National Coral Reef Monitoring Program: Socioeconomic Indicator Development

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NOAA's Office for Coastal Management

"Coastal management" is the term used by communities and organizations striving to keep the nation's coasts safe from storms, rich in natural resources, and economically strong. The national lead for these efforts is NOAA's Office for Coastal Management (OCM), an organization devoted to partnerships, science, and good policy. Housed within the National Ocean Service, OCM oversees major initiatives that include the National Coastal Zone Management Program, Coral Reef Conservation Program, Digital Coast, and National Estuarine Research Reserve System.

Executive Summary

In 2007, the National Oceanic and Atmospheric Administration (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. One of the major recommendations of the external review was to increase the CRCP's social science portfolio and use social science strategically to improve coral reef management by engaging local communities and better assessing the social and economic consequences of management policies, interventions, and activities on local communities. In 2010, the National Coral Reef Monitoring Program (NCRMP) Socioeconomic Component was created to standardize the collection of socioeconomic variables in the United States (US) coral reef jurisdictions, including demographics of coral reef adjacent communities, 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 through the calculation of socioeconomic indicators relevant to coral reef adjacent communities and their interactions with coral reef resources.

Coral reefs are among the most valuable ecosystems in the world, providing food for coastal communities, shoreline protection through the attenuation of wave energy, habitat for commercially important fish species, recreational opportunities for residents and tourists, and cultural value, among other ecosystem services. Understanding the complex relationship between humans and coral reef ecosystems allows natural resource managers responsible for managing coral reefs to more holistically understand the key social and ecological impacts of their strategies. Humans play a significant role in ecosystem health (or lack thereof) through their interactions with coral reef resources. Therefore, including humans in the systematic monitoring of coral reefs is critical for understanding the interconnected nature of social and ecological systems.

The NCRMP Socioeconomic Component uses primary and secondary data to track the status of coral reef adjacent communities in the US coral reef jurisdictions of South Florida, American Samoa, Hawai‘i, Puerto Rico, Guam, the Commonwealth of Northern Mariana Islands (CNMI), and the US Virgin Islands (USVI). Primary data are collected through surveys of residents in each of the jurisdictions. The survey instrument used contains a “core” module of questions that are asked in each jurisdiction to aid in comparability across geographies, as well as a jurisdictionally-specific module that collects data to address more localized management questions. Resident surveys were completed for South Florida, American Samoa, and Hawai‘i in 2014; Puerto Rico in 2015; Guam in 2016; and CNMI and USVI in 2017. Secondary data were collected from a variety of sources including (but not limited to) the US Census Bureau, the US Bureau of Economic Analysis, and local government agencies throughout these years as well. These primary and secondary data were then operationalized into 13 socioeconomic indicators, each of which are detailed in this report.

Results indicate significant differences across the Atlantic (South Florida, Puerto Rico, USVI) and Pacific (Hawai‘i, American Samoa, Guam, CNMI) jurisdictions in a number of areas. Residents in Pacific jurisdictions participate in a greater number of marine activities more frequently, have more positive perceptions of marine resource condition, have higher levels of self-reported knowledge of coral reefs, agree more with the cultural importance of reefs, and participate more frequently in pro-environmental behavior when compared to residents of Atlantic jurisdictions.

The population of residents has increased in all jurisdictions since 2013, except for Puerto Rico and USVI; and the population of annual visitors has increased in all jurisdictions since 2013, with the exception of American Samoa. Fishing for species dependent upon coral reefs is important in all jurisdictions, with commercial fishing revenues associated with coral reef fishing reaching over $72

million combined for all jurisdictions in 2015, representing 35% of all commercial fishing revenue. Tourism is also an important industry for the US coral reef jurisdictions, and many tourists visit these jurisdictions to specifically engage with coral reef resources. The tourism industry employed over 345,000 people in all jurisdictions combined in 2015, representing just over 8% of total employment.

Secondary data are also gathered to assess community well-being across the jurisdictions, based on a number of variables. The proportion of adult residents with a high school diploma is above 70% in all jurisdictions; however, over half of the populations of American Samoa and CNMI are considered to be living in poverty. Median annual household income, median home value, life expectancy, and health insurance coverage rates are highest in Hawai‘i. The territory of American Samoa has the highest proportion of the population receiving public assistance, lowest levels of internet access, and the highest average community tenure.

In terms of physical infrastructure, South Florida has the highest proportion of impervious surfaces and the most annual construction permits, American Samoa has the highest proportion of households that lack complete plumbing facilities, Puerto Rico has the most operating landfills, and Guam has the highest proportion of land with military facilities.

Governance is also tracked with secondary data, but developing reliable indicators is a nuanced process, and suitable data sources for this indicator were difficult to obtain. Each jurisdiction was found to have its own set of challenges to overcome related to compliance, enforcement capacity, and budget constraints on a local scale; and global phenomena like climate change that may manifest locally as well.

This research represents the first effort by NOAA to track the socioeconomic status of the US coral reef jurisdictions in a systematic and standardized fashion, and the data represent the baseline for monitoring socioeconomic conditions into the future. Methods were developed and applied to incorporate available primary and secondary information into concise measures that can help inform future management decisions. Additionally, intra- and inter-jurisdiction comparisons will become increasingly possible, relevant, and insightful as data from future rounds surveys and secondary data collection are incorporated.

However, this work is not without its challenges. Chiefly among them is the availability and consistency of secondary data throughout the US coral jurisdictions. The data from resident surveys provides the research team with geographically comparable data collected with similar methodologies to construct survey-based indicators. Unfortunately, that luxury does not exist for secondary data, and the research team is reliant upon existing datasets. Data was not always available for certain variables for all jurisdictions. For example, data on ocean economy contribution to gross domestic product, fishing licenses, visitor count data was available for South Florida counties but not for other US coral reef jurisdictions. Further, in some cases, the research team had to build indicator variables that are derived from different data sources with varying data collection methods in order to incorporate what is available. To note these challenges, each indicator is accompanied by a “confidence ranking” that provides additional context based on data availability constraints.

Survey data collection for the second round of NCRMP Socioeconomic monitoring began in April 2019. The core module of survey questions has been updated and refined for the second round of monitoring based on an assessment of which survey-based indicators needed more data, expert feedback, and the minimization of respondent burden. Continued review and refinement of these indicators and the input variable data on which they rely has the potential to increase the usefulness of the resulting series of indicator values. With this information, scientists, practitioners, and coral reef managers in the jurisdictions can integrate social and biophysical data streams to obtain more in-depth understanding of social-ecological relationships. These indicators also support communication, by taking a complex array of variables and joining them together in a single, trackable metric that encompasses the general breadth of a concept. As socioeconomic monitoring continues, these indicators will be tracked to make relevant temporal comparisons, and they will be improved as resident survey questions are refined and new data streams become available.

Contents

Exhibits

Acronyms and Abbreviations

Abt	Abt Associates
AS	American Samoa
BEA	U.S. Bureau of Economic Analysis
CBP	County Business Patterns
CNMI	Commonwealth of the Northern Mariana Islands
CRCP	Coral Reef Conservation Program
ENOW	Economics: National Ocean Watch
EPA	U.S. Environmental Protection Agency
FA	Factor Analysis
FL	South Florida
FWC	Florida Fish and Wildlife Conservation Commission
GDP	Gross Domestic Product
GU	Guam
HI	Hawai‘i
LMOP	Landfill Methane Outreach Program
MPA	marine protected area
MRIP	Marine Recreational Information Program
MSW	municipal solid waste
NAICS	North American Sector Classification System
NCRMP	National Coral Reef Monitoring Program
NCCOS	National Centers for Coastal Ocean Science
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OECD	Organization for Economic Co-operation and Development
PIFSC	Pacific Island Fishery Science Center
PR	Puerto Rico
TPDES	Territorial Pollutant Discharge Elimination System
USVI	U.S. Virgin Islands

National Coral Reef Monitoring Program: Socioeconomic Indicator Development

1. Background and Introduction

The National Oceanic and Atmospheric Administration's (NOAA's) Coral Reef Conservation Program (CRCP) developed the National Coral Reef Monitoring Program (NCRMP) to collect information to monitor changes in coral reef ecosystems in U.S. jurisdictions over time, including biological, climate, and socioeconomic conditions. This report represents the culmination of the first round of socioeconomic monitoring across the 7 inhabited U.S. coral reef jurisdictions, and presents 13 socioeconomic indicators that detail the status and trends related to coral reef adjacent communities in the jurisdictions.

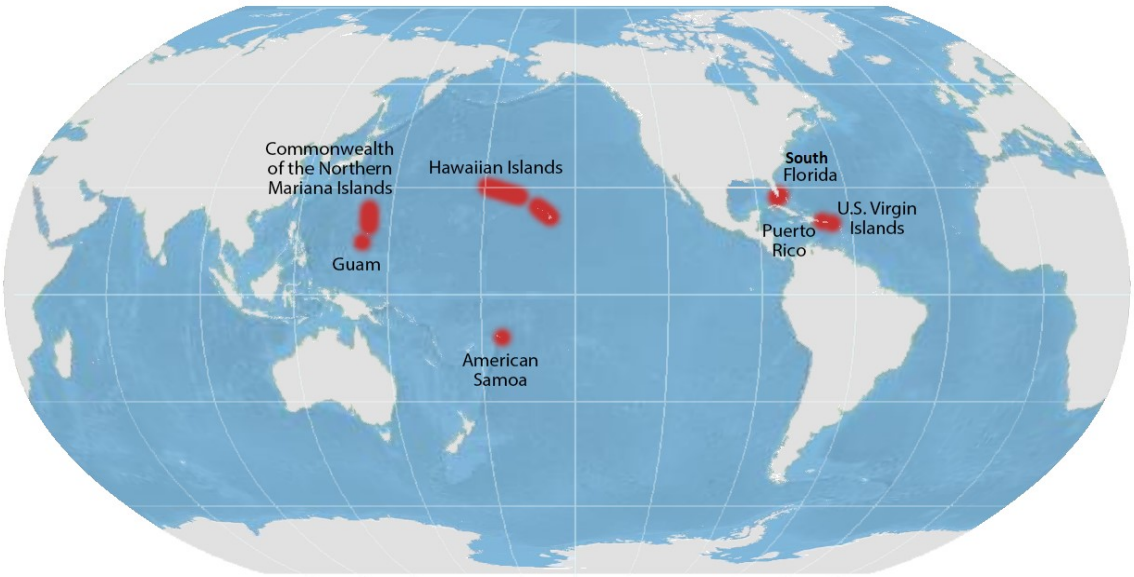
Exhibit 1 lists the seven U.S. coral reef jurisdictions the NCRMP Socioeconomic Component addresses, and Exhibit 2 shows the geographic locations of these jurisdictions.

Exhibit 1. Geographic Scope for Socioeconomic Monitoring and Indicator Development

Jurisdiction	Geographic Scope
American Samoa (AS)	Islands of Tutuila, Ta'u, Olosega, Ofu, and Aunu'u[A]
Commonwealth of the Northern Mariana Islands (CNMI)	Islands of Saipan, Tinian, and Rota
Guam (GU)	Entire island of Guam
Hawai'i (HI)	Main Hawaiian Islands only
South Florida (FL)[B]	Counties of Martin, Palm Beach, Broward, Miami-Dade, and Monroe
Puerto Rico (PR)	Puerto Rico, Vieques, and Culebra
U.S. Virgin Islands (USVI)	St. Croix, St. Thomas, and St. John

[A] Primary data available only for Tutuila; secondary data were collected at Tutuila and the other islands.

[B] Throughout this report, the jurisdiction of South Florida is often referred to as "FL" but it is noted if data or results refer to a specific county or for the entire state.



Coral reef systems are of particular interest as they are among the most biologically diverse and economically valuable ecosystems in the world, providing food, jobs, recreational activities, coastal protection, and many other vital services to residents, visitors, and other interconnected communities (National Oceanic and Atmospheric Administration, 2014).

An essential starting point to developing any indicator is to define the term itself. The terms measure, variable, parameter, analyte, metric, and index are often used interchangeably within relevant literature describing current efforts to develop and use indicator frameworks (Bowen and Riley, 2003). However, focusing on an indicator's function can provide clarity, and the Organization for Economic Co-operation and Development (OECD) has described a successful indicator as one that is able to "…reduce the number of measures which normally would be required for an exact presentation of a situation; and simplify the process of communication to managers, stakeholders and communities" (Bowen and Riley, 2003). Overall, indicators should be complex enough to be compelling to their intended users, but understandable and focused on answering the questions motivating the effort. Indicators are often developed to evaluate program performance, to explain the relationship between human activity and ecosystem health, or to monitor trends and conditions in ecosystem dynamics or resource use. However, focusing on an indicator's intended purpose can be challenging when using all available information obscures the underlying variation of interest. This is why designing a set of purposeful indicators is essential at the effort's inception prior to starting any data collection (Bowen and Riley, 2003).

In recent years, NOAA has led or contributed to a number of social or socioeconomic indicator development efforts focused on understanding the well-being, vulnerability, and resilience of U.S. fishing-dependent and other local communities using a number of methods. The following selection of NOAA and other studies illustrate some common methods used for indicator development that helped inform the current effort:

> A National Centers for Coastal Ocean Science (NCCOS) study (Dillard et al., 2013) developed a set of composite indicators for monitoring well-being at the county level in the Gulf of Mexico through collecting secondary data on social connectedness, economic security, basic needs, health, access to social services, education, safety, governance, and environmental conditions. A detailed measure selection process was used to determine an indicator component including theoretical factors (literature, prior study support, and face validity), methodological factors (data availability, consistency of data collection, and utility in applied setting), and statistical factors (descriptive analyses, correlation analyses, and exploratory factor analysis, FA). Then each indicator was used to derive composite indicators whose component values were normalized through the linear scaling method, summed as scores, and then computed as percent of possible score.
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> For the National Marine Fisheries Service (NMFS), Jepson, Colburn, and others attempted to address a gap in existing sustainable development indices that had not been implemented at the local or community level nor focused on addressing the social aspects of U.S. fisheries. This series of studies developed a suite of social indicators using a FA of time series, secondary data from government sources, and a ground-truthed cluster analysis to select a group of U.S. Southeast and Northeast communities to evaluate the derived social vulnerability and fishing-dependent indices. Prior to data collection, a group of regional fisheries experts and social scientists convened to develop the study approach, and a second workshop reviewed and suggested revisions to the indicators. Future studies incorporated new measures of climate change vulnerability along the U.S. Eastern and Gulf Coasts (Colburn and Jepson, 2012; Jepson and Colburn, 2013; Colburn et al., 2016; and Pollnac et al., 2015).

For NMFS, Himes-Cornell and others developed socioeconomic and fisheries involvement indices using secondary data to assess fishing community well-being in Alaska. Each index used a principle components FA to assess the relative position of the communities and track the status of their conditions over time (Himes-Cornell and Kasperski, 2015, 2016; Himes-Cornell et al., 2016).

Smith and Clay (2010) analyzed a set of case studies of North American marine commercial fisheries to evaluate subjective and objective measures of well-being. The study found that "…a well-being index is useful if it (1) is easily developed from available data; (2) enables temporal and spatial comparisons; (3) can be applied at multiple scales; and (4) possesses subjective and objective elements." It also stated common "problems with well-being variables are: they are typically static, covering only one point in time; data are not always readily available; predefined indices may miss situation-specific issues; and the data are expensive to collect."

For a study focusing on the vulnerability of coastal communities in the Northern Gulf of California, Mexico, Morzaria-Luna et al. (2014) accessed the effect of anthropogenic stressors, including climate change, on disruptions in fishing activities. Researchers developed quantitative indicator indices using principal components analysis and spatial analysis of secondary and primary field data covering the three aspects of vulnerability: sensitivity, exposure, and adaptive capacity. These aspects were combined into an overall score through normalization, summing of the individual factor scores assuming equal importance, and, when necessary, adjusting for directionality (i.e., low value = low adaptive capacity).

In 2010, NOAA developed the NCRMP to develop and summarize information on the conditions of coral reefs in the jurisdictions in three indicator groups: biological indicators, climate indicators, and socioeconomic indicators. The purpose of the socioeconomic indicators is to help answer the following questions:

- *What is the status of human knowledge, attitudes, and perceptions regarding coral reefs?*
- *How are human uses of, interactions with, and coral dependence on coral reefs changing over time?*

Because many of NOAA's and others' efforts to protect coral reefs rely on education and changing attitudes toward reef protection, the information collected for the socioeconomic indicators assists the CRCP in ensuring programs are designed appropriately at the start, evaluating programs over time, and enabling outreach efforts that target the intended recipients with useful information.

The set of 13 socioeconomic indicators (Exhibit 3) were developed through an iterative, collaborative process including the convening of two NCRMP indicator development workshops in 2010 and 2012. At the 2010 workshop, a Working Group of NOAA scientists and managers with expertise on coral reef ecosystems developed an initial set of indicators. These indicators were then refined and prioritized at the 2012 workshop, in addition to participants reviewing the NCRMP and developing secondary data measures and methods (Lovelace and Dillard, 2012). Participants included more than 20 NOAA scientists and managers along with academics with theoretical and methodological expertise in indicator development, and experience in both coral jurisdictions and the sociological dimensions of natural resources. In order to ensure the NCRMP Socioeconomic Component would achieve its purpose, participants focused on addressing measurement issues, data availability, and comparability of the measures and data across the jurisdictions; and ultimately reached a consensus on the list of indicators. Exhibit 3 presents NCRMP's 13 prioritized socioeconomic indicators along with the type of data source used to support each indicator's development. These 13 socioeconomic indicators are listed in order of

priority, as identified at the 2012 workshop, along with a qualifier of whether the indicator was derived from primary or secondary data.

Exhibit 3. Prioritized List of the NCRMP Socioeconomic Indicators

Priority Order	Indicator	Data Supporting the Indicator
1	Participation in reef activities	NCRMP primary survey data
2	Perceived resource condition	NCRMP primary survey data
3	Attitudes toward coral reef management strategies and enforcement	NCRMP primary survey data
4	Awareness and knowledge of coral reefs	NCRMP primary survey data
5	Human population changes near coral reefs	Secondary data
6	Economic impact of coral reef fishing to jurisdiction	Secondary data
7	Economic impact of dive/snorkel tourism to jurisdiction	Secondary data
8	Community well-being	Secondary data
9	Cultural importance of reefs	NCRMP primary survey data
10	Participation in behaviors that may improve coral reef health	NCRMP primary survey data
11	Physical infrastructure	Secondary data
12	Awareness of coral reef rules and regulations	NCRMP primary survey data
13	Governance	Marine protected area (MPA) Checklist survey data

The next four years focused on primary data collection for seven indicators through survey implementation in each jurisdiction, and the collection of secondary data for the other six indicators. Surveys were administered to residents in each of the jurisdictions, with a core module of questions (see Appendices A and B) asked in all jurisdictions as well as a jurisdictionally specific module to address more localized management needs. The respondent universe for each survey included adults aged 18 or older who live in the particular jurisdiction. The data collected by the surveys include questions for residents concerning their frequency of participation in reef activities, perception of the jurisdiction's marine resources condition, awareness and knowledge of coral reef threats, attitudes toward coral reef management strategies and enforcement, and frequency of participation in behaviors that may improve coral reef health, among other topics. At the same time, relevant secondary data were collected from the U.S. Census Bureau, the U.S. Bureau of Economic Analysis (BEA), and jurisdictional governments, among other sources. Exhibit 4 presents an overview of the surveys including the year, mode, and sample size for each jurisdiction.

Exhibit 4. Overview of NCRMP Socioeconomic Surveys

Jurisdiction	Year of Survey	Sampling Unit	Mode	Sample Size
South Florida	2014	Resident households	Telephone	1,210
American Samoa	2014	Resident households	Face to face	448
Hawai'i	2014	Resident households	Telephone	2,240
Puerto Rico	2014–2015	Resident households	Telephone	2,494
Guam	2016	Resident households	Telephone and face to face	712
CNMI	2016–2017	Resident households	Telephone and face to face	722
U.S. Virgin Islands	2017	Resident households	Telephone and face to face intercepts	1,188

Now that CRCP and its implementing partner, NCCOS, have completed a full cycle of data collection, the primary and secondary data can be synthesized into socioeconomic indicators to develop metrics for each jurisdiction. This is an essential next step in the socioeconomic monitoring process: establishing a baseline socioeconomic condition for tracking the indicators moving forward, thereby bolstering the capacity for effective monitoring using the best available and most recent science.

The selection of the socioeconomic indicators was informed by a need for measures that can inform local management decisions, as well as enable comparisons across jurisdictions. The challenge with this objective is that jurisdictions are associated with a wide range of physical and socioeconomic conditions; and reef habitats are subject to a wide range of stressors, governance, and use across the jurisdictions. To highlight some of these differences, Exhibit 5 presents a sample of the U.S. Census demographic data for each jurisdiction.

Exhibit 5. Demographic Data for the Coral Reef Jurisdictions

Jurisdiction	2010 U.S. Census Data[A]				
	Land Area (sq. mi.)[B]	Total Population[B]	Ethnic Origin/Race[C]	Median Age[C]	Median Income[C]
AS	98	55,519	88.9% Samoan; 2.9% Tongan; 2.7% Multiracial; 2.4% Other; 2.2% Filipino; 0.9% White	22.4	$23,892
CNMI	118	53,883	35.3% Filipino; 23.9% Chamorro; 12.7% Multiracial; 11.0% Other Pacific Islander; 6.8% Chinese; 7.8% Other Asian; 2.1% White; 0.4% Other	33.4	$19,958
GU	210	159,358	37.3% Chamorro; 26.3% Filipino; 8.3% Other Asian; 9.4% Multiracial; 7.1% White; 7.0% Chuukese; 4.6% Other	29.5	$48,274
HI	6,317	1,360,301	24.7% White; 23.6% Multiracial; 14.5% Filipino; 13.6% Japanese; 10.5% Other Asian; 5.9% Native Hawaiian; 4.1% Other Pacific Islander; 3.1% Other	38.6	$67,492
FL	6,686	5,784,065	75.0% White; 16.0% Black; 4.1% Other; 2.4% Asian; 2.5% Multiracial	40.7	$45,203
PR	3,455	3,725,793	75.8% White; 12.4% Black; 8.5% Other; 3.3% Multiracial	36.9	$19,515
USVI	133	106,405	76.0% Black; 15.6% White; 6.3% Other; 2.1% Multiracial	39.2	$37,254

[A] U.S. Census Bureau (2010a, 2010e, 2010l); [B] Based on geographic scope of socioeconomic monitoring; [C] Based on entire jurisdiction.

To support NCRMP's socioeconomic indicator development effort, Abt Associates (Abt) was tasked with developing and implementing methods to produce quantitative values for the 13 indicators listed in Exhibit 3 using the associated data. The goals of this effort were to use the available data to produce indicators that could:

- Reflect the changing conditions of attitudes related to coral reefs of adjacent populations within and across jurisdictions;
- Be easily explained and understood by the intended reporting audiences of Congress, Agency leadership (e.g., senior staff in the National Ocean Service), local coral reef management partners, and local government leaders; and
- Inform decision-making concerning coral reef management within and across jurisdictions.

Critical to the indicator development was the general incorporation of a "wide and thin" approach in contrast to one that was "narrow and deep." In practice, this was reflected in a willingness and preference

to increase the number of issues/themes addressed in developing an indicator by incorporating additional relevant data, in contrast to focusing on specific components of indicators. However, there were limitations to the indicator development effort, as supported by best professional judgment and relevant literature such as Bowen and Riley (2003) and Smith and Clay (2010), including the fact that indicator development inherently requires choices and universal agreement of their construction was unlikely in all cases. The preference was to collect time-series data that have been and will continue to be available with updated annual values. For each indicator, not all desired information was available and not all information could, or should, be incorporated. This effort generally relied on data produced by a reliable (i.e., generally government) source using reasonable methods that remain relatively constant over time and are well-documented. The limited number of jurisdictions (n = 7) also constrained the use of some potential analytical and statistical techniques.

As a first step in the indicator development process, CRCP and Abt held a facilitated discussion at the 2018 Social Coast Forum with coastal managers and scientists. During the session, participants were introduced to the project and the list of 13 indicators (see Exhibit 3) before breaking into smaller groups to discuss key data issues and questions focusing on the indicators derived from secondary data. Participants provided initial feedback on the potential data sources for each indicator as well as proposed approaches for their development. Incorporating that feedback, Abt refined key assumptions and proposed development methods, along with continuing the collection of relevant secondary data.

In July and August 2018, CRCP and Abt convened the first expert workshops to present the data collected for each indicator, along with the refined assumptions and development approaches prior to calculation of the indicators and their values. A group of experts were invited to these workshops that focused on specific groups of indicators (i.e., economic impacts; attitudes, perceptions, and behaviors; management; and stressors), who had previous experience with the NCRMP effort or had expertise in the relevant socioeconomic topics, indicator development, and/or coral reef management. Each workshop included approximately 10 participants, namely NOAA scientists, coastal managers, and leading academics, who provided detailed feedback on additional secondary data sources to consider and the proposed approaches to refine data and assess limitations in operationalizing the indicators. The central proposed approach involved scaling or indexing input data variables with a value (e.g., 0–100), and then computing a weighted sum of the indexed variables based on their relevance. While the experts generally agreed with this approach, the discussion yielded several key points concerning limitations such as the relatively small sample size (n = 7 jurisdictions) for exploring potential statistical analyses (i.e., FA or principle component analysis) to help narrow or understand the significance of specific variables, as well as the feasibility of weighting or normalizing variables or grouping similar indicators. Experts expressed experience with similar challenges in developing socioeconomic indicators, and provided additional relevant studies and research to consider in the effort. A list of participants and detailed notes from the workshops are provided in Appendix C.

Incorporating feedback from this first round of expert workshops, Abt proceeded to develop and calculate values for all 13 indicators. Prior to finalizing the indicator values, Abt and CRCP reconvened experts in a second round of workshops in December 2018. The initial group of experts from the first set of workshops were invited to attend the December workshops and about 15 participated in 2 identical sessions that reviewed methods and results for the 13 indicators. During the workshops, experts were presented with details on all data variables and refined methods used to calculate each indicator. This allowed experts a final opportunity to identify missing or suggest additional data sources; and evaluate the overall reasonableness and appropriateness of the approach, draft results, and interpretation in meeting each indicator's goal. Experts generally supported the presented methods and results; however, in one case there was a strong recommendation to decompose elements initially combined in a single indicator to produce two distinct indicators. The result was there are now indicators 5a and 5b, which

focus on changes in resident populations and changes in annual visitors to the coral reef jurisdictions, respectively. A list of participants and detailed notes from the workshops are provided in Appendix D. Following these workshops, Abt incorporated other final revisions to the indicators such as applying final relative weighting of individual data variables for applicable indicators. Details on the specific data variables, assumptions, weighting, and calculation methods are presented in Section 2 for each indicator. Throughout the report, all dollar values have been adjusted to 2017 based on gross domestic product (GDP) deflators estimated by the U.S. Bureau of Economic Analysis (2018). Further, throughout the data collection process, two indicators from the original list shown in Exhibit 4 were targeted for name changes based on data availability. First, for the "*Economic impact of dive/snorkel tourism to jurisdiction*," it is difficult to parse out dive/snorkel tourism in a uniform way across the jurisdictions, and while coral reef-based tourism was assessed where possible, this indicator is more aptly named the *"Economic impact of tourism to jurisdiction."* It is assumed that coral reefs and other marine areas drive much of the tourism in each of the seven jurisdictions. Secondly, *Awareness and knowledge of coral reefs*, which is tracked through NCRMP resident surveys, is technically a self-reported assessment of awareness and knowledge; therefore, this indicator name has been changed to "*Self-reported awareness and knowledge of coral reefs*." Both of these name changes are reflected throughout the rest of the document.

Finally, as a complement to the specific numeric indicator values, a confidence ranking was developed and applied for each indicator using values and criteria in Exhibit 6. Throughout the development of these indicators, the research team was constrained in the data that could be collected in two main areas: for primary data, researchers were constrained by minimizing respondent burden; and for secondary data, researchers were constrained by data availability and consistency across the jurisdictions. Many of the variables targeted for the development of secondary data indicators are not collected in a uniform, systematic way across all seven jurisdictions, which may increase the margin of error around the estimates. These confidence rankings are used to provide additional context for the indicator values, based on the constraints described above. For each indicator, notes are included discussing the rationale for each indicator's confidence ranking. As new primary data are collected for the next round of socioeconomic monitoring, these confidence rankings will be used to target primary data indictors that need improvement in terms of how they are addressed in the next round of surveys. For secondary data indicators, these confidence rankings will be used to track data availability and consistency (in a general sense) over time.

Exhibit 6. Confidence Ranking Values and Criteria

Confidence Ranking	Criteria for the Confidence Ranking Score
Low	Secondary data sources have questionable reliability either due to a lack of consistency in availability across the jurisdictions, a lack of consistency in availability across time periods, and/or a lack of consistency in a uniform data source across jurisdictions. For NCRMP survey-based indicators, the indicator relies on a single survey question that could be improved upon to fully cover the breadth of the topic with more survey questions.
Medium	Secondary data sources are reliable but there are gaps in the available information, either within a specific jurisdiction or across the jurisdictions collectively. For NCRMP survey-based indicators, the indicator could be improved upon to fully cover the breadth of the topic either with more survey questions or a more focused targeting of current survey questions.
High	Secondary data sources are highly reliable and there are few instances of missing values within or across jurisdictions. For NCRMP survey-based indicators, the indicator relies on multiple targeted survey questions that cover the breadth of the topic.

Before going into the details of how each indicator was calculated, it should be noted that respondent weights that were calculated in FL, USVI, and HI are used in all of the indicators derived from NCRMP

survey data; and all missing responses and answers of "not sure" are excluded from analysis. All of the data and results contained in this report can be considered updates from previously published reports (Gorstein et al., 2016, 2017, 2018a, 2018b, 2019a, 2019b; Levine et al., 2016). The indicator values for the jurisdictions presented in Section 2 were developed with the use of NCRMP survey data, archived and publically available through NOAA's National Centers for Environmental Information,[1] and through secondary data, publically available through various sources, but synthesized by NOAA into a database found by navigating to the NCRMP socioeconomic website.[2]

[1] American Samoa, South Florida, Hawai'i , Puerto Rico, Guam, CNMI, and USVI.

[2] https://www.coris.noaa.gov/monitoring/socioeconomic.html

2. Indicator Development and Results

In this section, details are provided for each indicator with respect to its:

- Goal
- Input variable data
- Calculation method
- Key results
- Caveats
- Confidence ranking

Indicator 1: Participation in Reef Activities

Goal

This indicator uses NCRMP survey data to account for residents' participation in a range of coral reef-related activities. The underlying survey data included information on the frequency of participation in each activity related to direct and indirect uses of reefs such as snorkeling, surfing, swimming, diving, fishing, and harvesting; with the specific list of activities tailored to the jurisdiction.

Additional considerations and assumptions in the development of this indicator included:

- Reef condition will be influenced by the type and amount of activities (e.g., sustainable use, carrying capacity, overfishing).
- Change in activity may be linked to carrying capacity; more activity participation equals more people obtaining reef's ecosystem services and more anthropogenic stressors, and may be consistent with an increased value of those reefs to human populations.
- Activities are tied to economy and culture, and so the type and amount/level of activity could affect reef condition.
- May be linked to overall economic conditions with individuals having more or less recreation time.
- Depends on population change since a large increase in residents or visitors could mean more marine activity participation.

Input Variable Data

Exhibit 7 presents the NCRMP input variables for the indicator and their associated range of values. In this case, the indicator was developed using normalized additive indices developed based on grouped survey questions.

Exhibit 7. Indicator Inputs for Participation in Reef Activities			
Survey Questions	**Jurisdiction(s) Covered**	**Source**	**Other Comments**
Activity Index: additive index of activity questions; increases as frequency of participation increases Question: How often do you usually participate in each of the following activities? [list of activities are specific to each jurisdiction]	All	NCRMP surveys	Activity Index normalized to a 0–100 scale based on question responses of: 1 = never 2 = once a month or less 3 = 2–3 times per month 4 = 4 times a month or more
Fishing Index: additive index of fishing questions; increases as frequency of fishing increases for various reasons Question: How often do you fish or harvest marine resources for each of the following reasons?[list of fishing reasons are specific to each jurisdiction]	All	NCRMP surveys	Fishing Index normalized to a 0–100 scale based on question responses of: 1 = never 2 = rarely 3 = sometimes 4 = frequently

Calculation Method

The evaluated NCRMP resident survey data included the coded responses for each surveyed resident in a jurisdiction. Respondent weights from FL, HI, and USVI were used to weight responses to best represent the jurisdiction's population where appropriate. Implicit weights of 1.0 were used in the remaining locations (AS, CNMI, GU, and PR).

This *Participation in Reef Activities* indicator was developed as follows:

- The *Activity Index* and *Fishing Index* were derived by adding up responses to the group of activity (Q1 in Appendix A) and fishing (Q2 in Appendix A) questions, respectively, then normalizing to a 0-100 scale using the minimum-maximum scaling method. A respondent had to answer every question contained in the index to receive and index value and answers of "not sure" were considered missing when constructing the additive indices. The minimum-maximum scaling method is defined by the following equation, where x is the value of a given variable, *min* is the minimum value in the distribution, and *max* is the maximum value in the distribution.

$$\frac{x - min}{max - min} = x_{norm}$$

- Respondent-weighted *activity index* values and respondent-weighted *fishing index* values, excluding responses coded as missing, were used to calculate indicator values for each survey respondent.
- The average indicator value is then calculated for each jurisdiction.

Key Results

After consulting with expert opinion, it was decided to weight the activity and fishing index at 40% and 60%, respectively. The additional weight given to the fishing index values reflects an emphasis on extractive activities associated with this variable in the belief they are more likely to have a direct impact on reef resources. Exhibit 8 presents the indicator values reflecting that weighting scheme, along with information and results for the input variables. To assist with interpretation, the indicator results were bounded by possible values from 0, reflecting no reef-related activity among residents; to 100, reflecting all residents participating to the maximum extent possible in reef-related activities, as defined by the survey.

Exhibit 8. Results for Participation in Reef Activities Indicator and Input Variables						
Jurisdiction	Indicator Values		*Fishing Index*		*Activity Index*	
	Mean	n[3]	Mean	n	Mean	n
AS	17.674	346	17.516	399	19.258	364
CNMI	15.694	704	14.815	720	17.328	706
FL	12.550	1,150	8.870	1,202	18.230	1,151
GU	14.684	705	13.277	712	16.766	705
HI	19.078	2,157	15.112	2,240	25.500	2,157
PR	6.768	2,392	3.211	2,476	12.096	2,405
USVI	15.180	1,069	11.359	1,177	21.013	1,077

Caveats

- The index variables incorporated as input variables in the indicator were coded as missing if the respondent failed to reply or answered "not sure" to any of the specific questions contributing to the index value.
- The NCRMP survey does not account for visitors to the jurisdictions, so tourist activity was not accounted for in this index.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the *Participation in Reef Activities* indicator should be treated with **High** confidence as the input variables cover a wide variety of comparable as well as jurisdictionally specific activities and reasons for fishing, which effectively addresses the scope of the topic being considered with the indicator.

[3] Sample Size.

Indicator 2: Perceived Resource Condition

Goal

This indicator uses NCRMP survey data to account for residents' perceived opinion of current marine resource condition in the jurisdiction, changes in resource condition over time, and expectations for resource condition in the future. Survey responses were based on individuals' perceptions of status and trends, with the specific list of resources tailored to the jurisdiction.

Additional considerations and assumptions in the development of this indicator included:

- Having the indicator may aid in seeing correlations (or a gap) between perceptions of resource condition and actual condition.
- The indicator may help evaluate links between improving public awareness campaigns and changes in residents' perceptions of resource conditions. Similarly, the indicator could also inform whether perceptions of resource conditions change following discrete bleaching and other impactful events, or as the frequency and severity of these events increase.

Input Variable Data

This indicator was developed using data from NCRMP's resident survey. Exhibit 9 presents the NCRMP variables and the associated values for these input variables to the indicator. In this case, the indicator was developed using normalized additive indices developed based on grouped survey questions (*Condition Index, Last 10 Index*) and values reported on a 1–3 Likert scale (*Next 10*).

Exhibit 9. Indicator Inputs for Perceived Resource Condition

Survey Questions	Jurisdiction(s) Covered	Source	Other Comments
Condition Index: additive index of condition questions; increases as positive perception increases Question: In your opinion, how are the jurisdiction's marine resources currently doing? Please rank from very bad to very good. [list of conditions are specific to each jurisdiction]	All	NCRMP surveys	Condition Index normalized to a 0–100 scale based on question responses of: 1 = very bad 2 = bad 3 = neither bad nor good 4 = good 5 = very good
Last 10 Index: additive index of last 10 questions; increases as positive perception increases Question: How would you say the condition of each of the following has changed over the last 10 years? Please indicate if it has gotten a lot worse, somewhat worse, no change, somewhat better, or a lot better. [list of conditions are specific to each jurisdiction]	All	NCRMP surveys	Last 10 Index normalized to a 0–100 scale based on question responses of: 1 = a lot worse 2 = somewhat worse 3 = no change 4 = somewhat better 5 = a lot better
Next10: In the next 10 years, do you think the condition of the marine resources in the jurisdiction will get worse, stay the same, or improve?	All	NCRMP surveys	Based on question responses of: 1 = get worse 2 = stay the same 3 = improve

Calculation Method

The evaluated NCRMP resident survey data included the coded responses for each surveyed resident in a jurisdiction. Respondent weights from FL, HI, and USVI were used to weight responses to best represent

the jurisdiction's population where appropriate. Implicit weights of 1.0 were used in the remaining locations (AS, CNMI, GU, and PR).

This *Perceived Resource Condition* indicator was developed as follows:

- This indicator was based on a mix of "index" variables and "Likert/ordinal" variables.
- The "index" values were constrained to a defined range (0–100), while the "Likert/ordinal" variables values have a defined set of ordinal responses.
- The *Condition Index* and *Last10 Index* were derived by adding up responses to the group of current condition (Q5 in Appendix A) and change in condition (Q6 in Appendix A) questions, respectively, then normalizing to a 0-100 scale using the minimum-maximum scaling method. A respondent had to answer every question contained in the index to receive and index value and answers of "not sure" were considered missing when constructing the additive indices.
- For the "Likert/ordinal" variable (*Next10*), the 1-3 scale was transformed to 0-1 using the minimum-maximum scaling method, then a weighted average value of the variable was calculated and multiplied by 100 to convert the ranked responses into a numeric value on the same 0–100 scale so that it could be combined with the index variables.
- Respondent-weighted *Condition Index, Last 10 index,* and *next10* values, excluding responses coded as missing, were used to calculate indicator values for each survey respondent.
- The average indicator value is then calculated for each jurisdiction.

Key Results

After consulting with expert opinion, it was decided to weight the *condition index, last10 index*, and *next10* at 60%, 20%, and 20%, respectively. The most weight was given to the current perception that assumes respondents will be more accurate without recall or anticipation. Exhibit 10 presents the indicator values reflecting that weighting scheme along with information and results for the input variables. To assist with interpretation, these results were bounded by possible values from 0, reflecting the worst possible perception of the reefs' condition over the different time periods; to 100, reflecting the best possible perception of the reefs' condition over the different time periods, as defined by the survey.

Exhibit 10. Results for Perceived Resource Condition Indicator and Input Variables

Jurisdiction	Indicator Values		*Condition Index*		*Last 10 Index*		*Next 10*	
	Mean	n	Mean	n	Mean	n	Mean	n
AS	46.542	197	49.523	249	46.515	269	49.290	352
CNMI	55.115	382	58.521	426	44.588	486	54.322	671
FL	43.193	470	50.541	565	35.020	620	35.218	1,076
GU	49.070	315	49.134	587	44.456	377	60.892	684
HI	46.772	1,429	55.688	1,576	42.048	1,760	30.420	2,145
PR	41.067	1,804	47.972	1,950	34.405	2,077	30.021	2,375
USVI	49.137	1,069	55.080	599	41.539	587	51.670	1,002

Caveats

- The index variables incorporated in the indicator were coded as missing if the respondent failed to reply or answered "not sure" to any of the specific questions contributing to the index value.
- The *Last 10 Index* variable was based on the respondent's recall about changes in conditions over a relatively long time period (last 10 years)
- As those who answered "not sure" were excluded from the analysis, this indicator can be interpreted as "perceived resource condition by those who are sure about their perception."

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the *Perceived Resource Condition* indicator should be treated with **High** confidence as the input variables address multiple comparable, as well as jurisdictionally specific, marine resources across three time periods.

Indicator 3: Attitudes toward Coral Reef Management Strategies and Enforcement

Goal

This indicator uses NCRMP survey data to account for resident support for MPAs and different reef management activities. The underlying survey data include both support and opposition toward management activities as well as agreement/disagreement about the functions of MPAs.

Additional considerations and assumptions in the development of this indicator included:

- Results should have direct management relevance because positive attitudes toward management should result in greater compliance, which should lead to improved reef condition.
- NOAA and local resource managers are interested in knowing how supportive the general population is of coral reef management strategies and actions.
- Both management actions and support can change over time depending on political climate and effective demonstration of positive results of coral reef management.
- MPAs have been shown to be effective, and greater support for MPAs would make implementation easier and translate to positive effects on the reefs.
- More support for management eases implementation.

Input Variable Data

This indicator was developed using data from NCRMP's resident survey. Exhibit 11 presents the NCRMP variables and the associated values for these input variables to the indicator. In this case, the indicator was developed using normalized additive indices developed based on grouped survey questions.

Exhibit 11. Indicator Inputs for Attitudes toward Coral Reef Management Strategies and Enforcement

Survey Questions	Jurisdiction(s) Covered	Source	Other Comments
Positive Perception of MPAs Index: additive index of MPA uses questions; increases as positive perception increases Question: Please indicate how much you disagree or agree with each of the following statements about MPA uses. [the list of MPA uses is specific to each jurisdiction]	All except FL and HI	NCRMP surveys	Positive perception of MPAs Index normalized to a 0–100 scale based on question responses of: 1 = strongly disagree 2 = disagree 3 = neither agree nor disagree 4 = agree 5 = strongly agree
Management Support Index: additive index of management support questions; increases as support increases Question: The following are proposed or existing management strategies used to manage the marine environment in the jurisdiction. We are interested in your opinion about the use of these strategies to improve the protection of coral reefs. Please indicate how much you disagree or agree with each of the following? [list of management strategies is specific to each jurisdiction]	All	NCRMP surveys	Management Support Index normalized to a 0–100 scale based on question responses of: 1 = strongly oppose 2 = oppose 3 = neither support nor oppose 4 = support 5 = strongly support

Calculation Method

The evaluated NCRMP resident survey data included the coded responses for each surveyed resident in a jurisdiction. Respondent weights from FL, HI, and USVI were used to weight responses to best represent the jurisdiction's population where appropriate. Implicit weights of 1.0 were used in the remaining locations (AS, CNMI, GU, and PR).

The *Attitudes towards Coral Reef Management Strategies and Enforcement* indicator was developed as follows:

- The *Positive Perception of MPAs Index* and *Management Support Index* were derived by adding up responses to the group of MPA (Q12 in Appendix A) and management (Q13 in Appendix A) questions, respectively, then normalizing to a 0-100 scale using the minimum-maximum scaling method. A respondent had to answer every question contained in the index to receive and index value and answers of "not sure" were considered missing when constructing the additive indices.
- Respondent-weighted *Positive Perception of MPAs Index* values and respondent-weighted M*anagement Support Index* values, excluding responses coded as missing, were used to calculate indicator values for each survey respondent.
- So as not to reduce sample size due to the nature of the survey skip pattern associated with the MPA perception questions, the *Positive Perception of MPAs Index* and *Management Support Index* were not combined into a single indicator value for each survey respondent. Alternatively, an average of the two respondent weighted average index values was calculated as the indicator value for each jurisdiction in which MPA perception questions were asked, and the mean of the *Management Support Index* is used as the indicator value in jurisdictions without MPA perception data available.

Key Results

After consulting with expert opinion, it was decided to weight the *Positive perception of MPAs Index* and the *Management Support Index* at 50% and 50%, respectively, as there was no reason to weight one input variable more than the other given that the *Positive Perception of MPAs Index* variable was not available for all jurisdictions. Exhibit 12 presents the indicator values reflecting that weighting scheme along with information and results for the input variables. To assist with interpretation, these results were bounded by possible values from 0, reflecting strong disagreement with MPAs and opposition toward management strategies among residents; to 100, reflecting all residents having the highest possible agreement with MPA goals and support for management strategies, as defined by the survey.

Exhibit 12. Results for Attitudes towards Reef Management Strategies and Enforcement Indicator and Input Variables

Jurisdiction	Indicator Values	*Positive Perception of MPAs Index*		*Management Support Index*	
		Mean	n	Mean	n
AS	72.365	80.218	226	64.513	349
CNMI	75.644	75.478	381	75.810	574
FL[A]	76.129	n/a	n/a	76.129	742
GU	74.437	76.657	352	72.217	636
HI[A]	75.259	n/a	n/a	75.259	1,599
PR	81.248	81.397	439	81.099	2,375
USVI	73.746	75.194	444	72.298	871

[A] Values for FL and HI were based only on the *Management Support Index* input variable as the underlying questions supporting the *Positive Perceptions of MPA Index* variable were not asked in either jurisdiction.

Caveats

- The index variables incorporated in the indicator were coded as missing if the respondent failed to reply or answered "not sure" to any of the specific questions contributing to the index value.
- Values for responses to the *Positive perception of MPAs index* were not available for FL and HI as these questions were not asked in those jurisdictions.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the *Attitudes towards Reef Management Strategies* indicator should be treated with **Medium** confidence. Although the survey questions cover a multitude of comparable and jurisdictionally specific management strategies and MPA functions, information on the perceptions of MPA functions was unavailable for FL and HI, posing challenges for comparisons across jurisdictions. Specific questions also varied across jurisdictions, and some specific management strategies proposed by the survey may have been more controversial than others.

Indicator 4: Self-Reported Awareness and Knowledge of Coral Reefs

Goal

This indicator used NCRMP survey data to synthesize residents' self-reported awareness of threats to the jurisdiction's coral reef habitat and knowledge about specific ecological services the reef provides. The underlying survey data include agreement with statements about coral reef values/functions and awareness of threats to coral reefs (e.g., climate change, coral bleaching), with the specific list of threats tailored to the jurisdiction.

Additional considerations and assumptions in the development of this indicator included:

- NOAA wants to track people's awareness of reef threats to understand how engaged and knowledgeable the population is.
- Changes in awareness could reflect behavior changes that lead to improved reef conditions, or support for management strategies to reduce threats.
- As more people are aware of threats, support for management actions to address threats may increase.

Input Variable Data

This indicator used data from NCRMP's resident survey. Exhibit 13 presents the NCRMP variables and the associated values for these input variables to the indicator. In this case, the indicator was developed using a normalized additive index developed based on grouped survey questions (*Threat Familiarity Index*) and a Likert variable with values reported on a 1–5 scale (*Value_1*).

Exhibit 13. Indicator Inputs for Self Reported Awareness and Knowledge of Coral Reefs

Survey Questions	Jurisdiction(s) Covered	Source	Other Comments
Threat Familiarity Index: additive index of threat familiarity questions; increases as familiarity increases Question: How familiar are you with each of the following potential threats facing the coral reefs in the jurisdiction? [list of threats is specific to each jurisdiction]	All	NCRMP surveys	Threat Familiarity Index normalized to a 0–100 scale based on question responses of: 1 = very unfamiliar 2 = unfamiliar 3 = neither unfamiliar nor familiar 4 = familiar 5 = very familiar
Value_1: Please say whether you disagree or agree with each of the following statements: Coral reefs protect the jurisdiction from erosion and natural disasters.	All	NCRMP surveys	Based on question responses of: 1 = strongly disagree 2 = disagree 3 = neither agree nor disagree 4 = agree 5 = strongly agree

Calculation Method

The evaluated NCRMP resident survey data included the coded responses for each surveyed resident in a jurisdiction. Respondent weights from FL, HI, and USVI were used to weight responses to best represent the jurisdiction's population where appropriate. Implicit weights of 1.0 were used in the remaining locations (AS, CNMI, GU, and PR).

This *Self-Reported Awareness and Knowledge of Coral Reefs* indicator was developed as follows:

- This indicator was based on a mix of "index" variables and "Likert/ordinal" variables.

- The "index" values were constrained to a defined range (0–100), while the "Likert/ordinal" variables values have a defined set of ordinal responses.
- The *Threat Familiarity Index* was derived by adding up responses to the group of threat familiarity (Q9 in Appendix A) questions, respectively, then normalizing to a 0-100 scale using the minimum-maximum scaling method. A respondent had to answer every question contained in the index to receive and index value and answers of "not sure" were considered missing when constructing the additive index.
- For the "Likert/ordinal" variable (*Value_1*), the 1-5 scale was transformed to 0-1 using the minimum-maximum scaling method, then a weighted average value of the variable was calculated and multiplied by 100 to convert the ranked responses into a numeric value on the same 0–100 scale so that it could be combined with the index variables.
- Respondent-weighted *Threat Familiarity Index* and *Value_1* values, excluding responses coded as missing, were used to calculate indicator values for each survey respondent.
- The average indicator value is then calculated for each jurisdiction.

Key Results

After consulting with expert opinion, it was decided to weight the *threat familiarity index* and *value_1* at 75% and 25%, respectively, in calculating the indicator value to avoid giving too much weight to responses for a single question (i.e., *value_1*) and for consistency with CRCP's greater interest in tracking threat awareness over time. Exhibit 14 presents the indicator values reflecting that weighting scheme, along with information and results for the input variables. To assist with interpretation, these results were bounded by possible values from 0, reflecting strong disagreement with reefs' shoreline protection functions and strong unfamiliarity with reef threats; to 100, reflecting all residents' agreement with reefs' shoreline protection functions and high familiarity with all coral reef threats presented in the survey.

Exhibit 14. Results for Self Reported Awareness and Knowledge of Coral Reefs Indicator and Input Variables

Jurisdiction	Indicator Values		*Threat Familiarity Index*		*Value_1*	
	Mean	n	Mean	n	Mean	n
AS	70.076	209	67.980	220	72.321	392
CNMI	68.929	591	66.653	599	75.530	707
FL	71.220	853	67.825	921	79.550	1,071
GU	64.690	667	59.998	684	78.206	694
HI	68.819	1,905	65.733	1,939	77.418	2,177
PR	62.438	2,261	56.671	2,332	78.286	2,343
USVI	70.418	797	65.154	864	80.499	1,035

Caveats

- The index variables incorporated in the indicator were coded as missing if the respondent failed to reply or answered "not sure" to any of the specific questions contributing to the index value.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the *Self-Reported Awareness and Knowledge of Reefs* indicator should be treated with **High** confidence as the input variables cover a multitude of comparable and jurisdictionally specific coral reef threats.

Indicator 5: Human Population Changes: Residents and Visitors

Goal

This indicator reflects the pressure residents and visitors place on coral reef habitats.

Additional considerations and assumptions in the development of this indicator included:

- More people near reefs increase contact with the reef and thus can lead to chances for anthropogenic stressors.
- Added stressors brought on by increased population pressure can lead to a decline in reef condition (in the absence of adequate management).

Input Variable Data

This indicator was developed with separate components for residents and visitors to the jurisdictions using secondary data. Exhibit 15 presents the data variables used to develop the components of this indicator; along with the jurisdictions covered by each, detailed sources, and comments as to missing years of data and other limitations.

Exhibit 15. Inputs for Human Population Change Indicator: Residents and Visitors

Data Variable	Jurisdiction(s) Covered	Source	Other Comments
Total Resident Population: 2010–2017	FL, HI, and PR	U.S. Census Bureau (2018a)	Only 2010 data available for AS, CNMI, GU, and USVI
Total Resident Population: 2010–2017	AS, CNMI, GU, and USVI	United Nations (2017)	Data through 2017
International Tourist Arrivals: 2010–2016	AS, CNMI, GU, PR, and USVI	World Bank Group (2019b)	Missing data for 2016 (USVI) and 2017 (AS, CNMI, GU, PR, and USVI)
Hawai'i Visitor Arrivals (by air and cruise ship): 2010–2016	HI	Hawai'i Tourism Authority (2019)	Missing data for 2017
Miami-Dade County Visitors (domestic and international): 2010–2017	FL (Miami-Dade County only)	Miami-Dade County (2019)	
Monroe County Visitor Stays: 2013–2017	FL (Monroe County only)	D.K. Shifflet (2018)	Missing data for 2010–2012
Palm Beach County Visitation: 2011–2016	FL (Palm Beach County only)	Palm Beach County (Undated)	Missing data for 2010 and 2017

The general challenge with this indicator involved identifying reliable sources of annual data, particularly for visitor data where, for HI, the most reliable data were from the state, while for FL, the most reliable data came from a subset of the counties.

Calculation Method

In a December 2018 review of the draft indicators, a strong sentiment was expressed that the initial formulation of the *Human Population Change* indicator should be revised. Specifically, the initial formulation combined results in the jurisdictions for changes in resident populations and annual visitors, and the expert reviewers expressed a desire for this information to be disaggregated into separate indicators that reflected changes in residents and changes in annual visitors. This recommendation was incorporated. As a result, while similar methods were used for both indicators, the methods and results for the resident and visitor indicators are presented separately, each with its own confidence ranking.

The *Human Population Change: Resident Population* indicator was developed as follows:

- To the extent possible, annual data for resident populations in each jurisdiction were collected from the sources in Exhibit 15, primarily the U.S. Census and the United Nations, for the years 2010 through 2017.
- Annual values in each year were indexed to the jurisdiction's 2013 resident population value (2013 was selected as this was the first year the NCRMP surveys were administered).
- The resulting relative annual values for the indicator were calculated by dividing the value in a given year by the 2013 reference value.
- As a result, the indicator values are theoretically bounded by 0 at the lower end, but are unconstrained at the upper end.

The *Human Population Change: Visitors* indicator was developed as follows:

- To the extent possible, annual data for total visitors to the jurisdictions were collected from the sources in Exhibit 15 for the years 2010 through 2017.
- Annual values in each year were indexed to the jurisdiction's 2013 visitor population value (2013 was selected as this was the first year the NCRMP surveys were administered).
- The resulting relative annual values were calculated by dividing the value for the number of annual visitors in a given year by the 2013 reference population value.
- As a result of the calculation method, the indicator results are theoretically bounded by 0 at the lower end, but are unconstrained at the upper end.

Key Results

Exhibit 16 and Exhibit 17 present the results for the resident population and visitor pressure indicator variables, respectively. To assist with their interpretation, indicator values equal 1.000 if there were the same number of residents (or visitors) in a given year compared to the 2013 reference year populations. Values greater than 1 for the indicators show increasing population relative to the reference year, while values less than 1 reflect decreasing population. The population indicator values can be interpreted as the percent change in population (e.g., a value of 1.04 would represent a 4% increase in population). The 2013 resident and visitor populations are also presented in each exhibit to help provide a relative sense of scale for the results across jurisdictions.

Exhibit 16. Results for Resident Population Indicator with 2013 Reference Year Values

Jurisdiction	Indicator Results								2013 Reference Resident Population	2013 Reference Population Density (persons per square mile)
	2010	2011	2012	2013	2014	2015	2016	2017		
AS	1.006	1.000	0.999	1.000	1.002	1.004	1.005	1.006	55,307	563.897
CNMI	1.007	0.995	0.994	1.000	1.008	1.014	1.018	1.021	54,036	458.476
FL	0.950	0.972	0.986	1.000	1.014	1.028	1.042	1.050	6,090,125	910.868
GU	0.994	0.996	0.997	1.000	1.004	1.009	1.016	1.024	160,375	763.690
HI	0.966	0.979	0.989	1.000	1.007	1.013	1.015	1.014	1,408,038	222.898
PR	1.030	1.025	1.014	1.000	0.982	0.961	0.944	0.923	3,615,086	1,046.368
USVI	1.003	1.002	1.001	1.000	0.999	0.997	0.995	0.993	108,044	815.303

Exhibit 17. Results for Visitor Indicator with 2013 Reference Year Values										
Jurisdiction	Indicator Results								2013 Reference Visitor Population	2013 Visitor to Resident Ratio
	2010	2011	2012	2013	2014	2015	2016	2017		
AS	1.111	1.087	1.087	1.000	1.038	0.976	0.966	0.962	21,600	0.39
CNMI	0.863	0.777	0.913	1.000	1.048	1.091	1.210	1.494	460,000	8.51
FL[A]	N/A[B]	N/A[B]	N/A[B]	1.000	1.031	1.091	1.109	N/A[B]	22,933,000	3.77
GU	0.897	0.870	0.981	1.000	1.007	1.056	1.151	1.157	1,409,000	8.79
HI	0.859	0.893	0.982	1.000	1.018	1.062	1.093	1.150	8,320,785	5.91
PR	1.004	0.961	0.968	1.000	1.023	1.117	1.178	1.197	3,246,000	0.90
USVI	0.969	0.961	1.051	1.000	1.042	1.088	1.131	N/A[B]	615,000	5.69

[A] Results based on visitor data only for Miami-Dade, Monroe, and Palm counties.
[B] N/A cells reflect a lack of visitor data for the year.

Caveats

- The need to draw on multiple data sources creates patterns of missing data that complicate analyses in earlier years, where data were unavailable; and later years, where data have not yet been released.
- Data from these sources were not presented with information on the potential accuracy (i.e., point estimates only).
- Data regarding the number of visitors were unavailable for Martin and Broward counties in South Florida.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the *Resident Population* indicator should be treated with **High** confidence, with the secondary data sources of the U.S. Census and the United Nations considered highly reliable.

The results for the *Human Population Change: Visitor* indicator should be treated with **Medium** confidence, with the secondary data sources considered generally reliable but with gaps in available information and the incorporation of a number of different sampling methodologies that are difficult to evaluate and reconcile.

Indicator 6: Economic Impact of Coral Reef Fishing to Jurisdiction

Goal

This indicator reflects the potential economic impact provided by coral reef fisheries, including both recreational and commercial activities where feasible, in the jurisdictions. Given the nature of economic impacts, an increase in impact may indicate both greater dependence on the ecosystem but also greater stress on the ecosystem. In particular, economic activity creates financial benefits to the local community but has a direct impact on biological condition as it is focused on resource extraction.

Additional considerations in the development of this indicator included the following.

- Variation in fishery catch could result from numerous different factors, for example:
  - Changes in the availability of fish, given changes in reef health;
  - Impactful climate hazards such as tropical cyclones or bleaching events;
  - Changes in dependence on ocean resources;
  - Changes in fishery prices, which affect the effort put into catching fish;
  - Changes in the value of outside labor opportunities, which also affect effort; or
  - Changes in fishery policies (e.g., quotas).
- Variation in fishery prices could also result from numerous different factors, for example:
  - Changes in catch can affect prices directly by changing supply (thus, any variable that affects catch above may also affect prices);
  - Changes in inflation, which affect prices (this is controlled for); or
  - Changes in other competing markets that affect prices (e.g., if purchasers can substitute fish from one market with fish from another, that will affect prices).
- Variation in "normalizing" variables (i.e., total GDP, employment, establishments) could result from numerous different factors, for example:
  - Changes in jurisdiction-level growth or other economic factors (interest rates, spending, etc.); or
  - Changes in the global economy that trickle down to jurisdictional economy.

This list demonstrates that variation in the indicator across time and jurisdictions is dependent on numerous factors, and thus must be interpreted taking these factors into account.

Input Variable Data

This indicator was developed using secondary data. Exhibit 18 presents the variables used to develop this indicator along with the jurisdictions covered by each, detailed sources, and comments as to missing years of data and other limitations. This analysis notes that the variables were not mutually exclusive, and in fact in many cases will be highly correlated. For example, commercial fishery revenue is a measure of the price multiplied by the quantity of fish caught and harvested. This is directly tied to several of the other variables, including commercial fishery catch (which is an input to revenue) and living resources GDP, which measures the total value of production from several fisheries-related sectors. The number of fishery licenses will also directly affect fishery catch and fishery revenue. As a result, the choice of numerous input variables should not be thought of as the combination of several independent variables, but rather, the aggregation of several potentially correlated variables.

The input variables were also normalized to adjust for jurisdiction-specific factors where possible (see the shaded rows in Exhibit 18). The choice of normalization variable was to adjust for the primary variation expected to affect the numerator variable, and was determined by expert judgment. However, it is noted that there was not a single "correct" normalizing variable and not all non-reef variation can be removed from the input variables. This was a limitation of the exercise in creating a single indicator from numerous fishery-related variables. A selection of input variable data for the year 2015 is available in Appendix I.

Exhibit 18. Indicator Inputs for Economic Impact of Coral Reef Fishing			
Data Variable (normalization bulleted below)	**Jurisdiction(s) Covered[A]**	**Source**	**Other Comments**
Commercial Reef Fish Species Landings and Revenue • Normalized Total Reef Fish Species Commercial Yield by dividing by Total Commercial Fishery Yield • Normalized Total Reef Fish Species Commercial Revenue by dividing by Total GDP	All	**AS, CNMI, statewide FL, GU, HI, PR, and USVI** – National Oceanic and Atmospheric Administration Fisheries (2018a and 2018c) **FL** – Florida Fish and Wildlife Conservation Commission (2018b)	GU, AS, and CNMI come from the Pacific Island Fishery Science Center (PIFSC) within NMFS. No missing years, but some species-level data may be missing for certain years (in some cases due to lack of harvest but in other cases due to missing data).
Recreational Reef Fish Species Catch • Normalized by dividing by Total Fishery Catch	HI, statewide FL, and PR	National Oceanic and Atmospheric Administration Fisheries (2018b)	No missing years, but some species-level data may be missing for certain years (in some cases due to lack of harvest but in other cases due to missing data). .
Living Resources GDP • Normalized by dividing by Total GDP	HI, FL, and statewide FL	National Oceanic and Atmospheric Administration (2017)	**HI, FL, and statewide FL** – 2016 • Filled with extrapolation.
Living Resources Employment (and self-employment) • Normalized by dividing by Total Employment	HI, FL, statewide FL, PR, GU, AS, and CNMI	**PR** – U.S. Bureau of Labor Statistics (2019b) **AS, CNMI, FL, statewide FL, GU, and HI** – National Oceanic and Atmospheric Administration (2017)	**HI, FL, and statewide FL** – 2016 • Employment and self-employment filled with extrapolation **GU, AS, and CNMI –** 2015 • Point estimates, no other years of data
Living Resources Establishments • Normalized by dividing by Total Establishments	All	**PR and USVI** – U.S. Bureau of Labor Statistics (2019b) **AS, CNMI, FL, statewide FL, GU, and HI** – National Oceanic and Atmospheric Administration (2017)	**HI, FL, and statewide FL** – 2016 • Economics: National Ocean Watch (ENOW) employment and self-employment filled with extrapolation **GU, AS, and CNMI** – 2015 • ENOW point estimates, no other years of data
Commercial Fishing Licenses and License Revenue • Commercial Fishing Licenses normalized by dividing by Total Population • Commercial Fishing License Revenue normalized by dividing by Total GDP	HI and statewide FL	**HI** – State of Hawai'i Division of Aquatic Resources (2019) **Statewide FL** – Florida Fish and Wildlife Conservation Commission (2018b)	**FL Commercial Revenue** – 2012–2016 • Data before 2012 were not considered reliable by the Florida Fish and Wildlife Conservation Commission (FWC)

Exhibit 18. Indicator Inputs for Economic Impact of Coral Reef Fishing			
Data Variable (normalization bulleted below)	**Jurisdiction(s) Covered[A]**	**Source**	**Other Comments**
Recreation Fishing Licenses and License Revenue	Statewide FL	**Statewide FL** – Florida Fish and Wildlife Conservation Commission (2018b)	FWC has data on the number of recreational licenses, but they were not obtained for this study. **FL Recreational Revenue** – 2012–2016 Data before 2012 were not considered reliable by FWC.
GDP[B] Used to normalize fishing variables: • Total Reef Commercial Fishery Revenue • Living Resource GDP • Commercial Fishing License Revenue • Recreational Fishing License Revenue Used to normalize tourism variables: • Tourism and Recreation GDP • National Park Total Value Added • National Park Coral Value Added	All	**PR** – World Bank Group (2019a) **AS, CNMI, statewide FL, GU, HI, and USVI** –U.S. Bureau of Economic Analysis (2018) **FL** – National Oceanic and Atmospheric Administration (2017)	BEA does not calculate GDP for PR. No missing years.
Employment[B] Used to normalize fishing variables: • Living Resources Employment + Self Employment Used to normalize tourism variables: • Tourism and Recreation Employment + Self Employment • National Park Total Visitor Employment • National Park Coral Visitor Employment • Scenic Water Transport (Charter Boats) Employment	All	**GU** – U.S. Bureau of Labor Statistics (2019a) **AS and CNMI** – U.S. Census Bureau (2018c) **FL, statewide FL, HI, PR, and USVI** – U.S. Bureau of Labor Statistics (2019b)	**AS and CNMI** – 2005–2016 • Economic Census was available for 2002, 2007, and 2012. • Other years filled with extrapolation.
Self-Employment[B] Used to normalize fishing variables: • Living Resources Employment + Self Employment Used to normalize tourism variables: • Tourism and Recreation Employment + Self Employment	HI, FL, and statewide FL	U.S. Census Bureau (2018d)	Only necessary for these jurisdictions since ENOW only includes self-employment for these jurisdictions. No missing years.

Exhibit 18. Indicator Inputs for Economic Impact of Coral Reef Fishing			
Data Variable (normalization bulleted below)	**Jurisdiction(s) Covered[A]**	**Source**	**Other Comments**
Establishments[B] Used to normalize fishing variables: • Living Resources Establishments Used to normalize tourism variables: • Tourism and Recreation Establishments • Scenic Water Transport (Charter Boats) Establishments	All	**GU and CNMI** – U.S. Census Bureau (2018b, 2018c) **AS** – U.S. Census Bureau (2018b) **FL, statewide FL, HI, PR, and USVI** – U.S. Bureau of Labor Statistics (2019b)	**GU and CNMI** – 2005 and 2006 • Filled with extrapolation using Economic Census years 2002 and 2007. **AS** – 2005–2007 • Economic Census was very different from County Business Patterns (CBP) values and therefore not used. • Filled with extrapolation (CBP).
Population[B] Used to normalize fishing variables: • Recreational Fishing Licenses • Local Fishing Used to normalize tourism variables: • Visitor Arrivals	All	**HI, FL, and statewide FL** – U.S. Census Bureau (2018a) **AS, CNMI, GU, PR, and USVI** – United Nations (2017)	No missing years.

[A] Indicators 6 and 7 were developed at the statewide level for Florida (statewide FL) and then narrowed down to the five counties considered in South Florida (FL). Some data variables were only able to be constructed at the statewide level due to limited availability.
[B] Variables in shaded rows were also used in Indicator 7.

Calculation Method

The *Economic Impact of Coral Reef Fishing* indicator was developed using the following steps:

- Raw variables were normalized to account for the overall size of the market, economy, or jurisdiction. There were multiple ways to adjust the input variables, and potential adjustments introduce the variation discussed at the beginning of the section. For example, commercial reef fishery revenues could be reasonably normalized using total commercial fishery revenues or by total GDP. In this case, utilizing total GDP as the denominator allows the indicator to reflect the reef fishery value as a fraction of the total size of the jurisdictional economy. If the analysis were to instead normalize using total commercial fishery revenues, then it would instead capture the size of the reef fishery relative to the total fishery.
- Indicator estimates were constructed from each of the adjusted variables, or as weighted averages of these variables. Because the variables operate on different scales, a "composite" indicator is not entirely driven by one variable.
- Recreational Fishing Catch and Commercial Fishing Landings and Revenue were broken down by species, and this assessment focused on highly reef-associated species wholly or predominantly residing and foraging on the reef and all non-fish marine life and fish that use the reef, but do not predominantly reside on the reef. The list of species was vetted by NCRMP fish experts from the biological monitoring teams in the Pacific and Atlantic regions, and a list of the species considered in the economic calculations is available in Appendix E.

Key Results

After consulting with expert opinion, input variable weights were tailored in each jurisdiction based on data availability to make use of as much data as possible. As a result, jurisdiction-to-jurisdiction comparisons are less relevant with this indicator; however, the status and trends within jurisdictions can be tracked over time. Exhibit 19 presents the final input variable weighting decisions by jurisdiction. As discussed above, the various input variables are not independent of each other and are in some cases highly correlated. However, the input received was to include multiple sources of information, which may contribute variation as a result of different coral reef-related economic impacts.

In terms of interpretation, the scale is zero to one, with a zero meaning that coral reef fishing and the living resources sector provide no economic impact and a one meaning that coral reef fishing comprises the jurisdiction's entire fishery and the living resources sector comprises the jurisdiction's entire economy.

It is noted that a challenge of constructing and reporting a single indicator was that the input variables may operate on very different scales in different jurisdictions. For example, in some jurisdictions and years, reef fishery yield as a fraction of total fishery yield may be 0.50 or greater (i.e., reef fisheries make up over 50 percent of total fishery yield). However, fishery revenues as a fraction of total jurisdiction GDP may be many orders of magnitude smaller – i.e., much less than one percent, or less than 0.01. As a result, when a weighted average of the two variables is constructed, the resulting indicator and thus indicator variation is driven chiefly by the fishery yield variable.

Exhibit 19. Input Variable Weights by Jurisdiction for the Economic Impact of Coral Reef Fishing Indicator

Variable	Jurisdiction							
	Statewide FL	FL	HI	PR	USVI	GU	AS	CNMI
Total Reef Commercial Fishery Yield / Total Commercial Fishery Yield	12.5%	20%	14.3%	20%	33.3%	25%	25%	25%
Total Reef Commercial Fishery Revenue / Total GDP	12.5%	20%	14.3%	20%	33.3%	25%	25%	25%
Total Reef Recreational Fishery Catch / Total Recreational Fishery Catch	12.5%	0%	14.3%	20%	0%	0%	0%	0%
Living Resources GDP / Total GDP	12.5%	20%	14.3%	0%	0%	0%	0%	0%
Living Resources Employment / Total Employment	12.5%	20%	14.3%	20%	0%	25%	25%	25%
Living Resources Establishments / Total Establishments	12.5%	20%	14.3%	20%	33.3%	25%	25%	25%
Commercial License Revenue/ Total GDP	12.5%	0%	14.3%	0%	0%	0%	0%	0%
Recreational License Revenue/ Total GDP	12.5%	0%	0%	0%	0%	0%	0%	0%

Exhibit 20 presents the values for the Economic Impact of Coral Reef Fishing indicator from applying the input variable weights in Exhibit 19.

Exhibit 20. Results for Economic Impact of Coral Reef Fishing Indicator						
Jurisdiction	Indicator Results					
	2010	2011	2012	2013	2014	2015
AS	N/A	N/A	N/A	N/A	N/A	0.168
CNMI	N/A	N/A	N/A	N/A	N/A	0.048
Statewide FL	N/A	N/A	0.119	0.120	0.111	0.113
FL	0.133	0.135	0.130	0.140	0.141	0.137
GU	N/A	N/A	N/A	N/A	N/A	0.079
HI	0.068	0.066	0.080	0.089	0.080	0.076
PR	0.241	0.232	0.217	0.188	0.205	0.230
USVI	0.154	0.180	0.219	0.216	0.187	0.189

Caveats

- Data consistency was the largest limitation for this indicator:
  - Commercial Fishing Landings and Revenue were the most consistent variables, available for all jurisdictions, available for 2005–2016, and originating from similar sources.
  - Living Resources Establishments and Employment were broadly available for HI and FL, but only point estimates were available for GU, AS, and CNMI.
    - Living Resources Establishments and Employment include both coral reef related living resources and non-coral reef related living resources as they could not be separated with the available data.
  - Most variables were only available for some jurisdictions, originated from numerous sources, or had limited years of data.
- Some data records from the commercial landings data from the PIFSC Western Pacific Fisheries Information Network may have been dropped due to confidentiality issues. Broadly, they generally don't give out data unless whatever the lowest level they give out comprises catch from at least 3 fishers.
- Fishing License data, which was only available for HI and FL, did not specifically examine coral reef fishing, but fishing more generally. In addition, recreational fishing licenses are not required in HI, which could lead to some error in estimates of recreational catch. FWC only provided the recreational fishing license revenue and not the number of licenses.
- Recreational Landings data come from the Marine Recreational Information Program (MRIP). Data for this program come from a network of voluntary surveys. Since these surveys are voluntary and some weight estimates are missing (Williams and Ma, 2013), there is concern related to margin of error of the estimates.
- The indicator does not include data from subsistence fishing, given lack of broadly available and consistently collected subsistence fishing data.
- Composite indicator values can be heavily influenced by results for one variable.
- The use of different input variable weights by jurisdiction will obscure jurisdiction-to-jurisdiction comparisons but will still provide a means for tracking changes over time within a jurisdiction.
- Commercial fishing data for FL is at the county level (i.e., reflects FL), whereas recreational fishing data for FL is at the state level as MRIP data are not available at the county level.
- As the denominator can vary across variables (i.e., total commercial reef yield/total commercial yield and total commercial reef revenue/total GDP), this can be considered a metric of coral reef fishing's relative impact to the economy and of coral reef fishing's relative importance to the total fishery, each interacting with one another within the composite indicator.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the *Economic Impact of Coral Reef Fishing* indicator should be treated with **Medium** confidence given the number of reliable data sources but with some gaps in available information.

Indicator 7: Economic Impact of Tourism to Jurisdiction

Goal

This indicator reflects the economic impact of tourism and recreation on the jurisdictional economy. Given the nature of economic impacts, an increase in impacts may indicate both greater dependence on the ecosystem but also greater stress on the ecosystem. In particular, economic activity creates financial benefits to the local community but has a direct impact on biological condition as more tourism can bring more people in contact with reefs. This indicator examines coral reef tourism where possible, but mainly focuses on tourism in general.

Additional considerations and assumptions in the development of this indicator included:

- Variation in tourism-related variables could result from numerous factors, e.g.:
  - Changes in actual reef quality
  - Changes in jurisdictional spending on marketing of the reefs
  - Changes in global economy affecting global spending on tourism.
- Variation in "normalizing" variables (i.e., total GDP, employment, establishments) could result from numerous different factors, e.g.:
  - Changes in the jurisdiction-level growth or other economic factors (interest rates, spending, etc.)
  - Changes in the global economy that trickle down to the jurisdictional economy.

Input Variable Data

This indicator was developed using secondary data. Exhibit 21 presents the variables used to develop this indicator along with the jurisdictions covered by each, detailed sources, and comments as to years of data used and other limitations. The data sources used to normalize the variables found in Exhibit 21 can be found in the shaded rows of Exhibit 18. This analysis notes that the variables were not mutually exclusive, and in fact in many cases will be highly correlated. A selection of input variable data for the year 2015 is available in Appendix I.

Exhibit 21. Indicator Inputs for Economic Impact of Tourism

Data Variable (normalization bulleted below)	Jurisdiction(s) Covered	Source	Other Comments
Tourism and Recreation GDP • Normalized by dividing by Total GDP	HI, GU, FL, statewide FL, and PR	**PR** – World Travel & Tourism Council (2019) **GU** – Guam Visitors Bureau (2019) **HI and FL** – National Oceanic and Atmospheric Administration (2017)	**HI, FL, and statewide FL** – 2016 • Filled with extrapolation. **GU** – 2005–2007 • Filled with extrapolation.
Tourism and Recreation Employment (and Self Employment) • Normalized by dividing by Total Employment	All	**HI, FL, and statewide FL** – National Oceanic and Atmospheric Administration (2017) **PR and USVI** – U.S. Bureau of Labor Statistics (2019b) **AS, CNMI, and GU** – U.S. Census Bureau (2018b)	Constructed from ENOW North American Sector Classification System (NAICS) codes. Calculations were close to ENOW point estimates. **HI and FL** – 2016 • Filled with extrapolation. **GU, AS, and CNMI** – 2005–2007 • Filled with extrapolation.

Exhibit 21. Indicator Inputs for Economic Impact of Tourism			
Data Variable (normalization bulleted below)	**Jurisdiction(s) Covered**	**Source**	**Other Comments**
Tourism and Recreation Establishments • Normalized by dividing by Total Establishments	All	**HI, FL, and statewide FL** – National Oceanic and Atmospheric Administration (2017) **PR and USVI** – U.S. Bureau of Labor Statistics (2019b) **AS, CNMI, and GU** – U.S. Census Bureau (2018b)	Constructed from ENOW NAICS codes. Calculations were close to ENOW point estimates. **HI and FL** – 2016 • Filled with extrapolation. **GU, AS, and CNMI** – 2005–2007 • Filled with extrapolation.
Visitor Spending • Normalized by dividing by Total Personal Expenditures by residents	AS, CNMI, statewide FL, GU, HI, PR, and USVI	**HI –** State of Hawai'i Department of Business, Economic Development & Tourism (2019e) **Statewide FL** – Tourism Economics (2016) **PR and USVI** – World Travel & Tourism Council (2019) **GU** – Guam Bureau of Statistics and Plans (2019) **AS** – American Samoa Department of Commerce American Samoa Visitors Bureau (2018) **CNMI** – Limtiaco (2017)	Normalization was done relative to jurisdiction-level consumer spending to reflect how large total visitor spending is relative to the spending of residents themselves. This is not a perfect normalization. Year range was expanded to include 2017 to incorporate AS and CNMI point estimates. **Statewide FL** – 2005–2007 • Filled with extrapolation. **GU** – 2005–2010 and 2016 • Filled with extrapolation. **AS and CNMI** – 2017 • Point estimates, no other years of data.
Visitor Arrivals • Normalized by dividing by Total Population	All	**HI** – State of Hawai'i Department of Business, Economic Development & Tourism (2019e) **FL**– Monroe County [Palm Beach County (Undated), D.K. Shifflet (2018), and Miami-Dade County (2019)] **AS, CNMI, GU, PR, and USVI** – World Bank Group (2019b) **Statewide FL** – Visitflorida.org (2019)	Normalization was done relative to jurisdiction-level population to reflect how many more visitors there are than residents. This is not a perfect normalization. **FL** – 2005–2012 • Filled with extrapolation. **AS** – 2002–2004 • Filled with extrapolation. **USVI** – 2016 • Filled with extrapolation. **Statewide FL** – 2005–2007 • Filled with extrapolation.

Exhibit 21. Indicator Inputs for Economic Impact of Tourism			
Data Variable (normalization bulleted below)	**Jurisdiction(s) Covered**	**Source**	**Other Comments**
National Park Variables • National Park Total Value Added and National Park Coral Value added normalized by dividing by Total GDP • National Park Total Visitor Spending and National Park Coral Visitor Spending normalized by dividing by Total Personal Expenditures • National Park Total Visitor Employment and National Park Coral Visitor Employment normalized by dividing by Total Employment	AS, FL, statewide FL, GU, HI, PR, and USVI	U.S. National Park Service (2019)	The National Park Coral variables are constructed through research of every national park in the jurisdiction. The National Park Coral variables are sums of the variable for parks within the jurisdiction containing or adjacent to coral reefs. The National Park Total variables are sums of the variables for all parks within the jurisdiction. **All** – 2005–2011. • Data not available before 2012, not extrapolated.
Hotel Occupancy Rate	CNMI, GU, HI, PR, and USVI	**HI** – State of Hawai'i Department of Business, Economic Development & Tourism (2019a) **PR** – Estadisticsas.pr (Undated(a)), (Undated(b)) **GU** – Guam Bureau of Statistics and Plans (2019) **USVI** – U.S. Virgin Islands Bureau of Economic Research (2016) **CNMI** – CNMI Department of Commerce Central Statistics Division (2018c)	**USVI** – 2016 • Filled with extrapolation. **CNMI** – 2005–2006 • Filled with extrapolation.
Total Personal Consumption by residents (Expenditures) Used to normalize: • National Park Total Visitor Spending • National Park Coral Visitor Spending • Total Visitor Spending	AS, CNMI, statewide FL, HI, GU, PR, and USVI	**PR** – Government of Puerto Rico Planning Board (2017a) and World Bank Group (2018a) **AS, CNMI, statewide FL, HI, GU, and USVI** – U.S. Bureau of Economic Analysis (2018)	

Calculation Method

The *Economic Impact of Tourism* indicator was developed using the following steps:

- Raw variables were normalized by adjusting for the overall size of the economy or jurisdiction.
- To derive value added, spending, and employment related to coral reef National Parks from the National Park Service data, a review of the National Parks of each jurisdiction was conducted to decide which parks contained coral reefs.

- Indicator estimates could then be constructed from each of the adjusted variables, or as weighted averages of these variables.
    - Because the variables operate on different scales, a "composite" indicator is not entirely driven by one variable.

Key Results

After consulting with expert opinion, input variable weights were tailored in each jurisdiction based on availability to make use of as much data as possible. As a result, jurisdiction-to-jurisdiction comparisons are obscured with this indicator; however, the status and trends within jurisdictions can be tracked over time. Exhibit 22 presents the final input variable weighting decisions by jurisdiction.

In terms of interpretation, the scale is constrained on the lower end by zero, indicating that tourism provides no economic impact; and is unconstrained at the upper bound, increasing as tourism's relative economic impact to the jurisdiction increases. The reason that this indicator is not bounded from zero to one is that the "total arrivals/population" variable is theoretically unbounded and is used in the calculation of the final Economic Impact of Tourism indicator.

Exhibit 22. Input Variable Weights by Jurisdiction for the Economic Impact of Tourism

Variable	Jurisdiction							
	Statewide FL	FL	HI	PR	USVI	GU	AS	CNMI
Tourism and Recreation GDP /Total GDP	16.7%	25%	14.3%	0%	0%	0%	0%	0%
Tourism and Recreation Employment (including self-employment*) / Total Employment	16.7%	25%	14.3%	14.3%	14.3%	14.3%	20%	25%
Tourism and Recreation Establishments / Total Establishments	16.7%	25%	14.3%	14.3%	14.3%	14.3%	20%	25%
Total Air Visitor Spending / Total Personal Expenditures by residents	16.7%	0%	14.3%	14.3%	14.3%	14.3%	0%	0%
National Park Coral Value Added/ Total GDP	0%	0%	0%	14.3%	14.3%	14.3%	20%	0%
National Park Coral Visitor Spending / Total Personal Expenditures	16.7%	0%	14.3%	14.3%	14.3%	14.3%	20%	0%
Total Arrivals / Population	16.7%	25%	14.3%	14.3%	14.3%	14.3%	20%	25%
Hotel Occupancy Rate	0%	0%	14.3%	14.3%	14.3%	14.3%	0%	25%

Exhibit 23 presents the values for the Economic Impact of Tourism indicator from applying the input variable weights in Exhibit 22.

Exhibit 23. Results for Economic Impact of Tourism Indicator						
Jurisdiction	Indicator Results					
	2010	2011	2012	2013	2014	2015
AS	N/A	N/A	0.107	0.106	0.114	0.107
CNMI	1.973	1.820	2.133	2.323	2.416	2.530
Statewide FL	0.765	0.801	0.828	0.841	0.865	0.922
FL	N/A	N/A	0.746	0.766	0.781	0.814
GU	N/A	N/A	1.412	1.416	1.426	1.483
HI	6.979	7.212	7.748	7.705	7.777	8.015
PR	N/A	N/A	0.250	0.256	0.259	0.292
USVI	N/A	N/A	1.088	1.067	1.102	1.139

Caveats

- Data consistency was the largest limitation for this indicator. Associated issues included:
  - Many variables were not available for all jurisdictions (Tourism and Recreation GDP, Total Air Visitor Spending, etc.)
  - Many variables were from numerous different sources (Visitor Spending, Hotel Occupancy, etc.)
  - Visitor Spending had only point estimates for AS and CNMI.
- Hotel Occupancy Rate, Visitor Spending, and Visitor Arrivals did not specifically examine coral reef tourism, but tourism more generally.
- The National Park Service coral reef tourism data are a conservative estimate of total tourism as tourism outside of National Parks are not counted; however, the data provide a way to isolate a form of coral reef tourism.
- Composite indicator values can be heavily influenced by results for one variable.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the *Economic Impact of Tourism* indicator should be treated with **Medium** confidence given the number of reliable data sources but with some gaps in available information in addition to the inherent difficulty of separating out coral reef tourism data from overall tourism data when reliant upon secondary data.

Indicator 8: Community Well-Being

Goal

The goal of this indicator was to reflect changes in well-being among residents in the jurisdictions. This effort recognizes the complex nature of attempting to quantify an essentially qualitative state such as community well-being. The proposed indicator attempts to leverage principles and approaches used by NOAA and others in similar efforts (e.g., Dillard et al., 2013; Jepson and Colburn, 2013) while accounting for the limitations of available data.

Additional considerations and assumptions in the development of this indicator included:

- There is the possibility for sudden, large changes in well-being in a jurisdiction following a significant or catastrophic event (e.g., hurricane, mass bleaching).
- Change is interpreted as general changes in quality of life.
- Reefs in good biological condition could increase community well-being and vice-versa.
- Many of the consistently available data streams lend themselves to a more "Western" view of well-being, in which commonly used metrics in more developed nations are utilized to quantify community well-being. While recognizing that this is sometimes not optimal for small island jurisdictions that may differ in culture and in way of life when compared to U.S. states, this effort is reliant upon data that are available in order to provide a framework for comparability across the jurisdictions.

Input Variable Data

The community well-being indicator was developed using secondary data. Exhibit 24 presents the input variables considered in developing this indicator along with information on the availability of the data by jurisdiction with respect to missing years and other limitations. These input variables have further been organized into general well-being categories using a framework adapted from Dillard et al. (2013). The data used in calculation of this indicator are available in Appendix I.

Exhibit 24. Indicator Inputs for Community Well Being

Data Variable	Jurisdiction(s) Covered	Source	Other Comments
Health Category			
Age adjusted death rate (per 1,000 people)	All	**HI** – Hawai'i Health Data Warehouse (2017a) **FL** – Florida Health (2018) **AS, CNMI, GU, PR, and USVI** – Centers for Disease Control and Prevention (2018)	Florida county-level data were not age adjusted. Years used: 2016 for all
Infant mortality rate (per 100,000 population)	All	**HI** – Hawai'i Health Data Warehouse (2017b) **FL** – Florida Health (2018) **AS, CNMI, GU, PR, and USVI** – CIA World Factbook (2018a)	Years used: HI – 2015 AS, FL, GU, PR, and USVI – 2016 CNMI – 2017
Life expectancy	All	**HI** – State of Hawai'i Department of Business, Economic Development & Tourism (2019d) **AS, CNMI, GU, PR, and USVI** – CIA World Factbook (2018b) **FL** – Institute for Health Metrics and Evaluation (2014a; 2014b)	Years used: FL and HI – 2014 AS, GU, PR, and USVI – 2016 CNMI – 2017

Exhibit 24. Indicator Inputs for Community Well Being			
Data Variable	**Jurisdiction(s) Covered**	**Source**	**Other Comments**
Physicians (per 1,000 people)	All	**AS** – American Samoa Department of Health (2013) **CNMI** – CNMI Department of Public Health (2008) **FL** – Florida Health (2019) **GU** – Guam Bureau of Statistics and Plans (2019) **HI** – State of Hawai'i Department of Business, Economic Development & Tourism (2019d) **PR** – Association of American Medical Colleges (2017) **USVI** – World Bank Group (2019c)	Years used: USVI – 1995 AS – 2003 CNMI – 2008 FL – 2016, GU, HI, PR
Education Category			
Education expenditure per pupil	All	**HI, FL, PR, GU, and USVI** – National Center of Education Statistics (Undated(a)) **CNMI and AS** – National Center of Education Statistics (Undated(b))	Years used: FL – 2011 AS, CNMI, GU, HI, PR, and USVI – 2015
Percent with high school diploma and percent with Bachelor's degree	All	**HI, FL, and PR** – U.S. Census Bureau (2017b) **GU** – U.S. Census Bureau (2010b) **CNMI** – CNMI Department of Commerce Central Statistics Division (2017a) **USVI** – University of the Virgin Islands (2019) **AS** – American Samoa Department of Commerce Statistics Division (2016)	Years used: GU – 2010 USVI – 2013 AS – 2015 FL, HI, and PR – 2016 CNMI – 2017
Proportion of school age population enrolled in K-12	All	**HI, FL, and PR** – U.S. Census Bureau (2017k) **GU, CNMI, and USVI** – U.S. Census Bureau (2010m) **AS** – American Samoa Department of Commerce Statistics Division (2016)	Years used: CNMI, GU, and USVI – 2010 AS – 2015 FL, HI, and PR – 2016
Access to Social Services Category			
Government payments for social assistance per capita	All	**HI** – Urban Institute et al. (2019) **FL** – Florida Legislature Office of Economic & Demographic Research (2019) **PR** – Government of Puerto Rico Government Development Bank for Puerto Rico (2018) **GU** – Guam Bureau of Statistics and Plans (2019) **CNMI** – CNMI Department of Commerce Central Statistics Division (2017b) **USVI** – U.S. Virgin Islands Department of Finance (2018) **AS** – Moss Adams LLP (2016)	Florida values for 2009–2016 did not contain values for Miami-Dade. Years used: CNMI – 2002 PR – 2015 AS, FL, GU, HI, and USVI – 2016

Exhibit 24. Indicator Inputs for Community Well Being			
Data Variable	**Jurisdiction(s) Covered**	**Source**	**Other Comments**
Hospital beds per 1,000 people	All	**HI** – Henry J Kaiser Family Foundation (2019) **GU** – Guam Bureau of Statistics and Plans (2017) **CNMI** – Commonwealth Healthcare Corporation Division of Hospital Services (Undated) **USVI** – Government of the U.S. Virgin Islands Department of Health (2011) **AS** – Britannica Book of the Year (2012) **FL** – Agency for Health Care Administration (2015) **PR –** American Hospital Directory (2018)	Years used: AS – 2008 FL – 2014 CNMI, GU, HI, and USVI – 2016 PR – 2018
Percent receiving public assistance income	All	**HI, FL, and PR** – U.S. Census Bureau (2017j) **GU, CNMI, AS, and USVI** – U.S. Census Bureau (2010k)	Years used: AS, CNMI, GU, and USVI – 2010 FL, HI, and PR – 2016
Economic Security Category			
Median home value	All	**HI** – State of Hawai'i Department of Business, Economic Development & Tourism (2019b) **FL and PR** – U.S. Census Bureau (2017e) **AS and GU** – U.S. Census Bureau (2010d) **CNMI** – CNMI Department of Commerce Central Statistics Division (2017a) **USVI** – University of the Virgin Islands (2019)	Years used: USVI – 2013 AS and GU – 2015 FL, HI, and PR – 2016 CNMI – 2017
Median household income	All	**HI** – State of Hawai'i Department of Business, Economic Development & Tourism (2019c) **FL** – U.S. Census Bureau (2018f) **PR** – U.S. Census Bureau (2017d) **AS and GU** – U.S. Census Bureau (2010f) **CNMI** – CNMI Department of Commerce Central Statistics Division (2017a) **USVI** – University of the Virgin Islands (2019)	Years used: AS and GU – 2010 USVI – 2013 CNMI, FL, HI, and PR – 2016
Poverty rate	All	**HI** – State of Hawai'i Department of Business, Economic Development & Tourism (2019c) **FL** – U.S. Census Bureau (2018f) **PR** – U.S. Census Bureau (2017h) **AS and GU** – U.S. Census Bureau (2010j) **CNMI** – CNMI Department of Commerce Central Statistics Division (2017a) **USVI** – University of the Virgin Islands (2019)	Years used: AS and GU – 2010 USVI – 2013 CNMI, FL, HI, and PR – 2016

Exhibit 24. Indicator Inputs for Community Well Being			
Data Variable	**Jurisdiction(s) Covered**	**Source**	**Other Comments**
Unemployment rate	All	**HI** – State of Hawai'i Department of Business, Economic Development & Tourism (2019c) **FL and PR** – U.S. Bureau of Labor Statistics (Undated) **GU** – World Bank Group (2018b) **CNMI** – CNMI Department of Commerce Central Statistics Division (2018a) **USVI** – Virgin Islands Electronic Workforce System (Undated) **AS** – U.S. Census Bureau (2010c)	Years used: AS – 2010 FL, GU, HI, PR, and USVI – 2016 CNMI – 2017
Environmental Condition Category			
Water quality (percent of coastal shoreline miles impaired)	All	**FL** – Florida Department of Environmental Protection (2018b) **AS, CNMI, GU, HI, PR, and USVI** – U.S. Environmental Protection Agency (2019)	Years used: AS, CNMI, GU, HI, PR, and USVI – 2016 FL – 2018
Percent impervious cover	All	National Oceanic and Atmospheric Administration (2015)	Years used: CNMI – 2005 AS, FL, and PR – 2010 GU and HI – 2011 USVI – 2012
Percent of beach days affected by notification actions at monitored beaches	All	U.S. Environmental Protection Agency (Undated)	Years used: AS, FL, GU, HI, PR, and USVI – 2016 CNMI – 2017
Basic Needs Category			
Percent of households without vehicle	All	**HI, FL, and PR** – U.S. Census Bureau (2017n) **GU** – U.S. Census Bureau (2010p) **CNMI** – CNMI Department of Commerce Central Statistics Division (2017a) **USVI** – University of the Virgin Islands (2019) **AS** – American Samoa Department of Commerce Statistics Division (2016)	Years used: GU – 2010 USVI – 2013 AS – 2015 CNMI, FL, HI, and PR – 2016
Health insurance coverage rate	All	**HI and FL** – U.S. Census Bureau (2018e) **PR** – U.S. Census Bureau (2017c) **AS and GU** – U.S. Census Bureau (2010d) **CNMI** – CNMI Department of Commerce Central Statistics Division (2018a) **USVI** – University of the Virgin Islands (2019)	Years used: AS, GU, and HI – 2010 USVI – 2013 FL and PR – 2016 CNMI – 2017

Exhibit 24. Indicator Inputs for Community Well Being			
Data Variable	**Jurisdiction(s) Covered**	**Source**	**Other Comments**
Healthy food outlets per 1,000 people	All	U.S. Census Bureau (2018b)	NAICS codes: 4451: Grocery Stores 4452: Specialty Food Stores 452910: Warehouse clubs and supercenters Years used: 2016 for all
Social Connectedness Category			
Percent with internet access	All	**HI, FL, and PR** – U.S. Census Bureau (2017i) **GU** – U.S. Census Bureau (2010n) **CNMI** – CNMI Department of Commerce Central Statistics Division (2018a) **USVI** – University of the Virgin Islands (2019) **AS** – American Samoa Department of Commerce Statistics Division (2016)	Years used: GU – 2010 USVI – 2013 AS – 2015 FL, HI, and PR – 2016 CNMI – 2017
Percent with telephone access	All	**HI, FL, and PR** – U.S. Census Bureau (2017m) **GU** – U.S. Census Bureau (2010o) **CNMI** – CNMI Department of Commerce Central Statistics Division (2017a) **USVI** – University of the Virgin Islands (2019) **AS** – American Samoa Department of Commerce Statistics Division (2016)	Years used: GU – 2010 USVI – 2013 AS – 2015 CNMI, FL, HI, and PR – 2016
Tenure in Community	All	**HI, FL, and PR** – U.S. Census Bureau (2017f) **GU** – U.S. Census Bureau (2010h) **CNMI** – CNMI Department of Commerce Central Statistics Division (2017a) **USVI** – University of the Virgin Islands (2019) **AS** – American Samoa Department of Commerce Statistics Division (2016)	Years used: GU – 2010 USVI – 2013 AS – 2015 CNMI, FL, HI, and PR – 2016

Calculation Method

A list of 77 variables was initially proposed for inclusion in the analysis of community well-being. Due to the high number of variables, a Principle Components Analysis and an FA were initially explored, but deemed to be insufficient due to the small number of sites (seven). A ranking exercise, based on the approach used by Breslow et al. (2017), was used to narrow the original list of potential input variables. The ranking exercise used a scale of 0–2 to indicate relevance (0 = not/somewhat relevant; 1 = relevant; or 2 = highly relevant) and availability of each variable (0 = unavailable for most jurisdictions; 1 = available for all or most but challenging to get or only somewhat available but easily accessible; or 2 = available for all and easy to get or available for all/ most but may pose minor challenges to access).

Ultimately, a subset of 24 input variables were selected based on data availability across the jurisdictions and organized using an adapted framework from Dillard et al. (2013).

This adapted framework included the following general categories of well-being, and data were collected for variables that influence each category (see Exhibit 24):

- Access to social services
- Economic security

- Environmental condition
- Social connectedness
- Basic needs
- Education
- Health.

This *Community Well-being* indicator was developed as follows:

- To the extent possible, annual data were collected from the sources in Exhibit 24 for the years 2000 through 2016.
- The most recent year of data were used to develop a well-being "snapshot"
- Variables that contribute negatively to well-being were inversed so that all variables contribute "positively" to well-being (e.g., poverty rate becomes "non-poverty rate," percent of impervious covers becomes "percent of non-impervious cover," etc.).
- All variables were scaled using the minimum-maximum method to a 0–1 scale (variables in percentage form were kept on a 0–1 scale unadjusted)
- Sub-indicators for each of the aforementioned well-being categories were calculated through an equally weighted additive index and then multiplied by 100 to convert to a 0–100 scale.
- These sub-indicators were then used to calculate the composite well-being indicator through an equally weighted additive method.
- As a result of the calculation method, the indicator results are theoretically bounded by 0 at the lower end, and 100 at the upper end.

Key Results

During the December 2018 expert workshops, it was agreed upon to weight each input category of well-being indicator equally considering the demographic differences across the jurisdictions, the inherently place-based nature of well-being, and the difficulty in deeming one category of well-being to supersede over another. Exhibit 25 presents the results reflecting the equal weighting of the input variable categories presented in Exhibit 24. Weights for individual input variables in this option were based on the number of variables in a category where, with seven input variable categories, a 14.3% weight for each category was then divided by the number of input variables in the category and the resulting value was assigned to each individual input variable in the category. To assist with interpretation, a resulting value of 0 indicates the jurisdiction had zero for every variable (e.g., $0 in median household income, 100% poverty), and a value of 100 indicates that the jurisdiction had the highest level of all variables when compared to all other jurisdictions. Another important note is that the results for well-being can only be interpreted relative to one another as the data used in the minimum-maximum scaling only correspond to the seven jurisdictions.

Exhibit 25. Results for Community Well being Indicator								
Jurisdiction	Indicator Results							
	Economic Security	Education	Access to Social services	Social Connect-edness	Health	Basic Needs	Environ-mental Condition	Community Well-being
AS	44.620	52.750	67.809	73.802	78.488	58.520	68.888	**63.554**
CNMI	43.133	58.537	55.100	62.329	75.285	79.567	84.945	**65.557**
FL	72.908	69.946	65.356	70.268	93.143	66.760	61.451	**71.405**
GU	70.291	63.766	49.241	73.778	81.465	77.904	54.127	**67.225**
HI	96.938	77.334	82.503	74.532	99.715	67.962	75.717	**82.100**
PR	47.557	62.890	72.034	77.188	95.586	68.894	62.463	**69.516**
USVI	55.279	63.894	97.728	63.800	86.497	59.423	91.767	**74.055**

Caveats

- Reliance upon different years of data based on data availability to create the snapshot for each jurisdiction limits direct comparisons across jurisdictions during a single year. However, these metrics can be considered as the most recent status of community well-being, as it is defined in this report, based on the most recent data available.
- The direct link between human well-being and coral health is not always clear.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the Well-being indicator should be treated with **Low** confidence given the complex nature of the concept of well-being across such different geographies and the reliance upon a variety of different data sources for single variables. This ranking was also consistent with the recognition there are gaps in the available information for input variables that complicate some of the within and across jurisdiction comparisons, and that the "snapshot" approach reflects different years of data for some variables. Further, attributing some portion of well-being directly to coral reefs is highly difficult with the data that are available.

Indicator 9: Cultural Importance of Reefs

Goal

This indicator used NCRMP survey data to account for residents' belief in the importance of coral reefs for a jurisdiction's cultures.

Additional considerations and assumptions in the development of this indicator included:

- Hard to quantify in a lot of cases, but the cultural importance of coral reefs and how they impact island fishing communities is well-documented.
- Has to do with the way people interact with the resource and how they value the resource.
- "Culture" is not just "traditional culture" – culture is dynamic and involving – incorporates tradition and current values and norms and behavior.
- Some participation in traditional practices could be on the decline.
- If people's culture is tied to directly to reefs, we would expect more awareness of the issue and more reverence/care for the reefs, which should translate into better biological condition compared to a situation where the reefs are not culturally important and no one cares about condition.
- Issue that residents could be respectful of reefs, but tourists may not be.

Input Variable Data

This indicator was developed using data from NCRMP's resident survey. Exhibit 26 presents the NCRMP variable and the associated values for the input variable to the indicator. In this case, the indicator was developed using values initially reported on a 1–5 scale.

Exhibit 26. Indicator Inputs for Cultural Importance of Reefs

Survey Questions	Jurisdiction(s) Covered	Source	Other Comments
Value_4: Please say whether you disagree or agree with each of the following statements: Coral reefs are important to the jurisdiction's cultures.	All	NCRMP surveys	Based on question responses of: 1 = strongly disagree 2 = disagree 3 = neither agree nor disagree 4 = agree 5 = strongly agree

Calculation Method

The evaluated NCRMP resident survey data included the coded responses for each surveyed resident in a jurisdiction. Respondent weights from FL, HI, and USVI were used to weight responses to best represent the jurisdiction's population where appropriate. Implicit weights of 1.0 were used in the remaining locations (AS, CNMI, GU, and PR).

This *Cultural Importance* indicator was developed as follows:

- For *Value*_4, the 1-5 scale was transformed to 0-1 using the minimum-maximum scaling method, then a weighted average value of the variable was calculated and multiplied by 100 to convert the ranked responses into a numeric value on the same 0–100 scale so that it could be compared more easily with other survey-based indicator values.
- The average indicator value is then calculated for each jurisdiction.

Key Results

Exhibit 27 presents the results for the Cultural Importance indicator. To assist with interpretation, these results are bounded by possible values from 0, reflecting no cultural importance among residents, to 100, reflecting maximum importance, as defined by the survey.

Exhibit 27. Results for Cultural Importance Indicator		
Jurisdiction	Indicator Values	
	Mean	n
AS	79.583	420
CNMI	79.208	713
FL	81.723	1,127
GU	82.112	703
HI	84.686	2,191
PR	72.656	2,389
USVI	83.428	1,132

Caveats

None.

Confidence Ranking

Although the question directly addressed the concept of cultural importance, this indicator was reliant upon a single survey question. Given this and the complex, in many cases, qualitative nature of cultural importance, the results for the Cultural Importance indicator should be treated with **Low** confidence.

Indicator 10: Participation in Behaviors that May Improve Coral Reef Health

Goal

This indicator used NCRMP survey data to account for residents' level of activity supporting coral reef habitats.

Additional considerations and assumptions in the development of this indicator included:

- To measure resident activism/apathy toward environmentally friendly behavior.
- Trying to understand in what ways people interact with the environment and if NOAA can draw upon positive behavior for coral reef protection.
- May change where targeted education and outreach are improved or if there is a new mechanism to support community involvement (i.e., recycling rates may change when bins are provided, make people aware, make it easy and socially desirable).
- Higher levels of individual involvement in pro-environmental behavior will ideally translate into reduced environmental impacts on coral reefs and associated ecosystems.

Input Variable Data

This indicator was developed using data from NCRMP's resident survey. Exhibit 28 presents the NCRMP variable and the associated values for the input variable to the indicator. In this case, the indicator was developed using values initially reported on a 1–5 scale.

Exhibit 28. Indicator Inputs for Participation in Behaviors that May Improve Coral Reef Health

Survey Questions	Jurisdiction(s) Covered	Source	Other Comments
Envbehavior: How often do you participate in any activity to protect the environment (for example, beach clean ups or volunteering with an environmental group)?	All	NCRMP surveys	Based on question responses of: 1 = not at all 2 = once a year or less 3 = several times a year 4 = at least once a month 5 = several times a month or more

Calculation Method

The evaluated NCRMP resident survey data included the coded responses for each surveyed resident in a jurisdiction. Respondent weights from FL, HI, and USVI were used to weight responses to best represent the jurisdiction's population where appropriate. Implicit weights of 1.0 were used in the remaining locations (AS, CNMI, GU, and PR).

This *Participation in Behaviors that May Improve Coral Reef Health* indicator was developed as follows:

- For *Envbehavior,* the 1-5 scale was transformed to 0-1 using the minimum-maximum scaling method, then a weighted average value of the variable was calculated and multiplied by 100 to convert the ranked responses into a numeric value on the same 0–100 scale so that it could be compared more easily with other survey-based indicator values.
- The average indicator value is then calculated for each jurisdiction.

Key Results

Exhibit 29 presents the results for the Participation in Behaviors that May Improve Coral Reef Health indicator. To assist with interpretation, these results were bounded by possible values from 0, reflecting no pro-environmental behavior among residents, to 100, reflecting all residents participating to the maximum extent possible in pro-environmental behaviors, as defined by the survey.

Exhibit 29. Results for Participation in Behaviors that May Improve Reef Health Indicator		
Jurisdiction	Indicator Values	
	Mean	n
AS	44.630	419
CNMI	38.526	719
FL	21.878	1,172
GU	24.577	709
HI	50.368	2,213
PR	18.537	2,379
USVI	32.322	1,163

Caveats

- Self-reported behavior may not correspond with actual behavior.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results the *Participation in Behaviors that May Improve Reef Health* indicator should be treated with **Low** confidence given the reliance on a single NCRMP survey question that does not focus on specific behaviors related to improving the health of coral reefs.

Indicator 11: Physical Infrastructure

Goal

This indicator assessed how coastal development, waste management, agricultural and industrial pollution/runoff, military operations, and other infrastructure illustrates a general understanding of human impact on the coast.

Additional considerations and assumptions in the development of this indicator included:

- More infrastructure near reefs can cause more runoff, Land-Based Sources of Pollution, and other stressors to the ecosystem which can harm their biological condition.
- Potential differences in impact depending on the quality or nature of the infrastructure. Damaging infrastructure (i.e., impermeable surfaces like pavement) versus infrastructure with a positive or neutral impact on coral reefs (i.e., installation of rain gardens, properly management wastewater treatment plant).
- Infrastructure that is damaging in some contexts can also mitigate harm in others (i.e., paving dirt roads may reduce sedimentation).
- Depends on human population change as more people tend to need more infrastructure.
- Other spatial and physical conditions could influence infrastructure's long-term impact such as distance to the reef, slope, intensity of rainfall, wind direction, coastal currents, among others.

Input Variable Data

This indicator was developed using secondary data. Exhibit 30 presents the seven data variables used to develop this indicator along with the jurisdictions covered by each, detailed sources, and comments as to years of data used and other limitations. To develop the indicator, a set of major categories for infrastructure-related stressors was identified and input variables were selected.

The research starting point was ReefBase's online database, which is a project by WorldFish (member of CGIAR) (WorldFish, 2019). The database synthesizes historical information from various state reports (such as those produced by the Global Coral Reef Monitoring Network) across 18 human threat categories. The information was it not necessary comprehensive, but likely representative of relevant reef threats. These entries were used as a proxy to understand the importance of human stressors to each jurisdiction and identify possible data sources for further research.

Researchers ultimately focused on finding consistent data across all jurisdictions for the categories of:

- Agriculture
- Coastal development
- Industrial and marine pollution
- Military operations (due to the prevalence of vessel and amphibious training activities, unexploded ordinance, bombing targets, etc., especially in the territories)
- Sewage
- Solid waste.

The data used in calculation of this indicator are available in Appendix I.

Exhibit 30. Indicator Inputs for Physical Infrastructure			
Data Variable	**Jurisdiction(s) Covered**	**Source**	**Other Comments**
Building permits (annual number)	All	**AS** – American Samoa Department of Commerce Research and Statistics Division (2018) **CNMI** – CNMI Department of Commerce Central Statistics Division (2018b) **GU** – Guam Bureau of Statistics and Plans (2019) **FL and HI** – U.S. Census Bureau (2017l) **PR** – Government of Puerto Rico Planning Board (2017b) **USVI** – U.S. Census Bureau (2017a)	Years used: PR – 2015 AS, CNMI, FL, GU, HI, and USVI – 2017
Impervious surface and cultivated land area	All	**AS, CNMI, GU, HI, PR and VI** – National Oceanic and Atmospheric Administration (2015)	Years used: CNMI – 2005 AS, FL, and PR – 2010 GU and HI – 2011 USVI – 2012
Wastewater permits from National Pollutant Discharge Elimination System (NPDES), U.S. Environmental Protection Agency (EPA) data, Florida Department of Environmental Protection data, EPA Territorial Pollutant Discharge Elimination System (TPDES) data (annual number effective)	All	**AS, CNMI, GU, HI (Federal only), and PR** – U.S. Environmental Protection Agency (2018b) **FL** – Florida Department of Environmental Protection (2018a) **HI** – Hawai'i Department of Health (2018) **USVI** – U.S. Environmental Protection Agency (2016)	NPDES permits not found in USVI, where they use TPDES permits, so TPDES permits are used for USVI Years used: USVI – 2016 AS, CNMI, FL, GU, HI and PR – 2017
Toxic releases (annual pounds)	All	U.S. Environmental Protection Agency (2018c)	Years used: 2017 for all
Landfills (annual number in operation)	All	**FL, HI, PR, and USVI** – U.S. Environmental Protection Agency (2018a) **AS, CNMI, and GU** – based on internet research each jurisdiction has one operating landfill	The U.S. Environmental Protection Agency Landfill Methane Outreach Program (LMOP) Database is not purported to contain every municipal solid waste landfill in the country and some entries were missing yearly information. Data may not include information dump sites and other non-regulated waste sites. Years used: 2017 for all

Exhibit 30. Indicator Inputs for Physical Infrastructure			
Data Variable	**Jurisdiction(s) Covered**	**Source**	**Other Comments**
Military sites (annual acreage)	All	U.S. Department of Defense (2018)	Years used: 2017 for all FL counties – sites that do not meet criteria of at least 10 acres AND at least $10 million plant replacement value were not listed individually in the inventory but were included in the other jurisdictional totals.
Percent of housing units lacking complete plumbing	All	**AS, CNMI, GU, USVI** – U.S. Census Bureau (2010i) **FL, HI, and PR** – U.S. Census Bureau (2017g)	Years used: AS, CNMI, GU, and USVI – 2010 FL, HI, and PR – 2017

Calculation Method

The *Physical Infrastructure* indicator was developed as follows:

- To the extent possible, annual data were collected from the sources in Exhibit 30 for the years 2000 through 2017.
- The most recent year of data are used to develop a physical infrastructure "snapshot."
- NPDES permits were only considered as in effect if an effective date range was specified.
- All absolute value variables were normalized by the length of coastline[4] (e.g., NPDES permits/mile of coast, toxic releases/mile of coast).
- All variables were scaled using the min-max method to a 0–1 scale (variables in percentage form were kept on a 0–1 scale unadjusted).
- The variables were then used to calculate the composite physical infrastructure indicator through an equally weighted additive method.
- As a result of the calculation method, the indicator results are theoretically bounded by 0 at the lower end, and 100 at the upper end.

Key Results

Exhibit 31 presents the results of the physical infrastructure indicator. Each of the categories are weighted equally due to the varying nature of development impact and type across the jurisdictions, and the difficulty in deeming one category of physical infrastructure to be superseding over another. To assist with interpretation, a resulting value of 0 indicates the jurisdiction has zero for every variable (e.g., 0 toxic releases, no impervious cover), and a value of 100 indicates that the jurisdiction has the highest level of all variables when compared to all other jurisdictions. Another important note is that the results for physical infrastructure can only be interpreted relative to one another as the data used in the minimum-maximum scaling only correspond to the seven jurisdictions.

[4] Rose Atoll (AS), The Northern Islands (CNMI), and the Northwest Hawaiian Islands (HI) were not included in these calculations.

Exhibit 31. Results for Physical Infrastructure Indicator	
Jurisdiction	**Indicator Results**
AS	10.477
CNMI	13.232
FL	12.380
GU	35.253
HI	29.353
PR	30.711
USVI	10.766

Caveats

- It is noted that there may be other types of infrastructure that impact coral reefs, but this assessment sought to make use of data that were available in a consistent form across the jurisdictions.
- Reliance upon different years of data based on data availability to create the snapshot for each jurisdiction limits direct comparisons across jurisdictions during a single year. However, these metrics can be considered as the most recent status of physical infrastructure, as it is defined in this report, based on the most recent data available.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the *Physical Infrastructure* indicator should be treated with **Medium** confidence given the number of reliable data sources, with some gaps in available information and that the "snapshot" approach reflects different years of data for some variables.

Indicator 12: Awareness of Coral Reef Rules and Regulations

Goal

This indicator used NCRMP survey data to account for residents' level of familiarity with MPAs/marine managed areas/marine preserves.

Additional considerations and assumptions in the development of this indicator included:

- Behaviors, norms, or customary rules depends on the type of protection reef has such as an MPA.
- If people are not aware of rules and regulations then it is hard to follow them. Also depends on enforcement.
- More awareness can lead to more support for and compliance with rules and regulations, ideally leading to improved biological condition.

Input Variable Data

This indicator was developed using data from NCRMP's resident survey. Exhibit 32 presents the NCRMP variable and the associated values for the input variables to the indicator. In this case, the indicator was developed using values initially reported on a 1–5 scale.

Exhibit 32. Indicator Inputs for Awareness of Coral Reef Rules and Regulations

Survey Questions	Jurisdiction(s) Covered	Source	Other Comments
MPAfam: A marine protected area 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 protected areas?	All, except FL	NCRMP surveys	Based on question responses of: 1 = very unfamiliar 2 = unfamiliar 3 = neither unfamiliar nor familiar 4 = familiar 5 = very familiar Values are not available for FL

Calculation Method

The evaluated NCRMP resident survey data included the coded responses for each surveyed resident in a jurisdiction. Respondent weights from FL, HI, and USVI were used to weight responses to best represent the jurisdiction's population where appropriate. Implicit weights of 1.0 were used in the remaining locations (AS, CNMI, GU, and PR).

This *Awareness of Coral Reef Rules and Regulations* indicator was developed as follows:

- For MPAfam, the 1-5 scale was transformed to 0-1 using the minimum-maximum scaling method, then a weighted average value of the variable was calculated and multiplied by 100 to convert the ranked responses into a numeric value on the same 0–100 scale so that it could be compared more easily with other survey-based indicator values.
- The average indicator value is then calculated for each jurisdiction.

Key Results

Exhibit 33 presents the results where the sole input variable receives all the weight. To assist with interpretation, these results are bounded by possible values from 0, reflecting strong unfamiliarity with MPAs among residents, to 100, reflecting all residents having maximum familiarity, as it is defined in the survey.

Exhibit 33. Results for Awareness of Reef Rules and Regulations Indicator		
Jurisdiction	Indicator Values	
	Mean	n
AS	57.919	382
CNMI	60.352	710
FL	N/A[A]	N/A[A]
GU	54.424	709
HI	52.762	2,226
PR	23.292	2,400
USVI	53.504	1,168

[A] The MPAfam question was not asked in the South Florida survey.

Caveats

- The *MPAfam* question was not asked in FL NCRMP survey.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the *Awareness of Reef Rules and Regulations* indicator should be treated with **Low** confidence given the reliance on a single NCRMP survey question that only addresses one form of marine regulation, as well as the gap in information for FL.

Indicator 13: Governance

Goal

This indicator evaluated governance of coral reefs in jurisdictions. Given data constraints, the indicator only covers governance of MPAs in coral reef jurisdictions. Additional considerations and assumptions in the development of this indicator included:

- Level of enforcement and implementation – what resources have been provided for protection and enforcement (e.g. number of officers, boats, time spent in protected areas, prosecution).
- Dependent on the intensity of use of these reefs (varies by jurisdiction).
- More effective governance is hoped to decrease negative human impacts, provide a basis for ecosystem improvement and then improve biological condition.
- Governance *effectiveness* is challenging to evaluate through secondary data alone, and assumes direct connections between management action and changes in biological condition and/or human behavior.

Input Variable Data

This indicator was developed using data from NOAA's *MPA Checklist* survey (Wusinich-Mendez and Holst, 2011). The MPA checklist has been administered to select staff involved with administering coral reef MPAs in the different jurisdictions seeking information from a prioritized subset of the coral reef sites in the jurisdiction (the survey has not been administered in FL). To date, the survey has been administered three times, in 2011, 2014, and 2017. The questions posed in the survey have changed in various iterations. There were no respondent weights associated with the survey responses.

Exhibit 34 presents the 12 variables that have data across all three iterations of the *MPA Checklist* survey and the associated values for these input variables to the indicator. In this case, the indicator was developed using values initially reported on a 1–3 scale.

Exhibit 34. Indicator Inputs for Governance

Survey Questions	Jurisdiction(s) Covered[A]	Source	Other Comments
Management Planning	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	Based on question responses of: 1 = Two steps away from target 2 = Meets target 3 = Exceeds target
Governance	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
On-Site Management	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
Enforcement	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
Boundaries	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
Biophysical Monitoring	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
Socio-economic Monitoring	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
MPA Effectiveness	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
Evaluation	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
Stakeholder Engagement	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
Financing	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
Outreach and Education	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	
Climate Change Resilience	AS, CNMI, GU, HI, PR, USVI	NOAA MPA Checklist survey	

[A] The MPA Checklist survey has not to date been administered in the South Florida jurisdiction.

Calculation Method

This *Governance* indicator was developed using the Likert/ordinal values for the input variables in Exhibit 34 as follows:

- Calculated the average response value for an input variable from the locations evaluated within a jurisdiction in a given iteration of the survey on a 1–3 scale.

Qualitative information developed in series of calls with CRCP liaisons in the jurisdictions is provided in Appendices F, G, and H. These appendices provide a more nuanced and localized examination of governance across the jurisdictions.

Key Results

Exhibit 35 presents the results for the *Governance* indicator reflecting the equal weighting of the input variables in the belief it would be subjective to prioritize one input variable above another. To assist with interpretation, these results are bounded by possible values from 1, reflecting the lowest level of effective governance of the surveyed reef habitats in a jurisdiction, to 3, reflecting exceptional governance in the surveyed reef habitats.

Exhibit 35. Results for Governance Indicator

Jurisdiction	Indicator Values		
	2011 Survey	2014 Survey	2017 Survey
AS	2.000	2.250	2.083
CNMI	1.917	2.125	2.083
FL[A]	N/A	N/A	N/A
GU	1.833	1.917	1.917
HI	2.021	2.229	2.188
PR	1.607	1.702	1.702
USVI	1.528	1.639	1.583

[A] The MPA Checklist survey has not to date been administered in South Florida.

Caveats

- The *MPA Checklist* was limited mainly by scope in terms of the number of participants and the coverage of the reef habitats in the jurisdictions.
- The *MPA Checklist* assessment areas did not include South Florida. However, a jurisdictionally specific question was asked in the South Florida NCRMP survey in regards to resident familiarity with various organizations and/or agencies working to protect Florida's reefs. While not a viable assessment of governance, results do indicate that South Florida residents are generally familiar with the Florida Keys National Marine Sanctuary, the Florida Department of Environmental Protection, and the FWC, and less familiar with the Southeast Florida Coral Reef Initiative and the Our Florida Reefs Community Planning Process. Although we cannot produce a governance metric for South Florida after this first round of monitoring, these results do lend some context to the state of awareness surrounding South Florida's governance of coral reefs.
- As of this time, governance as it is defined in this report is specific to MPAs and not to other aspects of environmental governance at the jurisdiction level more broadly.

Confidence Ranking

Considering the confidence ranking criteria (see Exhibit 6), the results for the Governance indicator should be treated with **Low** confidence. While this measures the effectiveness of only one type of governance regime (MPAs), the checklist remains the only known uniform assessment of coral reef governance in the U.S. coral reef jurisdictions (from the perspective of managers), as a result this is an appropriate ranking considering the limited number of respondents who contribute to the MPA Checklist, the limited number of MPAs considered in the assessment, the incomplete coverage of reef habitats in the jurisdictions, the lack of data for South Florida, and the approximate nature of the relationship between the input variables and the goal of the indicator.

3. Further Analysis of Survey-Based Indicators

Survey-based indicators are further analyzed in this section to investigate similarities and differences across the jurisdictions, across oceanic basins, and to investigate interactions with other variables collected in the surveys. First, one-way ANOVA tests are used to test for significant differences in the means for each survey-based indicator. Exhibit 36 below details the results.

Exhibit 36. One way ANOVA Analysis of Survey Based Indicators

Indicator number and title	Conclusion(s)
1. Participation in reef activities	PR < all others** FL < AS**, HI**, CNMI**, USVI** HI > GU**, CNMI**, and USVI**
2. Perceived resource condition	CNMI > All others** FL < HI*, GU**, and USVI** PR < AS**, HI**, GU**, and USVI**
3. Attitudes toward coral reef management strategies and enforcement • *Positive Perceptions of MPAs Index* • *Management Support Index*	*Positive Perceptions of MPAs Index* • AS > GU*, CNMI**, and USVI** • PR > GU**, CNMI**, and USVI** *Management Support Index* • PR > All others** • AS < All others** • FL > GU** and USVI** • CNMI > GU** and USVI** • HI > GU** and USVI**
4. Self-reported awareness and knowledge of coral reefs	FL > HI**, PR**, and GU** AS > PR** and GU** HI > PR** and GU** CNMI > PR** and GU** USVI > PR** and GU** GU > PR*
9. Cultural importance of reefs	PR < all others** HI > FL**, AS**, GU*, and CNMI** USVI > AS** and CNMI**
10. Participation in behaviors that may improve coral reef health	HI > all others** PR < all others**; (* for FL) AS > FL**, GU**, CNMI*, and USVI** USVI > FL** and GU** CNMI > FL**, GU**, and USVI**
12. Awareness of coral reef rules and regulations	PR < all others** CNMI > HI**, GU**, and USVI** AS > HI*

* = statistically significant with 95% confidence; ** = statistically significant with 99% confidence

The results in Exhibit 36 are further explained in the Discussion (Section 4). In addition to cross-jurisdictional comparisons, t-tests are used to test for significant differences in the means for each survey-based indicator across the Atlantic (South Florida, Puerto Rico, USVI) and Pacific (Hawai‘i, American Samoa, Guam, CNMI) oceanic basins. These results are shown in Exhibit 37.

Exhibit 377. Analysis of Survey Based Indicators Across Oceanic Basins			
Indicator number and title	**Pacific; Average Indicator Value (sample size)**	**Atlantic; Average Indicator Value (sample size)**	**Conclusion**
1. Participation in reef activities	17.551 (3,907)	10.166 (4,619)	PAC > ATL**
2. Perceived resource condition	48.442 (2,314)	42.657 (2,702)	PAC > ATL**
3. Attitudes toward coral reef management strategies and enforcement • *Positive Perceptions of MPAs Index* • *Management Support Index*	 • 77.028 (959) • 73.566 (3,172)	 • 78.307 (875) • 78.218 (4,025)	 • ATL > PAC* • ATL > PAC**
4. Self-reported awareness and knowledge of coral reefs	68.107 (3,406)	66.032 (3,951)	PAC > ATL**
9. Cultural importance of reefs	82.730 (4,018)	77.506 (4,679)	PAC > ATL**
10. Participation in behaviors that may improve coral reef health	43.169 (4,057)	22.761 (4,718)	PAC > ATL**
12. Awareness of coral reef rules and regulations	54.885 (4,024)	33.191 (3,570)	PAC > ATL**

* = statistically significant with 95% confidence; ** = statistically significant with 99% confidence

Results show statistically significant differences in survey-based indicators across the Atlantic and Pacific jurisdictions in a number of areas. Residents in Pacific jurisdictions were found to participate in a greater number of marine activities more frequently, have a more positive perception of marine resource condition, have less (although still relatively high on the scale) support for coral reef management, have a higher level of self-reported knowledge of coral reefs, agree more with the cultural importance of reefs, participate more frequently in pro-environmental behavior, and be more familiar with reef rules and regulations when compared to residents of Atlantic jurisdictions.

A Pearson Correlation Analysis was then done to investigate if significant directional relationships exist between indicators and other variables collected in NCRMP resident surveys. Exhibit 38 details these results, while key findings are highlighted below.

Results indicate that *participation in reef activities* is positively correlated with *perceived resource condition, self-reported awareness and knowledge of reefs, cultural importance of reefs, participation in behaviors that may improve reef health,* and *awareness of coral reef rules and regulations;* and negatively correlated with *management support* and *positive MPA perceptions.*

Perceived resource condition is found to be positively correlated with *participation in behaviors that may improve reef health,* and *awareness of coral reef rules and regulations;* but negatively correlated with *positive perceptions of MPAs* and *self-reported awareness and knowledge of reefs.*

Positive perceptions of MPAs is positively correlated with *management support, self-reported awareness and knowledge of reefs,* and *cultural importance of reefs.*

Management support is positively correlated with *self-reported awareness and knowledge of reefs, cultural importance of reefs, participation in behaviors that may improve reef health,* and *awareness of reef rules and regulations.*

Self-reported awareness and knowledge of reefs is positively correlated with *cultural importance of reefs, participation in behaviors that may improve reef health,* and *awareness of reef rules and regulations.*

Cultural importance of reefs is positively correlated with *participation in behaviors that may improve reef health* and *awareness of reef rules and regulations.*

Participation in behaviors that may improve reef health is positively correlated with *awareness of reef rules and regulations.*

Other variables analyzed include those who fish and gather, those who dive/snorkel, those who fish to feed themselves, those who fish to sell their catch, those who consume seafood at least once per week, those who agree that reefs are only important to fishermen, divers, and snorkelers, those who agree that reefs attract tourists, those who believe the threat level to reefs is "large" or "extreme", those who believe their community is at least moderately involved in managing coral reefs, those who report that they themselves are at least moderately involved in coral reef management, those who obtain environmental information from various sources, and demographics. Some selected results are further described below.

Residents who fish or gather for marine resources are positively correlated with *perceived resource condition, self-reported awareness and knowledge of reefs, cultural importance of reefs, participation in behaviors that may improve reef health,* and *awareness of reef rules and regulations;* but negatively correlated with *management support and positive perceptions of MPAs*.

Residents who dive or snorkel are positively correlated with the same indicators as those who fish or gather, but are not significantly correlated with *management support* or *MPA perceptions.*

Residents who fish for sustenance are positively correlated with *self-reported awareness and knowledge of reefs, participation in behaviors that may improve reef health,* and *awareness of reef rules and regulations.*

Residents who fish to sell their catch are positively correlated with *perceived resource condition, self-reported awareness and knowledge of reefs, participation in behaviors that may improve reef health,* and *awareness of reef rules and regulations;* but negatively correlated with *positive perceptions of MPAs*.

Residents who consume seafood at least once per week are positively correlated with *participation in reef activities, perceived resource condition, self-reported awareness and knowledge of reefs, cultural importance of reefs, participation in behaviors that may improve reef health,* and *awareness of reef rules and regulations;* but negatively correlated with *positive perceptions of MPAs.*

Residents who believe the threat level coral reefs are “large” or “extreme” are positively correlated with *participation in reef activities, management support, positive perceptions of MPAs, self-reported awareness and knowledge of reefs, cultural importance of reefs, participation in behaviors that may improve reef health,* and *awareness of reef rules and regulations;* but negatively correlated with *perceived resource condition.*

Exhibit 388. Correlation Analysis of Survey Based Indicators

	Participation in reef activities indicator	Perceived resource condition indicator	Positive Perceptions of MPAs Index	Management Support Index	Self-reported awareness and knowledge of coral reefs indicator	Cultural importance of reefs indicator	Participation in behaviors that may improve coral reef health indicator	Awareness of coral reef rules and regulations indicator
Participation in reef activities indicator	1							
Perceived resource condition indicator	.089**	1						
Positive Perceptions of MPAs Index	-.063**	-.185**	1					
Management Support Index	-.049*	-.013	.493**	1				
Self-reported awareness and knowledge of coral reefs indicator	.246**	-.085**	.249**	.310**	1			
Cultural importance of reefs indicator	.116**	-.018	.186**	.222**	.301**	1		
Participation in behaviors that may improve coral reef health indicator	.328**	.078**	.007	.089**	.247**	.147**	1	
Awareness of coral reef rules and regulations indicator	.347**	.062**	-.005	.081**	.447**	.181**	.324**	1
Fishes or gathers for marine resources	.762**	.077**	-.132**	-.119**	.168**	.054**	.243**	.292**
Dives or snorkels	.505**	.041**	-.005	-.017	.264**	.128**	.289**	.300**
Fishes to feed themselves/their family	.485**	.019	-.025	-.002	.060**	.000	.056**	.149**
Fishes to sell their catch	.441**	.114**	-.050*	-.043	.050*	.006	.105**	.088**
Consumes seafood at least once per week	.139**	.034*	-.042**	-.017	.074**	.026*	.066**	.089**
Agrees that reefs are only important to fishermen, divers, and snorkelers	.029**	.133**	-.071**	-.004	-.076**	.006	.005	-.031**
Agrees that reefs attract tourists	.001	.000	.168**	.166**	.106**	.205**	-.035**	.012
Believes the threat level to reefs is "large" or "extreme"	.053**	-.230**	.194**	.125**	.176**	.053**	.064**	.060**
Obtains environmental information from the newspaper	-.066**	.011	.030*	-.064**	-.038**	-.008	-.095**	-.028*
Obtains environmental information from the radio	-.021	.104**	-.051**	-.130**	-.102**	-.039**	-.065**	-.005

Exhibit 388. Correlation Analysis of Survey Based Indicators

	Participation in reef activities indicator	Perceived resource condition indicator	Positive Perceptions of MPAs Index	Management Support Index	Self-reported awareness and knowledge of coral reefs indicator	Cultural importance of reefs indicator	Participation in behaviors that may improve coral reef health indicator	Awareness of coral reef rules and regulations indicator
Obtains environmental information from the television	-.123**	.042**	.054**	-.051*	-.158**	-.084**	-.148**	-.126**
Obtains environmental information from the internet	-.006	-.066**	.094**	.050*	.046**	.008	.012	-.087**
Obtains environmental information from friends/family	.084**	-.029*	-.017	-.104**	.031**	.069**	.049**	.034**
Obtains environmental information from jurisdictional government	.045**	-.008	-.064**	.016	.045**	.001	.008	.079**
Obtains environmental information from federal government	.052**	-.026	.068**	.107**	.118**	-.023*	.100**	.087**
Believes community is at least moderately involved in managing coral reefs	.162**	.184**	-.037**	.029	.153**	.131**	.256**	.281**
Reports that they themselves are at least moderately involved in coral reef management	.240**	.057**	.034*	.038	.122**	.038**	.249**	.223**
Is male	.191**	0.006	-.038**	-.066**	.045**	.004	.006	.085**
Age	-.127**	-.069**	.042**	-.076**	.029*	.051**	-.099**	-.002
Has lived in the jurisdiction for 10 years or more	-.030**	-.103**	.060**	.011	-.001	-.045**	-.098**	-.053**
Completed college	-.036**	-.147**	.139**	.128**	.183**	.061**	.062**	.017
Completed high school	.007	-.057**	.101**	.117**	.111**	.031**	.045**	.018
Annual household income over $40,000	.128**	-.052**	.050**	.029	.209**	.099**	.136**	.198**

* = statistically significant with 95% confidence; ** = statistically significant with 99% confidence

4. Discussion and Next Steps

Exhibit 399 provides a summary of the most recent year of indicator values developed in the previous sections and their accompanying value scales and confidence rankings, where indicators highlighted in green are "high" confidence indicators, indicators highlighted in yellow are "medium" confidence indicators, and indicators highlighted in orange are "low" confidence indicators, as defined by the criteria in Exhibit 6. Exhibit 40 provides a more detailed guide to interpreting those values.

Exhibit 399. Summary of Indicator Values

Indicator number and title	Scale	AS	CNMI	FL	GU	HI	PR	USVI
1. Participation in reef activities	0–100	17.674	15.694	12.550	14.684	19.078	6.768	15.180
2. Perceived resource condition	0–100	46.542	55.115	43.193	49.070	46.772	41.067	49.137
3. Attitudes toward coral reef management strategies and enforcement[A]	0–100	72.365	75.644	76.129	74.437	75.259	81.248	73.746
4. Perceived awareness and knowledge of coral reefs	0–100	70.076	68.929	71.220	64.690	68.819	62.438	70.418
5a. Human population changes near coral reefs, resident populations[B]	0 < value	1.006	1.021	1.050	1.024	1.014	0.923	0.993
5b. Human population changes near coral reefs, annual visitors[C]	0 < value	0.962	1.494	1.109	1.157	1.150	1.197	1.131
6. Economic impact of coral reef fishing to jurisdiction[D]	0–1	0.168	0.048	0.137	0.079	0.076	0.230	0.189
7. Economic impact of tourism to jurisdiction[D]	0 < value	0.107	2.530	0.814	1.483	8.015	0.292	1.139
8. Community well-being[E]	0–100	63.554	65.557	71.405	67.225	82.100	69.516	74.055
9. Cultural importance of reefs	0–100	79.583	79.208	81.723	82.112	84.686	72.656	83.428
10. Participation in behaviors that may improve coral reef health	0–100	44.630	38.526	21.878	24.577	50.368	18.537	32.322
11. Physical infrastructure[E]	0–100	10.477	13.232	12.380	35.253	29.351	30.711	10.766
12. Awareness of coral reef rules and regulations	0–100	57.919	60.352	N/A[F]	54.424	52.762	23.292	53.504
13. Governance[G]	1–3	2.083	2.083	N/A	1.917	2.188	1.702	1.583

[A] The values for this indicator are composed of different combinations of input variables by jurisdiction; see text for Indicator 3 for additional details.

[B] The values shown are for year 2017, the indicator text develops results from 2010–2017.

[C] The values shown are for year 2017, except for FL and USVI, in which the year 2016 is reflected.

[D] The values shown are for year 2015.

[E] The values shown are comprised of data from the most recent year available for all jurisdictions.

[F] The underlying survey question for this indicator was not asked in FL.

[G] To date, the MPA Checklist survey, which supports this indicator, has not been administered in FL. Data shown are for 2017.

Exhibit 40. Summary of Indicator Data Sources, Scale, Value Interpretation, and Confidence				
Indicator (year of value)	**Data Source**	**Scale**	**Confidence**	**Value Interpretation**
1. Participation in reef activities	NCRMP survey	0–100	High	0 reflects no reef-related activity among residents; 100 reflects all residents participate to the maximum extent possible, as defined by the survey.
2. Perceived resource condition	NCRMP survey	0–100	High	Over the collective time periods, 0 reflects the worst possible perception of the reefs' condition and 100 reflects the best possible perception of the reefs' condition possible, as defined by the survey.
3. Attitudes toward coral reef management strategies and enforcement	NCRMP survey	0–100	Medium	0 reflects strong disagreement with MPAs and opposition toward management strategies among residents; 100 reflects all residents having the highest possible agreement with MPA goals and support for management strategies, as defined by the survey.
4. Self-reported Awareness and knowledge of coral reefs	NCRMP survey	0–100	High	0 reflects strong disagreement with reefs' shoreline protection functions and strong unfamiliarity with reef threats; 100 reflects all residents' agreeing strongly with reefs' shoreline protection functions and familiarity with all coral reef threats presented to the maximum extent possible, as defined by the survey.
5a. Human population changes near coral reefs, resident populations	Secondary data	0 < value	High	Values equal 1.000 if there were the same number of residents, or visitors, in a given year compared to the 2013 reference year resident, or visitor, populations. Values greater than 1 for the indicators show increasing population pressure relative to the reference year, while values less than 1 reflect decreasing pressure.
5b. Human population changes near coral reefs, annual visitors	Secondary data	0 < value	Medium	
6. Economic impact of coral reef fishing to jurisdiction	Secondary data	0–1	Medium	A value of 0 reflects local coral Reef fish species being completely irrelevant to the jurisdiction's fishery and economy while a value of 1 is equivalent to complete economic dependence on coral Reef fish species.
7. Economic impact of tourism to jurisdiction	Secondary data	0 < value	Medium	A value of 0 reflects tourism being completely irrelevant to the jurisdiction's economy while a value of 1 or greater indicates increasingly significant

Exhibit 40. Summary of Indicator Data Sources, Scale, Value Interpretation, and Confidence				
Indicator (year of value)	**Data Source**	**Scale**	**Confidence**	**Value Interpretation**
				dependence on tourism, which is assumed to be reef-related, at least in part.
8. Community well-being	Secondary data	0–100	Low	0 indicates the jurisdiction had zero value for every input variable (e.g., $0 in income, 100% poverty), a value of 100 indicates that the jurisdiction had the highest level of for each input variable across jurisdictions.
9. Cultural importance of reefs	NCRMP survey	0–100	Low	0 indicates no perceived cultural importance among residents, while 100 reflects maximum perceived importance, as defined by the survey.
10. Participation in behaviors that may improve coral reef health	NCRMP survey	0–100	Low	0 indicates no pro-environmental behavior among residents, to 100, where all residents are participating to the maximum extent possible, as defined by the survey.
11. Physical infrastructure	Secondary data	0–100	Medium	A value of 0 indicates the jurisdiction has zero for every variable (e.g., 0 toxic releases, no impervious cover), and a value of 100 indicates that the jurisdiction has the highest level of all variables when compared to all other jurisdictions.
12. Awareness of coral reef rules and regulations	NCRMP survey	0–100	Low	0 reflects complete unfamiliarity with MPAs among residents, while 100 reflects all residents having maximum possible familiarity with MPAs, as defined by the survey.
13. Governance	MPA Checklist survey	1–3	Low	1 reflects the lowest level of effective governance of the surveyed reef habitats in a jurisdiction while 3 reflects exceptional governance in the surveyed reef habitats.

Based on the results outlined in this report, there a number of conclusions that come to light. First, developing consistent indicators for each thematic area across widely different geographies is a challenge, and is constrained by a number of items including data availability or accessibility, data consistency, vast cultural differences, and the need to minimize burden placed on survey respondents. While these challenges are noted, the culmination of this effort represents NOAA's first attempt to standardize the socioeconomic monitoring of U.S. coral reef jurisdictions through systematic primary and secondary data collection and also serves as the baseline for NCRMP socioeconomic monitoring moving forward.

Participation in reef activities: Results indicate that HI and AS residents participate at the highest levels, while PR residents participate at the lowest level. AS residents have the highest participation frequency in extractive activities, while HI residents have the highest participation frequency in recreational-based activities. It should be noted that although the indicator values look relatively low when compared to the 0-100 scale of the index, that does not mean that participation rates are low, but rather participation frequency is not observed to approach the maximum (as defined by the survey) in all activities for most residents, as the index measures frequency of activity participation across a wide range of activities from never, once a month or less, 2–3 times per month, or 4 times a month or more.

Perceived resource condition: All jurisdictions hover just below or around the midpoint of the index (50), indicating that marine resource condition is not perceived as overly bad, nor overly good, in any jurisdiction. CNMI held the most positive perception of resource condition, with the most negative perception observed in PR. Overall, most residents across the jurisdictions, on average, felt marine resource condition had gotten somewhat worse over the last 10 years. The average perception of anticipated change is also below the midpoint for most jurisdictions, suggesting a lack of optimism toward future marine resource condition.

Attitudes toward coral reef management strategies and enforcement: Jurisdictions exhibit relatively positive attitudes toward management in terms of agreement with MPA functions[5] and support for management activities. The most positive perception is observed in PR, and the most negative perception was observed in AS. The latter result could be due in part to the fact that management support survey questions varied across jurisdictions (with the aim of asking locally relevant management questions), and the management strategies presented to respondents in AS were much more specific in nature than in other jurisdictions, including some recent controversial legislative actions. This indicator is targeted for improvement by including questions related to MPA functions in future surveys of FL and HI.

Self-reported awareness and knowledge of coral reefs: Residents of all of the jurisdictions self-reported that they were generally aware of various coral reef threats, especially tropical cyclones and pollution, and generally agreed that coral reefs provided shoreline protection. Residents across jurisdictions indicated less familiarity with threats like coral bleaching and coral disease, conditions that are not as visible from above the water. Residents of CNMI had the highest level of self-reported threat familiarity, and PR residents had the lowest levels of self-reported threat familiarity.

Human population change: AS, CNMI, FL, GU, and HI have all experienced a resident population increase since 2013 (the first year NCRMP surveys were administered), with the largest increase of 5% observed in FL. Conversely, PR and USVI have experienced a decrease in resident population. In terms of the visitor population, all jurisdictions except for AS have experienced an increase in visitors relative to the number of visitors in 2013. Overall, there is increasing population pressure in these coral reef adjacent communities.

Economic impact of coral reef fishing and dive/snorkel tourism: These indicators were highly constrained by data availability and consistency. In an effort to make use of as much relevant data as possible, the variables chosen to comprise these indicators are different for each jurisdiction, posing challenges for jurisdiction-to-jurisdiction comparisons, but allowing for these indicators to be tracked over time within each jurisdiction. Therefore, while not being able to compare results directly to one another, a few general conclusions can be drawn. The highest value for the economic impact of coral reef fishing indicator is for PR, which indicates that approximately 23% of the combined activity in commercial fishery revenue, commercial fishery yield, recreational fishery yield, business employment, and business establishments is related to fishing for reef-associated species (for fishery revenue and yield) and the living resources sector (for employment and establishments). The lowest value for the economic

[5] Note that questions about MPA functions were not asked in FL or HI.

impact of coral reef fishing indicator is for CNMI, indicating that approximately 5% of the combined activity in commercial fishery revenue, commercial fishery yield, business employment, and business establishments is related to fishing for reef-associated species (for fishery revenue and yield) and the living resources sector (for employment and establishments). As for tourism, this indicator posed an additional challenge of trying to separate coral reef-related tourism from tourism in general. At this point, secondary data is not collected in a systematic way that allows for researchers to parse out tourism directly related to reefs, so this indicator is instead a reflection of overall tourism in the jurisdictions, a sub-section of which is tied to coral reefs. In some cases (National Park tourism data), researchers were able to target data on visitation to parks that include reefs. When examining results, HI and CNMI appear to experience consistently high tourism economic impacts, and AS is observed to be the jurisdiction with the lowest tourism economic impact. Guam and USVI are also noted for their relatively higher tourism indicator values; in fact, visitor spending has exceeded resident spending in the USVI for the years 2012-2016.

While the reported indicator results reflect tourism in general, there are some studies that can lend context to the economic impact of dive/snorkel tourism more specifically in the jurisdictions. Leeworthy (2018a) conducted a survey in Puerto Rico from May 2016 to April 2017, and found that 33.91% of recreating visitors were reef-using visitors. Of these reef-using visitors, 360,745 (30.8%) and 22,673 (1.9%) engaged in snorkeling and diving, respectively. Leeworthy (2018b) used these figures to estimate visitor expenditures related to diving/snorkeling, and found that over $12.7 million (2017$) in visitor expenditures can be attributed to those activities.

In South Florida, it was found that visitors spent 4,737,364 person-days diving and 2,125,572 person-days snorkeling in the coral reefs of Broward, Miami-Dade, Palm Beach, and Monroe counties (Johns et al. 2001), and 3,804 person-days diving and 6,262 person-days snorkeling in the coral reefs of Martin County (Johns et al. 2004). Using the use value per person-day figures calculated in these reports, snorkeling and diving in South Florida's coral reefs produces an annual direct expenditure value of $188.5 million year 2017 dollars. A more recent study conducted by Leeworthy et al. (2010) updated the previously mentioned figures, but only for Monroe County. The updated study found that visitors spent 1,854,400 and 451,800 person-days snorkeling and diving, respectively in the Florida Keys from December 2007 – November 2008. The snorkeling figure is an increase of 8,920 from 1996, and the diving figure is a decrease of 15,470 from 1996.

Cesar and van Beukering (2004) found that visiting recreational divers in Hawai'i generated $12.4 million in direct expenditures, and that visiting recreational snorkelers generated $68.1 million in direct expenditures (2017$) in 2001. Using multiplier effects, the authors calculated the total economic value added (direct and indirect) from recreational diving and snorkeling by visitors in Hawai'i to be $380.7 million in 2001.

In 2016, it was found that Guam's coral reefs host over 300,000 tourist snorkelers and 100,000 tourist scuba divers (QMark Research 2016a, 2016b). Further, over 30% of visitors cite the marine environment as a top reason for visiting Guam (Guam Visitors Bureau 2018).

Van Beukering et al. (2006) estimate that approximately 199,500 dives by visitors take place in Saipan annually. These dives generate an annual direct economic value of $5.1 million (2017$) on Saipan. It was also estimated that snorkel trips (including both residents and visitors) generate over $1 million (2017$) in direct economic value annually on Saipan.

Van Beukering (2011) found that 42.46% of cruise visitors and 43.46% of air visitors report that their motivation to visit the USVI is coral reef-related. Further, the authors calculated the annual economic value of diving and snorkeling in the USVI to be 14.7 million (2017$).

While these studies certainly provide more nuanced details with regards to dive/snorkel tourism and its economic impact, they were ultimately not included in the final tourism indicator calculations as these assessments are not

available across all of the jurisdictions in a methodologically similar way, and the data are not tracked over time in a systematic uniform fashion.

Community well-being: This also proved to be a complex indicator with data availability constraints. Variables were selected first based on relevant connections to the concept of well-being and its sub-categories (adapted from Dillard et al., 2013). The list of variables was further pared down based on their availability across jurisdictions. Once selected, the most recent year of data for each variable in each jurisdiction was used. Due to this temporal variation, this indicator can be interpreted as "community well-being in 2018, based on the most recent data available." Given this framing, HI exhibits the highest level of community well-being, mostly driven by economic security and health. AS exhibits the lowest (but not necessarily "low") community well-being indicator value amongst the jurisdictions, and this is mostly driven by economic security and basic needs.

Cultural importance of reefs: All of the jurisdictions exhibit a relatively strong cultural connection to reefs and recognize reefs as important to their respective cultures. While all exhibited high levels of agreement with the cultural importance of reefs, HI was observed to have the highest indicator value, and PR had the lowest. This indicator is targeted for improvement in the next round of surveys as it is currently based on only one survey question.

Participation in behaviors that may improve coral reef health: This indicator is also targeted for improvement since it is based on a single survey question. Participation rates varied across the jurisdictions, with HI residents participating most frequently and PR residents participating least frequently.

Physical infrastructure: The jurisdictions experience vastly different levels of development and military presence. GU exhibits the highest level of physical infrastructure, chiefly driven by military presence relative to total coastline length, whereas AS exhibits the least physical infrastructure. At first glance, the low indicator value for physical infrastructure in FL may seem counter-intuitive given that it has a densely developed coastline and contains reefs in somewhat poor health. While the absolute value of consultation permits and NPDES permits in FL dwarf the other jurisdictions, when normalizing by miles of coastline, it tells a different story.

Awareness of coral reef rules and regulations: All of the jurisdictions range from "neither familiar nor unfamiliar" to slightly familiar with MPAs/marine managed areas/marine preserves (except for PR; in which familiarity is comparatively low). This indicator is also targeted for improvement as it is based on a single question corresponding to a single generalizable regulation, and the question was not asked in FL during the first round of surveys.

Governance: The MPA Checklist, conducted by NOAA CRCP, was used to track governance in the jurisdictions, informed by the perceptions of jurisdictional reef managers. Based on the 2017 results, HI exhibits the highest indicator value for governance, while USVI has the lowest. As of 2017, all jurisdictions have increased their governance indicator value since 2011, indicating positive advancements in meeting or exceeding governance targets in the thematic areas of the MPA Checklist. This indicator is targeted for improvement for the next round of surveys. The research team is exploring options for conducting a more comprehensive survey of reef managers to encompass perceptions concerning governance across the entirety of each jurisdiction instead of a subset of MPA(s).

A few indicators have been targeted for improvement in the next round of primary data collection. First, the NCRMP team will be adding a contingent valuation dichotomous choice question to the next round of surveys in order to estimate resident willingness-to-pay for coral reef conservation. This will lend more context to the economic indicators in articulating the value that residents place on coral reefs. Secondly, additional questions concerning the cultural importance of reefs and awareness of coral reef rules and regulations will be added. The participation in pro-environmental behavior question will be broken down into specific activities (e.g., recycling, volunteering with environmental groups) to understand more nuanced participation rates for different pro-environmental activities. The

NCRMP team will also push to include MPA questions (awareness of and agreement with functions) in future surveys in all jurisdictions. Other improvements include adding a question on the frequency of fishing for various species that are important to each jurisdiction, and adding question to examine the consumption of locally harvested coral reef seafood in addition to seafood consumption in general. These changes should improve the status of primary data collection and make certain indicators more robust as the second round of socioeconomic monitoring begins. As for secondary data, this effort proved incredibly useful in terms of identifying and synthesizing relevant data sources. For indicators derived from secondary data, researchers will always be constrained by what is available. During the second round of monitoring, the research team will continue to collect data from the sources identified in this report and will explore other data sources as they become available.

Overall, this first round of indicator collection and development is significant for its accomplishment in developing and applying clear and reasonable methods to incorporate available information, much of it generated from NOAA, into concise measures that can help inform future management decisions. This is particularly true with respect to the survey-based indicators, from both the NCRMP and MPA Checklist surveys, where intra- and inter-jurisdiction comparisons will become increasingly possible, relevant, and insightful as data from future rounds of surveys and secondary data collection are incorporated. Continued review and refinement of these indicators and the input variable data on which they rely has the potential to increase the robustness of the resulting series of indicator values. With this information, scientists, practitioners, and coral reef managers in the jurisdictions can integrate social and biophysical data streams to obtain a more in-depth understanding of social-ecological relationships. These indicators also support communication, by taking a complex array of variables and joining them together in single, trackable metrics that are intended to encompass the general breadth of a concept. As socioeconomic monitoring continues, these indicators will be tracked to make relevant temporal comparisons, and they will be improved as resident survey questions are refined and new data streams become available.

5. References

Agency for Health Care Administration. 2015. Hospital Beds and Services List. Available: https://ahca.myflorida.com/MCHQ/CON_FA/Publications/archives/docs/HospBedSrvList/Jul2015_HospitalBedsandServicesList.pdf. Accessed 1/24/2019.

American Hospital Directory. 2018. Individual Hospital Statistics for Puerto Rico. Available: https://www.ahd.com/states/hospital_PR.html. Accessed 1/24/2019.

American Samoa Department of Commerce American Samoa Visitors Bureau. 2018. American Samoa International Visitor Survey 2017. Available: http://doc.as.gov/american-samoa-international-visitor-survey-2017/. Accessed 3/1/2019.

American Samoa Department of Commerce Research and Statistics Division. 2010. 2009 American Samoa Statistical Yearbook. Available: http://doc.as.gov/research-and-statistics/statistical-yearbook/. Accessed 3/1/2019.

American Samoa Department of Commerce Research and Statistics Division. 2017. 2016 American Samoa Statistical Yearbook. Available: http://doc.as.gov/research-and-statistics/statistical-yearbook/. Accessed 3/1/2019.

American Samoa Department of Commerce Research and Statistics Division. 2018. 2017 American Samoa Statistical Yearbook. Available: http://doc.as.gov/wp-content/uploads/2018/10/2017-Statistical-Yearbook.pdf. Accessed 3/1/2019.

American Samoa Department of Commerce Statistics Division. 2016. 2015 American Samoa Household Income and Expenditures Survey. Available: https://www.doi.gov/sites/doi.gov/files/uploads/american-samoa-2015-household-income-and-expenditure-report.pdf. Accessed 3/1/2019.

American Samoa Department of Health. 2013. Western Pacific Health Databank. Available: http://www.wpro.who.int/countries/asm/1_asm_2012_final.pdf. Accessed 3/1/2019.

Association of American Medical Colleges. 2017. 2016 Puerto Rico Physician Workforce Profile. Available: https://www.aamc.org/download/484586/data/puertoricoprofile.pdf. Accessed 3/1/2019.

Bowen, R. and C. Riley. 2003. Socio-economic indicators and integrated coastal management. Ocean & Coastal Management 46:299–312.

Brander, L.M. 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. Available: https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/other_crcp_publications/TEV_US_Coral_Reefs_Literature_Review_2013.pdf. Accessed 3/1/2019.

Breslow, S.J., M. Allen, D. Holstein, B. Sojka, R. Barnea, X. Basurto, C. Carothers, S. Charnley, S. Coulthard, N. Dolšak, J. Donatuto, C. García-Quijano, C.C. Hicks, A. Levine, M.B. Mascia, K. Norman, M. Poe, T. Satterfield, K. St. Martin, and P.S. Levin. 2017. Evaluating indicators of human well-being for ecosystem-based management. Ecosystem Health and Sustainability 3(12):1–18. doi: 10.1080/20964129.2017.1411767.

Britannica Book of the Year. 2012. Nations of the World – American Samoa – Education and Health. 533 p. Available: https://books.google.com/books?id=EeqbAAAAQBAJ&pg=PA533&lpg=PA533&dq=%22american+samoa%22+hospital+beds+per+1000+population&source=bl&ots=ESc98pFRJB&sig=4A4uCXEUpl0tGx9KUbcxzL42Qk

8&hl=en&sa=X&ved=2ahUKEwi9zYzah-HeAhUovlkKHc6UDDk4ChDoATABegQIBxAB#v=onepage&q=%22american%20samoa%22%20hospital%20beds%20per%201000%20population&f=false. Accessed 3/1/2019.

Centers for Disease Control and Prevention. 2018. Deaths: Final Data for 2000 to 2016. National Vital Statistics Reports. U.S. Department of Health and Human Services. Available: https://www.cdc.gov/nchs/products/nvsr.htm. Accessed 3/1/2019.

Cesar, H. and P. van Beukering. 2004. Economic Valuation of the Coral Reefs of Hawai'i. Pacific Science. 58(2): 231-242.

CIA World Factbook. 2018a. Infant Mortality Rate (deaths/1,000 live births). Available: https://www.indexmundi.com/g/g.aspx?v=29&c=aq&c=gq&c=cq&c=rq&c=vq&l=en. Accessed 3/1/2019.

CIA World Factbook. 2018b. Life Expectancy at Birth (years). Available: https://www.indexmundi.com/g/g.aspx?v=30&c=aq&c=gq&c=cq&c=rq&c=vq&l=en. Accessed 3/1/2019.

CNMI Department of Commerce Central Statistics Division. 2017a. 2016 Commonwealth of the Northern Mariana Islands Household Income and Expenditures Survey Report. Available: http://ver1.cnmicommerce.com/wp-content/uploads/2010/07/2016-HIES-Final-Report.pdf. Accessed 3/1/2019.

CNMI Department of Commerce Central Statistics Division. 2017b. SY 2017 13.2 All Government Fund Expenditures by Function, CNMI: 1995 to 2002. Available: http://ver1.cnmicommerce.com/sy-2017-table-13-2-all-government-fund-expenditures-by-function-cnmi-1995-to-2002/. Accessed 3/1/2019.

CNMI Department of Commerce Central Statistics Division. 2018a. CNMI Labor Force Participation Measures: General Population, Potential Labor Force, Labor Force, Employed, Unemployed, Not In-Labor Force Populations, Unemployment Rate and Labor Force Participation Rate In the Commonwealth of the Northern Mariana Islands, 4th Quarter, 2017. Available: http://ver1.cnmicommerce.com/wp-content/uploads/2018/05/20174QLFPFD-ver.-1.1.pdf. Accessed 3/1/2019.

CNMI Department of Commerce Central Statistics Division. 2018b. Economic Indicator: Building Permits & Project Costs. Available: http://ver1.cnmicommerce.com/ei-building-permits-project-costs/. Accessed 3/1/2019.

CNMI Department of Commerce Central Statistics Division. 2018c. Economic Indicator: Hotel Occupancy Rates. Available: http://ver1.cnmicommerce.com/ei-hotels-occupancy-rates/. Accessed 3/1/2019.

CNMI Department of Public Health. 2008. Health Data Report. Western Pacific Health Databank Available: http://www.wpro.who.int/countries/mnp/23_mnp_2012.pdf. Accessed 3/1/2019.

Colburn, L.L. and M. Jepson. 2012. Social indicators of gentrification pressure in fishing communities: A context for social impact assessment. Coastal Management 40:289–300.

Colburn, LL., M. Jepson, C. Weng, T. Seara, J. Weiss, and J.A. Hare. 2016. Indicators of climate change and social vulnerability in fishing dependent communities along the Eastern and Gulf Coasts of the United States. Marine Policy 74:323–333.

Commonwealth Healthcare Corporation Division of Hospital Services. Undated. Commonwealth Health Center. Available: http://chcc.gov.mp/index.php/division-of-hospital-services. Accessed 3/1/2019.

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. Available: https://coastalscience.noaa.gov/publications/detail.aspx?resource = vEJnl8tRMtte2uSEyRGtPk33w24iNAPwSRAf9Pp6iYM=. Accessed 3/1/2019.

D.K. Shifflet. 2018. Year-End 2017 Visitor Volume and Spending (Monroe County, Florida). Chart 1. McLean, VA. Available: http://www.monroecounty-fl.gov/DocumentCenter/View/14535/2017-Monroe-County-Domestic-Visitor-Count?bidId. Accessed 3/1/2019.

Estadisticas.pr. Undated (a). Puerto Rico Tourism Company Monthly Statistics Reports: 2014 to 2016. Available: https://estadisticas.pr/en/inventario-de-estadisticas/selected-statistics-tourism-sectorhttps://estadisticas.pr/en/inventario-de-estadisticas/puerto_rico_tourism_company. Accessed 3/1/2019.

Estadisticas.pr. Undated (b). Selected Statistics of the Tourism Sector: 2000 to 2013. Available: https://estadisticas.pr/en/inventario-de-estadisticas/selected-statistics-tourism-sector. Accessed 3/1/2019.

Florida Department of Environmental Protection. 2018a. Division of Environmental Assessment and Restoration. Statewide Comprehensive Verified List of Impaired Waters. Available: https://floridadep.gov/dear/watershed-assessment-section/documents/comprehensive-verified-list. Accessed 1/24/2019.

Florida Department of Environmental Protection. 2018b. Wastewater Facility Information. Last updated 11-01-2018. Available: https://floridadep.gov/water/domestic-wastewater/content/wastewater-facility-information. Accessed 12/31/2018.

Florida Fish and Wildlife Conservation Commission. 2018a. Commercial Fisheries Landings Summaries. Available: https://public.myfwc.com/FWRI/PFDM/ReportCreator.aspx. Accessed 3/1/2019.

Florida Fish and Wildlife Conservation Commission. 2018b. Florida Fish and Wildlife Conservation Commission. Available: http://myfwc.com/. Accessed 3/1/2019.

Florida Health. 2018. Vital Statistics Annual and Provisional Reports-Deaths for 2000 to 2017. Available: http://www.flpublichealth.com/VSBOOK/VSBOOK.aspx. Accessed 3/1/2019.

Florida Health. 2019. Physician Workforce Development from 2008 to 2018. Available: http://www.floridahealth.gov/provider-and-partner-resources/community-health-workers/physician-workforce-development-and-recruitment/index.html. Accessed 3/1/2019.

Florida Legislature Office of Economic & Demographic Research. 2019. Statewide Expenditures and Revenue Reported by Florida's Counties, Municipalities, and Independent Special Districts. Available: http://edr.state.fl.us/Content/local-government/data/revenues-expenditures/stwidefiscal.cfm. Accessed 3/1/2019.

Gorstein, M., M. Dillard, J. Loerzel, P. Edwards, and A. Levine. 2016. National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for South Florida, 2014. US Dep. Commerce, NOAA Tech. Memo., NOAA-TM-NOS-CRCP-25, 57 p. + Appendices. doi: 10.7289/V5VH5KV5.

Gorstein, M., J. Loerzel, P. Edwards, A. Levine, and M. Dillard. 2017. National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for Puerto Rico, 2015. US Dep. Commerce, NOAA Tech. Memo., NOAA-TM-NOS-CRCP-28, 64 p. + Appendices. Available: https://doi.org/10.7289/V5BP00V9. Accessed 4/19/2019.

Gorstein, M., J. Loerzel, A. Levine, P. Edwards, and M. Dillard. 2018a. National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for Hawai'i, 2015. US Dep. Commerce, NOAA Tech. Memo., NOAA-TM-NOS-CRCP-30, 69 p. + Appendices.

Gorstein, M., J. Loerzel, A. Levine, P. Edwards, and M. Dillard. 2018b. National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for Guam, 2016. US Dep. Commerce, NOAA Tech. Memo., NOAA-TM-NOS-CRCP-32, 64 p. + Appendices. doi: 10.25923/kpvd-mj07.

Gorstein, M., J. Loerzel, P. Edwards, A. Levine, and M. Dillard. 2019a. National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for CNMI, 2016. US Dep. Commerce, NOAA Tech. Memo., NOAA-TM-NOS-CRCP-34, 69p. + Appendices.

Gorstein, M., J. Loerzel, P. Edwards, and A. Levine. 2019b. National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for USVI, 2017. US Dep. Commerce, NOAA Tech. Memo., NOAA-TM-NOS-CRCP-35, 72p. + Appendices.

Government of Puerto Rico Government Development Bank for Puerto Rico. 2018. Commonwealth CAFR. Available: http://www.gdb.pr.gov/investors_resources/commonwealth-cafr.html. Accessed 3/1/2019.

Government of Puerto Rico Planning Board. 2017a. Center of Macroeconomic Data: Historical Series. Available: http://jp.pr.gov/Economía/Centro-de-Datos-Macroeconómicos. Accessed 3/1/2019.

Government of Puerto Rico Planning Board. 2017b. Economic Indicators: Construction Permits. http://www.jp.gobierno.pr/. Accessed 3/1/2019.

Government of the U.S. Virgin Islands Department of Health. 2011. Virgin Islands Health Information Exchange: Strategic & Operational Plan. Available: https://www.healthit.gov/sites/default/files/usvi-hie-sop_12-15-11.pdf. Accessed 3/1/2019.

Guam Bureau of Statistic and Plans. 2017. Available at: https://bsp.guam.gov/.

Guam Bureau of Statistics and Plans. 2019. 2017 Guam Statistical Yearbook. Available: http://bsp.guam.gov/guam-statistical-yearbook/. Accessed 3/1/2019.

Guam Visitors Bureau. 2018. I Estoria. 2017 Annual Report. Tumon, Guam.

Guam Visitors Bureau. 2019. Guam Tourism Satellite Account-Research-Research and Reports. Available: https://www.guamvisitorsbureau.com/research-and-reports/research/guam-tourism-satellite-account. Accessed 3/1/2019.

Hawai‘i Department of Health. 2018. Environmental Health Portal, Water Pollution Control Viewer. Available: http://eha-web.doh.hawaii.gov/wpc-viewer/. Accessed 12/31/2018.

Hawai‘i Health Data Warehouse. 2017a. Deaths in Hawai‘i by State and County. Available: http://hhdw.org/wp-content/uploads/2017/03/Vital-Statistics_Resident-Deaths_IND_00027.pdf. Accessed 3/1/2019.

Hawai‘i Health Data Warehouse. 2017b. Infant Deaths in Hawaii. Available: http://hhdw.org/wp-content/uploads/Vitals_Infant-Deaths_IND3.pdf. Accessed 3/1/2019.

Hawai‘i Tourism Authority. 2019. Annual Visitor Research Reports. Table 1 worksheets in each annual Excel file. Available: https://www.hawaiitourismauthority.org/research/annual-visitor-research-reports/. Accessed 3/1/2019.

Henry J Kaiser Family Foundation. 2019. State Health Facts – Hospital Beds per 1,000 Population by Ownership Type. Available: https://www.kff.org/other/state-indicator/beds-by-ownership/?activeTab=graph&currentTimeframe=0&startTimeframe=17&selectedRows=%7B%22states%22:%

7B%22hawaii%22:%7B%7D%7D%7D&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D. Accessed 3/1/2019.

Himes-Cornell, A. and S. Kasperski. 2015. Assessing climate change vulnerability in Alaska's fishing communities. Fisheries Research 162:1–11.

Himes-Cornell, A. and S. Kasperski. 2016. Using socioeconomic and fisheries involvement indices to understand Alaska fishing community well-being. Coastal Management 44.1:36–70.

Himes-Cornell, A., C. Maguire, S. Kasperski, K. Hoelting, and R. Pollnac. 2016. Understanding vulnerability in Alaska fishing communities: A validation methodology for rapid assessment of indices related to well-being. Ocean & Coastal Management 124(2016):53–65.

Institute for Health Metrics and Evaluation. 2014a. Florida Life Expectancy Female-County Comparisons. Available: https://www.worldlifeexpectancy.com/usa/florida-life-expectancy-by-county-male. Accessed 1/24/2019.

Institute for Health Metrics and Evaluation. 2014b. Florida Life Expectancy Male-County Comparisons. Available: https://www.worldlifeexpectancy.com/usa/florida-life-expectancy-by-county-male. Accessed 1/24/2019.

Jepson, M. and L.L. Colburn. 2013. Development of Social Indicators of Fishing Community Vulnerability and Resilience in the U.S. Southeast and Northeast Regions. NOAA Technical Memorandum NMFS-F/SPO-129. Available https://sero.nmfs.noaa.gov/sustainable_fisheries/social/documents/pdfs/communities/2013/vulnerability_resilience_social_indicators.pdf. Accessed 4/19/2019.

Henry J Kaiser Family Foundation. 2019. State Health Facts – Hospital Beds per 1,000 Population by Ownership Type. Available: https://www.kff.org/other/state-indicator/beds-by-ownership/?activeTab=graph&currentTimeframe=0&startTimeframe=17&selectedRows=%7B%22states%22:%7B%22hawaii%22:%7B%7D%7D%7D&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D. Accessed 3/1/2019.

Johns, G., Leeworthy, V., Bell, F., and Bonn, M. 2001. Socioeconomic Study of Reefs in Southeast Florida: Final Report. Hazen and Sawyer Environmental Engineers and Scientists, Florida State University, NOAA. Pp. 348.

Johns, G., J. Milon, and D. Sayers. 2004. Socioeconomic Study of Reefs in Martin County, Florida: Final Report. Hazen and Sawyer Environmental Engineers and Scientists. Martin County, Florida Fish and Wildlife Conservation Commission. Hwd: 40526R008.

Levine, A., M. Dillard, J. Loerzel, and P. Edwards. 2016. National Coral Reef Monitoring Program Socioeconomic Monitoring Component. Summary Findings for American Samoa, 2014. Silver Spring, MD: NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 24. 80 pp. doi: 10.7289/V5FB50Z1.

Leeworthy, V.R., D.K. Loomis, and S.K. Paterson. 2010. Linking the Economy and the Environment of Florida Keys/Key West: Visitor Profiles; Florida Keys/Key West 2007-08. Silver Spring, MD: Office of National Marine Sanctuaries. National Oceanic and Atmospheric Administration.

Leeworthy, V.R., D. Schwarzmann, S. Hughes, J. Vaughn, D. Harris, and G. Padilla. 2018a. Visitor Profiles: Reef Users, Puerto Rico Coral Reef Valuation. Silver Spring, MD: Office of National Marine Sanctuaries. National Oceanic and Atmospheric Administration.

Leeworthy, V.R., D. Schwarzmann, S. Hughes, J. Vaughn, C. Dato, and G. Padilla. 2018b. Economic Contribution of Reef Using Visitor Spending to the Puerto Rican Economy. Silver Spring, MD: Office of National Marine Sanctuaries. National Oceanic and Atmospheric Administration.

Limtiaco, S. 2017. CNMI Economy Experienced Explosive Growth Last Year. Guam Pacific Daily News. Available: https://www.guampdn.com/story/news/2017/10/17/cnmi-economy-experienced-explosive-growth-last-year/770491001/. Accessed 3/1/2019.

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. National Oceanic and Atmospheric Administration, National Ocean Service, National Centers for Coastal Ocean Science, Hollings Marine Laboratory, Charleston, SC.

Miami-Dade County. 2019. Comprehensive Annual Financial Reports. Miscellaneous Information on County Tourism. Available: https://www8.miamidade.gov/global/finance/annual-reports.page. Accessed 3/1/2019.

Morzaria-Luna, H.N., P. Turk-Boyer, and M. Moreno-Baez. 2014. Social indicators of vulnerability for fishing communities in the Northern Gulf of California, Mexico: Implications for climate change. Marine Policy 45:182–193.

Moss Adams LLP. 2016. Single Audit Reports for Territory of American Samoa. Available: http://www.govwiki.info/pdfs/General%20Purpose/AS%20Territory%20Of%20American%20Samoa%202016.pdf. Accessed 3/1/2019.

National Center of Education Statistics. Undated (a). ELSi expressTables. Available: https://nces.ed.gov/ccd/elsi/expressTables.aspx. Accessed 3/1/2019.

National Center of Education Statistics. Undated (b). National Public Education Financial Survey Data. Available: https://nces.ed.gov/ccd/stfis.asp. Accessed 3/1/2019.

National Oceanic and Atmospheric Administration. 2014. National Coral Reef Monitoring Plan. Coral Reef Conservation Program. Available: https://www.coris.noaa.gov/monitoring/. Accessed 3/1/2019.

National Oceanic and Atmospheric Administration. 2015. Coastal Change Analysis Program (C-CAP) Regional Land Cover. National Oceanic and Atmospheric Administration Office for Coastal Management, Charleston, SC. Available: www.coast.noaa.gov/ccapftp. Accessed 3/1/2019.

National Oceanic and Atmospheric Administration. 2017. Economics: National Ocean Watch (ENOW) Data. Based on data from the Bureau of Labor Statistics and the Bureau of Economic Analysis. National Oceanic and Atmospheric Administration Office for Coastal Management, Charleston, SC. Available: https://coast.noaa.gov/digitalcoast/data/enow.html. Accessed 3/1/2019.

National Oceanic and Atmospheric Administration; National Marine Fisheries Service. 2018a. Commercial Fisheries Statistics. National Marine Fishery Service, Fisheries Statistics Division. Available: https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index. Accessed 3/1/2019.

National Oceanic and Atmospheric Administration; National Marine Fisheries Service. 2018b. Marine Recreational Information Program. National Marine Fishery Service, Fisheries Statistics Division. Available: https://www.st.nmfs.noaa.gov/st1/recreational/queries/. Accessed 3/1/2019.

National Oceanic and Atmospheric Administration; National Marine Fisheries Service; Pacific Islands Fisheries Science Center. 2018c. Western Pacific Fisheries Information Network; Total Commercial Landings by Island Area. Available: https://www.pifsc.noaa.gov/wpacfin/total-landings.php. Accessed 3/1/2019.

Palm Beach County. Undated. Tourism Statistics. The Palm Beaches Florida Tourist Development Council. Available: http://discover.pbcgov.org/touristdevelopment/PDF/Budget_2016/Section%209%20Tourism%20Statistics.pdf#search = tourism. Accessed 3/1/2019.

Pollnac, R.B., T. Seara, L.L. Colburn, and M. Jepson. 2015. Taxonomy of USA East Coast fishing communities in terms of social vulnerability and resilience. Environmental Impact Assessment Review 55:136–142.

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

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

Smith, C.L. and P.M. Clay. 2010. Measuring subjective and objective well-being: Analyses from five marine commercial fisheries. Human Organization 69(2):158–168.

State of Hawai‘i Department of Business, Economic Development & Tourism. 2019a. Quarterly Statistical & Economic Report. Available: http://dbedt.hawaii.gov/economic/qser/tourism/. Accessed 3/1/2019.

State of Hawai‘i Department of Business, Economic Development & Tourism. 2019b. State of Hawai‘i Databooks-Construction and Housing. Available: http://dbedt.hawaii.gov/economic/databook/. Accessed 3/1/2019.

State of Hawai‘i Department of Business, Economic Development & Tourism. 2019c. State of Hawai‘i Databooks-Income, Expenditures, and Wealth. Available: http://dbedt.hawaii.gov/economic/databook/. Accessed 3/1/2019.

State of Hawai‘i Department of Business, Economic Development & Tourism. 2019d. State of Hawai‘i Databooks-Vital Statistics and Health. Available: http://dbedt.hawaii.gov/economic/databook/. Accessed 3/1/2019.

State of Hawai‘i Department of Business, Economic Development & Tourism. 2019e. Visitor Statistics. Available: http://dbedt.hawaii.gov/visitor/. Accessed 3/1/2019.

State of Hawai‘i Division of Aquatic Resources. 2019. State of Hawai‘i Division of Aquatic Resources website. Available: http://dlnr.hawaii.gov/dar/. Accessed 3/1/2019.

Tourism Economics. 2016. The Economic Impact of Out-of-state Visitor Spending. Available: http://www.tampabaybeaches.com/uploads/5/8/1/9/58193091/florida-visitor-economic-impact-governors-conference-breakout-session.pdf. Accessed 3/1/2019.

United Nations. 2017. Population Division Department of Economic and Social Affairs World Population Prospects: The 2017 Revision File POP/1-1: Total Population (both sexes combined) by Region, Subregion and Country, Annually for 1950–2100 (thousands). Estimates, 1950–2015. POP/DB/WPP/Rev.2017/POP/F01-1. June. Available: https://population.un.org/wpp/Download/Standard/Population/. Accessed 3/1/2019.

University of the Virgin Islands. 2019. Document Library. Available: https://www.uvi.edu/research/eastern-caribbean-center/documents.aspx. Accessed 3/1/2019.

Urban Institute, Brookings Institution, Tax Policy Center, and individual authors. 2019. State and Local Finance Initiative Data Query System. Available: https://slfdqs.taxpolicycenter.org/index.cfm. Accessed 3/1/2019.

U.S. Bureau of Economic Analysis. 2018. Gross Domestic Product of the U.S. Territories. Available: https://www.bea.gov/data/gdp/gdp-us-territories. Accessed 3/1/2019.

U.S. Bureau of Economic Analysis. 2019. National Income and Product Accounts. Table 1.1.9. Implicit Price Deflators for Gross Domestic Product. Bureau of Economic Analysis. Last Revised on February 28, 2019. Available: https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=3&isuri=1&1921=survey&1903=13#reqid=19&step=3&isuri=1&1921=survey&1903=13. Accessed 4/19/2019.

U.S. Bureau of Labor Statistics. Undated. Local Area Unemployment Statistics. Available: https://data.bls.gov/PDQWeb/la. Accessed 3/1/2019.

U.S. Bureau of Labor Statistics. 2019a. Occupational Employment Statistics: 2000 to 2016. Available: https://data.bls.gov/oes/#/home. Accessed 3/1/2019.

U.S. Bureau of Labor Statistics. 2019b. Quarterly Census of Employment and Wages: 2001 to 2017. Available: https://data.bls.gov/PDQWeb/en. Accessed 3/1/2019.

U.S. Census Bureau. 2010a. Community Facts 2010 Census: General Population and Housing Characteristics and American Community Survey Estimates: Selected Economic Characteristics. Available: https://factfinder.census.gov. Accessed 3/1/2019.

U.S. Census Bureau. 2010b. Educational Attainment: 2010 Decadal Census. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/PCT36/0400000US66. Accessed 3/1/2019.

U.S. Census Bureau. 2010c. Employment Status: 2010 Decadal Census. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_ASSF/PBG38/0400000US60. Accessed 3/1/2019.

U.S. Census Bureau. 2010d. Health Insurance Coverage Status: 2010 Decadal Census. Guam. Available https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/PBG35/0400000US66. American Samoa. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_ASSF/PBG137/0400000US60. Accessed 3/1/2019.

U.S. Census Bureau. 2010e. Island Area Demographic Profiles: 2010 Decadal Census. Available: American Samoa: https://www.census.gov/population/www/cen2010/island_area/as.html; CNMI: https://www.census.gov/population/www/cen2010/island_area/cnmi.html; Guam: https://www.census.gov/population/www/cen2010/island_area/guam.html; USVI: https://www.census.gov/population/www/cen2010/island_area/usvi.html. Accessed 3/1/2019.

U.S. Census Bureau. 2010f. Median Family/Household Income (Dollars): 2010 Decadal Census. American Samoa Available https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_ASSF/PBG72/0400000US60. GU Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/PBG49/0400000US66. Accessed 3/1/2019.

U.S. Census Bureau. 2010g. Median Value (Dollars): 2010 Decadal Census. American Samoa Available https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_ASSF/HBG68/0400000US60. GU Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/HBG70/0400000US66. Accessed 3/1/2019.

U.S. Census Bureau. 2010h. Median Year Householder Moved into Unit by Tenure: 2010 Decadal Census. Guam. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/HBG24/0400000US66. Accessed 3/1/2019.

U.S. Census Bureau. 2010i. Plumbing Facilities. Demographic Profile of Selected Housing Characteristics (DP-4) for American Samoa, CNMI, Guam, and USVI. Available: American Samoa: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_DPAS/ASDP4; CNMI: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_DPMP/MPDP4; Guam: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_DPGU/GUDP4; USVI: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_DPVI/VIDP4. Accessed 3/1/2019.

U.S. Census Bureau. 2010j. Poverty Status: 2010 Decadal Census. American Samoa Available https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_ASSF/PBG84/0400000US60. GU Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/PBG84/0400000US66. Accessed 3/1/2019.

U.S. Census Bureau. 2010k. Public Assistance Income in the Past 12 Months for Households: 2010 Decadal Census. Guam. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/PBG56/0400000US66. CNMI. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_MPSF/PBG56/0400000US69. USVI. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_VISF/PBG54/0400000US78. American Samoa. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_ASSF/PBG56/0400000US60. Accessed 3/1/2019.

U.S. Census Bureau. 2010l. QuickFacts 2010 Census. Available: https://www.census.gov/quickfacts. Accessed 3/1/2019.

U.S. Census Bureau. 2010m. School Enrollment: 2010 Decadal Census. Guam. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/PCT32/0400000US66. CNMI. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_MPSF/PCT32/0400000US69. USVI. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_VISF/PBG23/0400000US78. Accessed 3/1/2019.

U.S. Census Bureau. 2010n. Tenure by Internet Service Available: 2010 Decadal Census. Guam Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/HBG49/0400000US66. Accessed 3/1/2019.

U.S. Census Bureau. 2010o. Tenure by Telephone Service Available: 2010 Decadal Census. Guam Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/HBG47/0400000US66. Accessed 3/1/2019.

U.S. Census Bureau. 2010p. Tenure by Vehicles Available: 2010 Decadal Census. Available: https://factfinder.census.gov/bkmk/table/1.0/en/DEC/10_GUSF/HBG32/0400000US66. Accessed 3/1/2019.

U.S. Census Bureau. 2017a. Building Permits Survey. US Department of Housing and Urban Development. Available: https://www.huduser.gov/publications/pdf/CMARtables_UnitedStatesVirginIslands_18.pdf. Accessed 3/1/2019.

U.S. Census Bureau. 2017b. Educational Attainment: American Community Survey 1-Year Estimates: 2005 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/S1501/0400000US15|0400000US72|0500000US12011|0500000US12085|0500000US12086|0500000US12087|0500000US12099. Accessed 3/1/2019.

U.S. Census Bureau. 2017c. Health Insurance Coverage Status: American Community Survey 1-Year Estimates: 2009 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/B27001/0400000US72. Accessed 3/1/2019.

U.S. Census Bureau. 2017d. Median Household Income: American Community Survey 1-Year Estimates: 2005 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/S1903/0400000US72. Accessed 3/1/2019.

U.S. Census Bureau. 2017e. Median Value (Dollars): American Community Survey 1-Year Estimates: 2005 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_5YR/B25077/0400000US72|0500000US12011|0500000US12085|0500000US12086|0500000US12087|0500000US12099. Accessed 3/1/2019.

U.S. Census Bureau. 2017f. Median Year Householder Moved into Unit: American Community Survey 1-Year Estimates: 2005 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/B25039/0400000US15|0400000US72|0500000US12011|0500000US12085|0500000US12086|0500000US12087|0500000US12099. Accessed 3/1/2019.

U.S. Census Bureau. 2017g. Plumbing Facilities for All Housing Units (B25047): American Community Survey (ACS) 1-Year Estimates. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/B25047/0400000US15|0400000US72|0500000US12011|0500000US12085|0500000US12086|0500000US12087|0500000US12099. Accessed 3/1/2019.

U.S. Census Bureau. 2017h. Poverty Status in the Past 12 Months: American Community Survey 1-Year Estimates: 2005 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/S1701/0400000US72. Accessed 3/1/2019.

U.S. Census Bureau. 2017i. Presence and Types of Internet Subscriptions in Household: American Community Survey 1-Year Estimates: 2013 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/B28002/0400000US15|0400000US72|0500000US12011|0500000US12085|0500000US12086|0500000US12087|0500000US12099. Accessed 3/1/2019.

U.S. Census Bureau. 2017j. Public Assistance Income in the Past 12 Months for Households: American Community Survey 1-Year Estimates: 2005 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/16_5YR/B19057/0400000US12|0400000US15|0400000US72. Accessed 3/1/2019.

U.S. Census Bureau. 2017k. School Enrollment: American Community Survey 1-Year Estimates: 2005 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/S1401/0400000US15|0400000US72|0500000US12011|0500000US12085|0500000US12086|0500000US12087|0500000US12099. Accessed 3/1/2019.

U.S. Census Bureau. 2017l. Supplemental Tables for Comprehensive Housing Market Analysis in U.S. Virgin Islands. US Department of Housing and Urban Development State of the Cities Data Systems. Available: https://socds.huduser.gov/permits/. Accessed 3/1/2019.

U.S. Census Bureau. 2017m. Tenure by Telephone Service Available by Age: American Community Survey 1-Year Estimates: 2005 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/B25043/0400000US15|0400000US72|0500000US12011|0500000US12085|0500000US12086|0500000US12087|0500000US12099. Accessed 3/1/2019.

U.S. Census Bureau. 2017n. Tenure by Vehicles Available: American Community Survey 1-Year Estimates: 2005 to 2017. Available: https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_1YR/B25044/0400000US15|0400000US72|0500000US12011|0500000US12085|0500000US12086|0500000US12087|0500000US12099. Accessed 3/1/2019.

U.S. Census Bureau. 2018a. Annual Estimates of the Resident Population for Counties: April 1, 1997 to July 1, 2017. American FactFinder. Available: https://www.census.gov/data/datasets/2017/demo/popest/counties-total.html. Accessed 3/1/2019.

U.S. Census Bureau. 2018b. County Business Patterns: 2008 to 2016. Available: https://www.census.gov/programs-surveys/cbp.html. Accessed 3/1/2019.

U.S. Census Bureau. 2018c. Economic Census of Island Areas: 2002, 2007, & 2012. Census.gov. Available: https://www.census.gov/programs-surveys/economic-census/about/island-areas.html. Accessed 3/1/2019.

U.S. Census Bureau. 2018d. Self Employment. Non-Employer Statistics: 2004 to 2016. American FactFinder. Available: https://www.census.gov/programs-surveys/nonemployer-statistics.html. Accessed 3/1/2019.

U.S. Census Bureau. 2018e. Small Area Health Insurance Estimates Program. Available: https://www.census.gov/programs-surveys/sahie.html. Accessed 3/1/2019.

U.S. Census Bureau. 2018f. Small Area Income and Poverty Program. Available: https://www.census.gov/programs-surveys/saipe.html. Accessed 3/1/2019.

U.S. Department of Defense. 2018. Office of the Assistant Secretary of Defense for Sustainment. FY 2018 Base Structure Report. Available: https://www.acq.osd.mil/eie/BSI/BEI_Library.html. Accessed 3/1/2019.

U.S. Environmental Protection Agency. Undated. BEACON 2.0 (Beach Advisory and Closing Online Notification). Available: https://19january2017snapshot.epa.gov/waterdata/beacon-20-beach-advisory-and-closing-online-notification_.html. Accessed 3/1/2019.

U.S. Environmental Protection Agency. 2016. NPDES Electronic Reporting Rule Phase 2 Implementation Plan For USVI Department of Planning and Natural Resources. Available: https://www.epa.gov/sites/production/files/2017-12/documents/usvi_dpnr_npdes_electronic_reporting_rule_implementation_plan_12.21.2016.pdf. Accessed 3/1/2019.

U.S. Environmental Protection Agency. 2018a. Landfill Methane Outreach Program (LMOP). Project and Landfill Data by State. Available: https://www.epa.gov/lmop/project-and-landfill-data-state. Accessed 12/31/2018.

U.S. Environmental Protection Agency. 2018b. NPDES Permits Around the Nation. Available: https://www.epa.gov/npdes-permits. Accessed 12/31/2018.

U.S. Environmental Protection Agency. 2018c. TRI Explorer On-site and Off-site Reported Disposed of or Otherwise Released for Facilities in All Industries for All Chemicals. Available: https://www.epa.gov/triexplorer. Accessed 12/31/2018.

U.S. Environmental Protection Agency. 2019. Water Quality Assessment and TMDL Information-Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS). Available: https://ofmpub.epa.gov/waters10/attains_index.home. Accessed 1/24/2019.

U.S. National Park Service. 2019. Visitor Spending Effects – Economic Contributions of National Park Visitor Spending – Social Science. Available: https://www.nps.gov/subjects/socialscience/vse.htm. Accessed 3/1/2019.

U.S. Virgin Islands Bureau of Economic Research. 2016. Hotel Occupancy Rates. Available: http://www.usviber.org/hotel-occupancy-rates/. Accessed 3/1/2019.

U.S. Virgin Islands Department of Finance. 2018. Audited Financial Statements. Available: https://dof.vi.gov/reports/audited-financial-statements. Accessed 3/1/2019.

Van Beukering, P., W. Haider, E. Wolfs, Y. Liu, K. van der Leeuw, M. Longland, J. Sablan, B. Beardmore, S. di Prima, E. Massey, H. Cesar, and Z. Hausfather. 2006. The Economic Value of the Coral Reefs of Saipan, Commonwealth of Northern Mariana Islands. Cesar Environmental Economics Consulting, US Department of the Interior, National Oceanic Atmospheric Administration. Awards CRI-3, 4, and 5. Pp. 128 + Appendices.

Van Beukering, P., L. Brander, B. van Zanten, E. Verbrugge, and K. Lems. 2011. The Economic Value of the Coral Reef Ecosystems of the United States Virgin Islands. IVM Institute for Environmental Studies. Report number: R-11/06. Pp. 160.

Virgin Islands Electronic Workforce System. Undated. Unemployment Rates 2000-2017. Available: https://www.vidolviews.org/gsipub/index.asp?docid=668. Accessed 3/1/2019.

Visitflorida.org. 2019. Research. Available: https://www.visitflorida.org/resources/research/. Accessed 3/1/2019.

Williams, I. and H. Ma. 2013. Estimating Catch Weight of Reef Fish Species Using Estimation and Intercept Data from the Hawaii Marine Recreational Fishing Survey. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Pacific Islands Fish. Sci. Cent. Admin. Rep. H-13-04, 53 p.

World Bank Group. 2018a. Households and NPISHs Final Consumption Expenditure (current US$). Available: https://data.worldbank.org/indicator/NE.CON.PRVT.CD?locations = PR. Accessed 3/1/2019.

World Bank Group. 2018b. Unemployment. International Labour Organization, ILOSTAT database. Available: https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS?end=2017&locations=GU&start=2000. Accessed 3/1/2019.

World Bank Group. 2019a. GDP (Current $). Available: https://data.worldbank.org/country/puerto-rico. Accessed 3/1/2019.

World Bank Group. 2019b. International Tourism, Number of arrivals | Data. Available: https://data.worldbank.org/indicator/ST.INT.ARVL?locations = PR-AS-GU-MP-VI. Accessed 3/1/2019.

World Bank Group. 2019c. Physicians (per 1,000 people) | Data. Available: https://data.worldbank.org/indicator/SH.MED.PHYS.ZS. Accessed 3/12/2019.

WorldFish. 2019. ReefBase: A Global Information System for Coral Reefs. Available: http://www.reefbase.org. Accessed 3/1/2019.

World Travel & Tourism Council. 2019. WTTC Data Gateway. Available: https://tool.wttc.org/. Accessed 3/1/2019.

Wusinich-Mendez, D. and S. Holst. 2011. User's Guide for the NOAA Coral Reef Conservation Program MPA Checklist. NOAA Coral Reef Conservation Program. Silver Spring, MD.

Appendices

- Appendix A: Socioeconomic Survey: CORE Questions Template, National Coral Reef Monitoring Program, November 2014
- Appendix B: Mapping of NCRMP Socioeconomic Survey Indices by Jurisdiction
- Appendix C: First Indicator Development Workshops – Notes and List of Participants, July–August 2018
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- Appendix E: List of Species for Economic Impact of Coral Reef Fishing Indicator
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Appendix A: Socioeconomic Survey: CORE Questions Template, National Coral Reef Monitoring Program, November 2014

NOAA Coral Reef Conservation Program
National Coral Reef Monitoring Program
(NCRMP)
Resident Coral Reef
Survey OMB Control Number
XXXX-XXXX

CORE MODULE

Hello,

My name is_____We are only interested in obtaining your opinions on some important issues related to coral reefs and the environment in _____

Your participation is voluntary and will be kept strictly confidential. 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.

Public reporting burden for this collection of information is estimated to average 20 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Send comments regarding this burden estimate or any other suggestions for reducing this burden to _____.

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 Answer
Swimming/wading					
Snorkeling					
Diving (SCUBA or free diving)					
Waterside/ beach camping					
Beach recreation (beach sports, picnics)					
Boating					
Fishing					
Gathering of marine resources (lobsters, conch, seaweed, examples)					

SKIP PATTERN-- If respondent answers 'never' to 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 do you or 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

SKIP PATTERN -- If respondent answers 'never' then skip to question #5

4. Where do you get the fish or seafood 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. Other, please specify _____

PERCEIVED RESOURCE CONDITION

5. In your opinion, how are [jurisdiction's] marine resources currently doing? Please rank from very bad to very good.

	Very Bad	Bad	Neither Bad nor Good	Good	Very Good	Don't Know
Ocean Water Quality (clean and clear)						
Amount of Coral						
Number of Fish						

6. 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						

7. In the next 10 years, do you think the condition of the marine resources in [jurisdiction] 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 – Threats including climate change

8. 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 the [jurisdiction] from erosion and natural disasters.						
Coral reefs are only important to fishermen, divers and snorkelers.						
Healthy coral reefs attract tourists to [jurisdiction].						
Coral reefs are important to [jurisdiction] culture.						

9. How familiar are you with each of the following potential threats facing the coral reefs in <location>?

	Very Unfamiliar	Unfamiliar	Neither Familiar nor Unfamiliar	Familiar	Very Familiar	Not sure
Climate change						
Coral bleaching						
Hurricanes and other natural disasters						
Pollution (stormwater, wastewater, chemical runoff and trash/littering)						
Coastal/urban development						
Invasive species						
Too much fishing and gathering						
Damage from ships and boats						

10. Do you believe that the threats to coral reefs in <location> are:

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

ATTITUDES TOWARDS CORAL REEF MANAGEMENT STRATEGIES AND ENFORCEMENT

11. A Marine Protected Area is an area of the ocean where human activity is typically restricted to protect living, non-living, cultural, and/or historic resources. How familiar are you with Marine Protected Areas (MPAs)?

    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:

12. 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
MPAs protect coral reefs						
MPAs increase the number of fish						
There should be fewer MPAs in [jurisdiction]						
There should be more MPAs in [jurisdiction]						
There has been economic benefit to [jurisdiction] from the establishment of MPAs						
Fishermen's livelihoods have been negatively impacted from the establishment of MPAs in [jurisdiction]						
MPAs help increase tourism in [jurisdiction]						
The establishment of MPAs increases the likelihood that people will vacation in [jurisdiction]						
I would support adding new MPAs in [jurisdiction] if there is evidence that the ones we have are improving [jurisdiction's] marine resources						
I generally support the establishment of MPAs						

ATTITUDES OR LEVEL OF SUPPORT FOR CORAL REEF MANAGEMENT STRATEGIES

13. The following are proposed or existing management strategies used to manage the marine environment and specifically, to improve the protection of coral reefs in <location>. Please rate whether you oppose or support each regulation.

	Strongly Oppose	Oppose	Neither Support nor Oppose	Support	Strongly Support	Don't Know
Increased enforcement of existing rules/regulations						
Limits per person for certain fish species (size and amount)						
Stricter control of sources of pollution to preserve water quality						
More restrictions on construction practices to prevent sediment going to sea						
Limits on recreational use						

PARTICIPATION IN BEHAVIORS THAT MAY IMPROVE CORAL HEALTH

14. 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

15. Which of the following would you consider to be your top 3 sources of information about coral reefs and the environment in [jurisdiction]?

Interviewer checks the top 3 sources of information.

16. 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 [jurisdiction]? ***Respondent rates only the top 3 sources of information.***

Top 3	Sources	Very untrustworthy	Untrustworthy	Neither Trustworthy nor Untrustworthy	Trustworthy	Very Trustworthy	Very Trustworthy
	Newspapers, other print publications						
	Radio						
	TV						
	Internet						
	Friends and family						
	Community leaders						
	Government (jurisdictional)						
	Federal government agencies (NOAA, EPA)						
	Non-profit organizations						
	Other						

17. 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

18. How involved are you in making decisions related to the management of coral reefs in [jurisdiction]?
    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>.

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

20. What is your year of birth? _____

21. How long have you lived in [jurisdiction]?
    a. 1 year or less
    b. 2-5 years
    c. 6-10 years
    d. more than 10 years
    e. all my life

22. Including your primary language, please name each language you speak.
[interviewer should not read options below, but should allow respondent to answer]

a. English
b. Spanish
c. French
d. German
e. Italian
f. Portuguese
g. Arabic
h. Chinese
i. Japanese
j. Korean
k. Tagolog
l. Hindi
m. Hawaiian
n. Hawai‘i Pidgin English
o. Sāmoan
p. Chamorro
q. Carolinian
r. Creole
s. Crucian
t. Tongan
u. Other: Please list _____
v. No Response

23. What race/ethnicity do you consider yourself?

a. American Indian or Alaskan Native
b. Asian
c. Black or African American
d. Puerto Rican
e. Carolinian
f. Chamorro
g. Chinese
h. Cuban
i. Filipino
j. Japanese
k. White
l. Korean
m. Mexican
n. Native Hawaiian or other Pacific Islander
o. Samoan
p. Taino
q. Thai
r. Tongan
s. Vietnamese
t. Other/Mixed
u. No response
v. Hispanic or Latino

24. 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

25. 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

26. What is your occupation? [Open Ended] _____

27. 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 B: Mapping of NCRMP Socioeconomic Survey Indices by Jurisdiction

For more information, see Appendix A: Socioeconomic Survey: CORE Questions Template, National Coral Reef Monitoring Program, November 2014; or resources available through the NCRMP website: https://www.coris.noaa.gov/monitoring/socioeconomic.html.

Survey Index	Variable	FL	AS	HI	PR	GU	CNMI	USVI
Activity index	Swimming/wading	✓	✓	✓	✓	✓	✓	✓
	Snorkeling	✓	✓	✓	✓	✓	✓	✓
	Diving (SCUBA or free diving)	✓	✓	✓	✓	✓	✓	✓
	Waterside/beach camping	✓	✓	✓	✓	✓	✓	✓
	Beach recreation	✓	✓	✓	✓	✓	✓	✓
	Boating	✓	✓	✓	✓	✓	✓	✓
	Fishing	✓	✓	✓	✓			
	Gathering of marine resources	✓	✓	✓	✓	✓	✓	✓
	Outrigger canoe/fautasi		✓					
	Surfing		✓					
	Watersports (kayaking, paddleboarding, wind/kite surfing)	✓						✓
	Island/sandbar recreation	✓						
	Wave riding			✓		✓		✓
	Canoeing or kayaking			✓	✓	✓	✓	✓
	Spearfishing				✓			
	Fishing from shore					✓	✓	✓
	Fishing or harvesting from a boat or kayak					✓	✓	✓
	Jet skiing					✓		
Fishing index	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	✓	✓	✓	✓	✓	✓	✓
	To give to pastors and village leaders		✓					
	For tournament or competition	✓			✓			
Condition index and Last10 index	Ocean water quality (clean and clear)	✓	✓	✓	✓	✓	✓	✓
	Amount of coral	✓	✓	✓	✓	✓	✓	✓
	Number of fish	✓	✓	✓	✓	✓	✓	✓
	Amount of animals for gleaning		✓					
	Beach quality	✓				✓		
	Mangroves	✓						
	Diversity of fish			✓	✓			

Survey Index	Variable	FL	AS	HI	PR	GU	CNMI	USVI
	Size of fish			✓				
	Amount of seagrass and mangroves				✓			
	Number of turtles					✓		
	Health of coral							✓
	Amount of marine debris or trash							✓
	Number of trochus (aliling)						✓	
	Number of sea cucumbers (balati)						✓	
Threat Familiarity index	Climate change	✓	✓	✓	✓	✓	✓	✓
	Coral bleaching	✓	✓	✓	✓	✓	✓	✓
	Hurricanes (or typhoons) and other natural disasters	✓	✓	✓	✓	✓	✓	✓
	Pollution	✓	✓	✓	✓	✓	✓	✓
	Coastal/urban development	✓	✓	✓	✓	✓	✓	✓
	Invasive species	✓	✓	✓	✓	✓	✓	✓
	Too much fishing and gathering	✓	✓	✓	✓	✓	✓	✓
	Damage from ships and boats	✓	✓	✓	✓	✓	✓	✓
	Crown of thorn starfish outbreaks (alamea)		✓					
	Beach renourishment	✓						
	Snorkeling and diving	✓						✓
	Impacts from recreational activity (trampling of reefs, anchor damage)			✓	✓			
	Ocean acidification			✓				
	Coral diseases				✓			
	Trash/littering					✓	✓	✓
	Sediment runoff into the ocean from fires					✓		
	Damage from small watercrafts					✓		
	Erosion/sedimentation, sediment runoff						✓	
Management Support index	Limits per person for certain fish species (size and amount)	✓		✓	✓			
	Stricter control of sources of pollution to preserve water quality	✓			✓			
	More restrictions on construction practices to prevent sediment going to sea	✓					✓	✓
	Ban on fishing “big fish” species including bumphead parrotfish, humphead wrasse, giant grouper		✓					
	Expansion of Fagatele National Marine Sanctuary		✓					
	Establishing community-based village MPAs		✓					
	Establishing permanent no-take MPAs		✓					

Survey Index	Variable	FL	AS	HI	PR	GU	CNMI	USVI
	Establishing areas with temporary fishing closures		✓					
	Law enforcement of existing rules/regulations	✓		✓				
	Community participation in management	✓		✓	✓			
	Seasonal openings/closures of fisheries	✓		✓				
	Restrictions on coastal development	✓						
	Marine zoning	✓		✓				
	Designated MPA	✓		✓				
	Limited use for recreational activities	✓		✓	✓			
	Restricted access	✓						
	No-take zones	✓		✓				
	Better regulation of land use practices to prevent sediment from going to sea			✓				
	Gear restrictions for fishing			✓				
	Better treatment of wastewater			✓				
	Establishment of a non-commercial fishing license			✓				
	Increased surveillance and law enforcement				✓			
	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					✓		
	Impose a license requirement and fee for land-based recreational fishers							✓
	Charge a small fee to non-residents visiting locally managed MPA to fund conservation						✓	✓
	Increased enforcement of wastewater and stormwater regulations to preserve water quality						✓	✓
	Amending building regulations to consider sea level rise and climate impacts							✓
Positive perception of MPAs index	MPAs protect coral reefs		✓		✓	✓	✓	✓
	MPAs increase the number of fish		✓		✓	✓	✓	✓
	There should be more MPAs in the jurisdiction		✓		✓	✓	✓	✓
	There has been economic benefit to the jurisdiction from the establishment of MPAs		✓		✓	✓	✓	✓

Survey Index	Variable	FL	AS	HI	PR	GU	CNMI	USVI
	I would support adding new MPAs in the jurisdiction if there is evidence that the ones we have are improving the jurisdiction's marine resources		✓		✓	✓	✓	✓
	I generally support the establishment of MPAs		✓		✓	✓	✓	✓
	I generally support the establishment of the federally managed Mariana Trench						✓	

Appendix C: First Indicator Development Workshops – Notes and List of Participants, July–August 2018

National Coral Reef Monitoring Program: Socioeconomic Indicator Development Webinar Series – Round 1

Expert Panel on Attitudes, Perceptions, and Behaviors Indicators (July 27, 2018)

Participants:

- Experts:
  - Chris Wynveen (Baylor University)
  - Dalton Helsey (University Miami)
  - Dr. Gary Green (University of Georgia)
  - Kirsten Oleson (University HI-Manila)
  - Kirsten Leong (Pacific Island Fisheries Island Center)
  - Nadine Heck (University of California Santa Cruz)
- NOAA: Jarrod Loerzel, Matt Gorstein, Chloe Fleming, Peter Edwards
- Abt Associates: Kelly Peak, Susan Taylor, and Claire Goydan

Notes:

Indicator 1: Participation in reef activities

Discussion question: *Is this the right data? Any other secondary sources we should be considering?*

Participants generally agreed that the existing questions related to participation in reef activities were appropriate. They agreed that the questions are useful but in some cases are not specific enough to reefs (e.g., "recreation activities"), and in other cases may miss interactions with marine resources more generally. One participant was concerned that question structure may prime participants to think about coral reefs in a specific way (e.g., generate some sort of desirability bias). One participant also noted that it would be useful to know the extent to which participants undertook harvest versus non-harvest (e.g., catch and release) activities.

Indicator 2: Perceived resource condition

Discussion question: *Is this the right data? Any other secondary sources we should be considering?*

Participants generally agreed with the data, but one participant noted that crowd sourcing questions would be a useful addition.

Indicator 4: Awareness and knowledge of coral reefs

Discussion question: *Is this the right data? Any other secondary sources we should be considering?*

Participants noted that questions may receive different responses if you ask whether "water quality is an issue for them, the ecosystem, or the region." Participants also noted that it will be useful to understand why people are concerned about coral reefs. Another participant noted that understanding awareness of disease is important, too.

Indicator 9: Cultural importance of reefs

Discussion question: *Is this the right data? Any other secondary sources we should be considering?*

Participants discussed trade-offs between open ended and closed form questions. Some participants also

noted the value of exploring place attachment literature and to investigate the PIFSC Community Profiles – Technical Memoranda.

Discussion questions: *Are there additional cultural data variables that should be considered? How do we gather more qualitative (rather than spatial or quantitative) aspects of culture in a consistent way?* Participants discussed place-attachment surveys, and other information available through citizen science and other outlets (e.g., Coral Restoration Consortium for FL).

Indicator 10: Participation in behaviors that may improve coral reef health

Discussion questions: *Is this the right data? Any other secondary sources we should be considering? What type of behaviors have a relevant impact on coral reef health?*

Participants provided feedback that it would also be useful to ask about indirect effects, and also to get information about behaviors that arise upstream (e.g., homeowners upstream).

Indicator Development Methodology

Discussion questions: *Which variables should be weighted more/less heavily? Is one indicator sufficient or is there a need for multiple indicators? Should we consider creating Uber or grouped indicators?*

Participants noted that the right variable depends on the question, and some participants also noted that collapsing or combining variables loses information. One participant suggested looking at the Great Barrier Reef Report card as an example.

Expert Panel on Economic Indicators (July 30, 2018)

Participants:

- Experts:
  - Amy Freitag (Oxford Lab in MD, works on FL Keys project looking at economic impact of new management scheme)
  - Gabe Sataloff (NOAA Office for Coastal Management, geospatial analyst, ENOW)
  - Jen Raynor (economist in Pacific Islands Science Center)
  - Kirsten Oleson (Professor at University of Hawai‘i, economic impacts on Palau National Marine Sanctuary, working with Hawai‘i team on 30x30 initiative)
  - Scott Crosson (NMFS, commercial and recreational fisheries in Caribbean and Florida)
  - Giselle Samonte (economist at Office of Habitat Conservation)
  - Maya Ward (Hawai‘i Coral Reef Initiative, PhD student at UH, 30x30 initiative)
  - Nadine Heck (research scientist at UC Santa Cruz)
- NOAA: Jarrod Loerzel, Matt Gorstein, Chloe Fleming, Peter Edwards
- Abt Associates: Kelly Peak, Susan Taylor, and Miranda Marks

Notes:

Indicator 6: Economic impact of coral reef fishing to jurisdiction – Data

Discussion question: *Is this the right data? Any other secondary sources we should be considering?*

Participants noted that MRIP doesn't completely capture subsistence fishing. Participants also noted that both ENOW and ENOW Self-Employed should be utilized, and that recreational fishery data is under the Ocean Recreation/Tourism files. Participants agreed that separating reef and bottom fish from all species was a valuable step. Participants also agreed that there is a limitation associated with splitting out reef fish from a broader set of species. The discussion also acknowledged the challenges associated with consistency across regions.

Indicator 7: Economic impact of dive/snorkel tourism to jurisdiction – Data

Discussion question: *Is this the right data? Any other secondary sources we should be considering?*

Participants generally agreed that the ENOW recreation data was a reasonable source for recreation-related data, and identified tourism-office expenditure information as another useful source of data (e.g., survey being done in Hawai‘i on snorkel/dive tourism). Note that expenditure surveys do not reflect non-market value of reefs. One participant also noted that increasing tourism may decrease value of reef to residents. There was some discussion of scaling down overall tourism to reflect reef-related tourism.

Refining Data

Discussion questions: *Which variables are most relevant and reflective of the economic impacts of coral reefs in each jurisdiction? Is it more informative to understand the absolute size of the coral reef economy across regions, or to understand how the economy changes in importance within a jurisdiction?*

Participants agreed better to control for relative size of economy and show normalized figures.

Indicator Development Methodology

Discussion questions: *Which variables should be weighted more/less heavily? Is one indicator sufficient or is there a need for multiple indicators? Should we consider creating Uber or grouped indicators?*

Participants identified sources of information related to social and resilience indicators, and one participant noted that value of taking a composite estimate and breaking it down into smaller pieces.

Expert Panel on Management Indicators (July 30, 2018)

Participants:

- Experts:
  - Chris Wynveen (Baylor University researching human dimensions of resource management, stakeholder involvement and public outreach)
  - Kirsten Oleson (University of Hawai'i, economics professor)
  - Kirsten Leong (Social Scientist with NOAA fisheries and Pacific Island Fishery Science Center)
  - Maya Ward (Hawai'i Coral Reef Initiative, Economics PHD student at University of Hawai'i at Manoa)
  - Nadine Heck (Research Scientist at the University of California Santa Cruz)
  - Supin Wongbusarakum (Pacific Island Fishery Science Center in Honolulu, Pacific Islander Coordinator for the Global Modeling Network, build capacity and support economic monitoring)
- NOAA: Jarrod Loerzel, Matt Gorstein, Chloe Fleming, Peter Edwards
- Abt Associates: Kelly Peak, Susan Taylor, and Sara Sokolinski

Notes:

Indicator 3: Attitudes toward coral reef management strategies and enforcement

Discussion question: *What types of data should feed into these indicators?*

Participants discussed the use of the MPA survey and what benefits it captured. It captures the managerial and economic benefits and not the biological and physical benefits. A participant asked how do we value cultural/heritage benefits. For example, Micronesia experience shows the importance of incorporating the local knowledge and community input into management. There was a question on traditional knowledge in American Samoa and CNMI. Local partners wanted the question, but it does not mean the same thing in different jurisdictions. A participant suggested using the phrasing "way of life."

Participants asked if there was a way to ask people what they want/expect from management. However, it was pointed out that most people don't know which agency is responsible for managing different resources. For example, people confuse state fisheries with NOAA. In Florida a question was asked about familiarity with different organizations, but that does not necessarily translate to knowing what they do.

Participants discussed how the needs of this ecosystem approach are met. Survey questions must balance between the average person and key/minimal resource users. Questions could gauge the public's knowledge of ecosystem approaches but must be worded carefully. However, a participant pointed out that it is the individual responses that make it an ecosystem approach. Questions should include maps and being very clear on boundaries and what is being asked. Specific boundaries were not presented because they would change from year to year. Questions were asked more generally on opinions on zoning and MPAs. Some jurisdictions (Florida) pushed back against using the terminology MPA which limited some questions from being included.

Indicator 12: Awareness of coral reef rules and regulations

Discussion question: *Are there additional, relevant rules and regulations related to coral reefs in the jurisdictions (beyond MPAs) that should be considered?*

A participant asked about questions on how people protect coastal resources. There were questions on how involved in management people were. The participant pointed out there are many informal/ traditional rules and will forward on a tool for Pacific Islands for MPA management questions.

Indicator 13: Governance

Discussion question: *What governance topics are most relevant to coral reef conservation?*

Participants discussed the need to define MPA clearly. In the survey it is defined as an area of the ocean where human activity is restricted to protect living, nonliving, cultural, and/or historic resources. However, secondary sources use NOAA's definition which limits most if not all of local, smaller areas. A participant suggested that state agencies should have maps of these and they could send one for Hawai'i. This has already been done by NOAA, but there are significant gaps in small scale MPAs.

A participant suggested GIS data could be combined with biological data to create effectiveness measures over time rather than static. Time series biological data would be needed. Another participant suggested asking performance questions on whether their voice was involved in decision making or that the agencies are transparent. One participant suggested looking into violations or citations. This is difficult to interpret because no citations could be caused by high compliance or low enforcement. When correlated with budgets, more citations could be overzealous officers. Employment is a good proxy and employment officers per unit area could be reflective of employment investments. Law enforcement can be hard to deal with because they don't all report to the same place.

A participant also suggested the investment of division of land and natural resources as percentage of state government budgets. This would require bounding the number of local institutions. NOAA asked should this be institutions raising awareness for wetland restoration, coastal development, or entirely coral reef specific. Participants suggested anything related to watersheds would be extremely related and that categorical weighting could be used. For the weighting, participants suggested asking local managers what the top issues affecting the jurisdiction. A participant also noted that University of Hawai'i is collecting information and mapping environmental groups.

Indicator Development Methodology

Discussion questions: *Which variables should be weighted more/less heavily? Is one indicator sufficient or is there a need for multiple indicators? Should we consider creating Uber or grouped indicators?*

Different indicators will use different methods depending on what suits each best. A participant cautioned calculation of an additive index. The weighting will be based on decisions on the theoretical foundation done by Abt literature review and expert opinion. Participants discussed the bias in weighting using expert opinion. For example, management perspectives will weight differently than other stakeholders. A participant stated that a theoretical model would be superior and sent along an article on trust and management. Another participant suggested looking for more literature on tracking intangible benefits.

Expert Panel on Stressor Indicators (August 28, 2018)

Participants:

- Experts:
  - Kirsten Leong (Social Scientist with NOAA PIFSC)
  - Stephanie L. Wear (TNC)
  - Peter Schuhmann (UNCW)
  - Michael Schuett (Texas A&M)
  - Sarah Cooley (Ocean Conservancy)
  - Ranjan Muthukrishnan (University of Minnesota)
  - Amy Freitag (NOAA)
  - Alastair Harborne (FL International University)
  - Kelly Biedenweg (University of Washington)
  - Liz Shaver (TNC/Reef Resilience Network)
  - Jessica Levy (Coral Reef Foundation)
- NOAA: Jarrod Loerzel, Matt Gorstein, Chloe Fleming, Seann Regan
- Abt Associates: Kelly Peak, Susan Taylor, and David Cooley

Notes:

Indicator 5: Human population change near coral reefs

Discussion questions: *Key population demographics? Time to observe change/signal? Data sources? Response to findings in papers? Use finer resolution data (block group) to identify populations physically closest to reef? And/or appropriate distances/buffers? Limitations of ACS and World Bank Data?*

Bruno et al. Paper:

One participant suggested that this paper is not widely accepted in the coral reef ecology community because of the wide population grid used and other issues. There is an alternative paper from Scripps (Jennifer Smith) that a participant said they would sent to us that uses Reef Risks population numbers as a proxy. A participant pointed out challenges associated with the use of county-level data, rather than a finer resolution, such as Census block. Another participant stated that ACS monthly data can be a problem because it's a moving target and that Census block data also has its limitations. Participants suggested that watershed-level data could be the most useful and has been used in other work. However, although USGS provides data on watersheds, they do not align well with social datasets, such as population.

Participants suggested capturing rates of tourism, both air and cruise travelers. A participant mentioned the Bob Leeworthy studies from the Caribbean and/or Florida Keys. NOAA staff mentioned having some tourism data. A participant has a questionnaire of people with boat registrations, with questions such as how often do they take their boats out, where do they go, etc.

Indicator 8: Community well-being

Discussion questions: *Which variables should be downloaded annually to better understand linkage between social conditions and reef health? Which variables are the leading or most relevant for indicator development? Are there any important variables missing?*

Participants discussed data and variables to include. All datasets are important and this cannot be condensed to 1 or 2. Homeownership is not best and disparity or economic status would be better. It is good to have a suite of variables. Perhaps include a measure of governance or corruption. Each jurisdiction would could have a different key indicator. A PCA analysis would not be the same across jurisdictions. For social, a participant suggested voting or church participation and/or number of churches

per 1,000 people. However, a participant pointed out there could be major religious that skew things. Another participant suggested number of community centers or environmental organizations. A participant cautioned using Dillard et al./U.S.-centric data. For example, what constitutes community well-being and security does not necessarily translate across jurisdictions.

Indicator 11: Physical infrastructure

Discussion questions: *What types of infrastructure have the most relevant impact on coral reef health? Is this the right data? Other sources that should be considered? Local stressors: Largest impact on coral reefs? Impact change by jurisdiction? Distance or buffer for impact area?*

Recreational fishing needs to be captured and a participant suggested looking at the size/location and structure of marinas or maybe number of boats or number of gasoline pumps. Another suggested including how many boats and gear are in the water. Participants also suggested looking at industrial activities such as mining and sand dredging, finding data on infrastructures with pipes such as sewers, and reviewing the characterization of the sewer quality, infrastructure and improvements. (Ex. Are there overflow systems? EPA or local water/environmental agencies may have this). Another suggestion was collecting data on building permits, noting that there is a wide range in geology and topography across jurisdictions (water and sediment flow). Assuming newer facilities are less bad than older facilities (WWRP/landfills; quality vs quantity), look at the age of infrastructure and regulations when it was built. Participants mentioned tourism and the number of beds available (from tourism boards) or tourism stress/degradation (number of dive charters and their behavior).

Participants discussed coastal development and whether industrial or tourism made the most impact. Average incomes could inform development types as not all industries are the same. Sewage and water quality measures could be used but actual discharge data from septic systems is better. Finally, one participant suggested analyzing data on rainfall patterns and impermeable surfaces in each jurisdiction.

Indicator Development Methodology

Discussion questions: *Which variables should be weighted more/less heavily? Is one indicator sufficient or is there a need for multiple indicators? Should we consider creating Uber or grouped indicators?*

Resilience indicator literature has lots of discussion on how to combine indicators. There have been lots of working groups convened to tackle same issues. There are merits to statistical analysis types mentioned but sometimes better to keep it simple; easily read and translated.

Appendix D: Second Indicator Development Workshops – Notes and List of Participants, December 2018

Final Webinar: Developing Socioeconomic Indicators for NOAA's National Coral Reef Monitoring Program, Session 1 (December 13, 2018)

High level questions for experts: Are we using best available data? Appropriate variables? Is the indicator construction consistent with other efforts you're aware of? Is any data you're aware of available for multiple locations?

Participants:

- NCRMP NOAA staff:
  - Peter Edwards: NOAA Coral Reef Conservation Program
  - Jarrod Loerzel: Hollings Marine Laboratory, Data support, acquisition, cleaning and analysis for NCRM
  - Matt Gorstein: Hollings Marine Laboratory, natural resource economist on NCRM Socio team
  - Chloe Fleming: Hollings Marine Laboratory, National Centers for Coastal Ocean science providing support to program
  - Arielle Levine: NOAA Coral Reef Conservation Program
- Experts:
  - Chris Wynveen: Baylor University, stakeholder engagement, coastal communities, national parks national marine sanctuary
  - Danika Kleiber: James Cliff University with the excellence and coral reef studies, previously with NOAA in Hawai'i office
  - Jen Raynor: Hawai'i NOAA office, economist
  - Jennifer Zhuang: Economist on the Social economic team at the office of coastal management
  - Jon Day: Microphone did not work
  - Scott Crosson: NOAA Southeast Fishery Science Center, economist with work in Florida and US Caribbean
  - Kirsten Leong: Social scientist at NOAA PIFSC
  - Melissa Poe: Washington sea grant social scientist, liaison with NOAA NW Fishery Science Center, integrated ecosystem assessment with wellbeing indicators with NOAA
  - Nathan Bennett: University of British Columbia, human dimensions research for focuses on MPA, Coastal areas, small-scale fisheries, community adaptation etc.
  - Peter Wiley: economist with NOAA Office Coastal Management
  - Siddharth Narayan: coastal engineer UC Santa Cruz, nature based solutions and adaptations, coastal risk
- Abt Team:
  - Kelly Peak: Project manager
  - Dave Mills: natural resource economist
  - Megan O'Grady: governance indicator
  - Liz Mettetal: economist, tourism and fisheries econ indicators
  - Claire Goydan: governance support
  - Susan Taylor: worked and reviewed different aspects of project
  - Sara Sokolinski: research assistant: data collection well-being and econ indicators

Notes:

The presenters walked through the current indicators, describing the methodology, data sources, results and implications. In general, participants agreed with the data sources utilized and did not suggest

additional sources. Participants generally noted the limitations of performing data transformations on the raw data, which the Abt Team agreed is a limitation of this exercise. Both Abt and the participants also discussed how different transformations can demonstrate a different story – for example, normalizing variables will provide a sense of the relative importance of the variable to the local economy but does not show the absolute differences across regions. Presenters and participants also noted that the more complex the transformation, the harder it is to refer back to the raw inputs. A general theme of the conversation was the challenge associated with interpreting the indicator values, which are based on an aggregation of data streams. Another general theme was that of missing variables, which was more relevant for non-survey based variables. Finally, participants suggested that different uses may require different organization of the data.

Final Webinar: Developing Socioeconomic Indicators for NOAA's National Coral Reef Monitoring Program, Session 2 (December 17, 2018)

High level questions for experts: Are we using best available data? Appropriate variables? Is the indicator construction consistent with other efforts you're aware of? Is any data you're aware of available for multiple locations?

Participants:

- NCRMP NOAA staff:
  - Jarrod Loerzel
  - Matt Gorstein
  - Chloe Fleming
- Experts:
  - David Gill: Duke University
  - Gabe Sataloff: NOAA Office for Coastal Management
  - Maria Dillard: National Institute of Standards and Technology (NIST)
  - Kurtis Gregg: NOAA Fisheries, Southeast Regional Office
  - Supin Wongbusarakum: NOAA Pacific Islands Fisheries Science Center (PIFSC)
  - Dana Wusinich-Mendez: NOAA Coral Reef Conservation Program
  - Helena Antoun: DNER, Caribbean Fisheries Management Council, PR
  - Giselle Samonte: NOAA NMFS Office of Habitat Conservation
  - Susie Holst: NOAA CRCP
  - Manoj Shivlani: University of Miami
  - Paulo Maurin: NOAA Coral Reef Conservation Program, Hawai'i
  - Melissa Watkinson: University of Washington
  - Matheus De Nardo: World Wildlife Fund
  - Becky Twohey: Coral.org
  - Laura Warmuth: Duke University
- Abt Team:
  - Kelly Peak
  - Dave Mills
  - Megan O'Grady
  - Liz Mettetal
  - Claire Goydan
  - Susan Taylor
  - Sara Sokolinski

Notes:

The presenters walked through the current indicators, describing the methodology, data sources, results and implications. Presenters agreed with comments on using the reference year, indexing and normalizing. A common theme in the feedback was the difficulty in disentangling various drivers of specific variation, and that there may be advantages to letting the data stand on its own rather than aggregating it. We discussed various options for weighting the variables. Participants also noted that there is significant variation in data quality among sources and across jurisdiction, which is a noted caveat for this process. Another theme that came up was that there may be significant spatial variation within the districts that is difficult to tease out. It was agreed upon to separate residents and visitors for the human population trends indicator, so as to tell each story individually. It was also agreed upon to weight each sub-category of community well-being equally as it can get largely subjective to rate any sub-category as more important than another. For similar reasons, it was agreed upon to weight each topic addressed by the MPA checklist equally when calculating the governance indicator. It was also suggested to better

separate out commercial fisheries landings and revenue data for the five South Florida counties, rather than the entire state of Florida. A final thought proposed by participants centered on the use of a "confidence ranking," taking into account the quantity and quality of available data comparable across the jurisdictions, in order to lend necessary context to the final results.

Appendix E: List of Species[6] for Economic Impact of Coral Reef Fishing Indicator

Table E-1: List of Pacific Species Used

Amberjack	Giant clam	Onespot snapper	Spadefish
Angelfish	Giant coral trout	Orange spotted trevally	Spiny lobster
Bandcheck wrasse	Giant grouper	Orangespine unicornfish	Spiny pufferfish
Bandtail goatfish	Giant trevally	Oriental sweetlips	Spotted grouper
Barred flagtail	Glasseye snapper	Other butterflyfishes	Squaretail grouper
Bigeye bream	Goatfishes	Other damselfishes	Squid
Bigeye emperor	Gold banded fusilier	Other goatfishes	Squirrelfishes
Bigeye squirrelfish	Goldenline bream	Other hawkfishes	Stareye parrotfish
Bigeye trevally	Goldring sureonfish	Other jacks	Steephead parrotfish
Bigscale soldierfish	Goldspot trevally	Other scorpionfishes	Stingrays
Bird wrasse	Greasy grouper	Other sea chubs	Stocky hawkfish
Black jack	Greater amberjack	Other skates/rays	Striped grouper
Blackeye thicklip	Groupers	Other soldierfishes	Surge wrasse
Blackspot sergeant	Hexagon grouper	Other surgeonfishes	Surgeonfishes
Blacktail snapper	Highfin rudderfish	Other wrasses	Surgeonfishes/tangs
Blacktip grouper	Honeycomb grouper	Parrotfishes	Swarthy parrotfish
Bloch's bigeye	Humpback snapper	Peacock grouper	Sweepers
Blubberlip, Harry hotlips	Humphead parrotfish	Pomfret	Sweetlips
Blue kingfish trevally	Humphead wrasse	Porcupinefish	Tagafi (red snapper)
Blue lined snapper	Inshore groupers	Puffers	Titan triggerfish
Bluebanded surgeonfish	Inshore snappers	Rabbitfishes	Tomato grouper
Bluefin trevally	Invertebrates	Rainbow runner	Trevallys
Blueline bream	Island jack	Rays	Triggerfishes
Bluespine unicornfish	Jack, almaco	Red crab	Triple tail wrasse
Bluestripe snapper	Jack, black	Redlip parrotfish	Trumpetfish
Brassy trevally	Jacks	Reef fishes (unknown)	Twinspot/red snapper
Bridled parrotfish	Japanese parrotfish	Rudderfishes	Unicornfishes
Brown-marbled grouper	Leopard coral trout	Runner, rainbow	White lyretail grouper
Butterflyfishes	Limpets	Saddleback grouper	White-edged lyretail
Camouflage grouper	Lobster, banded spiny	Scorpionfishes	Whitemouth trevally
Conger eels	Lobster, caribbean spiny	Sea chubs	Whitesaddle goatfish
Convict tang	Lobster, slipper	Sea cucumber	Whitespot parrotfish
Coral grouper	Lobsters	Sea urchins	Whitetip soldierfish

[6] Highly reef-associated species wholly or predominantly residing and foraging on the reef and all non-fish marine life and fish that use the reef, but do not predominantly reside on the reef.

Corals	Longnose parrotfish	Sergeant major	Wrasses
Cornetfish	Longspine grouper	Seven-11 crab	Ybanded grouper
Crabs	Manybar goatfish	Shellfish	Yellow banded grouper
Dark-capped parrotfish	Milkfish	Shrimp	Yellowband parrotfish
Dogtooth tuna	Minifin parrotfish	Shrimp (saltwater)	Yellowbarred parrotfish
Dragon wrasse	Mojarras	Shrimp, marine, other	Yellow-edged lyretail
Eels	Moray eels	Six-banded grouper	Yellowfin surgeonfish
Eight banded grouper	Napoleon wrasse	Slender grouper	Yellowmargin triggerfish
Emperors	Needlefishes	Slipper lobster	Yellowspot grouper
Filefishes	Netfin grouper	Smalltooth grouper	Yellowstripe goatfish
Flagtail grouper	Octopus	Snake eels	
Flounders	One-bloch grouper	Soldierfishes	

Table E-2: List of Atlantic Species Used

African pompano	Eagle ray family	Misty grouper	Shrimp,banded coral
Algae,green, ulotrichales	Echinoderm	Mojarra	Shrimp,cleaner
Almaco jack	Eel, conger	Mojarra family	Shrimp,pederson cleaner
Amberjack	Eel, morays	Moray family	Shrimp,peppermint
Amberjack genus	Eels	Mottled mojarra	Shrimp,pistol or snapping
Amberjack, greater	Eels, conger	Mutton snapper	Shrimp,spotted cleaner
Amberjack, lesser	Emerald parrotfish	Nassau grouper	Silk snapper
Anemone,speckled	Fileclam,rough	Neon goby	Silky shark
Angelfish family	Filefish,planehead	Night sergeant	Silver jenny
Angelfish,blue	Flagfin mojarra	Northern puffer	Silver porgy
Angelfish,french	Flamefish	Nudibranchs	Slender mojarra
Angelfish,gray	Florida pompano	Nurse shark	Slippery dick
Angelfish,queen	Flying gurnard	Ocean surgeon	Smallmouth grunt
Angelfishes	French angelfish	Ocean triggerfish	Smooth trunkfish
Atlantic bumper	French grunt	Octopus	Snapper caribbean red
Atlantic croaker	Frogfish genus	Octopus,common	Snapper family
Atlantic spadefish	Gag	Offshore lizardfish	Snapper genus
Atlantic stingray	Glasseye snapper	Orange filefish	Snapper, black
Atlantic tarpon	Goatfish	Orangespotted filefish	Snapper, blackfin
Balloonfish	Goatfish family	Painted wrasse	Snapper, cubera
Banded butterflyfish	Goby family	Palometa	Snapper, dog
Bandtail puffer	Goliath grouper	Parrotfish	Snapper, gray
Bandtail searobin	Gorgonian,sea blades	Parrotfish family	Snapper, grey (mangrove)

Bar jack	Gray angelfish	Parrotfish,blue	Snapper, lane
Batfish family	Gray snapper	Peacock flounder	Snapper, mahogany
Batfish,other	Gray triggerfish	Pearly razorfish	Snapper, mixed
Bearded brotula	Graysby	Permit	Snapper, mutton
Beauty,rock	Great barracuda	Pigfish	Snapper, other
Belted sandfish	Great hammerhead	Pinfish	Snapper, queen
Bermuda chub	Greater amberjack	Pinfish, spottail	Snapper, red
Bigeye	Green moray	Pipefish family	Snapper, schoolmaster
Bigeye family	Grouper genus (epinephelus)	Pipefishes	Snapper, silk
Bigeye mojarra	Grouper genus (mycteroperca)	Planehead filefish	Snapper, vermilion
Bigeye searobin	Grouper genus epinephelus	Plant,caulerpa	Snapper, yellowtail
Bighead searobin	Grouper genus mycteroperca	Plant,mermaid's shaving brush	Snappers
Black drum	Grouper, black	Pluma porgy	Snook
Black durgon	Grouper, gag	Polka-dot batfish	Snook genus
Black grouper	Grouper, marbled	Pomfrets	Snowy grouper
Black jack	Grouper, misty	Pompano	Soapfish genus
Black margate	Grouper, mixed	Pompano, african	Southern eagle ray
Black sea bass	Grouper, other	Pompano, florida	Southern puffer
Black snapper	Grouper, red	Porcupinefish	Southern stingray
Blackear wrasse	Grouper, scamp	Porgy family	Spadefish,atlantic
Blackfin snapper	Grouper, snowy	Porgy genus calamus	Spadefishes
Blacknose shark	Grouper, warsaw	Porgy, jolthead	Spanish grunt
Blacktip shark	Grouper, yellowedge	Porgy, knobbed	Spanish hogfish
Blackwing searobin	Grouper, yellowfin	Porgy, littlehead	Spanish mackerel
Blenny,other	Grouper, yellowmouth	Porgy, red	Spinner shark
Blue angelfish	Groupers	Porkfish	Spinycheek scorpionfish
Blue chromis	Grunt family	Princess parrotfish	Spotfin hogfish
Blue parrotfish	Grunt genus	Puddingwife (wrasse)	Spotfin mojarra
Blue runner	Grunt, cottonwick	Puffer family	Spottail pinfish
Blue tang	Grunt, french	Puffer genus	Spotted burrfish
Bluehead	Grunt, white	Puffer genus sphoeroides	Spotted eagle ray
Bluespotted cornetfish	Grunts	Puffers	Spotted goatfish
Bluestriped grunt	Hairy blenny	Queen angelfish	Spotted moray
Bonefish	Hamlet,butter	Queen parrotfish	Spotted scorpionfish
Bonnethead	Hammerhead shark genus	Queen snapper	Spotted trunkfish
Boxfish genus	Hermit,thinstripe	Queen triggerfish	Squid
Boxfishes	Hermit,tricolor	Rainbow parrotfish	Squirrelfish family
Brittle star,serpent	Highfin goby	Rainbow runner	Squirrelfish genus
Brotula, bearded	Highfin scorpionfish	Red cornetfish	Squirrelfishes

Bull shark	High-hat	Red grouper	Star,black brittle
Bulleye	Hind, red	Red hind	Starfish
Burrfish genus	Hind, rock	Red hind grouper	Stoplight parrotfish
Burrfish,striped	Hogfish	Red porgy	Striped burrfish
Butterflyfish genus	Hogfish,spotfin	Redband parrotfish	Striped croaker
Butterflyfishes	Honeycomb cowfish	Redfin parrotfish	Striped grunt
Caesar grunt	Horse-eye jack	Redtail parrotfish	Striped mojarra
Calamus genus	Jack family	Reef croaker	Striped parrotfish
Cero	Jack genus	Reef shark	Surgeonfish genus
Chain moray	Jack, almaco	Rock beauty	Surgeonfishes
Chub,bermuda	Jack, bar	Rock hind	Tang,blue
Clinid family	Jack, crevalle	Rough triggerfish	Tarpon
Clown wrasse	Jack, horse-eye	Runner, blue	Tattler
Cobia	Jack, mixed	Sailors choice	Tiger grouper
Cocoa damselfish	Jack, other	Sand diver	Tiger shark
Combtooth blenny family	Jack, yellow	Sand perch	Tilefish, sand
Common snook	Jackknife-fish	Sand tiger	Toadfish family
Conch (snail) meats	Jacks	Sand tilefish	Toadfish genus
Conch (whelk, helmet)	Jawfish family	Sandbar shark	Toadfishes
Conch,crown	Jellyfish	Saucereye porgy	Tobaccofish
Conch,florida fighting	Jolthead porgy	Scalloped hammerhead shark	Tomtate
Coney	King mackerel	Scamp	Triggerfish, gray
Conger eel	Knobbed porgy	Schoolmaster	Triggerfish, ocean
Conger eel family	Ladyfish	Scorpionfish family	Triggerfish, queen
Coral,deepwater	Lane snapper	Scorpionfishes	Trumpetfish
Corals	Lemon shark	Scrawled cowfish	Trunkfish (boxfish)
Corals,ricordea florida	Leopard searobin	Scrawled filefish	Turban,chestnut
Cottonwick	Leopard toadfish	Sea bream	Turtles
Crab, deepsea golden	Lesser amberjack	Sea cucumber	Unicorn filefish
Crab,false arrow	Lionfish	Sea squirts	Urchin,green sea
Crab,furcate spider	Lionfish genus	Sea urchins	Urchin,purple-spined sea
Crab,green clinging	Lionfishes	Searobin family	Urchin,rock boring
Crab,nimble spray	Littlehead porgy	Searobin genus	Urchin,slate pencil
Crab,spotted porcelain	Live rock,ornamental aquaculture	Searobins	Vermilion snapper
Crab,yellowline arrow	Lobster, caribbean spiny	Sergeant major	Viper moray
Crabs,brachyura	Lobster, slipper	Shark, blacknose	Warsaw grouper
Crabs,hermit	Lobster, spanish	Shark, blacktip	Whelk, lightning
Creole-fish	Lobster, spiny	Shark, bonnethead	White grunt

Crevalle jack	Lobster,spanish	Shark, bull	Whitebone porgy
Croaker	Longspine squirrelfish	Shark, dusky	Whitespotted filefish
Croaker, atlantic	Lookdown	Shark, great hammerhead	Whitespotted soapfish
Cubbyu	Mackerel, cero	Shark, hammerhead	Wrasse family
Cubera snapper	Mackerel, king	Shark, lemon	Yellow chub
Cucumber,florida sea	Mackerel, king and cero	Shark, sand tiger	Yellow goatfish
Damselfish family	Mackerel, spanish	Shark, sandbar	Yellow jack
Devil ray	Mahogany snapper	Shark, scalloped hammerhead	Yellow stingray
Doctorfish	Manta	Shark, silky	Yellowedge grouper
Dog snapper	Mantis shrimps	Shark, spinner	Yellowfin grouper
Downy blenny	Marbled grouper	Shark, tiger	Yellowfin mojarra
Drum, black	Margate	Sharpnose puffer	Yellowhead wrasse
Dusky damselfish	Margate grunt	Sheepshead porgy	Yellowmouth grouper
Dusky shark	Midnight parrotfish	Short bigeye	Yellowtail snapper
Dwarf sand perch	Mimic blenny	Shrimp, royal red	

Appendix F: Outline for Governance Indicator

1. Summary

a) **Recurring messages** related to governing[7] coral reef habitat:
   i) Management and enforcement structures vary considerably across jurisdictions.
   ii) The regulatory framework also varies considerably by jurisdiction:
      (1) several jurisdictions have adequate rules "on the books" that *could* result in effective governance of coral reef habitat.
      (2) some jurisdictions lack adequate rules.
   iii) Adequate enforcement is a challenge everywhere. Jurisdictions identified one or more of the following enforcement challenges:
      (1) limited dedicated resources,
      (2) a lack of political will,
      (3) inadequate training or organization, or
      (4) a lack of commitment to enforcement or compliance.
   iv) Jurisdictions see improving coral reef education for residents[8] and visitors as one key to improving governance.

b) **Challenges and opportunities** for developing a quantitative governance indicator:
   i) *Challenge*: The variation in the management structures between jurisdictions severely limits the potential for consistent data that can be collected to inform development of a quantitative governance indicator, outside of a survey effort.
   ii) *Challenge*: Non-survey information is available that could be quantified but may miss important components of overall nature and impact of governance:
      (1) For example: Count the number of regulations applicable to or targeting coral reef habitat in each jurisdiction and track them over time, but the impact of a change in the number of regulations has little direct bearing on governance without also recognizing potential changes in the commitment to enforcement (e.g., fewer regulations could be beneficial if paired with an improved commitment to enforcement).
   iii) *Opportunity*: Data collected through three rounds of the MPA Capacity Assessment Tool, commonly referred to as the "MPA Checklist", provides a systematic and consistent source of data to evaluate governance over time, although there are still limitations to this approach. (See Section 3 of this Appendix for more details).

c) Recommended **next steps:**
   i) Calculate a governance indicator based on the MPA Checklist results.
      (1) Abt team completed this and submitted the results to NOAA.
   ii) Identify gaps in the MPA Checklist and propose solutions for future iterations of the Assessment Tool (See Section 3 of this Appendix for more details).

2. Jurisdiction summary notes

a) Background about calls:

[7] We have been presenting and defining the governance indicator in our calls to encompass the regulatory, educational, and enforcement activities in an area intended to preserve and improve the ecological health reef habitat to promote and sustain its long-term use by resident and visiting populations. As a result, *governance* and *management* were presented as effectively interchangeable in our conversations with representatives from the jurisdictions.

[8] *Residents* here can also include local commercial and recreational fishing and tour operators.

i) Spoke with the coral reef and/or fisheries liaison in each of the 7 jurisdictions in the NOAA Coral Reef Conservation Program (CRCP)
ii) Calls occurred between September 13 and October 17, 2018.
iii) The calls were informal discussions guided by the call objectives and facilitated by Abt Associates.
iv) Table 1 lists the jurisdiction representatives who participated in each call.

Table 1. Summary of local participation in jurisdiction-specific calls

Jurisdiction	Participants	Title	Affiliation	Call date
Commonwealth of the Northern Mariana Islands (CNMI)	Robbie Greene	Coral & Coastal Liaison	NOAA	9/13/2018
	Jihan Younis	Coral Reef Initiative Education and Outreach Coordinator	CNMI Division of Coastal Resources Management, Bureau of Environmental and Coastal Quality	
	Steve McKagan		National Marine Fisheries Service Pacific Island Region Office	
Hawai'i	Paulo Maurin	National Education Coordinator and Fellowship Manager	NOAA Coral Reef Conservation Program (CRCP)	9/20/2018
American Samoa	Hideyo Hattori	Amerika Samoa Management Liaison	NOAA Coral Reef Conservation Program	10/3/2018
	Fatima Sauafea-Leau	Fishery Biologist/CRCP Fisheries Liaison	NOAA Fisheries - PIRO, Habitat Conservation Division, American Samoa Field Office	
Guam	Adrienne Loerzel	Coral and Coastal Zone Management Liaison, Guam	NOAA CRCP	10/17/2018
	Marybelle Quinata	Community outreach	NOAA Fisheries	
	Valerie Brown	Fisheries liaison	NOAA PIRO – Guam Field Office	
U.S. Virgin Islands	Marlon Hibbert	Coral reef liaison	NOAA CRCP	10/16/2018
	Ashley Ruffo	Fisheries liaison	NOAA CRCP	
Puerto Rico	Helena Antoun	Fisheries Liaison	DNER and Caribbean Fisheries Management Council	10/4/2018
Florida	Kurtis Gregg	Coral Reef Fisheries Biologist	NOAA Fisheries, Southeast Regional Office	10/2/2018
	Dana Wusinich-Mendez	Caribbean and Atlantic Coral Program Team Lead; NCRMP liaison to FL	NOAA CRCP	10/15/2018

v) Objectives of the calls:
(1) Provide an overview of NOAA's coral reef indicator project.
(2) Provide an overview of governance as defined in footnote #1 above to set the stage for a discussion of local governance of coral reef habitat.
(3) Gain a better understanding of local coral reef governance.
(4) Solicit opinions about what information a governance indicator should incorporate.

vi) Call structure:
(1) We did not have a standard set of questions for each discussion, but rather let the conversations flow organically.

(2) Following introductions, the Abt team began the conversations by requesting that the call participants provide us with an overview of local coral reef governance, including any challenges they face, considering:
  (a) Formal, informal, traditional, and modern ways of governance of affected resources and populations.
  (b) If effective governance be measured? If so, how?
  (c) How are local populations informed of existing regulations? Do they modify their behavior?
  (d) Issues related to enforcement, including who has the enforcement authority, how well regulations are enforced, and how well resourced enforcement agencies are.

b) High level summary of what we learned from the jurisdiction calls and resources

i) Three factors that influence governance[9]
  (1) Government Management:
    (a) Federal and state laws, regulations, and initiatives;
    (b) Type of management (MPAs, preserves, national parks, etc.);
    (c) Enforcement;
    (d) Fishing [licenses; regulations (take, seasonal, etc.); gear restrictions, etc.]; and
    (e) Political process (will, turnover, commitment, etc.).
  (2) Market Forces:
    (a) Tourism and
    (b) Commercial fishing.
  (3) Civil Society:
    (a) Local/regional level (e.g. NGOs) management efforts and initiatives;
    (b) Individuals/Residents [resident attitudes (behaviors, perception, support, etc.); individual enforcement; traditional and cultural beliefs]; and
    (c) Education and outreach efforts.

ii) The summary matrix organizes what we heard from the jurisdictions into three factors (Appendix D).

iii) Call notes provided in Appendix H.

c) Commonwealth of the Northern Mariana Islands (CNMI)

i) Take home messages[10]:
  (1) Strong public support for management and enforcement; strong traditional conservation values.
  (2) Relatively high level of management and enforcement:
    (a) CNMI has 7 MPAs, enforced by the Division of Fish and Wildlife (DFW) & Bureau of Environmental and Coastal Quality (BECQ);
    (b) CNMI shared 17 management-related documents with us; and
    (c) Management framework for MPAs is "very outdated" and doesn't address current conditions.
  (3) Increasing tourist pressure.

[9] This framework is based off of work done from 2011-2014 to assess the capacity of coral reef management by SustainaMetrix. See the project's summary report for additional information.

[10] These messages come from our conversations with the jurisdiction and review of the background material they provided.

(4) Notable of CNMI: part of the Micronesia Challenge, an agreement between CNMI, Guam, and others to effectively conserve 30% marine resources and 20% terrestrial resources across Micronesia by 2020.

ii) Call notes provided in Appendix H.

iii) Background documents provided and summary notes were provided to NOAA on Google Drive.

d) Hawai‘i

i) Take home messages:

(1) All waters (and therefore reefs) are under jurisdiction of the state, except for a portion of the low-lying atolls in the Northern part of Hawai‘i which also has some Federal management;

(2) Strong regulations for coral protection and many management efforts, but there is a low to medium level of commitment and enforcement;

(3) One of the biggest obstacles to effective management is the lack of data on the status and trends of many important resources and ecosystem components;

(4) Community-based management, including Community Based Subsistence Management Areas (native communities can apply to have more stewardship and management of the areas around them), has been effective in a number of locations; strong native sense of duty to protect reefs;

(5) HI tries to ensure that key socioeconomic and cultural concerns are well integrated in research and management;

(6) HI has 34 MPAS. The large number of restricted-access or restricted-fishing areas gives the impression of a substantial network of actively managed and protected marine areas, but the reality is that the majority of those areas are small (only 11% of HI ocean area is under any type of protection) and nearly all allow some or several forms of fishing within their boundaries (NOAA, 2008); and

(7) Hawai‘i does not require a fishing license for recreational fishing so they have no idea how many fish are being caught or of the actual level of effort as the lack of licenses prevents creel studies.

ii) Call notes provided in Appendix H.

iii) HI did not provide any additional background material.

e) Florida

i) Take home messages:

(1) Florida has 3 managed marine areas (Florida Keys National Marine Sanctuary, Tortugas Ecological Reserve, Biscayne National Park) and one management initiative (Southeast Florida Coral Reef Initiative).

(2) FL has a complex management structure that involved federal, state, and county level agencies. Southern two-thirds of the coral reef habitats are within areas that receive federal protection and management, everything else is state and county managed. Some of the agency partnerships (including between federal and state agencies, or state and local, etc.) work well; for others the coordination can be tricky and political.

(3) The Florida Department of Environmental Protection (DEP) has a coral reef program that governs the reef system in the Northern 1/3 of the reef habitat, but it does not have an enforcement arm.

(4) FL passed a state wide coral reef protection act in 2009 that makes it illegal to take or damage corals, but it is not well enforced. In March the FL legislature designed a

Southeast FL coral reef conservation area but it doesn't have any special management plan or policies (this addresses the Northern 1/3 of the coral habitat).

(5) FWC has enforcement officers but they can't get into the water so they can never verify take or reef damage. Officers are also poorly paid so there is a lot of turnover.

(6) Dana Wusinich-Mendez believes that the governance issues spring from a lack of proper training, experience and/or coordination versus not enough enforcement activity.

(7) In FL the regulations are often times too complex to effectively apply them, e.g., they have a different regulation for every different kind of species you can pull from the ocean (i.e., have season and harvest limits versus general restrictions on where the fishing can occur).

(8) Recreational fishery community has a strong legislative presence because they have sector backing so hire lobbyists to prevent creating protected areas; commercial fishing is limited by Guide Licenses and permits (i.e., captains have to pay for permits, but there is not a limit on permits); dive and snorkel operators just have to meet Coast Guard vessel operating requirements versus being permitted to interact with reefs.

(9) Surveys have shown a low level of understanding of general public awareness of good coral reef conservation practices and regulations.

ii) Call notes provided in Appendix H.

iii) Background documents provided and summary notes were provided to NOAA on Google Drive.

f) American Samoa

i) Take home messages:

(1) 42% of residents surveyed had a government sponsored marine management program in their village; 50% of them rated the programs as highly effective.

(2) Management structure includes several types of MPA programs (including village-level), a NOAA sanctuary program, and National Reef Park sites.

(3) In AS, there is a marine tenure system where the communities play a strong role in reef management and oversee a lot of their own resources.

(a) They have their own village by-laws and set their own boundaries.

(b) Coral reef programs have a strong community engagement component which helps also to address land-based impacts to reefs

(c) Deputize village leaders to help with enforcement

(d) Different models from 100% independent to a blend of local and federal support

(e) Some challenges but in general the community level management works well

(4) Main threats to reef are fisheries, climate change, and land-based pollution:

(a) Fisheries: There isn't much of a commercial fishery sector; not much trade in reef species. Artisanal and recreational fishing.

(b) Climate change: sea level rise, mass bleaching, Crown of Thorns sea star outbreaks, and more intense cyclones.

(c) Pollution: from human waste due to poor water management systems, leaching contaminants from legacy military installments, and pesticides from agriculture.

(5) Not many tourists on AS. Most are family or friends and so learn local rules. Those that do come mainly go to National Park. Villages have signed leases to National Parks and so there is an agreement about visitors' use of the resources in these areas.

ii) Call notes provided in Appendix H.

iii) Background documents provided and summary notes were provided to NOAA on Google Drive.

g) Puerto Rico

i) Take home messages:
   (1) In PR, corals are in state water. There are 40 MPAs, with 6 of the sites designated as no-take areas.
   (2) No local law enforcement. Also indirect enforcement issues, e.g., water quality, navigation. The will to carry through with enforcement is a bigger issue in PR than the lack of resources. They rangers are dedicated but haven't been able to secure the equipment they need to patrol. There is only one NOAA law enforcement officer in charge of the entire Caribbean but he recently retired.
   (3) One of the biggest pressures on reefs is recreational use of the reefs, lack of education among recreational users of the reefs. Some places are more aware (e.g., areas where the Sierra Club is partnering with communities). In many cases the material is available but it isn't being pushed into the communities. Only gets shared when someone asks for it. More reactive than proactive.
   (4) Commercial fishers don't believe science behind restrictions so they are not likely to follow them.
   (5) Recreational fishers are supposed to have a license but the infrastructure to issue and enforce licenses isn't in place.
   (6) In PR, traditional knowledge does not play a role in conservation.

ii) Call notes provided in Appendix H.

iii) Background documents provided and summary notes were provided to NOAA on Google Drive.

iv) Additional contacts (note: we did not speak with any of these individuals):
   (1) Eileen Alicea, a NOAA staff person who has worked extensively with DNER on issues regarding corals and law enforcement.
   (2) Tania Metz, DNER Coral Reef Program Coordinator
   (3) Ruperto Chaparro, Executive Director of Sea Grant Puerto Rico
   (4) Jose Rivera, NOAA Habitat Conservation Division

h) U.S. Virgin Islands

i) Take home messages:
   (1) Reefs are managed by the Department of Planning and Natural Resources, Division of Environmental Protection and the Division of Fish and Wildlife. In general the agencies work well together. USVI is a small community so that has an influence on how everybody works together.
   (2) They do have boundaries in place but there are maintenance issues; there is no budget to repair or maintain them.
   (3) Enforcement had gotten better for a time but then went through a rough leadership transition and they lost a lot of staff. Poor enforcement isn't the MPA managers' fault because they have no control over enforcement.
   (4) No informal community-based protection areas. In general, local population is skeptical of national parks because they see it as the federal government pushing their interests and not looking out for local interests.
   (5) There is a strong need for more public outreach and engagement.
   (6) No recreational fishing license.

ii) Call notes provided in Appendix H.

iii) Background documents provided and summary notes were provided to NOAA on Google Drive.

i) Guam

i) Take home messages:
   (1) A mix of protected areas owned mainly by territory, federal government (National Parks Service); the military; and some NGOs. Boundaries between federal and territorial areas aren't clear so there is spatial overlap. Instead of double the enforcement, these areas tend not to get any.
   (2) Territorial MPAs enforced; federal enforcement doesn't have any personnel or capacity largely because of past mismanagement that resulted in budget cuts.
   (3) Small community involved in MPA management and there are differences in management approaches.
   (4) No fishing license required.
   (5) There are fishing restrictions in many areas but people don't take them seriously because they're not well enforced. No effective recognition for native Chamorro people to fishing rights.
   (6) Locals are mostly aware of them of rules, but they won't follow them if they don't see other people following them. Tourists are the bigger concern; many don't speak English. Types of tourists have been changing from organized group tours to independent, less well-regulated tourists. Hotels are adverse about supporting educating tourists because they don't want anything to affect their guests' stay.

ii) Call notes provided in Appendix H.

iii) Background documents provided and summary notes were provided to NOAA on Google Drive.

j) Additional sources of information on local governance of coral reef habitat
   (1) Local contacts often recommended we review additional sources of information to help further understand their governance issues.
   (2) These additional resources are saved in the Google Drive, and also specifically linked by jurisdiction below.
   (3) If the resource is only available online then a link is provided in the call notes.

3. Governance Indicator: using data from the MPA Management Assessment Checklist to develop a quantitative indicator

a) Developed a quantitative indicator based on NOAA's Coral Reef Conservation Program MPA Management Assessment Checklist
   i) Checklist is a survey that has been administered in 2011, 2014, and 2017
   ii) In 2011 evaluated 14 assessment areas; in 2017, evaluated 19 assessment areas
   iii) Includes priority MPAs identified by every jurisdiction except Florida
   iv) Uses a tier ranking
      (1) Tier 1 represents a low score
      (2) Tier 3 represents a high score
   v) Assessment areas & tier values

Input Variables	Tier 1	Tier 2	Tier 3
Management Planning	Some management activity being implemented, but no management plan in place	Some management activity being implemented and management plan developed	Approved management plan that is being implemented

Input Variables	Tier 1	Tier 2	Tier 3
Ecological Network Development	Site is either not associated with a network or is part of an ecological MPA network but is not designed to support network goals and management is not coordinated across the network	Site is part of an ecological MPA network and site is designed to support the goals of an ecological network but management is not coordinated across the network	Site is part of an ecological MPA network, site is designed to support the goals of an ecological network and site management coordinated with other sites across the ecological network
Governance	Site has been legally established or is under equivalent customary tenure or other form of community-based protection status, but there are few or no official or community based rules and regulations in place supporting the MPA and its management plan	Laws or customary instruments for the establishment of the MPA are in place, and official or community based rules or regulations governing some specific activities within the MPA are also in place	Clearly defined laws or customary instruments and official or community based rules and regulations governing all specific activities included in the objectives of the site management plan are in place
On-Site Management	No management personnel assigned to site and/or little or no formalized community oversight	Some management personnel assigned to site or some formalized community oversight	Full-time site manager and programmatic personnel assigned to site or local community based management leader in place that has been formally designated and accepted and is able to dedicate sufficient time to the management of the site
Enforcement	Few or no established rules and regulations exist or there is little or no enforcement of existing rules and regulations	Inconsistent enforcement of rules and regulations	Active and consistent enforcement of rules and regulations
Boundaries	Lack of clearly defined boundaries and/or zones	Clearly defined boundaries and/or zones	Clearly defined boundaries and zones and information on boundary locations and permitted activities in various zones (if applicable) provided to public and MPA stakeholders
Biophysical Monitoring	Little or no existing biophysical monitoring activity	Existing biophysical monitoring program	Data produced from biophysical monitoring program being evaluated and used to inform management decisions
Socio-economic Monitoring	Little or no existing socioeconomic monitoring activity	Existing socioeconomic monitoring program	Data produced from socioeconomic monitoring program being evaluated and used to inform management decisions
MPA Effectiveness Evaluation	Little or no evaluation of MPA effectiveness	MPA effectiveness evaluated but no ongoing effectiveness monitoring and evaluation program in place	MPA effectiveness evaluated and effectiveness monitoring and evaluation program in place with findings being applied to adapt management strategies

Input Variables	Tier 1	Tier 2	Tier 3
Stakeholder Engagement	Little or no community and stakeholder engagement in management planning	Community and stakeholder engagement in management planning	Community and stakeholder engagement in management planning and implementation of site management efforts
Financing	Little or no reliable source of funding identified to support management activities	Existing funding for management activities	Sustainable finance plan being implemented that provides long term sustainable funding mechanisms
Outreach and Education	Little or no ongoing outreach and education activities exist	Ongoing outreach and education activities in support of the MPA	Existence of an outreach and education program with various activities and strategies focused on the MPA that helps achieve the MPA's goals and objectives
Conflict Resolution Mechanism	Little or no existing mechanism to resolve conflict with MPA stakeholders	Mechanism for conflict resolution with MPA stakeholders is available but is not being used and stakeholders are not aware of this mechanism	Mechanism for conflict resolution is available and MPA stakeholders are aware of and use this mechanism
Climate Change Resilience	Little or no consideration of climate change resilience in the management of the MPA	Management includes actions intended to increase the resilience of coral reef resources to the effects of climate change	Site is designed to increase resilience of coral reef resources to the effects of climate change and management includes actions necessary to avoid or minimize impacts and spread the risk due to climate change

vi) Advantages of this approach
  (1) Provides a time-series evaluation of coral reef governance
  (2) Allows NOAA to create a quantitative indicator

vii) Limitations of this approach & proposed solutions
  (1) *Gap:* Limited scope. The MPA checklist does not cover every MPA, only those prioritized by the jurisdiction. It also does not cover coral reefs areas outside the MPAs. Florida is completely excluded from the assessment, as it did not identify priority MPAs for the checklist.
    (a) *Solution 1:* Use the checklist for more, if not all, coral reef areas in each jurisdiction.
    (b) *Solution 2:* Include Florida
  (2) *Gap:* Self-assessment. The MPA manager or other MPA staff complete the checklist for their MPA. This does not always include the perspective of all parties familiar with the MPA.
    (a) *Solution 1:* Approach the checklist with a two pronged approach: conduct jurisdiction-wide meetings where a larger group of those involved with coral reef management in the jurisdiction come together to collectively discuss the checklist responses.
    (b) *Solution 2:* Collect anonymous responses from multiple people involved in MPA or coral reef management.
  (3) *Gap:* Identify the potential for additional questions on the next survey round
    (a) *Solution 1:* Identify a consistent person or position (or multiple positions) who could be regularly contacted to provide a response on a Likert scale for status of local reef governance.

(b) *Solution 2:* Conduct an informal gap assessment asking coral reef managers what questions should be included in the next checklist.

(4) *Gap:* New assessment areas added in 2017 – no time series data available for those questions.

(5) *Gap:* Complexity of governance issue is difficult to convey in a survey with pre-defined response options.

(a) *Solution 1:* Either as part of the survey, or potentially through other administrative reporting mechanisms to avoid issues with approval as part of a survey, develop either an open ended survey question or request an annual update on the status of coral reef governance in the jurisdictions that would ask respondents to summarize existing challenges, opportunities for improvement, and prioritize next steps. Can be short but creates a record that could be informative for management.

viii) Methods for creating governance indicator

(1) Draft of the quantitative indicator, including methods, delivered to NOAA on November 12 for review and comment.

Appendix G: Summary Matrix of Notes for Governance Indicator

These notes represent a summary collection of thoughts Abt heard during calls with the jurisdictions and key points that were extracted from the background documents (see Appendix F, Section 2.a, for additional details). These notes are organized around common themes within three factors that influence governance: government, market forces, and civil society (see Appendix F, Section 2.b, for additional details).

	Themes	CNMI	Hawai'i	Florida	Puerto Rico	American Samoa	USVI	Guam
Government	Federal and state laws, regulations, and initiatives	• State: Regulated by local division of DFW	• Strong regulations for coral protection • Federal: Marine Monument (COI/NOAA co-manage with Hawai'i) • Federal: government manages some of the northern atolls • State: DAR primarily responsible for waters directly around the islands. Shares jurisdiction with feds in northern atolls	• Participate in the US Coral Reef Task Force • FL Coral Reef Protection Act (2009) • FDEP: land and water quality; coral reef conservation program – this is what agencies use to govern the reefs • FWC: fish and animals; fisheries resources • SE FL coral reef ecosystem conservation area (March 2018), but it doesn't include a management plan	• DNER (corals are in state waters)	• Marine Sanctuary program managed by NOAA • National Reef Parks managed by the Federal National Parks	• Corals managed by Department of Planning and Natural Resources • Some authority also under the Division of Fish and Wildlife and Division of Environmental Protection	• In addition to traditional coral agencies, on Guam DOD is also involved because of military presence • Eco permit • MPA checklist

Themes	CNMI	Hawai'i	Florida	Puerto Rico	American Samoa	USVI	Guam
Type of management (MPAs, preserves, national parks, etc.)	• Federal: National Monument • Protected no-take areas • MPAs	• Marine Monument, World Heritage Site; Marine Life Conservation District	• Lower two-thirds of reef within Federal Protection; everything else managed by state/county • 3 managed areas (1 national marine sanctuary: Florida Keys National Marine Sanctuary, two national parks: Tortugas Ecological Reserve, Biscayne National Park) • 1 management initiative (Southeast Florida Coral Reef Initiative)	• Have 35 territory MPAs and 5 federal MPAs; 6 are no take	• Several MPAs, including community-based/village MPAs	• Federal: Virgin Islands National Park - covers ~2/3 of St. John and majority of water resources on island; Buck Island National Monument • Territorial: Marine parks • Several MPAs – mostly federal and territorial	• 5 territorial MPAs cover 10% of the coast line • Some questions about boundaries between federal and territorial protected areas because they aren't clearly mapped or defined and they overlap in some areas

Themes	CNMI	Hawai'i	Florida	Puerto Rico	American Samoa	USVI	Guam
Enforcement	• DFW • BECQ	• There is legislative mandate through existing coral reef laws, but enforcement is uneven and therefore compliance has been eroded as well	• Injury protection ppl for State of FL. FWC can't cite ppl for damages because they can't assess the damages. • No enforcement arm of DEP; FWC has enforcement but their officers can't get in the water so they can't verify reef damages • Local police officers are supposed to be cross-deputized to enforce environmental regulations but she's not sure how well they're trained. • Rules are too complex to effectively comply or enforce them. Separate regulations for every fish.	• Dedicated rangers but they are limited because they don't have the equipment they need. • Four enforcement agencies: border, coast guard, DNER, and police + local NOAA law enforcement (in charge of the entire Caribbean). • Border patrol mainly focuses on drugs	• AS has adopted some village bylaws to help with enforcement. They also deputize local chiefs or village leaders to help with enforcement. • The community can invite Department of Marine and Wildlife Resources to assist with enforceable policies but it is voluntary	• There is a Division of Environmental Enforcement (Office of Compliance Management and Environmental Enforcement under VI Waste Management Authority) but it isn't part of the Park Division. • MPA managers don't have control over enforcement. • Recently had a change of leadership and lots of staff turnover due to corruption. • They do have some police offers assigned to enforcement but training is probably not adequate.	• Territorial MPAs have take prohibitions that are somewhat enforced, vs. federal MPAs that have limited or no enforcement. • Used to be a volunteer marine patrol in the Pati Point MPA (near Anderson Air Force Base) but no longer exists

Themes	CNMI	Hawai'i	Florida	Puerto Rico	American Samoa	USVI	Guam
Fishing (licenses, regulations, gear)	• Gear restrictions on fishing	• Commercial license required but no recreational (full list p.31) • No fishing licenses on HI; means they can't check coolers, etc.	• Recreational fishers have powerful supporters who have hired lobbyists to prevent creating protected areas • # of recreational saltwater fishing licenses purchased annually has risen by 25% since 1992 • See graph in commercial fishing	• System for issuing fishing licenses isn't in place.	• Commercial license required but no recreational (confirming)	• No recreational fishing license required.	• No fishing license required (except for Trochus fish). Some regulations include no chemicals, no dynamite, some mesh limits, but limited enforcement.
Political process (will, turnover, commitment)	• Management plans for MPA is really outdated	• Currently a push to create recreational fishing licenses in a way that hasn't happened before.	• Political turf wars between agencies • Recreational fishers have powerful supporters who have hired lobbyists to prevent creating protected areas so there is political opposition to conservation			• Much of the management between agencies happens at the individual level/because of personal relationships.	• Issue re: federal-level recognition, because there is some spatial overlap between territorial and federal areas

	Themes	CNMI	Hawai'i	Florida	Puerto Rico	American Samoa	USVI	Guam
Market Forces	Tourism	• Mariana's Visitors Authority • With almost half a million tourists visiting Saipan every year, this value is estimated at as much as $42 million per year. (2006)	• Tourists impact reefs through consumption of seafood and damaging reefs with things like fins and sunscreen. • Some tourist sites such as Hanauma Bay Marine Reserve are tightly regulated, but some tour operators take advantage of loopholes. Puts operators who follow the rules at a disadvantage. • Other popular tourist areas have no regulations. • Hotels have educational media; Maui hotels are particularly good. Also some Airbnb renters are proving reef-friendly sunscreen on their own will.	• Fishing operators are regulated by Guide License program. Captains have to pay for permits but there isn't a limit on the number of permits.	• Lack of comprehensive approach to build awareness and education. Material available but you have to ask for it. • Tourists are more likely to be aware that there might be regulations so they ask.	• AS doesn't have much tourism. Tourists that do come go to the National Park	• Most of their tourists are coming from mainland US so they know there are likely restrictions and they ask about them. • Bare boat or fishing charters have charts and guides that outline restrictions. • Local magazines also have information about parks	• Tourists (mostly from Asian countries and Russia) are damaging reefs, hotels don't want to stop them • Most arrests are of non-residents; points to need for translation services
	Commercial fishing	• Annual commercial value of fishing	• License required, but recreational is much bigger (100,000 vessels		• Fishers have been educated about the science of sustainable	• Not much commercial fishing on reefs	It has been established that commercial	• Fishermen spent around $165 a month to fish; only a small

Themes		CNMI	Hawai'i	Florida	Puerto Rico	American Samoa	USVI	Guam
		($0.43 mil) is half that of cultural value of fishing ($0.83 mil) (2006)	vs 1,000 vessels) (SustainaMetrix)		catch numbers but many don't believe the science. Belief that things are overly restricted.		fishing, recreational marine use, land-based pollution, and climate change are the main stressors of coral reefs throughout the USVI	number of fishermen on Guam sell part of their catch, indicating that fishing in Guam is neither a subsistence, nor a commercial, activity. (2008)
Civil Society	Local/regional level (e.g., NGOs) management efforts and initiatives	• Coral Reef Initiative	• Local communities (volunteers) are working with DOCARE to perform enforcement • Community-based Subsistence Management Areas (gives native communities more stewardship over local areas)		• Sierra Club has been working with some local areas	• AS has a strong and unique local marine governance system. Villages have their own by-laws and manage their own resources. Lots of different types of management systems.	• The Nature Conservancy has done an environmental law gap analysis for VI	• Friends of Reefs Guam community program

Themes	CNMI	Hawai'i	Florida	Puerto Rico	American Samoa	USVI	Guam
Individuals/ Residents (attitudes, enforcement, tradition)	• Strong sense of protection among native cultures on CNMI	• Native Hawaiians' creation chant calls out life emerging from the ocean and the coral reefs having the first life. They feel a strong sense of duty to protect reefs.	• Report public outcry over lack of enforcement • Big outcry from recreational fishing community over rules	• There are pockets where the locals are more aware and do their own enforcement, but in general locals are not well informed about coral regulations.	• Strong traditional involvement in conservation. • Traditional knowledge incorporated in local MPA program.	• Not the same local/traditional commitment to the natural environment as there is the Pacific. • Locals are wary of parks because they feel like they are a federal level construct to serve federal interests	• Residents feel a right to fish • There is self-enforcement for more traditional villages but locals and tourists are not always treated equally. • There was a law passed to establish traditional fishing rights for Chamorro people in 2010, but it was poorly written and not fully implemented.
Education and outreach efforts	• Micronesia Challenge • CRI Internship	• Strong outreach to tourists via hotels.	• Some signage about coral reef conservation in airports. • Middle school coral reef education program is very active.	• Pocket education programs	• Conduct outreach for communities before they can approve a local MPA • Need more outreach to tourists	• Stated that more outreach and education is necessary for both locals and tourists. • There is an Education and Outreach Coordinator at St. Croix's East End Park • MOES-VI (Marine Outreach and Education U.S. Virgin Islands Initiative)	• Tourist education has ebbed and flowed. Have a coral reef management fellow working on that right now • Make up of tourists' nationalities have changed which has changed nature of tourism. More self-guided tourists who don't bother to find out or obey rules.

Appendix H: Jurisdictional Call Notes for Governance Indicator

NOAA and Abt Associates held calls with NOAA coral and fish liaisons from each jurisdiction to discuss relevant inputs for the governance indicator. Below we briefly highlight key takeaways from each of the discussions.

American Samoa Call (10/3/18)

Participants discussed the current governance structure, including both MPAs and village governance systems. Also discussed were the different kinds of MPA programs. The representatives noted that there are also National Reef Park sites which are out in the villages and under the jurisdiction of Federal National Parks. The liaisons also noted that village MPAs have their own village governance system, and communities oversee a lot of their own resources. They have their own village by-laws, and set their own village boundaries. It took years to integrate village with local governance so they could coordinate activities within coastal villages. About 10 years ago, AS adopted some of the village by-laws to assist in monitoring and enforcing local regulations. Each village is different – have different by-laws to meet different needs and priorities as important to them for consumption and resources. Given the marine tenure system, local villages can manage their own coral reefs. Participants discussed whether there is enough flexibility to address problems locally with guidance or advice from NOAA or others. The sanctuary program has their own system which includes a lot of community engagement. This was important because it helped address the land-based impacts to reefs such as land-based pollution.

Participants also discussed the main threats to reefs and whether they were related to the ongoing land-based activities. Local partners are looking at different impacts, both human + climate change and looking at including restoration of coral reefs. In reality there are challenges to this system. It is not that easy to get the management or governance through the community. However, they are still working on the approach and hope to expand it. The primary threats to the reefs are fisheries decline, climate change, and land-based sources of pollution. Population on American Samoa isn't changing that much so development (e.g., building that fills in wetlands, construction runoff) isn't impacting the reefs as much as it might be in other places.

Commonwealth of Northern Mariana Islands (CNMI) Call (9/12/18)

Participants discussed the significant amount of local information related to coral reef governance that has been collected by the region. This includes elder fisher interviews, socio-economic surveys, household surveys, and various management plans. CNMI is preparing for another socioeconomic assessment for 2019 and 2020. In terms of management, participants discussed how CNMI provides guidance to local and tourists about dos and don'ts on the reef. This is primarily done through the Coral Reef Initiative. The participants also discussion various issues related to who manages different local areas as well as restrictions on fishing near coral reefs. A general takeaway was that what is most effective are other rules such as gear restrictions for fishing. For example, you can't use gill nets, scuba, and other fishing techniques for harvest. Those rules are archipelago-wide. Finally, participants discussed issues related to tourists or burden/stress from local populations. The general assessment was that tourism may provide a significant stress and threat on reefs.

Florida Call (10/2/2018)

Participants discussed several topics, including the Outreach Florida Planning Process, enforcement, "ground level" activities, coverage, and other issues. The discussion laid our jurisdictional management and acknowledged the complexity of broad authority combined with site-specific authority. Florida may

be in a better position than some other places given they have relatively more staff, though there are some gaps and turf-related issues. The participants discussed the DEP Coral Reef Conservation program, which came about because of local action strategy process. They have a staff – manager and administrative support staff, plus focus area/threat area coordinators, i.e. land-based pollution, diving, maritime and coastal construction, etc. – who advise the program manager and upper levels. There is also a reef injury prevention program, which provides rapid response capacity.

The participants also discussed that FL is an open access state, with 9 inlets in SE FL. This creates some challenges. Finally, the participants suggested that a governance indicator would ideally include some qualitative backstory, and that NOAA should think through the audience and purpose for the indicator.

Florida, Caribbean and Atlantic Call (10/15/2018)

Participants discussed the end goal of the project. A NOAA participant expressed concern over developing a suite of questions about governance because the jurisdictions are so different. A participant developed an assessment tool to measure governance of MPAs against the goals of coral programs. NOAA then uses the results to identify areas where their program can provide capacity and support. They have done this assessment every 3 years since 2010 – last one in 2017. The assessment covers legally recognized protected areas that meet the definition of an MPA, but they can include community-based protected areas. They did not do the assessment in every MPA.

The participants discussed the state's approach to managing coral reef habitat. Within the state there are two primary management agencies: Department of Environmental Protection (FDEP) and Florida Fish and Wildlife Conservation Commission (FWC) – DEP has authority over habitat and water quality; Fish and Wildlife over critters and fish. All the counties have resource management divisions that play a role in permitting and monitoring habitat. They have installed mooring buoys to prevent direct impact. The participants also discussed the DEP's coral reef conservation program and the state-wide coral reef protection act. Participants noted challenges associated with enforcing this, though they noted that FWC has a substantial enforcement capacity. They noted that because they don't have the ability to dive, it hinders their ability to assess coral reef damage.

Guam Call (10/17/2018)

The participants discussed that MPAs do not manage the reefs. Participants reported that territorial MPAs have take prohibitions that are somewhat enforced, vs. federal MPAs that have limited or no enforcement. NPS and military have two each, and the wildlife refuge claims some. The participants also discussed the MPA checklist, and reported some limitations of this. Enforcement issues and existing regulations were also discussed, including regulations such as no chemicals, no dynamite, and some mesh limits. They noted that MPAs do have limited take. Participants also noted that regulations are fairly well known, though there are infractions. The participants discussed a big issue with traditional fishing rights, which occurred between 2008 and 2010. There was a movement to try to establish recognition for Chamorro people to gain rights to fishing. Law was passed but not fully implemented. One participant noted that resources are challenged and have many more users than CNMI (who self-enforce). There is self-enforcement for more traditional villages but not as much for MPAs.

The participants noted that education for tourists has waxed and waned, and they have a coral reef management fellow right now tasked on working on that. It was noted that approximately 1.5 million tourists came to Guam in the last year, mostly from Japan, China, Korea, and Russia. It was noted that there is still a big gap in reaching out to tourists. Some issues with enforcement were brought up including tourists fishing in preserves and tourists/companies trampling in preserves. In 2004 they passed

an eco-permit law to regulate non-fishing activities, but they had a change in leadership and never moved forward after that. Not much has happened other than jet ski regulation.

Hawai'i Call (9/2/2018)

The participants discussed several topics. First, they discussed how NOAA's coral program helps to coordinate funding for coral-related activities but in Hawai'i, the Hawai'i Department of Aquatic Resources (DAR) is the primary agency responsible for the reefs. For marine life, DAR is in control from the high tide mark to EEZ of the state (200 mi out). They don't have authority on the land, but we do fund projects on land. Northern part of Hawai'i is low-lying atolls. Federal government manages a portion of it, state does as well. It includes sanctuaries and monuments.

The participants noted that in terms of fisheries, Hawai'i does not require a license to do recreational fishing which is a huge gap. Last state in the nation. No idea how many people fish. Other states when you get a license you agree to inspections. In Hawai'i, officers can't inspect coolers even with probable cause – they have to catch someone in the act. The participants also discussed how fishing may place greater pressure on the reefs than tourism. However, there is also significant tourism. In terms of enforcement, participants discussed how Hawai'i Division of Conservation and Resource Enforcement (DOCAR), a state, sister agency to DAR, is charged with enforcement. But there are very few staff doing marine enforcement, especially when compared with land-based enforcement staff. Other than lack of license, Hawai'i does have strong regulations for coral protection. Fishing is the largest one.

Participants also noted that the Native Hawaiians have a creation chant that calls out life emerging from the ocean and coral reefs having the first life. This suggests a strong sense of duty to protect coral reefs and environment among natives. They are very involved to protect coastal and other areas. Participants discussed the Community Based Subsistence Management Areas, a new program where native communities can apply to have more stewardship and management over the areas surrounding them.

Puerto Rico Call (10/4/18)

Participants discussed several topics. First, they discussed management boundaries. Corals are in state water so the local DNER has jurisdiction over the corals. They manage and enforce local regulations. Participants noted that for fisheries, local law enforcement has always been a major issue. It is the building block of any management plan. For corals, there are indirect enforcement issues – water quality, navigation. PR doesn't have a problem with illegal harvesting but do have a recreational use problem. Then participants discussed both self and peer enforcement activities, of which there are some but not extensive. Sierra Club works with communities to establish protected areas and increase local awareness.

In terms of tourism, participants noted that lot of pocket efforts for outreach and education, but not a comprehensive approach to educating tourists. DNER has an outreach and education division that provide educational materials and gives workshops. Participants also noted that there is not much traditional knowledge related to conservation.

US Virgin Islands Call (10/16/2018)

Participants discussed several topics related to governance. First, they discussed boundary issues and the MPA management checklist. Participants noted that informal community-based protection is less developed, and the education and outreach programs could be improved. In terms of tourism, participants suggested that tourists coming from US are used to regulations so they know there are restrictions in

protected areas. In terms of management, corals are managed by Planning and Natural Resources – specifically coastal zone management. Some authority also falls under the Division of Fish and Wildlife and the Division of Environmental Protection. Water quality issues are managed by DEP as well, including storm water management, and discharges under the Clean Water Act. Participants noted several studies that had been performed which are relevant and will be shared.

Appendix I: Supplementary Data Tables for Secondary Data Indicators

Table I-1: Economic Impact of Coral Reef Fishing Indicator Variables; 2015[11]

Variable	AS	CNMI	FL	GU	HI	PR	USVI
Total commercial fishing yield (lbs)	5,016,753	170,274	17,449,846	140,610	34,622,881	1,515,046	642,807
Total commercial Reef fish[12] yield (lbs)	80,504	27,440	11,928,837	42,632	1,376,071	820,533	364,088
Total commercial fishing revenue (2017$)	$5,690,358	$440,509	$86,930,446	$346,304	$106,515,586	$6,315,209	$3,990,111
Total commercial Reef fishing revenue (2017$)	$263,141	$85,709	$63,152,637	$143,535	$3,135,743	$3,614,055	$2,389,956
Proportion of commercial yield that is Reef fish	2%	16%	68%	30%	4%	54%	57%
Proportion of commercial revenue that is Reef fish	5%	19%	73%	41%	3%	57%	60%
Total recreational fishing catch (number of fish)	N/A	N/A	N/A	N/A	5,179,095	957,819	N/A
Total recreational Reef fishing catch (number of fish)	N/A	N/A	N/A	N/A	2,019,710	582,216	N/A
Proportion of recreational catch that is Reef fish	N/A	N/A	N/A	N/A	39%	61%	N/A
Total GDP produced by living resources sector (2017$)	N/A	N/A	$63,822,714	N/A	$88,833,636	N/A	N/A
Proportion of total GDP produced by living resources sector	N/A	N/A	0.02%	N/A	0.11%	N/A	N/A
Total establishments within living resources sector	4	10	152	13	123	10	1
Proportion of total establishments within living resources sector	0.82%	0.58%	0.07%	0.37%	0.31%	0.02%	0.03%
Total employment within living resources sector	2,923	45	2,525	95	2,219	19	N/A
Proportion of total employment within living resources sector	64.05%	0.49%	0.07%	0.16%	0.30%	<0.01%	N/A
Commercial fishing license revenue (2017$)	N/A	N/A	N/A	N/A	$284,784	N/A	N/A

[11] Data sources found in Exhibit 18.
[12] Defined as highly reef-associated species wholly or predominantly residing and foraging on the reef and all non-fish marine life and fish that use the reef, but do not predominantly reside on the reef.

Table I-2: Economic Impact of Tourism Indicator Variables; 2015[13]

Variable	AS	CNMI	FL	GU	HI	PR	USVI
Number of arrivals	20,300	479,000	24,264,000	1,409,000	78,086,081	3,542,000	642,000
Total GDP produced by tourism sector (2017$)	N/A	N/A	$8,731,062,603	$1,121,726,300	$7,167,820,752	$2,483,820,000	$1,186,620,000
Total employment within tourism sector	432	3,453	150,961	12,766	103,512	67,501	6,754
Total establishments within tourism sector	35	228	6,809	479	3,893	4,021	381
Proportion of GDP produced by tourism sector	N/A	N/A	3%	19%	8%	2%	31%
Proportion of total employees in tourism sector	9%	38%	4%	21%	14%	8%	18%
Proportion of total establishments within tourism sector	7%	13%	1%	14%	10%	9%	11%
Total visitor spending (2017$)	N/A	N/A	N/A	$1,814,242,910	$15,388,839,685	$4,068,830,000	$2,975,410,000
Ratio of visitor spending to resident spending	N/A	N/A	N/A	55%	24%	6%	113%
Hotel occupancy rate	N/A	87%	N/A	76%	79%	80%	57%
Total value added by National Parks (2017$)	$641,781	.	$208,913,668	$14,937,121	$297,712,279	$70,874,065	$63,663,041
Total value added by National Parks containing coral reefs (2017$)	$641,781	.	$31,316,447	$14,937,121	$37,703,354	$70,874,065	$58,269,195
Total visitor spending at National Parks (2017$)	$819,996	.	$233,122,106	$19,057,706	$376,003,397	$90,446,845	$74,067,519
Total visitor spending at National Parks that contain coral reefs (2017$)	$819,996	.	$37,188,281	$19,057,706	$48,107,832	$90,446,845	$67,128,453
Jobs supported by National Parks	9	.	3,282	232	4,460	1,110	938
Jobs supported by National Parks that contain coral reefs	9	.	502	232	591	1,110	856

[13] Data sources found in Exhibit 21.

Table I-3: Community Well-Being Indicator Variables[14]

Variable	AS	CNMI	FL	GU	HI	PR	USVI
Economic Security							
Poverty Rate	58%	56%	15%	22%	9%	44%	47%
Median Household Income (2017$)	$26,835	$19,566	$51,696	$54,219	$73,504	$20,460	$31,015
Unemployment Rate	9%	11%	5%	5%	3%	12%	11%
Median Home Value (2017$)	$57,735	$80,000	$267,711	$227,492	$644,519	$114,026	$239,249
Education							
Percent with High school Diploma	87%	83%	85%	79%	92%	76%	70%
Percent with Bachelor's Degree	10%	15%	31%	20%	32%	25%	17%
Proportion of School Age Population enrolled in K-12	83%	86%	90%	82%	85%	91%	88%
Education Expenditure per pupil (2017$)	$4,503	$7,130	$10,611	$10,469	$14,240	$8,456	$11,508
Access to Social Services							
Government Payments for Social Assistance per capita (2017$)	$1,036	$537	$22	$621	$1,968	$973	$1,971
Percent receiving public assistance income	14%	12%	2%	14%	4%	9%	7%
Hospital beds per 1,000 people	2.17	1.65	3.23	0.99	1.70	2.52	3.32
Social Connectedness							
Percent with telephone access	95%	92%	97%	96%	97%	96%	88%
Percent with internet access	27%	71%	84%	91%	88%	62%	52%
Tenure in Community	20.50	5.00	6.20	7.00	8.00	15.00	10.50
Health							
Life expectancy	75.40	75.40	80.78	79.10	81.50	79.40	80.00
Infant mortality rate (per 100,000 population)	850.00	1270.00	697.73	530.00	570.00	740.00	650.00
Physicians (per 1,000 people)	0.78	0.36	2.52	1.01	3.35	2.89	1.65
Age adjusted death rate (per 1,000 people)	9.72	8.41	8.52	8.71	5.72	6.38	5.75
Basic Needs							
Health insurance coverage rate	41%	66%	83%	80%	96%	94%	70%
Healthy food outlets per 1,000 people	1.42	1.91	0.50	1.16	0.31	0.31	0.54
Percent of households without vehicle	40%	27%	8%	7%	8%	4%	20%
Environmental Condition							
Percent impervious cover	5%	6%	14%	10%	3%	9%	11%
Percent of beach days affected by notification actions at monitored beaches	26%	1%	1%	28%	3%	17%	2%
Percent of coastal shoreline miles impaired	63%	38%	100%	100%	67%	86%	12%

[14] Data sources and years used found in Exhibit 24.

Table I-4: Physical Infrastructure Indicator Variables[15]

Variable	AS	CNMI	FL	GU	HI	PR	USVI
Percent impervious cover	5%	6%	14%	10%	3%	9%	11%
Percentage of cultivated land area	2%	1%	15%	<1%	3%	3%	<1%
Percent of housing units lacking complete plumbing facilities	27%	14%	1%	11%	1%	7%	8%
Number of Construction Permits	409	342	20,345	1,294	4,035	3,623	260
Number of effective NPDES permits	0	3	2,837	14	2,014	33	85
Total toxic releases (lbs)	56,221	19,518	1,224,901	435,993	3,061,992	1,643,448	35,414
Number of operating landfills	1	1	8	1	9	21	1
Coastline (mi)	208.63	133.81	7,565.92	149.37	1,525.03	804.66	220.24
construction permits/mile of coast	1.96	2.56	2.69	8.66	2.65	4.50	1.18
NPDES permits/mile of coast	0.00	0.02	0.37	0.09	1.32	0.04	0.39
TRI releases/mile of coast	269.48	145.86	161.90	2918.88	2007.82	2042.41	160.80
operating landfills/mile of coast	0.005	0.007	0.001	0.007	0.006	0.026	0.005
Percent of land with Department of Defense facilities	0.2%	20.5%	0.2%	28.2%	5.7%	1.0%	0.1%

[15] Data sources and years used found in Exhibit 30.