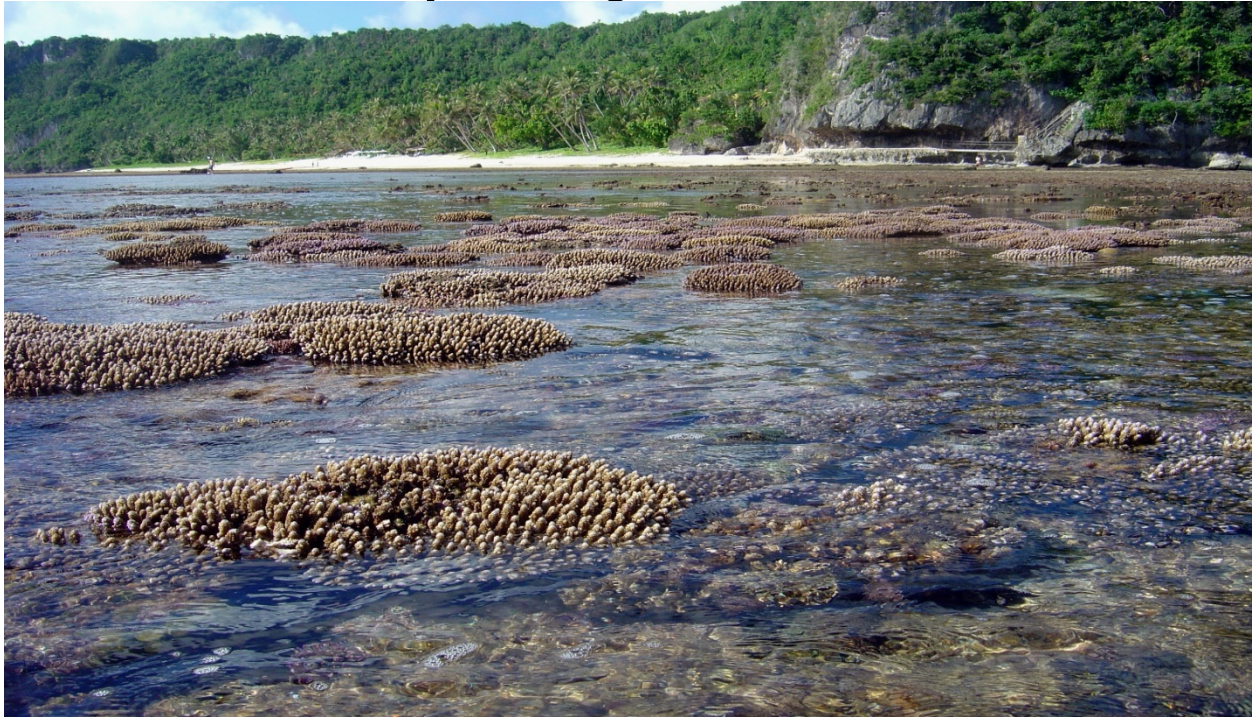**NOAA Technical Memorandum CRCP 32**

National Coral Reef Monitoring Program Socioeconomic Monitoring Component

Summary Findings for Guam, 2016

NOAA Coral Reef Conservation Program

Silver Spring, MD

September 2018

United States Department of Commerce	National Oceanic and Atmospheric Administration	National Ocean Service
Wilbur L. Ross Secretary	RDML Tim Gallaudet Assistant Secretary of Commerce for Oceans and Atmosphere and Acting Under Secretary of Commerce for Oceans and Atmosphere	Nicole LeBoeuf Acting Assistant Administrator

National Coral Reef Monitoring Program Socioeconomic Monitoring Component

Summary Findings for Guam, 2016

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National Oceanic and Atmospheric Administration

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About this document

The mission of the National Oceanic and Atmospheric Administration (NOAA) is to understand and predict changes in the Earth's environment and to conserve and manage coastal and oceanic marine resources and habitats to help meet our Nation's economic, social, and environmental needs. As a branch of NOAA, the National Ocean Service (NOS) conducts or sponsors research and monitoring programs to improve the scientific basis for conservation and management decisions. The NOS strives to make information about the purpose, methods, and results of its scientific studies widely available.

Coral Reef Conservation Program (CRCP) along with the National Centers for Coastal Ocean Science (NCCOS) uses the NOAA Technical Memorandum NOS series to achieve timely dissemination of scientific and technical information that is of high quality but inappropriate for publication in the formal peer-reviewed literature. The contents are of broad scope, including technical workshop proceedings, large data compilations, status reports and reviews, lengthy scientific or statistical monographs, and more. NOAA Technical Memoranda published by the CRCP, although informal, are subjected to extensive review and editing, and reflect sound professional work. Accordingly, they may be referenced in the formal scientific and technical literature.

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http://www.coris.noaa.gov/monitoring/socioeconomic.html

Acknowledgements

Executive Summary

The Socioeconomic Component of the National Coral Reef Monitoring Program (NCRMP) is currently in the process of monitoring socioeconomic indicators across all United States (US) coral reef territories and jurisdictions. These indicators fall under the following broader categories: the demographics of these areas, human use of coral reef resources, and knowledge, attitudes, and perceptions of coral reefs and coral reef management. The overall goal of this endeavor is to track relevant information regarding each jurisdiction's population, social and economic structure, society's interactions with coral reef resources, and the responses of local communities to coral management. From there, these baseline data are used to develop indicators that describe the state of each jurisdiction and provide researchers with the ability to compare jurisdictions to one another. The National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Conservation Program (CRCP) will use the information for future research, to assess the socioeconomic outcomes of management activities, and to improve the results of programs designed to protect coral reef resources.

This report outlines human dimensions information relevant to coral reef resources in Guam. The findings here are derived from a combination of data gathered through household surveys conducted from February to July of 2016, and additional secondary sources of socioeconomic information for the region.

With respect to human participation in recreational coral reef-related activities, the surveys demonstrated that Guam residents participate in swimming and beach recreation most frequently. Additionally, 30% of residents indicated that they participate in fishing or gathering of marine resources. Perceptions concerning marine resource condition differed in some aspects between respondents based on village of residence. If perceptions of coral reef health truly vary by location, this may correlate to differing resource quality in different regions, which could, in part, explain the lack of consensus across villages concerning the condition of marine resources. Surveys also revealed that Guam residents generally support a range of potential marine management policies and regulations, and are moderately familiar with the various threats facing coral reefs (such as typhoons, pollution, and coastal development).

Unlike other US coral reef jurisdictions, the population of Guam increased by 3% between 2000 and 2010. In addition to a growing population, the jurisdiction faces a number of other social challenges including a declining real median household income from 2000 to 2010 and increased dependence upon public assistance income in the territory.

Coral bleaching, diseases, pollution, and physical damage have contributed to the declining health of the reefs. This fact, coupled with the increased frequency of natural disturbances and pressures from coastal development (Puglise and Kelty, 2007), exemplifies the strong connection between communities and environment. Conversely, it is also important to note that island and coastal communities are positively connected to coral reef resources through continued

subsistence and cultural-based fishing, the tourism industry, commercial fishing, and a range of recreational activities enjoyed by residents.

There were key lessons learned from this first NCRMP socioeconomic data collection in Guam. This was the first iteration of the NCRMP socioeconomic survey that distinguished between pelagic fish/seafood consumption and reef fish/seafood consumption. However, a need still exists to distinguish between locally caught and imported fish. As similar surveys are implemented across other US coral reef jurisdictions, the NCRMP team will be making adjustments to the data collection effort to improve the information being generated. Thus, the findings contained within this report should be considered a starting point to the development of more detailed research questions for future work. Surveys are planned to be repeated in each US coral reef jurisdiction after the completion of a full monitoring cycle, approximately once every five to seven years.

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List of Acronyms

ACS	American Community Survey
BEA	Bureau of Economic Analysis
BEACON	Beach Advisory and Closing On-line Notification
BLS	Bureau of Labor Statistics
CATI	Computer Assisted Telephone Interviewing
C-CAP	Coastal Change Analysis Program
CRCP	Coral Reef Conservation Program
ENSO	El Niño-Southern Oscillation
EPA	Environmental Protection Agency
ESA	Endangered Species Act
GDP	Gross Domestic Product
GIS	Geographic Information System
HHS	Department of Health and Human Services
HIES	Hawaii International Environmental Services
MPA	Marine Protected Area
NCCOS	National Centers for Coastal Ocean Science
NCRMP	National Coral Reef Monitoring Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NWS	National Weather Service
OMB	Office of Management and Budget
OR&R	Office of Response and Restoration
PIFSC	Pacific Islands Fisheries Science Center
RDD	Random Digit Dialing
SCUBA	Self Contained Underwater Breathing Apparatus
UNEP	United Nations Environment Programme
US	United States
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WTP	Willingness to pay

Introduction

In 2007, the National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Conservation Program (CRCP) underwent an external review by an expert panel to provide an independent assessment of the CRCP's effectiveness in meeting its mandates, and to suggest recommendations for future improvement. Some major recommendations from the external review included increasing the CRCP's social science portfolio, strategically using social science to improve coral reef management by engaging local communities, and better assessing the social and economic consequences of management policies, interventions, and activities for local communities. In response, the *CRCP Social Science Strategy* (Loper *et al.*, 2010) recommended three priority activities:

1. Developing of a set of national-level social science indicators
2. Collecting these indicators via regular and repeated jurisdictional surveys
3. Increasing social science capacity within the coral reef conservation program

In 2010, the CRCP created the National Coral Reef Monitoring Program (NCRMP), which for the first time, included a socioeconomic monitoring component that would improve the Program's ability to track social science information in coral reef jurisdictions. The socioeconomic component of the NCRMP addresses the first two priorities. Because the socioeconomic component of NCRMP is situated within a larger social science program dedicated to a range of social science activities in United States (US) and international coral reef jurisdictions, the results of this monitoring have a wide range of applications.

The inclusion of socioeconomic indicators in the NCRMP represents a strong step forward for the CRCP, which has recognized the need to integrate socioeconomic information with biophysical indictors relevant to the conservation of coral reef resources. The main purpose of the Socioeconomic Component of the NCRMP is to answer the following questions: What is the status of human knowledge, attitudes, and perceptions regarding coral reefs? And, how are human uses of, interactions with, and dependence upon coral reefs changing over time? Integration of socioeconomic information will strengthen national coral reef monitoring and improve the Program's ability to explain how people interact with coral reef resources, as well as how coral reef ecosystems and coral reef management strategies are perceived by the public – issues of utmost interest to our partners, resource managers, and policy makers.

The NCRMP is an integrated long-term program designed to monitor the condition of coral reefs and coral reef ecosystems. The program now conducts sustained observations of biological, climatic, and socioeconomic indicators in US states and territories where coral reefs are present. More information about all components of the monitoring program can be explored in "NOAA Coral Reef Conservation Program: National Coral Reef Monitoring Plan" (NOAA CRCP 2014) available at:

ftp://ftp.library.noaa.gov/noaa_documents.lib/CoRIS/CRCP/noaa_crcp_national_coral_reef_monitoring_plan_2014.pdf.

Purpose of this Report

This technical memorandum presents the findings from the initial Guam NCRMP socioeconomic data collection. The report presents preliminary social indicators and provides examples of how indicators can be used to analyze changes over time in a long term setting. The main objective is to lay the groundwork for combining and comparing socioeconomic variables with a goal of developing meaningful indicators that can be used to examine trends in human dimensions of coral reef resources and better understand human influences on effective coral reef conservation. It should be noted that this report presents information that, in many instances, is being collected for the first time. In all instances, the information represents baseline socioeconomic data for the NCRMP. Some of the variables presented in this report identify gaps in information, and we provide suggestions on how these gaps can be addressed in the future.

Overall Approach of the Socioeconomic Component of NCRMP

The socioeconomic component of NCRMP gathers and monitors a collection of socioeconomic variables, including demographics in coral reef areas, human use of and their interactions (over time) with coral reef resources, as well as knowledge, attitudes, and perceptions of coral reefs and coral reef management. The overall goal is to track relevant information regarding each jurisdiction's population, social and economic structure, society's interactions with coral reef resources, and the responses of local communities to coral management actions. The CRCP will use the information in future research, to assess and monitor socioeconomic status and change over time, to assess the socioeconomic outcomes of management activities, and to improve programs designed to protect coral reefs within each jurisdiction. Ultimately, in consultation with stakeholders, partners, and other scientists, the information collected will inform the development of indicators. The development of composite indicators is a method that allows researchers to measure the complex two-way relationship between the environment and humans, and to track the various facets of this relationship over time by breaking down an intellectually complex and immeasurable concept into its various smaller and more measureable parts to improve communication and policy (Schirnding, 2002).

Each indicator will be created using primary data from resident surveys in US coral reef jurisdictions and from existing socioeconomic data collected from secondary sources such as the US Census Bureau and local government agencies. These indicators will include information about the population, the social and economic structure, the impacts of society on coral reefs, and the contributions of healthy corals to nearby residents. The indicators can also be used to track and assess the status of human knowledge, attitudes, and perceptions regarding coral reefs and

management activities related to coral reef resources. The indicators and the rationale for their selection are provided below in Table 1. The process of selecting and prioritizing these indicators can be explored further in the workshop report "Developing Social and Economic Indicators for Monitoring the US Coral Reef Jurisdictions" (Lovelace and Dillard, 2012) available at: https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/project/626_Loper/Social_and_Economic _Indicators_for_Monitoring_the_U.S._Coral_Reef_Jurisdictions_Workshop_Report_2012.pdf.

Indicator Development

The indicators identified in Table 1 will be developed at the conclusion of the first full monitoring cycle (end of 2018) by combining data from **primary** and **secondary** sources. The assessment of all US coral reef jurisdictions will draw upon indicators that may be composites of multiple distinct measures that address the same higher level concepts such as 'Attitudes towards coral reef management strategies.' For example, Dillard *et al.* (2013) established a methodology for creating composite indicators of well-being in coastal communities; and this work will be used as a guide for developing indicators for the well-being of populations living in US coral reef jurisdictions. Box 1 provides a description of the conceptual framework for developing the community well-being composite indicators, as an example of the way in which multiple measures can be used to assess a single composite indicator, such as Basic Needs or Economic Security, that ultimately capture aspects of a larger concept like well-being. It should be noted that the data presented in this report represent the current status of the collection, ultimately intended to contribute to the development of indicators. Once developed, these indicators will be used to assess all US coral reef jurisdictions at the conclusion of the first full monitoring cycle. Both the primary and secondary data presented in this report serve as a snapshot of the collection and analysis of the NCRMP socioeconomic monitoring component for Guam in 2016.

Primary Data

Primary data for the socioeconomic component of NCRMP are collected via a survey administered to individuals reporting on behalf of their households. The survey instrument is composed of one set of questions that remains the same for all US coral reef jurisdictions, as well as a sub-set of jurisdiction-specific questions relevant to local management needs. NCRMP socioeconomic data are collected using a variety of modes as appropriate to the context in each jurisdiction. For example, in Guam, a random digit dial (RDD) telephone survey method that utilized both landlines and cell phones was employed in addition to utilizing a face to face interview method. For all jurisdictions, the aim is a representative sample of the population that meets a 95% confidence level with a minimum of a +/-5% margin of error. The survey methodology generally follows Dillman's Tailored Design Method (Dillman *et al.,* 2009). It should be noted that the survey was developed by utilizing questions from a "bank" of over 120 questions. These questions were approved for use by the Office of Management and Budget (OMB), which is responsible for administering the Paper Work Reduction Act (1995), the main

purpose being to ensure that the public is not unduly burdened (in terms of time) and that confidentiality is assured. Surveys are planned to be repeated in each US coral reef jurisdiction after the completion of a full monitoring cycle, approximately once every five to seven years.

Secondary Data

Not only is the use of secondary data ideal for the development of a sustainable, cost effective, and long term socioeconomic monitoring plan, but secondary data is also well suited for the development of indicators used to track population and environmental trends over time. Secondary data collection involves compiling data that was gathered by other organizations from multiple sources and across US coral reef jurisdictional geographies into a centralized database. The use of data sources that are collected in a standardized way over time (such as US Census Bureau data) can help facilitate the integration of social, economic, and biophysical data collected under NCRMP because integration is aided by broad spatial and temporal coverage of social, economic, and biophysical data. Many of the secondary datasets that provide social and economic data have this quality and allow for more robust analyses with biophysical data.

Original sources for much of the secondary data presented in the report can be found in the secondary data sources table (Appendix 4). Secondary data items included in this report, but not listed in Appendix 4, are not considered part of the formal NCRMP secondary data collection because they are unique to the jurisdiction or are not available in a standardized format over time. These items may be included in the formal NCRMP secondary data collection at a later time if availability across geographies increases.

Box 1: Composite Indicator – Community Well Being

Well-being is a concept used to assess the status of people, either individually or collectively, at different scales (e.g., individual, community and national; Costanza *et al*. 2007). Well-being assessments can be used to determine how people are doing in relation to an optimum standard of life experience (Doyal and Gough 1991) and are generally used by decision-makers to inform policies and programs focused on improving the societal conditions. It provides a means of tracking the relationship between communities and the environment, and a better means of understanding the ecosystem as a whole. When the environment is providing ecosystem services that communities need and desire, well-being has positive gains. Conversely, if there is decline or disruption in ecosystem services, we may expect a decline in well-being, particularly with increased dependence on these services (Butler and Oluoch-Kosura 2006; Costanza *et al*. 1997; MEA 2005). Being able to predict the consequence to humans, both positive and negative, associated with changes in ecosystem states is critical to informed management.

Composite indicators that can ultimately be tracked alongside coral reef ecosystem condition will be employed. The composite indicators are shown in the figure below and each composite indicator is conceptually complex. At the conclusion of the first monitoring cycle, the coral reef jurisdictions like Guam will be scored on select indicators of well-being. These scores will be compared across US coral reef jurisdictions and will then be used in statistical analyses with indicators of environmental condition to analyze the dynamic relationship between the ecosystem services that people regularly enjoy and community well-being.

Figure 1: Framework of composite indicators for well-being and ecosystem condition, adapted from Dillard *et al*. 2013

Table 1: NCRMP Socioeconomic Indicators

	Indicators	Rationale
1	Participation in coral reef activities (including snorkeling, diving, fishing, harvesting)	Measuring participation in coral reef activities enhances understanding of the economic and recreational importance of coral reefs to local residents as well as the level of extractive and non-extractive pressures on reefs
2	Perceived resource condition	Assessment of perceived conditions is a complement to biophysical information and is key to evaluating differences in levels of support for various management strategies
3	Attitudes towards coral reef management strategies	Monitoring this information over time will be valuable to decision makers, as it will provide insight into possible changes in public perception concerning coral reef management strategies
4	Awareness and knowledge of coral reefs	Monitoring this information over time is key to tracking whether CRCP constituents understand threats to coral reefs and will help inform management strategies (and education/outreach efforts)
5	Human population trends (change) near coral reefs	Monitoring human population trends is important for understanding increasing pressure on coral reefs, as well as reef-adjacent populations
6	Economic impact of coral reef fishing to jurisdiction	Tracking the economic contributions of coral reefs can help justify funds allocated for coral reef protection
7	Economic impact of dive/snorkel tourism to jurisdiction	Tracking the economic contributions of coral reefs can help justify funds allocated for coral reef protection
8	Community well-being	Tracking changes in health, basic needs, and economic security enhances understanding of linkages between social conditions and coral reefs
9	Cultural importance of coral reefs	Measuring cultural importance improves understanding of traditional and cultural significance of coral reefs to jurisdictional residents, and whether this is changing over time
10	Participation in behaviors that may improve coral reef health (*e.g.*, beach cleanups, sustainable seafood choices)	Measuring participation improves understanding of positive impacts to coral reefs as well as negative impacts
11	Physical Infrastructure	Assessment of coastal development footprint, physical access to coastal resources, and waste management/water supply infrastructure provides general understanding of human impact on the coast
12	Knowledge of coral reef rules and regulations	Tracking this information over time at the jurisdictional/national level will inform investment in education and outreach
13	Governance	Measurement of governance provides information on the current status of local institutions involved in coral reef conservation, number of functioning management strategies, and percent area of coral reefs under protection

Geographic Scope

Overall, the NCRMP focuses on the CRCP's geographic priority areas; however, as some of those areas are uninhabited, the socioeconomic variables are being collected from only the inhabited areas. When feasible, indicators formulated at the sub-jurisdictional scale will be reported alongside biological indicators collected at the same scale. Efforts will be made to ensure sufficiently robust sample size to allow for reporting of socioeconomic indicators at appropriate sub-jurisdictional scales.

Table 2: Geographic scope of current NCRMP Socioeconomic Monitoring

Location	Sampling Units
American Samoa	Island of Tutuila
Florida	Martin, Palm Beach, Broward, Miami-Dade, and Monroe Counties
Hawai'i	Islands of Hawaii, Maui, Oahu, Kauai, Molokai, and Lanai
Puerto Rico	Islands of Puerto Rico, Vieques, and Culebra
Commonwealth of the Northern Mariana Islands	Islands of Saipan, Tinian and Rota
Guam	Entire island of Guam
US Virgin Islands	Islands of St. Croix, St. Thomas, and St. John

Jurisdiction Description

The island of Guam is an unincorporated, organized territory of the United States, and has been occupied by the US (outside of a brief period during World War II) since 1898. Located in the western Pacific Ocean, Guam is one of five American territories with an established civilian government. The capital city is Hagåtña, and the most populous city is Dededo. Guam is the southernmost island in the Mariana Archipelago (Figure 2). It is the largest and most populous island in Micronesia, with a land mass of 560 square km, a maximum elevation of approximately 405 meters, and a total shoreline length of 244 km. Guam is a volcanic island completely surrounded by a coralline limestone plateau. The relatively flat northern half of the island, which is primarily comprised of uplifted limestone, is the site of the island's principle aquifer. The southern half of the island has more topographic relief, and is comprised mainly of volcanic rock, with areas of highly erodible lateritic soils. The hilly topography creates numerous

watersheds drained by 101 rivers (Quinata pers. comm., 2018). The coral reef ecosystem in Guam consists of a variety of reef types including fringing reefs, patch reefs, submerged reefs, offshore banks, and barrier reefs (Burdick *et al.,* 2008; NOAA CRCP, 2016). Fringing reefs are the predominant reef type, extending around much of the island. Mangrove growth on Guam is limited to Apra Harbor, which hosts the largest and most developed mangrove forest in the Mariana Islands (approximately 70 ha), and two smaller areas in the southern villages of Merizo and Inarajan. Over 5,100 marine species have been identified from Guam's coastal waters, including over 1,000 nearshore fish species and over 300 species of scleractinian coral (Paulay, 2003; Porter *et al.*, 2005). Guam lies relatively close to the Indo-Pacific center of coral reef biodiversity (Veron, 2000), and possesses one of the most species-rich marine ecosystems among US jurisdictions.

Guam's climate is classified as *equatorial* (Kottek *et al.,* 2006). Temperatures are moderated by seasonal easterly trade winds. The weather is generally very warm with little seasonal temperature variation. The mean annual temperature on Guam is 28°C (82°F), with a mean annual rainfall of approximately 260 cm (102 inches) (Lander and Guard, 2003). The dry season extends from December until June, while the wet season falls between July and November. Sea surface temperatures around Guam range from about 27-30°C, with higher temperatures measured on the reef flats and in portions of the lagoons (Paulay, 2003). Guam lies within an El Niño-Southern Oscillation (ENSO) core region, which experiences interannual variations of rainfall and drought-like conditions in years following El Niño events. Guam is located in "Typhoon Alley," and it is common for the island to be threatened by tropical storms and possible typhoons during the wet season. The highest risk of typhoons is from August through October.

Coral reef related tourism is an integral aspect of Guam's economy, and the Guam Visitors Bureau (2018) reports that over 30% of visitors list the coastal and marine environment or ocean-related activities as a top reason for visiting Guam, contributing $323 million per year to Guam's local economy (Spalding *et al.*, 2016). Owing to its island status and its favorable equatorial climate, Guam is a frequently visited tourist destination for Asian and US travelers alike. These high rates of tourism, coupled with relatively higher population density near the coast, bring even more humans in contact with coral reef ecosystems in the region; thereby creating more opportunities for humans to derive ecosystem services from reefs, but also more opportunities for human-induced stressors to impact reefs.
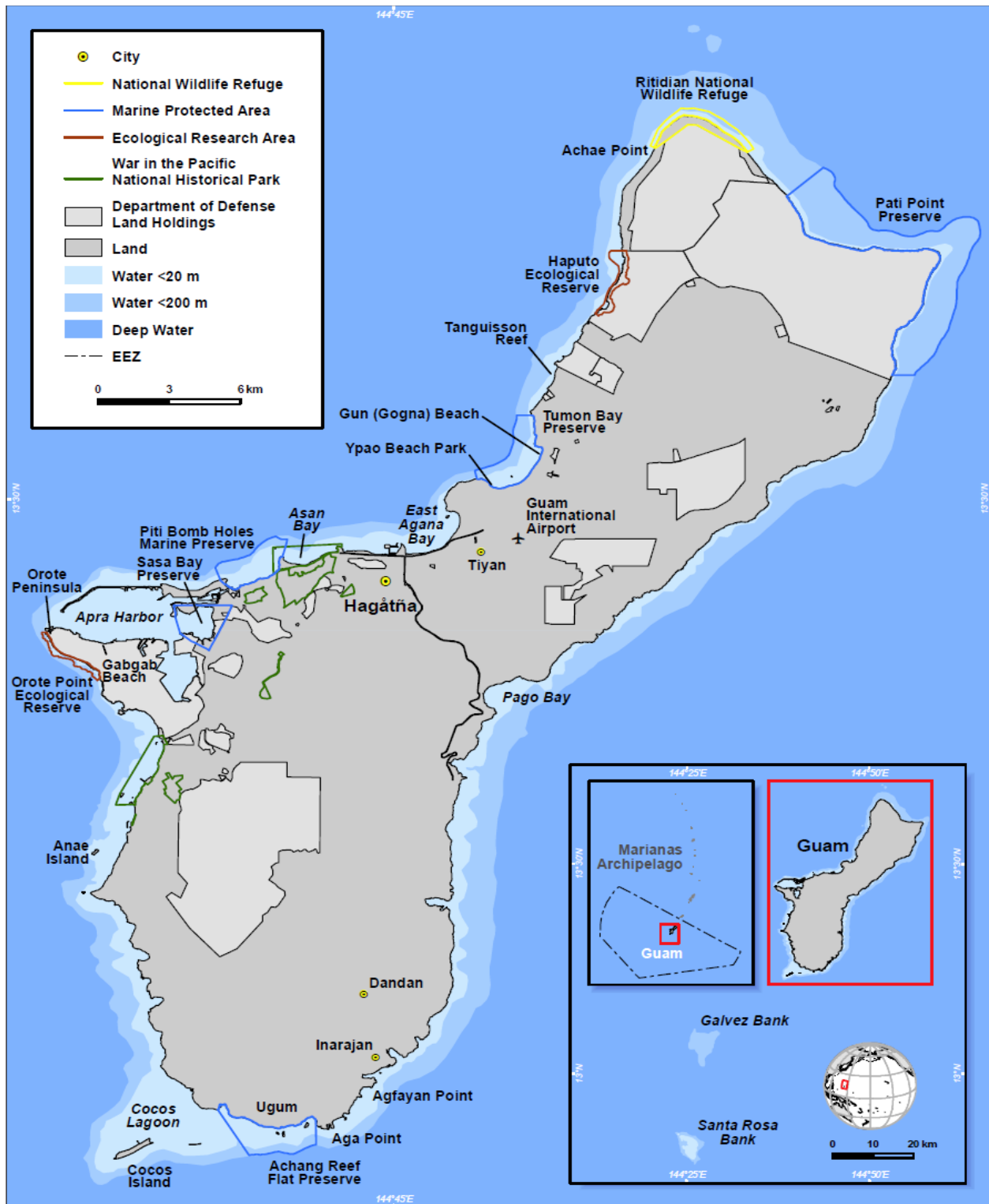
Figure 2: Map of Guam

Source: K. Buja, 2008

Methodology

2016 NCRMP Survey

Resident surveys took place on the island of Guam in 2016. The island encompasses 19 villages[1]: Agana Heights, Agat, Asan, Barrigada, Chalan Pago-Ordot, Dededo, Hagåtña, Inarajan, Mangilao, Merizo, Mongmong-Toto-Maite, Piti, Santa Rita, Sinajana, Talofofo, Tamuning, Umatac, Yigo, and Yoña. The potential respondent universe for this study was adults, eighteen years or older, who live on Guam. Due to the importance of understanding all potential users of the coral reefs who may be affected by activities related to NOAA's CRCP, the survey was not restricted to those who live directly on the coastline. Therefore, all adults on the island were included in the potential respondent universe.

The Guam survey data collection was focused on the following indicators:

- Participation in coral reef activities[2] (including snorkeling, diving, fishing, harvesting)
- Perceived resource condition
- Attitudes towards coral reef management strategies and enforcement
- Awareness and knowledge of coral reefs
- Cultural importance of reefs
- Participation in behaviors that may improve coral reef health
- Awareness/knowledge of coral reef rules and regulations

More information on the general survey methods applied can be found here: http://www.coris.noaa.gov/monitoring/resources/FAQs_NCRMP_Social_Survey.pdf, while details for the Guam effort are provided below.

Residents of Guam over the age of 18 were surveyed via telephone and face to face interviews from February 2016 to July 2016. To achieve statistical representativeness of this target sample, the survey size was set at 710 residents (95% confidence with a 5% margin of error). The final sample size was 712 completed surveys. Census data benchmarks were established to obtain a representative sample across the island as 2010 US Census population density data were used to develop a density dependent sampling strategy. The Guam census Geographic Information System (GIS) data layer, available from the US Census website[3], divides the island into 56

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[1] There is also a portion of the population residing on the Naval Base on Guam; however, researchers were unable to gain access to these residents for primary data collection.

[2] The most direct linkage between beaches and coral reefs is through the protection afforded to beaches by coral reefs which help protect beaches from erosion due to storm events. Additionally, reefs provide material for "natural beach replenishment" (NOAA CRCP 2015). As a result of these linkages, coral reefs are important to coastal residents' and visitors' use of beaches (Shivlani 2014).

[3] http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

Census tracts that include population information. Eleven of the tracts were removed from the potential survey pool because their population density was too small to be included. The population information of over 18 residents in the remaining 45 tracts was then converted to a proportion of the total population over 18 years old for all 45 remaining tracts. The proportion was used to calculate how many of the target goal of 710 surveys would be completed within each Census tract. Military installations were initially included in the sampling strategy, but removed later due to restricted access. The Census parcels that represented the military installations had been assigned 13 surveys total, which were reassigned to other parcels. This was done using the following method: The ratio of people to surveys was calculated for each parcel; the parcels for which this ratio was the highest (i.e. more people represented per survey) were assigned additional surveys to bring the ratio closer to the average for all parcels.

Phone numbers were obtained from online phone books for Guam, and were compiled into a project database. The majority of numbers were for landlines, as cell phone numbers were largely unavailable. The database was then filtered by phone number prefix to remove the majority of non-residential numbers and to roughly categorize by village. The number of phone surveys allotted to each village was based on the density dependent strategy explained above; however, most villages encompassed multiple Census parcels and phone prefixes. The number of phone surveys was calculated as a proportion of the total surveys allotted to all parcels within that village. Surveyors worked within a specific village until its quota had been met to ensure there was no overlap in numbers being called. The database was used to randomly select phone numbers, as well as track which numbers had been tried and the results of each call (i.e. no answer, disconnected, refused survey, successful survey, non-residential number). Contracted surveyors used Computer Assisted Telephone Interviewing (CATI) software, and offered the survey in four languages: English, Chamorro, Carolinian, and Tagalog. A total of 712 interviews were completed, yielding a response rate[4] of approximately 51% (13% for telephone and 60% for face to face interviews). No names or personally identifiable information were collected during surveying. A full breakdown of the representativeness of the Guam NCRMP sample compared to the 2010 US Census is available in Appendix 3.

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[4] A survey's response rate is the result of dividing the number of people who were interviewed by the total number of people in the sample who were eligible to participate.
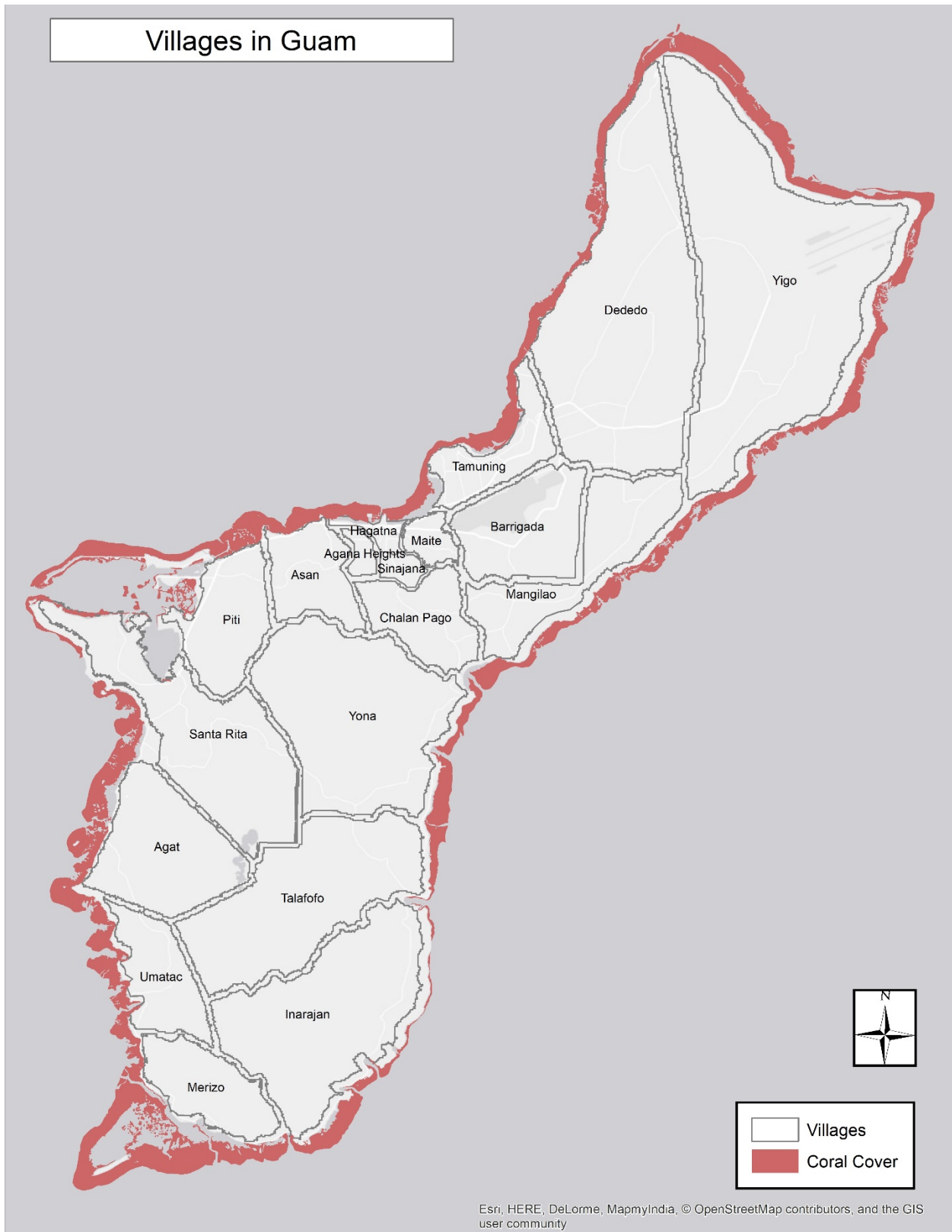
Figure 3: Location of sampled villages in Guam in relation to coral cover

This report presents a summary of select measures collected via the survey instrument and secondary data sources. A presentation on all survey data results for Guam is available at: http://www.coris.noaa.gov/monitoring/socioeconomic.html.

Secondary Data Collection

Socioeconomic data were compiled for Guam from secondary data sources including the US Census Bureau, the US Bureau of Economic Analysis (BEA), the US Bureau of Labor Statistics (BLS), the Environmental Protection Agency (EPA), the US Department of Health and Human Services (HHS), the National Weather Service (NWS), and local government agencies. These data were collected and analyzed at the jurisdiction level, though smaller geographies may be included in future analyses. Secondary data collection included cleaning and transforming data prior to analyses, maintaining documentation from original sources, evaluating data for errors, and other data proofing procedures.

The secondary data collection for Guam was focused on the following indicators:

- Human population change near coral reefs
- Community well-being
- Physical infrastructure
- Economic impact of coral reef fishing to jurisdiction
- Economic impact of dive/snorkel tourism to jurisdiction

Many of the secondary data presented in this report were taken from the NCRMP socioeconomic project collection as described above. More information about original sources for these data can be found in the data sources table (Appendix 4). Secondary data items included in this report, but not in Appendix 4, are not considered part of the formal NCRMP secondary data collection because they are unique to the jurisdiction or are not available in a standardized format over time.

As the secondary data collection and final indicator development for Guam is in progress, there are several indicators that will be more comprehensively addressed by combining the survey (primary) and secondary data. These include indicators that benefit from both existing data from management plans, as well as survey data on the involvement of local residents in resource management decisions (e.g., Governance). At the conclusion of the first full cycle of monitoring, the following indicators will be developed using a combination of primary and secondary data:

- Governance
- Community well-being
- Cultural importance of coral reefs
- Participation in behaviors that may improve coral health

Data analysis

Data analysis of both survey and secondary data included descriptive analyses (e.g., measures of central tendency, examination of distribution), as well as examinations of statistical relationships between variables (e.g., cross tabulations, correlation, regression analyses). Additionally, geospatial analyses were used to examine the extent of governance and specifically, the amount of coral reef area under protected status. Some of the key findings will be discussed in the following sections of this report.

Coral reefs in Guam (Photo Credit: David Burdick, NOAA)

Results: Primary Data Indicators

Results are reported by indicator in order to demonstrate which individual measures will be used to assess the indicators presented in Table 1. The first section of indicators presented includes those measured through the use of primary survey data; the first of which is the frequency of participation in marine activities related to coral reefs, as displayed in Table 3.

Frequency of participation in recreational and extractive activities

Table 3: Frequency of participation in various extractive and non-extractive reef activities (n=712)

Frequency	Non-extractive activities							Extractive Activities		
	Swimming/ wading	Snorkeling	Diving (SCUBA or free)	Boarding (surfing, kitesurfing, SUP, body-surfing, body-boarding)	Beach Recreation	Paddling/ Kayaking	Jet Skiing	Fishing from shore	Fishing or harvesting from a boat or kayak	Gathering of animals for gleaning
Never	23.0%	62.2%	79.5%	83.7%	19.4%	83.7%	89.9%	74.0%	89.0%	87.8%
Once a month or less	44.2%	20.5%	10.4%	10.3%	45.2%	10.1%	7.7%	12.8%	6.6%	7.4%
2-3 times a month	15.4%	8.4%	4.8%	2.5%	21.2%	2.9%	0.8%	7.2%	2.2%	2.8%
4 times a month or more	16.7%	8.7%	5.3%	3.4%	14.2%	3.1%	1.5%	6.0%	2.1%	2.0%
Not sure, Refused, or No response	0.6%	0.1%	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%

Table 3 outlines respondents' self-reported frequency of participation in coral reef related activities. It must be noted that these results reflect only residents of Guam, and do not take tourist activity participation into account. Participation in non-extractive recreational reef activities varies in Guam, with the two activities that residents participate in most frequently being beach recreation (81% participate) and swimming/wading (76% participate). Participation in fishing and gathering (extractive activities) of marine resources is less common, with 26% of respondents indicating that they fish from the shore, 11% of respondents indicating that they fished from a boat/kayak, and just over 12% of respondents indicating that they gathered marine animals for gleaning. Twenty-nine percent of respondents fish from either a boat/kayak or the shore, and 30% stated that they fish or gather marine resources.

Figure 4 displays respondents' self-reported reasons for fishing. These questions were only answered by respondents that indicated that they fish and/or gather in the "activity" question (Table 3). Therefore, the sample size for this question is relatively small when compared to other questions in the survey. The most common reason for fishing among Guam respondents who fish is "To feed myself and my family/household;" with 94% of respondents that fish indicating that they fish "To feed myself and my family/household," and 31% indicating that they do so "frequently." Of respondents who fish, fishing "to sell" was the least chosen response, with 80% of respondents indicating that they never sell their catch. This finding suggests that approximately 42 people surveyed fish to sell their catch either rarely, sometimes, or frequently.
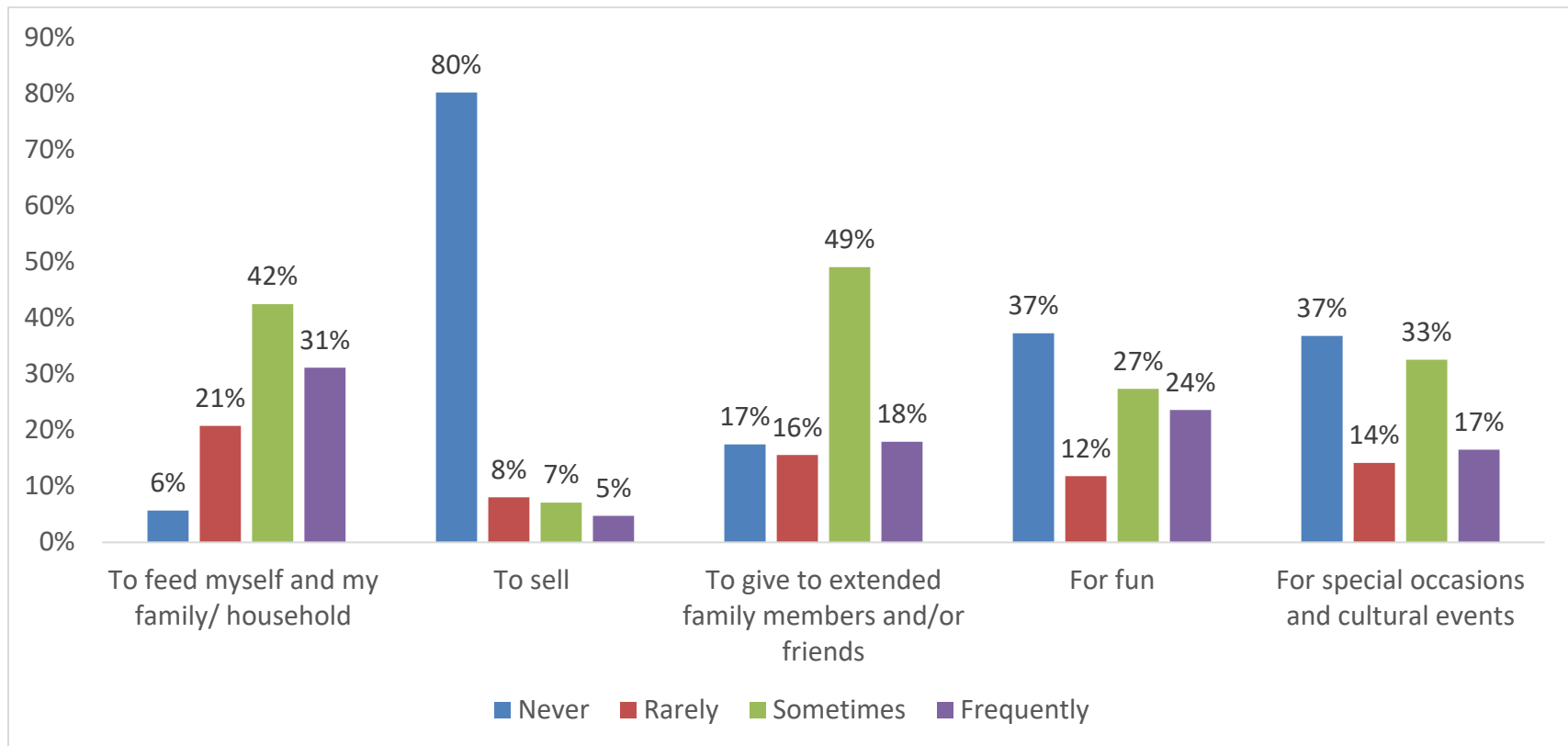
Figure 4: Frequency of fishing for various purposes in Guam (n = 212)

Frequency of seafood consumption

Of the 711 people that responded to the question "How often do you or your family eat fish/seafood?" over 98% indicated that they consume seafood, with 66% indicating that they consume seafood at least once a week. Of the 707 people that answered the question "How often does your family eat fish/seafood that is harvested from coral reefs?" over 83% indicated that they consume seafood from coral reefs, with 29% indicating that they consume seafood from coral reefs at least once a week. When considering where respondents obtained their seafood from, "purchased by myself or someone in my household at a store or restaurant" was the most frequently encountered response, with 72% of respondents indicating that they use this source as one of their sources for seafood. This choice was followed by "purchased by myself or someone in my household at a market or roadside vendor" (51%).

Participation in behaviors that improve coral reef health

Respondents were also asked about their environmental behavior practices. These practices included behaviors such as participating in beach clean-ups and volunteering for an environmental group, as it was assumed that these types of behaviors would help sustain and/or improve coral reef health in the region. Of the 711 that responded, over half (59%) indicated that they participate in environmental behavior at any frequency, and 29% of respondents indicated that they participate in environmental behavior at least "several times a year."

An advertisement for beach a clean-up in Guam (Ad credit: Bureau of Statistics and Plans' Guam Coastal Management Program)

Perceived resource condition

Figure 5 illustrates respondents' perceptions of the current condition of marine resources in Guam. Residents responded most favorably when asked about their perceived condition of ocean water quality, with 57% of respondents indicating that ocean water quality condition was "good." Residents responded least favorably when asked about their perceived condition of the number of turtles, with 38% of respondents indicating that the current condition of the number of turtles was "bad;" however, number of turtles was also the resource that respondents were most unsure about, with 37% of respondents indicating that they were "not sure" of the number of turtles.
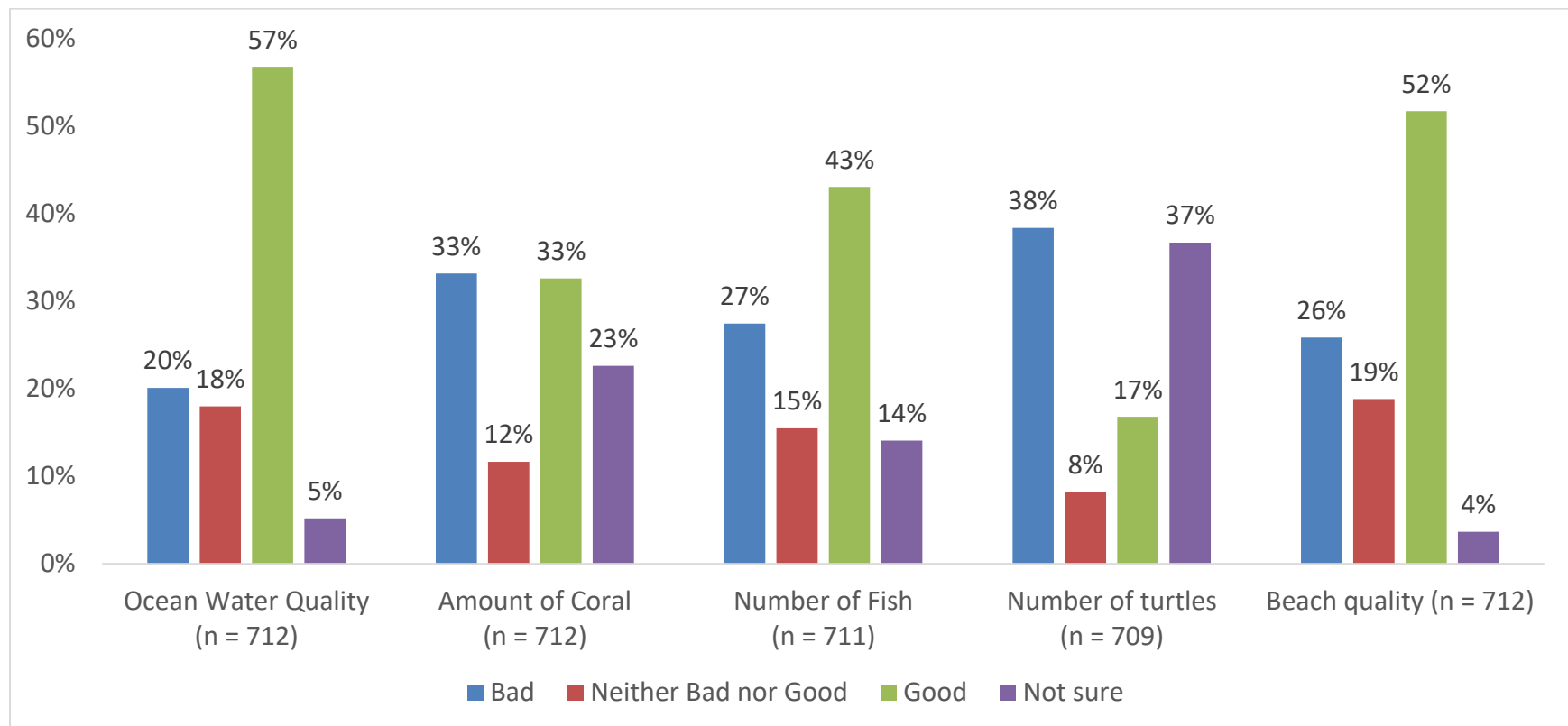
Figure 5: Resident opinions regarding current conditions of marine resources

Figure 6 illustrates respondents' perceptions concerning the change in the condition of marine resource over the last 10 years in Guam. Overall, less than half of respondents believed that the condition of these marine resources has gotten better over the last decade. "Amount of coral" was the marine resource that the highest proportion of respondents felt had gotten worse over the last decade (38%). When asked about the change in condition over the last decade, the marine resources that respondents were most unsure about was "number of turtles" (41%).
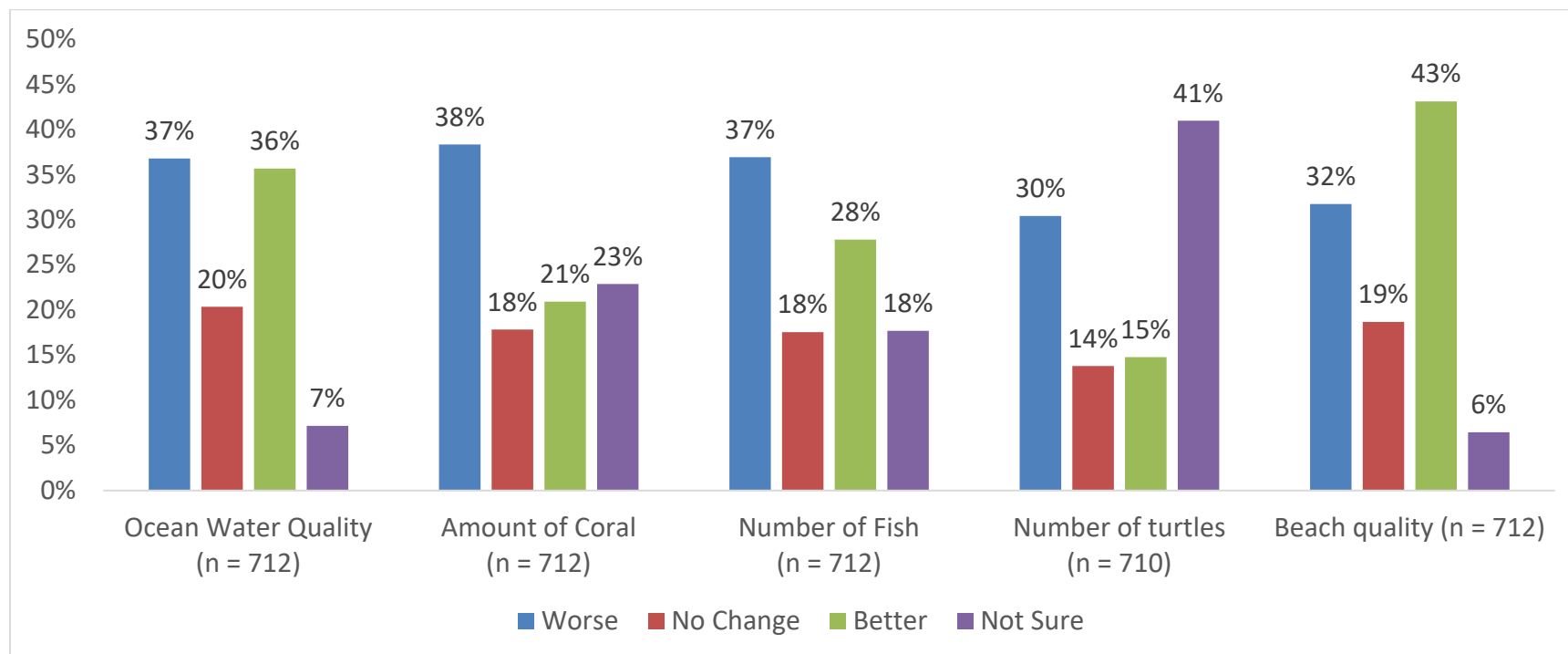
Figure 6: Resident opinions on change in condition of marine resources over past 10 years

Respondents were asked how they felt the condition of marine resources will change over the next 10 years as well. Of the 709 that responded, almost half (49%) indicated that they thought that the condition of marine resources will "get better" over the next decade, while 20% felt that the condition would "stay the same," and 28% believed that the condition will "get worse." Four percent were unsure.

Attitudes towards coral reef management strategies

Table 4 depicts respondent opinions regarding the various purposes and functions of marine protected areas (MPAs). Survey results indicated that under 49% of respondents were familiar with MPAs. When examining respondent attitudes toward the above statements concerning MPAs, respondents agreed the most with "Marine Preserves protect coral reefs" (94%) and agreed the least with "There should be fewer Marine Preserves in Guam" (71% disagree). Respondents were the most unsure about "Fishermen's livelihoods have been negatively impacted from the establishment of Marine Preserves in Guam" (6%). It also must be noted this series of questions were only answered by respondents who indicated that they were "neither unfamiliar no familiar," "familiar," or "very familiar" with Marine Preserves (See Appendix 2).

Table 4: Resident opinions regarding marine protected areas in Guam

Marine Preserve Statement	Disagree	Neither Agree nor Disagree	Agree	Not Sure	Sample Size
Marine Preserves protect coral reefs	4%	1%	94%	<1%	380
Marine Preserves increase the number of fish	4%	2%	93%	1%	380
There should be fewer Marine Preserves in Guam	71%	10%	17%	1%	378
There should be more Marine Preserves in Guam	15%	10%	75%	1%	379
There has been economic benefit to Guam from the establishment of Marine Preserves	7%	8%	79%	6%	379
Fishermen's livelihoods have been negatively impacted from the establishment of Marine Preserves in Guam	38%	13%	42%	6%	379
Marine Preserves help increase tourism in Guam	7%	6%	84%	3%	379
The establishment of Marine Preserves increases the likelihood that people will vacation in Guam	9%	9%	80%	2%	378
I would support adding new Marine Preserves in Guam if there is evidence that the ones we have are improving Guam's marine resources	8%	4%	87%	1%	380
I generally support the establishment of Marine Preserves	4%	3%	92%	1%	380

Figure 7 depicts respondents' attitudes toward various management options that were presented in the survey as common strategies used in the management of coral reef ecosystems. Overall, respondents were generally very supportive of all potential management strategies that could be used to improve the protection of coral reefs. The management option with the most support was "Permit and certification requirements for water sports tour operators," with 89% of respondents agreeing with this strategy. While the majority of respondents agreed with all of the presented management options, the option with the least support was "Restrictions on SCUBA spear fishing," with 19% of respondents disagreeing with this strategy. "Lower the number of sea cucumbers allowed per person" was the management option that respondents were the most unsure about (7%).
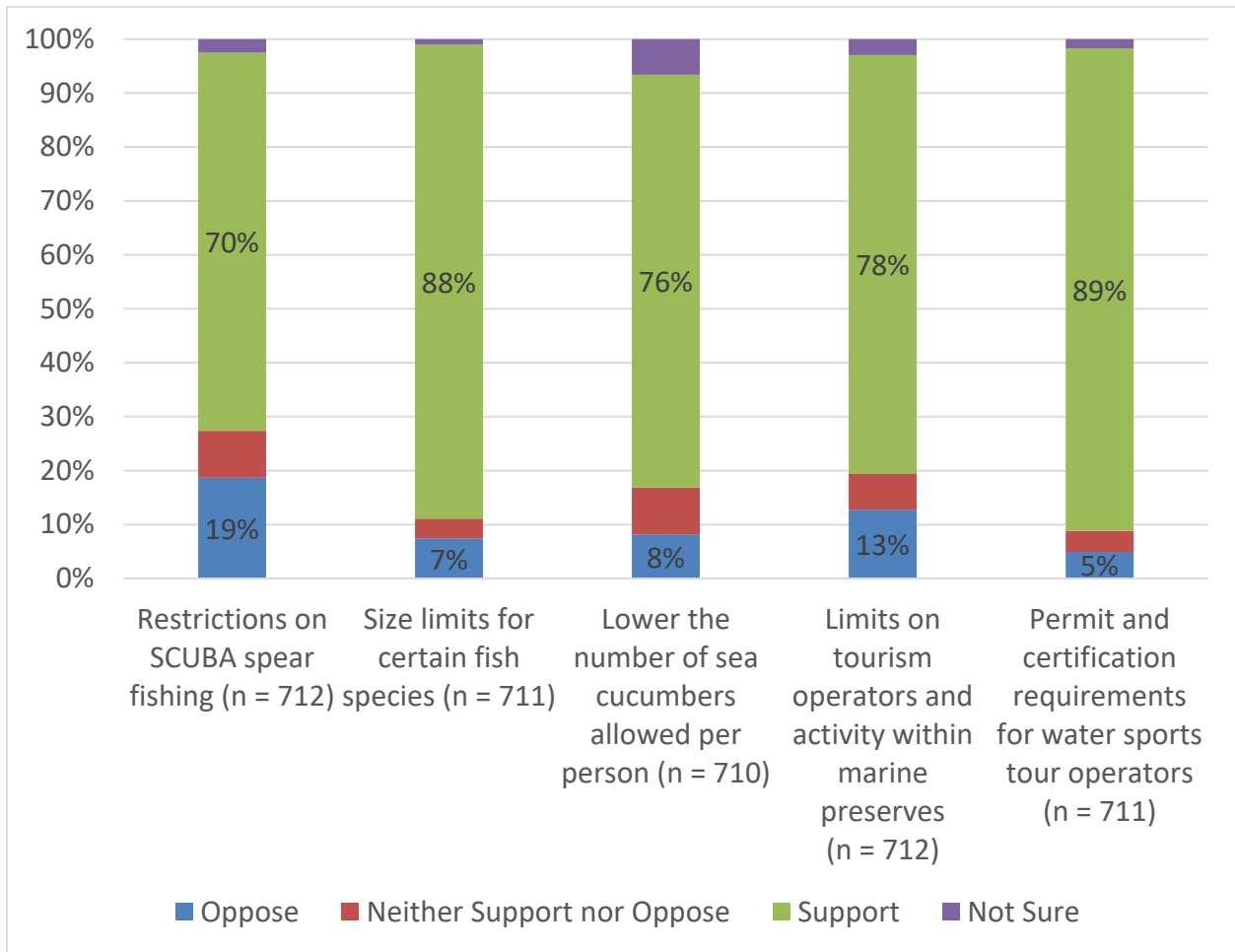
Figure 7: Resident opinions regarding potential management strategies for Guam

Knowledge of coral reef rules and regulations

In order to contribute to the indicator of "knowledge of coral reef rules and regulations," Figure 8 displays respondents' self-reported relative familiarity with marine preserves in Guam. It was found that 49% of respondents indicated that they were familiar with MPAs, and 46% were either unfamiliar with MPAs or unsure of their level of familiarity.
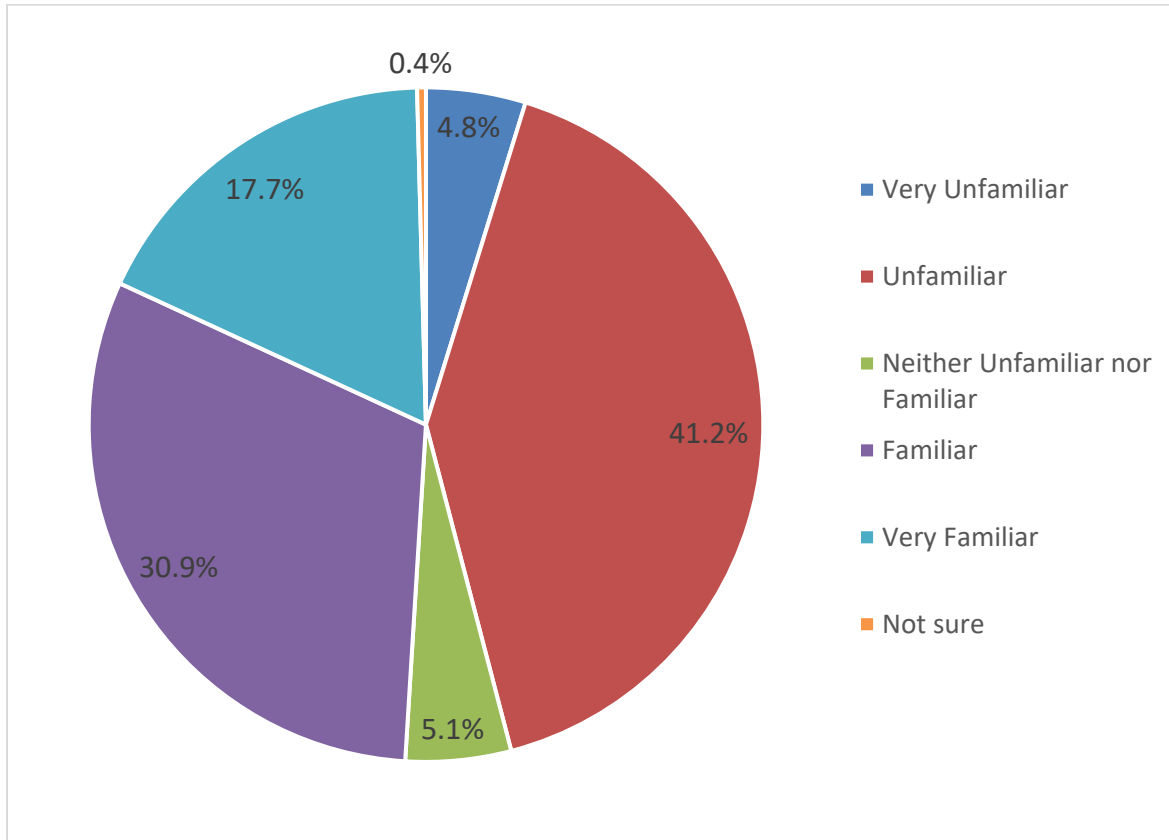
Figure 8: Residents' familiarity with Marine Preserves (MPAs) in Guam (n = 712)

Awareness and knowledge of coral reef functions and threats

Figure 9 displays respondent attitudes pertaining to the services and byproducts of healthy coral reef ecosystems. The majority of respondents agreed with the above statements in the graph, except for one item: 82% of respondents disagree with the statement "coral reefs are only important to fishermen, divers and snorkelers." The statement that respondents were most unsure about was "Healthy coral reefs attract tourists to Guam" (3%).
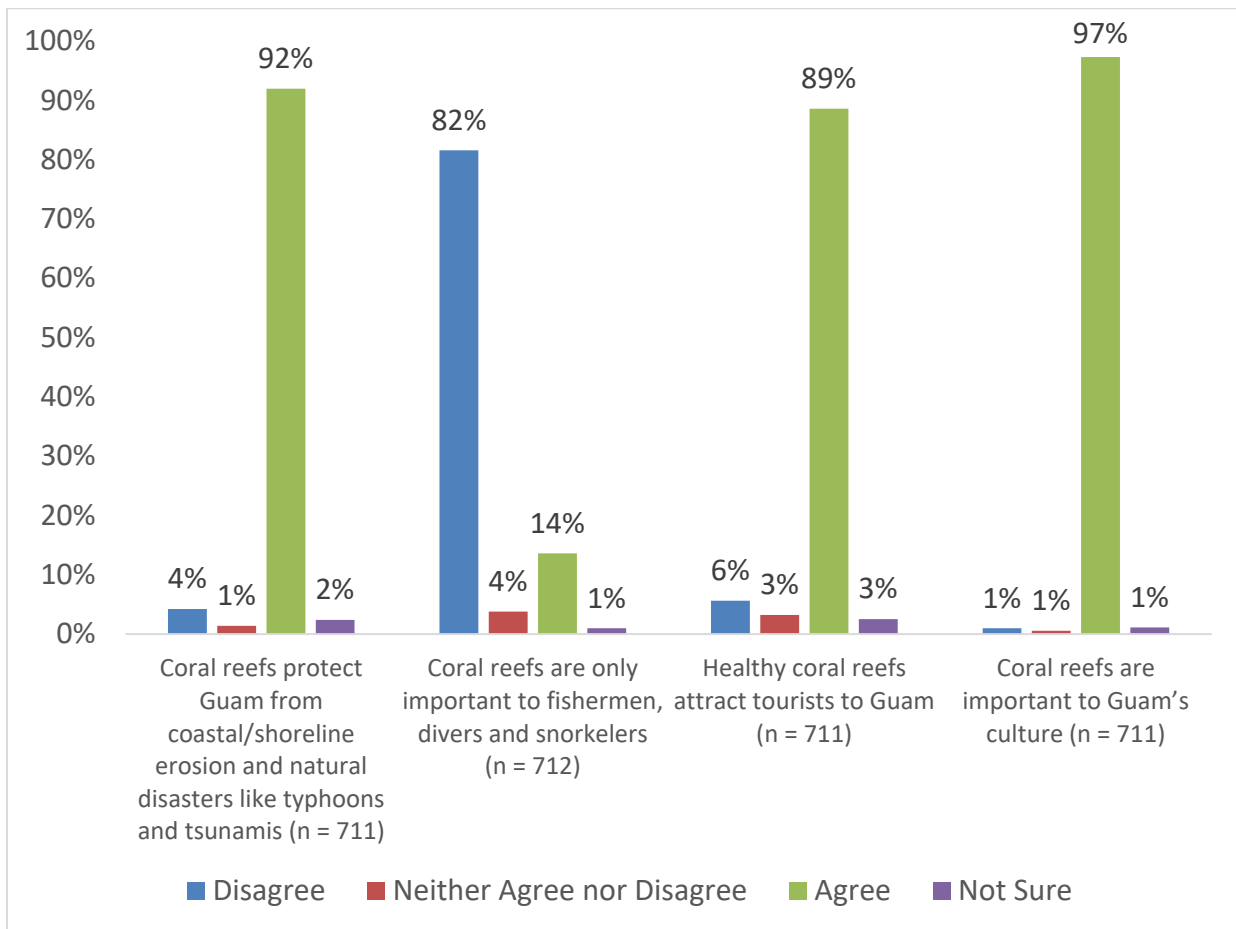
Figure 9: Resident perceptions regarding coral reef services

Familiarity with threats

Respondents were also asked about their relative familiarity with various issues that pose a threat to coral reef ecosystems. Residents were, overall, mostly familiar with the various threats faced by coral reefs. Respondents were familiar with most of the eleven threats listed in the survey; however, they were mostly unfamiliar with three issues (coral bleaching, invasive species, and damage from small watercraft). Figure 10 shows that respondents were most familiar with the threat of trash/littering (90%), followed by the threat of pollution from stormwater, sewage, fertilizer and other chemical runoff (77%).
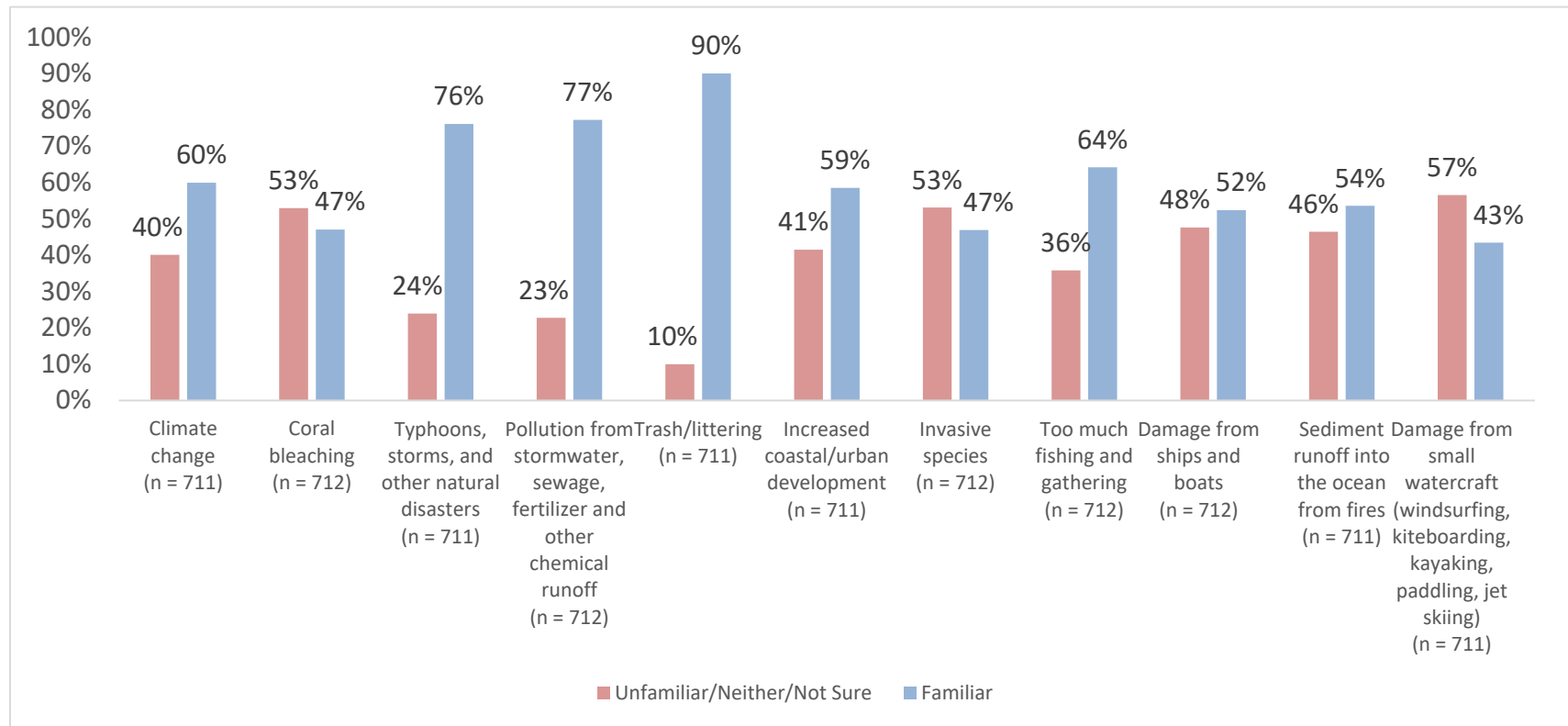
Figure 10: Residents' familiarity with threats to coral reefs

Level of threats to coral reefs

Figure 11 illustrates respondent perceptions concerning the level of threat severity facing coral reef ecosystems in Guam. Over half of the respondents (53%) believed that the threat severity to coral reefs in Guam is at least "large." Just over 1% of respondents indicated that they believe coral reefs are facing no threats at all. Additionally, 6% of respondents indicated that they are not sure about overall coral reef threat severity.
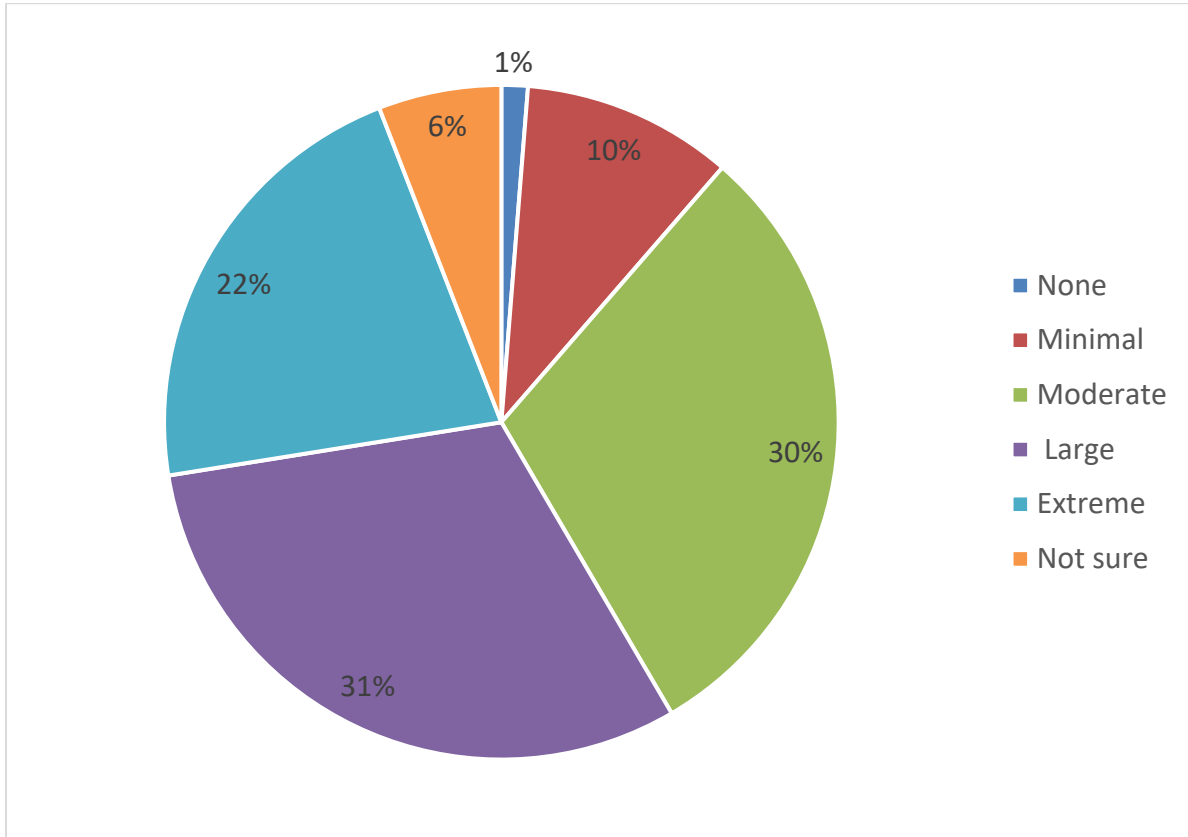
Figure 11: Residents' perceptions of the severity of threats to coral reefs (n = 712)

Results: Secondary Data Indicators

In the following section, the measures presented for each indicator originate from various secondary data sources. These indicators may be ultimately measured through secondary data alone or through a combination of primary and secondary data.

Human population composition and trends near coral reefs

Figure 12 illustrates the recent trend in population numbers for Guam. The population of Guam increased slightly from 2000-2010 (increase of 2.6%). However since 2010, the population of Guam has increased by 6.6% as of 2015 (World Bank).
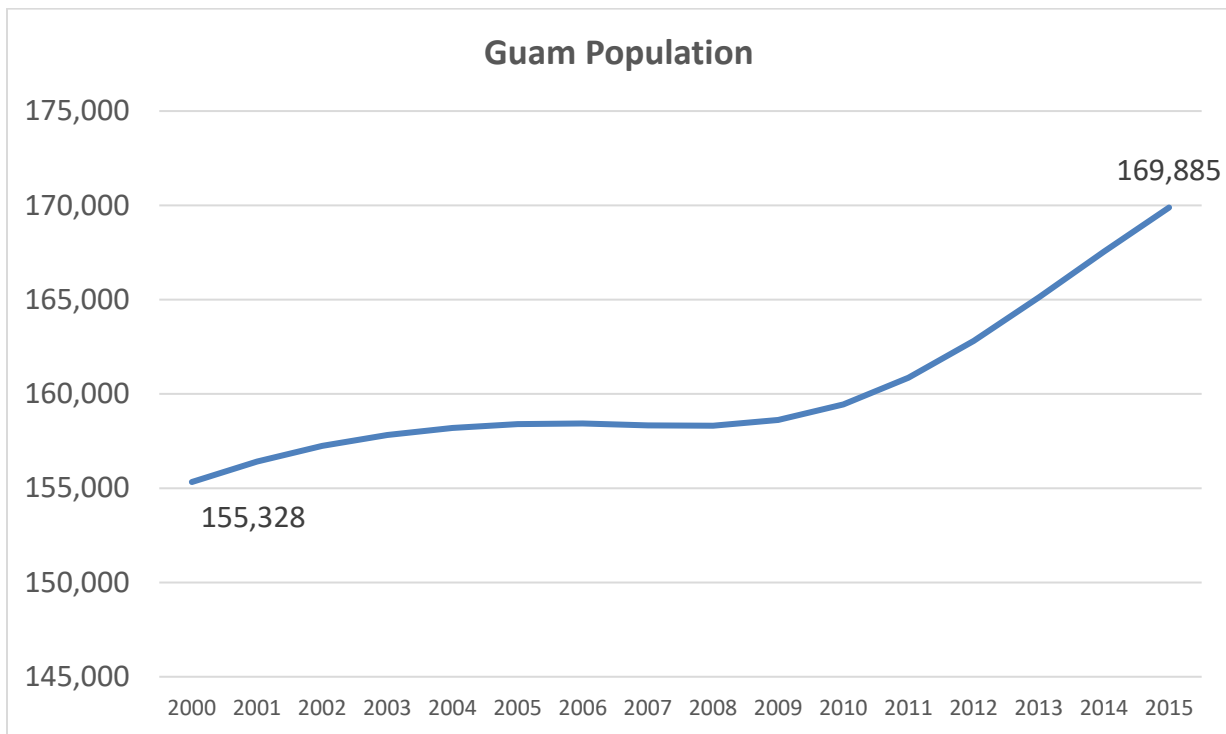
Figure 12: Guam's population trend, 2000-2015

Source: World Bank World Development Indicators: Population; Total

Table 5 shows that the Mongmong-Toto-Maite village exhibited the largest population increase from 2000-2010 in percentage terms (17%), while the village of Dededo (the most populous village overall) exhibited the largest population increase in absolute terms (1,963). Some villages experienced a net population decrease, with Santa Rita losing the most people in absolute terms (-1,416) and Inarajan losing the most people in percentage terms (-26%) (US Census Bureau).

Table 5: Population change for each of Guam's villages, 2000-2010

Village	Population change	Percent Change
Agana Heights	-132	-3%
Agat	-739	-13%
Asan	47	2%
Barrigada	223	3%
Chalan Pago-Ordot	899	15%
Dededo	1963	5%
Hagåtña	-49	-4%
Inarajan	-779	-26%
Mangilao	1878	14%
Merizo	-313	-14%
Mongmong-Toto-Maite	980	17%
Piti	-212	-13%
Santa Rita	-1416	-19%
Sinajana	-261	-9%
Talofofo	-165	-5%
Tamuning	1673	9%
Umatac	-105	-12%
Yigo	1065	5%
Yona	-4	0%

Source: US Census Bureau, Decennial Census of Population and Housing

Table 6 shows that from 2000 to 2010, population density increased in 9 out of 20 villages, with Mongmong-Toto-Maite exhibiting the largest growth in population density (19%) and Inarajan exhibiting the largest decrease in population density (-25%) over the course of the decade. The overall population density of Guam increased by 3% from 2000 to 2010 (US Census Bureau).

Table 6: Population density in Guam's villages, 2000-2010

	Population Density, 2000 (persons per square mile of land area)	Population Density, 2010 (persons per square mile of land area)	Percent change in population density, 2000-2010
Agana Heights	3,810.50	3,705.60	-3%
Agat	538.70	475.90	-12%
Asan	377.10	375.50	0%
Barrigada	1,020.50	1,044.60	2%
Chalan Pago-Ordot	1,041.60	1,203.80	16%
Dededo	1,406.30	1,472.80	5%
Hagåtña	1,220.70	1,112.00	-9%
Inarajan	161.90	121.30	-25%
Mangilao	1,303.60	1,490.30	14%
Merizo	341.80	295.70	-13%
Mongmong-Toto-Maite	3,163.20	3,749.50	19%
Piti	224.10	192.80	-14%
Santa Rita	463.70	374.10	-19%
Sinajana	3,363.30	2,908.60	-14%
Talofofo	181.80	171.40	-6%
Tamuning	3,183.00	3,484.50	9%
Umatac	138.20	125.10	-9%
Yigo	550.00	576.80	5%
Yona	319.70	322.10	1%
Guam total	**737.7**	**759.60**	**3%**

Source: US Census Bureau, Decennial Census of Population and Housing

Figure 13 depicts Guam's population density at the Census tract level. It is widely understood that increased population density in proximity to coral reefs can lead to stress in the coral reef ecosystem (Brewer, 2013). The inset map illustrates an area of high population density along the west central coast of Guam in relation to coral cover, and shows how Guam contains areas of differing popualtion density that may impact its coral reef ecosystem through stressors from development, recreation, and other types of anthropogenic effects.
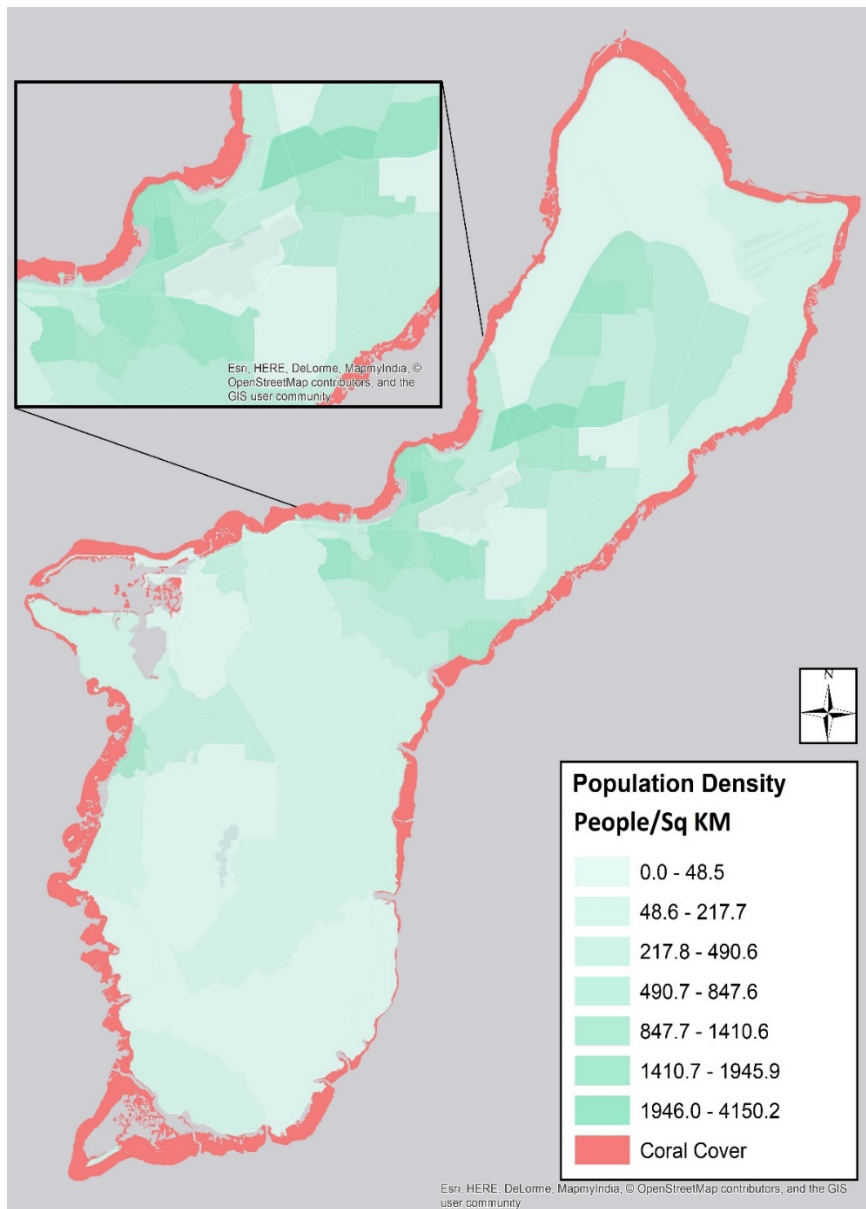
Figure 13: Population density (2010) in Guam by US Census Tract and proximity to coral cover.

As evidenced by Figure 14, the racial composition of Guam is just under half Pacific Islander (49%), followed by Asian (32%), and other/two or more races (10%). Of the 49% that identified as a Pacific Islander, 76% are Chamorro and 14% are Chuukese. Of the 32% that identified as Asian, 82% are Filipino and 7% are Korean (US Census Bureau).

As for the age structure of the population of Guam, the 2010 US Census Bureau reports that 33% of the population was under 18 years old (35% in the 2000 Census) and 7% of the population was 65 years or older (5% in 2000 Census). The 2010 US Census Bureau reports an overall median age of 29.5 years old for Guam's population (27.4 years old in 2000 Census).

Racial Composition and Age Structure of Guam

Racial Composition

- Native Hawaiian/Pacific Islander — 49%
- Asian — 32%
- Black/African American — 1%
- Hispanic/Latino — 1%
- White — 7%
- 10%

Breakdown of Pacific Islander Population

- Chamorro — 76%
- Chuukese — 14%
- Kosraean — 3%
- Pohnpeian — 1%
- Palauan — 3%
- Yapese — 2%
- Other Pacific Islander — 2%

Breakdown of Asian Population

- Chinese — 5%
- Filipino — 82%
- Japanese — 5%
- Korean — 7%
- Vietnamese — 1%
- Other Asian — 2%
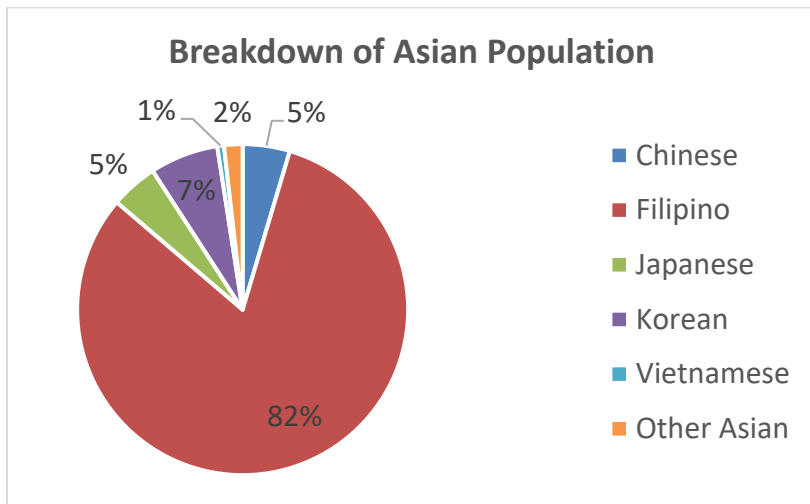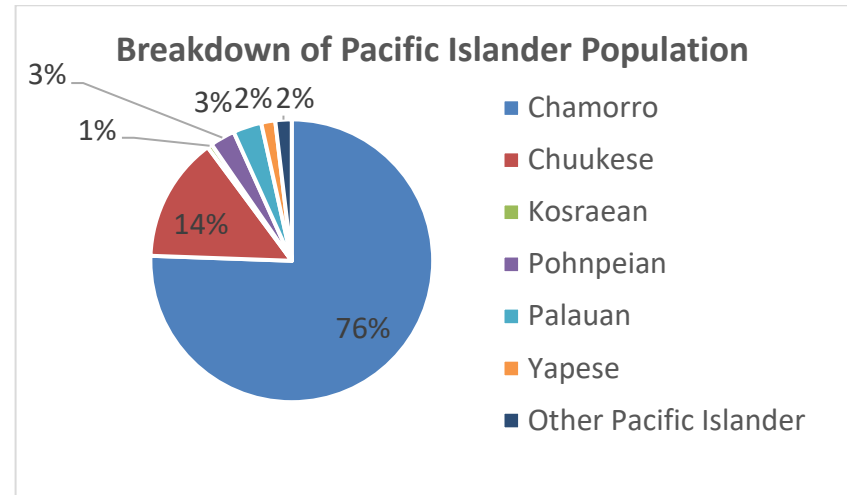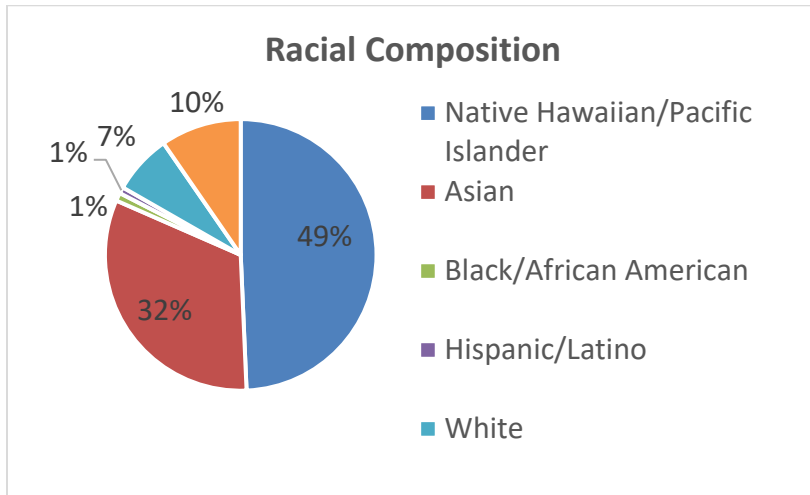
Figure 14: Racial and ethnic composition of Guam
Source: US Census Bureau, Decennial Census of Population and Housing

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Community well-being

In addition to the basic demographics described above, composite indicators can be utilized to further explain social variance (see Box 1). Five composite indicators related to human well-being are being tracked as part of the NCRMP socioeconomic component: Economic Security, Health, Basic Needs, Access to Social Services, and Education.

Each composite indicator is conceptually complex. The indicators, demonstrated in Figure 15 with *Economic Security*, are made up of multiple of measures that, in turn, operationalized multiple dimensions of the composite indicator.
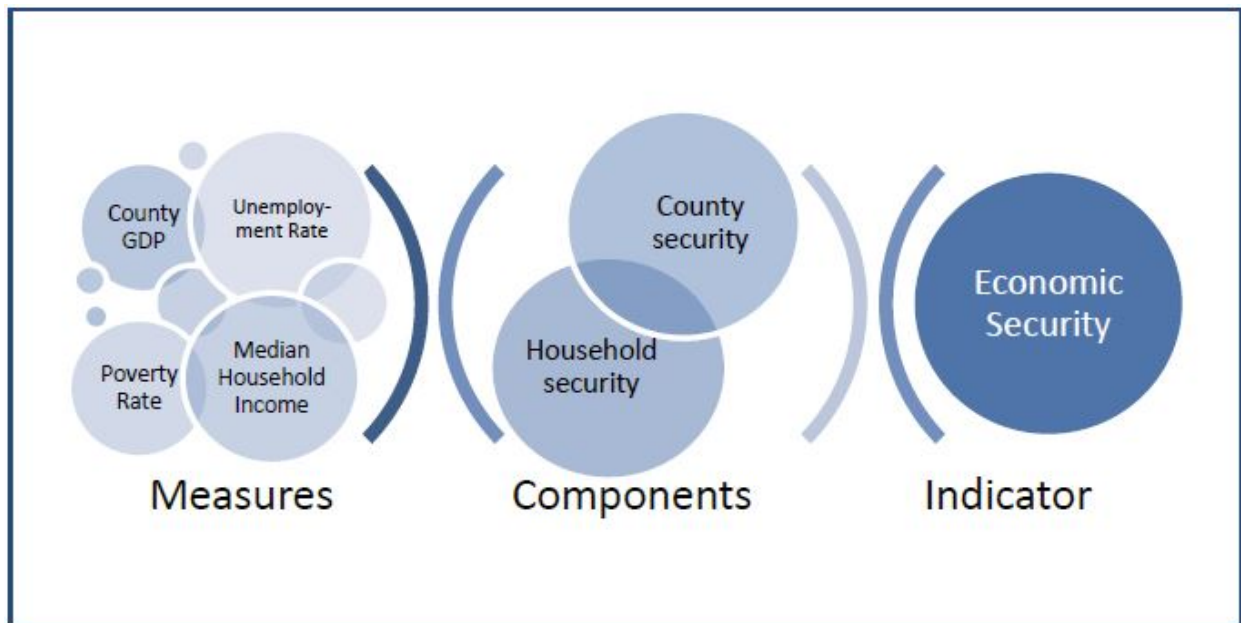
Figure 15: Economic Security presented as an example of operationalizing a composite indicator

At the conclusion of the first monitoring cycle, the coral reef jurisdictions will be scored on select indicators of well-being. These scores will allow for comparisons across jurisdictions and will be used in statistical analyses with indicators of environmental condition to analyze the dynamic relationship between the ecosystem services that people regularly enjoy and community well-being. A selection of measures that will be used to operationalize the well-being indicators of Economic Security, Health, Basic Needs, Access to Social Services, and Education are presented and discussed below.

Economic Security

The measures used to operationalize economic security will include gross domestic product, median household income, the percent of the population in poverty, unemployment rate, and the percentage of households receiving public assistance.

One of the most telling measures of economic well-being is real gross domestic product (GDP). Figure 16 shows that from 2005 to 2015, real GDP increased by 7% in Guam. Real GDP dipped from 2005 to 2006, but has been increasing ever since. This upward trend is similar to the nationwide US trend over this time period, however, US national real GDP decreased from 2007-2009 during the recession, whereas Guam's real GDP did not decrease during this time period, perhaps indicating that Guam's economy was more resistant to the recession.
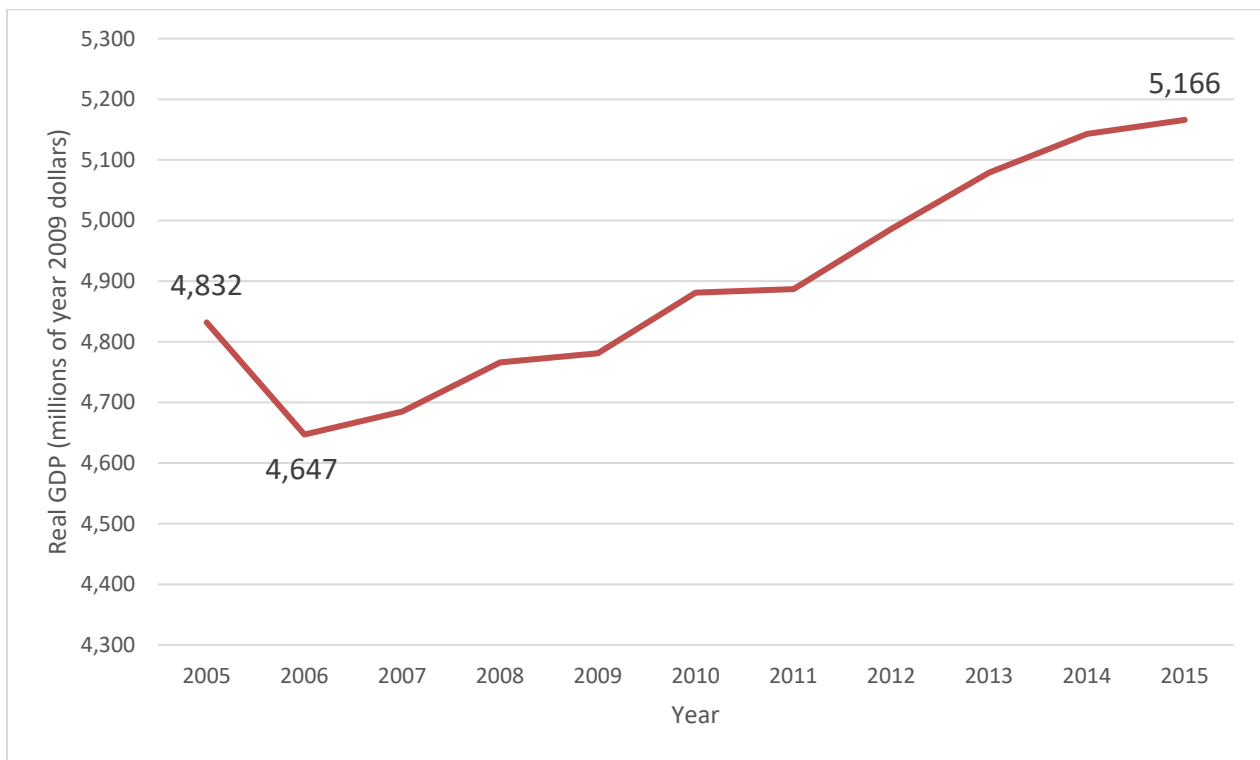
Figure 16: Real GDP trend in Guam

Source: US Bureau of Economic Analysis

According to the 2012 ACS five year estimates, 5.1% of the civilian population in Guam age 16 years and older were unemployed. This is a decrease of 2% from the figure of 7.1% reported in the 2000 US Census.

As shown in Figure 17, real median household income, measured in 2009 dollars using the consumer price index, increased in 6 out of 19 villages in Guam villages from 2000 to 2010 (US Census). The largest increase was observed in Chalan Pago-Ordot, where real median household income increased by 20% over the course of the decade and the largest decrease was observed in Agana Heights, where real median household income decreased by 16% from 2000-2010. For Guam as a whole, real median household income decreased by 5% from $50,630 in 2000, to $48,274 in 2010.
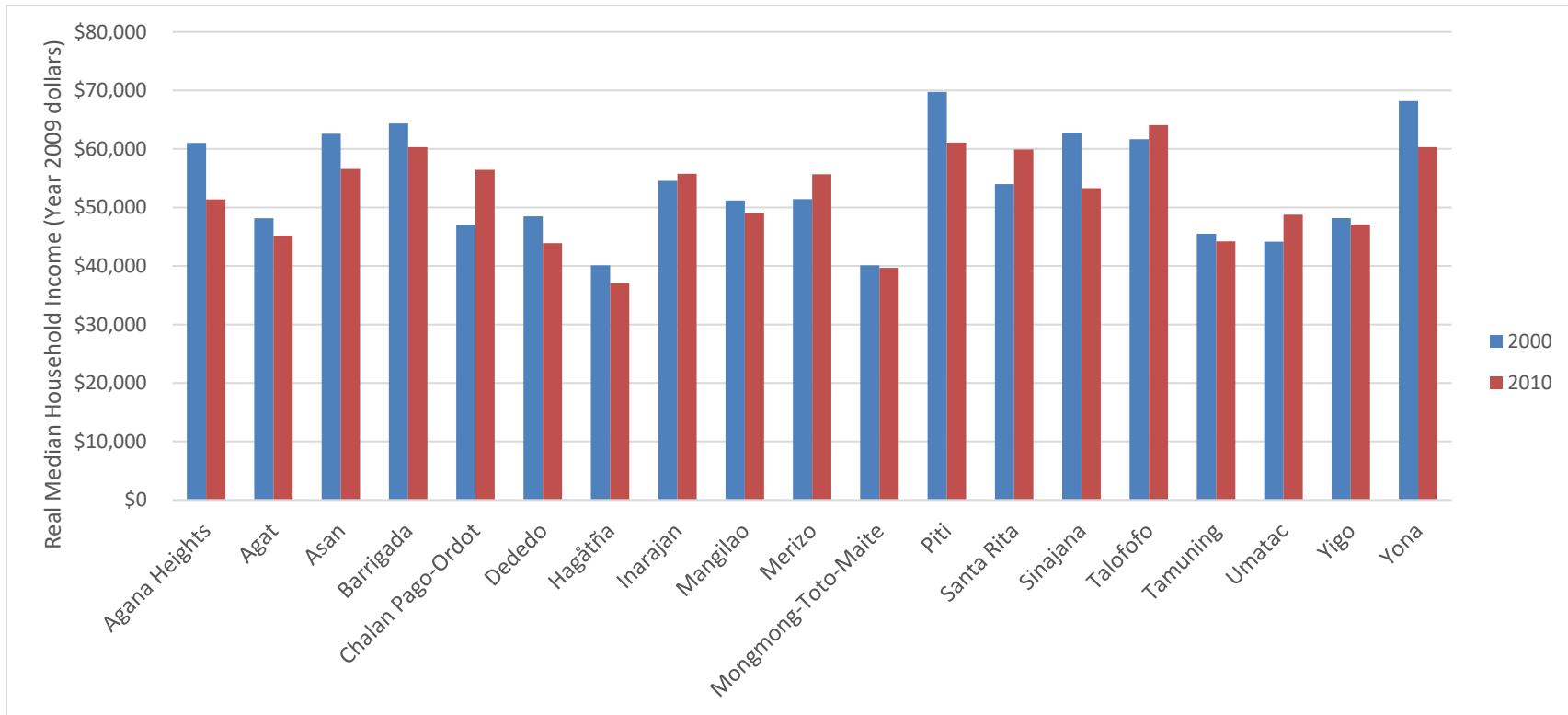
Figure 17: Median household income in Guam villages (inflation adjusted to 2009 dollars)

Source: US Census Bureau, Decennial Census of Population and Housing

Additionally, Figure 18 shows that the percent of the population below the poverty line decreased in 12 out of 19 villages from 2000 to 2010, with the largest decrease observed in Chalan Pago-Ordot (US Census). In Chalan Pago-Ordot, the poverty rate decreased from 28% in 2000, to 18% in 2010. The poverty rate increased the most in Santa Rita (increase of 3%). For Guam as a whole, the poverty rate decreased by less than 1% from 2000-2010.
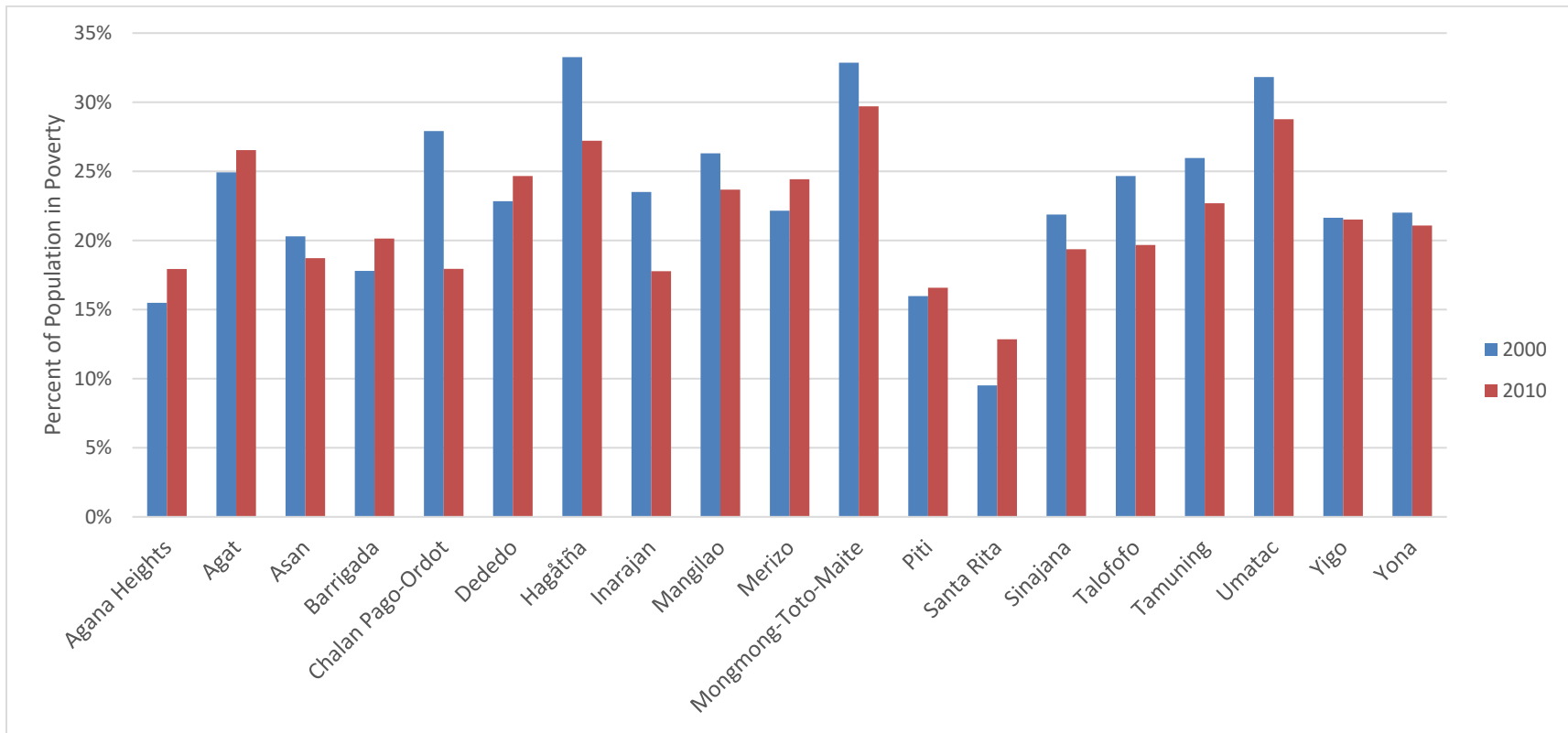
Figure 18: Level of poverty in Guam villages

Source: US Census Bureau, Decennial Census of Population and Housing

Figure 19 shows the percentage of households receiving public assistance income increased in 15 out of 19 villages from 2000 to 2010 (US Census). The most drastic decrease was observed in Mongmong-Toto-Maite; 21% of households in Mongmong-Toto-Maite were receiving public assistance income in 2010, compared to just 13% of households receiving public assistance income in Mongmong-Toto-Maite in 2000. For Guam as a whole, the percentage of households receiving public assistance income increased from 11% in 2000, to 14% in 2010. The complete well-being assessment will examine the percentage of the population in need that is not being served by public assistance in order to measure the efficacy of support services in reaching target populations. Such measures are important to understanding the overall vulnerability of the population independent of stressors such as resource decline, severe storm events, and climate change.
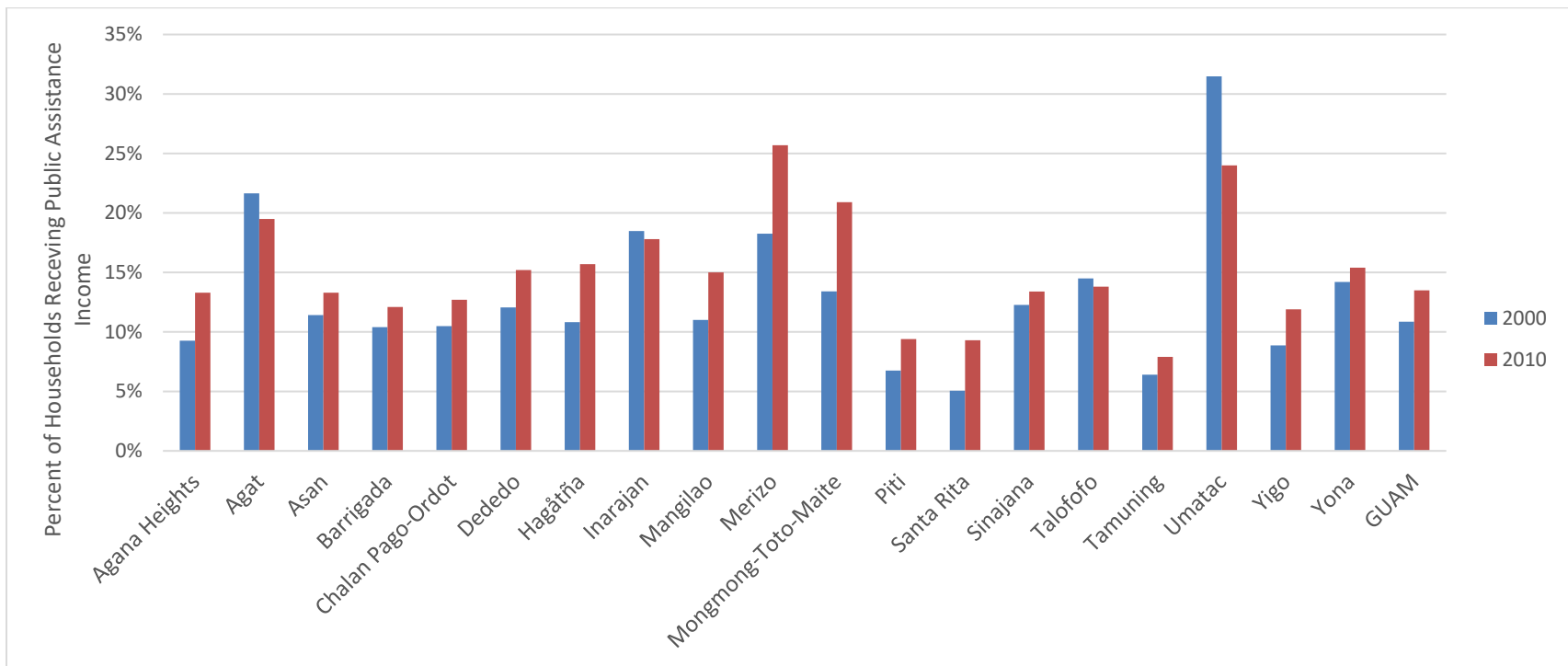
Figure 19: Public assistance in Guam

Source: US Census Bureau, Decennial Census of Population and Housing

Health

Health, both physical and mental, contributes tremendously to individual and population well-being. Measures of life expectancy, mortality, and opportunity for a healthful lifestyle can be used to assess a population's health. Some of the measures that will be used as part of the indicator for health across all jurisdictions include leading cause of death, life expectancy, and three categories of age-adjusted death rates (from all cancers, from heart disease, and overall). The leading cause of death in Guam in 2010 was diseases of the heart (Live Healthy Guam 2011). The average life expectancy (2012) was 78.66 years of age. In 2010, the age-adjusted death rate from all cancers was 133.6 per 100,000 people, the age-adjusted death rate from heart disease was 254.9 per 100,000 people, and the overall age-adjusted death rate was 756.1 per 100,000 people. It is important to track the overall health of the population in relation to the state of the environment, as the impact of environmental stressors on human health has been shown to have severe consequences. For example, a recent report finds that "the air we breathe, the food we eat, the water we drink, and the ecosystems which sustain us are estimated to be responsible for 23% of all deaths worldwide" (UNEP, 2016).

Basic Needs, Access to Social Services, and Education

Basic needs, access to social services, and education are important social dimensions of well-being. The measures for basic needs include those related to the adequacy of housing, access to healthy food, and clean water. Basic needs are linked to the environment and its ability to provide the regulating and provisioning services that are necessary for water, food, and shelter. Of the 2010 US Census Bureau reported figure of 50,567 housing units in Guam, 42,026 (83%) were occupied. Of the occupied housing units, 21,140 (slightly over 50%) were owner-occupied and 20,886 (slightly under 50%) were renter-occupied. In 2010, the median value of owner occupied housing units in Guam was $216,145, and the median age of housing units was 23 years. The average household size in 2010 was 3.67 persons per household. This is a decrease of 5.7% from the figure of 3.89 persons per household reported in 2000. Similarly, the average family size in Guam also decreased by 4.7% from 4.27 persons per family in 2000 to 4.07 persons per family in 2010.

In 2010, 78.9% of the civilian non-institutionalized population in Guam had health insurance coverage. Also as of 2010, 6.7% of occupied households in Guam lacked access to a vehicle and 3.9% of occupied households lacked access to telephone service. Additionally, 10.9% of occupied households in Guam lacked access to complete plumbing (US Census), and similarly, 9.7% of occupied households in Guam lacked access to a complete kitchen (US Census). Further, the 2010 US Census reports that 75.6% of occupied households in Guam had access to a computer or laptop at home; and of those, 91.1% had access to internet service.

One of the key components of community well-being is education. K-12 enrollment, along with high school and college educational attainment will be combined to examine education. Figure 20 shows that in 2010, 79.4% of Guam residents aged 25 and older had completed high school or

higher, and 20.4% of Guam residents aged 25 and older had completed a bachelor's degree or higher. Both of these figures represented an increase in educational attainment since 2000, in which 76.3% of Guam residents aged 25 and older had completed high school or higher, and 20.0% of Guam residents aged 25 and older had completed a bachelor's degree or higher (US Census).
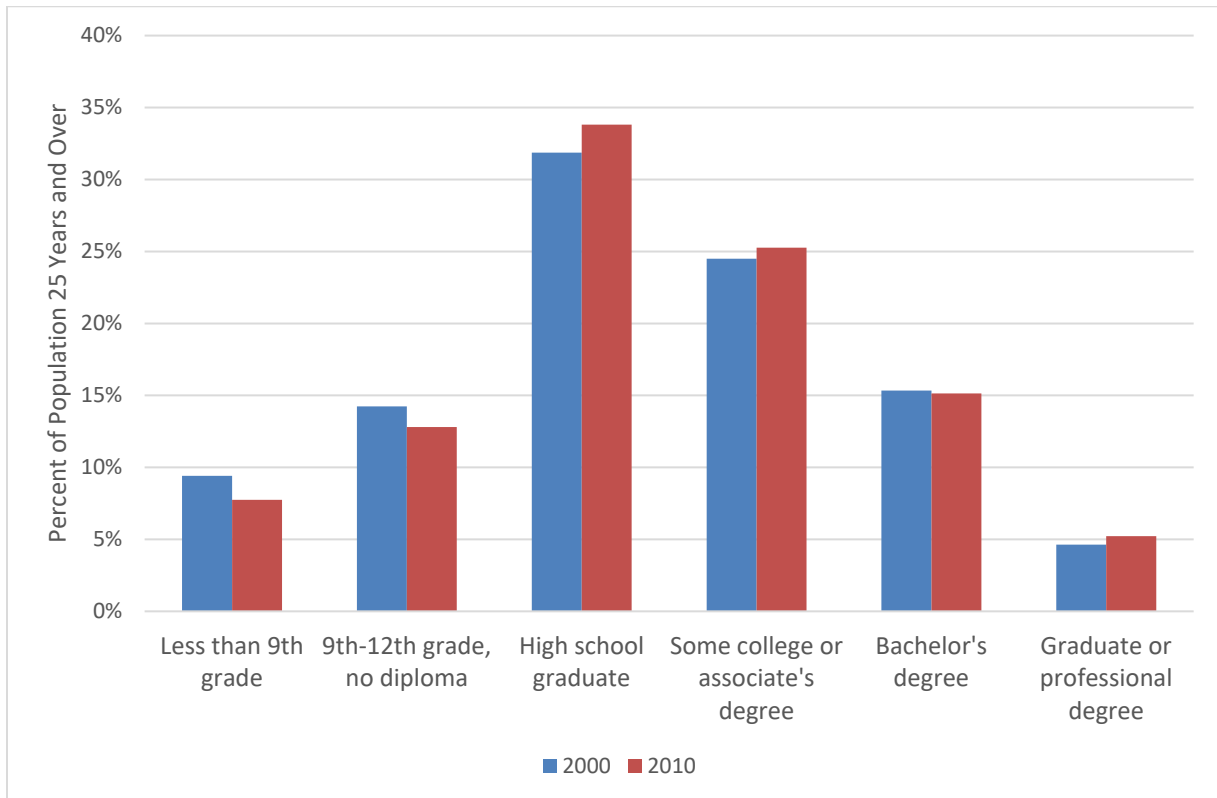
Figure 20: Levels of educational attainment in Guam

Source: US Census Bureau, Decennial Census of Population and Housing

Physical Infrastructure

In addition to the five community well-being indicators, an indicator of physical infrastructure will be monitored in order to track coastal development, access to coastal resources, and waste management/water supply infrastructure. Indicators for physical infrastructure relate to both the human development footprint, as well as the measures in place to mitigate human impacts to the marine environment (e.g., point and non-point sources of land-based pollution, as well as sewage treatment and abatement). Some key aspects of physical infrastructure in Guam are outlined below.

Pollution

Water

One hundred percent of all beaches in Guam were monitored in 2012. All of these beaches were impacted by a beach advisory action, resulting in 51% of beach days being impacted (EPA). As evidenced by Table 7, of the coastal shoreline water bodies in Guam that were assessed, 100% were deemed to be "impaired" in 2010 (EPA). A waterbody is considered "impaired" if any one of its uses is not met ("uses" include aquatic life, recreation, fish/wildlife propagation water supply, fish consumption, etc. and "impairments" can be caused by a variety of things including bacteria, dissolved oxygen, sulfate, algal blooms, metal content, mercury, etc.). Along with the prevalence of pollution in Guam's non-coastal water bodies, this fact indicates that water pollution in Guam is fairly widespread.

Table 7: Guam water quality assessment report; 2010

	Rivers and Streams (miles)	Wetlands (acres)	Bays and Estuaries (sq miles)	Coastal Shoreline (miles)
Good waters	55.7	0.0	20.4	0.0
Previously impaired waters now attaining all uses	0.0	0.0	0.0	0.0
Threatened Waters	0.0	0.0	0.0	0.0
Impaired Waters	29.0	6.4	14.8	16.1
Total Assessed Waters	84.7	6.4	35.1	16.1
Total Waters	228.7	915.0	116.5	1,795.4
Percent of Waters Assessed	37.0%	3.8%	13.8%	0.4%
Percent of Assessed Waters that are impaired	34.2%	100%	42.2%	100%

Source: US Environmental Protection Agency; Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS)

Air

In 2012, Guam produced over 85.87 kilotons of greenhouse gas emissions, 1.68 kilotons of which were nitrous oxide emissions, and 71.49 kilotons of which were methane emissions (World Bank).

Land cover

Impervious land cover is a good indicator of development and is also associated with land-based pollution that can damage coral reefs. Table 8 shows that Guam had a total of 58.1 square kilometers of impervious cover out of a total of 595.4 square kilometers of land area in 2011; or that approximately 9.76% of Guam is impervious cover (NOAA Digital Coast, C-CAP).

Table 8: Impervious surfaces in Guam, 2011

Island	Total Land Area (Sq. km)	Impervious Cover (Sq. km)	Percent of Impervious Cover
Guam	595.4	58.1	9.76

Source: 2010 US Census Bureau, Decennial Census of Population and Housing and NOAA C-CAP

As of 2005, the development of man-made shorelines in Guam reached a total of 36.38 km (22.61 miles), or about 15% of the recorded total, while sandy shoreline represented 85.05 km (52.85 miles), or about 35% of the recorded total (NOAA/OR&R, 2005). For the purposes of this report, man-made shoreline includes: sheltered solid man-made structures (wooden or concrete seawalls, boat docks, and the like that are not directly exposed to the ocean); riprap (large stones or other large rough cut solid materials placed on the shore to prevent or reduce erosion due to wave action); and, sheltered riprap (large stones or other large rough cut solid materials placed on shore in an area not exposed to the ocean in order to prevent or reduce erosion due to wave action). Sandy shoreline type classifications include: "fine to medium grained sand beaches" and "mixed sand and gravel beaches."

Most of the development in Guam lies on the coast, with the island's most densely populated and urbanized region being near Agana Bay and Tumon Bay areas on the west central coast of the island. As one ventures to the northern and southern coasts of the island, communities become more rural as development becomes progressively less dense.

Construction Permits

Construction permits are indicative of development trends, and data concerning these permits are utilized here to further operationalize the indicator of physical infrastructure. As of 2015, the number of construction permits granted had increased by 24% and the value of construction permits (in inflation adjusted dollars) had decreased by 27% since 2009 (Table 9). The number of construction permits granted in Guam has been increasing since 2011, with a slight dip in 2015, while the value of construction permits took a large dip from 2014 to 2015 (Office of the Governor of Guam, 2016). In 2015, 539 of the 1,378 construction permits granted (39%) were for residential structures, and the village with the most granted permits overall was Tamuning with 356 (26% of the total). Further, there is expected to be increasing coastal development in Guam in the coming years with the forthcoming transfer of US marines previously stationed in Okinawa, Japan, and the subsequent construction of military infrastructure on a 400-acre plot of coastal land slated to begin in 2020 (Raymundo and Williams 2017).

Table 9: Construction Permits in Guam; 2009-2015

Year	Number of construction permits	Value of construction permits (nominal dollars)	Value of construction permits (constant 2015 dollars)
2009	1,115	$262,471,000	$289,973,706
2010	1,112	$278,246,000	$302,440,805
2011	937	$217,969,000	$229,672,749
2012	1,085	$363,955,000	$375,722,023
2013	1,636	$324,121,000	$329,769,816
2014	1,688	$423,212,000	$423,714,343
2015	1,378	$212,949,000	$212,949,000

Source: Office of the Governor of Guam; Bureau of Statistics and Plans; 2015 Guam Statistical Yearbook

Waste Management and Water Supply

Of Guam's 50,567 occupied housing units in 2010, 36,624 (72.4%) used public sewers, and 13,943 (27.6%) used septic tanks, cesspools, or some other means of sewage treatment (US Census). There are seven wastewater treatment facilities in Guam (Figure 21). The Hagåtña WWTF and Northern District WWTF are regional facilities providing wastewater treatment for a number of villages as well as for Andersen Air Force Base. The five remaining WWTFs provide wastewater treatment for their respective villages (Guam Water Works, 2017). The main landfill in Guam is the Layon landfill located in the southern part of Guam near Inarajan. The old Ordot landfill was closed in 2011 due to high levels of contaminant discharge (Guam Solid Waste Authority, 2011).
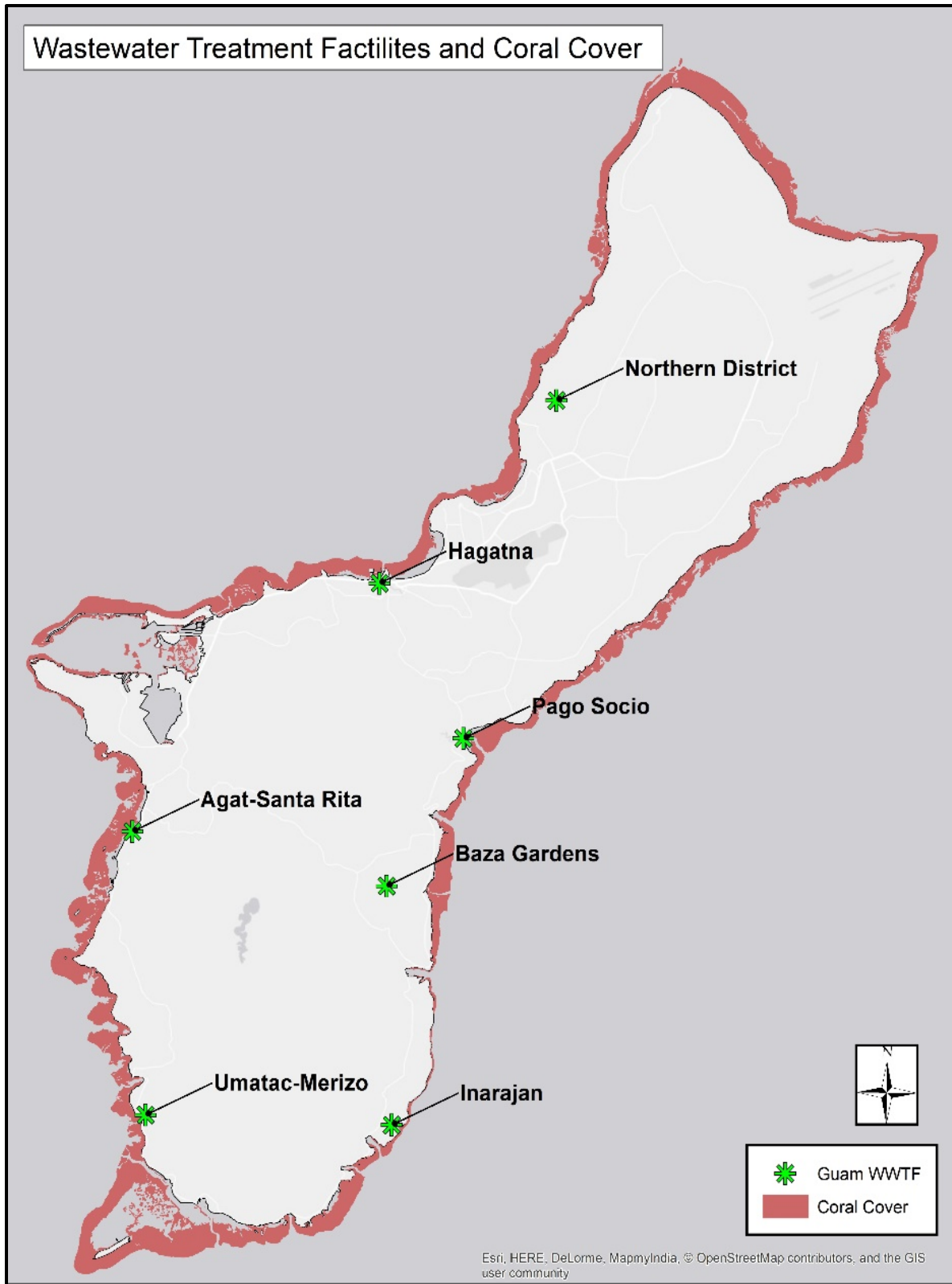
Figure 21: The proximity of wastewater treatment facilities to coral reef cover in Guam

As of 2006, there are three water sources in Guam: wells, springs, and surface water. There are 120 wells (18 of which are inactive), and all active wells are in the northern region of the island (Guam Waterworks Authority, 2006). There are five springs, three of which are in the central region, and two of which are in the southern region. Additionally, there are two surface water treatment plants: the US Navy's Fena Water Treatment Plant (serves customers part of the southern and most of the central region) and the Ugum Water Treatment Plant (serves customers in most of the southern region) (Guam Waterworks Authority, 2006). As of 2015, 99.5% of Guam's population has access to an improved water source (World Bank).

Physical Access to Coastal Resources

As of 2012, there are 44 identified beaches in Guam, and all 44 are considered to be publically accessible, as shown in Figure 22 (Guam Bureau of Statistics & Plans, 2012). Out of 150.44 miles of shoreline, 30.73 miles are publically accessible beaches, or 20.4% of the total. Additionally, there are 8 documented boat ramps and 9 documented marinas in Guam, as partially shown in Figure 23 (NOAA OR&R, 2005).
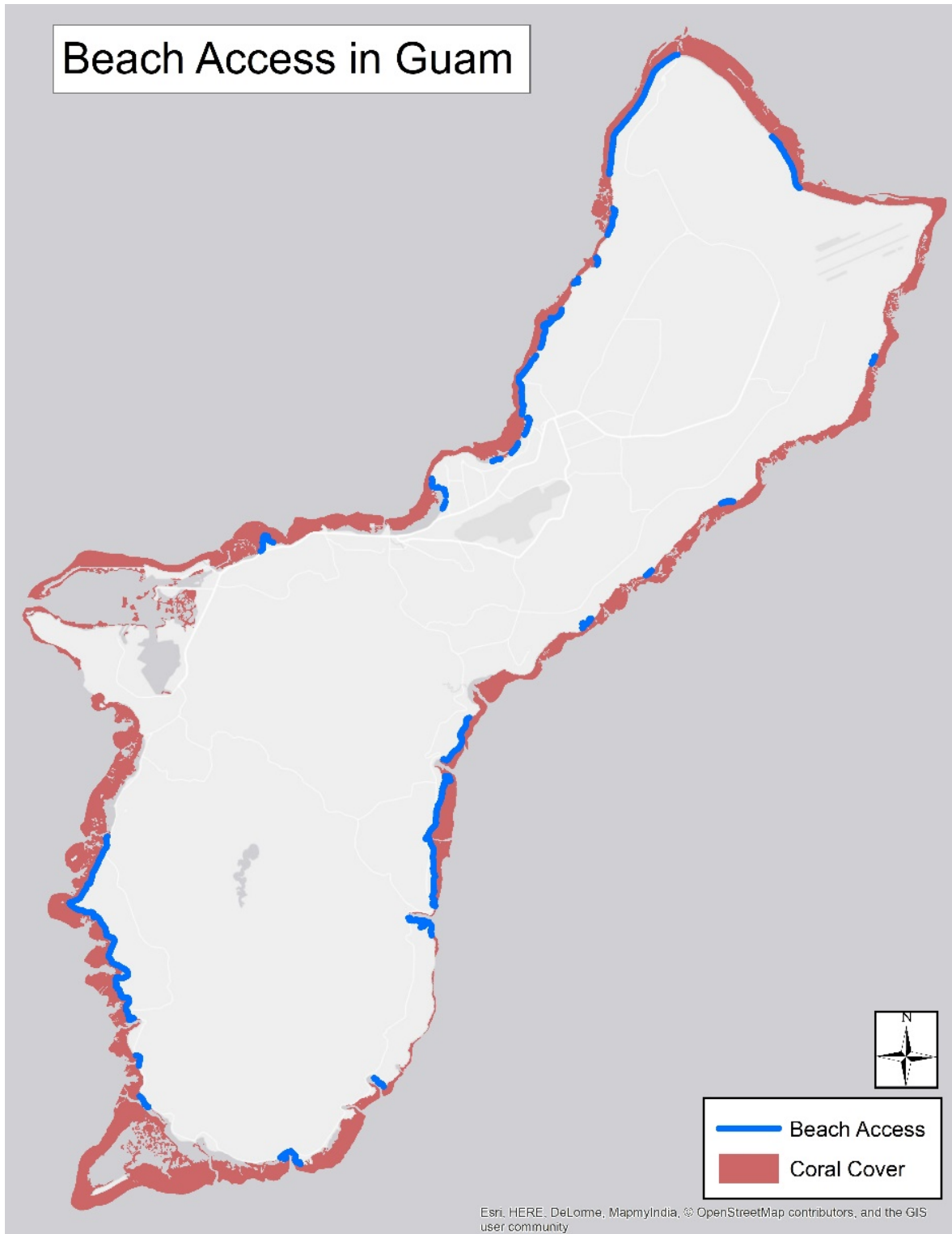
Figure 22: Beach Access in Guam

Source: EPA BEACON, 2018
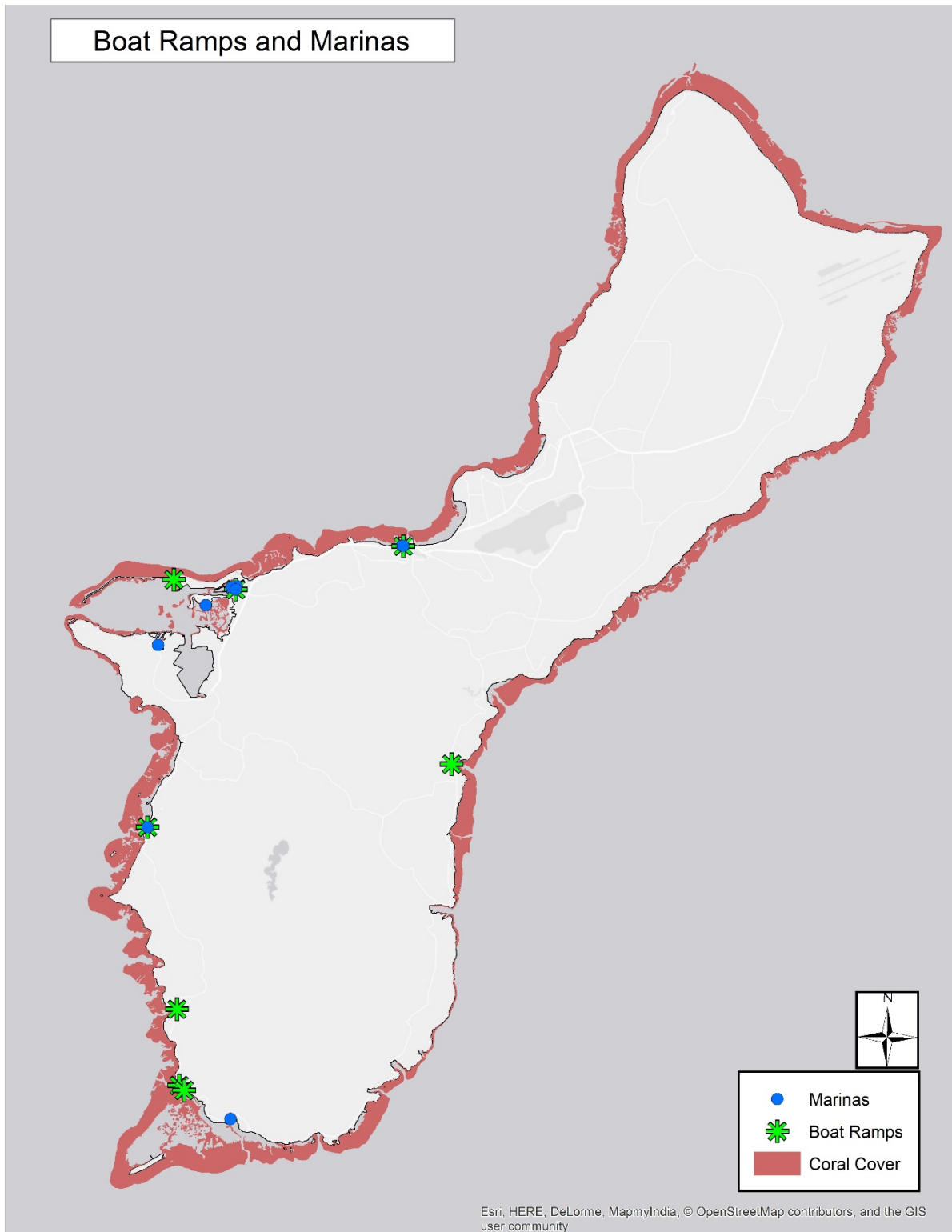
Figure 23: Marine facilities in Guam

Economic activities related to reefs

Also relevant to the NCRMP socioeconomic monitoring component are the various economic activities taking place along the coast. These activities can have direct and indirect impacts on coral reefs, and are outlined below.

Fishing

Much of fishing in Guam, both commercial and recreational, is coral reef dependent. Coral reefs provide the habitat that is necessary for several commercially important fish species such as snapper, grouper, spiny lobster, and parrotfish. It has been shown that when coral reefs are healthier and more widespread, fish biomass and abundance increase as well (Vincent *et al.,* 2011; Friedlander and DeMartini, 2002); therefore, the health of coral reefs is an important driver of commercial and recreational fishing harvest and value. While healthy coral reef ecosystems directly impact coral reef fish species, it is also important to note that coral reef ecosystems still support pelagic fish populations and health as they provide critical nursery habitat for juveniles (Thorrold and Williams, 1996; Doherty and Carleton, 1997) and act as a food source for pelagic species that venture near the coast, such as sharks (Roff *et al.,* 2016).

Table 10 displays time-series data from the Pacific Islands Fisheries Science Center (PIFSC) concerning commercial coral reef and bottom fish harvest in Guam for the years 2000-2015. Although the overall trend is downward for total harvest and for harvest value, there have been spikes upward (2003-2005 and 2008-2009) throughout this time period as well. Since 2000, Guam's commercial coral reef and bottom fishery harvest in pounds has decreased by 81% and Guam's commercial coral reef and bottom fishery harvest value in inflation-adjusted 2015 dollars has decreased by 85%, indicating that the coral reef ecosystem has lost some of its commercial fishing value over this time. Coral reef and bottom fish species accounted for 30% of total species harvested in 2015.

Subsistence fishing plays a large role in Guam, in which the subsistence/commercial ratio is about 30/70 (i.e. subsistence fishing accounts for 30% of landings). Using this ratio, subsistence landings can be estimated to be 60,262 lbs in 2015 and be worth $144,072 in constant 2015 dollars. The contribution of fishing to Guam's GDP was $1.36 million in 2014 (0.03% of Guam's total GDP). As of 2007, fisheries in Guam supported 1,565 full time fishers, 60 part time fishers, and 170 occasional fishers (Gillett, 2016).

Table 10: Commercial fishing harvest for all coral reef and bottom fish species in Guam, 2000-2015[5]

Year	Harvest (lbs)	Value of Harvest (nominal dollars)	Value of Harvest (constant 2015 dollars)
2000	226,465	$685,092	$942,964
2001	213,041	$624,100	$835,247
2002	156,680	$432,286	$569,534
2003	80,653	$232,888	$299,991
2004	111,144	$316,242	$396,796
2005	144,378	$420,633	$510,482
2006	143,113	$417,071	$490,342
2007	149,183	$430,827	$492,587
2008	139,326	$420,274	$462,660
2009	150,512	$469,919	$519,159
2010	136,627	$430,775	$468,233
2011	114,225	$362,244	$381,695
2012	72,245	$235,509	$243,123
2013	58,180	$190,006	$193,317
2014	63,870	$211,876	$212,127
2015	42,760	$142,715	$142,715

Source: Pacific Islands Fisheries Science Center; Western Pacific Fisheries Information Network

Hospital and Beavers (2012) surveyed 145 small boat fishermen in Guam, and found that just over 8% of fishing trips taken by small boat fishermen in Guam are primarily targeting reef fish species, and 85% of these small boat fishermen acknowledge reef fish as an important source of food. Fishermen also reported an average reef fish trip to cost approximately $116 (median of $85).

The NCRMP socioeconomic survey asks respondents about how coral reefs contribute to their island's culture, and in the Guam iteration of the survey, 97% of Guam residents agreed with the statement that coral reefs are important to their island's culture. Van Beukering *et al.* (2007) quantified the non-market value of cultural activities related to coral reefs and found that the cultural value of coral reefs is approximately $43 per household per year on Guam, with aggregate cultural value ranging from $859,544 to $5,976,932 per year, depending on assumptions concerning household dependence on fishing.

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[5] Species included in these figures include: goatfishes, parrotfishes, wrasses, rabbitfishes, rudderfish, snappers, squirrelfishes, surgeonfishes, sweetlips, unicornfishes, groupers, jacks, amberjack, lehi, emperors, black jacks, deep bottomfishes, alfonsin, and other unknown reef/bottom fish.

Snorkeling/Diving

Each year, Guam's reefs host over 300,000 tourist snorkelers and 100,000 tourist scuba divers (QMark Research 2016a, 2016b). Divers/snorkel tourism generates economic value on the island and provides jobs, while also facilitating more human contact with the coral reef ecosystem.

A survey of divers in Guam was administered in 2013 to understand divers' willingness to pay (WTP) for improved coral reef conditions. Table 11 outlines the findings. Divers in Guam are, on average, willing to pay the most for improved conditions of sharks and turtles, and willing to pay the least for sharks alone (Grafeld *et al.,* 2016).

Table 11: Diver willingness to pay for ecological attributes of a coral reef environment

Attribute	Average WTP	Lower limit	Upper limit
High Biomass	$13.48	$3.15	$23.82
High Diversity	$13.33	$2.94	$23.72
Many wrasse	$8.95	$1.54	$15.36
Sharks alone	$3.86	-$1.49	$9.21
Turtles alone	$16.27	$3.71	$28.83
Sharks and Turtles	$35.14	$9.38	$60.91

Source: Grafeld *et al.* 2016

Tourism

The World Bank indicates that international tourism arrivals have fluctuated over the years in Guam; however, they have been increasing since 2011 (Figure 24). The tourism industry, which welcomed 1.54 million visitors in 2017, supports over 21,000 jobs annually, representing 34% of total employment (Guam Visitors Bureau 2018), indicating a notable reliance upon the tourism sector. Coral reef tourism is a major driver of these numbers, contributing $323 million per year to Guam's local economy (Spalding *et al.,* 2016). In addition, over 30% of visitors list the coastal and marine environment or ocean-related activities as a top reason for visiting Guam (Guam Visitors Bureau 2018).
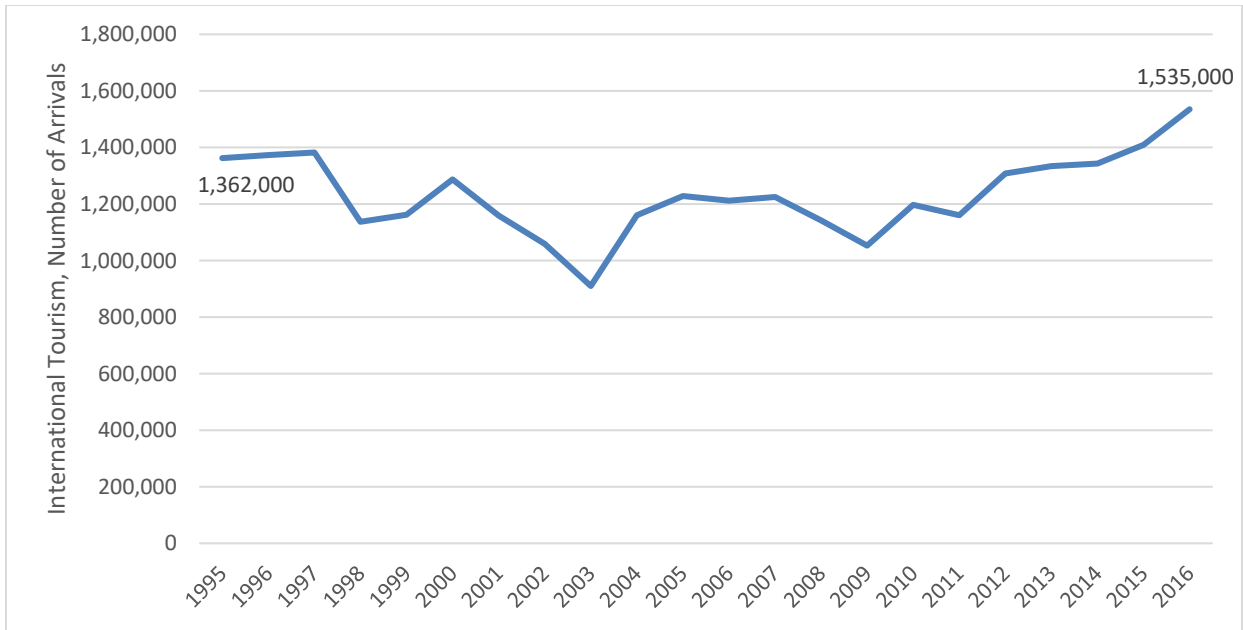
Figure 24: Guam's international tourism arrivals, 1995-2016

Source: World Bank

Tourism in Guam (Photo Credit: Pacific Daily News)

Results: Combination of Primary and Secondary Data Indicators

The final section of results presents Governance as an example of an indicator that will be measured through a combination of NCRMP survey data as well as secondary data. Below, examples of both types of measures are featured. The measurements concerning the sources of coral reef-related information, the level of trust for each information source, and involvement in coral reef decision making come from NCRMP survey data, while all other facets of the governance indicator were derived from secondary data sources.

Governance

Governance measures such as public trust in information sources, percent areas of coral reefs under management or protection, level of community involvement in decision making/local reef governance, and the presence, longevity, and focus of MPAs and other marine managed areas were used to assess governance related to coral reefs and the marine environment for Guam.

Sources of coral reef-related information and level of trust

Seventy-two percent of respondents indicated that they use the newspaper as a source for information pertaining to coral reefs (first, second, or third choice). Respondents' top 3 sources for information about coral reefs and the environment were newspaper, TV, and radio (Figure 25). The least used information sources were non-profit organizations and community leaders. Respondents were then asked to rate their trustworthiness of each of the information sources that they indicated they used (Figure 26).
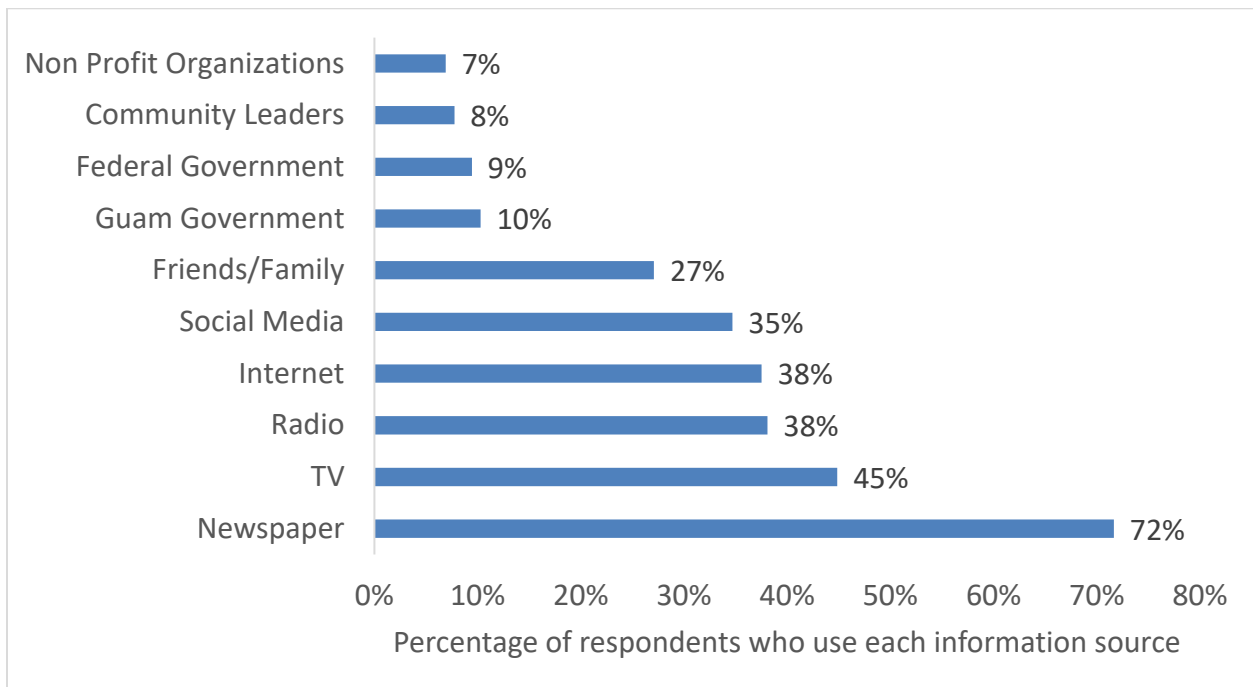
Figure 25: Top sources of information on coral reefs (n = 709)
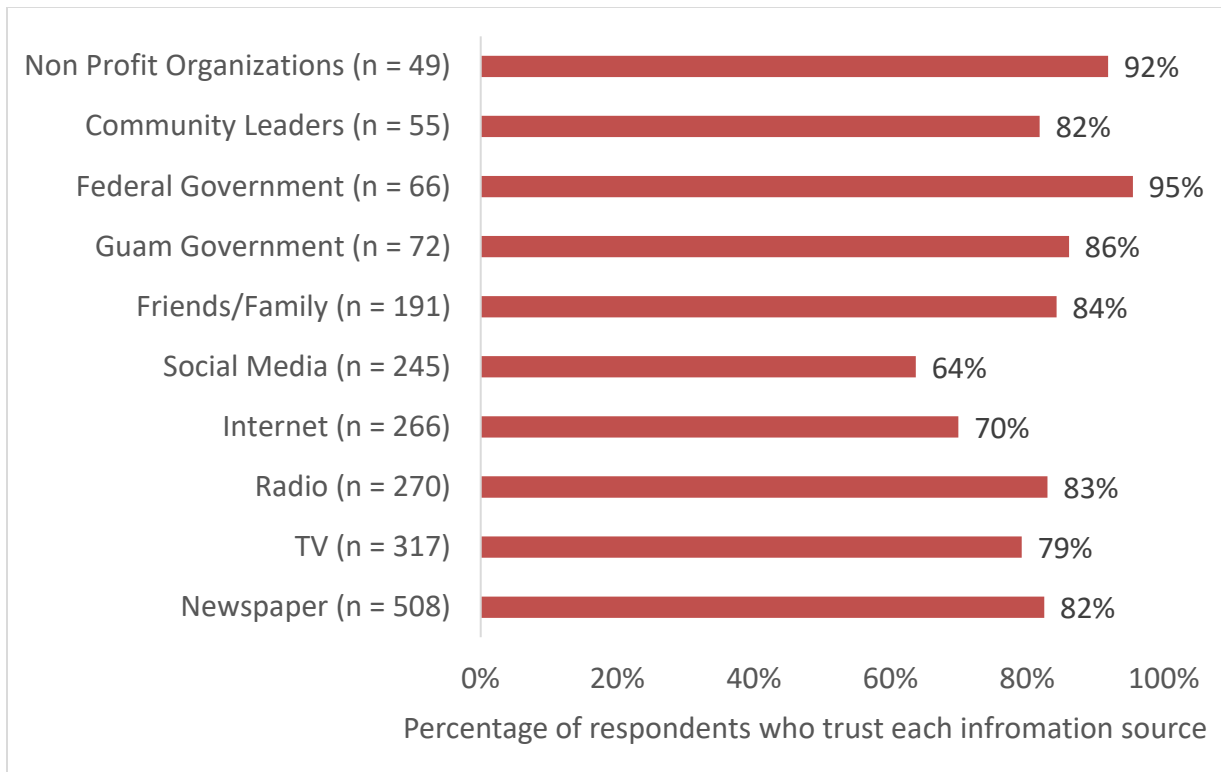
Figure 26: Respondent level of trust in each coral reef information source

Respondents also ranked their top three information sources in terms of how much they trusted each source. For those who listed these information sources, 82% (newspaper), 79% (television), and 83% (radio) of respondents indicated that these sources are "very trustworthy" or "trustworthy" (Figure 26). According to respondents, the information sources that people trusted most (when they used them) were the federal government (95%) and non-profit organizations (92%), whereas the information sources found to be least trustworthy ("very untrustworthy" or "untrustworthy") by people who use them were social media (6%) and community leaders (5%).

Involvement in coral reef management decision making
Survey respondents in Guam were asked how much they felt their communities were involved in protecting and managing coral reefs. Of the 711 that responded, 49% stated that communities were at least "moderately involved," and 8% stated that communities were "not at all involved." Respondents were also asked this question at the individual level, and of the 452 that responded, 36% indicated that they themselves were at least "moderately involved" in decisions related to protecting and managing coral reefs, and 31% indicated that they were "not at all involved." With respect to quantifying the opportunities in place for residents to get involved in the protection and management of coral reefs in Guam, of the 708 that responded, 38% of respondents indicated that there were "never" any opportunities to get involved, and 7% of respondents felt that there were "frequent" opportunities to get involved.

Other governance indicators

Based on the 2014 NOAA Marine Protected Areas (MPA) Inventory, 75% of all marine managed areas in Guam had management plans in place (Table 12). The oldest inventoried marine managed area was established in 1974, while others were established as recently as 1997. Of the inventoried marine managed areas, sustainable production was the primary focus of 5 areas, cultural heritage was the primary focus of 4, and natural heritage was the primary focus of 3. Additionally, commercial and recreational fishing were prohibited at one of the marine managed areas. Investigation shows that 33.6% of the mapped coral reef ecosystems in and around Guam were under some form of management regime.[6] However, it should be noted that this analysis of known coral reef habitat falling within management boundaries is not intended to equate to an assessment of management adequacy or efficacy. Additional metrics would be required for this type of evaluation.

A survey completed by PIFSC found that 71% of Guam residents have never heard of the Marianas Trench National Marine Monument; however, after receiving information about the monument through completing the survey, 72% of Guam residents indicated that they support the monument. Furthermore, Guam residents most often reported moderate or strong confidence in federal agencies' ability to manage the monument. (Kotowicz and Allen, 2015).

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[6] Data regarding coral reef cover was obtained from NOAA's NCCOS Data Collections portal: https://products.coastalscience.noaa.gov/collections/benthic/e99us_pac/data_guam.aspx
Marine Protected Area data was obtained from NOAA's Marine Protected Inventory portal: https://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/

Table 12: Details of the Marine Managed Areas of Guam

Site Name	Government Level	Management Plan	Area (sq km)
Pati Point	Territorial	MPA Programmatic Management Plan	19.95
Sasa Bay	Territorial	MPA Programmatic Management Plan	2.13
Tumon Bay	Territorial	MPA Programmatic Management Plan	4.52
Tokai Maru	Partnership	No Management Plan	0.28
Cormoran	Partnership	No Management Plan	0.28
Aratama Maru	Partnership	No Management Plan	0.22
Haputo Ecological Reserve Area	Federal	Site-Specific Management Plan	0.57
Piti Bomb Holes	Territorial	MPA Programmatic Management Plan	3.57
Orote Ecological Reserve Area	Federal	Site-Specific Management Plan	0.67
Achang Reef Flat	Territorial	MPA Programmatic Management Plan	4.55
Guam National Wildlife Refuge	Federal	Site-Specific Management Plan	13.73
War in the Pacific National Historical Park	Federal	Site-Specific Management Plan	4.30
			54.77

Source: 2014 NOAA Marine Protected Areas Inventory

Discussion

Based on the survey findings, a few general conclusions about the population of Guam and their interactions with and knowledge/awareness of coral reefs can be made. These can be considered preliminary findings, and more detailed analyses of this data are planned for the future. We conclude this section by proposing directions for future research.

With respect to participation in reef activities, study findings indicate that Guam residents participate in purely recreational coral reef related activities (SCUBA diving, snorkeling) at varying frequencies, with swimming/wading and beach recreation being the most common activities. It should be noted that the reported activity participation rates presented in this report represent conservative estimates for Guam's coastal communities, as these estimates do not take the participation rates of tourists into account; which if combined with resident participation, would result in an overall higher rate of marine activity participation.

Fishing and gathering of marine resources are both practiced in Guam, but do not occur as frequently as swimming or beach recreation. Our findings show that 30% of households stated that they engaged in fishing from shore, fishing from a boat, or gathering. The survey found that 66% of households consumed fish/seafood once a week or more, and that most fishers (80%) did not sell the fish they catch; however, it is uncertain what proportion of fishing targeted coral reef species, as this distinction was not specified in the survey. This distinction was made, however, when asking about seafood consumption, indicating that 29% of Guam residents consume reef fish/seafood at least once a week. Additionally, seafood consumed by Guam residents is predominantly purchased in supermarkets, grocery stores, and restaurants.

Survey respondents were asked about their perceptions of the health of Guam's coral reef resources. The findings showed that residents generally perceived **marine resource conditions** to be average, with most residents believing that ocean water quality and beach quality condition to be good and the number of turtles to be bad. However, residents tended to have a more negative perception concerning the change in marine resources over the last decade (that is, residents perceived that the condition of marine resources have worsened over time). When examining the effect of tenure (i.e. how long a resident has lived in the jurisdiction), it was found that residents who have lived in Guam for their entire life had a more positive perception concerning the change in condition of marine resources over the last decade, as well as a more positive perception concerning the current condition of ocean water quality. Differences in perceptions concerning marine resource condition were identified between respondents based on

village of residence. The initial results provide strong support for continued exploration and analysis of the parameter "differences in perception" as future data collections allow for greater sample sizes. If perceptions of coral reef health truly vary by location, this may correlate to differing resource quality in different regions, which could, in part, explain the lack of consensus across villages concerning the condition of marine resources.

Regarding the public's **awareness and knowledge of coral reefs**, this study found that the majority of the population stated that they are familiar with threats facing coral reefs (except coral bleaching, invasive species, and damage from small watercrafts). That being said, 29% believed that the condition of coral reef resources would get worse in the next 10 years, and over half believed that the threats to coral reefs are "large" or "extreme." This suggests varying levels of confidence amongst Guam residents that current threats to coral reefs are being (or can be) effectively addressed by current efforts.

The study found that the public's **attitudes towards coral reef management strategies and enforcement** were largely positive. Residents expressed support for all of the potential marine management measures, some of which are in use in various parts of Guam. In particular, 89% of the respondents supported permit and certification requirements for water sports tour operators. The least supported management option was "Lower the number of sea cucumbers allowed per person" (however, 76% still support this, further exemplifying the widespread resident support for management). When examining resident perceptions of marine preserves, the overall sentiment toward them was positive; 75% agreed that there should be more marine preserves in Guam and 93% agreed that marine preserves increase the number of fish. There was some disagreement, however, over whether marine preserves have negatively impacted fishermen's lives in Guam (42% agree, 38% disagree, 13% neither). Furthermore, residents that were found to be more reliant on coral reefs for sustenance were more likely to agree that there should be fewer marine preserves in Guam. Fishing regulations were updated and all marine preserves on Guam were established in 1997, so to further explore potential patterns in the data, the total pool of respondents was divided into sub-groups based on if they were 18 or over or younger than 18 in 1997 when the marine preserves were established. It was found that when compared to those who were adults in 1997, children in 1997 were more likely to agree more with the statements "Marine preserves help increase tourism in Guam" and "The establishment of marine preserves increases the likelihood that people will vacation in Guam." They were also more likely to agree less with the various management options proposed in the survey. Given the range of management options presented in the survey and the potential for these options to be applied in

various combinations, this question was developed to provide a range of important feedback to resource managers. The responses allowed for evaluation of both support for each option, as well as the reaction to the particular words used to describe the management strategy. For example, although some marine preserves may limit recreational use, 92% of respondents indicated that they "generally support the establishment of MPAs;" however, when asked about limiting SCUBA spear fishing alone, 70% of respondents agreed with this option.

The research team also attempted to track public participation and attitudes with respect to the **governance** of coral reefs and their resources. It was found that 75% of all marine managed areas in Guam had management plans in place, and 33.6% of all coral reef habitat was under some form of management. There appeared to be a moderate level of community involvement in coral reef decision making, as well as a high involvement in pro-environmental behavior aimed at improving the health of the marine environment and coral reefs (58% of survey respondents indicated that they participate in pro-environmental behavior). The survey also found that Guam residents rarely relied on the federal government for information regarding coral reef topics even though the federal government was rated as the most trustworthy information source by those who use it as a source of information.

The collection of **secondary data,** including economic impacts of tourism and fishing, as well as data contributing to the development of some of the community well-being indicators, will continue over time. As updated data sets are produced by other NOAA offices and relevant agencies, these will be collected, synthesized and housed within a centralized database, and will be used to track changes over time. These data may be incorporated into indicators that combine or compare biophysical parameters (e.g., fish biomass) with commercial landings data and public perceptions of general reef health. It is notable that population growth and net increase in population density in Guam may have a potential impact on coral reef resources. Net growth could result in increased demand for coral reef ecosystem services including recreation and provisioning (food, products). Growth could also result in increases in impervious surfaces due to general urbanization as well as higher volumes of solid and sewage waste production, which in turn, can add more stress to coral reef ecosystems in Guam.

Future approaches and research ideas
There were a few lessons learned from this first NCRMP socioeconomic data collection in Guam. As similar surveys are implemented across other US coral reef jurisdictions, the NCRMP team will be making adjustments to the data collection effort to improve on the type of

information generated. These findings can be considered as a starting point from which more detailed research questions could be developed for future work. For example, there was a need to distinguish between locally caught and imported fish as it relates to the seafood consumption questions. In this Guam-based iteration of the NCRMP socioeconomic survey, the research team differentiated between fish/seafood consumption and coral reef fish/seafood consumption in the survey questionnaire for the first time. The monitoring team will also aim to improve the level of comparability of questions across the different jurisdictions while maintaining questions that will provide information specifically relevant to the local context and management needs in Guam.

Another future research direction is to conduct analyses that explore relationships between different socioeconomic indicators, as well as comparisons between sub-populations as defined by the sampled respondents. These may include categories such as; age, gender, or familiarity with coral reefs, among others. For example, our results showed that there was a difference in the perceptions of those who fish/gather versus those who do not fish/gather in relation to their attitudes towards some statements concerning marine preserves. These findings indicate that non-fishermen were more likely to agree that there should be more marine preserves in Guam and that marine preserves have had an economic benefit; however, these non-fishermen were less likely to state that they are familiar with MPAs. Additional future analysis will include an examination of the possible statistically significant differences in resident agreement levels pertaining to limited entry and access management measures versus top-down management measures in order to understand what types of management strategies are best suited to foster support and adherence amongst the population.

Other potential improvements include the elicitation of public awareness of climate change and ocean acidification and their potential impacts on humans. This might include adaptation measures that are perceived to be more effective for community resiliency. Subsequent improvements to the survey instrument might include better distinguishing the sources of information on coral reefs and level of trustworthiness. This would provide information that could be incorporated into specific public outreach and education programs for current and future management measures.

The NCRMP socioeconomic data collection builds on and supplements the considerable social science research that has been conducted in Guam to date. Integrating NCRMP data with these studies, or comparing and contrasting findings, has the potential to provide a more complete understanding of human interactions with coral reef resources in the territory. For example, Brander and van Beukering (2013) found that Guam's coral reefs provide an estimated $139

million in ecosystem service benefits per year to humans in year 2007 dollars (includes tourism, recreation, commercial fishery harvest, amenity value, coastal protection, and research value). The socioeconomic monitoring data collected through NCRMP provides further evidence of the contribution of Guam's coral reefs to the economic stability of the communities of the island.

By coupling studies like these with socioeconomic monitoring of coral reef-adjacent communities, we can help provide managers with useful information for determining resource management needs that will align to communities' use and value for the resource. At the highest level, NCRMP socioeconomic data are intended to allow for analyses across jurisdictions and regions (e.g. comparisons of Pacific to Caribbean) and within a single jurisdiction over time. These investigations will largely be aimed at answering questions related to the success of US coral reef conservation efforts.

In future years, NCRMP will continue to increase sample sizes to strengthen the survey's statistical representation at smaller geographic scales within each jurisdiction. For example, in Guam, we intend to adjust our jurisdictional sampling schedule to enable us to increase the total sample size so that we can survey representative samples of each village. This enhanced sample will enable comparisons between areas with very different populations, levels of coastal development, and coral reef management. Sampling at a finer geographic scale would allow for more nuanced comparisons across the island of Guam. For example, a socioeconomic assessment was conducted in the Guam village of Merizo in 2016 (Wongbusarakum *et al.,* 2018). Findings from that study indicate some key differences when comparing the NCRMP results for the entire island of Guam to these results from Merizo. For instance, Merizo residents were, on average, more likely to fish to feed themselves/their family (t=6.60, p<0.01) and more likely to participate in pro-environmental behavior (t=22.03, p<0.01) when compared to Guam residents overall. This study in Merizo indicates that human use; knowledge, attitudes, and perceptions; management support; and other social characteristics can vary across Guam. This study also provides evidence that sampling at a smaller geographic scale would provide natural resource managers and stakeholders with better, more site-specific information. Expanding our survey sample will also improve our ability to compare NCRMP socioeconomic data to biophysical data collected through NCRMP and jurisdictional agencies (for instance, comparing perceived coral reef resource condition to biological indicators), and to inform coral reef management and monitoring across the entire jurisdiction. Finally, ongoing analyses of the individual metrics presented here will move us toward reporting the survey and secondary data collection results for a variety of composite indicators such as governance and perceived resource condition. These indicators will

aid in comparisons across jurisdictions, where individual metrics may not be the same. Further, the use of indicators will support communication of complex data in a way that facilitates resource management decision making.

Giant clam in coral reef habitat off the coast of Guam (Photo credit: NOAA)

References

Bauman, A., B. Smith, L. Stoker, B. Bellew, and M. Booth 1999. "Geographical Influences Upon Physical Activity Participation: Evidence of a 'Coastal Effect'." Australian and New Zealand Journal of Public Health 23(3):322-24.

Brander, L., and P. van Beukering. 2013. "The Total Economic Value of U.S. Coral Reefs: A Review of the Literature." NOAA Coral Reef Conservation Program. Silver Spring, MD. Pp. 28.

Brewer, T.D., J.E. Cinner, A. Green, and R.L. Pressey. 2013. "Effects of human population density and proximity to markets on coral reef fishes vulnerable to extinction by fishing." Conservation Biology 27(3): 443-452.

Burdick, D., V. Brown, J. Asher, M. Gawell, L. Goldman, A. Hall, J. Kenyon, T. Leberer, E. Lundblad, J. McIlwainm J. Miller, D. Minton, M. Nadon, N. Pioppi, L. Raymundo, B. Richards, R. Schroeder, P. Schupp, E. Smith, and B. Zgliczynski. 2008. "The State of Coral Reef Ecosystems of Guam. pp. 465-509. In: J.E. Waddell and A.M. Clarke (eds.), "The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008." NOAA Technical Memorandum NOS NCCOS 73. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. Silver Spring, MD. Pp. 569

Butler, C., and W. Oluoch-Kosura. 2006. "Linking Future Ecosystem Services and Future Human Well-Being." Ecology & Society 11(1):1-16.

Costanza, R., B. Fisher, S. Ali, C. Beer, L. Bond, R. Boumans, N.L. Danigelis, J. Dickinson, C. Elliot, J. Farley, D.E. Gayer, L.M. Glenn, T. Hudspeth, D. Mahoney, L. McCahil, B. McIntosh, B. Reed, S. A T. Rizui, D.M. Rizzo, T. Simpatico and R. Snapp. 2007. "Quality of Life: An Approach Integrating Opportunities, Human Needs, and Subjective Well-Being." Ecological Economics 61:267-76.

Costanza, R. R. D'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van den Belt. 1997. "The Value of the World's Ecosystem Services and Natural Capital." Nature 387: 253-260.

Crossett, K. M., C. G. Clement and S. O. Rohmann. 2008. "Demographic Baseline Report of US Territories and Counties Adjacent to Coral Reef Habitats." Edited by Department of Commerce: NOAA NOS CRCP. Silver Spring, MD. Pp. 65.

Dillard, M. K., T. L. Goedeke, S. Lovelace, and A. Orthmeyer. 2013. "Monitoring Well-being and Changing Environmental Conditions in Coastal Communities: Development of an Assessment Method." NOAA Technical Memorandum NOS NCCOS 174. Silver Spring, MD. Pp. 176.

Dillman, Don A. 1978. "Mail and Telephone Surveys: The Total Design Method." New York: Wiley-Interscience.

Dillman, Don A, J.D. Smyth, and L.M. Christian. 2009. "Internet, mail and mixed-mode surveys: The Tailored Design Method," (3rd ed.). Hoboken, NJ: John Wiley.

Doherty, P.J. and J.H. Carleton. 1997. "The Distribution and Abundance of Pelagic Juvenile Fish Near Grub Reef, Central Great Barrier Reef. In: H.A. Lessios and I.G. Macintyre (eds.). Proceedings of the 8th International Coral Reef Symposium Vol. 2. Smithsonian Tropical Research Institute, Panama. 1155-1160.

Doyal, L. and I. Gough. 1991. "A Theory of Human Need." London, England: Palgrave Macmillan.

Environmental Protection Agency. 2013. "EPA's BEACH Report: Guam 2012 Swimming Season." EPA 820-F-13-035.
URL: http://www.epadatadump.com/pdf-files-2013/gu2012.pdf. Accessed 2-21-17.

Environmental Protection Agency. 2018. "BEACON 2.0: Beach Advisory and Closing On-line Notification – Reports." URL: https://watersgeo.epa.gov/BEACON2/reports.html. Accessed 8-20-17.

Friedlander, A., and E. DeMartini. 2002. "Contrasts in Density, Size, and Biomass of Reef Fishes Between the Northwestern and the Main Hawaiian Islands: The Effects of Fishing Down Apex Predators." Marine Ecology Progress Series. 230. 253-264.

Grafeld, S., K. Oleson, M. Barnes, M. Peng, C. Chan, and M. Weijerman. 2016. "Divers' Willingness to Pay for Improved Coral Reef Conditions in Guam: An Untapped Source of Funding for Management and Conservation?" Ecological Economics 128: 202-213.

Gillett, R. 2016. "Fisheries in the Economics of Pacific Island Countries and Territories." Pacific Community. Noumea, New Caledonia. Pp. 666.

Guam Bureau of Statistics & Plans. 2012. *Beach Access*. Guam: Land Use Planning/Coastal Management Program.

Guam Solid Waste Authority. 2011. "Ceremonies for Closing of Ordot Dump and Opening of the Layon Landfill." News and Media. URL: http://www.guamsolidwasteauthority.com/pr_11_08_18.html. Accessed: 7-6-17.

Guam Visitors Bureau. 2018. "2017 Annual Report." Tumon, Guam. Pp. 63.

Guam Waterworks Authority. 2006. "Water System Summary: Vol 2." October 2006 Final Water Resources Master Plan. 14 Pp.

Guam Waterworks Authority. 2017. "GWA Operations & Maintenance." URL: http://guamwaterworks.org/operations-maintenance/. Accessed 8-1-17.

Hospital, J. and C. Beavers. 2012. "Economic and Social Characteristics of Guam's Small Boat Fisheries." NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center. Honolulu, HI 96822-2396. Administrative Report H-12-06. 60 pp. + Appendices.

Kotowicz, D. and S. Allen. 2015. "Results of a Survey of CNMI and Guam Residents on the Marianas Trench National Marine Monument." NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center. Honolulu, HI. PIFSC Data Report DR-13-009. Pp. 55. doi: 10.7289/V5TD9V9G.

Kottek, M., J. Grieser, C. Beck, B. Rudolf, and F. Rubel, 2006: "World Map of Köppen-Geiger Climate Classification updated". Meteorologische Zeitschrift 15(3): 259-263.

Lander, M.A. and C.P. Guard. 2003. "Creation of a 50-year rainfall database, annual rainfall climatology, and annual rainfall distribution map for Guam." Technical Report 102. Water and Environmental Research Institute of the Western Pacific, University of Guam. Mangilao, Guam. Pp. 20.

Live Healthy Guam. 2011. "Guam Non-Communicable Disease Strategic Plan." Department of Public Health and Social Services and the Non-Communicable Disease (NCD) Consortium. Mangilao, Guam. Pp. 97.

Loper, C., A. Levine, J. Agar, M. Hamnett, V. R. Leeworthy, M. Valdez-Pizzini, and K. Wallmo. 2010. "NOAA Coral Reef Conservation Program Social Science Strategy: 2010-2015."

Lovelace, S., and M. Dillard. 2012. "Developing Social and Economic Indicators for Monitoring the US Coral Reef Jurisdictions: report from a scientific workshop to support the National Coral Reef Monitoring Program." Charleston, SC: National Oceanic and Atmospheric Administration, National Ocean Service, National Centers for Coastal Ocean Science, Hollings Marine Laboratory.

Millennium Ecosystem Assessment. 2005. "Ecosystems and Human Well-being Synthesis." Washington DC: World Resources Institute. Pp. 137.

National Oceanic and Atmospheric Administration (NOAA), Office of Response and Restoration (OR&R). 2005. "Sensitivity of Coastal Environments and Wildlife to Spilled Oil: Guam and the Northern Mariana Islands: ESIP". Available at: http://response.restoration.noaa.gov/maps-and-spatial-data/download-esi-maps-and-gis-data.html.

National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP). 2014. "National Coral Reef Monitoring Plan." Silver Spring, MD: NOAA Coral Reef Conservation Program.

National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP). 2015. "About Corals: Values; Coastal Protection." Silver Spring, MD. URL: http://coralreef.noaa.gov/aboutcorals/values/coastalprotection/. Accessed 5-20-16.

National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP). 2016. "NOAA Coral Reef Information System: Guam Regional Portal." Silver Spring, MD. URL: http://www.coris.noaa.gov/portals/guam.html. Accessed: 2-23-17.

Office of the Governor of Guam. 2016. "2015 Guam Statistical Yearbook." Bureau of Statistics and Plans. 470 Pp.

Paulay, G. 2003. "Marine Biodiversity of Guam and the Marianas: Overview." Micronesica 35-36: 3-25.

Porter, V., T. Leberer, M. Gawel, J. Gutierrez, D. Burdick, V. Torres, and E. Lujan. "The State of the Coral Reef Ecosystems Of Guam." pp. 442-487. In: J.E. Waddell (ed.). The State

of the Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005. NOAA Technical Memorandum NOS NCCOS 11. Silver Spring, MD. Pp. 522.

Puglise, K.A. and R. Kelty (eds.). 2007. "NOAA Coral Reef Ecosystem Research Plan for Fiscal Years 2007 to 2011." Silver Spring, MD: NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 1. Pp. 128.

QMark Research. 2016a. "Guam Visitors Bureau: Japan visitor tracker exit profile, FY2016 data aggregation." Prepared for the Guam Visitors Bureau. Pp. 106.

QMark Research. 2016b. "Guam Visitors Bureau: Korean visitor tracker exit profile, FY2016 data aggregation." Prepared for the Guam Visitors Bureau. Pp. 104.

Quinata, Marybelle. 2018. Personal communication. August 22, 2018.

Raymundo and Williams. 2017. "Guam Buildup Project for Marine Corps Base Construction Awarded." Guam Pacific Daily News; USA Today Network. URL: https://www.guampdn.com/story/news/2017/08/18/contract-awarded-marine-corps-guam-buildup/578376001/. Accessed 8-31-18.

Roff, G., C. Doropoulos, A. Rogers, Y. Bozec, N.C. Krueck, E. Aurellado, M. Priest, C. Birrell, and P. Mumby. 2016. "The Ecological Role of Sharks on Coral Reefs." Trends in Ecology & Evolution. 31(5): 395-407.

Schirnding, Y. 2002. "Health in Sustainable Development Planning: The Role of Indicators." World Health Organization; Geneva. WHO/HDE/HID/02.11.

Shivlani, M. 2014. "The Human Dimensions of Southeast Florida Reefs: Benefits, Uses, and Perceptions." Presentation to the Community Working Group of *Our Florida Reefs*.

Spalding, M.D., R.D. Brumbaugh, and E. Landis. 2016. "Atlas of Ocean Wealth." The Nature Conservancy. Arlington, VA.

Thorrold, S. and D. Williams. 1996. "Meso-Scale Distribution Patterns of Larval and Pelagic Juvenile Fishes in the Central Great Barrier Reef Lagoon." Marine Ecology Press Series. 145: 17-31.

United Nations Environment Programme (UNEP). 2016. "Healthy Environment, Healthy People." in Thematic Report of the Second session of the United Nations Environment Assembly of the United Nations Environment Programme. Nairobi, Kenya.

United States Census Bureau. 2010. "Decennial Census of Population and Housing." in Summary File 2. Washington, DC.

United States Department of Health and Human Services. 1995. "Paper Work Reduction Act (PRA) of 1995."

Van Beukering, P., W. Haider, M. Longland, H. Cesar, J. Sablan, S. Shjegstad, B. Beardmore, Y. Liu, G. Omega Graces. 2007. "The Economic Value of Guam's Coral Reefs." University of Guam Marine Laboratory. Technical Report No. 116. Pp. 102.

Veron, J.E.N. 2000. "Corals of the world, Vol. 3." Australian Institute of Marine Science. Townsville, Australia. Pp. 490.

Vincent, I.V., C.M. Hincksman, I.R. Tibbetts, and A. Harris. 2011. "Biomass and Abundance of Herbivorous Fishes on Coral Reefs off Andavadoaka, Western Madagascar." Western Indian Ocean Journal of Marine Science. 10(1). 83-99.

Wheeler, B.W., M. White, W. Stahl-Timmins, and M.H. Depledge. 2012. "Does Living by the Coast Improve Health and Well-Being?" Health and Place. 18. 1198-1201.

Wongbusarakum, S., A. Heenan, V. Brown, M. Gorstein, M. Iwane, D. Kleiber, and M. Quinata. 2018. "Integrated monitoring for adaptive management: Challenges and opportunities of the case study NOAA Habitat Blueprint site Manell-Geus, Guam." Manuscript in preparation.

Appendix 1: National Coral Reef Monitoring Program

Understanding Socioeconomic Connections

The Socioeconomic Component of the National Coral Reef Monitoring Plan (NCRMP) gathers and monitors a collection of socioeconomic variables, including demographics in coral reef areas, human use of coral reef resources, as well as knowledge, attitudes, and perceptions of coral reefs and coral reef management. The overall goal of the socioeconomic monitoring component is to track relevant information regarding each jurisdiction's population, social and economic structure, the impacts of society on coral reefs, and the impacts of coral management on communities. NOAA's Coral Reef Conservation Program (CRCP) will use the information for research and to improve the results of programs designed to protect coral reefs.

The main purpose of the Socioeconomic Component of NCRMP is to answer the following questions: What is the status of human knowledge, attitudes, and perceptions regarding coral reefs? And, how are human uses of, interactions with, and coral dependence on coral reefs changing over time?

More details can be found here: http://www.coris.noaa.gov/monitoring/socioeconomic.html

Appendix 2: The NCRMP Survey Instrument

NCRMP Resident Coral Reef Survey for Guam
OMB control Number 0648-0646

Survey conducted in (circle one): *English   Chamorro   Carolinian   Tagalog*

Introduction: *[greeting specific to jurisdiction]*

Hello, my name is [interviewer name]. I'm calling from [CONTRACT COMPANY] on behalf of the National Oceanic and Atmospheric Administration (NOAA) and the National Coral Reef Monitoring Program. We are interested in obtaining your opinions on important issues related to coral reefs in Guam. You were selected because you live in a coastal area near coral reefs.

This survey is being conducted in accordance with the Privacy Act of 1974 and the Paperwork Reduction Act. Your participation is voluntary, your answers are confidential and you can stop the interview at any time. The interview is expected to take less than 20 minutes. If you have questions or would like to know more about the survey I will provide you with contact information.

Notwithstanding any other provisions of the law, no person is required to respond to, nor shall any person be subjected to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number. The OMB Control number for this survey is 0648-0646

The 25 minute estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Please send comments regarding this burden estimate or any other suggestions for reducing this burden to Peter Edwards, National Oceanic and Atmospheric Agency, National Ocean Service, Coral Reef Conservation Program, (1305 East West Highway, Silver Spring, MD, 20910, USA).

1.   Are you at least 18 years of age?
IF "YES" CONTINUE TO SCREENING QUESTION 2. IF "NO", END SURVEY.

Now that we have established that you are qualified, we will continue with the survey. Remember that you can stop at any time.

PARTICIPATION IN REEF ACTIVITIES

1. How often do you usually participate in each of the following activities?

	Never	Once a month or less	2-3 times a month	4 times a month or more	No Response
Swimming/wading					
Snorkeling					
Diving (SCUBA or free diving)					
Boarding (surfing, kitesurfing, SUP, body-surfing, body-boarding)					
Beach recreation (beach sports, picnics)					
Fishing from shore (spear, cast net, gill net, drag net)					
Fishing or harvesting from a boat or kayak (rod and reel, trolling, free diving, scuba spear)					
Gathering of animals for gleaning (trochus/ailingling, clams, sea cucumbers, octopus, urchins)					
Paddling/kayaking					
Jet skiing					

SKIP PATTERN-- If respondent answers 'never' to BOTH fishing AND gathering of marine resources, then skip to #3:

CORAL REEF RELIANCE / CULTURAL IMPORTANCE OF REEFS

2. How often do you fish or harvest marine resources for each of the following reasons?

	Frequently	Sometimes	Rarely	Never	No Response
To feed myself and my family/ household					
To sell					
To give to extended family members and/or friends					
For fun					
For special occasions and cultural events					

3. How often does your family eat fish/seafood?
   - a. Every day
   - b. A few times a week
   - c. About once a week
   - d. 1-3 times a month
   - e. Less than once a month
   - f. Never

4. What are the two main sources of the fish and seafood that you and your family eats?

   - a. Purchased by myself or someone in my household at a store or restaurant
   - b. Purchased by myself or someone in my household at a market or roadside vendor
   - c. Caught by myself or someone in my household
   - d. Caught by extended family members
   - e. Caught by friends or neighbors
   - f. Other, please specify _____
   - g. Not Sure
   - h. Refused

5. How often does your family eat fish/seafood that is harvested from coral reefs? (For example parrotfish, humphead wrasse, unicorn fish, octopus or shells)?
   - a. Every day
   - b. A few times a week
   - c. About once a week
   - d. 1-3 times a month
   - e. Less than once a month
   - f. Never

PERCEIVED RESOURCE CONDITION

6. In your opinion, how are Guam's marine resources currently doing? Please rank from very bad to very good.

	Very Bad	Bad	Neither Bad nor Good	Good	Very Good	Not sure
Ocean Water Quality (clean and clear)						
Amount of Coral						
Number of Fish						
Number of turtles						
Beach quality (clean, no litter)						

7. How would you say the condition of each of the following has changed over the last 10 years: from 1=it has gotten a lot worse to 5=it has gotten a lot better.

	A lot Worse	Somewhat Worse	No Change	Somewhat Better	A lot Better	Not Sure
Ocean Water Quality (clean and clear)						
Amount of Coral						
Number of Fish						
Number of turtles						
Beach quality (clean, no litter)						

8. In the next 10 years, do you think the condition of the marine resources in Guam will get worse, stay the same or improve?
    a. Get worse
    b. Stay the same
    c. Improve
    d. Not sure

AWARENESS AND KNOWLEDGE OF CORAL REEFS

9. Please say whether you disagree or agree with each of the following statements.

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Not Sure
Coral reefs protect Guam from coastal/shoreline erosion and natural disasters like typhoons and tsunamis.						
Coral reefs are only important to fishermen, divers and snorkelers.						
Healthy coral reefs attract tourists to Guam.						
Coral reefs are important to Guam's culture.						

10. How familiar are you with each of the following potential threats facing the coral reefs in Guam?

	Very Unfamiliar	Unfamiliar	Neither Familiar nor Unfamiliar	Familiar	Very Familiar	Not sure
Climate change						
Coral bleaching						
Typhoons, storms, and other natural disasters						
Pollution from stormwater, sewage, fertilizer and other chemical runoff						
Trash/littering						
Increased coastal/urban development						
Invasive species						
Too much fishing and gathering						
Damage from ships and boats						
Sediment runoff into the ocean from fires						
Damage from small watercraft (windsurfing, kiteboarding, kayaking, paddling, jet skiing)						

11. Do you believe that the threats to coral reefs in Guam are:

  a. Extreme
  b. Large
  c. Moderate
  d. Minimal
  e. None
  f. Not sure

ATTITUDES TOWARDS CORAL REEF MANAGEMENT STRATEGIES AND ENFORCEMENT

12. A marine preserve is an area of the ocean where "measures must be taken to preserve local traditions and to protect the natural resource, which is so valuable to both the community and the economy." How familiar are you with marine preserves?

  a. Very Unfamiliar
  b. Unfamiliar
  c. Neither Unfamiliar nor Familiar
  d. Familiar
  e. Very Familiar
  f. Not sure

SKIP PATTERN-- If respondent answers 'Very unfamiliar' or 'Unfamiliar', then skip to #12:

13. Please indicate how much you disagree or agree with each of the following statements.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not Sure
Marine preserves protect coral reefs						
Marine preserves increase the number of fish						
There should be fewer marine preserves in Guam						
There should be more marine preserves in Guam						
There has been economic benefit to Guam from the establishment of marine preserves						
Fishermen's livelihoods have been negatively impacted from the establishment of marine preserves in Guam						
Marine preserves help increase tourism in Guam						

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not Sure
The establishment of marine preserves increases the likelihood that people will vacation in Guam						
I would support adding new marine preserves in Guam if there is evidence that the ones we have are improving Guam's marine resources						
I generally support the establishment of marine preserves						

14. The following are rules and regulations that can be used to manage the marine environment. We are interested in your opinion about the use of these rules and regulations for the protection of coral reefs. Please indicate how much you disagree or agree with each of the following:

Rules/Regulations	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not Sure
Restrictions on SCUBA spear fishing						
Size limits for certain fish species						
Lower the number of sea cucumbers allowed per person						
Limits on tourism operators and activity within marine preserves						
Permit and certification requirements for water sports tour operators						

PARTICIPATION IN BEHAVIORS THAT MAY IMPROVE CORAL HEALTH

15. How often do you participate in any activity to protect the environment (for example, beach clean ups, volunteering with an environmental group, recycling)?

    a. Not At All
    b. Once a year or Less
    c. Several times a year
    d. At least once a month
    e. Several Times a Month or more
    f. Not Sure

16. Which of the following would you consider to be your top 3 sources of information about coral reefs and the environment in Guam?
Interviewer checks the top 3 sources of information in box below.

17. To what degree do you trust each of your top rated sources of information to provide you the most accurate information on coral reefs and coral reef related topics in Guam?
Respondent rates only the top 3 sources of information in box below.

Top 3	Sources	Very untrustworthy	Untrustworthy	Neither Trustworthy nor Untrustworthy	Trustworthy	Very Trustworthy	Not sure
	Newspapers, other print publications						
	Radio						
	TV						
	Internet						
	Social Media						
	Friends and family						
	Community leaders						
	Jurisdictional government agencies (BSP, EXAMPLES)						
	Federal government agencies (NOAA, EPA)						
	Non-profit organizations						
	Other						

18. How involved is the local community in protecting and managing coral reefs?

    a. Not at all involved
    b. Somewhat involved
    c. Moderately involved
    d. Involved
    e. Very involved
    f. Not sure

19. How often do you feel you are given the opportunity to be involved in making decisions related to the management of coral reefs?

        a. Never
        b. Rarely
        c. Sometimes
        d. Frequently
        e. Not Sure

SKIP PATTERN -- *If respondent answers a, then skip to #20.*

20. How involved are you in making decisions related to the management of coral reefs in Guam?

        a. Not at all involved
        b. Slightly involved
        c. Moderately involved
        d. Involved
        e. Very involved
        f. Not sure

DEMOGRAPHICS

I just have a few more questions that will help us to interpret our results. As a reminder, the information you provide is completely <u>confidential</u>.

21. Are you male or female?
        a. Male
        b. Female

22. What is your year of birth? _____

23. How long have you lived in Guam?
    a. 1 year or less
    b. 2-5 years
    c. 6-10 years
    d. more than 10 years, but less than all my life
    e. all my life

24. Including your primary language, please name each language you speak.

1. English	8. Chinese
2. Spanish	9. Japanese
3. French	10. Korean
4. German	11. Tagolog
5. Italian	12. Hindi
6. Portuguese	13. Hawaiian
7. Arabic	14. Hawaii Pidgin English

15. Sāmoan
16. Chamorro
17. Carolinian
18. Creole
19. Crucian

20. Tongan
21. Other: Please list
_____
22. No Response

25. What race/ethnicity do you consider yourself?

1. American Indian or Alaskan Native
2. Asian
3. Black or African American
4. Palauan
5. Carolinian
6. Chamorro
7. Chinese
8. Marshallese
9. Filipino
10. Japanese
11. White
12. Korean
13. Yapese
14. Native Hawaiian or other Pacific Islander
15. Samoan
16. Chuukese
17. Pohnpeian
18. Kosraean
19. Vietnamese
21. Other/Mixed
22. Hispanic or Latino
23. No response

26. What is the highest level of education you have completed?
    a. 8th Grade or Less
    b. Some high school
    c. High School Graduate, GED
    d. Some college, community college or AA
    e. College Graduate
    f. Graduate School, Law School, Medical School
    g. No Response

27. What is your current employment status?
    a. Unemployed
    b. Student
    c. Employed full-time
    d. Homemaker
    e. Employed part-time
    f. Retired
    g. None of the above: Please specify _____
    h. No Response

28. What is your occupation? [*open ended*] _____

29. May I ask, what is your annual household income?
    a. Under $10,000
    b. $10,000-19,999
    c. $20,000-29,999
    d. $30,000-39,999
    e. $40,000-49,999
    f. $50,000-59,999
    g. $60,000-74,999
    h. $75,000-99,999
    i. $100,000-149,999
    j. $150,000 or More
    k. No Response

Appendix 3: Guam NCRMP Survey Demographic Results[7]

Gender	Sample	2010 US Census
Male	55%	51%
Female	45%	49%

Age	Sample	2010 US Census
18-24 year olds	18%	17%
25-34 year olds	22%	20%
35-44 year olds	18%	22%
45-64 year olds	29%	32%
65+ years old	12%	10%
No Response	1%	N/A

Education Level	Sample	2010 US Census
Less than high school	14%	21%
High School Graduate, GED	43%	35%
Some college, community college or AA	22%	26%
Bachelor's Degree	18%	13%
Graduate School, Law School, Medical School	2%	4%
No Response	1%	N/A

Annual Household Income	Sample[8]	2010 US Census
Under $10,000	7%	8%
$10,000 to $19,999	15%	10%
$20,000 to $29,999	18%	11%
$30,000 to $39,999	16%	11%
$40,000 to $49,999	11%	10%
$50,000 to $59,999	9%	9%
$60,000 to $99,999	16%	23%
$100,000 to $149,999	8%	11%
$150,000 or More	5%	4%

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[7] 2010 US Census results in this section refer to the adult population of Guam.

[8] Answers of "no response" are left absent from analysis of household income due to high rate of occurrence (approximately 36%).

Race	Sample	2010 Census
Asian	19.0%	36.5%
Chinese	0.0%	1.9%
Filipino	18.0%	29.4%
Japanese	0.0%	1.8%
Korean	0.0%	2.5%
Taiwanese	0.0%	0.2%
Vietnamese	0.0%	0.3%
Other Asian	1.0%	0.5%
Black/African American	1.0%	1.1%
Native Hawaiian/Other Pacific Ilsander	70.0%	46.2%
Carolinian	0.0%	0.1%
Chamorro	45.0%	35.8%
Chuukese	12.0%	5.7%
Kosraean	0.0%	0.2%
Marshallese	0.0%	0.2%
Palauan	2.0%	1.7%
Pohnpeian	2.0%	1.2%
Yapese	2.0%	0.7%
Other Native Hawaiian/Pacific Islander	7.0%	0.6%
White	5.0%	8.3%
Hispanic	1.0%	0.9%
Other race	4.0%	0.3%
2 or more races	N/A	6.8%

Languages Spoken [9]	Sample
English	99%
Chamorro	35%
Other	19%
Japanese	5%
Spanish	2%
German	1%
French	<1%
Chinese	<1%
Korean	<1%
Hawaiian	<1%
Carolinian	<1%

[9] The 2010 US Census did not collect this type of information.

Employment Status[10]	Sample
Unemployed	23%
Student	7%
Employed full-time	31%
Homemaker	9%
Employed part-time	10%
Retired	17%
Other	<1%
No Response	2%

Occupation[11]	Sample
Government of Guam	10%
Federal Government	4%
US Military	3%
Private Company	30%
Self Employed	4%
Retired	10%
Unemployed, but looking for a job	7%
Unemployed, but not looking for a job	12%
Student (High school or post secondary)	6%
Other	1%
No Response	14%

Year(s) of Residence[12]	Sample
1 year or less	2%
2-5 years	6%
6-10 years	5%
More than 10 years (less than all my life)	35%
All my life	49%
No Response	2%

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[10] The 2010 US Census did not collect this type of information.
[11] The 2010 US Census did not collect this type of information.
[12] The 2010 US Census did not collect this type of information.

Appendix 4: NCRMP Secondary Data Sources for Guam

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
Central Intelligence Agency	The World Factbook Life Expectancy at Birth	2013	These data represent the average number of years to be lived by a group of people born in the same year, if mortality at each age remains constant in the future.	2014	https://www.cia.gov/library/publications/the-world-factbook/rankorder/2102rank.html
Central Intelligence Agency	The World Factbook Inflation Rate (Consumer Prices)	2014	Inflation rate (consumer prices) compares the annual percent change in consumer prices with the previous year's consumer prices.	2003-2014	https://www.cia.gov/library/publications/the-world-factbook/rankorder/2092rank.html
Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), Ocean and Coastal Resource Management (OCRM), National Marine Protected Areas Center (MPAC)	MPA Inventory Database (10/2014)	2014	The MPA Inventory is a comprehensive catalog that provides detailed information for existing marine protected areas in the United States. The inventory provides geospatial boundary information (in polygon format) and classification attributes that seek to define the conservation objectives, protection level, governance and related management criteria for all sites in the database. The comprehensive inventory of federal, state and territorial MPA sites provides governments and stakeholders with access to information to make better decisions about the current and future use of place-based conservation. The information also will be used to inform the development of the national system of marine protected areas as required by Executive Order 13158.	2014	http://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
Environmental Protection Agency	EPA Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS)	2014	The Assessment and Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS) is an online system for accessing information about the conditions in the Nation's surface waters. The Clean Water Act requires states, territories and authorized tribes (states for brevity) to monitor water pollution and report to EPA every two years on the waters they have evaluated. This process is called assessment. Part of this process is deciding which waters do not meet water quality standards because they are too polluted. These degraded waters are called impaired (polluted enough to require action) and are placed on a State list for future actions to reduce pollution. This information reported to EPA by states is available in ATTAINS. The information is made available via the ATTAINS web reports, as well as through other EPA tools. The ATTAINS web reports provide users with easy access to view the information on the status of waters at the national, state and site-specific waterbody levels. To access this information, click the Get Data/Tool tab above.	2002, 2004, 2006, 2008, 2010, 2012, 2014	https://www.epa.gov/waterdata/assessment-and-total-maximum-daily-load-tracking-and-implementation-system-attains
Environmental Protection Agency	EPA Annual Beach Notification Summary	2012	These fact sheets summarize beach monitoring and notification data submitted to EPAfor each swimming season. Beach water monitoring is conducted primarily to	2006, 2010, 2011, 2012	http://water.epa.gov/type/oceb/beaches/2011_season.cfm

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
	Reports -- Closures and Advisories		detect bacteria that indicate the possible presence of disease-causing microbes (pathogens) from sewage or fecal pollution. People swimming in water contaminated with these types of pathogens can contract diseases of the gastrointestinal tract, eyes, ears, skin, and upper respiratory tract. When monitoring results show levels of concern, the state or local government issues a beach advisory or closure notice until further sampling shows that the water quality is meeting the applicable standards. Beach water pollution can occur for a number of reasons including stormwater runoff after heavy rainfall, treatment plant malfunctions,sewer system overflows, and pet and wildlife waste on or near the beach. To help minimize beachgoers' risk of exposure to pathogens in beachwaters, EPA is helping communities build and properly operate sewage treatment plants, working to reduce overflows as much as possible, and working with the U.S. Coast Guard to reduce discharges from boats and larger ships. Under the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000, EPA provides annual grants to coastal and Great Lakes states, territories, and eligible tribes to help local authorities monitor their coastal and Great Lakes beaches and notify the public of water quality conditions that may be unsafe for swimming.		

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
Environmental Protection Agency; Technology Transfer Network Clearinghouse for Inventories & Emissions Factors.	The National Emissions Inventory	2016	This data set summarizes ammonia, carbon monoxide, nitrogen oxide, particulate matter, sulfur dioxide, volatile organic compounds, mercury, acid gas, greenhouse gases, glycol ether, metals, VOC, PCBs, POM, and PAH emissions at the national, state, and county level for 2011 and 2014. Data is measured in tons.	2011, 2014	https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei
Environmental Protection Agency; Landfill Methane Outreach Program (LMOP)	Landfill-level data only	2016	LMOP tracks key data for landfill gas (LFG) energy projects and municipal solid waste (MSW) landfills in the United States. LMOP's Landfill and Landfill Gas Energy Database contains information about projects in various stages such as planning, under construction, operational, and shutdown, and is also a data repository for more than 2,400 MSW landfills that are either accepting waste or closed in the past few decades. The LMOP Database contains landfill information such as such as physical address, latitude and longitude, owner/operator organization, operational status, year opened, actual or expected closure year, design capacity, amount of waste in place, gas collection system status, and LFG collected amount. For landfills that report under EPA's Greenhouse Gas Reporting Program (GHGRP), LMOP cross-references that dataset by including GHGRP's 7-digit Facility Identifier.	2016	https://www.epa.gov/lmop/landfill-gas-energy-project-data-and-landfill-technical-data#landfills
Guam Bureau of Statistics and	Guam Statistical Yearbook 2012	2013	This source book presents a collection of current and historical socio-economic information that portrays Guam's economic	2003-2012	https://docs.google.com/a/noaa.gov/file/d/0B4H7gm

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
Plans, Office of the Governor			trend and performance over time. A wide range of statistics including Guam's population, consumer price index, labor force, social welfare, tourist industry, and land use activities are included in this report to name a few. Detailed demographic characteristics on Guam's villages regarding population, households and income are also included.		eMoSpYNFNvV3VwRFlwaGM/edit
Guam Department of Public Health and Social Services, Guam Cancer Registry	Cancer on Guam: A report on the incidence of cancer and cancer deaths on the Island of Guam, U.S.A, 1995-2001	2002	This report gives total reported cancer incidences by type and rate of occurrence on the island of Guam from 1995-2001.	1996-2001	http://www.pacificdigitallibrary.org/cgi-bin/pdl?e=d-000off-pdl--00-2--0--010---4-------0-1l--10en-50---20-text---00-3-1-00bySR-0-0-000utfZz-8-00&a=d&cl=CL1.3&d=HASH012cf6071ecfc91a66bc91cb.1
HML Project Team	Environmental Use and Dependence - HML Project Team Collection	2014	This data set is comprised of uses occurring in study areas as well as attendance figures for parks located in the study areas. Park visitation to national, state, and county parks as well as National Wildlife Refuge areas are included in this data set. Use data includes fishing, diving, and boating in the study area. Sources: -AS Sources: U.S. Fish and Wildlife	2013	

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
			Service, National Park Service, U.S. Department of Homeland Security/U.S. Coast Guard Office of Auxiliary and Boating Safety, Professional Association of Diving Instructors, National Oceanic and Atmospheric Administration. -CNMI Sources: U.S. Fish and Wildlife Service, National Park Service, U.S. Department of Homeland Security/U.S. Coast Guard Office of Auxiliary and Boating Safety, Professional Association of Diving Instructors, Diveadvisor.com, National Oceanic and Atmospheric Administration. -FL Sources: U.S. Fish and Wildlife Service, National Park Service, U.S. Department of Homeland Security/U.S. Coast Guard Office of Auxiliary and Boating Safety, Professional Association of Diving Instructors, Diveadvisor.com, Worldwidefishing.com, Florida Fish and Wildlife Conservation Commission, Florida Department of Highway Safety and Motor Vehicles, Florida Park Service. -Guam Sources: U.S. Fish and Wildlife Service, National Park Service, U.S. Department of Homeland Security/U.S. Coast Guard Office of Auxiliary and Boating Safety, Professional Association of Diving Instructors, Diveadvisor.com,		

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
			National Oceanic and Atmospheric Administration. -HI Sources: U.S. Fish and Wildlife Service, National Park Service, U.S. Department of Homeland Security/U.S. Coast Guard Office of Auxiliary and Boating Safety, Professional Association of Diving Instructors, Diveadvisor.com, Worldwidefishing.com, Department of Land and Natural Resources, National Oceanic and Atmospheric Administration, Hawaii Tourism Authority, National Association of State Park Directors, County of Hawaii Fire Department: Ocean Safety Division. -PR Sources: U.S. Fish and Wildlife Service, National Park Service, U.S. Department of Homeland Security/U.S. Coast Guard Office of Auxiliary and Boating Safety, Professional Association of Diving Instructors, Diveadvisor.com, Worldwidefishing.com, Puerto Rico Department of Natural and Environmental Resources, U.S. Department of Agriculture. -USVI Sources: U.S. Fish and Wildlife Service, National Park Service, U.S. Department of Homeland Security/U.S. Coast Guard Office of Auxiliary and Boating Safety, Professional Association of Diving Instructors, Diveadvisor.com, Worldwidefishing.com, National Archives		

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
			and Records Administration Office of the Federal Register, Department of Planning and Natural Resources Division of Fish & Wildlife.		
Institute for Health Metrics and Evaluation (IHME)	United States Adult Life Expectancy by County 1987-2007	2011	This is a complete time series for life expectancy from 1987 to 2007 for all US counties, and released as part of IHME research published in *Population Health Metrics.*	2007	http://ghdx.health data.org/record/u nited-states-adult-life-expectancy-county-1987-2007
National Oceanic and Atmospheric Administration (NOAA), Coastal Change Analysis Program (CCAP)	National Oceanic and Atmospheric Administration, Coastal Change Analysis Program (CCAP) Regional Land Cover Data	2012	The Coastal Change Analysis Program (C-CAP) produces a nationally standardized database of land cover and land change information for the coastal regions of the U.S. C-CAP products are developed using multiple dates of remotely sensed imagery and consist of raster-based land cover maps for each date of analysis, as well as a file that highlights what changes have occurred between these dates and where the changes were located. These data highlight the relative effects of different landscape features on water quality, such as increased polluted runoff from impervious surfaces and the mitigating impacts of forests. NOAA produces high resolution C-CAP land cover products, for select geographies. GIS and tabular data was accessed June 2012 and prepared for the project by NOAA Coastal Services Center, Charleston SC.	2001-2007 (various)	http://www.csc.n oaa.gov/digitalco ast/data/ccapregi onal

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Pacific Islands Fisheries Science Center (PIFSC),	Western Pacific Fisheries Information Network	2016	Established in 1981, the Western Pacific Fisheries Information Network (WPacFIN) is a cooperative program involving the WPacFIN central office at the Pacific Islands Fisheries Science Center (PIFSC) and fisheries agencies of American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), Guam, and Hawaii. WPacFIN compiles fisheries information collected by these agencies and provides them technical expertise and tools to help them collect, manage, summarize, and quality control fishery-dependent data needed for local, federal, and international assessment and management decisions. WPacFIN also works closely with the Western Pacific Regional Fishery Management Council and NOAA's Pacific Islands Regional Office (PIRO).	1980-2015	https://www.pifsc.noaa.gov/wpacfin/
National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Office of Response and Restoration, Hazardous Materials Response Division, Seattle, Washington; Coral Reef Conservation Program, Silver	Guam and the Northern Mariana Islands ESI: HYDRO (Hydrography Lines and Polygons)	2006	This data set contains vector lines and polygons representing coastal hydrography used in the creation of the Environmental Sensitivity Index (ESI) for Guam and the Northern Mariana Islands. The HYDRO data layer contains all annotation used in producing the atlas. The annotation features are categorized into three subclasses in order to simplify the mapping and quality control procedures: GEOG for geographic features, SOC for socioeconomic features, and HYDRO for water features. This data set comprises a portion of the ESI	1999-2005	http://archive.orr.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id%28entry_subtopic_topic%29=849&subtopic_id%28entry_subtopic_topic%29=8&t

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
Spring, Maryland; and Pacific Services Center, Honolulu, Hawaii.			data for Guam and the Northern Mariana Islands. ESI data characterize the marine and coastal environments and wildlife by their sensitivity to spilled oil. The ESI data include information for three main components: shoreline habitats, sensitive biological resources, and human-use resources.		opic_id%28entry_subtopic_topic%29=1
The Henry J. Kaiser Family Foundation	State Health Facts: Infant Mortality Rate (Deaths per 1,000 Live Births)	2013	These data represent the number of infant deaths per 1,000 live births based on linked birth and death records from the period from 2007-2009.	2007-2009	http://kff.org/other/state-indicator/infant-death-rate/
The Henry J. Kaiser Family Foundation	State Health Facts: Number of Cancer Deaths per 100,000 Population	2013	These data represent age-adjusted rates per 100,000 U.S. standard population. Rates for the United States and each state are based on populations enumerated in the 2010 census as of April 1. Rates for Puerto Rico, Virgin Islands, Guam, American Samoa, and Northern Marianas are based on the 2010 census, estimated as of July 1, 2010. Since death rates are affected by the population composition of a given area, age-adjusted death rates should be used for comparisons between areas because they control for differences in population composition.	2010	http://kff.org/other/state-indicator/cancer-death-rate-per-100000/
The World Bank	World Bank – Annual Visitor Arrivals	2014	The World Bank is a vital source of financial and technical assistance to developing countries around the world. We are not a bank in the ordinary sense but a unique partnership to reduce poverty and	1995-2014	http://data.worldbank.org/indicator/ST.INT.ARVL

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
			support development. The World Bank Group comprises five institutions managed by their member countries. Annual visitor arrivals is an international tourism indicator based on the number of tourists who travel to a country other than that in which they usually reside, and outside their usual environment, for a period not exceeding 12 months and whose main purpose in visiting is other than an activity remunerated from within the country visited. When data on number of tourists are not available, the number of visitors, which include tourists, same-day visitors, cruise passengers, and crew members, is shown instead.		
The World Bank	World Bank – Fish/Mammal species threatened	2010, 2011	The World Bank is a vital source of financial and technical assistance to developing countries around the world. We are not a bank in the ordinary sense but a unique partnership to reduce poverty and support development. The World Bank Group comprises five institutions managed by their member countries. Fish species are based on Froese, R. and Pauly, D. (eds). 2008. Threatened species are the number of species classified by the IUCN as endangered, vulnerable, rare, indeterminate, out of danger, or insufficiently known. Mammal species are mammals excluding whales and porpoises. Threatened species are the number of species classified by the IUCN as endangered, vulnerable, rare,	2010, 2011	http://data.worldbank.org/indicator/EN.FSH.THRD.NO http://data.worldbank.org/indicator/EN.MAM.THRD.NO

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
			indeterminate, out of danger, or insufficiently known.		
The World Bank	World Bank – Climate Change Knowledge Portal	2012	The World Bank is a vital source of financial and technical assistance to developing countries around the world. We are not a bank in the ordinary sense but a unique partnership to reduce poverty and support development. The World Bank Group comprises five institutions managed by their member countries. The World Bank Climate Change Knowledge Portal reports monthly data since 1900 on temperature and precipitation for each world nation	1900-2012	http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download&menu=historical
The World Bank	World Bank - Population, Total	2014	The World Bank is a vital source of financial and technical assistance to developing countries around the world. We are not a bank in the ordinary sense but a unique partnership to reduce poverty and support development. The World Bank Group comprises five institutions managed by their member countries. Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. The values shown are midyear estimates.	2012-2013	http://data.worldbank.org/indicator/SP.POP.TOTL
The World Bank	World Bank - GDP (current US$)	2014	The World Bank is a vital source of financial and technical assistance to developing countries around the world. We	2005-2013	http://data.worldbank.org/indicator/NY.GDP.MKTP.

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Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
			are not a bank in the ordinary sense but a unique partnership to reduce poverty and support development. The World Bank Group comprises five institutions managed by their member countries. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates.		CD/countries/PR ?display=graph
The World Bank	World Bank - Total greenhouse gas emissions	2015	This data set provides country-by-country greenhouse gas emissions data. Total greenhouse gas emissions in kt of CO2 equivalent are composed of CO2 totals excluding short-cycle biomass burning (such as agricultural waste burning and Savannah burning) but including other biomass burning (such as forest fires, post-burn decay, peat fires and decay of drained peatlands), all anthropogenic CH4 sources, N2O sources and F-gases (HFCs, PFCs and SF6). Source: European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research	1970-2012	http://data.worldb ank.org/indicator/ EN.ATM.GHGT. KT.CE

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
			(EDGAR), EDGARv4.2 FT2012: http://edgar.jrc.ec.europa.eu/		
The World Bank	World Bank - Methane emissions	2015	This data set provides country-by-country methane (CH4) emissions data. Methane emissions are those stemming from human activities such as agriculture and from industrial methane production. Source: European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR): http://edgar.jrc.ec.europa.eu/	1970-2012	http://data.worldbank.org/indicator/EN.ATM.METH.KT.CE
The World Bank	World Bank – Nitrous oxide emissions	2015	This data set provides country-by-country nitrous oxide (NoX) emissions data. Nitrous oxide emissions are emissions from agricultural biomass burning, industrial activities, and livestock management. Source: European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR): http://edgar.jrc.ec.europa.eu/	1970-2012	http://data.worldbank.org/indicator/EN.ATM.NOXE.KT.CE
The World Bank	World Bank - Improved water source (% of population with access)	2015	Access to an improved water source refers to the percentage of the population using an improved drinking water source. The improved drinking water source includes piped water on premises (piped household water connection located inside the user's dwelling, plot or yard), and other improved drinking water sources (public taps or standpipes, tube wells or boreholes,	1990-2015	http://data.worldbank.org/indicator/SH.H2O.SAFE.ZS

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
			protected dug wells, protected springs, and rainwater collection).		
U.S. Department of Commerce Bureau of Economic Analysis	Gross Domestic Product for Guam, 2015	2016	Estimates of gross domestic product (GDP) for the territory for 2015, in addition to estimates of gross domestic product by industry and compensation by industry for 2014 are presented in this document. These estimates were developed under the Statistical Improvement Program funded by the Office of Insular Affairs (OIA) of the U.S. Department of the Interior. The latest estimates of GDP for 2007 to 2014 are also presented in this release, as well as GDP by industry and compensation by industry for 2007 to 2014.	2007-2015	https://www.bea.gov/newsreleases/general/terr/2016/guamgdp_092116.pdf
U.S. Department of Health and Human Services	National Vital Statistics Reports: Deaths: Preliminary Data for 2011	2012	These are preliminary U.S. data on deaths, death rates, life expectancy, leading causes of death, and infant mortality for 2011 by selected characteristics such as age, sex, race, and Hispanic origin. Preliminary data in this report are based on records of deaths that occurred in calendar year 2011, which were received from state vital statistics offices and processed by the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) as of June 12, 2012.	2011	http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_06.pdf
U.S. Department of Health and Human Services	National Vital Statistics Reports: Deaths: Final Data for 2010	2013	These data represent final 2010 data on U.S. deaths, death rates, life expectancy, infant mortality, and trends by selected characteristics such as age, sex, Hispanic origin, race, state of residence, and cause of death.	2010	http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_04.pdf

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
U.S. Energy Information Administration	EIA State Electricity Profiles	1991-2014	The State Electricity Profiles presents a summary of key State statistics for 2000, and 2004 through 2010. The tables present summary statistics; ten largest plants by generating capacity; top five entities ranked by retail sales; electric power industry generating capacity by primary energy source; electric power industry generation of electricity by primary energy source; utility delivered fuel prices for coal, petroleum, and natural gas; electric power emissions estimates; retail sales, revenue, and average revenue per kilowatthour by sector; and utility retail sales statistics. Data published in the State Electricity Profiles are compiled from five forms filed annually by electric utilities and other electric power producers.	1990-2014	http://www.eia.gov/electricity/state/
United States Census Bureau	Census 2000	2002	Summary File 3 contains population and housing data based on Census 2000 questions asked on the long form of a one-in-six sample of the population. Population items include marital status, disability, educational attainment, occupation, income, ancestry, veteran status, and many other characteristics. Housing items include tenure (whether the unit is owner- or renter-occupied), occupancy status, housing value, mortgage status, price asked, and more. In addition to the 50 states and District of Columbia, the U.S. Census Bureau also conducts censuses and surveys in the the	2000	http://www.census.gov/main/www/cen2000.html

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
			United States' Island Areas. Census and survey operations are conducted in cooperation with the governments of the the Island Areas and frequently include modifications to the questionnaires to help the local and federal governments better understand the populations being counted.		
United States Census Bureau	2010 Census	2011	Summary File 1 shows detailed tables on age, sex, households, families, relationship to householder, housing units, detailed race and Hispanic or Latino origin groups, and group quarters.	2010	http://www.census.gov/2010census/data/
United States Census Bureau	2008-2012 ACS 5-Year Estimates	2013	The ACS provides information on more than 40 topics, including education, language ability, the foreign-born, marital status, migration and many more. Each year the survey randomly samples around 3.5 million addresses and produces statistics that cover 1-year, 3-year, and 5-year periods for geographic areas in the United States and Puerto Rico.	2012	http://www2.census.gov/acs2012_5yr/summaryfile/
United States Census Bureau	2010 Census Guam (GU) Summary File	2013	This summary file contains subject-matter content from the 2010 Census — age (including single years of age), sex, race and ethnicity, household type, relationship, population in group quarters, whether the residence is owned or rented (tenure), and vacancy status among other social, economic, housing, and demographic characteristics.	2010	https://www.census.gov/2010census/news/press-kits/island-areas/island-areas.html
United States Census Bureau	2013 Population Estimates:	2014	The estimates are based on the 2010 Census and reflect changes to the April 1, 2010 population due to the Count Question	2010-2013	http://factfinder.census.gov/faces/tableservices/jsf/p

Source (originator)	Data Set Title	Publication Date	Abstract	Data Year(s)	URL
	Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2013		Resolution program and geographic program revisions. The resident population for each year is estimated since the most recent decennial census by using measures of population change. The resident population includes all people currently residing in the United States.		ages/productview.xhtml?pid=PEP_2013_PEPANNRES&prodType=table
United States Census Bureau	2009-2013 ACS 5-Year Estimates	2014	The ACS provides information on more than 40 topics, including education, language ability, the foreign-born, marital status, migration and many more. Each year the survey randomly samples around 3.5 million addresses and produces statistics that cover 1-year, 3-year, and 5-year periods for geographic areas in the United States and Puerto Rico.	2013	http://www2.census.gov/acs2013_5yr/summaryfile/
United States Census Bureau	County Business Patterns	2014	County Business Patterns (CBP) is an annual series that provides subnational economic data by industry. This series includes the number of establishments, employment during the week of March 12, first quarter payroll, and annual payroll.	1998-2012	http://www.census.gov/econ/cbp/
United States Department of Agriculture Food and Nutrition Service	Supplemental Nutrition Assistance Program: Average Monthly Participation (Persons)	2015	SNAP offers nutrition assistance to millions of eligible, low-income individuals and families and provides economic benefits to communities. The number of persons participating is reported monthly. Annual averages are the sums divided by twelve.	2010-2014	http://www.fns.usda.gov/pd/supplemental-nutrition-assistance-program-snap