraft (e.g., jetski, wetbike, etc.)
- Other Beach Recreational Activity
- Other Non-Beach Activity
- Not Identifiable

Definitions for the shore-based activities recorded during this study are found in Appendix C.

An on-site protocol was used to ensure that counters inspected the entire shoreline of each shoreline unit within the allotted three-hour period. The on-site protocol for counts was altered from Count 1 to Count 2. The temporal coverage of sampling units was increased for Count 2. For Count 1, the following protocols were used:

Figure 3.3. Counters recorded the number of people who were fishing or engaged in other shore-based activities such as walking, sunbathing or paddle boarding. Source: NOAA NCCOS

- The counter began each count at the top of the hour for the time period assigned.
- If the entire shoreline unit could be inspected from one vantage point at the starting point of the count assignment, then the counter was allowed to stand in one position and, using binoculars, inspect the activities that people were engaged in along the unit (Figures 3.4 and 3.5).

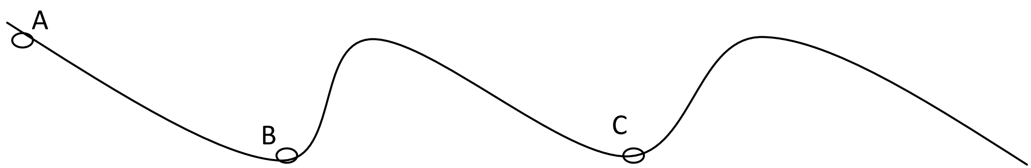


Figure 3.4. Count vantage protocol.

- The counter moved through the unit conducting a count of shore-based recreational activities, including fishing, until the last vantage point was gained.
- Counters recorded the number of persons engaged in a range of shore-based activities.

Figure 3.5. If the entire shoreline unit could be inspected from one vantage point at the starting point of the count assignment, then the counter was allowed to stand in one position and, using binoculars, inspect the activities that people were engaged in along the unit. Source: NOAA NCCOS

For Count 1, similar to the Interview Component, the counter was instructed to take as much time as was required during the three-hour period to complete one count for the sampling unit. The counter was instructed to stop counting once:

1) the three-hour period expired or
2) the entire shoreline unit had been inspected.

If the counter completed the count prior to expiration of the three-hour period, he or she did not remain at the site until expiration of the three-hour period waiting for additional shore-based users to arrive. This protocol resulted in uneven temporal coverage across sampling units during Count 1, as well as systematic non-coverage of the latter portion of the three-hour time period for several sampling units. Therefore, the on-site protocol for Count 2 was adjusted to increase temporal coverage of sampling units.

Rather than completing only one count pass during the three-hour period, counters were instructed to conduct repeated counts for the sampling unit during Count 2. The following protocol was implemented:

- The counter began each count at the top of the hour for the time period assigned.
- If the entire shoreline unit could be inspected from one vantage point at the starting point of the count assignment, then the counter was allowed to stand in one position and, using binoculars, inspected the activities that people engaged in along the unit.
- The counter moved through the unit conducting a count of shore-based recreational activities, including fishing, until the last vantage point was gained.
- After the last vantage point was gained, the counter waited 15 minutes in the location where the previous count concluded. After 15 minutes had elapsed, the counter began a second count pass by counting people engaged in shore-based activities to the end of the shoreline unit before returning along the unit back to the starting point. This procedure was repeated until expiration of the three-hour time period.
- GPS coordinates were taken at the starting point, as well as at every point where the counter stopped to conduct a count along the shoreline unit.

Multiple count passes were completed during the three hour period for Count 2. The number of count passes conducted per sampling unit was relative to the time required to traverse the shoreline units. For example, a sampling unit taking 30 minutes to traverse necessarily resulted in more count passes conducted per assignment than a unit taking 120 minutes to traverse. If the time period expired before the counter reached the last vantage point for the shoreline unit, he or she stopped the count pass in progress, recording only persons within sight who were engaged in shore-based activities. A GPS waypoint was taken to mark the location of the final vantage point. The counter marked incomplete counts as “partial” on the count form.

3.7. DATA PREPARATION

Interview Component

Adjustments to the interview data were not made prior to analysis.

Count Component 1

For the Count 1 Component, the proportion of the three-hour period used to complete count assignments varied widely across sampling units, from a maximum duration of 165 minutes to a minimum duration of 12 minutes. The average duration for assignment completion during Count 1 was forty-seven minutes. Therefore, per hour participation for each sampling unit was estimated by calculating an hourly rate of fishers and other shore users using the number of participants counted and the count duration:

Equation 1: Hourly Participation Rate for Fishers and Other Shore Users =
(Number of Fishers or Shore Users Counted/Count Duration in Minutes) * 60

Estimates assume activity pressure was uniform across each hour of the three-hour period. Stated differently, for Count 1, the estimated count per hour is assumed to be representative of the number of persons counted at any given hour per sampling unit.

To determine whether fisher encounter rates per hour were likely to be different from the Count Component 1 to Count Component 2, the difference in minutes between the average count duration for Count Component 2 (a proxy for the time required for a counter to complete one pass per shoreline unit) was compared to the time elapsed in minutes before fishers were encountered (i.e., completed interviews or refusals) at shoreline units during the Interview Component. Where possible, this comparison allowed researchers to identify for which shoreline units fishers were encountered outside of the time required to complete one pass of the shoreline unit. If interviewed fishers were encountered outside of the Count 2 Component average count duration, there was a greater likelihood that fishers were missed during counts at these sites during the Count Component 1 because of shorter count durations. Of the shoreline units compared across the Interview Component and Count Component 2, for three units fishers were encountered during the Interview Component outside the average count pass duration documented for Count Component 2. This means that for these sites the assumption that activity pressure was uniform across each hour of the three-hour period of Count Component 1 may not be valid.

Count 1 data were adjusted to account for one missed assignment. The dataset was aggregated at the sampling unit level; sampling weights for the dataset were then adjusted using a weighting class adjustment:

- Spatial
    - West End (shoreline units 1 -18),
    - Mid Island (shoreline units 20-25, 36-38) and
    - East End (shoreline units 26-35).

- Temporal
    - AM (6:00 a.m. to 12:00 p.m.)
    - NOON (12:00 p.m. to 3:00 p.m.)
    - PM (3:00 p.m. to 9:00 p.m.).

A weighting class adjustment factor was calculated for each class; the analysis weights were then re-calculated as the original sampling weights multiplied by the class weight factor (Table 3.1).

Table 3.1. Count 1 weighting class adjustment factors.

Class	Expected Sample Size	Actual Sample Size	Sum Expected Sample Class Weight	Sum Actual Sample Class Weight	Response Probability by Class	Class Weight Factor
1	19	19	3,367	3,367	1	1
2	21	21	3,784	3,784	1	1
3	30	30	4,918	4,918	1	1
4	12	12	2,743	2,743	1	1
5	4	4	833	833	1	1
6	15	15	3,032	3,032	1	1
7	13	13	2,837	2,837	1	1
8	5	5	935	935	1	1
9	8	7	1,431	1,253	0.88	1.14

Count Component 2

To address partial counts for Count 2, an imputation procedure taking into account the length of count passes and information from completed previous passes was used to impute (i.e., complete) the missing portion of incomplete count passes. Imputed values were calculated by one of three approaches. These imputation methods are described in Appendix D. Twenty-two count assignments with incomplete count passes were subjected to imputation procedures.

Once incomplete count passes were adjusted, the data were then aggregated by sampling unit. For each sampling unit, a per hour mean of the activity count per category was calculated. In other words, if four full count passes were executed during the three-hour period, the average of the four counts was calculated and recorded for the assignment. This figure represents the estimated average number of shore-based users per hour during the three-hour count period. This approach was taken to mitigate the issue of possible duplicate counting of the same individuals across count passes, which would have artificially inflated the number of shore-based users counted per sampling unit if count totals were summed. Based on the limited amount of interview data collected during the Interview Component, the research team assumed that the same individuals would likely be counted during multiple count passes for any given assignment. This was so because the reported duration of fishing trips lasted at least 60 minutes and often longer. Therefore, taking an average of all passes was deemed a more accurate representation of the actual number of persons on the shoreline during the count period.

After the dataset was aggregated at the sampling unit level, sampling weights for the dataset were then adjusted using weighting class adjustment to account for the missing assignments. As indicated previously, five count assignments were missed, dropped or aborted during the Count 2 data collection period. Three of these missed assignments were due to random events, and two of the missed assignments were deemed non-random. To adjust for the missing assignments, both the expected sample and completed sample datasets were grouped into nine classes based on spatial and temporal classes described above.

Research Methods

A weighting class adjustment factor was calculated for each class; the analysis weights were calculated as the original sampling weights multiplied by the class weight factor (Table 3.2).

Table 3.2. Count 2 weighting class adjustment factors.

Class	Expected Sample Size	Actual Sample Size	Sum Expected Sample Class Weight	Sum Actual Sample Class Weight	Response Probability by Class	Class Weight Factor
1	12	12	1,704	1,704	1	1
2	4	4	853	853	1	1
3	29	27	4,407	4,172	1	1
4	10	10	1,327	1,327	1	1
5	8	8	928	928	1	1
6	11	10	2,132	2,026	1	1
7	2	2	773	773	1	1
8	2	2	236	236	1	1
9	11	11	1,610	1,610	1	1

3.8. DATA ANALYSIS

Interview Component

Data for the Interview Component were analyzed using SPSS V23 and MS Excel 2010. The analyses include an examination of frequencies for those fishers interviewed, as well as statistical analyses of variance and association using tests such as Tukey's HSD post-hoc comparison, Pearson's r, and scatterplots to analyze relationships between continuous variables.

Count Components

Data were analyzed using PROC SURVEYMEANS in SAS V9.4. To evaluate participation rates for fishing and other shore-based activities, mean participation per hour statistics and ratio estimators were calculated. For Counts 1 and 2, measures (and corresponding standard errors) reported and interpreted included the mean number of fishers and other shore users per hour, the mean number of total shore users per hour, the number of fishers per other shore users, and estimated number of fishers and other shore users per 100 total shore users. For fishing participation, domains reported included shoreline unit, time of day, and type of day. For other shore-based activities described, findings are reported for shoreline unit. All estimates for the count components were derived using sampling weights.

Multivariate Analyses

Multivariate analyses were conducted to determine if observed shore-based activities were correlated with each other and whether there were significant spatial and temporal patterns in the types of activities for which the St. Croix shoreline was being used. One major question was whether certain pairs of activities were more likely to co-occur than others. Caribbean island residents often use nearby shorelines for multiple recreational and harvest activities because of space, resource, and accessibility limitations. Therefore, it is quite possible that some shore-based activities are equally likely to occur among observed users, and that a typical resident may participate in several different activities observed during the study regardless of time of day, month, or shoreline location.

A second major question was, is there significant spatial and temporal variation observed in the occurrence of shore-based activities? Some shoreline features are naturally more suitable to some shore-based activities than others. For example, a sandy shallow beach will be more suitable for deploying seine nets than a steep rocky shore. Additionally, the availability of living resources and sea conditions vary markedly by season. Most likely, these varying conditions will affect the time of, and spatial occurrence of, some common shore-based activities. Therefore, we questioned whether some observed shore-based activities were more likely to occur at some locations than others or, similarly, whether observed activities were equally likely to occur at all locations during all times.

Pair-wise correlations among shore-based activities

The weighted Count 1 dataset used for this analysis contained 126 random daily counts stratified into two day-types (week-day vs. week-end/holidays) and five three-hour time segments. For purposes of the multivariate analysis the three time segments corresponding to those segments employed for re-weighting of the Count 1 and 2 samples were used: 6:00 a.m. to 12:00 p.m.; 12:00 p.m. to 3:00 p.m., and 3:00 p.m. to 9:00 p.m. This was done to capture greater variation in activity across the daily periods of the recreation day. Daily counts were conducted by a single field technician. Nineteen activity categories were observed during the Count 1 study period (Table E.8, Appendix E).

The weighted Count 2 dataset comprised 86 random daily counts, 83% of which were conducted by one of two field technicians. Eighteen different activities were observed during the Count 2 study period (Table F.7, Appendix F). For both Counts 1 and 2, a non-parametric correlation coefficient, Spearman's Rho (ρ), and its associated probability value (P) were computed for each activity to determine the strength of linear relationships between paired activities. A nonparametric approach was better suited for analyzing statistical relationships among these activity variables because assumptions of normality and homoscedasticity required for parametric analyses were not met. Spearman's (ρ), which measures the strength of association between paired variables, was computed on the ranks of data values and ranged from 1 to -1, with a value of 1 indicating a strong positive relationship and a value of -1 indicating a strong negative relationship (SAS 2012, version 9.4). Values of ρ near zero (i.e., $|\rho| < 0.3$) were considered not indicative of linear relationships between paired variables.

Given that hundreds of pair-wise comparisons were possible to test for correlations among identified activities within each count period, adjustments were made to reduce the probability of Type I error in obtaining statistically significant results. For all $|\rho| > 0.3$, the level of alpha (α) considered statistically significant for each pair-wise correlation was determined with the sequential Bonferroni technique (Rice 1989). After selecting an initial $\alpha = 0.05$, corresponding P values from each set of pair-wise correlations were ranked in ascending order from i to k. Each ranked P value was sequentially compared to an alpha value such that $\alpha_i = 0.05/(1+k-i)$, where i denotes the P-value rank and k is the total number of pair-wise correlations being tested for significance. Pair-wise correlations were considered significant only if $p_i \leq \alpha_i$. The smallest value at which $P > \alpha_i$ was the level at which all subsequent pair-wise correlations were not considered significant. For pair-wise correlations where $|\rho| > 0.3$, a posteriori Kruskall-Wallis tests and nonparametric Tukey-type multiple comparisons were used to determine if counts for each activity category varied significantly among location and time strata (Rohlf and Sokal 1995; Zar 1999).

Section 4
Findings: Interview Component

Findings: Interview Component

4.1. INTRODUCTION

Interview data were collected to address aspects of project Goal 2 (gather data needed to calculate fishing effort and catch, as well as to provide catch characteristics) and Goal 3 (gather data needed to profile one culturally-important sub-group of fishers, in terms of demographic characteristics, fishing behavior and subsistence reliance). Data were collected between December 2013 and June 2014, and include 49 completed interviews from shore-based, non-commercial fishers (Appendix G).

Challenges with the Interview Component resulted in the elimination of this component from the study after eight months of fieldwork. Challenges included low fisher encounter rates, incomplete temporal coverage of sampling units during the assignments, and staffing limitations. The final decision to terminate the Interview Component was largely based on the small number of fishers encountered during the survey assignments coupled with the need to increase labor efficiencies to focus more closely on documenting fishing participation rates on the island.

Based on previous research findings by Mateo et al. (2000, 2004), researchers anticipated an average of five fisher encounters per day over the course of the study period. In 183 sampling days, a sample size of 915 fishers was estimated for statistically reliable generalization of findings on the social and economic questions to the shore-based recreational fishing population. However, by the close of June 2014, after 124 survey assignments in eight months of surveying, only 61 fishers had been encountered. Based on low encounter rates experienced during survey assignments, the research team concluded that fishing pressure from shore-based recreational fishing on St. Croix was substantially less than anticipated at the outset of the project. Moreover, given changes in the social and economic condition of the island preceding and during the period of interest, the research team suspected that published estimates regarding the size of the shore-based fishing population on St. Croix were no longer accurate.

The project team and partners reached consensus on the decision to intensify efforts to count fishers; modification to the study design allowed the prioritization of the count component, which was essential for gathering more robust information on fishing participation. The Interview Component was discontinued after July 2014; it was not included during Count 2.

The following is a set of analyses based on the data collected from interviews with fishers on St. Croix during the Interview Component. A total of only 61 fishers were encountered; five interviews were terminated when the fishers were determined to be commercial and seven fishers refused to be interviewed. The small number of completed interviews means that the data collected cannot be used to represent the entire population of shore-based, non-commercial fishers on St. Croix. To be representative, the sample would have to meet particular targets, which are related to the level of confidence in the data accurately representing the population and the level of precision required (Salant and Dilman 1994). For this study, at least 824 completed surveys would be required to represent the population. This value is based upon a potential universe of 2,667 residents of St. Croix engaged in shore-based, non-commercial fishing. Instead, this data can only be used to draw conclusions about the sample of fishers interviewed and to help inform future methodologies to interview this group. For example, the results of the analyses can be used to:

- Assess and refine the survey instrument
- Assess sample weights
- Determine preliminary profiles of sub-groups of shore-based, non-commercial fishers
- Develop improved strategies for targeting fishers
- Better understand behavioral patterns of fishers (e.g., length of fishing activity per outing)

Findings: Interview Component

4.2. TARGET AND CATCH SPECIES

Among the small sample of respondents who answered the question “Were you fishing for any particular kinds of fish today? If yes, what kinds?” (n=17), the most common finfish species targeted were Yellowfin mojarra and Mutton snapper (Table 4.1). In terms of actual catch, as opposed to what fishers were targeting, only five respondents allowed the interviewer to observe their catch; 44 respondents either did not have the catch to show or refused to show the catch. A potential survey modification that might elicit information necessary for differentiating between refused and no catch would change the following question:
“Did you catch any fish while you were fishing that I might be able to look at?” to: “Did you catch any fish while you were fishing?” [yes] [no] [refused] AND IF YES: “Can I look at these fish?” [yes] [no] [refused].

Table 4.1. Species of fish that were targeted by the respondent.

Species Common Name	Species Scientific Name	Frequency
Yellowfin Mojarra	*Gerres cinereus*	7
Mutton Snapper	*Lutjanus analis*	4
Blue Crab	*Callinectes spp*	2
Tarpon Snook	*Centropomus pectinatus*	2
Barracuda genus	*Sphyraena*	1
Redear Herring	*Harengula humeralis*	1

Of the catch shown to the interviewer, bar jacks (*Carangoides ruber*), flat needlefish (*Ablennes hians*), and blue runners (*Caranx crysos*) were the most common finfish species (Table 4.2). In a previous study by Mateo and colleagues (2000), conducted from the middle to late 1990s, the most common finfish species documented as catch by shore-based fishers were squirrelfish (*Holocentrus spp.*), French grunt (*Haemulon flavolineatum*) and bar jacks (*Caranx ruber*). With a more robust sample, the most common species from fishers’ catch could be compared to those in previous studies and used to identify changes in fish populations over time.

Table 4.2. Species of fish that were caught by the respondent and shown to the interviewer.

Species Common Name	Species Scientific Name	Frequency
Bar Jack	*Carangoides ruber*	4
Flat Needlefish	*Ablennes hians*	3
Blue Runner	*Caranx crysos*	3
Yellow Jack	*Carangoides bartholomaei*	2
Horse-Eye Jack	*Caranx latus*	2

4.3. ANALYSIS OF DEMOGRAPHICS

The sample was 87% male (n=47) and 13% female (n=7). Most of the respondents were born on St. Croix (59%), followed by St. Lucia (8%), mainland USA (8%), and Puerto Rico (8%) (Figure 4.1). Detailed tabular data corresponding to the information in the charts can be found in Appendix H.

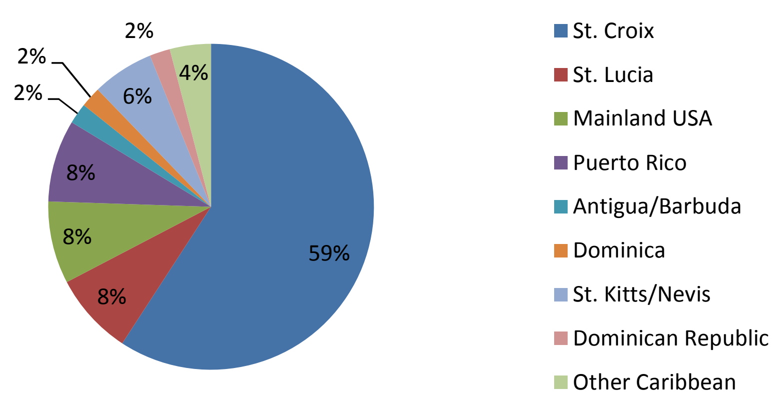


Figure 4.1. Survey respondents’ place of birth by percentage.

Over two thirds of respondents indicated that they were in the lowest household monthly income category ($0-$999 per month); therefore, this range represents the median monthly household income of the sample.

Only 2% of respondents indicated that their household earns $6,000 per month or more (Figure 4.2).

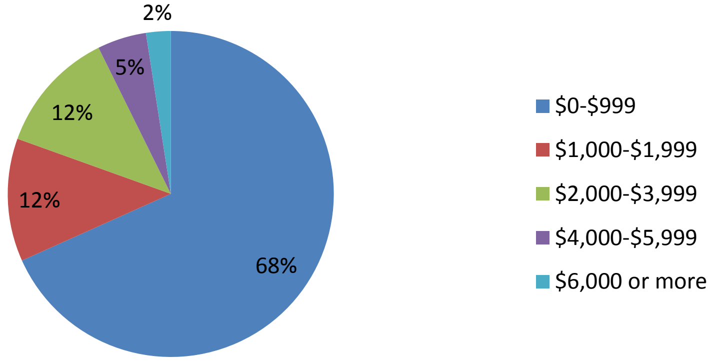


Figure 4.2. Survey respondents' monthly income by percentage.

Half of the sample indicated that they were unemployed. One quarter of the sample worked full time, and none of the respondents indicated that they were a student (Figure 4.3). The average age of the respondents was 47 years old. The average household size was just under three persons, and just under half of these households included at least one minor. Additionally, an average of 1.37 persons per household had fished recreationally in the last 3 months. Finally, respondents report having lived on St. Croix for a substantial amount of time (mean = 35.63 years) (Table 4.3).

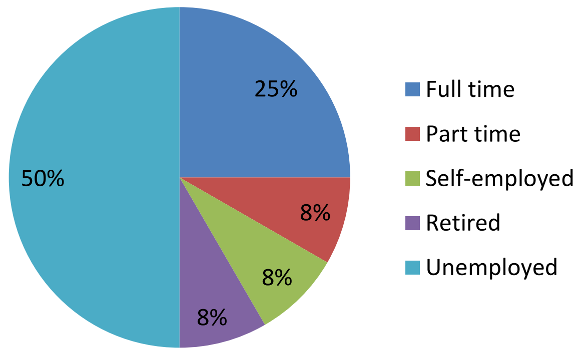


Figure 4.3. Survey respondents' employment status by percentage.

Only 1 out of 49 who answered the question about primary residence did not live in the USVI, and all 48 who answered that they lived in the USVI indicated that they lived on St. Croix.

Table 4.3. Descriptive statistics of the survey respondents.

Variable	N	Minimum	Maximum	Mean	Median	SD	Mode
Age	45	19	73	47.04	48	15.63	63
Years respondent has lived on St. Croix (if respondent lives on St. Croix)	48	2	71	35.63	31.5	17.84	20
Household size	48	1	9	2.98	3	1.79	1
Number of minors in household	48	0	5	0.79	0	1.12	0
Number of fishers in household that have fished in last three months	48	1	4	1.37	1	0.70	1

4.4. ANALYSIS OF FISHING BEHAVIOR

Almost 60% of the interviewees were fishing from a sandy or rocky beach when interviewed. The next most frequent fishing location was a dock (14.81%) (Figure 4.4).

The most frequently used type of fishing gear in the sample was a handline (63.27%), followed by a cast net (20.41%) (Figure 4.5).

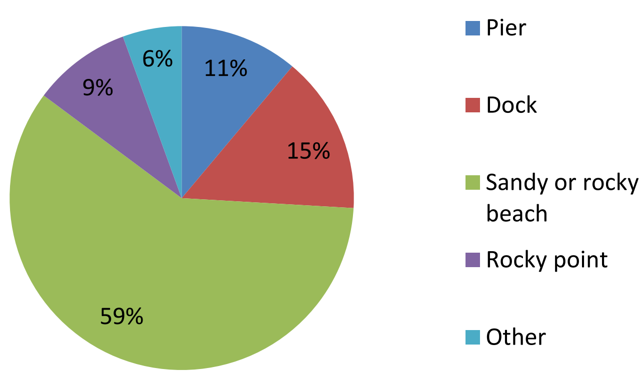


Figure 4.4. Fishing location by percentage.

Findings: Interview Component

A majority of respondents (62.5%) indicated that they were satisfied with the amount of access points for shoreline recreational fishing.

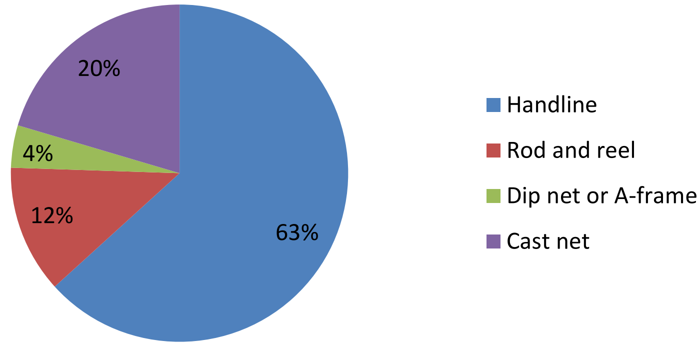


Figure 4.5. Survey respondents' fishing gear type by percentage.

Two thirds of respondents indicated that the reason that they fish is for food. The next most frequent choice was fishing for sport (22.92%) (Figure 4.6).

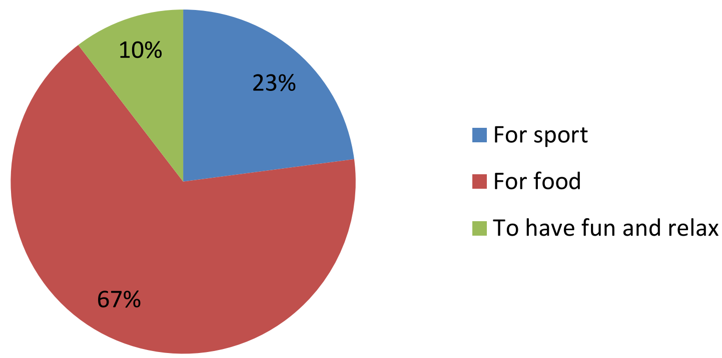


Figure 4.6. Respondents' reason for fishing by percentage.

Most respondents (64.58%) indicated that less than 10% of their household's food comes from personal-use fishing or gathering. However, approximately 10% of respondents exhibit a high level of dependence on fishing or gathering, with 50% or more of their household's food coming from these activities (Figure 4.7).

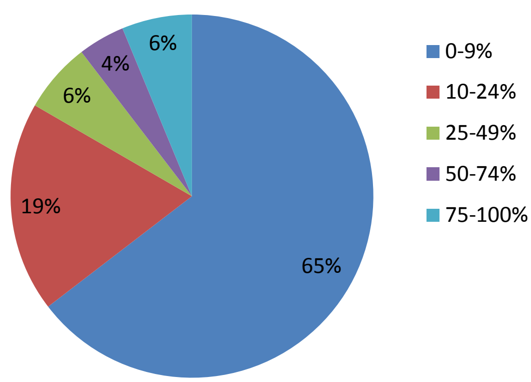


Figure 4.7. Percentage of household's food coming from fishing or gathering food from the sea.

Respondents were asked to estimate (to the nearest half hour) how much time that they had spent fishing that day before the interview had taken place, as well as how many hours they planned to spend fishing after the interview was complete (Survey Question 10, Appendix G). Respondents had spent an average of 1.88 hours fishing before the interview took place, and planned to spend, on average, an additional 2.30 hours fishing after the interview (Table 4.4). By taking the sum of hours spent fishing prior to the interview and additional hours planned following the interview, an estimate of total fishing hours per fishing occasion per respondent was derived. This information can provide a better understanding of the behavioral patterns of fishers. The total fishing hours estimated per respondent ranged from 1 to 13 hours, with an average of just over 4 hours. Half of all respondents fished an estimated 2.5 hours or more, while one quarter of respondents fished 6.5 hours or more. These results suggest that shore-based, recreational fishers likely engage in fishing occasions that last at least one hour, and often, much more.

Table 4.4. Descriptive statistics for number of hours spent fishing.

Variable	N	Minimum	Maximum	Mean	Median	SD	Mode
Total Hours Spent Fishing Already	49	0.10	8.5	1.88	1.00	1.91	0.50
Total Additional Hours Planned to Spend Fishing	49	0.50	8.0	2.30	1.50	2.05	0.50
Total Fishing Hours Estimated per Fishing Occasion	49	1.0	13.0	4.18	2.50	3.46	1.50

4.5. TOWARD A SHORE-BASED FISHER PROFILE

Several demographic and non-demographic characteristics may be used to profile fishers with respect to fishing behaviors. The results of the analyses feature examples based on reason for fishing, gear type, and fishing hours. However, it is important to note that this exercise is merely done to provide information concerning this sample. As previously mentioned in Section 3, the interview component was terminated at the end of July 2014. Inferences on the population of shore-based recreational fishers in St. Croix cannot be made with this interview data. However, these "fisher profiles" do provide information that can aid the advancement of the methods for surveying (e.g., for NOAA's Marine Recreational Information Program) and improve our understanding of non-commercial fishers more broadly. Specifically, the information provides an increased understanding of when and where fishers are engaging in non-commercial fishing activity.

4.5.1. Reason for Fishing

A pairwise Pearson correlation analysis was conducted to examine the characteristics associated with fishers who fish for sport, fun, and food (Table 4.5).

Table 4.5. Pairwise correlation coefficients related to analysis of fishers' reason for fishing.

Reason to Fish	Percentage of household's food that comes from fishing or gathering from the sea	Hours Spent Fishing	Additional Hours Planned to Spend Fishing	Use of Rod and Reel	Use of Cast Net	Monthly Household Income	Full Time Employment	Unemployed	Number of fishers in household that have fished in last three months	Born on St. Croix	Born in Mainland USA
For Sport	-0.238	-0.238*	-0.259*	0.247*	-0.272*	0.189	0.149	-0.136	0.128	-0.150	0.197
For Food	0.305**	0.315***	0.296**	-0.251*	0.263*	-0.404***	-0.283**	0.285**	-0.244*	0.267*	-0.409***
For Fun	-0.144	-0.171	-0.165	0.080	-0.171	0.348***	0.278*	-0.195	0.200	-0.132	0.392***

* = significant at the 10% level; ** = significant at the 5% level; *** = significant at the 1% level.

1. Fishers who indicated that they fish for sport were more likely to:
   - Have a shorter "fishing occasion"
   - Use a rod and reel instead of a cast net
2. Fishers who indicated that they fish for food were more likely to:
   - Have a higher percentage of their household's food come from fishing/gathering from the sea, but have less people in their household that have fished within the last 3 months
   - Have a longer "fishing occasion"
   - Use a cast net instead of a rod and reel
   - Have less monthly household income and be unemployed
   - Have been born on St. Croix
3. Fishers who indicated that they fish for fun were more likely to:
   - Have more monthly household income and be employed full time
   - Be born in mainland USA

A key finding of this analysis is that variables correlated with "fishing for sport" were always inversely correlated with "fishing for food." These correlations include gear type and fishing hours. For the fishers interviewed, the reason for fishing is a critical factor in determining a profile of fishing behavior.

4.5.2. Type of Fishing Gear

A pairwise Pearson correlation analysis was conducted to examine the characteristics associated with fishers who used a handline, a rod and reel, a dip net/A-frame, and a cast net (Table 4.6).

Table 4.6. Pairwise correlation coefficients related to analysis of fishers' gear type.

	Fishing from a Pier	Hours Spent Fishing	Additional Hours Planned to Spend Fishing	Born on St. Croix	Born in Mainland USA	Satisfied with Amount of Access Points	Fish For Sport	Fish For Food	Percentage of household's food that comes from fishing or gathering from the sea	Self Employed	Unemployed	Monthly Household Income
Use of Handline	0.285**	-0.082	-0.191	0.056	-0.237	0.436***	0.106	-0.111	-0.388***	-0.237	0.238	-0.217
Use of Rod and Reel	-0.140	-0.174	-0.284**	-0.070	0.571***	-0.086	0.247*	-0.251*	-0.007	0.343**	-0.366***	0.348**
Use of Dip Net or A-Frame	-0.077	-0.151	0.072	-0.248*	-0.062	0.164	-0.111	0.150	-0.124	-0.062	0.211	-0.125
Use of Cast net	-0.189	0.314**	0.425***	0.111	-0.151	-0.532***	-0.272*	0.263*	0.545***	0.034	-0.091	0.040

** = significant at the 10% level; ** = significant at the 5% level; *** = significant at the 1% level.*

1. Fishers who used a handline were more likely to:
   - Fish from a pier
   - Be satisfied with the amount of access points to shoreline recreational fishing
   - Have a lower percentage of their household's food come from fishing/gathering from the sea

2. Fishers who used a rod and reel were more likely to:
   - Have a shorter "fishing occasion"
   - Be born in mainland USA
   - Fish for sport instead of fishing for food
   - Have more monthly household income and be self employed

3. Fishers who used a dip net or A-frame were more likely to:
   - Not be born on St. Croix

4. Fishers who used a cast net were more likely to:
   - Have a longer "fishing occasion"
   - Not be satisfied with the amount of access points to shoreline recreational fishing
   - Fish for food instead of fishing for sport
   - Have a higher percentage of their household's food come from fishing/gathering from the sea

These analyses suggest that the population of fishers might be broken out into sub-groups based on factors like tenure on St. Croix, gear type, and reason for fishing. Understanding how these factors influence fishing behavior would allow for more targeted approaches to sampling. Further, the unique characteristics of the sub-groups might influence modifications to the survey instrument.

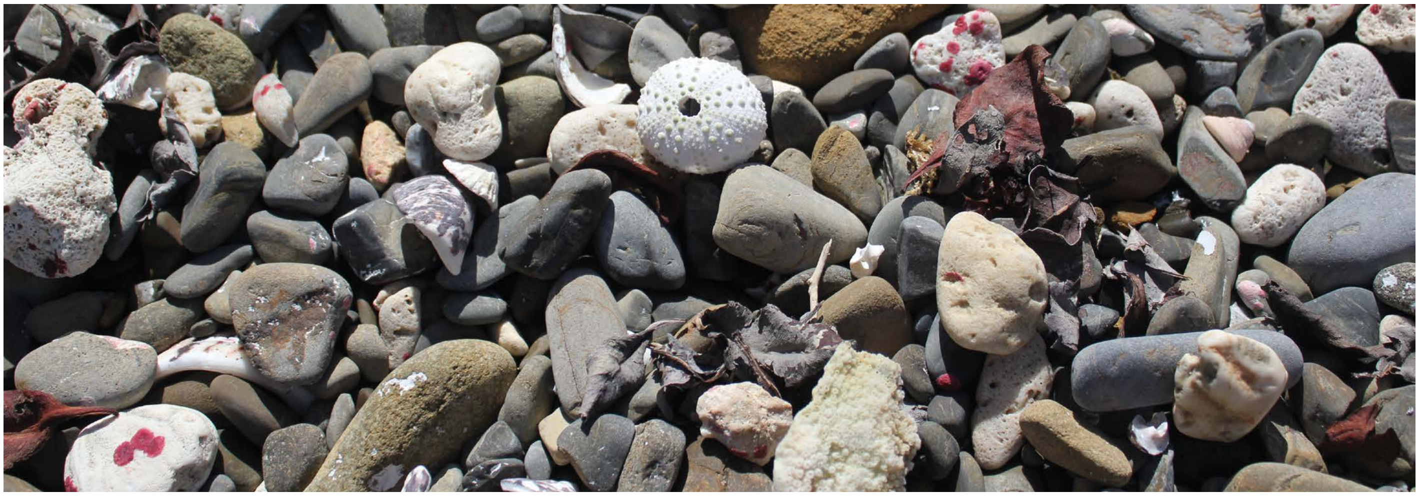
4.6. SUMMARY OF INTERVIEW COMPONENT

Overall, the analyses reveal many interesting features of shore-based, non-commercial fishers that were interviewed. Among this small number of respondents, fishing tends to occur from a sandy or rocky beach with a handline and is motivated by acquiring food. Most fishers were unemployed, with a monthly income of less than $1000. Fishers were overwhelmingly born in the Caribbean and all reside on St. Croix. Within this sample, the reason for fishing is strongly associated with gear type, length of fishing occasion, and socioeconomic background, including income and employment status. The results highlight the potential of this type of data to be used to identify species of management concern, monitor recreational landings and effort, and regulate fishing gears when a more representative sample can be achieved. In the meantime, the data can inform the design of future surveys of non-commercial fishers.

The performance of the survey instrument itself revealed few issues. Respondents did not have trouble understanding questions and were able to easily provide the requested information. The length of the survey and respondent burden, estimated to be ten minutes, did not arise as a challenge for interviewers or a deterrent for potential respondents. Instead, low response rates were entirely a result of low encounter rates with shoreline fishers. Minor modifications to the survey would elicit additional information that might be of use in refining the overall methodology. For example, researchers recommend adding a question to distinguish those fishers who refused to show their catch from those fishers who did not have catch to show. Also, an additional question to assess other shoreline activities that the fisher is planning to engage in would provide a better understanding of the behaviors of shoreline recreational fishers during a typical fishing occasion. However, unless participation in shoreline recreational fishing substantially increases, the additional information is not likely to represent big gains in terms of data to inform management.

There was a typical non-response rate (Schwartz and Paulin 2000) on the income question of approximately 19.5%. The response rate for the catch attributes section could not be determined, given that fishers either refused to show their catch or had not caught any fish when asked. Though this ambiguity in the survey question does not allow for confirmation, the research team suspects that the refusal rate was high among those interviewed. This creates a risk for future survey efforts where catch attributes are of great interest.

The challenges to the Interview Component of the study are more an issue of encounter rates with the target population, since there were fewer fishers encountered than expected from previous research. The survey results that have been obtained and analyzed, in addition to the results of the Count Components, offer a path forward in addressing the methodological challenges of surveying shore-based recreational fishers on St. Croix.



Section 5
Findings: Count Component 1

Findings: Count Component 1

5.1. INTRODUCTION

The research objective for Count 1 was to produce an estimate of fishing participation for shore-based fishing on St. Croix, USVI. Data collection for this component was undertaken from December 2013 through July 2014. Thus, weighted estimates from Count 1 apply to this period.

5.2. ESTIMATES FOR SHORE-BASED FISHING PARTICIPATION

During Count 1, as indicated in Table 5.1, researchers estimated an average of 0.66 fishers and 17.83 total shore users per hour per recreation day (6:00 a.m. to 9:00 p.m.) on St. Croix. This yielded a ratio estimator of 0.04 (SE 0.008) fishers per shoreline user hours. Based on this estimate, for any given day during the period of December 2013 to July 2014, and from 6:00 a.m. to 9:00 p.m., one might expect to see an average of four fishers per 100 persons engaged in all shore-based activities during any given hour of the recreation day in the study area.

Table 5.1. Count 1: Fishing participation estimates. SE = Standard Error.

Mean Fishers per Hour	SE Mean Fishers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Fishers Per 100 Shore Users
0.66	0.14	17.83	3.13	0.04	0.008	4

Except for a few shoreline units, the mean number of fishers and shore-based users per hour (MPH) was generally low across the study area. Table E.1 in Appendix E shows a summary of the mean number of fishers and shore users per hour by shoreline unit. The ratio estimator, corresponding standard error, and estimated number of fishers per 100 shore users are displayed.

On six of the selected shoreline units (SUs), SUs 1, 3, 15, 19, 29 and 30, no shore-users were counted. SUs 3 and 29 were sampled once during the period of interest, while units 1, 15, 19 and 30 each were sampled two or more times. Four of these shoreline units are located further than five miles from the nearest population center. For all sampling units at these locations, field staff recorded cloud cover and/or precipitation. Three sampling units at SU 3 and 15 were ranked as posing a security risk for field personnel; the remaining eleven sampling units were rated as low security risk. For SUs 2, 6, 11, 13, 21, 26, 28, 31, 33, 34 and 37, shore users were counted but no fishers were among them. SUs 6, 11, 13, and 31 were each sampled once. SUs 26, 28, 34 and 37 were each sampled three times. The remaining units were sampled 5 to 9 times.

There were two shoreline units (unit 9 and 25) with relatively more fishers recorded. SU 9 is on the west end of the island and includes Frederiksted Pier. Because of its proximity to a population center and the amenities offered at the location (i.e., a pier, accessible beach and boat launch), this shoreline unit was anticipated to have more fishing pressure and overall use relative to other shoreline units on the island. Mateo et al. (2000) found Frederiksted Pier to be the second most commonly used fishing location on the island during the middle to late 1990s. Findings were similar for this study. At roughly 5 fishers per hour, SU 9 had the highest mean number of fishers per hour counted for any shoreline unit during the sampling period. Additionally, about 10% of all shore-users at this location could be expected to be engaged in fishing activity.

The shoreline unit with the next highest mean number of fishers was SU 25, with a mean of 3.14 fishers per hour (Figure 5.1). This shoreline unit is located in the population center of Christiansted. It includes a popular park called Altona Lagoon, which has a boat ramp, parking, accessible shoreline, and common park amenities (e.g., picnic tables, shelters, play equipment, etcetera). At this unit, many people were engaged in activities other than shore-based fishing (Mean number of users per hour 90.89). At this sampling unit, one might

Findings: Count Component 1

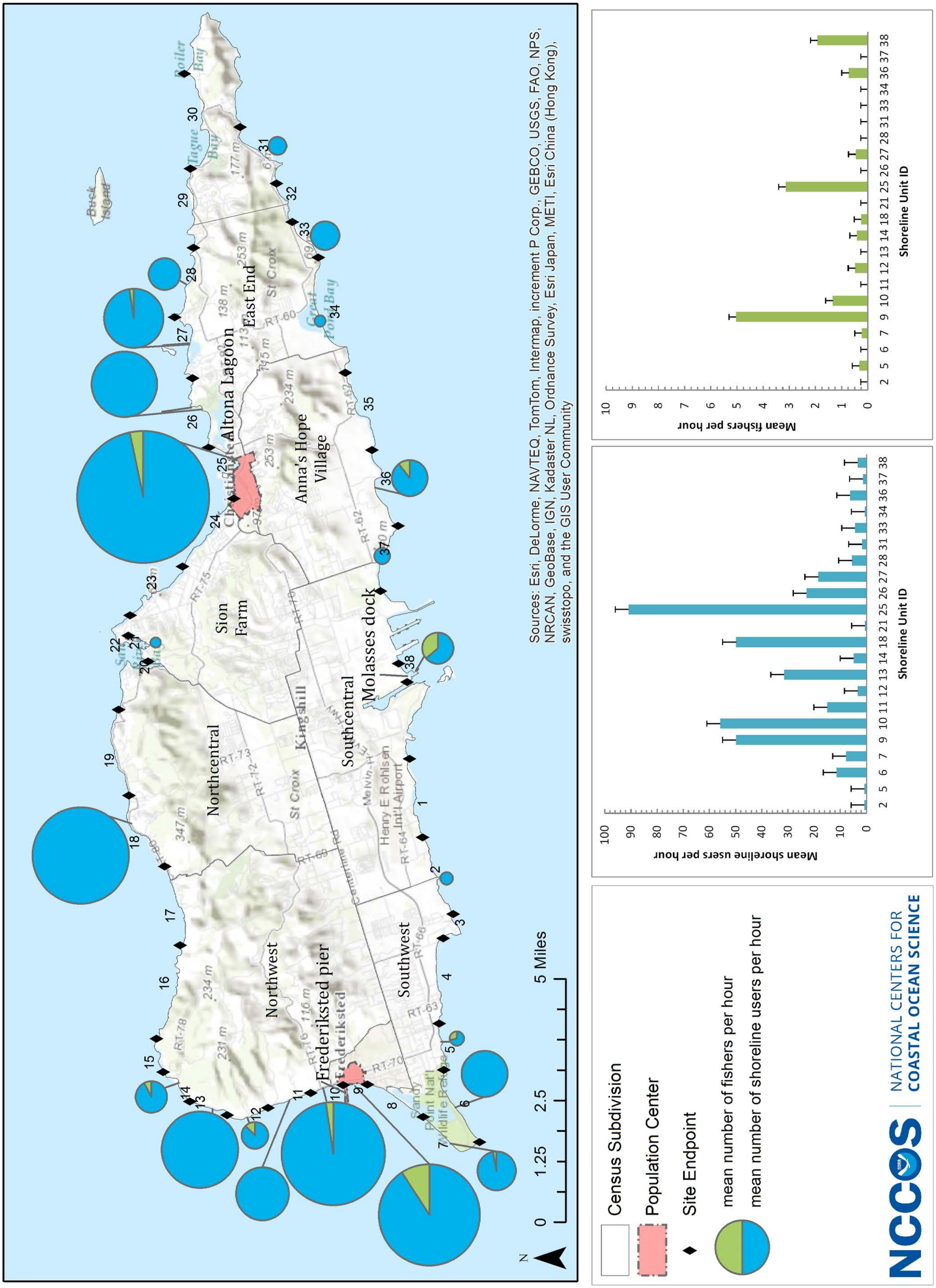


Figure 5.1. Map of mean number of shore-based fishers and other shoreline users per shoreline unit during the Count 1 portion of the study. Pie charts correspond to the ratio of shoreline users to shore-based fishers. The diameter of the pie charts is proportional to the number of shore users. Shoreline units with no pie charts were either not sampled during Count 1, or there was no one observed fishing at or conducting other activities at the given unit.

expect to see only 3 fishers (SE = 1) for every 100 people engaged in any shore-based activity per hour, or roughly 3% of total shore-based users.

Unlike Mateo et al. (2000) who found Molasses Dock to be the most commonly used shoreline location for non-commercial fishing, the present study found this location to be the third most intensely used location for Count 1. For SU 38, which includes Molasses Dock, 1.92 (SE 1.12) mean fishers per hour were documented. Additionally, the participation rate for this unit for all shore-based activities was relatively low during the study period, with a mean of 3.35 shore users per hour. For every 100 shore-based users at this unit, approximately 57 could be expected to be fishers. Thus, while the unit was not as heavily used by shore-based users in general, over half of the users present were engaged in shore-based fishing.

Regarding the time of day, the largest mean number of fishers counted per hour was in the evening between 6:00 p.m. and 9:00 p.m. (MPH 1.04), followed by the morning between 9:00 a.m. and 12:00 p.m. (MPH 0.83), then the afternoon between 3:00 p.m. and 6:00 p.m. (MPH 0.50) (Table 5.2). The time periods with the highest proportion of fishers per hour to total shore users per hour were the afternoon (3:00 p.m. to 6:00 p.m.) and the evening (6:00 p.m. to 9:00 p.m.). During these time periods 7% and 6% of all shore users, respectively, could be expected to be fishing from shore. However, for all time periods, field staff was likely to encounter shore users who were not engaged in shore-based recreational fishing activities.

Table 5.2. Count 1: Fishing participation estimates by time of day.

Time Segment	N	Mean Fishers per hour	SE Mean Fishers per hour	Mean Shore Users per hour	SE Mean Shore Users per hour	Ratio	SE Ratio	Number of Fishers per 100 Shore Users
6:00 a.m. to 9:00 a.m.	17	0.37	0.19	8.74	2.45	0.04	0.02	4
9:00 a.m. to 12:00 p.m.	27	0.83	0.34	15.55	7.55	0.05	0.02	5
12:00 p.m. to 3:00 p.m.	30	0.44	0.20	34.44	6.83	0.01	0.01	1
3:00 p.m. to 6:00 p.m.	22	0.50	0.26	6.78	2.76	0.07	0.02	7
6:00 p.m. to 9:00 p.m.	30	1.04	0.46	17.38	7.61	0.06	0.03	6

During the sampling period for Count 1, field staff encountered slightly more fishers and shore users per hour during the week than on weekends and holidays (Table 5.3). The mean number of fishers counted for weekdays per hour was 0.80, while the mean number of fishers for weekends and holidays per hour was 0.40. According to study findings, for every 100 persons engaged in some sort of activity along the shore during the week an estimated four fishers per hour (SE = 1) would be among them. For every 100 persons engaged in an activity on the shore on the weekends, only an estimated two fishers per hour (SE = 1) would be among them.

Table 5.3. Count 1: Fishing participation estimates on weekdays versus weekends.

Day Type	N	Mean Fishers per hour	SE Mean Fishers per hour	Mean Shore Users per hour	SE Mean Shore Users per hour	Ratio	SE Ratio	Number of Fishers per 100 Shore Users
Weekday	82	0.80	0.21	18.15	4.04	0.04	0.01	4
Holiday/ Weekend	44	0.40	0.14	17.24	4.68	0.02	0.01	2

Findings: Count Component 1

5.3. ESTIMATES OF PARTICIPATION IN OTHER SHORE-BASED ACTIVITIES

Because fishing was only a small component of all shore-based activities recorded for the period, it is useful to examine participation rates for other activities. For Count 1, an average of 17.83 people was observed engaging in any shore-based activity, including fishing.

In terms of spatial distribution (Table D.2, Appendix D), shoreline unit (SU) 25 had the highest mean number of shore-based users per hour (MPH 90.89) (Figure 5.2). Again, this unit is in Christiansted and includes several recreational amenities: Altona Lagoon park, the downtown boardwalk, and the Christiansted National Historic Site, managed by the National Park Service. This area is frequented by residents and tourists, alike. Other shoreline units with a high MPH of shore users were SUs 9 (MPH 49.91), 10 (MPH 55.91), and 18 (MPH 49.80). Units 9 and 10 are in Frederiksted, the island's second population center. SU 18 includes Cane Bay, which is an important destination for water-based activities, like swimming, snorkeling and shore-based SCUBA. These units, therefore, were expected to have the high participation rates for shore-based activities.

As noted in Table 5.4, ranked by mean shore users per hour (MPH) for the period of interest, the five activities with the highest per hour participation estimates were:

1. observing/watching;
2. walking;
3. swimming, soaking and wading;
4. camping; and
5. snorkeling.

The "other" activity category was omitted from ranking because of the wide range of shore-based activities encompassed in this category, including many activities not specifically related to shore-based recreation. For

Table 5.4. Count 1: Participation estimates for all shore-based activities, ranked by mean number of shore users per hour (excluding Other Category) SE = Standard Error. .

Activity Category	Mean Shore Users Per Hour	SE Mean Shore Users Per Hour	Variance Mean Shore Users Per Hour	Ratio estimator	Standard Error Ratio Estimator	Number Engaged in Activity Per 100 Shore Users
Observing	6.01	1.31	1.73	0.34	0.03	34
Walking	4.18	0.80	0.64	0.23	0.03	23
Swimming, Soaking and Wading	1.87	0.42	0.17	0.10	0.02	10
Camping	0.84	0.47	0.22	0.05	0.02	5
Snorkeling	0.74	0.23	0.05	0.04	0.01	4
Sunbathing	0.66	0.28	0.08	0.04	0.01	4
Fishing	0.66	0.14	0.02	0.04	0.01	4
Kayaking, Canoeing, Paddle Boarding	0.48	0.22	0.05	0.03	0.01	3
SCUBA	0.41	0.18	0.03	0.02	0.01	2
Use of Personal Watercraft	0.07	0.05	0.00	0.00	0.00	0
Other Combined (excluded from rank order)	1.91	0.60	0.36	0.11	0.02	11

a comprehensive list of activities included in the other category, see Table B.1 in Appendix B of this document. The most common shore-based activity, observing, was defined as any person on or along the shoreline in a standing or seated position who was watching or looking out over the shoreline. Observing was by far the most recorded shore-based activity during the study period. As presented in Table 5.4, an average of 6.01 people per hour (mean per hour = MPH) were engaged in observing, with a ratio estimator of 0.34 (SE 0.03). Thus, for any given day during the period of December 2013 to July 2014 one might expect to see about 34% of all shore users engaged in observing.

Spatially, consistent with findings for all shore-based activities, the shoreline units having the most mean observers per hour were SUs 9 (MPH 21.01) and 25 (MPH 39.78) (Figure 5.2, Table E.3 in Appendix E). SU 13 (MPH 22.50), on the west end, also had many observers. The shoreline units having a higher ratio of observers per all shore users were units 2 (Ratio 1.00; SE 0.00), 11 (Ratio 0.67; SE 0.00), 13 (Ratio 0.71; SE 0.00), and 25 (Ratio 0.44; SE 0.05). SUs 2, 11, and 13 are located on the west end of the island. Four units on the East End had the lowest ratio of observers to total shore users: 26 (Ratio 0.24; SE 0.03), 27 (Ratio 0.21; SE 0.05), 33 (Ratio 0.20; SE 0.23), and 36 (0.12; SE 0.06).

Finally, no observers were recorded at units 5, 6, 21, 31, 34, and 38. SU 5 is on the west end of the island on the south shore, near the Sandy Point National Wildlife Refuge. SU 6 is a part of the Sandy Point National Wildlife Refuge, which is closed to the public from April through August to protect nesting sea turtles annually. SU 21 is located mid-island on the north shore in the Salt River area. SUs 31 and 34 are more remote, located on the East End. Finally, SU 38, inclusive of Molasses Dock, is on the south shore amid an industrial complex.

The second most common shore-based activity during Count 1 was walking. Walking was defined as any person walking along the shoreline in any direction. The purpose of the person's walking (e.g., fitness walking, nature walking, strolling for pleasure, etc.) was not recorded. A MPH of 4.18 persons walked along the shoreline during the study period. The ratio estimator was 0.23 (SE 0.03), equivalent to 23% of shoreline users being engaged in walking.

As shown in Figure 5.2 (or in Table E.4 of Appendix E), SU 25 had the largest MPH number of walkers (MPH 30). SUs 31 and 34 had 100% of shoreline users engaged in walking. However, walkers were not recorded in units 1, 2, 3, 6, 13, 15, 19, 29, 30, 33, or 37. Many of these units, whether on the east or west end, are characterized by limited access or a lack of convenient parking. For example, SU 6 is part of the Sandy Point National Wildlife Refuge on the southeast side of the refuge, away from the developed public beach access area.

Swimming, wading, and soaking were combined into a single activity category for the analysis. Swimming was defined as any person actively swimming in the water along the shoreline. Wading was defined as anyone walking or standing in the shallow water (at least ankle deep) along the shoreline for no other purpose besides wading. Persons who were clearly wading in the water to cast a fishing line/net or watching wildlife/the horizon were not recorded as wading, but as fishing or observing, respectively. Finally, soaking was defined as any person fully immersed in the water floating, bobbing, or standing, but not actively swimming. As indicated in Table 5.4, a MPH of 1.87 people were engaged in swimming, soaking, and wading activities in the study region, or 10% of shoreline visitors.

At SU 7, which includes Sandy Point National Wildlife Refuge, the MPH number of swimmers, waders and soakers was 2.19 with a ratio of .09 (SE.05), meaning 9% of total shoreline users (Figure 5.2). Although the refuge contains a popular swimming beach, the refuge is closed seasonally from April through August to protect nesting sea turtles. During closure, access is strictly controlled by the US Fish and Wildlife Service. Counts were

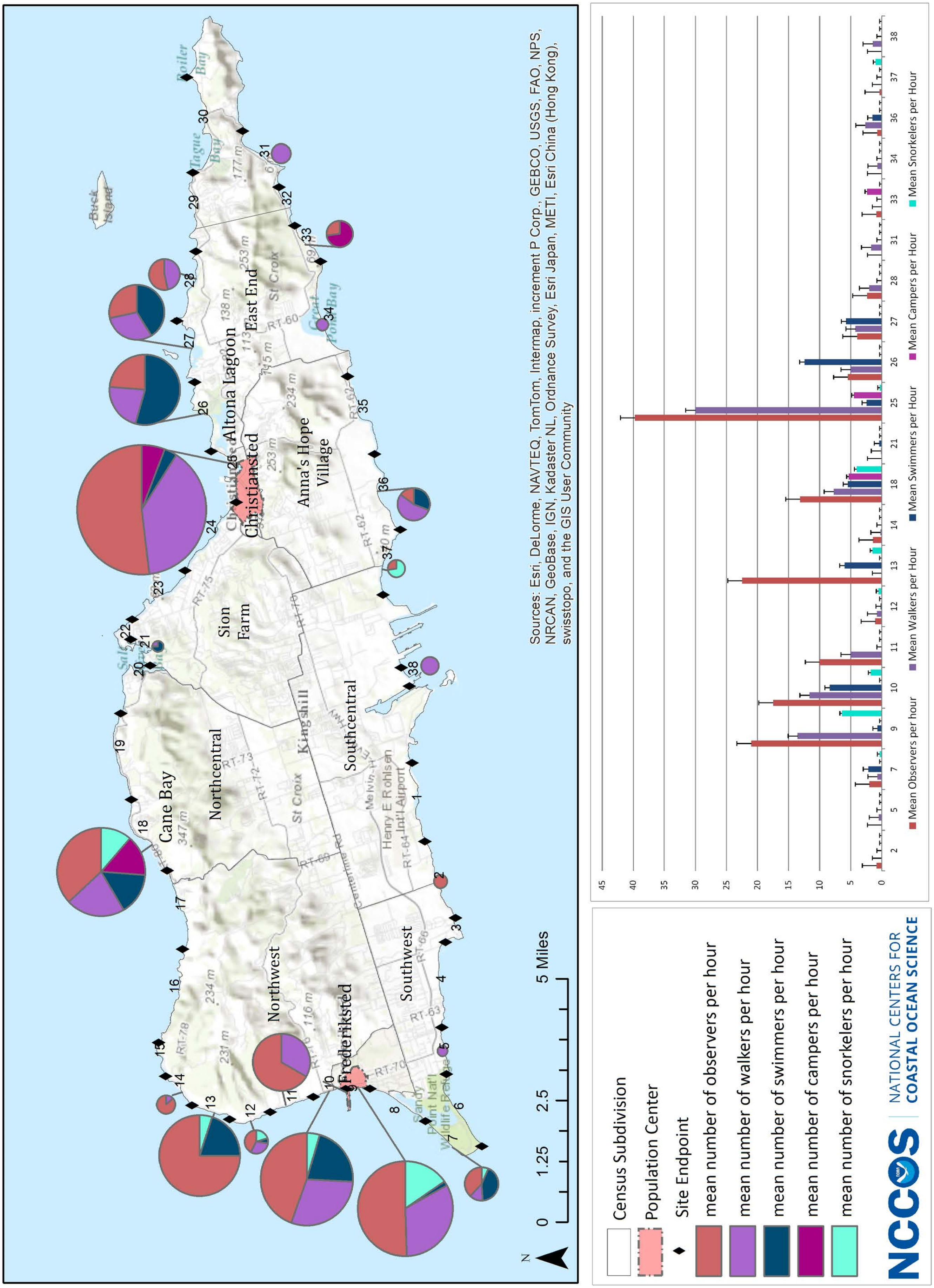


Figure 5.2. Map of mean number of shoreline users per hour by top activities (observers, walkers, swimmers, campers and snorkelers) during the Count 1 portion of the study. Pie charts correspond to percentage of the means of the top activities. The diameter of the pie charts is proportional to the number of shore users.

conducted at the refuge during the December 2013 to July 2014 period, which was inclusive of four months of the seasonal closure. SU 10, which includes Frederiksted Beach, was anticipated to have notable swimming, wading, and soaking activity. With the MPH of swimmers, waders, and soakers being 8.36 (second highest figure in the study period), this expectation was upheld.

No swimmers, waders or soakers were observed at units 1, 2, 3, 5, 6, 11, 14, 15, 19, 28, 29, 30, 31, 33, 34, 37 and 38 during Count 1 (Table E.5 of Appendix E). Units 1 and 2 are located on the south side of the island where access is limited and the shoreline can be somewhat steep and narrow. SU 14 is on the northwest end of the island where the terrain is characterized by cliffs and rocky outcroppings, making access to the shoreline extremely difficult. Units 31, 33, and 34 are on the island's East End, some distance away from the island's population centers. Parking at these fairly remote areas can be limited and the beaches are narrow and rocky. While SU 38 does have a small stretch of beach included, this beach is characterized by mangrove and vegetative cover. This beach lies near Molasses Dock and the entire unit is located amidst an industrial complex.

Camping is a culturally important shore-based activity on St. Croix. While camping largely occurs during important holidays, such as Christmas and Easter, it can occur throughout the year. As indicated in Table 5.4, a MPH of 0.84 people were engaged in camping activities during Count 1. Camping was defined as any person who had set up a temporary housing structure (e.g., tent, camper trailer, etc.) along the shoreline for the purpose of staying multiple nights. Persons recorded as camping were assumed to be engaged in overnight camping, as opposed to day camping. Picnickers were not included in this category. The ratio of campers to other shore users per hour was 0.05 (SE 0.02) to one. Campers were recorded in April (MPH 4.44) and May (MPH 2.21) during Count 1. In April, campers roughly represented 17% of all shore users recorded, while in May only about 7% of total shore users would be expected to be engaged in camping.

Based on anecdotal evidence gathered from territorial resource managers, local field staff, and research partners, the shoreline units most commonly used for camping on the island are units 8, 9, 18, 19, 20, 26, 27, 28, 30, 32, 33, 36, and 38. As shown in Figure 5.2 and in Table E.6 in Appendix E, campers were recorded at three shoreline units with SU 18 having the highest mean campers per hour at 5.30, followed by SU 25 at 4.47. The ratios of campers per hour to total shoreline users per hour for shoreline units 18 and 25 were 0.10 (SE .08) and 0.05 (SE .04), respectively. The shoreline unit with the largest ratio of campers per hour to total shoreline users per hour was unit 33 (Ratio 0.53; SE 0.16). Thus, of every 100 shore based users per hour during the study period, we recorded approximately 53% engaged in camping along SU 33. This unit is located on the East End on the south shore of the island.

No campers were observed along shoreline units 1-3, 5-7, 9-15, 19, 21, 26-31, 34, and 36-38. While no campers were documented in these units during the study period, it is possible that people were present at camping areas, but engaged in shore-based activities other than camping per the project definition. In other words, a camper who was engaged in fishing would have been counted as a fisher, as opposed to a camper.

As indicated in Table 5.4, a MPH of 0.74 people were engaged in snorkeling activities in the study region. Snorkeling was defined as any person actively engaged in snorkeling in the water. Persons who were sitting on the beach, but who had snorkel gear, were not counted as snorkelers; they were recorded in the appropriate activity category. Persons entering or exiting the water with snorkel gear at the time of the count were included as actively snorkeling. Overall, for every 100 shore-based users per hour, approximately 4% were engaged in snorkeling.

Findings: Count Component 1

Snorkelers were documented at SUs 7, 9, 10, 12, 13, 18, 25, and 37. However, as shown in Figure 5.2 and in Table E.7 in Appendix E, the shoreline unit with the highest mean number of snorkelers per hour was SU 9 with 6.37, followed by unit 18 at 4.05. The ratios of snorkelers per hour to total shoreline users per hour for shoreline units 9 and 18 were 0.13 (SE 0.04) and 0.08 (SE 0.03), respectively. SU 9 is near Frederiksted Pier, which is a popular location for snorkelers and divers who come to view the sea life living on the pylons of the pier. There is a dive shop near the pier where snorkel equipment can be rented or purchased. Similarly, SU 18 includes Cane Bay where there is a dive shop adjacent to a popular beach. This area has coral in shallow waters near the beach, making snorkeling convenient.

The shoreline unit with the largest ratio of snorkelers per hour to total shoreline users per hour was unit 37 (Ratio 0.72; SE 0.28) (Figure 5.2). Thus, for every 100 shore based users per hour during the study period, we recorded approximately 72% to be engaged in snorkeling along shoreline unit 33. However, the mean number of snorkelers and shore users per hour was low for this unit overall, at 1.00 (SE 0.82) and 1.38 (SE 0.71), respectively. No snorkelers were observed along SUs 1-3, 5, 6, 11, 14, 15, 19, 21, 26-31, 33, 34, 36, and 38.

5.4. COUNT 1 - PAIR-WISE CORRELATIONS AMONG SHORE-BASED ACTIVITIES

Sixteen of nineteen activity categories showed significant pair-wise associations, with Spearman (ρ) values ranging from 0.31 ($P = 0.0007$) to 0.71 ($P < 0.0001$) (Table E.8, Appendix E). Strongest pair-wise correlations ($\rho \geq 0.50$) occurred between observing and walking, walking and line fishing, observing and line fishing, as well as scuba and hand gathering. Observing and walking were the two most common activities recorded during the survey period, which explains their strong-pairwise associations with several other activities. It is possible that observing and walking along the shoreline are used opportunistically for other activities, like fishing.

Weaker pair-wise correlations ($0.40 \leq \rho < 0.50$) occurred among various pairwise combinations of camping, cast netting, hand- gathering, other netting, kayaking, observing, beach recreation, scuba, snorkeling, soaking, sunbathing, swimming, walking, watercraft use, and other unidentified activities. A possible reason for these associations is that such types of activities typically are commonly done for leisure. Not surprisingly, it is quite likely that the various harvest activities such as hand-gathering and netting which were observed during leisure activities, occurred as part of those leisure activities. For example, it is quite common for campers to fish and gather food from their surroundings while camping.

Weakest significant pair-wise associations ($0.30 \leq \rho < 0.40$) occurred among various pairwise combinations of hand gathering, kayaking, observing, beach recreation, non-beach activity, scuba, snorkeling, soaking, sunbathing, swimming, and walking. Interestingly, only one harvest activity (hand-gathering) correlated significantly with any of the non-harvest activities (kayaking) ($\rho = 0.31$, $P = 0.0003$).

5.5. TEMPORAL PATTERNS FROM TWO-WAY CLUSTERING – COUNT 1

Two-way hierarchical clustering of observations from Count 1 by month-day-type strata and activity category revealed interesting patterns (Figure 5.3). Activity categories observed during April weekend-holidays and May weekdays had more similar levels (i.e., counts) than activity categories observed during other month-day type combinations. Yet April weekend-holidays were very different from May weekdays in the activity categories that took place. Interestingly, camping occurred only during April weekend-holidays (39 campers) and May weekdays (18 campers), but was not observed during other times. Watercraft usage and sunbathing also were highest on April weekend-holidays, whereas cast-netting, kayaking, observing, beach recreation, walking, and other non-beach activity mostly occurred on May weekdays. Other than hand-gathering, other harvest activity categories were hardly observed and were indistinguishable among months and day types during the study period.

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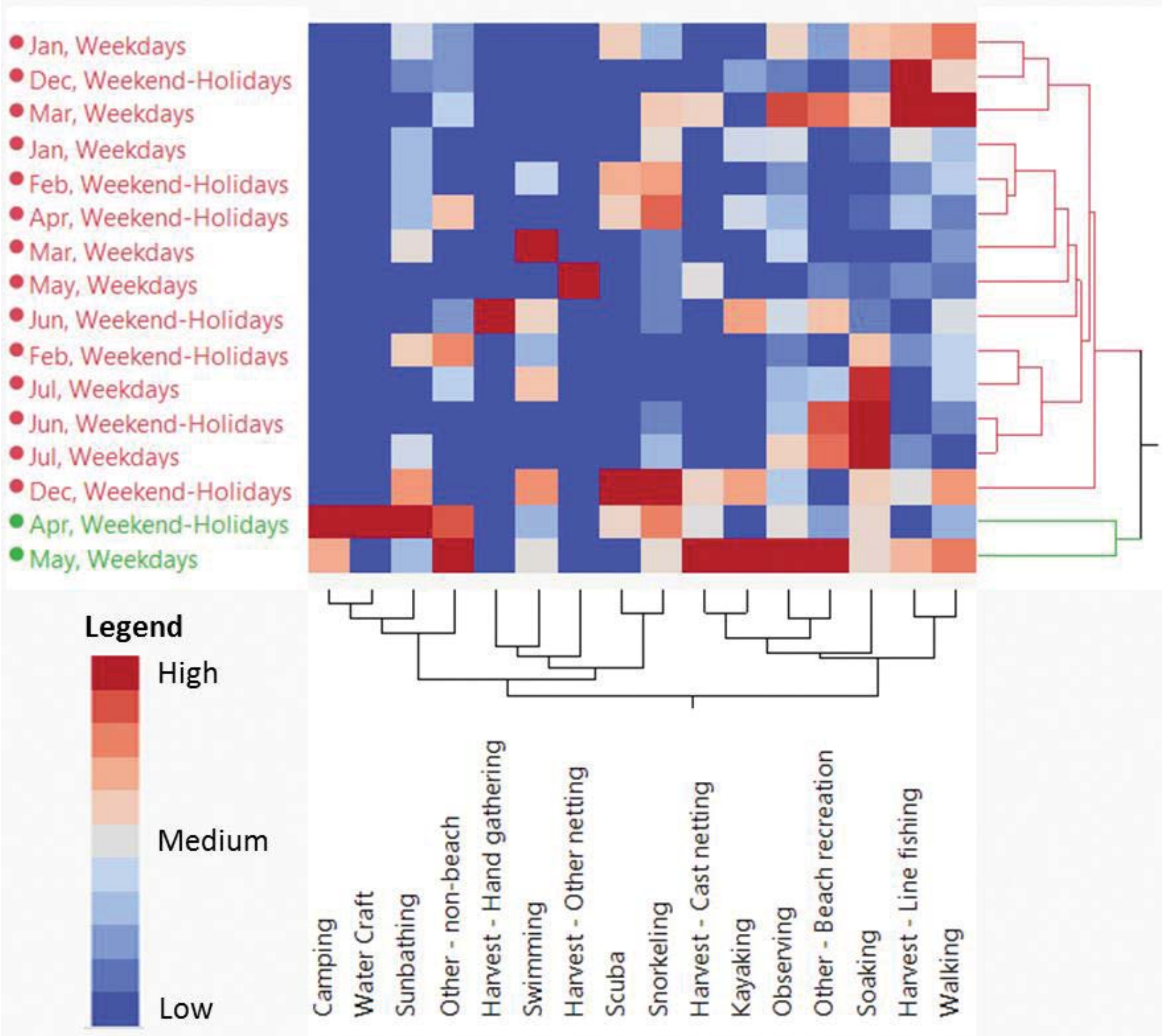

Figure 5.3. Results of Ward's minimum variance hierarchical clustering to identify similarities in shore-based activity counts among temporal strata and activity categories during count 1 in St. Croix, U.S. Virgin Islands.

5.6. SPATIAL PATTERNS FROM SHORELINE CLUSTERING – COUNT 1

Two-way hierarchical clustering of shoreline units revealed three meaningful shoreline clusters and two broad groupings of activity categories (Figure 5.4). SUs 9, 25, and 18 comprised one cluster. These areas are near population centers (SUs 9 and 25) or are popular beaches. SU 18 (Cane Bay) was most associated with camping, scuba, snorkeling, and sunbathing. SU 25 (Christiansted town/ Altona Lagoon) was mostly associated with netting, recreational walking, and observing. SU 9 (South Frederiksted/ Frederiksted pier) was associated mainly with snorkeling (no fishing), netting, and linefishing (meaning any form of fishing that employs a fishing line, including handline or rod and reel). SU 10 (Frederiksted pier/ Frederiksted beaches) formed its own cluster and was associated with eleven of the nineteen activity categories.

The analyses failed to distinguish unique groupings from the remaining shoreline units; however, two activities associated markedly with specific shoreline units within this large site cluster. Soaking associated mostly with SU 26 (Little Bay, near Christiansted) and line fishing associated more with SU 38 (Molasses Dock), when compared with other activity categories.

Findings: Count Component 1

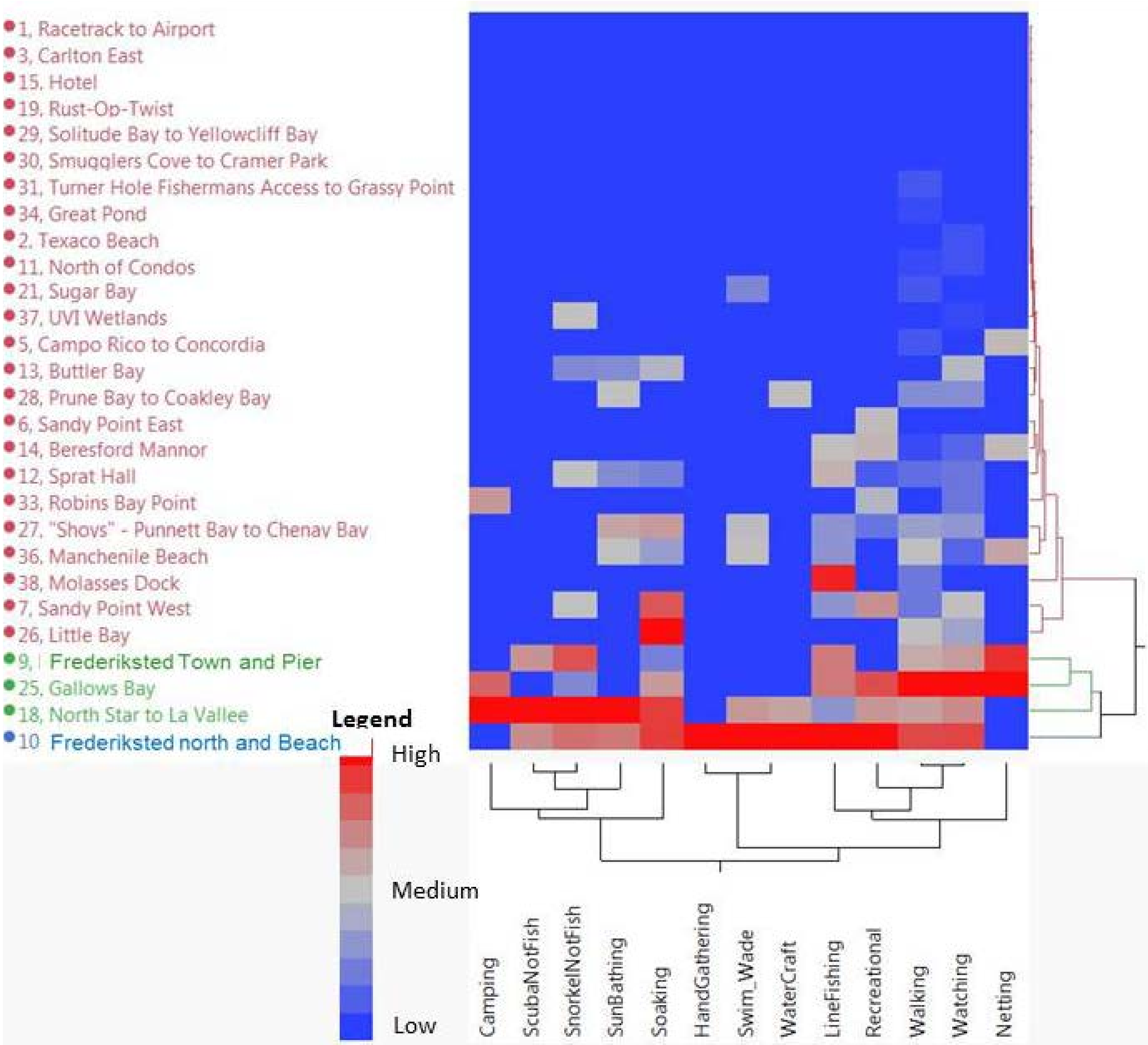

Figure 5.4. Results of Ward's minimum variance hierarchical clustering of count 1 data to identify similarities among shoreline units in shore-based activity based on summed counts for nineteen activity categories in St. Croix, U.S. Virgin Islands.

5.7. SUMMARY OF COUNT COMPONENT 1

During the period December 2013 through July 2014, the mean number of fishers and shore-based users per hour was generally low across the study area. Shoreline unit (SU) 25 had the highest documented participation rate for total shore users during the period of interest. This indicates that the Christiansted area was an extremely important location for shore-based activities of all types on St. Croix during the period. Other shoreline units popular with people engaging in shore-based recreational activities were units 9, 10, and 18.

Fishing was not among the shore-based activities most often participated in. Rather, the top five shore-based activities documented during this period were observing, walking, swimming/wading/soaking, camping, and snorkeling. Spatially, SU 25 was an important location for observing, walking, and camping. The popularity of these activities at this location is likely related to the nature of the space as well as the amenities available, including Altona Lagoon, the National Park Service area, and the Christiansted downtown boardwalk. SU 9, located in Frederiksted, was an important location for observing and snorkeling, as well as fishing. Thus, along with unit 25, this area was an important location in the community for multiple shore-based activities during Count 1.

Although shore-based fishing was not among the dominant activities documented, it was recorded during the study period. Participation in shore-based fishing was most common at two shoreline units directly adjacent to St. Croix's two population centers, SU 9 at Frederiksted and SU 25 at Christiansted. In terms of temporal trends, shore-based fishers were most likely to be documented on weekdays, as opposed to weekends and holidays, and during the evening hours between 6:00 p.m. and 9:00 p.m. In general, however, field staff encountered shore-based users involved in activities other than fishing more often during Count 1.

An important contextual note for the period of Count 1 relates to precipitation. As indicated in Section 2, St. Croix experienced higher than average rainfall for four out of the eight months of sampling for Count 1. Field staff reported flooding and treacherous shore conditions on multiple occasions during this collection period, as well as difficulty reaching access points due to muddy service roads. Presumably, fishers and other shore users would have faced similar challenges accessing and using the shoreline during these times, which could have depressed participation rates for shore-based activities during Count 1.

Section 6

Findings: Count Component 2

6.1. INTRODUCTION

The research goal for Count 2 was to produce a more accurate estimate of fishing participation for shore-based fishing on St. Croix, USVI. This was accomplished by increasing the number of daily count assignments conducted for the remainder of the project, as well as increasing the number of count passes conducted for each sampling unit to ensure complete coverage of the three-hour time period. As stated previously, the period of interest was August to October 2014.

6.2. ESTIMATES OF SHORE-BASED FISHING PARTICIPATION

During Count 2, an average of two fishers and 16 total shore users per hour were estimated per recreation day. For any given day during the period of August to October 2014 one might expect about 10% of persons engaged in a shore-based activity on St. Croix in the study area to be engaged in shore-based fishing (Table 6.1).

Table 6.1. Count 2: Fishing participation estimates.

Mean Fishers per Hour	SE Mean Fishers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio Estimator	SE Ratio Estimator	Number of Fishers Per 100 Shore Users
1.56	0.34	15.98	4.98	0.10	0.034	10

Similar to findings from Count 1, the mean number of fishers was low across the study area. Table F.1 of Appendix F shows a summary of the mean number of fishers and shore users per shore unit per hour for Count 2. On four of the shoreline units sampled, units 1, 21, 33 and 35, no shore-users were counted during the data collection period. Shoreline units 1, 21 and 35 were sampled only once during the period of interest, while unit 33 was sampled twice. Three of these shoreline units are located further than five miles from the nearest population center. For four out of the five sampling units at these locations, field staff recorded cloud cover and/or precipitation, so weather conditions could have influenced participation in shore-based activities. One sampling unit at SU 1 was deemed a security risk for field personnel; the other five sampling units were rated as low or no security risk.

At SUs 10, 11, 16, 17, 22 and 23, no fishers were recorded among the shore users counted. Each of these shoreline units was sampled at least twice, with the exception of SU 23, which was sampled only once during the period of interest.

Consistent with Count 1 findings, relatively more fishers were recorded at SUs 9 and 25 during Count 2 (Figure 6.1). At eight fishers per hour, SU 9 had the highest mean number of fishers per hour counted for any shoreline unit during the sampling period. Further, at 31 per hour, this unit had the third largest number of shore users of all kinds. At this shoreline unit, there was a 0.25 (SE 0.033) to one relationship of fishers to shore-based users per hour for the sampling period. On average 25% of all shore users at this unit were recorded as fishing in a given hour during the study period.

The shoreline unit with the next highest mean number of fishers for Count 2 was SU 25 in Christiansted, with a mean of three fishers per hour. However, at this unit many people were engaged in activities other than shore-based fishing (MPH= 70). Consequently, at SU 25, there was a 0.05 (SE 0.01) to 1 relationship of fishers to shore-based users per hour during the sampling period. Thus, proportionately, SU 9 (Frederiksted pier) was more important for fishing activities during Count 2.

Findings: Count Component 2

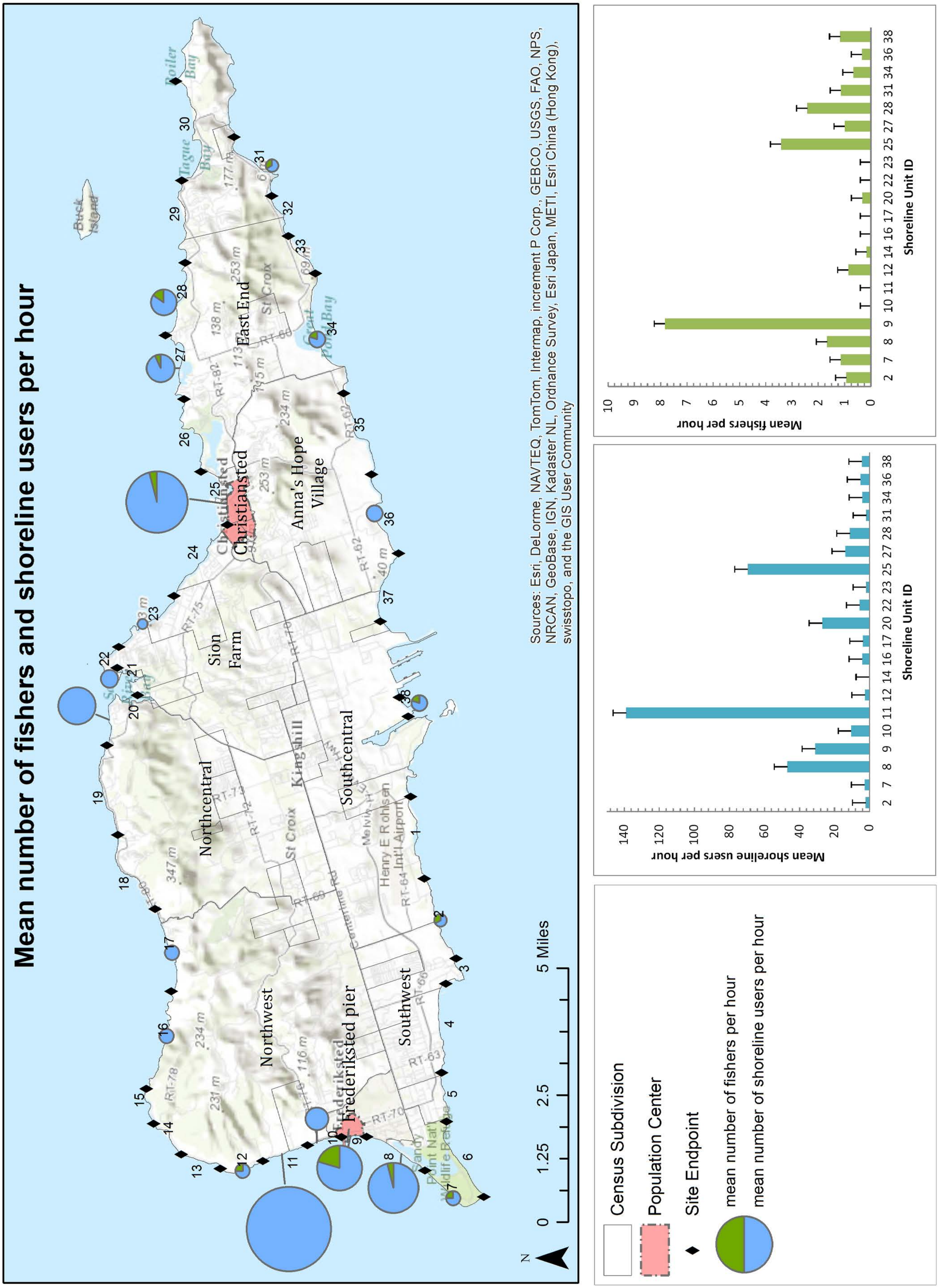

Figure 6.1. Map of mean number of fishers and shoreline users per shoreline unit during the Count 2 portion of the study. Pie charts correspond to percentage of the means of the top activities. The diameter of the pie charts is proportional to the number of shore users.

For SU 38, which includes Molasses Dock, a mean of only one (SE 0.62) fisher per hour was documented for Count 2. Similarly, the participation rate for this unit for all shore-based activities was low during the study period, with a mean of 4 shore users per hour. The ratio estimator of fishers to shore-based users was 0.27 (SE 0.07), meaning that for every 100 shore-based users approximately 27% could be expected to be fishers. Thus, while the unit was not heavily used by shore-based users in general, when used, fishing was one activity that could be expected.

As seen in Table 6.2 related to the time of day, the largest mean numbers of fishers counted per hour were in the evening between 6:00 p.m. and 9:00 p.m. (MPH 3) and afternoon between 3:00 p.m. and 6:00 p.m. (MPH 2). However, considering ratio estimators, the time periods with the highest proportion of fishers per hour to total shore users were the morning (6:00 a.m. and 9:00 a.m.) and the evening (6:00 p.m. and 9:00 p.m.), with ratios of 0.18 (SE 0.04) and 0.17 (SE 0.05), respectively. For all time periods, field staff was more likely to encounter shore users who were not engaged in shore-based recreational fishing activities.

Table 6.2. Count 2: Fishing participation estimates by time of day.

Time Segment	N	Mean Fishers per hour	SE Mean Fishers per hour	Mean Shore Users per hour	SE Mean Shore Users per hour	Ratio Estimator	SE Ratio Estimator	Number of Fishers per 100 Shore Users
6:00 a.m. to 9:00 a.m.	13	1.12	0.51	6.17	1.82	0.18	0.04	18
9:00 a.m. to 12:00 p.m.	11	0.81	0.33	11.10	4.79	0.07	0.02	7
12:00 p.m. to 3:00 p.m.	14	0.83	0.37	16.85	6.80	0.05	0.02	5
3:00 p.m. to 6:00 p.m.	24	1.50	0.53	22.52	14.53	0.07	0.05	7
6:00 p.m. to 9:00 p.m.	24	2.60	1.02	15.38	5.29	0.17	0.05	17

As with Count 1, during Count 2, field staff encountered more fishers during the week than on weekends and holidays, although they encountered more shore users per hour on weekends and holidays (Table 6.3). The mean number of fishers counted for weekdays per hour was 2 (SE 0.48), while the mean number of fishers for weekends and holidays per hour was 1 (SE 0.32). For every 100 persons engaged in some sort of activity along the shore during the week for Count 2, an estimated 16 fishers per hour would be among them. The ratio of fishers per hour to total shore users per hour was much smaller for weekends and holidays, as more shore users were counted overall. For weekends and holidays, a ratio estimator of 0.04 (SE 0.02) was calculated, meaning that for every 100 persons engaged in an activity on the shore, only an estimated four fishers per hour would be among them.

Table 6.3. Count 2: Fishing participation estimates on weekdays versus weekends.

Day Type	N	Mean Fishers per hour	SE Mean Fishers per hour	Mean Shore Users per hour	SE Mean Shore Users per hour	Ratio	SE Ratio	Number of Fishers per 100 Shore Users
Weekday	62	1.86	0.48	11.31	2.18	0.16	0.03	16
Holiday/ Weekend	24	0.93	0.32	25.72	14.35	0.04	0.02	4

Findings: Count Component 2

6.3. ESTIMATES OF PARTICIPATION IN OTHER SHORE-BASED ACTIVITIES

For Count 2, an average of 16 people (SE 4.98) were observed engaging in any shore-based activity documented in the study area per hour, including fishing.

In terms of spatial distribution (Figure 6.2 and Table F.2 of Appendix F), SU 11 had the highest mean number of shore users per hour (MPH 139). This unit, located on the west end of the island near Frederiksted, includes several popular beaches. Other units with a high per hour mean number of shore users were SU 8 (MPH 47), SU 9 (MPH 31), and SU 25 (MPH 70). Related to units 9 and 25, this finding is similar to Count 1. SU 8 is also located in Frederiksted and includes a length of beach near residences. No shore users were recorded at units 1, 21, 33, and 35 during the Count 2 period.

Sorted by mean participation per hour, the five activities with the highest per hour participation estimates for Count 2 were:

1. observing/watching;
2. swimming, soaking and wading;
3. walking;
4. fishing; and
5. sunbathing.

As with Count 1, the "other" activity category was omitted from this ranking. Readers should refer to Appendix C, Table C.1 for list of the activities included in the other category.

Similar to Count 1, observing was by far the most recorded shore-based activity during this period. As presented in Table 6.4, a MPH of five people were engaged in observing. For any given day during the period of August to October 2014, one might expect to see about 29% of all shore users engaged in observing.

The units having larger average number of observers per hour were SUs 8 (MPH 25), SU 11 (MPH 26) and 25 (MPH 26). The units having a higher ratio of per hour observers per all shore users were SU 2 (Ratio 0.45; SE 0.11), SU 8 (Ratio 0.54; SE 0.00), SU 10 (Ratio 0.57; SE 0.15), and 14 (Ratio 0.43; SE 0.35). All of these units are located on the west end of the island. Four geographically dissimilar units had the lowest ratio of observers per total shore users: 7 (Ratio 0.04; SE 0.03), 12 (Ratio 0.11; SE 0.05), 16 (Ratio 0.05; SE 0.00), and 22 (Ratio 0.12; SE 0.13). No observers were recorded at units 1, 21, 23, 33, 34 or 35. SUs 1, 21 and 23 are located mid-island, while units 33, 34 and 35 are located on the south shore of the East End (Figure 6.2 and Table F.3 of Appendix F).

The second most recorded activity category during Count 2 was swimming, wading and soaking (Table 6.4). A MPH of three people were recorded as engaged in these water-based activities. The ratio of swimmers, soakers and waders to other shore users per hour was 0.21 (SE 0.07) to one.

SU 11, located on the leeward side of St. Croix, at 60 had by far the largest MPH number of people swimming, soaking, or wading for the study period. It also had the largest proportion of swimmers, soakers, or waders per all shore users across the island. At this unit, for every 100 participants engaged in all shore-based activities per hour one could expect approximately 44% of these users to be enjoying some form of swimming-like activity. Again, SU 11 encompasses several popular beaches near Frederiksted, including Rainbow Beach (Figure 6.2 and Table F.4 of Appendix F).

Table 6.4. Count 2: Participation estimates for all shore-based activities, ranked by MPH (excluding Other Category).

Activity Category	Mean Shore Users Per Hour	SE Mean Shore Users Per Hour	Variance Mean Shore Users Per Hour	Ratio Estimator	Standard Error Ratio Estimator	Number Engaged in Activity Per 100 Shore Users
Observing	4.70	1.51	2.27	0.29	0.03	29
Swimming, Soaking and Wading	3.29	2.07	4.30	0.21	0.07	21
Walking	2.12	0.42	0.18	0.13	0.03	13
Fishing	1.56	0.34	0.12	0.10	0.03	10
Sunbathing	1.22	1.04	1.08	0.08	0.04	8
Kayaking, Canoeing, and Paddle Boarding	0.43	0.34	0.12	0.03	0.02	3
SCUBA	0.19	0.10	0.01	0.01	0.01	1
Use of Personal Watercraft	0.17	0.09	0.01	0.01	0.00	1
Snorkeling	0.09	0.04	0.00	0.01	0.00	1
Camping	0.03	0.03	0.00	0.00	0.00	0
Other Combined (excluded from rank order)	2.19	0.71	0.50	0.14	0.05	14

At SU 7, which includes Sandy Point National Wildlife Refuge, the MPH number of swimmers, waders, and soakers was less than one. Although the refuge contains a popular swimming beach, the entire refuge is closed seasonally from April through August to protect nesting sea turtles. Counts were conducted at the refuge during the August to October 2014 period, which included one month of the seasonal closure. SU 10, which includes Frederiksted Beach, was anticipated to have notable swimming, wading, and soaking activity for this period. However, the MPH of swimmers, waders, and soakers at this location was also less than one. Finally, it is important to note that SUs 18 and 30, which both include popular public swimming beaches at Cane Bay and Cramer Park, respectively, were not sampled during Count 2. Sampling units were weighted to increase the likelihood of encountering fishers, as opposed to other shore users; the sample was randomly drawn and these SUs were not selected.

No swimmers, waders, or soakers were observed at units 1, 2, 14, 21, 22, 23, 31, 33, 34, 35 and 38 during Count 2. Again, units 1 and 2 are located on the south side of the island where access is limited. SU 14 is on the northwest end of the island where the terrain is rocky with cliffs. Units 21, 22, and 23 are located on north shore, mid-island near Salt River. Some parts of the shoreline in this area are undeveloped, while other segments are developed; however, much of the shoreline in this area is privately owned, which may limit access to the general public. Finally, units 31, 33, 34 and 35 are on the island's East End, some distance away from the island's population centers. SU 38 lies amid the island's industrial complex and has only a small stretch of beach characterized by vegetative cover.

The third most common shore-based activity during Count 2 was walking. A MPH of 2 persons walked along the shoreline during the study period. For every 100 shore users there were 13 walkers during Count 2. As with the first count component, SU 25 had the largest MPH number of walkers (MPH 13). Walkers were not recorded in units 2, 14, 22, 23, 31, 34 or 38. With the exception of SU 38, each of these units is characterized by rather limited access (Table F.5, Appendix F).

Findings: Count Component 2

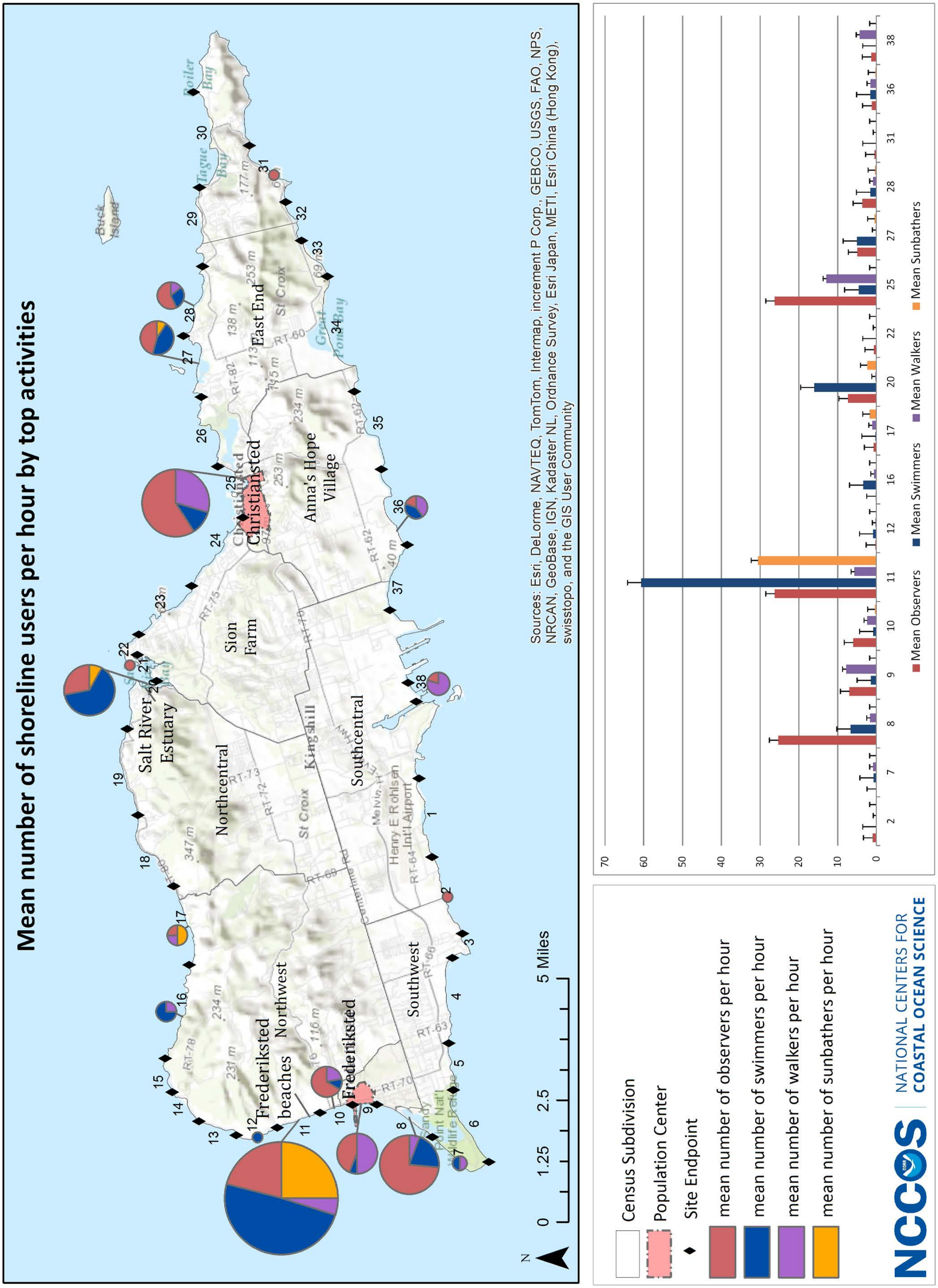

Figure 6.2. Map of mean number of shoreline users per hour by top activities (observers, swimmers, walkers and sunbathers) during the Count 2 portion of the study. Pie charts correspond to percentage of the means of the top activities. The diameter of the pie charts is proportional to the number of shore users.

Finally, the fifth most common shore-based activity during Count 2 was sunbathing. A MPH of one person sunbathing was found for the period of interest. For every 100 persons engaged in any shore-based activity per hour along the shoreline, one could expect approximately 8 of them to be sunbathing. A notable presence of sunbathers was recorded at four shoreline units: 11, 17, 20, and 27 (Table F.6, Appendix F).

SU 11 had a mean of 31 sunbathers per hour with a ratio estimator of 0.22 (SE 0.002). This unit includes popular beaches on the west end of the island. SU 17, on the northwest end of the island, had a MPH of two sunbathers and a ratio of 0.45 (SE 0.18) sunbathers for every one shore user. Thus, almost half of shore users at this location could be expected to be sunbathing. SU 20, also with a MPH of two sunbathers, is located mid-island on the north shore. Roughly 9% of total shore users at this unit would be expected to be sunbathing. This shoreline unit includes part of Salt River and, to the west, two stretches of beach. One stretch of beach is located below the Salt River National Park and Ecological Preserve, managed by the National Park Service. The other stretch of beach is located further west adjacent to an enclave of upscale condominium residences, a few of which are available as vacation rentals.

Finally, SU 27 had a MPH of one sunbather with a ratio estimator of 0.04 (SE 0.02). This unit is located on the East End and includes beaches along Chenay Bay. There are beach resorts along the shoreline in this area. Again, however, it is important to note, for the reasons provided above, that shoreline units inclusive of beaches at Cane Bay and Cramer Park, where participation in sunbathing might be expected, were not sampled during Count 2.

6.4. COUNT 2 - PAIR-WISE CORRELATIONS AMONG SHORE-BASED ACTIVITIES

Seventeen of nineteen activity categories showed significant pair-wise correlations, with Spearman (ρ) values ranging from 0.34 ($P = 0.0013$) to 0.65 ($P < 0.0008$). Similar to the COUNT 1 period, strongest pair-wise correlations ($\rho \geq 0.50$) occurred between observing and walking, walking and line fishing, observing and line fishing, and scuba and hand gathering. Weaker pair-wise correlations ($0.40 \leq \rho < 0.50$) occurred among various pairwise combinations of camping, cast netting, hand gathering, other netting, kayaking, observing, beach recreation, scuba, snorkeling, soaking, sunbathing, swimming, walking, watercraft use, and other unidentified activities. Interestingly, nine of eleven non-harvest recreational activity categories correlated significantly with at least one form of harvesting (Table F.7, Appendix F).

6.5. TEMPORAL PATTERNS FROM TWO-WAY CLUSTERING

Two-way hierarchical clustering of counts by day-type-month strata by activity category revealed two interesting patterns. First, clustering revealed two temporal groupings. Activity categories observed during August weekdays and October weekend / holidays had more similar levels (i.e., counts) than activity categories observed during August, September, and October. Yet August weekdays was very different from October weekends in the activity categories that took place. Camping, kayaking, using watercraft, observing, spearfishing and walking were more associated with August weekdays, whereas hand-gathering, soaking, snorkeling, sunbathing, swimming, and other un-identified activities associated more with October weekend counts. Other than spearfishing and hand-gathering, counts for other harvest activity categories seemed ubiquitous and indistinguishable among the months and day types during the study period (Figure 6.3).

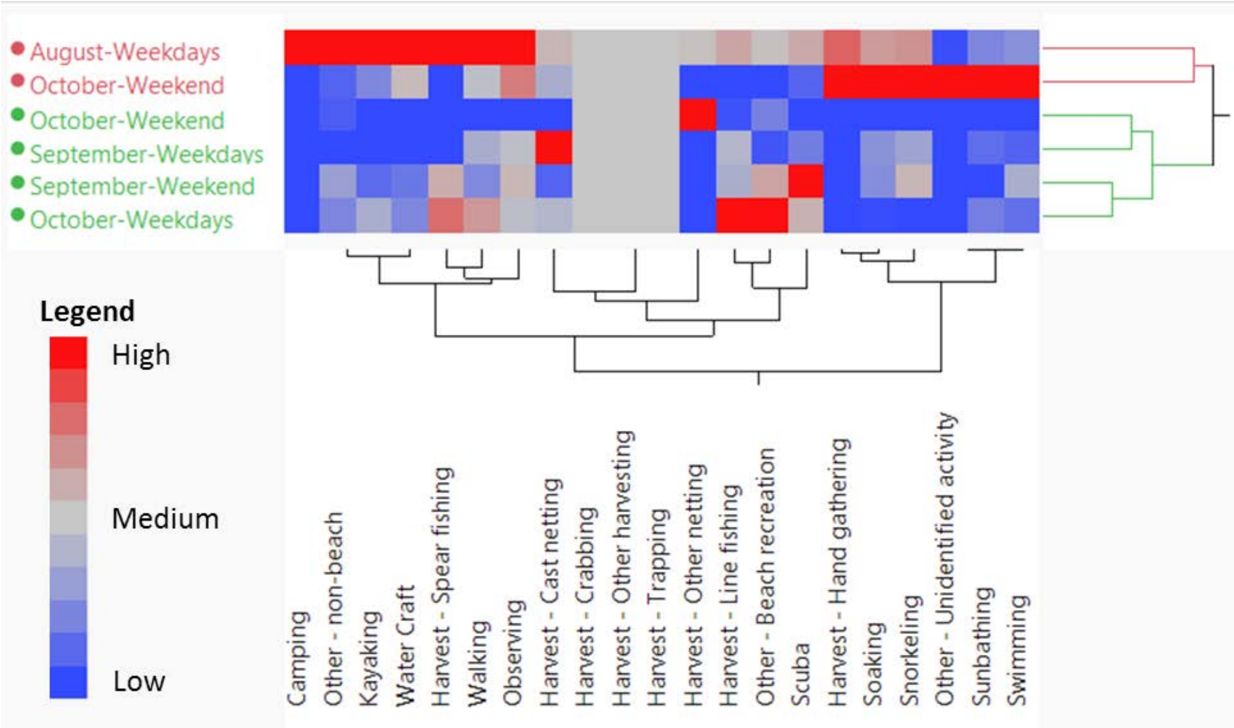

Figure 6.3. Results of Ward's minimum variance hierarchical clustering to identify similarities in shore-based activities among temporal strata and activity categories during Count 2 study period in St. Croix, U.S. Virgin Islands.

6.6. MULTIVARIATE CLUSTERING TO REVEAL SPATIAL PATTERNS IN ACTIVITY COUNTS

Two-way hierarchical clustering of shoreline units based on summed counts for nineteen activities revealed three meaningful shoreline clusters and two broad groupings of activity categories (Figure 6.4). SU 25 comprised one cluster and was more associated with camping, netting, recreational walking, snorkeling and wading. SU 9 associated more with recreational uses such as walking, snorkeling and scuba diving, but also with harvesting activities such as hand gathering, line fishing and spearfishing. The analyses failed to distinguish unique groupings from the remaining shoreline units; however, a few sites associated markedly with specific activity categories. SU 11 associated more with swimming, soaking, and sunbathing activities than with other activity categories. SU 22 (in the area of Salt River) associated mostly with watercraft activities, whereas SU 36 (inclusive of Manchineel Beach) seemed most associated with spearfishing.

6.7. SUMMARY OF COUNT COMPONENT 2

While shore-based fishers were documented in the study area during the period of August 1 through October 31, 2014, researchers were more likely to encounter persons participating in other non-fishing shore-based activities. Sorted by relevance, the shore-based activities most commonly documented for the period were observing, swimming/wading/soaking, walking, fishing, and sunbathing. The shoreline units having the highest documented usage for all shore-based activities during the period (SUs 8, 9, 10, 11 and 25) are each in proximity to Frederiksted (units 8, 9, 10, and 11) and Christiansted (unit 25). During Count 2, SU 25 was an important location for observing, walking, and fishing. SU 11 was popular for observing, swimming, and sunbathing. These two locations appeared to be important multiuse areas for the most popular shore-based activities on St. Croix during the period.

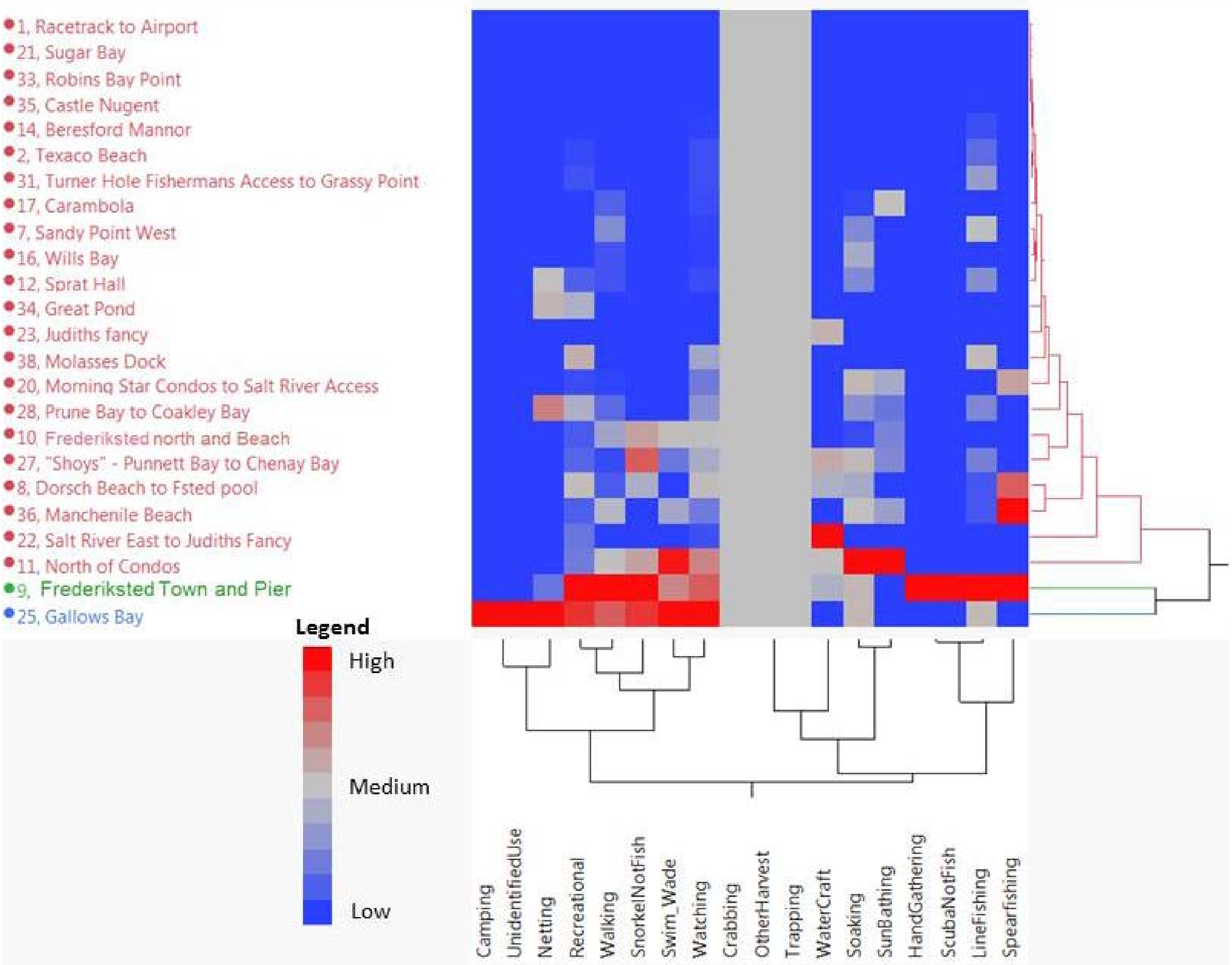

Figure 6.4. Results of Ward's minimum variance hierarchical clustering to identify similarities among shoreline units in shore-based activities based on summed counts for eighteen activity categories during Count period 2, in St. Croix, U.S. Virgin Islands.

Shore-based fishing was found to be within the top five shore-based activities documented for the period. Spatial and temporal patterns for shore-based fishing during the study period are noteworthy. SUs 9 and 25 had the highest documented participation rates. Again, these units are in proximity to the two population centers on the island and have amenities that facilitate shore-based fishing activity. Temporally, shore-based fishers were more likely to be encountered on weekdays, as opposed to weekends when more total shore users were documented. The times of day with the highest documented participation in shore-based fishing activity were evening (6:00 p.m. to 9:00 p.m.) and afternoon (3:00 p.m. 6:00 p.m.).

Finally, there is one important contextual note of importance for the Count 2 period. The study period coincided with a seaweed landing event on the island, specifically of the genus Sargassum. As indicated previously, field staff reported that for stretches of shoreline with large volumes of seaweed present, use of the shoreline for many recreational activities could have been negatively influenced. This nuisance event lasted several months of the study period.

Section 7
Conclusions and Recommendations

Conclusions and Recommendations

7.1. CONCLUSIONS

The four research goals of this study were to:

1. Field test use of a roving study design for collecting information on non-commercial fishing in the USVI via site surveys and direct interviews;
2. Gather data needed to calculate fishing effort and catch, as well as to provide catch characteristics;
3. Gather data needed to profile shore-based non-commercial fishers, in terms of demographic characteristics, fishing behavior and subsistence reliance; and
4. Document the spatial distribution of participation in shore-based fishing and other recreational activities.

Goal one is the primary contribution of this work and represents a significant advance in assessing the challenges and advantages of methods used to collect data on shore-based recreational fishing. Goal two is partially addressed in terms of fishing effort, in the form of documenting fishing participation rates. Because of low fisher encounters during surveys, catch characteristics are not provided in this report. However, low fisher encounters are an indication of aggregate effort and catch. So while we are not statistically able to provide this information, in aggregate we have shown that fishing pressure is low. Related to goal three, statistically generalizable interview data needed to profile the shore-based non-commercial fishing community were not achieved. Thus, findings to generalize to this culturally-important sub-group of fishers, in terms of demographic characteristics, fishing behavior, and subsistence reliance, are not forthcoming. Provision of information on the spatial distribution of shore-based fishing and other activities (Goal 4) is a major contribution of this study to existing research on non-commercial fishing on St. Croix. General conclusions of findings relative to the research goals addressed by this study are provided below.

7.2. SITES USED FOR FISHING AND OTHER SHORE-BASED ACTIVITIES

One goal of this project was to document locations across the island where fishing and other shore-based recreational activities occurred. This information is important because it highlights locations across the island notable for hosting multiple shore-based uses, including fishing. This information can be useful to understand the dynamics of multi-use shorelines, such as co-occurrence of particular uses, which could be indicative of the presence of incompatible uses or areas of high community value.

Across the two count components, encompassing an eleven-month period, researchers documented the most commonly participated in shore-based activities, as well as the shoreline units where these activities occurred. For both count periods, shoreline unit (SU) 25 (in Christiansted) was found to be an important location for shore-based activities. This unit was important for observing and walking for both Count 1 and Count 2. This unit was also popular for camping during Count 1. For both count periods, this unit had the second highest participation rate for shore-based fishing. For both counts, unit 25 ranked highly for participation in all shore-based activities.

For Count 1, SU 9 in Frederiksted was important for two of the period's top ranked shore-based activities, observing and snorkeling. This unit was also the most important location for shore-based fishing during Count 1 and Count 2. This unit had the fourth highest participation rate (mean per hour = MPH) for all shore users during Count 2. Thus, SU 9 appears to be a location of importance for shore-based recreational users on St. Croix. Depending on the daily timing of fishing and snorkeling activities, these uses could be incompatible around the Frederiksted Pier, which is popular location for fishing, snorkeling, and diving.

Finally, during Count 2, SU 11 had the highest mean number of total shore users per hour. This unit, also in Frederiksted, was particularly associated with three of the top ranked activities for the period, observing, swimming, and sunbathing. This unit was not highly associated with shore-based fishing during either Count 1 or Count 2.

7.3. FISHING PARTICIPATION AND SITES USED FOR FISHING ACTIVITY

Based on study findings across both count components, shore-based fishing on St. Croix is a relatively low participation activity, compared with other types of shore-based activities. For Count 1, the MPH participation rate for fishing was one, while the MPH participation rate for Count 2 was two. Additionally, for both count periods, the ratio of fishers per total shore users was relatively low, meaning that fishers could be expected to be only a small percentage of all shore users across the study area for either count period. As discussed in the previous summary, one was more likely to encounter persons engaged in non-fishing activities during both count components; however, some areas were far more popular with fishers, as discussed below.

In terms of the spatial distribution of fishing participation, for both count periods, SUs 9 and 25 were the sites with the highest MPH fishing participation rate. Considering the ratio of fishers to total shore users for both count components, at SU 9 the ratio was higher than that for SU 25. Thus, while both sites were important for fishers, SU 25 saw more diverse shore uses than unit 9. Stated differently, SU 9 had a higher percentage of fishers per total shoreline users during both components of the study, meaning it had less diverse shore-based activities than unit 25. Both of these units appeared important to shore-based fishers, with SU 9 being a location more oriented to fishing activity as opposed to other uses.

Turning to temporal trends for fishing participation, for both count components, the time of day with the highest mean participation rate for fishing was 6:00 p.m. to 9:00 p.m. In terms of the proportion of shore-based fishers per total shore users, a higher percentage of total shore users were fishers from 3:00 p.m. to 6:00 p.m. and 6:00 p.m. to 9:00 p.m. for both count components. Finally, when considering day type, for both count components, both the MPH fishing participation and the ratio of fishers to total shore users were highest for weekdays, as opposed to weekends and holidays. Thus, for both count periods, one was more likely to encounter fishers on weekdays from 3:00 p.m. to 9:00 p.m.

7.4. CONCLUSIONS FROM METHODOLOGICAL FIELD TEST

Provision of information on the non-commercial fishery in the USVI has been limited by a number of methodological and practical challenges to executing needed research. Challenges cited include: lack of a sample frame, difficulty recruiting and retaining field staff, lack of adequate information to increase sampling efficiency, difficulty achieving adequate survey coverage of accessible shoreline, and safety concerns for field staff (Munoz et al. 2012). The present project was designed to evaluate the efficacy of employing a roving survey approach combined with independent counts for collection of data on shore-based fishing for St. Croix. The roving survey approach was chosen because the open-access shoreline on St. Croix limits the usefulness of access point surveys.

Midway through the twelve-month period of the project, researchers noted that encounters with shore-based fishers were extremely low. In consultation with statistical advisors and project partners, the research team opted to discontinue the survey component of the study, instead focusing remaining labor and field time on documenting participation in shore-based fishing on the island. Without additional data collection, it is not possible to determine if the difference between estimates resulting from the different on-site protocols across the count periods are statistically different. Nevertheless, a number of conclusions can be drawn about the efficacy of using a roving survey approach on St. Croix, as implemented in the present study.

7.4.1. Logistical Challenges to Fieldwork

As mentioned previously, St. Croix has a number of shoreline types. Anticipating that the shoreline of St. Croix could be difficult to traverse in some locations, researchers originally planned to implement activity counts from the water, meaning to situate field staff in a boat where the shore could be easily inspected and users counted. Unfortunately, procurement of a boat and captain was cost-prohibitive. Although much of the shoreline is open and fairly easily accessible, some of the shoreline types and features on the island, including mangrove, rocky points, cliffs, and steep banks, did pose a serious challenge to field staff during this study. A kayak was used for coverage of some shoreline units (SUs 20, 21, 22, and 34) because walking the shoreline across the entire unit was simply not possible. For some shoreline units with physical barriers impeding passage along the shoreline (SUs 11, 12, 13, 14, 25, and 26), a combination of driving and walking was required. In these cases, at some point during the count or survey, field staff had to exit the shoreline unit and drive to the next available access point, then continue with the count or survey on foot.

Also related to field logistics was the difficulty of getting to shoreline access points for some units. While some shoreline units were located near a paved or gravel roadway, others were not situated near a developed road. In the latter cases, field staff had to either drive on what might be termed service roads or pathways, or exit their vehicle and walk several miles to gain access to the shoreline unit. Field staff reported getting vehicles stuck in mud after heavy rains, as well as some damage to vehicles from driving on service roads. Challenges related to both traversing difficult shoreline and reaching access points were substantially compounded in darkness or inclement weather.

Finally, security issues and the safety of field staff were of concern during the entire data collection period. Explicit and detailed security protocols were developed and implemented. Key to addressing security risks were requirements that field staff: 1) notify law enforcement when counting or surveying at high risk sampling units, and 2) conduct assignments at high risk sampling units only with an escort (meaning a second person). Researchers are pleased to report that no field staff was injured due to criminal activity during the period of study, although project equipment was stolen on one occasion. However, the need to send field staff out to high risk sampling units in pairs increased the labor costs and complicated logistics for the project. In situations when field staff was not available for escort duties, local volunteer escorts had to be secured or off-site staff was deployed to the study area, increasing travel costs.

7.4.2. Labor Requirements, Limitations and Project Costs

Researchers experienced challenges related to the recruitment, availability, and retention of field staff. At peak labor, the field team consisted of one full-time and two part-time field staff. Despite a high unemployment rate on St. Croix, identifying and hiring individuals with the qualifications to conduct field activities was difficult. Both of the part-time field staff persons that were hired for the project were employed full-time with other organizations, so scheduling of assignments was challenging. Researchers originally planned to collect data through November 2014, but decided to end collection in October 2014 because only one full-time staff person remained on the team, and there was no time to hire and train a new part-time person prior to expiration of fieldwork.

Logistical challenges related to security increased labor costs for fieldwork because of the need to send two field staff to sampling units rated as a high security risk. Researchers allocated a total of $48,000 for on-site field labor for a twelve month period of data collection. Actual labor costs for on-site field labor for the eleven months of data collection and one month of project close-out were $61,517.12, not inclusive of contract overhead costs. This total also does not include the labor cost of two off-site project staff deployed throughout the project period to augment on-site labor, nor of volunteer labor contributed by on-site partners to serve as security escorts. Total project costs from FY12 – FY14 were $296,467.12, inclusive of one full-time and two part-time on-site contract staff, four off-site contract staff, travel/mileage, information technology and equipment, materials and supplies, two public meetings, overhead, etc. This figure excludes the cost of federal labor, which was contributed in-kind to the project.

7.4.3. Recommendations for Future Research

Despite the tremendous challenges associated with designing and implementing a roving survey design along the shoreline of St. Croix, researchers remain convinced that this is the most promising approach to surveying this subgroup of fishers for this geography. Study findings indicate that, while there are locations where fishing participation is higher, shore-based fishing does appear to occur across the island at varying levels. Therefore, if the goal of future data collections is to make estimates applicable to the entire island, then coverage of all fishable locations is required.

Of the two methodological designs for counts employed in this study, researchers recommend the approach used in Count 2 because comprehensive temporal coverage of sampling units was achieved. Additional improvements to the count protocol could be made by employing some form of remote sensing or access technology, as opposed to walking the shoreline, which would increase efficiency and reduce cost and logistical obstacles. This could be accomplished by conducting counts from the water using a boat or from the air using aircraft. Remote sensing approaches such as satellite imagery or drones could plausibly be employed as well. For surveying or counting, an on-water bus route approach might be tested for the collection of data. Generally, for land-based roving surveys, researchers would suggest a larger data collection team consisting of full-time field staff to ensure reliable and adequate coverage of sampling units, and greater flexibility in scheduling. A roving survey approach undoubtedly could be improved with additional investment into technology or field labor. However, given the findings of this study, the present researchers question the value of investing in such a collection, in terms of data to be gained, versus the cost of undertaking the collection.

Fishing participation estimates documented in this study indicate that shore-based non-commercial fishing on St. Croix is not a high participation activity. The number of fishers using the shoreline at any given time is relatively low compared with the other types of shore-based users. Our findings suggest that anecdotal information as well as previous studies may have overestimated the level of fishing activity. This possibility should be further tested using site-specific collections. Regardless, from the standpoint of investing in data collections that will yield the most useful data for understanding non-commercial fishing in the USVI, there may be other collections that prove a better value. For example, researchers may direct limited research funds to on-site surveys of boat-based non-commercial fishing or charter fishing, or opt to invest in household surveys. To better characterize and profile this fishing subgroup, a priority investment of limited research funds would be to conduct a household survey with a sample size adequate to parse out the shore-based fishers from other fisher subgroups (e.g., boat-based). Such a survey would be invaluable at providing a current, valid, and reliable estimate of the population of shore-based non-commercial fishers, which is presently lacking. Finally, such a survey could be used to collect information on subsistence reliance as well as the temporal and spatial patterns of fishing activity, in terms of fisher behavior, that could then be used to refine sampling designs and data collection protocols for roving or access point surveys.

Conclusions and Recommendations

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Appendices

APPENDIX A: Weighting of Sampling Units

Shoreline units having a high ranking for fishing pressure, a larger number of fishing access points, and a shorter distance to a population center (i.e., Christiansted or Frederiksted) were adjusted up to increase the probability of selection according to the following formulae:

- Fishing pressure rankings were assigned based on an estimated number of fishers expected per 15 hour fishing day for each of the five corresponding geographic study areas defined by Mateo et al. (2000, p. 13); Fishing Pressure Ranking: 5 = 20+ fishers; 4 = 15 to 19; 3 = 11 to 14; 2 = 5 to 10; 1= 0 to 4
- Access Point Ranking: 5 = 4+ access pts; 4 = 3 access pts; 3 = 2 access pts; 2 = 1 access pts; 1 = 0 access pts
- Calculated as Euclidean distance from the centroid of each urban area polygon (Christiansted and Frederiksted) to the linear midpoint of each shoreline unit.
- Proximity to Population Ranking: 5= 0 to 1.99 mi; 4 =2.0 to 3.99 mi; 3 = 4.0 to 5.99 mi; 2 = 6.0 to 7.99 mi; 1 = 8.0 + mi

Maximum canopy height - for each soft biota type (e.g., gorgonians, sponges-except encrusting form, algae) the maximum height is recorded to the nearest 1 cm.

Abundance and maturity of queen conchs (*Strombus gigas*) - conch encountered within the 25 x 4 m belt transect are enumerated. The maturity of each conch is determined by the presence or absence of a flared lip and labeled mature or immature respectively.

Abundance of spiny lobsters (*Panulirus argus*) - a count of the total number of lobsters encountered within the 25 x 4 m belt transect.

Abundance of long-spined urchin (*Diadema antillarum*) - a count of the total number of urchins encountered within the 25 x 4 m belt transect.

Photos – Two photos are taken in opposite directions at each transects starting position to document the surrounding habitat. Additional photos may be taken to document disease, bleaching or other events of note.

Marine debris – type of marine debris within the 25 x 4 m belt transect is noted. The size of the marine debris and area of habitat that it is affecting is also recorded along with a note identifying any flora or fauna that has colonized it.

Appendices

APPENDIX B: Species Sampling Protocol

Finfish

The surveyor will begin by moving the fisher's fish to Sampling Bucket A from whatever the fisher used to contain his or her catch. As the surveyor transferred the fish from Sampling Bucket A back to the fisher's containment unit, he or she counted the number of fish for each species.

* 10 Count or Less for Any One Finfish Species: All of the fish of that species were measured for length and weight.

Data Recording Procedure: For fish of the same species, the surveyor recorded on the survey form the species name and species code once, and then recorded the total number of fish measured for length and weight. The disposition code was recorded for each fish or all of the fish, depending upon the response from the fisher.

* 11 to 20 Count for Any One Finfish Species: Recorded the length and weight for the first 10 fish returned to the fisher's containment unit.

Data Recording Procedure: For fish of the same species, the surveyor recorded on the survey form the species name and species code once, and then recorded the total number of fish for that species. The surveyor then recorded the length and weight for each fish measured per protocol. The disposition code used was for the majority of fish caught.

* 21 Count or Over for Any One Finfish Species: Divided the number of fish by 10 and round to the nearest whole number. For example, if a fisher had 38 white grunts, the equation was: 38 /10 = 3.8, rounded to 4, the nearest whole number. So, every 4th fish was measured for length and weight, meaning 9 fish were measured for length and weight.

Data Recording Procedure: For fish of the same species, the surveyor recorded the species name and species code once, and then recorded the total number of fish for that species. In other words, the number of fish recorded totaled the number of that species caught, not the total number of fish measured. The surveyor recorded the length and weight for each fish measured per protocol. The disposition code recorded was for the majority of fish caught.

Bait fish

For buckets of bait fish, the surveyor recorded the species name of any species identified in the fisher's containment unit. The surveyor determined the total weight of all bait fish by transferring the fisher's bait fish catch to Sampling Bucket A, weighing the bucket, and then subtracting the weight of Sampling Bucket A from the total weight. The difference of this calculation was recorded.

Mollusks

For mollusks (squid, shellfish, conch, octopus, snails), the surveyor recorded the species name and code, as well as the total number of each species inspected. Measurement of length and weight was not collected for mollusks.

Caribbean Spiny Lobster

The surveyor counted the total number of lobster. The surveyor followed Sub-Sampling Protocols (as described for finfish) for lobster as warranted. For lobster, the surveyor recorded data in all fields except weight.

Fish Measurement Procedure

Each fish was laid on the fish board, nose to the "zero" end of the board so that it is touching the end. The length was taken from the nose of the fish to the fork of the tail. For lobsters, measuring calipers were be used beginning at the forward edge between the eyeballs and proceeding along the middle to the rear edge of the carapace. Length was recorded to the nearest millimeter.

Fish Weighing Procedure

After the fish was measured, it was weighed using a handheld scale. The dull hook at the end of the scale was hooked to the fish under the gills, and the scale and fish was suspended at eye level. Alternatively, the scale was calibrated to the weight of one of the sampling buckets, the fish placed in this bucket and the bucket then hooked to the end of the scale to determine the weight of the fish. Even if the fish were gutted by the fisher, the surveyor weighed the gutted fish and recorded the cleaned weight. Weight was recorded to the nearest 0.1 kg.

Lobsters and mollusks were not weighed. Bait fish were weighed according to the Bait fish Sampling Protocol, above.

Fish Species Identification

The surveyor was provided with a list of commonly caught species, as well as a list of codes for finfish and other species known to occur in the waters of the U.S. Virgin Islands. Hard to identify fish were photographed by field staff using a digital camera. Photographs were used by fish experts on the team to later identify the fish.

Appendices

APPENDIX C: Definitions of Shore-based Activities

Fishing/Harvest-- Fishing/harvest is defined as the act of catching or attempting to catch fish or other marine species. A person with their gear in the water or, alternatively, working with gear or catch on the shoreline, are considered to be fishing.

Walking—Any person walking along the shoreline, in any direction, is considered to be walking. The purpose of their walking is not relevant (e.g., fitness walking, nature walks, strolling for pleasure, etc.).

Observing/Watching—Any person along the shoreline who is standing or seated in one position watching or observing the shoreline. The object of their observation is not relevant; it may be other people, the horizon, clouds, wildlife, etc.

Sunbathing—Any person laying on the beach with the obvious purpose of getting sun or a suntan.

Swimming/Wading—Any person who is actively swimming in the water along the shoreline or walking/ standing in the shallow water (at least ankle deep) along the shoreline for no other purpose besides wading. For example, do not include persons who are wading into the water to cast a fishing line in the wading category. Do include a person who is standing in the water watching birds or looking at the horizon as wading for the purpose of this survey.

Soaking—Any person who is fully immersed in the water, but is not actively swimming. The person may be floating, bobbing, standing, etc. There person may be in shallow or deep water.

Snorkeling—Any person who is actively engaged in snorkeling in the water. Do not count persons who are sitting on the beach, but who have snorkel gear, for example. Persons entering or exiting the water with snorkel gear at the time of the count should be included as actively snorkeling.

SCUBA Diving—Any person who is entering or exiting the water with SCUBA gear at the time of the count should be included as engaged in SCUBA diving.

Camping—Any person who has set up a temporary housing structure (e.g., tent, camper trailer, etc.) along the shoreline for the purpose of staying multiple nights. Do not include picnickers in this category. Picnickers should be included under “Other beach recreational activity”.

Kayaking/Canoeing/Paddle Boarding—Any person actively engaged in the use of this equipment or craft in the water. Include persons who are entering or exiting the water with the equipment or craft at the time of the count. Do not include persons who have their equipment or craft sitting on the beach at the time of the count. Do count craft that is in the water with a person, but that is stationary or adrift.

Use of Personal Watercraft—Any person actively engaged in the use of a jet ski, wet bike, or any other form of personal watercraft in the water along the shoreline. Count any persons on watercraft that are in the water, even if they are stationary or adrift.

Table C.1. Other shore-based activities documented.

Activity	Count Component 1	Count Component 2
Arriving on a sail boat		1
At a restaurant		4
Bike riding	1	8
Cleaning fish		10
Cleaning trash along the shoreline	2	2
Construction	2	
Deploying marker buoys		2
Eating/cooking	2	6
Emptying the trash can		1
Filling up sand bags		1
Going over to/ arriving from Ruth Cay		2
Horseback riding	4	4
Jumping off the pier		29
Kite Boarding	1	
Loading cement bags into trailers		4
Loading merchandise on the ferry for the cay		1
Loading/launching boat to go fishing		10
Packing up to leave the beach		1
Picking up conch shells, artifacts	1	1
Picking fruit	1	
Playing baseball on the beach		1
Playing in the sand		1
Playing soccer	1	
Policing	1	
Preparing kayak to take out		1
Putting up sign by boardwalk		1
Repairing boat trailer		2
Returning boat from water or shore (returning from fishing)		6
Riding scooters		1
Running/Exercising	3	5
Sex	1	2
Skateboarding/Skating	1	1
Surfing	1	1
Swimming dogs		1
Turtle watch program	1	
Waiting for boat trip	1	1
Washing car		1
Total	**24**	**112**

Appendices

APPENDIX D: Imputation Methods for Incomplete Passes, Count Component 2

VEHICLE DESCRIPTION

Approach 1: For incomplete passes having GPS waypoints, a spatial approach was used. Researchers determined the proportion of the shoreline unit for each partially completed count pass. The incomplete count value was divided by the proportion of shoreline unit area completed to impute a total count value for the pass as:

Equation 2: Imputation for Incomplete Pass Approach 1

Imputed count value for incomplete count pass = Count value for incomplete pass / Proportion of shoreline unit completed during incomplete pass

In four cases, researchers were unable to use the spatial approach to impute a count total because GPS location data were not available.

Approach 2: For these incomplete count passes, a temporal approach was used. The average duration for a complete pass during the assignment was calculated. This value was assumed to be the time necessary to complete one count pass. To impute a count value for incomplete passes using the temporal approach, the average duration was then divided by the duration recorded for the incomplete count pass. Next the incomplete count recorded during the incomplete pass was used to impute the total count:

Equation 3: Imputation for Incomplete Pass Approach 2

Imputed count value for the incomplete count pass = (Average duration of all complete count passes for assignment / Duration of incomplete count pass) * Count value for incomplete pass

However, for one of these four incomplete count passes using the temporal approach, imputed estimates for the count pass were deemed unreasonably high compared to the average number of shore users counted per activity category across complete passes.

Approach 3: For this particular shoreline unit, it took field staff only an average of 20 minutes to complete one count pass and the incomplete count pass lasted only 5 minutes. The average number of shore users per activity category was generally lower than the imputed number. For example, for the soaking activity category, the average number of users counted across all complete passes was 6.8 while the imputed number of users was 27.20. In consultation with a statistical advisor, it was decided that the temporal approach to imputation was overestimating for this unit. Thus, the average number of users counted across all complete passes for each activity category was used as the imputed value for this assignment:

Equation 4: Imputation for Incomplete Pass Approach 3

Imputed count value for the incomplete pass = (∑ Complete pass totals) / Number of complete passes

APPENDIX E: Count Component 1: Tables by Shoreline Unit

Table E.1. Count 1 Fishers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Fishers per Hour	SE Mean Fishers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Fishers Per 100 Shore Users
1	3	0.00	0.00	0.00	0.00	-	-	-
2	5	0.00	0.00	0.82	0.73	0.00	0.00	0
3	1	0.00	0.00	0.00	0.00	-	-	-
5	6	0.32	0.30	0.79	0.47	0.41	0.34	41
6	1	0.00	0.00	11.43	0.00	0.00	0.00	0
7	6	0.23	0.21	7.82	6.43	0.03	0.04	3
9	5	5.04	1.29	49.91	9.62	0.10	0.04	10
10	13	1.34	0.75	55.91	13.99	0.02	0.02	2
11	1	0.00	0.00	15.00	0.00	0.00	0.00	0
12	10	0.48	0.32	3.32	1.18	0.14	0.10	14
13	1	0.00	0.00	31.50	0.00	0.00	0.00	0
14	9	0.42	0.26	4.93	2.40	0.09	0.07	9
15	2	0.00	0.00	0.00	0.00	-	-	-
18	7	0.25	0.23	49.80	11.36	0.00	0.00	0
19	4	0.00	0.00	0.00	0.00	-	-	-
21	5	0.00	0.00	0.55	0.36	0.00	0.00	0
25	7	3.14	1.09	90.89	26.01	0.03	0.01	3
26	3	0.00	0.00	22.91	2.93	0.00	0.00	0
27	2	0.47	0.33	18.41	10.17	0.03	0.00	3
28	3	0.00	0.00	5.45	3.37	0.00	0.00	0
29	1	0.00	0.00	0.00	0.00	-	-	-
30	3	0.00	0.00	0.00	0.00	-	-	-
31	1	0.00	0.00	1.71	0.00	0.00	0.00	0
33	9	0.00	0.00	4.38	3.31	0.00	0.00	0
34	3	0.00	0.00	0.67	0.54	0.00	0.00	0
36	6	0.73	0.42	6.23	2.05	0.12	0.04	12
37	3	0.00	0.00	1.38	0.71	0.00	0.00	0
38	6	1.92	1.12	3.35	1.30	0.57	0.19	57

Appendices

Table E.2. Count 1 Mean shore users per hour for all shore uses by shoreline unit.

Shoreline Unit ID	N	Distance to Nearest Population Center (mi)	Mean Shore Users per Hour	SE Mean Shore Users per Hour
1	3	6.26	0.00	0.00
2	5	4.83	0.82	0.73
3	1	3.77	0.00	0.00
5	6	2.06	0.79	0.47
6	1	2.03	11.43	0.00
7	6	2.75	7.82	6.43
9	5	0.24	49.91	9.62
10	13	0.48	55.91	13.99
11	1	1.41	15.00	0.00
12	10	2.37	3.32	1.18
13	1	3.15	31.50	0.00
14	9	3.76	4.93	2.40
15	2	4.21	0.00	0.00
18	7	6.40	49.80	11.36
19	4	6.46	0.00	0.00
21	5	3.99	0.55	0.36
25	7	0.28	90.89	26.01
26	3	1.45	22.91	2.93
27	2	2.83	18.41	10.17
28	3	4.02	5.45	3.37
29	1	5.45	0.00	0.00
30	3	6.96	0.00	0.00
31	1	7.07	1.71	0.00
33	9	5.25	4.38	3.31
34	3	4.54	0.67	0.54
36	6	2.86	6.23	2.05
37	3	3.31	1.38	0.71
38	6	5.27	3.35	1.30

Table E.3. Count 1 Observers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Observers per Hour	SE Mean Observers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Observers Per 100 Shore Users
1	3	0.00	0.00	0.00	0.00	-	-	-
2	5	0.82	0.73	0.82	0.73	1.00	0.00	100
3	1	0.00	0.00	0.00	0.00	-	-	-
5	6	0.00	0.00	0.79	0.47	0.00	0.00	0
6	1	0.00	0.00	11.43	0.00	0.00	0.00	0
7	6	1.97	1.84	7.82	6.43	0.25	0.03	25
9	5	21.01	4.24	49.91	9.62	0.42	0.07	42
10	13	17.49	5.07	55.91	13.99	0.31	0.04	31
11	1	10.00	0.00	15.00	0.00	0.67	0.00	67
12	10	1.05	0.59	3.32	1.18	0.32	0.14	32
13	1	22.50	0.00	31.50	0.00	0.71	0.00	71
14	9	1.38	1.30	4.93	2.40	0.28	0.20	28
15	2	0.00	0.00	0.00	0.00	-	-	-
18	7	13.18	5.40	49.80	11.36	0.26	0.07	26
19	4	0.00	0.00	0.00	0.00	-	-	-
21	5	0.00	0.00	0.55	0.36	0.00	0.00	0
25	7	39.78	13.33	90.89	26.01	0.44	0.05	44
26	3	5.45	0.46	22.91	2.93	0.24	0.03	24
27	2	3.96	1.18	18.41	10.17	0.21	0.05	21
28	3	2.35	1.98	5.45	3.37	0.43	0.12	43
29	1	0.00	0.00	0.00	0.00	-	-	-
30	3	0.00	0.00	0.00	0.00	-	-	-
31	1	0.00	0.00	1.71	0.00	0.00	0.00	0
33	9	0.87	0.83	4.38	3.31	0.20	0.23	20
34	3	0.00	0.00	0.67	0.54	0.00	0.00	0
36	6	0.72	0.33	6.23	2.05	0.12	0.06	12
37	3	0.38	0.31	1.38	0.71	0.28	0.28	28
38	6	0.00	0.00	3.35	1.30	0.00	0.00	0

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Table E.4. Count 1 Walkers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Walkers per Hour	SE Mean Walkers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Walkers Per 100 Shore Users
1	3	0.00	0.00	0.00	0.00	-	-	-
2	5	0.00	0.00	0.82	0.73	0.00	0.00	0
3	1	0.00	0.00	0.00	0.00	-	-	-
5	6	0.47	0.43	0.79	0.47	0.59	0.34	59
6	1	0.00	0.00	11.43	0.00	0.00	0.00	0
7	6	0.67	0.39	7.82	6.43	0.09	0.05	9
9	5	13.53	4.34	49.91	9.62	0.27	0.04	27
10	13	11.63	2.88	55.91	13.99	0.21	0.07	21
11	1	5.00	0.00	15.00	0.00	0.33	0.00	33
12	10	0.75	0.51	3.32	1.18	0.22	0.13	22
13	1	0.00	0.00	31.50	0.00	0.00	0.00	0
14	9	0.21	0.20	4.93	2.40	0.04	0.04	4
15	2	0.00	0.00	0.00	0.00	-	-	-
18	7	7.72	0.81	49.80	11.36	0.16	0.03	16
19	4	0.00	0.00	0.00	0.00	-	-	-
21	5	0.14	0.12	0.55	0.36	0.24	0.26	24
25	7	30.00	6.39	90.89	26.01	0.33	0.04	33
26	3	5.00	4.03	22.91	2.93	0.22	0.15	22
27	2	4.22	2.98	18.41	10.17	0.23	0.04	23
28	3	2.05	0.84	5.45	3.37	0.38	0.17	38
29	1	0.00	0.00	0.00	0.00	-	-	-
30	3	0.00	0.00	0.00	0.00	-	-	-
31	1	1.71	0.00	1.71	0.00	1.00	0.00	100
33	9	0.00	0.00	4.38	3.31	0.00	0.00	0
34	3	0.67	0.54	0.67	0.54	1.00	0.00	100
36	6	2.63	0.75	6.23	2.05	0.42	0.10	42
37	3	0.00	0.00	1.38	0.71	0.00	0.00	0
38	6	1.43	0.69	3.35	1.30	0.43	0.19	43

Table E.5. Count 1 Swimmers, waders, soakers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Swimmers per Hour	SE Mean Swimmers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Swimmers Per 100 Shore Users
1	3	0.00	0.00	0.00	0.00	-	-	-
2	5	0.00	0.00	0.82	0.73	0.00	0.00	0
3	1	0.00	0.00	0.00	0.00	-	-	-
5	6	0.00	0.00	0.79	0.47	0.00	0.00	0
6	1	0.00	0.00	11.43	0.00	0.00	0.00	0
7	6	2.19	2.04	7.82	6.43	0.28	0.04	28
9	5	0.67	0.38	49.91	9.62	0.01	0.01	1
10	13	8.36	3.34	55.91	13.99	0.15	0.04	15
11	1	0.00	0.00	15.00	0.00	0.00	0.00	0
12	10	0.17	0.16	3.32	1.18	0.05	0.05	5
13	1	6.00	0.00	31.50	0.00	0.19	0.00	19
14	9	0.00	0.00	4.93	2.40	0.00	0.00	0
15	2	0.00	0.00	0.00	0.00	-	-	-
18	7	5.46	1.39	49.80	11.36	0.11	0.03	11
19	4	0.00	0.00	0.00	0.00	-	-	-
21	5	0.42	0.37	0.55	0.36	0.76	0.26	76
25	7	2.40	1.38	90.89	26.01	0.03	0.01	3
26	3	12.45	1.75	22.91	2.93	0.54	0.13	54
27	2	5.73	3.24	18.41	10.17	0.31	0.00	31
28	3	0.00	0.00	5.45	3.37	0.00	0.00	0
29	1	0.00	0.00	0.00	0.00	-	-	-
30	3	0.00	0.00	0.00	0.00	-	-	-
31	1	0.00	0.00	1.71	0.00	0.00	0.00	0
33	9	0.00	0.00	4.38	3.31	0.00	0.00	0
34	3	0.00	0.00	0.67	0.54	0.00	0.00	0
36	6	1.50	0.85	6.23	2.05	0.24	0.09	24
37	3	0.00	0.00	1.38	0.71	0.00	0.00	0
38	6	0.00	0.00	3.35	1.30	0.00	0.00	0

Table E.6. Count 1 Campers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Campers per Hour	SE Mean Campers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Campers Per 100 Shore Users
1	3	0.00	0.00	0.00	0.00	-	-	-
2	5	0.00	0.00	0.82	0.73	0.00	0.00	0
3	1	0.00	0.00	0.00	0.00	-	-	-
5	6	0.00	0.00	0.79	0.47	0.00	0.00	0
6	1	0.00	0.00	11.43	0.00	0.00	0.00	0
7	6	0.00	0.00	7.82	6.43	0.00	0.00	0
9	5	0.00	0.00	49.91	9.62	0.00	0.00	0
10	13	0.00	0.00	55.91	13.99	0.00	0.00	0
11	1	0.00	0.00	15.00	0.00	0.00	0.00	0
12	10	0.00	0.00	3.32	1.18	0.00	0.00	0
13	1	0.00	0.00	31.50	0.00	0.00	0.00	0
14	9	0.00	0.00	4.93	2.40	0.00	0.00	0
15	2	0.00	0.00	0.00	0.00	-	-	-
18	7	5.30	4.41	49.80	11.36	0.10	0.08	10
19	4	0.00	0.00	0.00	0.00	-	-	-
21	5	0.00	0.00	0.55	0.36	0.00	0.00	0
25	7	4.47	4.21	90.89	26.00	0.05	0.04	5
26	3	0.00	0.00	22.91	2.93	0.00	0.00	0
27	2	0.00	0.00	18.41	10.17	0.00	0.00	0
28	3	0.00	0.00	5.45	3.37	0.00	0.00	0
29	1	0.00	0.00	0.00	0.00	-	-	-
30	3	0.00	0.00	0.00	0.00	-	-	-
31	1	0.00	0.00	1.71	0.00	0.00	0.00	0
33	9	2.34	2.23	4.38	3.31	0.53	0.16	53
34	3	0.00	0.00	0.67	0.54	0.00	0.00	0
36	6	0.00	0.00	6.23	2.05	0.00	0.00	0
37	3	0.00	0.00	1.38	0.71	0.00	0.00	0
38	6	0.00	0.00	3.35	1.30	0.00	0.00	0

Table E.7. Count 1 Snorkelers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Snorkelers per Hour	SE Mean Snorkelers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Snorkelers Per 100 Shore Users
1	3	0.00	0.00	0.00	0.00	-	-	-
2	5	0.00	0.00	0.82	0.73	0.00	0.00	0
3	1	0.00	0.00	0.00	0.00	-	-	-
5	6	0.00	0.00	0.79	0.47	0.00	0.00	0
6	1	0.00	0.00	11.43	0.00	0.00	0.00	0
7	6	0.34	0.21	7.82	6.43	0.04	0.04	4
9	5	6.37	2.51	49.91	9.62	0.13	0.04	13
10	13	1.78	0.68	55.91	13.99	0.03	0.02	3
11	1	0.00	0.00	15.00	0.00	0.00	0.00	0
12	10	0.50	0.48	3.32	1.18	0.15	0.12	15
13	1	1.50	0.00	31.50	0.00	0.05	0.00	5
14	9	0.00	0.00	4.93	2.40	0.00	0.00	0
15	2	0.00	0.00	0.00	0.00	-	-	-
18	7	4.05	1.95	49.80	11.36	0.08	0.03	8
19	4	0.00	0.00	0.00	0.00	-	-	-
21	5	0.00	0.00	0.55	0.36	0.00	0.00	0
25	7	0.30	0.28	90.89	26.00	0.00	0.00	<1
26	3	0.00	0.00	22.91	2.93	0.00	0.00	0
27	2	0.00	0.00	18.41	10.17	0.00	0.00	0
28	3	0.00	0.00	5.45	3.37	0.00	0.00	0
29	1	0.00	0.00	0.00	0.00	-	-	-
30	3	0.00	0.00	0.00	0.00	-	-	-
31	1	0.00	0.00	1.71	0.00	0.00	0.00	0
33	9	0.00	0.00	4.38	3.31	0.00	0.00	0
34	3	0.00	0.00	0.67	0.54	0.00	0.00	0
36	6	0.00	0.00	6.23	2.05	0.00	0.00	0
37	3	1.00	0.82	1.38	0.71	0.72	0.28	72
38	6	0.00	0.00	3.35	1.30	0.00	0.00	0

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Table E.8. Count 1 Spearman coefficients rho (ρ) *computed for pair-wise correlations between shore uses observed during Count 1 period at 24 shoreline units over a period of 86 days in 2014. Bold type indicates significant correlations (ρ ≥ 0.30, p ≤α_i). Levels of α_i were calculated using the sequential Bonferroni technique (α = 0.05 table-wise, Rice 1989).*

Activity	By Activity	Spearman's (ρ)	P	α_i
Water Craft	**Camping**	**0.71**	**0.0000**	**0.0004**
Observing	**Walking**	**0.61**	**0.0000**	**0.0004**
Soaking	**Observing**	**0.58**	**0.0000**	**0.0004**
Soaking	**Sunbathing**	**0.49**	**0.0000**	**0.0004**
Snorkeling	**Sunbathing**	**0.47**	**0.0000**	**0.0004**
Scuba	**Sunbathing**	**0.46**	**0.0000**	**0.0004**
Kayaking	**Swimming**	**0.45**	**0.0000**	**0.0004**
Swimming	**Sunbathing**	**0.43**	**0.0000**	**0.0004**
Snorkeling	**Observing**	**0.43**	**0.0000**	**0.0004**
Scuba	**Snorkeling**	**0.42**	**0.0000**	**0.0005**
Other - non-beach	**Camping**	**0.42**	**0.0000**	**0.0005**
Other - non-beach	**Observing**	**0.39**	**0.0000**	**0.0005**
Soaking	**Walking**	**0.39**	**0.0000**	**0.0005**
Kayaking	**Snorkeling**	**0.38**	**0.0000**	**0.0005**
Scuba	**Walking**	**0.35**	**0.0000**	**0.0005**
Kayaking	**Walking**	**0.35**	**0.0001**	**0.0005**
Swimming	**Walking**	**0.35**	**0.0001**	**0.0005**
Other - non-beach	**Walking**	**0.35**	**0.0001**	**0.0005**
Kayaking	**Sunbathing**	**0.35**	**0.0001**	**0.0005**
Snorkeling	**Walking**	**0.34**	**0.0001**	**0.0005**
Sunbathing	**Observing**	**0.33**	**0.0002**	**0.0005**
Kayaking	**Scuba**	**0.33**	**0.0002**	**0.0005**
Other - Beach recreation	**Observing**	**0.33**	**0.0002**	**0.0005**
Kayaking	**Harvest - Hand gathering**	**0.31**	**0.0003**	**0.0005**
Swimming	Harvest - Hand gathering	0.30	0.0007	0.0005
Scuba	Soaking	0.29	0.0009	0.0005
Scuba	Swimming	0.29	0.0009	0.0005
Snorkeling	Soaking	0.29	0.0010	0.0005
Walking	Harvest - Line fishing	0.29	0.0011	0.0005
Sunbathing	Walking	0.28	0.0016	0.0005
Other - non-beach	Harvest - Line fishing	0.27	0.0021	0.0006
Camping	Soaking	0.27	0.0024	0.0006
Kayaking	Observing	0.26	0.0036	0.0006
Water Craft	Scuba	0.25	0.0054	0.0006
Observing	Harvest - Line fishing	0.24	0.0064	0.0006
Other - non-beach	Soaking	0.24	0.0065	0.0006
Other - non-beach	Other - Beach recreation	0.24	0.0069	0.0006
Other - Beach recreation	Walking	0.24	0.0076	0.0006
Camping	Sunbathing	0.24	0.0076	0.0006
Swimming	Observing	0.23	0.0083	0.0006
Other - non-beach	Sunbathing	0.23	0.0100	0.0006
Other - Beach recreation	Soaking	0.22	0.0121	0.0006

Table E.8. continued.

Activity	By Activity	Spearman's (ρ)	P	α_i
Walking	Harvest - Cast netting	0.22	0.0136	0.0006
Soaking	Swimming	0.20	0.0260	0.0006
Snorkeling	Swimming	0.19	0.0313	0.0007
Snorkeling	Harvest - Hand gathering	0.19	0.0334	0.0007
Observing	Harvest - Cast netting	0.19	0.0338	0.0007
Other - non-beach	Water Craft	0.18	0.0395	0.0007
Other - non-beach	Swimming	0.18	0.0480	0.0007
Other - Beach recreation	Water Craft	0.17	0.0503	0.0007
Water Craft	Swimming	0.17	0.0505	0.0007
Sunbathing	Harvest - Line fishing	0.17	0.0584	0.0007
Camping	Walking	0.17	0.0620	0.0007
Water Craft	Sunbathing	0.16	0.0680	0.0007
Camping	Harvest - Cast netting	0.16	0.0708	0.0008
Other - non-beach	Scuba	0.16	0.0742	0.0008
Camping	Scuba	0.16	0.0797	0.0008
Soaking	Harvest - Line fishing	0.15	0.0918	0.0008
Observing	Harvest - Hand gathering	0.14	0.1113	0.0008
Scuba	Observing	0.14	0.1163	0.0008
Soaking	Harvest - Other netting	0.14	0.1250	0.0008
Snorkeling	Harvest - Line fishing	0.13	0.1392	0.0008
Kayaking	Soaking	0.13	0.1394	0.0009
Soaking	Harvest - Cast netting	0.13	0.1592	0.0009
Other - Beach recreation	Swimming	0.12	0.1897	0.0009
Water Craft	Soaking	0.11	0.2307	0.0009
Camping	Observing	0.11	0.2359	0.0009
Harvest - Cast netting	Harvest - Line fishing	0.10	0.2564	0.0009
Walking	Harvest - Other netting	0.10	0.2691	0.0010
Camping	Swimming	0.10	0.2705	0.0010
Other - Beach recreation	Camping	0.10	0.2817	0.0010
Other - Beach recreation	Snorkeling	0.09	0.2924	0.0010
Water Craft	Observing	-0.09	0.2997	0.0010
Sunbathing	Harvest - Cast netting	-0.09	0.3222	0.0011
Scuba	Harvest - Line fishing	0.09	0.3225	0.0011
Other - non-beach	Snorkeling	0.09	0.3276	0.0011
Swimming	Harvest - Cast netting	-0.07	0.4047	0.0011
Other - Beach recreation	Scuba	-0.07	0.4047	0.0012
Kayaking	Harvest - Cast netting	-0.07	0.4289	0.0012
Camping	Snorkeling	0.06	0.4794	0.0012
Walking	Harvest - Hand gathering	0.06	0.4808	0.0013
Scuba	Harvest - Cast netting	-0.06	0.5134	0.0013
Observing	Harvest - Other netting	0.06	0.5363	0.0013
Water Craft	Harvest - Line fishing	-0.05	0.5533	0.0014
Water Craft	Snorkeling	-0.05	0.5534	0.0014
Kayaking	Camping	-0.05	0.5549	0.0014

Table E.8. continued.

Activity	By Activity	Spearman's (ρ)	P	α_i
Camping	Harvest - Line fishing	0.05	0.5555	0.0015
Other - non-beach	Harvest - Cast netting	0.05	0.6064	0.0015
Soaking	Harvest - Hand gathering	-0.05	0.6151	0.0016
Harvest - Other netting	Harvest - Line fishing	-0.04	0.6764	0.0016
Harvest - Hand gathering	Harvest - Line fishing	-0.04	0.6764	0.0017
Snorkeling	Harvest - Other netting	-0.04	0.6765	0.0017
Water Craft	Kayaking	-0.04	0.6788	0.0018
Kayaking	Harvest - Line fishing	0.04	0.6859	0.0019
Other - Beach recreation	Harvest - Cast netting	0.03	0.7023	0.0019
Sunbathing	Harvest - Other netting	-0.03	0.7154	0.0020
Sunbathing	Harvest - Hand gathering	-0.03	0.7154	0.0021
Water Craft	Harvest - Cast netting	-0.03	0.7322	0.0022
Other - non-beach	Harvest - Other netting	-0.03	0.7364	0.0023
Other - non-beach	Harvest - Hand gathering	-0.03	0.7364	0.0024
Other - Beach recreation	Kayaking	0.03	0.7437	0.0025
Water Craft	Walking	0.03	0.7438	0.0026
Swimming	Harvest - Other netting	-0.03	0.7588	0.0028
Other - Beach recreation	Harvest - Other netting	-0.03	0.7588	0.0029
Other - Beach recreation	Harvest - Hand gathering	-0.03	0.7588	0.0031
Kayaking	Harvest - Other netting	-0.03	0.7706	0.0033
Other - Beach recreation	Harvest - Line fishing	0.03	0.7726	0.0036
Other - Beach recreation	Sunbathing	-0.02	0.7827	0.0038
Harvest - Other netting	Harvest - Cast netting	-0.02	0.8096	0.0042
Harvest - Hand gathering	Harvest - Cast netting	-0.02	0.8096	0.0045
Scuba	Harvest - Other netting	-0.02	0.8096	0.0050
Scuba	Harvest - Hand gathering	-0.02	0.8096	0.0056
Camping	Harvest - Other netting	-0.02	0.8572	0.0063
Camping	Harvest - Hand gathering	-0.02	0.8572	0.0071
Water Craft	Harvest - Other netting	-0.01	0.8995	0.0083
Water Craft	Harvest - Hand gathering	-0.01	0.8995	0.0100
Swimming	Harvest - Line fishing	0.01	0.9057	0.0125
Harvest - Hand gathering	Harvest - Other netting	-0.01	0.9292	0.0167
Other - non-beach	Kayaking	0.00	0.9856	0.0250
Snorkeling	Harvest - Cast netting	0.00	0.9864	0.0500

APPENDIX F: Count Component 2: Tables by Shoreline Unit

Table F.1. Count 2 Fishers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Fishers per Hour	SE Mean Fishers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Fishers Per 100 Shore Users
1	1	0.00	0.00	0	0.00	·	·	·
2	2	0.94	0.70	2	0.53	0.43	0.22	43
7	6	1.15	0.61	3	1.57	0.40	0.02	40
8	1	1.67	0.00	47	0.00	0.04	0.00	4
9	15	7.84	1.64	31	4.98	0.25	0.03	25
10	3	0.00	0.00	10	1.51	0.00	0.00	0
11	2	0.00	0.00	139	94.31	0.00	0.00	0
12	5	0.87	0.34	3	0.72	0.33	0.07	33
14	4	0.17	0.15	0	0.15	0.57	0.35	57
16	2	0.00	0.00	4	2.65	0.00	0.00	0
17	2	0.00	0.00	4	1.16	0.00	0.00	0
20	1	0.33	0.00	27	0.00	0.01	0.00	1
21	1	0.00	0.00	0	0.00	·	·	·
22	3	0.00	0.00	6	2.60	0.00	0.00	0
23	1	0.00	0.00	2	0.00	0.00	0.00	0
25	6	3.42	0.52	70	14.19	0.05	0.01	5
27	3	1.00	0.82	14	3.20	0.07	0.07	7
28	3	2.42	0.34	11	2.27	0.21	0.07	21
31	4	1.15	0.52	2	0.42	0.60	0.17	60
33	2	0.00	0.00	0	0.00	·	·	·
34	2	0.67	0.48	4	2.99	0.16	0.00	16
35	1	0.00	0.00	0	0.00	·	·	·
36	6	0.34	0.20	5	0.96	0.06	0.03	6
38	10	1.17	0.62	4	1.49	0.27	0.07	27

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Table F.2. Count 2 Mean shore users per hour for all shore uses by shoreline unit.

Shoreline Unit ID	N	Distance to Nearest Population Center (mi)	Mean Shore Users per Hour	SE Mean Shore Users per Hour
1	1	6.26	0.00	0.00
2	2	4.83	2.21	0.53
7	6	2.75	2.89	1.57
8	1	1.55	47.00	0.00
9	15	0.24	31.04	4.98
10	3	0.48	10.43	1.51
11	2	1.41	138.89	94.31
12	5	2.37	2.63	0.72
14	4	3.76	0.29	0.15
16	2	4.20	4.25	2.65
17	2	4.75	3.85	1.16
20	1	4.91	27.00	0.00
21	1	3.99	0.00	0.00
22	3	4.08	5.68	2.60
23	1	3.24	2.00	0.00
25	6	0.28	69.56	14.19
27	3	2.83	13.98	3.20
28	3	4.02	11.31	2.27
31	4	7.07	1.90	0.42
33	2	5.25	0.00	0.00
34	2	4.54	4.17	2.99
35	1	3.02	0.00	0.00
36	6	2.86	5.36	0.96
38	10	5.27	4.37	1.49

Table F.3. Count 2 Observers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Observers per Hour	SE Mean Observers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Observers Per 100 Shore Users
1	1	0.00	0.00	0.00	0.00	.	.	.
2	2	1.00	0.00	2.21	0.53	0.45	0.11	45
7	6	0.11	0.10	2.89	1.57	0.04	0.03	4
8	1	25.33	0.00	47.00	0.00	0.54	0.00	54
9	15	7.00	2.45	31.04	4.98	0.23	0.06	23
10	3	5.99	2.19	10.43	1.51	0.57	0.15	57
11	2	26.26	39.28	138.89	94.31	0.28	0.00	28
12	5	0.30	0.16	2.63	0.72	0.11	0.05	11
14	4	0.13	0.11	0.29	0.15	0.43	0.35	43
16	2	0.20	0.14	4.25	2.65	0.05	0.00	5
17	2	0.75	0.53	3.85	1.16	0.19	0.08	19
20	1	7.33	0.00	27.00	0.00	0.27	0.00	27
21	1	0.00	0.00	0.00	0.00	.	.	.
22	3	0.67	0.54	5.68	2.60	0.12	0.13	12
23	1	0.00	0.00	2.00	0.00	0.00	0.00	0
25	6	26.26	3.66	69.56	14.19	0.38	0.08	38
27	3	4.95	0.44	13.98	3.20	0.35	0.07	35
28	3	3.68	0.65	11.31	2.27	0.33	0.08	33
31	4	0.50	0.15	1.90	0.42	0.26	0.13	26
33	2	0.00	0.00	0.00	0.00	.	.	.
34	2	0.00	0.00	4.17	2.99	0.00	0.00	0
35	1	0.00	0.00	0.00	0.00	.	.	.
36	6	1.26	0.57	5.36	0.96	0.23	0.08	23
38	10	1.37	0.60	4.37	1.49	0.31	0.06	31

Table F.4. Count 2 Swimmers, waders, and soakers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Swimmers per Hour	SE Mean Swimmers per Hour	Mean Shore Users per Hour	SE Mean Shore Users Per Hour	Ratio	SE Ratio	Number of Swimmers Per 100 Shore Users
1	1	0.00	0.00	0.00	0.00	.	.	.
2	2	0.00	0.00	2.21	0.53	0.00	0.00	0
7	6	0.72	0.50	2.89	1.57	0.25	0.08	25
8	1	6.67	0.00	47.00	0.00	0.14	0.00	14
9	15	1.44	0.55	31.04	4.98	0.05	0.02	5
10	3	0.80	0.25	10.43	1.51	0.08	0.03	8
11	2	60.63	41.59	138.89	94.31	0.44	0.00	44
12	5	0.87	0.44	2.63	0.72	0.33	0.13	33
14	4	0.00	0.00	0.29	0.15	0.00	0.00	0
16	2	3.40	2.40	4.25	2.65	0.80	0.07	80
17	2	0.25	0.18	3.85	1.16	0.06	0.03	6
20	1	16.00	0.00	27.00	0.00	0.59	0.00	59
21	1	0.00	0.00	0.00	0.00	.	.	.
22	3	0.00	0.00	5.68	2.60	0.00	0.00	0
23	1	0.00	0.00	2.00	0.00	0.00	0.00	0
25	6	4.63	1.88	69.56	14.19	0.07	0.02	7
27	3	5.06	2.10	13.98	3.20	0.36	0.09	36
28	3	1.62	0.67	11.31	2.27	0.14	0.04	14
31	4	0.00	0.00	1.90	0.42	0.00	0.00	0
33	2	0.00	0.00	0.00	0.00	.	.	.
34	2	0.00	0.00	4.17	2.99	0.00	0.00	0
35	1	0.00	0.00	0.00	0.00	.	.	.
36	6	1.61	0.69	5.36	0.96	0.30	0.12	30
38	10	0.00	0.00	4.37	1.49	0.00	0.00	0

Table F.5. Count 2 Walkers per Hour by shoreline unit.

Shoreline Unit ID	N	Mean Walkers per Hour	SE Mean Walkers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Walkers Per 100 Shore Users
1	1	0.00	0.00	0.00	0.00	.	.	.
2	2	0.00	0.00	2.21	0.53	0.00	0.00	0
7	6	0.90	0.56	2.89	1.57	0.31	0.12	31
8	1	1.67	0.00	47.00	0.00	0.04	0.00	4
9	15	7.84	1.09	31.04	4.98	0.25	0.03	25
10	3	2.37	0.99	10.43	1.51	0.23	0.10	23
11	2	5.65	3.88	138.89	94.31	0.04	0.00	4
12	5	0.25	0.17	2.63	0.72	0.09	0.06	9
14	4	0.00	0.00	0.29	0.15	0.00	0.00	0
16	2	0.65	0.11	4.25	2.65	0.15	0.07	15
17	2	1.10	0.78	3.85	1.16	0.29	0.29	29
20	1	0.33	0.00	27.00	0.00	0.01	0.00	1
21	1	0.00	0.00	0.00	0.00	.	.	.
22	3	0.00	0.00	5.68	2.60	0.00	0.00	0
23	1	0.00	0.00	2.00	0.00	0.00	0.00	0
25	6	12.97	1.86	69.56	14.19	0.19	0.02	19
27	3	0.22	0.18	13.98	3.20	0.02	0.01	2
28	3	0.91	0.10	11.31	2.27	0.08	0.01	8
31	4	0.00	0.00	1.90	0.42	0.00	0.00	0
33	2	0.00	0.00	0.00	0.00	.	.	.
34	2	0.00	0.00	4.17	2.99	0.00	0.00	0
35	1	0.00	0.00	0.00	0.00	.	.	.
36	6	1.55	0.44	5.36	0.96	0.29	0.09	29
38	10	4.37	1.49	4.37	1.49	0.00	0.00	0

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Table F.6. Count 2 Sunbathers per hour by shoreline unit.

Shoreline Unit ID	N	Mean Sunbathers per Hour	SE Mean Sunbathers per Hour	Mean Shore Users per Hour	SE Mean Shore Users per Hour	Ratio	SE Ratio	Number of Sunbathers Per 100 Shore Users
1	1	0.00	0.00	0.00	0.00	.	.	.
2	2	0.00	0.00	2.21	0.53	0.00	0.00	0
7	6	0.00	0.00	2.89	1.57	0.00	0.00	0
8	1	0.00	0.00	47.00	0.00	0.00	0.00	0
9	15	0.00	0.00	31.04	4.98	0.00	0.00	0
10	3	0.44	0.19	10.43	1.51	0.04	0.02	4
11	2	30.57	20.97	138.89	94.31	0.22	0.00	22
12	5	0.00	0.00	2.63	0.72	0.00	0.00	0
14	4	0.00	0.00	0.29	0.15	0.00	0.00	0
16	2	0.00	0.00	4.25	2.65	0.00	0.00	0
17	2	1.75	1.23	3.85	1.16	0.45	0.18	45
20	1	2.33	0.00	27.00	0.00	0.09	0.00	9
21	1	0.00	0.00	0.00	0.00	.	.	.
22	3	0.00	0.00	5.68	2.60	0.00	0.00	0
23	1	0.00	0.00	2.00	0.00	0.00	0.00	0
25	6	0.00	0.00	69.56	14.19	0.00	0.00	0
27	3	0.50	0.24	13.98	3.20	0.04	0.02	4
28	3	0.35	0.29	11.31	2.27	0.03	0.03	3
31	4	0.00	0.00	1.90	0.42	0.00	0.00	0
33	2	0.00	0.00	0.00	0.00	0.00	0.00	0
34	2	0.00	0.00	4.17	2.99	0.00	0.00	0
35	1	0.00	0.00	0.00	0.00	0.00	0.00	0
36	6	0.31	0.20	5.36	0.96	0.06	0.04	6
38	10	0.00	0.00	4.37	1.49	0.00	0.00	0

Table F.7. Count 2 Spearman coefficients rho (ρ) computed for pair-wise correlations between shore uses observed during Count 2 period at 24 shoreline units over a period of 86 days in 2014. Bold type indicates significant correlations ($\rho \geq 0.30$, $p \leq \alpha_i$). Levels of α_i were calculated using the sequential Bonferroni technique ($\alpha = 0.05$ table-wise, Rice 1989).

Activity	By Activity	Rho (ρ)	P	α_i
Observing	**Walking**	**0.66**	**0.0000**	**0.0008**
Walking	**Harvest - Line fishing**	**0.53**	**0.0000**	**0.0008**
Observing	**Harvest - Line fishing**	**0.52**	**0.0000**	**0.0009**
Scuba	**Harvest - Hand gathering**	**0.50**	**0.0000**	**0.0009**
Soaking	**Walking**	**0.48**	**0.0000**	**0.0009**
Other - Unidentified activity	**Harvest - Other netting**	**0.48**	**0.0000**	**0.0009**
Water Craft	**Camping**	**0.46**	**0.0000**	**0.0009**
Soaking	**Observing**	**0.44**	**0.0000**	**0.0009**
Other - Beach recreation	**Scuba**	**0.43**	**0.0000**	**0.0010**
Kayaking	**Snorkeling**	**0.42**	**0.0000**	**0.0010**
Other - Unidentified activity	**Harvest - Cast netting**	**0.42**	**0.0001**	**0.0010**
Soaking	**Sunbathing**	**0.41**	**0.0001**	**0.0010**
Scuba	**Snorkeling**	**0.41**	**0.0001**	**0.0010**
Swimming	**Observing**	**0.41**	**0.0001**	**0.0011**
Snorkeling	**Observing**	**0.41**	**0.0001**	**0.0011**
Swimming	**Walking**	**0.40**	**0.0001**	**0.0011**
Snorkeling	**Harvest - Hand gathering**	**0.40**	**0.0001**	**0.0011**
Water Craft	**Snorkeling**	**0.37**	**0.0005**	**0.0012**
Other - non-beach	**Other - Beach recreation**	**0.37**	**0.0005**	**0.0012**
Scuba	**Harvest - Line fishing**	**0.36**	**0.0007**	**0.0012**
Walking	**Harvest - Cast netting**	**0.36**	**0.0007**	**0.0013**
Observing	**Harvest - Cast netting**	**0.35**	**0.0011**	**0.0013**
Scuba	**Walking**	**0.34**	**0.0013**	**0.0013**
Other - Beach recreation	**Observing**	**0.34**	**0.0014**	**0.0014**
Harvest - Spear fishing	Harvest - Hand gathering	0.34	0.0015	0.0014
Sunbathing	Harvest - Line fishing	0.33	0.0016	0.0014
Snorkeling	Walking	0.33	0.0019	0.0015
Other - Beach recreation	Walking	0.32	0.0022	0.0015
Other - non-beach	Observing	0.31	0.0025	0.0016
Snorkeling	Sunbathing	0.31	0.0035	0.0016
Other - Beach recreation	Harvest - Line fishing	0.31	0.0037	0.0017
Snorkeling	Swimming	0.30	0.0040	0.0017
Other - Beach recreation	Harvest - Spear fishing	0.30	0.0047	0.0018
Snorkeling	Soaking	0.30	0.0050	0.0019
Other - non-beach	Walking	0.29	0.0055	0.0019
Water Craft	Scuba	0.29	0.0063	0.0020
Water Craft	Harvest - Hand gathering	0.28	0.0073	0.0021
Other - Unidentified activity	Walking	0.26	0.0096	0.0022
Harvest - Cast netting	Harvest - Line fishing	0.26	0.0138	0.0023

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Table F.7. continued.

Activity	By Activity	Rho (ρ)	P	α_i
Camping	Harvest - Cast netting	0.26	0.0142	0.0024
Other - Beach recreation	Harvest - Hand gathering	0.26	0.0151	0.0025
Water Craft	Soaking	0.26	0.0162	0.0026
Other - Beach recreation	Water Craft	0.26	0.0164	0.0028
Swimming	Harvest - Spear fishing	0.25	0.0170	0.0029
Scuba	Observing	0.24	0.0213	0.0031
Other - non-beach	Harvest - Cast netting	0.24	0.0235	0.0033
Soaking	Harvest - Spear fishing	0.24	0.0236	0.0036
Other - Unidentified activity	Observing	0.24	0.0256	0.0038
Snorkeling	Harvest - Spear fishing	0.23	0.0291	0.0042
Water Craft	Walking	0.23	0.0297	0.0045
Observing	Harvest - Spear fishing	0.23	0.0326	0.0050
Other - non-beach	Camping	0.23	0.0354	0.0056
Sunbathing	Observing	0.23	0.0356	0.0063
Other - non-beach	Kayaking	0.22	0.0371	0.0071
Other - Beach recreation	Harvest - Other netting	0.22	0.0393	0.0083
Kayaking	Harvest - Hand gathering	0.22	0.0394	0.0100
Soaking	Harvest - Line fishing	0.22	0.0422	0.0125
Water Craft	Swimming	0.21	0.0425	0.0167
Kayaking	Soaking	0.21	0.0482	0.0250
Other - Unidentified activity	Snorkeling	-0.34	0.0496	0.0500

APPENDIX G: Survey Instrument

St. Croix, U.S.V.I. Shore-based Non-commercial Fishing Survey OMB Control No. 0648-0671 Expiration Date: 06/30/2016

1. INTERVIEWER ID
2. ASSIGNMENT/SITE CODE
3. MM/DD/YYYY __ / __ / 2 0 1 _
4. INTERCEPT NO.
5. INTERVIEW TIME (use 2400 clock) — *Time this interview was completed*

6. SEX OF RESPONDENT
1 Male 2 Female 3 Not Known

7. FISHER IS FISHING FROM:
1 Pier
2 Dock
3 Jetty/Groin
4 Sandy/Rocky Beach
5 Rocky Point
6 Rocky Pavement
7 Other:______________

Good [*morning, afternoon, evening*]. **How are you? My name is** [*First name*], **and I'm talking to fishers today to learn how important fishing is to them and to collect information about their catch. Participation is voluntary and your individual answers will be treated as confidential in accordance with NOAA Administrative Order 216-100 and section 402(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1881, et seq.). At the end of the study, the information collected will be reported for the group as a whole. We can skip any questions that you do not want to answer. The survey will take 7 to 10 minutes. Could I ask you some questions about fishing?** [Agreed: *Great, thank you.*] [Refused: *Okay, thank you for your time. Have a good day.*]

8. **We are primarily interested in getting information about fishing that is for fun, sport, or for the personal use of fish. We don't want to collect information about fishing for commercial uses because this information is already gathered on commercial catch reports or trip ticket forms. Will you be reporting today's catch on a commercial catch report or trip ticket form?**

1 Yes → Terminate interview
2 No
8 Don't Know
Go on to Q9

9. **How long have you been fishing here today? That is, how many hours have you spent with your gear in the water?** [Surveyor: Probe to nearest half hour.]

Number of hours to nearest half hour
999 Refused

10. **How many additional hours do you expect to fish from this site today? That is, how many more hours will you have your gear in the water?** [Surveyor: Probe to nearest half hour.]

Number of hours to nearest half hour
999 Refused

11. **Have you fished at any other location today or do you plan to fish at another location today?**

1 Yes
2 No
9 Refused

12. **What type of gear did you primarily use today?**

1 Handline
2 Rod and Reel
3 Dip net, A-frame
4 Cast net
5 Spear
6 Snare
7 Hand
8 Other:__________
98 Don't Know
99 Refused

13. **Were you fishing for any particular kinds of fish today? If yes, what kinds?**

1st Target
Common Name
Species Name
Species Code

2nd Target
Common Name
Species Name
Species Code

111111 Anything/No particular species
99999 Refused

14. **Did you catch any fish while you were fishing that I might be able to look at?**

1 Yes → Go to Q15
2 No
3 Yes, but fish are reported on another fisher's form.
→ Record intercept number from survey where catch is recorded. Go to Q19

15. **Did you catch these fish yourself or did someone else catch some of them?**

1 All caught by fisher → Go to Q18
2 Other contributors → Go to Q16

16. **Can you separate out your individual catch?**

1 Yes → Go on to Q18 and record only this fisher's fish. Interview other fishers separately.
2 No
9 Refused
→ Go to Q17. For Q18 record all fish together.

17. **How many fishers, including yourself, have their catch here? Please do not include anyone who did not catch fish. Only count those fishers who have their catch here.**

Number of fishers
99 Refused

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18. AVAILABLE CATCH. May I look at your fish? What do you plan to do with the MAJORITY of the (species)?
[Surveyor: Do not read the list of responses for disposition of fish; simply record the respondent's answers.]

Disposition codes for Q18

1 Thrown back alive/plan to throw back alive
2 Eaten/plan to eat
3 Used for bait/plan to use for bait
4 Thrown back dead/plan to throw away
5 Some other purpose
6 Given away/plan to give away
8 Don't know/ Didn't ask
9 Refused

Notes/Comments:

Species Name	Species Code	# of Fish	Length (mm)	Weight (kg)	Disp.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

19. UNAVAILABLE CATCH. Did you land any fish that are not here for me to look at? For example, any that you may have thrown back or used for bait? Please tell me about only the fish that you caught yourself.
[Surveyor: Do not read the list of responses for disposition of fish; simply record the respondent's answers.]

Disposition codes for Q19

1 Thrown back alive/plan to throw back alive
2 Eaten/plan to eat
3 Used for bait/plan to use for bait
4 Thrown back dead/plan to throw away
5 Some other purpose
6 Given away/plan to give away
8 Don't know/ Didn't ask
9 Refused

Species Name	Species Code	# of Fish	Length (mm)	Disp.
1				
2				
3				
4				
5				
6				
7				

Notes/Comments:

Now that we've looked at your fish, could I ask you just a few more questions? Answers to these questions will help us to better understand how important recreational, personal use fishing is to fishers and their households on St. Croix. Information collected with these questions will only be reported for the whole fishing community. In other words, at the end of the study, the information will be grouped together for everyone that we survey. We will not share a person's individual responses with anyone.

20. What year were you born? ☐☐☐☐ Refused: code 9999

21. Do you live primarily in the U.S. Virgin Islands? That is, do you live in the U.S. Virgin Islands for 6 or more months out of each year?

1 ☐ Yes → Complete Q22
2 ☐ No → Go to Q23
9 ☐ Refused → Go to Q23

22. What is your island of residence?

1 ☐ St. Croix → 22a
2 ☐ St. Thomas
3 ☐ St. John
4 ☐ Water Island
9 ☐ Refused

22a. How many years have you lived on St. Croix? ☐☐☐ Refused: code 999

22b. Which estate do you live in on St. Croix?

Estate Name ☐

Estate Code ☐☐☐☐☐

Refused: code 99999

23. What is your zip code? ☐☐☐☐☐

22222 ☐ Foreign Country
99999 ☐ Refused

24. Where were you born?

1 ☐ St. Croix
2 ☐ St. John
3 ☐ St. Thomas
4 ☐ Puerto Rico
5 ☐ Anguilla
6 ☐ Antigua/Barbuda
7 ☐ Dominica
8 ☐ Dominican Repub.
9 ☐ St. Kitts-Nevis
10 ☐ St. Lucia
11 ☐ Trinidad/Tobago
12 ☐ Other Caribbean
13 ☐ Mainland U.S.A.
14 ☐ Another U.S. island
15 ☐ Other foreign country
98 ☐ Don't Know
99 ☐ Refused

Appendix G: Site information form.

[Surveyor, please copy interview identification information from page one of the survey.]

1. INTERVIEWER ID
2. SITE CODE
3. MM/DD/YYYY __ __ / __ __ / 2 0 1 _
4. INTERCEPT NO.

25. Have you been interviewed previously by one of our survey staff in the past *[# of months study has been underway]* **months?**

1 Yes → Terminate interview at this point.
2 No
8 Don't Know
9 Refused
→ Complete Q26-33

26. Are you satisfied with the number of access points available for shoreline fishing?

1 Yes
2 No
3 No opinion
9 Refused

27. What is your main reason for fishing?
[Surveyor: Please read the list of responses and check the response chosen by the respondent.]

1 For sport
2 For food
3 To be outdoors
4 To have fun or relax
5 To teach younger generations about fishing
6 To spend time with friends and family
7 Other:___________________________________
9 Refused

28. In a typical week, approximately what percentage of your household's food comes from personal-use fishing or gathering other food from the sea? [Surveyor: Do not read the list of responses; simply check the response category that reflects the respondent's answer.]

1 0% to 9%
2 10% to 24%
3 25% to 49%
4 50% to 74%
5 75% to 100%
8 Don't know

30. How many minors, meaning people under the age of 16, presently live in your household?

Number of persons in household
99 Refused

31. How many people in your household, including yourself, engaged in fishing for recreation or personal use of fish at least once in the past three months?

Number of persons in household
99 Refused

32. What is your current employment status?
[Surveyor: Do not read the list of responses; simply check the response that reflects the respondent's answer.]

1 Full-time employment
2 Part-time employment
3 Self-employed
4 Student
5 Retired
6 Unemployed
7 Other:___________________________________
9 Refused

33. Could you estimate for me your household's typical monthly income? That is, could you estimate the combined monthly income for everyone who works for pay in your household?
[Surveyor: Provide respondent with income category card and mark the response selected by the respondent.]

1 $0 to $999
2 $1000 to $1,999
3 $2,000 to $3,999
4 $4,000 to $5,999
5 $6,000 or more
8 Don't know
9 Refused

Appendices

APPENDIX H: Tables of Responses to Selected Survey Questions

Appendix G: Count form:

Table H.1. Survey respondents' place of birth.

Place of Birth	Frequency	Percent
St. Croix	29	59.18%
St. Lucia	4	8.16%
Mainland USA	4	8.16%
Puerto Rico	4	8.16%
St. Kitts/Nevis	3	6.12%
Dominica	1	2.04%
Antigua/Barbuda	1	2.04%
Dominican Republic	1	2.04%
Other Caribbean	2	4.08%
Total	49	100%

Table H.2. Survey respondents' monthly income.

Respondent Monthly Income	Frequency	Percent
$0-$999	28	68.29%
$1,000-$1,999	5	12.20%
$2,000-$3,999	5	12.20%
$4,000-$5,999	2	4.88%
$6,000 or more	1	2.44%
Total	41	100%

Table H.3. Survey respondents' employment status.

Employment Status	Frequency	Percent
Full time	12	25.00%
Part time	4	8.33%
Self-employed	4	8.33%
Student	0	0.00%
Retired	4	8.33%
Unemployed	24	50.00%
Total	48	100%

Table H.4. Fishing location by shoreline type.

Fishing Location	Frequency	Percent
Sandy or rocky beach	32	59.26%
Dock	8	14.81%
Pier	6	11.11%
Rocky point	5	9.26%
Other	3	5.56%
Total	54	100%

Table H.5. Survey respondents' fishing gear types.

Fishing Gear Type	Frequency	Percent
Handline	31	63.27%
Cast net	10	20.41%
Rod and Reel	6	12.24%
Dip net or A-frame	2	4.08%
Total	49	100%

Table H.6. Survey respondents' satisfaction with number of access points.

Are you satisfied with Amount of Access Points?	Frequency	Percent
Yes	30	62.50%
No	18	37.50%
Total	48	100%

Table H.7. Survey respondents' reason for fishing.

Reason for Fishing	Frequency	Percent
For sport	11	22.92%
For food	32	66.67%
To have fun and relax	5	10.42%
Total	48	100%

Table H.8. Percentage of household food coming from personal-use fishing.

What percentage of your household's food comes from personal-use fishing or gathering other food from the sea?	Frequency	Percent
0-9%	31	64.58%
10-24%	9	18.75%
25-49%	3	6.25%
50-74%	2	4.17%
75-100%	3	6.25%
Total	48	100%

U.S. Department of Commerce

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National Oceanic and Atmospheric Administration

Kathryn Sullivan, ***Acting Under Secretary for Oceans and Atmosphere***

National Ocean Service

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