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Resident Perceptions of Ecosystem Services Provided by U.S. Coral Reefs: Highlights from the First Cycle of the National Coral Reef Monitoring Program's Socioeconomic Survey

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Abstract: Despite being among the most valuable ecosystems on Earth, coral reefs face ongoing threats that could negatively impact the human populations who depend on them. The National Coral Reef Monitoring Program (NCRMP) collects and monitors data on various aspects of U.S. coral reefs to provide a holistic understanding of the status of the reefs and adjacent human communities. This paper explores results from the NCRMP's first socioeconomic monitoring cycle using an ecosystem services framework and examines how these results can be used to improve coral reef management in the following U.S. coral reef jurisdictions: American Samoa, the Commonwealth of the Northern Mariana Islands, Florida, Guam, Hawai'i, Puerto Rico, and the U.S. Virgin Islands. Results suggest that residents in the U.S. Pacific coral reef basin may hold stronger cultural and provisioning values, whereas residents in the U.S. Atlantic coral reef basin may hold stronger regulating values. These findings suggest that outreach efforts have been successful in communicating benefits provided by coral reef ecosystems to the public. They also provide insight into which ecosystem services are valued in each jurisdiction, allowing resource managers to make science-based decisions about how to communicate conservation and management initiatives.

Keywords: coral reefs; ecosystem services; socioeconomic monitoring; human dimensions; social-ecological systems; ecosystem-based management

1. Introduction

Coral reefs are among the most valuable ecosystems on Earth, providing food, protection from storms, recreational opportunities, and many other benefits to coastal communities [1–3]. However, coral reef ecosystems face a series of ongoing threats, including climate change, fishing pressures, and land-based sources of pollution [4], and the condition of these ecosystems has been in global decline for decades (e.g., [5]). As ecosystem health degrades, its ability to provide benefits, known as ecosystem services (ES) [6,7], is diminished [7–9], and dependent human populations, both within the ecosystem and farther

away, are threatened (e.g., [9,10]). As human populations are often the source of ecosystem degradation, a targeted and coordinated response is needed to mitigate the pressures on coral reef ecosystems to preserve both the underlying ecosystem conditions and processes as well as the ES they provide.

The need for holistic approaches to ecosystem-based management is not new. In fisheries management, for example, there have been national and international recommendations over the past two decades to acknowledge the cyclical connections between human and biological systems [11] through the use of ecosystem-based fisheries management (EBFM) that considers these connections (e.g., [12,13]). This concept of social-ecological systems has also influenced other marine and coastal management efforts, such as ongoing integrated ecological assessments (e.g., [14]) and coral reef management (e.g., [15]). In the United States (U.S.), the National Oceanic and Atmospheric Administration (NOAA) is at the forefront of interdisciplinary coral reef management and conservation efforts that integrate socioeconomic information with biophysical data. NOAA's Coral Reef Conservation Program (CRCP) was established in 2000 to preserve, sustain, and restore the condition of U.S. coral reef ecosystems while also promoting the sustainable use of these ecosystems and the benefits they provide [16]. In 2013, the CRCP created the National Coral Reef Monitoring Program (NCRMP) to develop and implement an integrated long-term monitoring program to observe biological (benthic composition and coral reef fisheries), climate, and socioeconomic conditions of U.S. coral reef ecosystems [17]. By consistently collecting and monitoring data on these components of U.S. coral reef areas, the NCRMP provides a holistic understanding of the status of U.S. coral reefs and the human communities who use and depend on the ES that coral reefs provide. This is critical because the communities adjacent to coral reefs are not only likely to gain the most ES from these ecosystems, but are also most likely to directly impact surrounding ecological conditions.

1.1. Overview of NCRMP Socioeconomic Monitoring

The socioeconomic component of the NCRMP collects and monitors socioeconomic information, including human use of coral reef resources; knowledge, attitudes, and perceptions of coral reefs and coral reef management; and demographics of the populations living in coral reef areas. To accomplish this, NOAA scientists, in consultation with partners and stakeholders, developed a set of thirteen core social and economic indicators that are regularly measured over time in each of the seven inhabited U.S. coral reef jurisdictions: South Florida (Martin, Palm Beach, Broward, Miami-Dade, and Monroe Counties), Puerto Rico, and the U.S. Virgin Islands (USVI) in the Atlantic basin; and American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), Guam, and Hawai'i in the Pacific basin [18]. To measure the NCRMP socioeconomic indicators, the CRCP collects primary data through resident household surveys conducted once every 5-7 years in each jurisdiction, and these data are supplemented by secondary data sources (Table 1). Secondary data are obtained from external organizations such as the U.S. Census Bureau, Bureau of Labor Statistics, NOAA Economics: National Ocean Watch (ENOW), and The World Bank. Each indicator is then measured once per monitoring cycle for each jurisdiction by aggregating subsets of these variables [19,20]. After multiple data collection cycles, researchers will be able to track changes in indicator scores to inform policy, management, and research needs related to coral reefs and adjacent communities [21]. The 13 NCRMP indicators and data sources are presented in Table 1 (numbered but not ranked).

Coral reef-related research typically targets resource users, including recreational (e.g., [22,23]) and commercial users (e.g., [24]), that tend to be more familiar with current ecosystem conditions and more knowledgeable about the direct and indirect benefits of these ecosystems (e.g., [25,26]). While these perspectives are useful in certain management contexts, the NCRMP measures the social conditions of jurisdictional residents over time to better understand how local populations understand and interact with coral reef resources to improve education and outreach efforts. Further, as residential civic engagement is often the driving force behind impactful local governance and enforcement [27], measuring

aspects of this dynamic at a local level enhances an understanding previously limited to those who routinely interact with coral reefs. Ultimately, tracking civic engagement and awareness of threats to coral reefs are critical to the justification of funding, supporting legislation, and policy to enable the conservation of coral reef resources. The sustainability of coral reef ecosystems and the benefits reefs provide is supported by legislation such as the Coral Reef Conservation Act of 2000 (P.L. 106-562; 16 U.S.C. 6401 et seq.), as well as protection from various state and territorial legislation. Socioeconomic data and monitoring assists management in fulfilling these mandates.

Table 1. The thirteen NCRMP socioeconomic indicators and data sources.

	Indicator	Data Source
1	Participation in coral reef activities	Primary
2	Perceived resource condition	Primary
3	Attitudes towards coral reef management strategies	Primary
4	Awareness and knowledge of coral reefs	Primary
5	Human population trends near coral reefs	Secondary
6	Economic impact of coral reef fishing on jurisdiction	Secondary
7	Economic impact of dive/snorkel tourism to jurisdiction	Secondary
8	Community well-being	Secondary
9	Cultural importance of coral reefs	Primary
10	Participation in behaviors that may improve coral reef health	Primary
11	Physical infrastructure	Secondary
12	Knowledge of coral reef rules and regulations	Primary
13	Governance	Secondary

1.2. Purpose

The purpose of this paper is to explore a subset of results from the NCRMP's first socioeconomic monitoring cycle conducted in all seven inhabited U.S. coral reef jurisdictions (2014–2018) using an ES framework and examine how those results can be used to improve coral reef ecosystem management. ES can be categorized by the benefits they provide: cultural, regulating, and provisioning [7,28]. In this context, "cultural" services are defined as the non-material benefits obtained from ecosystems, such as spiritual and religious, recreation and ecotourism, aesthetic, inspirational, educational, sense of place, and cultural heritage. "Regulating" services are benefits obtained from the regulation of ecosystem processes, such as climate regulation, hazard moderation, water regulation, and water purification. "Provisioning" services are products obtained from ecosystems, such as food, fisheries, ornamental resources, biochemicals, and genetic resources [7]. (There are also "supporting" services that allow for the production and maintenance of ecosystem services (for example, the supporting service of primary production or nutrient cycling by seagrass) [7]; however, support services are not addressed in this manuscript because the NCRMP survey does not include relevant questions).

The next section of this paper presents an overview of the survey methodology and sampling design. In Section 3, residents' perceptions of specified ES values are examined across the seven inhabited U.S. coral reef jurisdictions, and differences between Atlantic and Pacific basins are analyzed. Section 4 discusses the importance of these findings and Section 5 explores how the chosen variables support broader NCRMP initiatives and the implications for ecosystem-based management. Finally, future areas of research are detailed in Section 6.

2. Materials and Methods

Surveys of residents 18 years of age or older were conducted in each of the seven U.S. coral reef jurisdictions from 2014 to 2017. Because vacation homeowners comprise a significant proportion of three of the jurisdictions, residency of at least three months of the year was required of survey respondents in South Florida and Hawai'i, and residency of at least six months of the year was required of survey respondents in USVI. (Residency periods

were established by jurisdictional partner needs and definitions of residency). Surveys were administered face-to-face, by telephone, or a combination of the two depending on the local socio-cultural context. Stratified sample designs were commonly used to ensure adequate spatial representation of the target populations. The survey was translated into local languages by native speakers where appropriate to increase comprehension, coverage, and data accuracy. Reported response rates ranged from 1.5% to 27.8%. Responses were weighted for all jurisdictions except American Samoa. (Due to the sampling technique employed and the demographic comparability to the general population, sampling weights were not developed). For the remaining jurisdictions, base weights were developed to account for the complex sample designs and were then further calibrated using age, race, and/or sex for Florida and USVI to mitigate potential non-response bias. Table 2 provides details of the sample methodologies for each jurisdiction, including difficulties associated with each collection. (For greater detail, please see the appropriate technical memorandum for each jurisdictional data collection, as cited in Table 2 and the references section).

The survey instrument was developed in consultation with local partners and consists of a core module with questions asked in all jurisdictions to allow for national consistency and the ability to track information over time. While the indicators are applicable to all jurisdictions, there are considerable geographical, cultural, and linguistic differences among residents living near these coral reef areas, as well as differences in the ecology and types of species that inhabit coral reefs in the Atlantic and Pacific basins. To account for these differences, many of the core module question matrices also include items that are specific to the local context. Jurisdiction-specific questions and items also allow for the flexibility to ask about local resource management issues and emerging threats to reefs, though substantial modifications are restricted to maintain the scientific integrity of the monitoring effort. All included survey questions were approved for use by the Office of Management and Budget (OMB) under OMB#0648-0646 and are publicly available [29].

The present study focuses on six survey questions from the core module to analyze a series of ES values (cultural, regulating, and provisioning services), as well as one additional question to contextualize this study and analyze the status of the coral condition. A summary of the survey questions is shown in Table 3 (greater detail is provided in Appendix A). Except for coral condition, each scale was transformed to a binary measure for ease of analysis and interpretation, and weighted proportions were compared between jurisdictions and basins and tested for significant differences using t-tests.

Table 2. Sample methodologies by U.S. coral reef jurisdiction.

Jurisdiction	Date	Mode	Sample Frame	Sample Design	Sample Selection	Languages Offered	Completes (Response Rate)	Difficulties
American Samoa [30]	Feb, 2014	FTF	None	Proportionate stratified sample (village by degree of urbanization and location)	Opportunistic	EN, SM	448 (NR)	No street addresses; Many unoccupied structures; Surveyor safety issues
South Florida [31]	Jan–Jul, 2014	CATI	Purchased phone list (landline and mobile)	SRS	SRS	EN, ES	1210 (13.4%)	None identified
Hawai'i [32]	Nov, 2014	CATI	Purchased phone list (landline and mobile)	Disproportionate stratified sample (county/island)	Systematic	EN	2240 (1.5%)	Small populations in Molokai and Lanai
Puerto Rico [33]	Dec, 2014–Feb, 2015	CATI	NR (landline and mobile)	Disproportionate stratified sample (socioeconomic region)	NR	EN, ES	2503 (5.61%)	Cultural and social norms affected calling dates/times
Guam [34]	Feb–Jul, 2016	CAPI	Census tracts divided into survey units	Proportionate stratified sample (Census tract)	Systematic	EN, CH, TL	582 (NR)	Small populations in some Census tracts; Restricted access to military installations
		CATI	Online phone books (primarily landline)		SRS		130 (NR)	
CNMI [35]	Aug, 2016–Apr, 2017	CAPI	NR	Proportionate stratified sample (island)	Systematic	EN, CH, CAL, TL	20 (NR)	Inaccurate 2010 Census populations (e.g., Typhoon Soudelor)
		CATI	Online phone books (landline and mobile)		SRS		702 (NR)	
USVI [36]	Feb–Apr, 2017	CATI	Purchased phone list (landline and mobile)	Disproportionate stratified sample (island)	NR	EN, ES	368 (27.8%)	None identified
		CAPI	30 sites, 6 h per day		Opportunistic		820 (15–20%)	

Abbreviations: CAL—Carolinian; NR—not reported; CH—Chamorro/Chamoru; FTF—face-to-face; EN—English; CAPI—computer-assisted personal interviewing; ES—Spanish; CATI—computer-assisted telephone interviewing; SM—Samoan; SRS—simple random sample; TL—Tagalog

Table 3. Overview of survey questions examined in this study.

Value	Survey Item	NCRMP Indicator	Measurement of Survey Item	Modified Measure for Analysis
Coral condition	Perceived condition of amount of coral	Indicator 2	5-point Likert scale of very bad to very good	Full scale
Cultural values	“Coral reefs are important to [jurisdiction]’s culture”	Indicator 9	5-point Likert scale of strongly disagree to strongly agree	Agreement (“agree” + “strongly agree”)
	Participation in fishing, swimming/wading, snorkeling, and diving	Indicator 1	Never, once a month or less, 2-3 times a month, 4 times a month or more	Participation at any frequency (excludes “never”)
Regulating values	“Coral reefs protect [jurisdiction] from erosion and natural disasters”	Indicator 4	5-point Likert scale of strongly disagree to strongly agree	Agreement (“agree” + “strongly agree”)
Provisioning values	Seafood consumption	Indicator 9	Every day, a few times a week, about once a week, 1-3 times a month, less than once a month, never	At least once a week (“every day” + “a few times a week” + “about once a week”)
	Fishing for food	Indicator 1	Frequently, sometimes, rarely, never	Combined “frequently” + “sometimes”
	Fishing for income	Indicator 1	Frequently, sometimes, rarely, never	Combined “frequently” + “sometimes”

3. Results

The following results present residents' perceptions of the status of coral condition and values of cultural, regulating, and provisioning services across the seven inhabited U.S. coral reef jurisdictions. Differences between Atlantic and Pacific basins are also explored.

3.1. Perceptions of the Amount of Coral

Perceived quality of the amount of coral differed across and within jurisdictions (Table 4). Residents of CNMI ($5.69 < t < 20.88, p < 0.01$) and USVI ($4.61 < t < 12.79, p < 0.01$) were most likely to think the amount of coral is good, while residents of Florida ($4.02 < t < 9.97, p < 0.01$) and Puerto Rico ($3.52 < t < 32.44, p < 0.01$) were most likely to think the amount of coral is bad. In comparison, residents of American Samoa ($t = 0.76, p = 0.45$), Guam ($t = 0.49, p = 0.62$), and Hawai'i ($t = 1.16, p = 0.25$) had more divided perceptions and were equally likely to think coral amount is either good or bad.

Table 4. Perceptions of the condition of the amount of coral across U.S. coral reef jurisdictions.

Condition of the Amount of Coral	Atlantic Basin				Pacific Basin		
	Florida	Puerto Rico	USVI	American Samoa	CNMI	Guam	Hawai'i
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Very bad	0.23 (0.02)	0.06 (0.01)	0.07 (0.01)	0.13 (0.02)	0.02 (0.01)	0.07 (0.01)	0.11 (0.01)
Bad	0.38 (0.02)	0.42 (0.01)	0.22 (0.02)	0.35 (0.03)	0.28 (0.02)	0.36 (0.02)	0.31 (0.01)
Neither	0.14 (0.02)	0.35 (0.01)	0.24 (0.02)	0.13 (0.02)	0.16 (0.02)	0.15 (0.02)	0.18 (0.01)
Good	0.17 (0.02)	0.16 (0.01)	0.40 (0.02)	0.32 (0.03)	0.48 (0.02)	0.38 (0.02)	0.34 (0.01)
Very good	0.08 (0.01)	0.02 (0.00)	0.07 (0.01)	0.08 (0.02)	0.06 (0.01)	0.04 (0.01)	0.07 (0.01)

On average, Atlantic basin residents were most likely to believe that coral amount is bad ($5.88 < t < 30.32, p < 0.01$) and Pacific basin residents were most likely to believe that coral amount is good ($3.00 < t < 25.29, p < 0.01$). Both basins were least likely to believe that coral amount is very good (Pacific: $7.80 < t < 30.32, p < 0.01$; Atlantic: $3.20 < t < 25.29, p < 0.01$).

3.2. Cultural Services

Most (90.0%) residents of U.S. coral reef jurisdictions agreed that "coral reefs are important to [jurisdiction's] culture" (Table 5). Of all seven jurisdictions, residents of Guam had the highest level of consensus with this statement ($2.64 < t < 21.02, p < 0.01$) and residents of Puerto Rico the lowest ($2.64 < t < 21.02, p < 0.01$). Swimming/wading (69.0%) was the most common marine recreational activity among residents of all jurisdictions and diving (17.0%) was the least common. Compared to the other jurisdictions, residents of American Samoa were more likely to participate in fishing ($5.87 < t < 14.95, p < 0.01$), and residents of Hawai'i were more likely to participate in snorkeling ($3.11 < t < 17.12, p < 0.01$) and diving ($4.01 < t < 14.44, p < 0.01$). Residents of Puerto Rico were the least likely to participate in swimming/wading ($4.23 < t < 16.46, p < 0.01$), fishing ($5.75 < t < 14.95, p < 0.01$), and snorkeling ($2.26 < t < 17.12, 0.00 < p < 0.02$). Residents of American Samoa and Puerto Rico were equally unlikely to participate in diving ($t = 1.49, p = 0.14$).

On average, Pacific basin residents were more likely to believe coral reefs are important to their jurisdiction's cultures ($t = 14.27, p < 0.01$) than Atlantic basin residents and were more likely to participate in each of the selected activities than Atlantic basin residents (fishing: $t = 11.82, p < 0.01$; swimming: $t = 13.48, p < 0.01$; snorkeling: $t = 11.60, p < 0.01$; diving: $t = 9.34, p < 0.01$). However, of the Atlantic basin jurisdictions, residents of USVI were more likely to believe that coral reefs are culturally important and more likely to participate in coral reef activities.

Table 5. Average responses to survey questions pertaining to cultural, regulating, and provisioning ecosystem services among U.S. coral reef jurisdictions.

Ecosystem Service	Survey Item	Measure	Atlantic Basin			Pacific Basin				U.S. All Jurisdictions Mean(SE)
			Florida Mean (SE)	Puerto Rico Mean (SE)	USVI Mean (SE)	American Samoa Mean (SE)	CNMI Mean (SE)	Guam Mean (SE)	Hawai'i Mean (SE)	
Cultural	Coral reefs are important to the jurisdiction's cultures	Agreement	0.91 (0.01)	0.76 (0.01)	0.96 (0.01)	0.94 (0.01)	0.92 (0.01)	0.98 (0.00)	0.95 (0.01)	0.90 (0.00)
	Swimming/wading	Activity participation	0.62 (0.02)	0.53 (0.01)	0.81 (0.01)	0.79 (0.02)	0.70 (0.02)	0.77 (0.02)	0.79 (0.01)	0.69 (0.01)
	Fishing		0.26 (0.02)	0.15 (0.01)	0.37 (0.02)	0.52 (0.02)	0.35 (0.02)	0.29 (0.02)	0.36 (0.01)	0.29 (0.01)
	Snorkeling		0.29 (0.02)	0.22 (0.01)	0.44 (0.02)	0.27 (0.02)	0.34 (0.02)	0.38 (0.02)	0.51 (0.01)	0.35 (0.01)
	Diving		0.19 (0.02)	0.08 (0.01)	0.16 (0.01)	0.06 (0.01)	0.12 (0.01)	0.21 (0.02)	0.28 (0.01)	0.17 (0.00)
Regulating	Coral reefs protect the jurisdiction from erosion and natural disasters	Agreement	0.88 (0.01)	0.89 (0.01)	0.93 (0.01)	0.85 (0.02)	0.92 (0.01)	0.94 (0.01)	0.83 (0.01)	0.89 (0.00)
Provisioning	Seafood consumption	At least once a week	0.60 (0.02)	0.58 (0.01)	0.64 (0.02)	0.78 (0.02)	0.85 (0.01)	0.66 (0.02)	0.66 (0.01)	0.65 (0.01)
	Fish to feed myself and my family/household	Sometimes or frequently	0.49 (0.03)	0.44 (0.03)	0.40 (0.03)	0.54 (0.03)	0.80 (0.02)	0.74 (0.03)	0.49 (0.02)	0.52 (0.01)
	Fish to sell		0.04 (0.01)	0.08 (0.02)	0.07 (0.01)	0.15 (0.02)	0.11 (0.02)	0.12 (0.02)	0.12 (0.01)	0.10 (0.01)

3.3. Regulating Services

Most (89.0%) residents of U.S. coral reef jurisdictions agreed that “coral reefs protect [jurisdiction] from erosion and natural disasters” (Table 5). On average, Atlantic basin residents were slightly more likely to agree that coral reefs are protective against erosion and natural disasters ($t = 3.36, p < 0.01$).

3.4. Provisioning Services

Roughly 65.0% of U.S. coral reef jurisdiction residents indicated they consume seafood at least once a week (Table 5). Residents of CNMI were the most likely to consume seafood at least once a week ($8.75 < t < 15.97, p < 0.01$) and residents of Puerto Rico ($2.65 < t < 15.97, p < 0.01$) were the least likely. Of the residents who indicated they fished or gathered, 52.0% did so sometimes or frequently to feed their family or household, and 10.0% to sell their catch. Residents of CNMI were also the most likely to fish or gather to consume seafood ($1.70 < t < 9.25, 0.00 < p < 0.09$), and residents of Florida, Puerto Rico, and USVI were equally unlikely to fish to sell their catch ($0.17 < t < 1.60, 0.11 < p < 0.87$). On average, Pacific basin residents were more likely to consume seafood at least once a week than Atlantic basin residents ($t = 8.73, p < 0.01$), as well as to fish for food ($t = 6.29, p < 0.01$) or to sell ($t = 4.51, p < 0.01$).

4. Discussion

The differences in perception between ocean basins suggest these two regions may value certain ES differently and/or may benefit from different management approaches. In the Pacific region, there is a stronger emphasis on the cultural importance of reefs, higher participation in marine activities, higher seafood consumption, and higher levels of fishing for food or income, which suggests greater resident cultural and personal provisioning service values. In the Atlantic region, residents have slightly higher values for the protection afforded by coral reefs, which suggests higher regulating service values. However, some resident responses in the USVI were more similar to those of residents in the Pacific basin than in the Atlantic basin.

4.1. Activity Participation

While the majority of residents in coral reef jurisdictions typically do not engage in diving, a significant proportion (35.0%) participate in snorkeling, and these jurisdictions are popular tourist destinations for diving and snorkeling as well. Tourism-driven diving and snorkeling can be major contributors to the local economy, thus providing further benefits to local residents, in addition to the cultural ES derived from recreation. Despite the potential for differences in activity participation among residents and non-residents, management should ensure that multiple stakeholders have access to the diverse opportunities for recreation provided by coral reefs while also ensuring that coral reefs are functioning to provide these desired ES.

Given limited local participation in underwater activities (diving and snorkeling), jurisdictional residents may not always be aware of changes in coral cover, coral bleaching, or changes in coral reef ecosystem status from first-hand knowledge. Therefore, communication and outreach strategies should seek to incorporate as many visuals as possible to convey the problems that coral reefs are facing, especially to those who are less directly familiar with underwater coral reef conditions [37–39], and to frame outreach messages in a way that is relevant to the way people conceptualize these issues [40].

4.2. Seafood Consumption and Subsistence Fishing

The provision of seafood is also a critical ES to coastal communities. Residents of all U.S. coral reef jurisdictions frequently consume seafood, indicating a reliance on seafood and fishery resources by coastal communities in general. While the data do not indicate whether the consumed seafood came from a coral reef or another source, residents who participate in fishing often do so to provide food for their families or, in some cases, as a

way to make income from selling fish. This is particularly important to residents in the U.S. Pacific Islands, where more than 50% of residents in CNMI, Guam, and American Samoa sometimes or frequently fish to feed themselves or their household. Fishing to obtain food for personal use rather than for commercial or recreational purposes is typical in the Pacific Islands where seafood is important not only in dietary terms but also in terms of social organization and cultural continuity [41]. These findings support existing literature emphasizing the often underestimated and sometimes undocumented role of subsistence fisheries as a food source in island nations (e.g., [42,43]) and highlight the importance for management to ensure subsistence fishing is supported without overtaxing the environment, such as through decisions regarding marine protected area designations and policies.

4.3. Other Considerations

Marine activity participation and seafood dependence both contribute to cultural ES among jurisdictional residents and between ocean basins, but these may stem from broader cultural attachments to the marine environment and coral reef ecosystems. Six of the seven jurisdictions had over 90% agreement with the notion that coral reefs are important to the jurisdiction's culture (76% of Puerto Rican residents agreed), which for some jurisdictions, may be influenced by ancestral connections. For example, corals are considered ancient ancestors in Hawaiian culture, which may elevate the biological, cultural, social, and ecological relevance of corals to Native Hawaiian residents [44].

Demographic differences may also explain some of the differences in ES values. For example, jurisdictions with higher population densities and larger urban areas, such as Florida and Puerto Rico, tend to have lower perceptions about cultural and provisioning values than other jurisdictions. This could be explained by the historical context of settlement or geographic differences in the proximity of residency to the coast. While all jurisdictions and sampled populations are considered coastal, there is variation in the degree of association with the coast among populations of all coastal areas [45]. In Puerto Rico, for example, approximately 3.6 million people (67% of the population) live in coastal portions of the territory [46], but people who live further inland may have different values than those who live directly on the coast. For instance, there are distinct agricultural communities in the upper mountainous area and lower Lajas Valley of the Guánica Bay watershed in coastal Puerto Rico [47,48] that may not value coral reefs the same way as communities in lower elevation areas with increased coastal ties.

However, the status of coral reef conditions is influenced by many short- and long-term drivers and pressures, including land-based sources of pollution and climate change, that operate at different temporal and spatial scales. Therefore, natural resource managers may need to consider both coastal and inland populations when making policy decisions. For example, watershed conservation actions, such as the use of green infrastructure or rainwater harvesting, that help to protect coral reefs as well as improve a variety of ES that residents care about on both land and water [3].

5. Conclusions and the Role of Integration

The first cycle of the NCRMP's socioeconomic monitoring suggests a general consensus among residents of all U.S. coral reef jurisdictions that coral reefs provide important ES, specifically coastal protection from erosion and natural disasters, recreational and cultural importance, and consumptive benefits. From a management perspective, these findings are a positive indication that outreach and education efforts have generally been successful in communicating benefits provided by coral reef ecosystems to the public. This is especially important because literature has found that people are more likely to support conservation measures if they value the underlying ecosystem and associated social services [49]. These findings also provide insight into which ES are valued to different degrees in each jurisdiction, which will allow resource managers to make science-based decisions about how to communicate conservation and management initiatives.

The NCRMP is the first effort to take a holistic approach to ecosystem-based management and monitoring of both biophysical and social conditions of all U.S. coral reefs. Similar efforts toward integration are also being made at the international level through the Socioeconomic Monitoring Initiative for Coastal Management (SocMon) [50], through which case studies have highlighted the benefits of incorporating socio-ecological indicators in integrated management decisions [51,52]. The integration of social science into natural resource monitoring and management is crucial to achieve holistic management approaches [53–55] as it depends on understanding the dynamics of human populations who use and rely upon these key ecosystems. The NCRMP's socioeconomic results presented in this study demonstrate the connectivity of U.S. communities to coral reef ecosystems and services and contribute to the broader calculation of socioeconomic indicators that can be tracked through time and integrated with benthic, climate, and fisheries monitoring data. This study underscores the CRCP's belief that conservation cannot be successfully achieved without an informed and engaged public [17,56] and marks the beginning of an ongoing effort to better integrate social science into national coral reef conservation science in a consistent, documentable, and rigorous framework. Recently, a subset of NCRMP socioeconomic data was recently incorporated into the NCRMP Status Report designed for U.S. policymakers [57]. This report integrated socioeconomic data with biophysical data to demonstrate the status of U.S. coral reefs from a holistic perspective. As NCRMP continues into the second cycle of socioeconomic surveys, trend analyses will inform managers how social conditions are changing over time [58].

6. Limitations and Future Research

At its core, the NCRMP employs a wide-but-thin research approach, which allows for broad thematic and geographic data integration, but limits its abilities to explore more targeted research questions. The NCRMP provides baseline information and encourages regional partners to further explore potential nuances highlighted by these data. Of particular interest may be comparisons of values between general resident populations and tourists or residents specifically engaged in a certain activity. Exploration of other value types may also be considered.

Within the broader NCRMP context, there are four main areas for future research. First, resident perceptions of resource conditions could be compared to the conditions being observed by NCRMP biological and climate monitoring. For example, products or infographics displaying data side-by-side could be used to identify discrepancies between resident perceptions and observed coral conditions in a jurisdiction. Second, finer resolution socioeconomic data could be used to better perform subgroup analyses, as certain subgroups may value some ES more than others. For example, coastal residents may hold different ES values than inland residents. Similarly, there could be differences in values among various activity groups. Third, evaluation of certain ES could be enhanced by the refinement of survey questions. For example, cultural ties to coral reef ecosystems could be expanded through the collection of ancestral connections, the local language, or cultural folklore. Fourth, as the socioeconomic component extends beyond its first monitoring cycle (post-2018), trend analysis will be possible, and data will more easily integrate with biological and climate data streams. For example, changes in behavior related to increased public awareness efforts, such as increased use of reef-safe forms of sun protection or increased engagement in reef-related citizen science efforts, could be linked to changes in resource conditions. These four additional ways to refine NCRMP socioeconomic data collection and analysis could then be used to inform social-ecological ecosystem-based management, provide opportunities for communication and outreach efforts among scientists, managers, and residents, and assessments of existing outreach campaigns and targeted communication strategies.

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Appendix A. Overview of Relevant Survey Questions

The National Coral Reef Monitoring Program Socioeconomic Component allows for jurisdictional variation for local management needs. As such, variations in question wording are shown below. Please note that following the first cycle of data collection, the survey instrument has been revised for consistency in the terminology of questions, items, and scales where appropriate.

AS—American Samoa

CNMI—Commonwealth of the Northern Mariana Islands

FL—South Florida

GU—Guam

HI—Hawai'i

PR—Puerto Rico

USVI—U.S. Virgin Islands

Table A1. Detailed overview of relevant survey questions.

Analysis Theme	Question Phrasing, Item Phrasing, Interviewer Prompts, and Scale Used	AS	CNMI	FL	GU	HI	PR	USVI
Status of coral condition	Question: "In your opinion, how are [jurisdiction]'s marine resources currently doing?"	X		X	X	X	X	
	Question: "In your opinion, how are the marine resources currently doing on the island of your residence?"		X					
	Question: "In your opinion, what is the current condition of [jurisdiction]'s marine resources on the island of your residence?"							X
	Scale: Very bad, Bad, Neither bad nor good, Good, Very Good, Not sure	X	X	X	X	X	X	X
	Item: "Amount of coral" Item: "Amount of coral and invertebrates"	X	X	X	X	X	X	X
Cultural values: Reef importance to culture	Question: "Please say whether you disagree or agree with each of the following statements."	X	X	X	X	X	X	
	Question: "Please indicate the extent to which you disagree or agree with each of the following statements."							X
	Prompt: remind respondent of the definition of South Florida so that they answer these questions with respect to all counties, not just the Keys			X				
	Scale: Strongly disagree, Disagree, Neither, Agree, Strongly agree, Not sure	X	X	X	X	X	X	X
	Item: "Coral reefs are important to [jurisdiction] culture/s" Item: "Coral reefs are important to my island's culture"	X	X	X	X	X	X	X
Cultural values: Activity participation	Question: "How often do you usually participate in each of the following activities?"	X	X	X	X	X	X	X
	Scale: Never, Once a month or less, 2-3 times a month, 4 times a month or more	X	X	X	X	X	X	X
	Item: "Swimming/wading"	X	X	X	X	X	X	X
	Item: "Snorkeling"	X	X	X	X	X	X	X
	Item: "Diving (SCUBA or free diving)"	X		X	X	X	X	
	Item: "Recreational diving (SCUBA)"		X					X
	Item: "Fishing"	X						
	Item: "Fishing from shore—casting (rod & reel), cast netting"		X					X
	Item: "Fishing from a boat, canoe or paddle board—rod and reel, trolling, speargun, free diving, SCUBA"		X					X
	Item: "Fishing" with prompt: fishing for finfish			X				X
	Item: "Fishing from shore (spear, cast net, gill net, drag net)"				X			
Regulating values	Item: "Fishing or harvesting from a boat or kayak (rod and reel, trolling, free diving, scuba gear)"				X			
	Item: "Fishing (for finfish)"					X		
	Item: "Spearfishing"						X	
	Question: "Please say whether you disagree or agree with each of the following statements."	X	X	X	X	X	X	
	Question: "Please indicate the extent to which you disagree or agree with each of the following statements."							X
Provisioning values: Seafood consumption	Scale: Strongly disagree, Disagree, Neither, Agree, Strongly agree, Not sure	X	X	X	X	X	X	X
	Item: "Coral reefs protect [jurisdiction] from erosion and natural disasters"	X		X		X	X	
	Item: "Coral reefs protect [jurisdiction] from coastal erosion and natural disasters"		X					X
	Item: "Coral reefs protect [jurisdiction] from coastal/shoreline erosion and natural disasters like typhoons and tsunamis"				X			
Provisioning values: Seafood consumption	Question: "How often does your family eat fish/seafood?"	X	X		X	X		
	Question: "How often do you or your family eat fish/seafood?"			X			X	X
	Scale: Every day, A few times a week, About once a week, 1-3 times a month, Less than once a month, Never	X	X	X	X	X	X	
	Scale: Every day, A few times a week, About once a week, 1-3 times a month, Less than once a month, Never, Not sure							X

Table A1. *Cont.*

Analysis Theme	Question Phrasing, Item Phrasing, Interviewer Prompts, and Scale Used	AS	CNMI	FL	GU	HI	PR	USVI
Provisioning values: Fishing for income	Question: "How often do you fish or harvest marine resources (includes all fishing and harvesting of shells, octopus, lobster, sea cucumber, or other non-fish species) for each of the following reasons?"	X						
	Question: "How often do you fish or harvest marine resources for each of the following reasons?"		X	X	X	X	X	X
	Scale: Frequently, Sometimes, Rarely, Never	X	X	X	X	X	X	X
	Item: "To sell"	X	X	X	X			
	Item: "To sell" with prompt: "or for work" to include fishing/harvesting as part of employment					X	X	
Provisioning values: Fishing for food	Question: "How often do you fish or harvest marine resources (includes all fishing and harvesting of shells, octopus, lobster, sea cucumber, or other non-fish species) for each of the following reasons?"	X						
	Question: "How often do you fish or harvest marine resources for each of the following reasons?"		X	X	X	X	X	X
	Scale: Frequently, Sometimes, Rarely, Never	X	X	X	X	X	X	X
	Item: "To feed myself and my family/household"	X	X	X	X	X	X	X

References

1. Brander, L.; van Beukering, P. *The Total Economic Value of U.S. Coral Reefs: A Review of the Literature*; NOAA Coral Reef Conservation Program: Silver Spring, MD, USA, 2013.
2. Loomis, D.K.; Paterson, S. The human dimensions of coastal ecosystem services: Managing for social values. *Ecol. Indic.* **2014**, *44*, 6–10. [[CrossRef](#)]
3. Storlazzi, C.D.; Reguero, B.G.; Cole, A.D.; Lowe, E.; Shope, J.B.; Gibbs, A.E.; Nickel, B.A.; McCall, R.T.; Van Dongeren, A.R.; Beck, M. *Rigorously Valuing the Role of U.S. Coral Reefs in Coastal Hazard Risk Reduction*; Open-File Report 2019–1027; USGS: Reston, VA, USA, 2019. [[CrossRef](#)]
4. Karasik, R.; Pickle, A.; Roady, S.; Vegh, T.; Viridin, J. *Analysis of Policies Related to the Protection of Coral Reefs—Analysis of Global and Regional Policy Instruments and Governance Mechanisms Related to the Protection and Sustainable Management of Coral Reefs*; United Nations Environment Programme: Nairobi, Kenya, 2019.
5. Hughes, T.P.; Barnes, M.; Bellwood, D.R.; Cinner, J.; Cumming, G.; Jackson, J.B.C.; Kleypas, J.; Van De Leemput, I.A.; Lough, J.M.; Morrison, T.; et al. Coral reefs in the Anthropocene. *Nat. Cell Biol.* **2017**, *546*, 82–90. [[CrossRef](#)]
6. Costanza, R.; D’Arge, R.; De Groot, R.; Farber, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem, S.; O’Neill, R.V.; Paruelo, J.M.; et al. The value of the world’s ecosystem services and natural capital. *Nat. Cell Biol.* **1997**, *387*, 253–260. [[CrossRef](#)]
7. Millennium Ecosystem Assessment Program. *Ecosystems and Human Well-Being*; Island Press: Washington, DC, USA, 2005.
8. Sandifer, P.; Sutton-Grier, A. Connecting stressors, ocean ecosystem services, and human health. *Nat. Resour. Forum* **2014**, *38*, 157–167. [[CrossRef](#)]
9. Ford, A.E.S.; Graham, H.; White, P.C.L. Integrating Human and Ecosystem Health Through Ecosystem Services Frameworks. *EcoHealth* **2015**, *12*, 660–671. [[CrossRef](#)] [[PubMed](#)]
10. Jackson, L.E.; Daniel, J.; McCorkle, B.; Sears, A.; Bush, K.F. Linking ecosystem services and human health: The Eco-Health Relationship Browser. *Int. J. Public Health* **2013**, *58*, 747–755. [[CrossRef](#)] [[PubMed](#)]
11. Binder, C.R.; Hinkel, J.; Bots, P.W.G.; Pahl-Wostl, C. Comparison of Frameworks for Analyzing Social-ecological Systems. *Ecol. Soc.* **2013**, *18*, 26. [[CrossRef](#)]
12. Marshall, K.N.; Levin, P.S.; Essington, T.E.; Koehn, L.E.; Anderson, L.G.; Bundy, A.; Carothers, C.; Coleman, F.; Gerber, L.R.; Grabowski, J.H.; et al. Ecosystem-Based Fisheries Management for Social-Ecological Systems: Renewing the Focus in the United States with Next Generation Fishery Ecosystem Plans. *Conserv. Lett.* **2017**, *11*, 1–7. [[CrossRef](#)]
13. Karnauskas, M.; Walter, J.F.; Kelble, C.R.; McPherson, M.; Sagarese, S.R.; Craig, J.K.; Rios, A.; Harford, W.J.; Regan, S.; Giordano, S.D.; et al. To EBFM or not to EBFM? That is not the question. *Fish Fish.* **2021**, *22*, 646–651. [[CrossRef](#)]
14. Levin, P.S.; Breslow, S.J.; Harvey, C.J.; Norman, K.C.; Poe, M.R.; Williams, G.D.; Plummer, M.L. Conceptualization of Social-Ecological Systems of the California Current: An Examination of Interdisciplinary Science Supporting Ecosystem-Based Management. *Coast. Manag.* **2016**, *44*, 397–408. [[CrossRef](#)]
15. Weijerman, M.; Grace-McCaskey, C.; Grafeld, S.L.; Kotowicz, D.M.; Oleson, K.L.; Van Putten, I.E. Towards an ecosystem-based approach of Guam’s coral reefs: The human dimension. *Mar. Policy* **2016**, *63*, 8–17. [[CrossRef](#)]
16. NOAA. *Coral Reef Conservation Act, 16 U.S.C. §§ 6401 et seq*; NOAA: Washington, DC, USA, 2000.
17. Coral Reef Conservation Program. *National Coral Reef Monitoring Plan*; National Oceanic and Atmospheric Administration Coral Reef Conservation Program: Silver Spring, MD, USA, 2014.
18. Lovelace, S.; Dillard, M. *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, USA, 2012.
19. Loomis, D.K.; Paterson, S. Human dimensions indicators of coastal ecosystem services: A hierarchical perspective. *Ecol. Indic.* **2014**, *44*, 63–68. [[CrossRef](#)]
20. Loomis, D.; Ortner, P.; Kelble, C.; Paterson, S.S.K. Developing ecosystem indices. *Ecol. Indic.* **2014**, *44*, 57–62. [[CrossRef](#)]
21. Ferriss, A. The Uses of Social Indicators. *Soc. Forces* **1988**, *66*, 601–617. [[CrossRef](#)]
22. Brander, L.M.; van Beukering, P.; Cesar, H.S. The recreational value of coral reefs: A meta-analysis. *Ecol. Econ.* **2007**, *63*, 209–218. [[CrossRef](#)]
23. Oleson, K.L.; Bagstad, K.J.; Fezzi, C.; Barnes, M.D.; Donovan, M.K.; Falinski, K.A.; Gorospe, K.; Htun, H.; Lecky, J.; Villa, F.; et al. Linking Land and Sea Through an Ecological-Economic Model of Coral Reef Recreation. *Ecol. Econ.* **2020**, *177*, 106788. [[CrossRef](#)]
24. Marshall, N.; Marshall, P.A.; Abdulla, A.; Roupahel, T. The Links Between Resource Dependency and Attitude of Commercial Fishers to Coral Reef Conservation in the Red Sea. *Ambio* **2010**, *39*, 305–313. [[CrossRef](#)] [[PubMed](#)]
25. Loerzel, J.L.; Goedeke, T.L.; Dillard, M.K.; Brown, G. SCUBA divers above the waterline: Using participatory mapping of coral reef conditions to inform reef management. *Mar. Policy* **2017**, *76*, 79–89. [[CrossRef](#)]
26. Agar, J.; Shivilani, M.; Fleming, C.; Solís, D. Small-scale fishers’ perceptions about the performance of seasonal closures in the commonwealth of Puerto Rico. *Ocean Coast. Manag.* **2019**, *175*, 33–42. [[CrossRef](#)]
27. Linkhart, D. Civic Engagement for Environmental Sustainability. *Natl. Civ. Rev.* **2018**, *107*, 65–71.
28. Farber, S.; Costanza, R.; Childers, D.; Erickson, J.D.; Gross, K.; Grove, M.; Hopkinson, C.; Kahn, J.; Pincetl, S.; Troy, A.; et al. Linking Ecology and Economics for Ecosystem Management. *Bioscience* **2006**, *56*, 121–133. [[CrossRef](#)]

29. N.C.R.I. System. *National Coral Reef Monitoring Program: Understanding Socioeconomic Connections*; National Ocean Service, Coral Reef Conservation Program: Silver Spring, MD, USA, 2021. Available online: <https://www.coris.noaa.gov/monitoring/socioeconomic.html> (accessed on 18 June 2021).
30. Levine, A.S.; Dillard, M.K.; Loerzel, J. *National Coral Reef Monitoring Program Socioeconomic Monitoring Component. Summary Findings for American Samoa*; NOAA Technical Memorandum CRCP 24; Coral Reef Conservation Program: Silver Spring, MD, USA, 2014. [[CrossRef](#)]
31. Gorstein, M.; Dillard, M.; Loerzel, J.; Edwards, P.; Levine, A.S. *National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for South Florida, 2014*; NOAA Technical Memorandum NOAA-TM-NOS-CRCP-25; US Department of Commerce: Silver Spring, MD, USA, 2016.
32. Gorstein, M.; Loerzel, J.; Levine, A.; Edwards, P.; Dillard, M. *National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for Hawai'i, 2015*; NOAA Technical Memorandum NOAA-TM-NOS-CRCP-30; US Department of Commerce: Silver Spring, MD, USA, 2018.
33. Gorstein, M.; Loerzel, J.; Edwards, P.; Levine, A.; Dillard, M. *National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for Puerto Rico, 2015*; NOAA Technical Memorandum NOAA-TM-NOS-CRCP-28; US Department of Commerce: Silver Spring, MD, USA, 2017.
34. Gorstein, M.; Loerzel, J.; Levine, A.; Edwards, P.; Dillard, M. *National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for Guam, 2016*; NOAA Technical Memorandum NOAA-TM-NOS-CRCP-32; US Department of Commerce: Silver Spring, MD, USA, 2018.
35. Gorstein, M.; Loerzel, J.; Edwards, P.; Levine, A.; Dillard, M. *National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for CNMI, 2016*; NOAA Technical Memorandum NOAA-TM-NOS-CRCP-34; US Department of Commerce: Silver Spring, MD, USA, 2019.
36. Gorstein, M.; Loerzel, J.; Edwards, P.; Levine, A. *National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for USVI, 2017*; NOAA Technical Memorandum NOAA-TM-NOS-CRCP-35; US Department of Commerce: Silver Spring, MD, USA, 2019.
37. Gigliotti, L.M. Environmental Education: What Went Wrong? What can be Done? *J. Environ. Educ.* **1990**, *22*, 9–12. [[CrossRef](#)]
38. Petty, R.E.; Cacioppo, J.T. Communication and Persuasion: Central and Peripheral Routes to Attitude Change. *Am. J. Psychol.* **1988**, *101*, 155. [[CrossRef](#)]
39. Petty, R.; Brinol, P.; Priester, J. Mass media attitude change: Implications of the elaboration likelihood model of persuasion. In *Media Effects: Advances in Theory and Research*; Bryant, J., Oliver, M., Eds.; Taylor & Francis: New York, NY, USA, 2009.
40. Wagner, B.; Petty, R. The elaboration likelihood model of persuasion: Thoughtful and non-thoughtful social influence. In *Theories in Social Psychology*; Chadee, D., Ed.; Wiley Blackwell: London, UK, 2011; pp. 96–116.
41. Leong, K.; Torres, A.; Wise, S.; Hospital, J. *Beyond Recreation: When Fishing Motivations Are More Than Sport or Pleasure*; NOAA Admin Report H-20-05; NOAA PIFSC: Honolulu, HI, USA, 2020.
42. Zeller, D.; Harper, S.; Zyllich, K.; Pauly, D. Synthesis of underreported small-scale fisheries catch in Pacific island waters. *Coral Reefs* **2014**, *34*, 25–39. [[CrossRef](#)]
43. Grafeld, S.; Oleson, K.L.L.; Teneva, L.; Kittinger, J.N. Follow that fish: Uncovering the hidden blue economy in coral reef fisheries. *PLoS ONE* **2017**, *12*, e0182104. [[CrossRef](#)]
44. Gregg, T.M.; Mead, L.; Burns, J.H.R.; Takabayashi, M. Puka Mai He Ko'a: The Significance of Corals in Hawaiian Culture. In *Ethnobiology of Corals and Coral Reefs. Ethnobiology*; Narchi, N., Price, L., Eds.; Springer: Cham, Switzerland, 2015; pp. 103–115.
45. Kiousopoulos, J. Anthropogenic intensity' and 'coastality': Two new spatial indicators for exploring and monitoring the coastal areas, in the framework of environmental management. In *Environmental Management*; Sarkar, K., Ed.; Sciyo: Rijeka, Croatia, 2010; p. 258.
46. NOAA. Coastal Puerto Rico. Available online: <https://coast.noaa.gov/states/puerto-rico.html> (accessed on 21 July 2021).
47. Gregory, R.; Gonzalez, J. *Protecting the Guánica Bay Watershed: A Public Values Forum*; Guánica Bay Public Values Forum, Final Workshop Report; Value Scope Research: Vancouver, BC, Canada, 2013.
48. Bradley, P.; Fisher, W.; Dyson, B.; Yee, S.; Carriger, J.; Gambirazzio, G.; Bousquin, J.; Huertas, E. *Application of a Structured Decision Process for Informing Watershed Management Options in Guánica Bay, Puerto Rico*; EPA/600/R-15/248; Narragansett, R.I., Ed.; U.S. Environmental Protection Agency, Office of Research and Development: Washington, DC, USA, 2016.
49. Bennett, N.; Di Franco, A.; Calo, A.; Nethery, E.; Niccolini, F.; Milazzo, M.; Guidetti, P. Local support for conservation is associated with perceptions of good governance, social impacts, and ecological effectiveness. *Conserv. Lett.* **2019**, *12*, e12640. [[CrossRef](#)]
50. SOCMON. *Global Socioeconomic Monitoring Initiative for Coastal Management (SocMon/SEM-Pasifika), Strategic Plan*; NOAA: Silver Spring, MD, USA, 2014.
51. Edwards, P.; Pena, M.; Medeiros, R.; McConney, P. Socioeconomic Monitoring for Sustainable Small-Scale Fisheries: Lessons from Brazil, Jamaica, and St. Vincent and the Grenadines. In *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*; MARE Publication Series; Salas, S., Barragán-Paladines, M., Chuenpagdee, R., Eds.; Springer: Cham, Switzerland, 2019; Volume 19.
52. Pena, M.; McConney, P.; Blackman, K. Common Socio-economic monitoring indicators for Caribbean Challenge MPAs. In *Proceedings of the 65th Gulf and Caribbean Fisheries Institute, Santa Maria, Colombia, 5–9 November 2012*.

53. Bennett, N.; Roth, R.; Klain, S.C.; Chan, K.; Christie, P.; Clark, D.A.; Cullman, G.; Curran, D.; Durbin, T.J.; Epstein, G.; et al. Conservation social science: Understanding and integrating human dimensions to improve conservation. *Biol. Conserv.* **2017**, *205*, 93–108. [[CrossRef](#)]
54. Hicks, C.C.; Levine, A.; Agrawal, A.; Basurto, X.; Breslow, S.J.; Carothers, C.; Charnley, S.; Coulthard, S.; Dolsak, N.; Donatuto, J.; et al. Engage key social concepts for sustainability. *Science* **2016**, *352*, 38–40. [[CrossRef](#)]
55. Smith, H.D. The role of the social sciences in capacity building in ocean and coastal management. *Ocean Coast. Manag.* **2002**, *45*, 573–582. [[CrossRef](#)]
56. Edwards, P.; Levine, A.; Dillard, M.; Loerzel, J. *NOAA Coral Reef Conservation Program Social Science Strategy, 2016–2021*; Coral Reef Conservation Program, National Ocean Service: Silver Spring, MD, USA, 2016.
57. Donovan, C.; Towle, E.; Kelsey, H.; Allen, M.; Barkley, M.; Besemer, N.; Blondeau, J.; Eakin, M.; Edwards, K.; Enochs, I.; et al. *Coral Reef Condition: A Status Report for U.S. Coral Reefs*; NOAA Coral Reef Conservation Program: Silver Spring, MD, USA; University of Maryland Center for Environmental Science: Cambridge, MD, USA, 2020.
58. Allen, M.; Fleming, C.; Zito, N.; Gonyo, S.; Regan, S.; Towle, E. *National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for South Florida, 2019*; U.S. Department of Commerce, NOAA: Silver Spring, MD, USA, 2020.