NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AND THE UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE

2018 Status Report Scoring Methodology for Pacific Jurisdictions

Indicator calculations and scoring for coral reef status reports of the Pacific jurisdictions: American Samoa, Hawaiian Archipelago, Pacific Remote Islands, Guam, and Northern Mariana Islands

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I. Background

The motivation behind status and trends reporting

The National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP) invests significant funds to support a National Coral Reef Monitoring Program (NCRMP) throughout the U.S. Pacific, Atlantic, Gulf of Mexico, and Caribbean coral reef areas. A key component of this program is a periodic, national-level assessment on the status and trends of U.S. coral reef areas. To develop and implement this report framework, CRCP partnered with the Integration and Application Network (IAN) at the University of Maryland Center for Environmental Science (UMCES). The framework, termed herein a status report, is based on the timely and transparent assessment of biophysical and human dimension indicators against reference and assessment points, which are synthesized into overall condition scores for each jurisdiction. The primary purpose of the CRCP status report products is to communicate the status and trends of U.S. coral reefs to Congress, NOAA leadership, and the interested public. The primary purpose of this document is to describe the scoring process used for all the Pacific jurisdictions: American Samoa, Hawaiian Archipelago, Pacific Remote Islands, Guam, and Northern Mariana Islands.

Ecosystem condition assessments are a common approach to synthesizing a large amount of ecosystem monitoring data into a public-friendly report that can be understood by decision makers, managers, and scientists alike. Fundamentally, status reports help answer the question “How is the ecosystem doing?” The goals of a status report are to: provide a broad-level assessment, communicate complex information, use real data, and engage communities. These assessments are produced by a variety of groups from small, community–based organizations to regional management agencies, to large international partnerships. To advance this effort, CRCP and IAN-UMCES brought together science experts, natural resource managers, and other stakeholders from NOAA and local jurisdictions in order to develop biological, climatological, and human connection indicators and reference/assessment points for coral reefs.

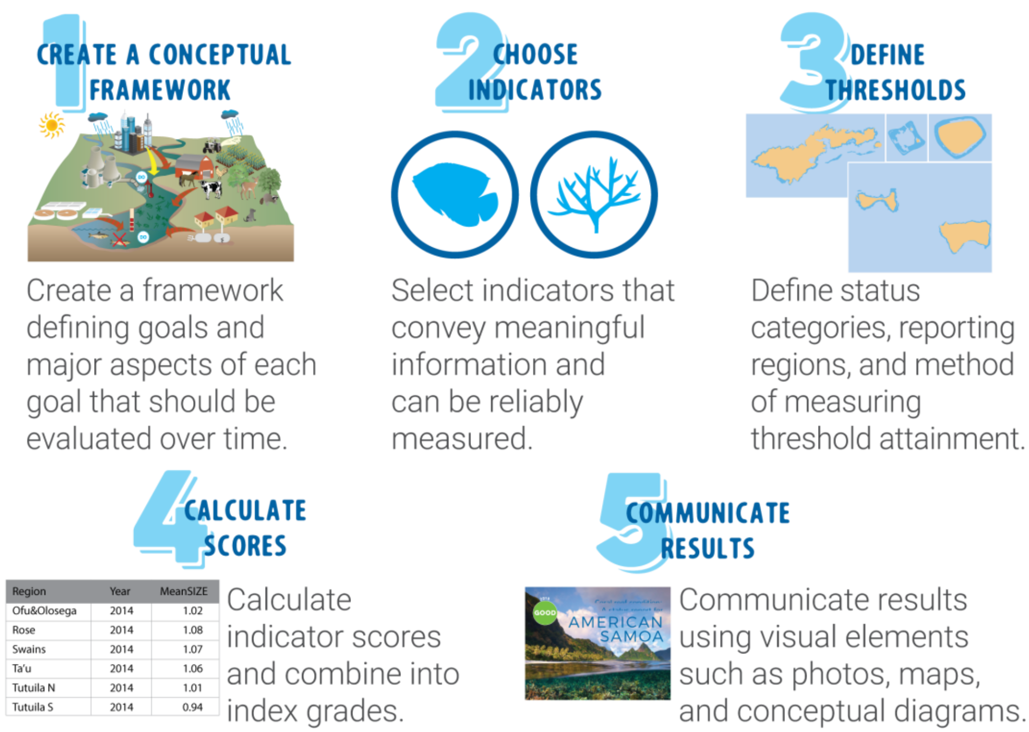
In the case of the CRCP and IAN-UMCES partnership to develop a coral reef status report, there was an identified need to summarize and communicate coral reef monitoring in the U.S. jurisdictions and create a framework to support continued reporting. These assessments provide the status of U.S. coral reef areas in order to track change over time and are evaluating ecosystem condition, not management efforts or restoration success. The goals stated above are accomplished by producing a simple and concise product that tells the story of coral reefs using effective visual and narrative elements. All jurisdictions were assessed on coral & algae, fish, climate, and human connections indicators. To allow for regionally and context specific baselines, the scoring of indicators is unique to each jurisdiction. Reference and assessment points against which data is evaluated are developed based on literature review, regulatory guidelines, institutional goals, biological limits, reference conditions, historical benchmarks, and expert judgement. These reference and assessment points are determined by a group of experts—scientists and managers—from NOAA and local jurisdictional agencies. By developing jurisdiction-specific reference and assessment points, indicator scores are representative of that system. By using the same indicators across jurisdictions, indicator scores are comparable.

The data used in the scoring process is restricted to NCRMP data. Localized data, such as those collected by jurisdictional agencies, are not included in the scoring of indicators. This is because blending data that are collected under different sampling designs and/or different sampling methodologies is difficult. In the absence of a targeted calibration exercise that would allow for integrating disparate datasets, we focus here on the NCRMP data that is designed to monitor coral reefs at a jurisdictional scale. It is a goal of future efforts to include this other data in indicator scoring. However, local long-term data products are included when possible as a time-series or highlight story. Highlight stories are meant to message locally relevant information.

Create a conceptual framework

The first step in developing a status report is to conceptualize the ecosystem and determine the threats to that system and the parts of the system that people value. A two-day stakeholder engagement workshop, which includes not only decision makers and managers of the systems, but also the scientists that gather and analyze data in the region, is critical to creating buy-in and support for the assessment process and final product. Workshops were held for each jurisdiction. These workshops brought together scientists, managers, and decision makers to determine the conceptual framework, potential indicators and thresholds, and draft layout of the report.

This 5-Step process was used to create the status reports:



II. Pacific jurisdictions with reef areas

American Samoa

American Samoa is an unincorporated United States Territory in the South Pacific. The Territory consists of five volcanic islands and two atolls, all of which are surrounded by fringing coral reefs. American Samoa was divided into six regions based on geographic location and data availability. The six regions are North Tutuila, South Tutuila, Ta‘u, Swains Island, Ofu & Olosega, and Muliava/Rose Atoll.

American Samoa Status report regions and areas. Note that the total area for each reporting region is the hardbottom forereef habitat less than 30 meters in depth:

Region	**Area (km²)**
North Tutuila	19.23
South Tutuila	21.61
Ta‘u	9.04
Ofu & Olosega	7.93
Swains	2.81
Muliava (Rose Atoll)	1.20

Hawaiian Archipelago

The Hawaiian Archipelago includes the state of Hawai‘i and the Northwestern Hawaiian Islands. The archipelago consists of volcanic islands, atolls, and seamounts that stretch over 1500 miles from southeast to northwest. For the status report, there are two main regions, the Main Hawaiian Islands (the State of Hawai‘i) and the Northwestern Hawaiian Islands. The Main Hawaiian Islands were further sub-divided into four regions based on geographic location and data availability. The four regions are O‘ahu, Hawai‘i, Maui Nui, and Kaua‘i + Ni‘ihau.

Hawaiian Archipelago Status report Main Hawaiian Islands regions and areas. Note that the total area for each reporting region is the hardbottom forereef habitat less than 30 meters in depth:

Region	**Area (km²)**
O‘ahu	251.19
Hawai‘i	168.40
Maui Nui	280.56
Kaua‘i and Ni‘ihau	273.93

Hawaiian Archipelago Status report Northwestern Hawaiian Islands regions and areas. Note that the total area for each reporting region is the hardbottom forereef habitat less than 30 meters in depth:

Region	Area (km^2)
French Frigate	169.02
Kure	24.39
Laysan	33.996
Lisianski	309.55
Maro	256.07
Midway	32.94
Pearl & Holmes	84.98

Pacific Remote Islands

Pacific Remote Islands Status report regions and areas. Note that the total area for each reporting region is the hardbottom forereef habitat less than 30 meters in depth:

Region	Area (km^2)
Johnston	65.74
Kingman Palmyra	49.78
Howland Baker	5.63
Jarvis	3.66
Wake	2.80

Guam

Guam Status report regions and areas. Note that the total area for each reporting region is the hardbottom forereef habitat less than 30 meters in depth:

Region	Area (km^2)
Western Guam	22.30
Eastern Guam	21.13
Marine Protected Areas	7.70

Northern Mariana Islands

Located just north of Guam in the Western Pacific, the Northern Mariana Islandsis a three-hundred-mile archipelago consisting of 14 islands. The Northern Mariana Islandswere divided into four sub-regions, Saipan, Tinian, and Aguijan, Northern Islands, Rota, and National Monument.

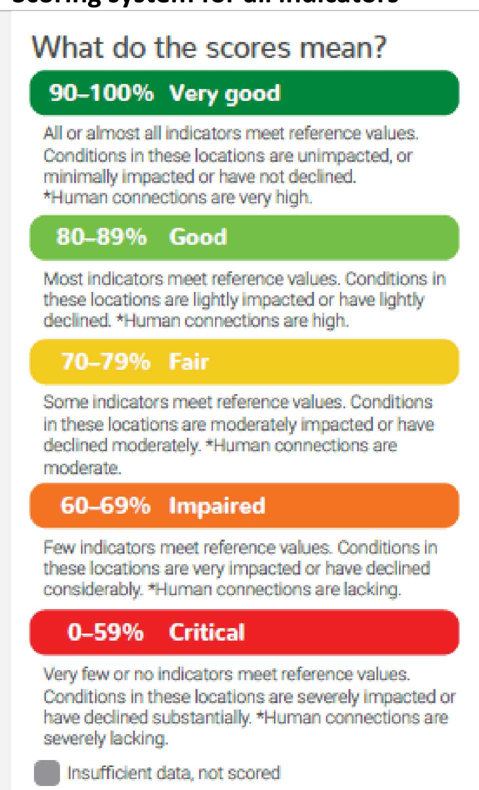
Northern Mariana IslandsStatus report regions and areas. Note that the total area for each reporting region is the hardbottom forereef habitat less than 30 meters in depth:

Region	Area (km^2)
Saipan, Tinian, Aguijan	53.59
Northern Islands	31.07
Rota	13.31
National Monument	7.01

III. Indicator Development

NOAA's National Coral Reef Monitoring Program defines its four main monitoring data themes in its monitoring plan (NOAA, 2014). The four themes are fish, benthos, climate, and human connections monitoring with associated indicators within each theme. During the initial workshop, presentations of available data were given by experts followed by breakout sessions to determine appropriate indicators for this product within each theme (fish, benthos, climate, and human connections). The criteria which experts used to choose indicators were: 1) data availability, 2) sufficient understanding of reference conditions, and 3) importance to overall ecosystem health. These indicators were refined over months of discussion between different groups, jurisdictions, and NOAA headquarters.

Coral reef status report indicators, indicator categories, and scoring system.

Indicators	Indicator categories	Scoring system for all indicators
Coral reef cover	Coral and algae	
Coral populations		
Herbivory		
Mortality		
Diversity (not scored)		
Reef fish	Fish	
Sustainability		
Sharks and other predators		
Diversity (not scored)		
Temperature stress	Climate	
Ocean acidification		
Reef material growth		
Awareness	Human Connections	
Support for management actions		
Pro-environmental behavior		

Define reference and assessment points

The reference point (or baseline) is the value against which the current status is evaluated. The reference points for all fish and climate indicators were chosen to represent an historical or pre-human impact condition. For benthic indicators, the reference points were either a combination of expert opinion, published literature, or the best available data. Human Connection reference and assessment points were chosen differently – please refer to that section for more information. Assessment points are the breakpoints used to determine different scoring bins. Reference and assessment points can be determined in several ways, including using regulatory criteria assessment, established management goals, literature reviews of best practices, and expert opinions. At each of the workshops, breakout groups proposed potential ideas for assessment of specific indicators. Most of the reference and assessment points were determined through a series of exploratory data analyses with input from a variety of stakeholders in each jurisdiction.

IV. Indicators and scoring process

The following sections detail the process by which individual indicators for each Pacific jurisdiction were scored. The sections are organized by theme – coral and algae (benthos), fish, climate, and human connections. Scores are calculated on a 0-100% scale, with descriptive words and narrative text accompanying each score.

Corals and Algae (Benthos)

Indicators in this theme include: Coral reef cover (coral cover, algal cover and CCA cover), coral populations (juvenile and adult coral density), partial mortality of adult corals, herbivory, and diversity.

Coral cover, crustose coralline algae cover, and macroalgae cover are averaged and reported as coral reef cover. Juvenile density and adult density scores are averaged, but are shown as individual scores on the status report. The overall coral and algae score consists of the average of coral reef cover, coral populations (density), partial mortality, and herbivory.

The goal was to include a limited number of metrics that provide stable indicators of coral population and benthic community status, and can be tracked over time with NCRMP data. Surveys were located using a stratified-random survey design with the survey domain being all hard bottom forereef habitat from 0-30 m.

Coral reef cover indicator (benthic cover)

Raw benthic cover data are derived from the analysis of benthic photos collected at all coral and fish survey sites. Coral reef cover includes three sub-indicators: percent coral cover, percent crustose coralline algae (CCA) cover, and percent macroalgae cover. For some islands lacking analyzed benthic imagery, the benthic cover indicator metric was derived from visual estimates collected at the fish survey sites.

Adult and juvenile coral density

Juvenile and adult coral densities are measures of the population's ability to reproduce and sustain itself. Juvenile coral density was included in this status report to provide additional information about the potential outlook for these coral populations – Are there babies on the reef that will potentially grow into adults?

Raw coral colony density data is derived from benthic demographic surveys conducted at each site (see table below) within two, 18-m belt transects. Adult coral colonies (≥ 5 cm) were surveyed within 4, 1 x 2.5 m^2 segments (total of 10 m^2) on each transect. Adult colonies were identified to genus or species and measured (maximum diameter) to the nearest cm. Juvenile coral colonies (< 5 cm) were surveyed within 3, 1 m^2 segments (total 3 m^2) on each transect and identified in the field by a distinct features that distinguished them from asexual fragments of larger adult colonies. Each juvenile colony was identified to the lowest taxonomic level possible (genus or species) and measured (both the maximum and perpendicular diameter to the nearest 2 mm).

Partial mortality

Partial mortality is a measure of cumulative mortality and may be a proxy for loss of reproductive biomass within coral populations. The adult coral partial mortality indicator was calculated as mean 'old dead' percent. Old dead mortality is defined as the non-living portion of a colony where the skeletal structures are either eroded or covered over by organisms that are not easily removed. This portion of the colony is where the live tissue is presumed to have died within the last few months to years or longer and has a low probability of tissue recovery.

Raw coral partial mortality data is derived from the same surveys conducted to assess adult coral colony densities (as above), whereby for each adult colony assessed partial colony mortality is visually quantified as the percent of dead tissue.

Herbivory

This herbivory indicator is a measure of the level of feeding pressure by fish on corals and algae. While the herbivory indicator is included as a benthic indicator, the sampling data, methodologies and scoring follow the same protocols as the reef fish biomass indicator (see that section). The status of each region was scored based on a study published in 2015 that used data from these islands and >30 others in the U.S. Pacific, and which assessed the importance of a range of human, oceanographic (e.g. temperature, oceanic productivity) and habitat drivers (e.g. coral cover, habitat structural complexity). That study estimated what 'baseline biomass' would be at each location in the absence of humans – i.e. what would be natural for each location, based entirely on its oceanographic and habitat setting (Williams et al PLoS One, 2015). For the herbivory indicator, local and baseline biomass are for those species classified as 'primary consumers', which include parrotfishes, chub, most surgeonfishes, as well as a number of other mostly small fishes such as some damselfishes.

Diversity

Biodiversity is the complex variety of life within our ecosystems that forms the foundation for the vast array of ecosystem services that contribute to human well-being. Each of the many 1000s of species occupying coral reefs provide essential ecological functions that maintain ecosystem health. Since different related species often play similar and redundant functional roles but have levels of sensitivity to certain stressors, reefs with higher levels of biodiversity tend to have increased functional redundancy and likelihood of reef survival during episodic disturbance events, such as disease outbreaks or coral bleaching. Hence, biodiversity serves as a useful indicator of ecological resilience and the ability to survive or recover from disturbance events.

At the time of the status report process, we were not yet able to come to consensus on appropriate biodiversity thresholds that relate meaningfully to scores for ecosystem health. In future status reports, however, biodiversity will hopefully be developed into a scored indicator.

American Samoa

Data collected in 2015 were used for the current status report.

Coral reef cover indicator (benthic cover)

Coral reef cover includes three sub-indicators: percent coral cover, percent crustose coralline algae (CCA) cover, and percent macroalgae cover. Each of these sub-indicators followed a similar scoring process. Benthic cover estimates were calculated for each site. The site-specific percent cover estimates were pooled by sector and area weighted to provide an island-wide or sector-wide mean. These area-weighted benthic cover estimates were scored using criteria below. Island/sector- wide means were area-weighted by percent forereef habitat when rolled up to the jurisdiction-level.

For American Samoa, reference and assessment points were chosen using expert judgement by the NOAA Pacific Islands Fisheries Science Center, Ecosystem Sciences Division benthic team (Bernardo Vargas-Ángel and Dione Swanson) and reviewed by a larger expert group of partners and collaborators.

Number of sampling sites for all benthic cover indicator data (coral and fish survey sites).

Island or sector	# of sites
South Tutuila	142
North Tutuila	104
Ofu & Olosega	82
Muliava (Rose Atoll)	76
Taʻu	67
Swains	50

Coral cover

For corals, a maximum of 50% and above was considered very good based on expert opinion, while <10% was considered a critical condition.

Coral cover assessment points and associated scoring. The score is determined using an equation that relates coral cover to a percent score.

Coral cover (%)	Score (%)	Equation
≥50	100	Y=100
40-<50	90-<100	Y=x+50
30-<40	80-<90	Y=x+50
20-<30	70-<80	Y=x+50
10-<20	60-<70	Y=x+50
0-<10	0-<60	Y=6x

CCA cover

For CCA, a maximum of 30% and above was considered very good based on expert opinion, while <2% was considered severely deteriorated (critical).

Crustose coralline algae assessment points and associated scoring. The score is determined using an equation that relates crustose coralline algae cover to a percent score.

CCA cover (%)	Score (%)	Equation
≥30	100	Y=100
20-<30	90-<100	Y=x+70
10-<20	80-<90	Y=x+70
5-<10	70-<80	Y=2x+60
2-<5	60-<70	Y=3.33x+53.33
0-<2	0-<60	Y=30x

Macroalgal cover

For macroalgae a reverse scale was set, whereby lower macroalgal levels scored higher. As such, macroalgal cover of 2.5% or less was considered very good while 30% and above was considered a critical reef condition.

Macroalgae assessment points and associated scoring. The score is determined using an equation that relates macroalgal cover to a percent score. For macroalgae, this is a negative relationship (more macroalgae receives a worse score).

Macroalgae (%)	Score (%)	Equation
≤2.5	100	Y=100
>2.5-5	90-<100	Y=-4x+110
>5-10	80-<90	Y=-2x+100
>10-20	70-<80	Y=-x+90
>20-30	60-<70	Y=-x+90
>30	0-<60	Y=-6x+240

Adult and juvenile coral density

The juvenile and adult coral density indicators were generated from a select list of the most abundant and ecologically relevant taxa represented across all islands within the region. The use of the selected taxa (genera and species) provides information about existing coral populations and incorporates a mechanism to determine how coral populations are changing over time (fluctuations in one or more of the most abundant or important taxa). The selected 10 genera and 4 species that were used to generate estimates for the coral population indicators are listed in the table below.

Number of sampling sites for all benthic population indicator data.

Island or sector	# of sites
South Tutuila	48
North Tutuila	41
Ofu & Olosega	31
Muliava (Rose Atoll)	11
Taʻu	21
Swains	18

The juvenile and adult coral density indicators were generated from a select list of abundant and important coral genera and species represented across all islands within the region. The use of the selected taxa (genera and species) provides information about existing coral populations and incorporates a mechanism to determine how coral populations are changing over time (fluctuations in one or more of the most abundant or important taxa). The following 10 genera and 4 species were used to generate estimates for the coral population indicators:

Genera
Acropora
Astreopora
Galaxea
Goniastrea
Isopora
Montipora
Pavona
Pocillopora
Porites
Psammocora

Species
Astreopora myriophthalma
Galaxea fascicularis
Astrea curta
Pavona varians

Throughout the literature, there are not clear benchmarks to establish reference and assessment points for density of juvenile and adult corals due to the natural variability in abundance across habitat space. Island and sector level scores for adults and juveniles were calculated similar to percent cover in American Samoa using the following steps.

1. Reef area-weighted island and sector density estimates were generated from strata means for each of the 10 genera and 4 species listed above for 2015 when the stratified random surveys were conducted.
2. The score was calculated as a percent of the maximum island or sector density as follows:
    a. Taxon density score (%) = (taxon A density estimate for island A / maximum island or sector density estimate for taxon A) * 100.
    b. The scores were average across all taxa for a given island or sector.
    c. The scores were then converted to a 0-100% scale.

Coral population density assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum density to a percent score.

Coral population (colonies per square meter)	Score (%)	Equation
60-100	90-100	Y=0.25x+75
40-<60	80-<90	Y=0.50x+60
20-<40	70-<80	Y=0.50x+60
10-<20	60-<70	Y=x+50
0-<10	0-<60	Y=6x

The bins were truncated at the lower range as a conservative approach to account for habitat specific difference in density for adults and juveniles. For example, some habitats have naturally low coral density and low density of juveniles can co-occur with high adult density because the amount of available space for settlement is low.

Partial mortality

The partial mortality indicator was generated from the same select list of abundant and important coral species and genera used for juvenile and adult density.

Similar to colony density, there are not clear benchmarks for thresholds of partial mortality estimates other than low values are good and higher values may be bad. In the process of threshold development, we evaluated the range in island estimates in American Samoa as well as other regions in the Pacific and Atlantic. The maximum of the range was set at 30% for all genera and species. This represents a conservative approach but hopefully can indicate significant shifts in partial mortality.

Mean partial mortality scores were generated for each genus and species using the following formula for each taxon and each island or sector:

Taxon partial mortality score (%) = (taxon A partial mortality estimate for island A (%)) / 30 %) * 100.

Mean scores were then calculated from the 10 genera and 4 species for each island and sector.

Coral mortality assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum mortality to a percent score. For mortality, this is a negative relationship (more mortality receives a worse score).

Coral mortality (%)	Score (%)	Equation
0-20	>90-100	Y=-0.5x+100
20-<40	80-<90	Y=-0.5x+100
40-<60	70-<80	Y=-0.5x+100
60-<80	60-<70	Y=-0.5x+100
80-100	0-<60	Y=-3x+300

Hawaiian Archipelago

In the Main Hawaiian Islands, data collected in 2016 were used for the current status report. For the Northwestern Hawaiian Islands, the data collected from a combination of survey efforts was used for the status report to provide the most recent estimates for each island across the Northwestern portion of the archipelago. These survey years include 2010 through 2016.

To account for differences in how benthic communities form across a range of habitats (e.g. coral-rich, pavement, rock and bolder), the benthic maps in the main Hawaiian Islands are divided into sectors of broad reef structure which include coral-rich (e.g. aggregate reef, spur and groove), complex (e.g. rock and boulder), and simple (e.g. pavement). Sites within each sector and island were classified by these habitat types.

In the Northwestern Hawaiian Islands, mapped benthic habitats are currently unreliable. Instead we used diver visual habitat classifications between 2010 and 2016 to calculate the percent of sites for a given island that fell within certain habitat structure types. We then assigned each island a habitat structure type if greater than 50% of the sites were classified of that habitat structure. Habitat structure types consisted of coral-rich (e.g. aggregate reef, spur and groove) and simple (e.g. pavement) for the islands included in this status report.

Coral reef cover indicator (benthic cover)

Coral reef cover includes three sub-indicators: percent coral cover, percent crustose coralline algae (CCA) cover, and percent macroalgae cover. Each of these sub-indicators followed a similar scoring process. Average benthic cover estimates were calculated for each site. The site-specific percent cover estimates were pooled by depth stratum, averaged, and stratum area weighted to provide an island-wide or sector-wide mean. These area-weighted benthic cover estimates were scored using criteria below. Island/sector- wide means were area-weighted by percent forereef habitat when rolled up to Main Hawaiian Island –wide level and Northwestern Hawaiian Island –wide level.

For each sub-indicator, the most recent percent cover values for a given island or sector were compared to the maximum island or sector-level value reported between 2013 and 2016 for the Main Hawaiian Islands and between 2010 and 2016 for the Northwestern Hawaiian Islands. These were categorized for a given habitat structure to calculate the percent of maximum. In other words, islands dominated by coral-rich habitats were only compared to other coral-rich islands. The percent of maximum values were then converted to a 0–100% scale using the equations listed in the tables below. For macroalgae, this is a negative relationship (more macroalgae receives a worse score). To calculate scores for macroalgae the 60–100% scores were inverted so that 0% max = 100%.

Number of sampling sites for all benthic cover indicator data (coral and fish survey sites). The number of sites are listed for Main Hawaiian Islands (MHI) and Northwestern Hawaiian islands (NWHI). CR= Coral Rich, CM= Complex, SI= Simples

OBS_YEAR	REGION	ISLAND	Habitat	n
2013	MHI	Hawaii	CM	58
2013	MHI	Hawaii	CR	22
2013	MHI	Kauai	SI	50
2013	MHI	Lanai	CM	21
2013	MHI	Lanai	CR	22
2013	MHI	Maui	CM	28
2013	MHI	Maui	SI	12
2013	MHI	Molokai	CM	21
2013	MHI	Molokai	CR	17
2013	MHI	Molokai	SI	21
2013	MHI	Niihau	CM	7
2013	MHI	Niihau	SI	36
2013	MHI	Oahu	SI	22
2013	MHI	Oahu	SI	74
2015	MHI	Hawaii	CM	32
2015	MHI	Hawaii	CR	65
2015	MHI	Kauai	SI	20
2015	MHI	Lanai	CM	15
2015	MHI	Maui	CM	28
2015	MHI	Maui	SI	2
2015	MHI	Molokai	CR	32
2015	MHI	Molokai	SI	16
2015	MHI	Niihau	CM	15
2015	MHI	Niihau	SI	33
2015	MHI	Oahu	SI	1
2015	MHI	Oahu	SI	34
2016	MHI	Hawaii	CM	36
2016	MHI	Hawaii	CR	54
2016	MHI	Kauai	SI	47
2016	MHI	Lanai	CM	29
2016	MHI	Lanai	CR	12
2016	MHI	Maui	CM	34
2016	MHI	Maui	SI	10
2016	MHI	Molokai	CM	9
2016	MHI	Molokai	CR	10
2016	MHI	Molokai	SI	15
2016	MHI	Niihau	CM	2
2016	MHI	Niihau	SI	15

2016	MHI	Oahu	SI	23
2016	MHI	Oahu	SI	63
2016	MHI	Kahoolawe	CR	35
2010-2012	NWHI	French Frigate	CR	35
2010-2012	NWHI	Kure	CR	30
2010-2012	NWHI	Laysan	S	23
2010-2012	NWHI	Lisianski	CR	59
2010-2012		Midway	S	17
2010-2012	NWHI	Pearl & Hermes	CR	48
2013-2015	NWHI	French Frigate	CR	31
2013-2015	NWHI	Kure	CR	8
2013-2015	NWHI	Laysan	S	8
2013-2015	NWHI	Lisianski	CR	46
2013-2015		Midway	S	42
2013-2015	NWHI	Pearl & Hermes	CR	21
2016	NWHI	French Frigate	CR	73
2016	NWHI	Kure	CR	58
2016	NWHI	Laysan	S	11
2016	NWHI	Lisianski	CR	56
2016	NWHI	Midway	S	10
2016	NWHI	Pearl & Hermes	CR	75

Coral and CCA cover

Coral and CCA cover assessment points and associated scoring. The score is determined using an equation that relates the percent maximum coral and CCA cover to a percent score.

Coral and CCA cover (% of max)	Score (%)	Equation
80-100	>90-100	Y=0.5x+50
60-<80	>80-<90	Y=0.5x+50
40-<60	>70-<80	Y=0.5x+50
20-<60	>60-<70	Y=0.5x+50
0-<20	0-<60	Y=3x

Macroalgal cover

Macroalgae assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum macroalgal cover to a percent score. For macroalgae, this is a negative relationship (more macroalgae receives a worse score).

Macroalgae (%)	Score (%)	Equation
0-<20	>90-100	Y=-0.5x+100
20-<40	>80-90	Y=-0.5x+100
40-<60	>70-80	Y=-0.5x+100
60-<80	>60-70	Y=-0.5x+100
80-100	0-60	Y=-3x+300

Adult and juvenile coral density

The juvenile and adult coral density indicators were generated from a select list of the most abundant and important coral genera and species represented across all islands within a given habitat. The use of the selected taxa (genera and species) provides information about existing coral populations and incorporates a mechanism to determine how coral populations are changing over time (fluctuations in one or more of the most abundant or important taxa). The selected coral taxa for each habitat structure type with in the Main Hawaiian Islands and Northwestern Hawaiian Islands that were used to generate estimates for the coral population indicators are listed in the table below.

Number of sampling sites for all benthic population indicator data in the (A) Main Hawaiian Islands and (B) Northwestern Hawaiian Islands. The dashes indicate the habitat structure type was not found and the zeros indicate not surveyed.

Main Hawaiian Islands

Island	Coral-Rich	2013 Complex	Simple	Coral-Rich	2016 Complex	Simple
Hawaii	6	18	-	18	13	-
Kahoolawe	0	-	-	11	-	-
Kauai	-	-	14	-	-	17
Lanai	7	7	-	4	11	-
Maui	-	6	2	-	11	4
Molokai	6	8	7	3	3	5
Niihau	-	6	11	-	0	5
Oahu	-	6	35	-	12	20

Northwest Hawaiian Islands

Island	n (2011-2012)	n (2014-2015)	n (2016)	Habitat type
FFS	4	16	26	Coral-rich
KUR	9	6	19	Coral-rich
LAY	9	5	0	Simple
LIS	17	21	16	Coral-rich
MAR	10	10	0	Coral-rich
MID	6	19	0	Simple
PHR	13	14	20	Coral-rich

The selected taxa of scleractinian coral used to generate all coral population indicators for the Main Hawaiian Islands and Northwestern Hawaiian Islands by habitat structure type.

Main Hawaiian Islands	Northwestern Hawaiian Islands
Coral-rich habitat structure	
Montipora capitata	*Acropora cytherea*
Montipora patula	*Cyphastrea ocellina*
Porites compressa	*Montipora capitata*
Porites lobata	*Montipora patula*
Pocillopora meandrina	*Porites compressa*
	Porites lobata
Complex habitat structure	
Montipora capitata	
Montipora patula	
Porites compressa	
Porites lobata	
Pocillopora meandrina	
Simple habitat structure	
Montipora capitata	*Montipora capitata*
Montipora patula	*Porites compressa*
Porites lobata	*Pavona duerdeni*
Pocillopora meandrina	*Porites lobata*
	Pocillopora meandrina

Throughout the literature, there are not clear benchmarks to establish reference and assessment points for density for juvenile and adult corals due to the natural variability in abundance across habitat space. The island level scores for adults and juveniles we calculated similar to the percent cover using the following steps:

1. Reef area-weighted island and sector density estimates were generated from strata means for each of the species listed above for 2013 through 2016 (MHI) and 2011 through 2016 (NWHI) when stratified random surveys were conducted.
2. The score was calculated as a percent of the maximum island or sector density as follows:
    a. Taxon density % max score = (taxon A density estimate for island or sector A / maximum island or sector density estimate for habitat A reported for all years for taxon A) * 100.
    b. The scores were averaged across all taxa for a given island or sector.
    c. The scores were then converted to a 0-100% scale using equations in the table below.
    d. These scores were generated separately for juveniles and adults.

Coral population density assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum density to a percent score.

% of Maximum	Score (%)	Equation
80-100	90-100	y = 0.5x + 50
60-80	80-89	y = 0.5x + 50
40-60	70-79	y = 0.5x + 50
20-40	60-69	y = 0.5x + 50
0-20	0-59	y = 3x

Partial mortality

The partial mortality indicator was generated from the same select list of abundant and important coral species used for juvenile and adult density.

Similar to density, there are not clear benchmarks to establish reference and assessment points for partial mortality due to the natural variability in abundance across habitat space. The island level scores for partial mortality we calculated similar to the other benthic metrics as follows:

1. Reef area-weighted island and sector density estimates were generated from strata means for each of the taxa listed above for 2013 through 2016 (MHI) and 2011 through 2016 (NWHI) when stratified random surveys were conducted.
2. The score was calculated as a percent of the maximum island or sector density as follows:
    a. Taxon density % max score = (taxon A density estimate for island or sector A / maximum island or sector density estimate for habitat A reported for all years for taxon A) * 100.
    b. The scores were averaged across all taxa for a given island or sector.
    c. The scores were then converted to a 0-100% on an inverted scale using equations in table below.

Coral mortality assessment points and associated scoring. The score is determined using an equation that relates the percent of maxium mortality to a percent score. For mortality, this is a negative relationship (more mortality receives a worse score).

% of Maximum	Score (%)	Equation
0-20	90-100	y = -0.5x + 100
20-40	80-89	y = -0.5x + 100
40-60	70-79	y = -0.5x + 100
60-80	60-69	y = -0.5x + 100
80-100	0-59	y = -3x + 300

Pacific Remote Islands

Data collected in 2015 were used for the current status report for all islands except Jarvis Island and Wake Atoll. Recent surveys conducted during 2017 were used these two locations. The habitat structure types were determined to be similar among all island and atolls in the Pacific Remote jurisdiction.

Coral reef cover indicator (benthic cover)

Coral reef cover includes three sub-indicators: percent coral cover, percent crustose coralline algae (CCA) cover, and percent macroalgae cover. Each of these sub-indicators followed a similar scoring process. Average benthic cover estimates were calculated for each site. The site-specific percent cover estimates were pooled by stratum, averaged, and stratum area weighted to provide and Island-wide or sector-wide mean. These area weighted benthic cover estimates were scored using criteria below. Island/sector- wide means were area weighted by percent forereef habitat when rolled up to Pacific Remote–wide level.

For each sub-indicator, the most recent percent cover values for a given island were compared to the maximum island-level value reported between 2014 and 2017 to calculate the percent of maximum. The percent of maximum values where then converted to a 60-100% scale using the equations listed in the table below. To calculate scores for macroalgae the 60–100% scores were inverted so that 0% max = 100%.

Number of sampling sites for all benthic cover indicator data (coral and fish survey sites). CR = coral-rich

Year	Island	Habitat	n
2014	Wake	CR	65
2015	Baker	CR	51
2015	Howland	CR	56
2015	Jarvis	CR	102
2015	Johnston	CR	46
2015	Kingman	CR	73
2015	Palmyra	CR	114
2017	Wake	CR	81
2017	Baker	CR	23
2017	Howland	CR	20
2017	Jarvis	CR	60

Coral and CCA cover

Coral and CCA cover assessment points and associated scoring. The score is determined using an equation that relates coral and CCA cover to a percent score. The score relates to narrative text describing coral condition.

% of maximum	Score (%)	Equation
80-100	90-100	Y=0.5x+50
60-<80	80-<90	Y=0.5x+50
40-<60	70-<80	Y=0.5x+50
20-<40	60-<70	Y=0.5x+50
0-<20	0-<60	Y=3x

Macroalgal cover

Macroalgae assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum macroalgal cover to a percent score. For macroalgae, this is a negative relationship (more macroalgae receives a worse score).

% of maximum	Score (%)	Equation
0-<20	>90-100	Y=-0.5x+100
20-<40	>80-90	Y=-0.5x+100
40-<60	>70-80	Y=-0.5x+100
60-<80	>60-70	Y=-0.5x+100
80-100	0-60	Y=-3x+300

Adult and juvenile coral density

The juvenile and adult coral density indicators were generated from a select list of the most abundant and important coral genera and species unique to each island or atoll given the physical distance between them. The use of the selected taxa (genera and species) provides information about existing coral populations and incorporates a mechanism to determine how coral populations are changing over time (fluctuations in one or more of the most abundant or important taxa). The selected coral taxa for each island or atoll in the Pacific Remote jurisdiction that were used to generate estimates for the coral population indicators are listed in the table below.

Number of sampling sites for all benthic population indicator data.

Island/year	n
2014-2015	
Baker	15
Howland	21
Jarvis	41
Johnston	10
Kingman	21
Palmyra	39
Wake	20
2016	
Jarvis	30
2017	
Jarvis	32
Wake	28

The selected taxa of scleractinian coral used to generate all coral population indicators for each island or atoll in the Pacific Remote Island Areas jurisdiction.

Baker	**Kingman**
Genera	Genera
Acropora	*Acropora*
Montipora	*Favia*
Pocillopora	*Fungia*
Porities	*Montipora*
Species	*Pavona*
Favia mattahaii	*Pocillopora*
	Porities
	Species
	Astrea curta
Howland	**Palmyra**
Genera	Genera
Acropora	*Favia*
Montipora	*Montipora*
Pavona	*Pavona*
Pocillopora	*Pocillopora*
Porites	*Porites*
	Species
	Astrea curta
Jarvis	**Wake**
Genera	Genera
Fungia	*Acanthastrea*
Montipora	*Astreopora*
Pavona	*Favia*
Pocillopora	*Goniastrea*
Porites	*Montipora*
	Pocillopora
	Porites
Johnston	
Genera	
Acropora	
Montipora	
Pavona	
Pocillopora	
Porites	

Throughout the literature, there are no clear benchmarks to establish reference and assessment points for density for juvenile and adult corals due to the natural variability in abundance across habitat space. The island level scores for adults and juveniles we calculated similar to the percent cover using the following steps:

1. Reef area-weighted island and sector density estimates were generated from strata means for each of the coral taxon listed above for the most recent data (2015 or 2017) when stratified random surveys were conducted.
2. The score was calculated as a percent of the maximum island or sector density as follows:
    a. Taxon density % max score = (taxon A density estimate for island A / maximum island or sector density estimate reported between 2014 and 2017 for taxon A) * 100.
    b. The scores were averaged across all taxa for a given island or sector.
    c. The scores were then converted to a 60-100% scale using the equations below.
    d. These scores were generated separately for juveniles and adults.

Coral population density assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum density to a percent score.

% of maximum	Score (%)	Equation
60-100	90-100	Y=0.25x+75
40-<60	80-<90	Y=0.50x+60
20-<40	70-<80	Y=0.50x+60
10-<20	60-<70	Y=x+50
0-<10	0-<60	Y=6x

Partial mortality

The partial mortality indicator was generated from the same select list of abundant and important coral species and genera used for juvenile and adult density.

Similar to density, there are no clear benchmarks to establish reference and assessment points for partial mortality due to the natural variability in abundance across habitat space. The island level scores for partial mortality we calculated similar to the other benthic metrics as follows:

1. Reef area-weighted island and sector density estimates were generated from strata means for each of the coral taxon listed above for 2015 and 2017 when stratified random surveys were conducted.
2. The score was calculated as a percent of the maximum island or sector density as follows:
    a. Taxon density % max score = (taxon A density estimate for island A / maximum island or sector density estimate reported between 2014 and 2017 for taxon A) * 100.
    b. The scores were averaged across all taxa for a given island or sector.
    c. The scores were then converted to a 60-100% on an inverted scale.

Coral mortality assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum mortality to a percent score. For mortality, this is a negative relationship (more mortality receives a worse score).

% of maximum	Score (%)	Equation
0-20	90-100	Y=-0.5x+100
20-<40	80-<90	Y=-0.5x+100
40-<60	70-<80	Y=-0.5x+100
60-<80	60-<70	Y=-0.5x+100
80-100	0-<60	Y=-3x+300

Guam

Habitat structure types around Guam consisted of coral-rich habitat structure (e.g. aggregate reef, spur and groove). Benthic indicator estimates are scaled as described below by estimates generated throughout Guam and the Northern Mariana Islands. Habitat structure types throughout the Northern Mariana Islandsincluded the habitat structure types coral-rich, mixed habitat structures (no predominant habitat types), and complex (e.g. rock and boulder).

Coral reef cover indicator (benthic cover)

Coral reef cover includes three sub-indicators: percent coral cover, percent crustose coralline algae (CCA) cover, and percent macroalgae cover. Each of these sub-indicators followed a similar scoring process. Average benthic cover estimates were calculated for each site. The site-specific percent cover estimates were pooled by stratum, averaged, and stratum area weighted to provide and Island-wide or sector-wide mean. These area weighted benthic cover estimates were scored using criteria below. Sector-wide means were area weighted by percent forereef habitat when rolled up to Guam–wide level.

Number of sampling sites for all benthic cover indicator data (coral and fish survey sites). CR = Coral Rich.

Year	Habitat	n
2014	CR	108
2017	CR	97

For each sub-indicator, the most recent percent cover values for a given island were compared to the maximum island-level value reported between 2014 and 2017 for a given habitat structure type to calculate the percent of maximum. In other words, islands dominated by coral-rich habitats were only compared to other coral rich islands. The percent of maximum values where then converted to a 60-100% scale using the equations listed below. To calculate scores for macroalgae the 60-100% scores were inverted so that 0% max = 100%.

Coral and CCA cover

Coral and CCA cover assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum coral and CCA cover to a percent score.

% of maximum	Score (%)	Equation
80-100	90-100	Y=0.5x+50
60-<80	80-<90	Y=0.5x+50
40-<60	70-<80	Y=0.5x+50
20-<40	60-<70	Y=0.5x+50
0-<20	0-<60	Y=3x

Macroalgal cover

Macroalgae assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum macroalgal cover to a percent score. For macroalgae, this is a negative relationship (more macroalgae receives a worse score).

% of maximum	Score (%)	Equation
0-<20	>90-100	Y=-0.5x+100
20-<40	>80-90	Y=-0.5x+100
40-<60	>70-80	Y=-0.5x+100
60-<80	>60-70	Y=-0.5x+100
80-100	0-60	Y=-3x+300

Adult and juvenile coral density

The juvenile and adult coral density indicators were generated from a select list of the most abundant and important coral genera and species represented across all islands within Guam and Northern Marianas Islands for a given habitat structure type. The use of the selected taxa provides information about existing coral populations and incorporates a mechanism to determine how coral populations are changing over time (fluctuations in one or more of the most abundant or important taxa). The selected coral taxa for the coral-rich habitat structure type, which include east and west sectors of Guam (open areas outside of Marine Protected Areas) that were used to generate estimates for the coral population indicators, are listed in the table below.

Number of sampling sites for all benthic population indicator data for Guam sectors.

Guam sectors	2014 (n)	2017 (n)
East Open	13	12
West Open	11	11

The selected taxa of scleractinian coral used to generate all coral population indicators for Guam.

Coral-rich habitat structure
Genera
Acropora

Astreopora
Cyphastrea
Favia
Goniastrea
Leptastrea
Montipora
Pavona
Pocillopora
Porites

Throughout the literature, there are no clear benchmarks to establish reference and assessment points for density for juvenile and adult corals due to the natural variability in abundance across habitat space. The island level scores for adults and juveniles we calculated similar to the percent cover using the following steps:

1. Reef area-weighted island and sector density estimates were generated from strata means for each of the coral taxon listed above when stratified random surveys were conducted.
2. The score was calculated as a percent of the maximum island or sector density as follows:
    a. Taxon density % max score = (taxon A density estimate for sector A / maximum island or sector density estimate for habitat A reported for all years for taxon A) * 100.
    b. The scores were averaged across all taxa for a given island or sector.
    c. The scores were then converted to a 0-100% scale using equations in the table below.
    d. These scores were generated separately for juveniles and adults.

Coral population density assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum density to a percent score

% of maximum	Score (%)	Equation
60-100	90-100	Y=0.25x+75
40-<60	80-<90	Y=0.50x+60
20-<40	70-<80	Y=0.50x+60
10-<20	60-<70	Y=x+50
0-<10	0-<60	Y=6x

Partial mortality

The partial mortality indicator was generated from the same select list of abundant and important coral species and genera used for juvenile and adult density.

Throughout the literature, there are not clear benchmarks to establish reference and assessment points for density for partial mortality due to the natural variability in abundance across habitat space. The island level scores for partial mortality we calculated similar to the other benthic metrics as follows:

1. Reef area-weighted island and sector density estimates were generated from strata means for each of the coral taxon listed above when stratified random surveys were conducted.
2. The score was calculated as a percent of the maximum island or sector density as follows:
    a. Taxon density % max score = (taxon A density estimate for sector A / maximum island or sector density estimate for habitat A reported for all years for taxon A) * 100.
    b. The scores were averaged across all taxa for a given island or sector.
    c. The scores were then converted to a 60-100% on an inverted scale using equations below.

Coral mortality assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum mortality to a percent score. For mortality, this is a negative relationship (more mortality receives a worse score).

% of maximum	Score (%)	Equation
0-20	90-100	Y=-0.5x+100
20-<40	80-<90	Y=-0.5x+100
40-<60	70-<80	Y=-0.5x+100
60-<80	60-<70	Y=-0.5x+100
80-100	0-<60	Y=-3x+300

Northern Mariana Islands

To account for differences in how benthic communities form in across a range of habitats (e.g. coral-rich, pavement, rock and bolder), we used diver visual habitat classifications between 2011 and 2017 to calculate the percent of sites for a given island that fell within certain habitat types. We then assigned each island a habitat type if greater than 50% of the sites were classified that that habitat type. Habitat structure types throughout the Northern Marianas Islands included the habitat structure types coral-rich, mixed habitat structures (no predominant habitat types), and complex (e.g. rock and boulder).

Coral reef cover indicator (benthic cover)

Coral reef cover includes three sub-indicators: percent coral cover, percent crustose coralline algae (CCA) cover, and percent macroalgae cover. Each of these sub-indicators followed a similar scoring process. Average benthic cover estimates were calculated for each site. The site-specific percent cover estimates were pooled by stratum, averaged, and stratum area weighted to provide and Island-wide or sector-wide mean. These area weighted benthic cover estimates were scored using criteria below. Island/sector- wide means were area weighted by percent forereef habitat when rolled up to Northern Marianas Islands –wide level.

Number of sampling sites for all benthic cover indicator data (coral and fish survey sites). MX = mixed, CR = coral-rich.

Year	Island	Habitat	n
2014	Aguijan	MX	16
2014	Alamagan	MX	17

2014	Asuncion	CM	33
2014	Farallon de Pajaros	CM	18
2014	Guguan	MX	16
2014	Maug	CR	60
2014	Pagan	MX	62
2014	Rota	CR	38
2014	Saipan	CR	70
2014	Sarigan	CM	16
2014	Tinian	CR	26
2017	Agrihan	MX	26
2017	Aguijan	CR	27
2017	Alamagan	MX	13
2017	Asuncion	CM	31
2017	Farallon de Pajaros	CM	28
2017	Guguan	MX	12
2017	Maug	CR	65
2017	Pagan	MX	59
2017	Rota	CR	41
2017	Saipan	CR	58
2017	Sarigan	CM	14
2017	Tinian	CR	38

For each sub-indicator, the most recent percent cover values for a given island were compared to the maximum island-level value reported between 2014 and 2017 for a given habitat type to calculate the percent of maximum. In other words, islands dominated by coral-rich habitats were only compared to other coral rich islands. The percent of maximum values where then converted to a 60-100% scale using the equations listed below. To calculate scores for macroalgae the 60-100% scores were inverted so that 0% max = 100%.

Coral and CCA cover

Coral and CCA cover assessment points and associated scoring. The score is determined using an equation that relates percent of maximum coral and CCA cover to a percent score.

% of maximum	Score (%)	Equation
80-100	90-100	Y=0.5x+50
60-<80	80-<90	Y=0.5x+50
40-<60	70-<80	Y=0.5x+50
20-<40	60-<70	Y=0.5x+50
0-<20	0-<60	Y=3x

Macroalgal cover

Macroalgae assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum macroalgal cover to a percent score. For macroalgae, this is a negative relationship (more macroalgae receives a worse score). The score relates to narrative text describing macroalgal condition.

% of maximum	Score (%)	Equation
0-<20	>90-100	Y=-0.5x+100
20-<40	>80-90	Y=-0.5x+100
40-<60	>70-80	Y=-0.5x+100
60-<80	>60-70	Y=-0.5x+100
80-100	0-60	Y=-3x+300

Adult and juvenile coral density

The juvenile and adult coral density indicators were generated from a select list of the most abundant and important coral genera and species represented across all islands within a given habitat. The use of the selected taxa (genera and species) provides information about existing coral populations and incorporates a mechanism to determine how coral populations are changing over time (fluctuations in one or more of the most abundant or important taxa). The selected coral taxa for each habitat structure type for the Mariana Islands that were used to generate estimates for the coral population indicators are listed in the table below.

Number of sampling sites for all benthic population indicator data. Habitat structure types are noted for each island.

Island	2014 (n)	2017 (n)	Habitat type
Farallon de Pajaros	7	12	Complex
Maug	22	27	Coral-rich
Asuncion	12	12	Complex
Agrihan	0	7	Mixed
Pagan	19	19	Mixed
Alamagan	6	4	Mixed
Guguan	5	3	Mixed
Sarigan	5	5	Complex
Saipan	22	22	Coral-rich
Tinian	7	14	Coral-rich
Aguijan	6	10	Coral-rich
Rota	10	13	Coral-rich

The selected taxa of scleractinian coral used to generate all coral population indicators for the Northern Mariana Islands.

Coral-rich habitat structure
Genera
Acropora
Astreopora
Cyphastrea
Favia
Goniastrea
Leptastrea
Montipora
Pavona
Pocillopora
Porites
Mixed habitat structure
Genera
Astreopora
Cyphastrea
Favia
Galaxea
Goniastrea
Leptastrea
Montipora
Pavona
Pocillopora
Porites
Complex habitat structure
Genera
Astreopora
Cyphastrea
Favia
Goniastrea
Leptastrea
Montipora
Pavona
Pocillopora
Porites

Throughout the literature, there are no clear benchmarks to establish reference and assessment points for density for juvenile and adult corals due to the natural variability in abundance across habitat space. The island level scores for adults and juveniles we calculated similar to the percent cover using the following steps:

1. Reef area-weighted island and sector density estimates were generated from strata means for each of the coral taxa listed above when stratified random surveys were conducted.
2. The score was calculated as a percent of the maximum island or sector density as follows:
    a. Taxon density % max score = (taxon A density estimate for island A / maximum island or sector density estimate for habitat A reported for all years for taxon A) * 100.
    b. The scores were averaged across all taxa for a given island or sector.
    c. The scores were then converted to a 0-100% scale using equations in the table below.
    d. These scores were generated separately for juveniles and adults.

Coral population density assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum density to a percent score.

Coral population (colonies per square meter)	Score (%)	Equation
60-100	90-100	Y=0.25x+75
40-<60	80-<90	Y=0.50x+60
20-<40	70-<80	Y=0.50x+60
10-<20	60-<70	Y=x+50
0-<10	0-<60	Y=6x

Partial mortality

The partial mortality indicator was generated from the same select list of abundant and important coral species and genera used for juvenile and adult density.

Throughout the literature, there are not clear benchmarks to establish reference and assessment points for density for partial mortality due to the natural variability in abundance across habitat space. The island level scores for partial mortality we calculated similar to the other benthic metrics as follows:

1. Reef area-weighted island and sector density estimates were generated from strata means for each of coral taxa listed above when stratified random surveys were conducted.
2. The score was calculated as a percent of the maximum island or sector density as follows:
    a. Taxon density % max score = (taxon A density estimate for island A / maximum island or sector density estimate for habitat A reported for all years for taxon A) * 100.
    b. The scores were averaged across all taxa for a given island or sector.
    c. The scores were then converted to a 60-100% on an inverted scale using equations below.

Coral mortality assessment points and associated scoring. The score is determined using an equation that relates the percent of maximum mortality to a percent score. For mortality, this is a negative relationship (more mortality receives a worse score).

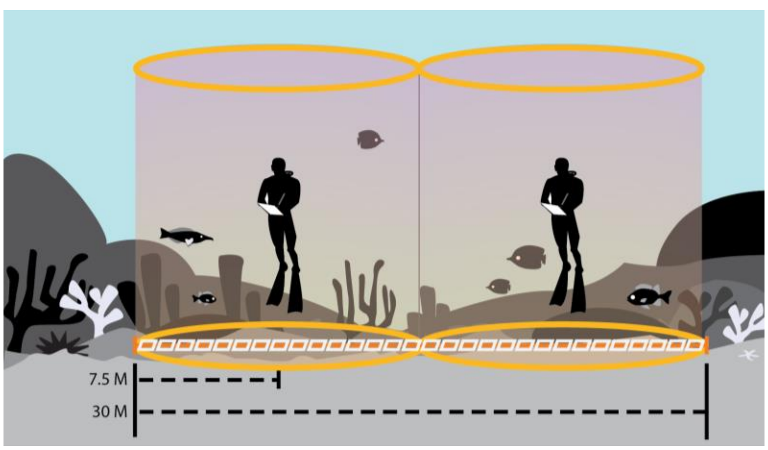
% of maximum	Score (%)	Equation
0-20	90-100	Y=-0.5x+100
20-<40	80-<90	Y=-0.5x+100
40-<60	70-<80	Y=-0.5x+100
60-<80	60-<70	Y=-0.5x+100
80-100	0-<60	Y=-3x+300

Fish indicators

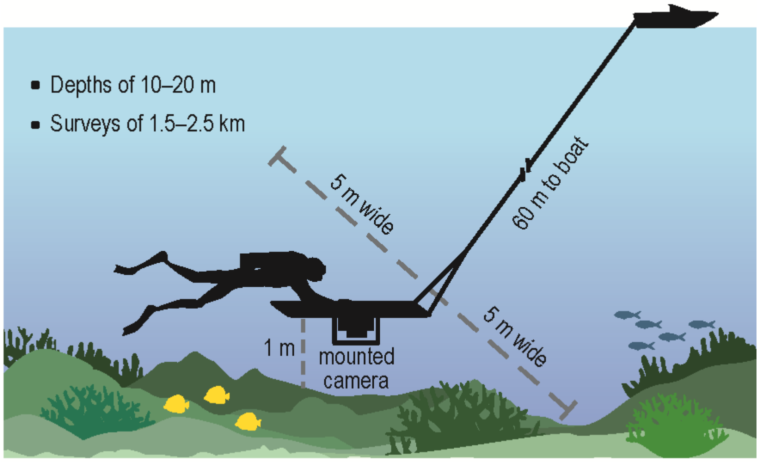
The indicators for the fish theme are reef fish, predators, sustainability, and diversity. Field sampling included stationary point counts (SPC) and towed diver surveys. SPC surveys were located using a stratified-random survey design with the survey domain being all hardbottom forereef habitat 0-30 m. Towed diver surveys were conducted in ~10-20m deep forereef areas, with tows located haphazardly around islands with a goal of broadly spreading them around the island circumference. All fish sampling sites were co-located with benthic cover sampling.

Sharks and other predators are averaged together before averaged with other fish indicators. The overall fish score consists of the average of reef fish biomass, average of sharks + other predators, and sustainability.

Stationary point count collected data are used in the reef fish biomass, sustainability and herbivory indicators:

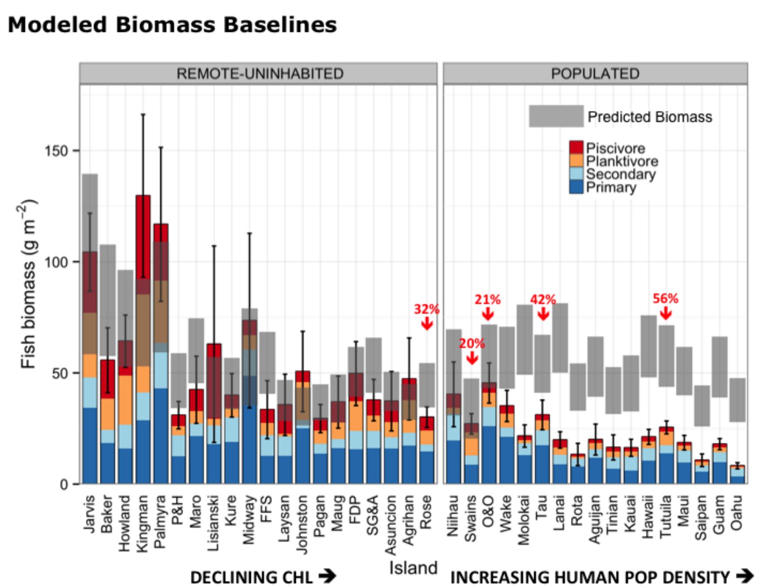


Towed diver survey data are used in the predator indicator:



Reef fish biomass

The Reef fish indicator is a measure of the amount of fish present, specifically the weight of fish per unit area (i.e. 'biomass'). Total reef fish biomass is probably the most widely used measure for reef fish condition by research and monitoring scientists, and has been repeatedly shown to be responsive to human impacts such as fishing and protection. For the status report, the status of each region was scored based on a study published in 2015 that used data from these islands and >30 others in the US Pacific, and which assessed the importance of a range of human, oceanographic (e.g. temperature, oceanic productivity) and habitat drivers (e.g. coral cover, habitat structural complexity). That study estimated what 'baseline biomass' would be at each location in the absence of humans – i.e. what would be natural for each location, based entirely on its oceanographic and habitat setting (Williams *et al* PLoS One, 2015). Some results from that study are shown in the figure below.



Reef fish biomass from surveys and modeled 'baseline biomass' for each of 40 islands surveyed by Pacific National Coral Reef Monitoring Program between 2010 and 2013. Percentages over American Samoa islands represent the difference between survey mean and modeled baseline biomass at each island in that group. This figure and results taken from Williams et al PLoS ONE 2015.

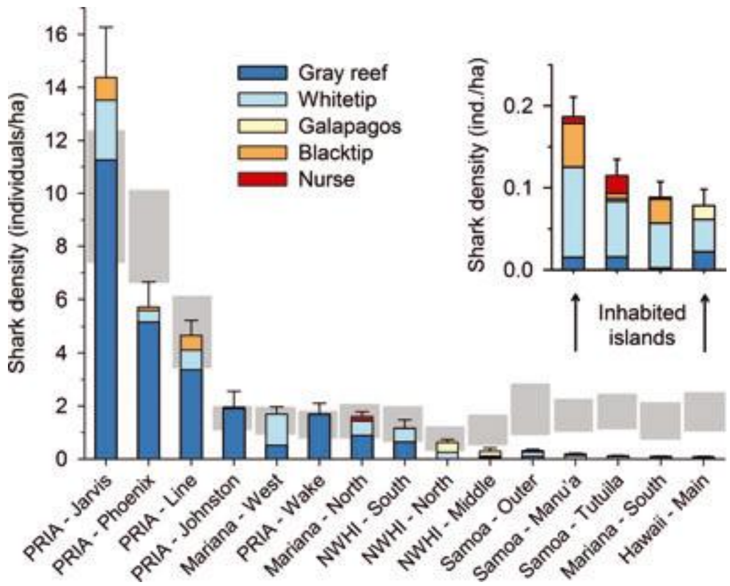
The indicator is measured as the total instantaneous reef fish biomass from the SPC surveys as a proportion of modeled 'baseline' biomass per island (from *Williams et al PLoS One 2015)*. In American Samoa those ranged from 44% at Tutuila, i.e. that actual biomass of reef fishes around Tutuila was ~44% of what it would be in the absence of human impacts, to 80% at Swains. Sharks and jacks were excluded for the biomass estimates and the baseline modeling exercise because their biomass is generally not well sampled by small-scale surveys such as the SPC. As a general rule, small-area surveys tend to overestimate densities of such highly mobile species and are prone to bias due to different behavioral responses of those species to divers in different locations (Ward et al 2010, Parrish et al. 2000).

Reef fish biomass as a proportion of baseline biomass was converted to an indicator score on a 0-100% scale, with a conversion function and break points determined by expert opinion. It is becoming widely recognized that even small human populations tend to have quite significant impacts on local reef fish biomass, and that fish biomass around human-populated islands is typically <50% and not uncommonly <25% of pristine biomass (Williams et al. 2015, MacNeil et al. 2015). Thus, the scoring system was created to reflect that understanding – specifically that (i) reef fish biomass > 80% of pristine biomass was about the highest that would be likely to occur around any populated island, and that (ii) even biomass of around 1/3rd of baseline is not uncommon for populated islands. Specifically, reef fish biomass > 80% of baseline was considered 'very good' (score 90%+), with the expectation that would only occur at uninhabited island, and a reef fish biomass level of 33% of baseline would be considered 'fair' (score=70%). Most populated islands in the Pacific would score 'poor' (score=60-70%) or 'fair' in this system, but American Samoa tends to score higher than islands in other populated regions.

Predators

The predators indicator is a measure of the status of upper trophic level fishes – i.e. fishes that primarily eat other fishes. Predators are considered both ecologically important, and also a suitable indicator of human impacts, because large predators tend to be preferentially targeted and highly vulnerable to human impacts. The predators' indicator was separated into two sub-indicators: shark abundance and biomass of other predators. Those were broken out separately for 2 main reasons: (i) they are better surveyed by different methods – sharks by towed diver surveys, 'other predators' by SPC; and (ii) because reef sharks recently became protected in American Samoa, and as such tracking the status of reef shark populations separately is of management interest. Drawbacks to using shark abundance as an indicator include their tendency to avoid divers around populated areas and that, generally, large portions of their populations are in waters that are deeper than can be surveyed by divers on SCUBA. Nevertheless towed diver abundance is a useful measure of relative abundance, and is one that we expect to respond well to changes in their populations.

As with reef fish, sharks abundance is scored by first comparing the density from surveys with a model generated estimate of baseline abundance in the absence of humans (Nadon et al 2012). And the converting proportion of baseline values into scores using a scoring function.



Shark abundance from towed diver surveys (data bars) and 'baseline abundance' (gray shaded blocks) for different island groups. Note that baseline abundance is generated separately per island, but pooled into island groups for simplicity in this figure which is taken from Nadon et al 2012.

For this status report, we modified the approach used by Nadon et al (2012) by including only sharks estimated to be 1m or larger in counts, and adjusting baseline estimates to remove the average number of sharks smaller than that size in the complete data set (i.e. 12% of all encounters). Small (< 1m long) sharks were excluded because divers occasionally encounter large schools of juvenile gray reef sharks (as occurred at Swains Island in 2012). Not only do those encounters introduce a lot of variability into the raw count data, they are also likely not to be representative of the long-term shark populations.

'Other predator' biomass was generated from biomass of all predators other than sharks and jacks in SPC surveys, and compared against baseline biomass estimates generated in the same way as for the reef fish indicator, and documented in Williams et al (2015). Biomass of 'other predators' primarily comes from snapper, grouper, and barracuda species, but includes other predatory emperors, moray eels, goatfish, wrasse, mackerel and others.

Sustainability

Sustainability indicates whether the targeted fish stocks have large numbers of mature individuals and particularly of large mature individuals. Therefore this indicator is intended to represent a measure of local stocks' ability to reproduce themselves. This indicator is sensitive to fishing pressure, as size and number of large individuals both respond to human impacts such as fishing, and management e.g. fishery limits or closed areas. Additionally, the maintenance of sufficient breeding stock is a core fisheries and conservation goal.

The following methods used for Sustainability were developed after the completion of the American Samoa status report. These methods are used for the Hawaiian Archipelago, Pacific Remote Islands, Guam, and the Northern Mariana Islandsstatus reports produced and released in 2018. For methods for American Samoa, see below. In the future, all iterations of all status report will use these methods, including American Samoa.

Defining ‘Generally Targeted Species’

In order to develop a method that was suitable across all regions, it was necessary to come up with broad definitions of potential target species. Specifically, not all species are present in all regions, and even where they are present, there are differences in fishing preference among regions – in fact, for the Pacific Remote Islands, there is little or no fishing of reef fishes. Therefore, for the purposes of this indicator, target species were defined as all large-bodied species (maximum length greater than 40cm) of the following, commonly-targeted, families: Jack, Surgeon, Parrot, Emperor, Grouper, Snapper, Goatfishes, and Squirrel/Soldierfish (Carangidae, Acanthuridae, Scaridae, Lethrinidae, Serranidae, Lutjanidae, Mullidae, and Holocentridae). Following discussions with local resource managers, a number of those species were excluded, because they are not generally preferred targets or because visual survey data are likely to poorly represent their real size distributions. Those species were: the jacks *Trachinotus* spp, *Seriola* spp, and *Elagatis bipinnulata*, the surgeonfish *Naso brevirostris*, N. tonganus, and *N. vlamingii*; and the snappers *Lutjanus bohar* and *L. fulvus*.

<u>Calculating regionally-appropriate sizes-at-maturity per species</u>

Given the lack of information on size at maturity for most species at most regions, we used a standardized approach to generate size at maturity (L50) per species per region – L50 being the size at which 50% of individuals are expected to be sexually mature. First, we determined the maximum observed size (from survey data) by species within each region (*regional LMax*). Because the Pacific Remote Islands are an administrative and not a geographic region, Wake was pooled with the Marianas and Johnson with Hawaiʻi for this assessment. The remaining Pacific Remote Islands make up the US Line & Phoenix Islands, which was considered a reasonable biogeographic grouping. Species with fewer than 20 observations within a region were dropped from that region on the basis that the *regional LMax* could not be reliably estimated. The *regional L50* was derived from a published empirical relationship for teleost fishes:

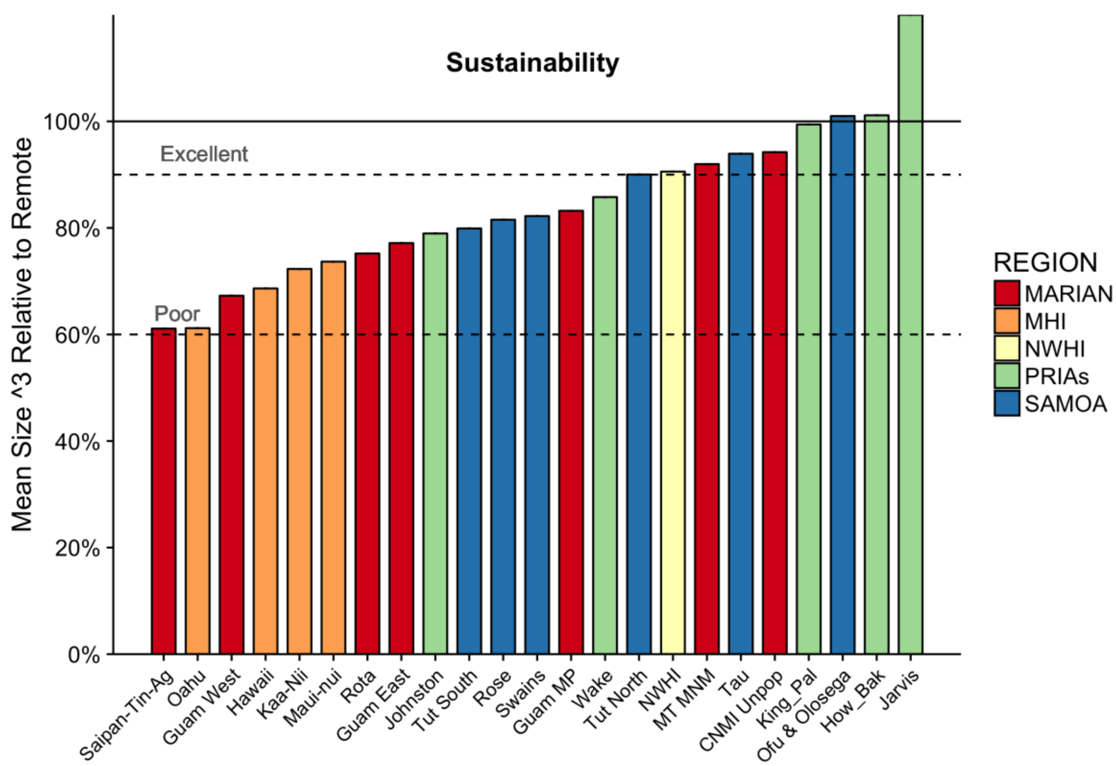
$\log10(L50) = -0.1189 + 0.9157 * \log10(Lmax)$ [Binholand & Froese J Appl Ichthyology 2009].

<u>Calculating interim sustainability metrics by species, family, and status report unit</u>

To generate interim sustainability metrics per species, we first calculated the mean size of fishes of that species observed in each region; first dropping fishes smaller than 40% of their *regional LMax* – those were considered likely to be juvenile fishes. That size cut off is intended to ensure that the measured stocks are of fishable size classes and to prevent large recruitment pulses from bringing down the mean size (e.g., when there are many young-of-year fishes). Species for which fewer than 5 individuals were observed in a reporting unit were dropped on the basis that a reliable mean size could not be generated for that location. For each species and reporting unit, mean-size was divided by the *regional L50* for that species, to generate a metric that represented mean size relative to size at maturity for that species in that location. Those values were averaged within families – so that each family would be weighted equally – and the overall sustainability metric for each location was generated by averaging the metrics for each of the families at that location. Finally, we cubed those values in order to convert what was essentially a length-based metric to a volume-based value. Fishes are 3 dimensional objects – thus, for example, doubling their size results in an approximately 8-fold increase in volume and therefore biomass, and likely a similar increase in their reproductive output.

Converting sustainability metric per location into a 'sustainability score'

The sustainability metric described above is essentially a derived measure of mean volume of a large number of fish species at a location relative to their sizes at maturity. High scores indicate that mean sizes of those fishes are generally large relative to the size at which they will start contributing to the regional breeding pool – and higher values therefore represent higher likely population fecundity. To convert that to a score that is applicable across all locations and comparable with other status report scores (which are scored as percentages), we first developed a standard for what we would expect from largely un-fished stocks. Specifically, we calculated the average of the sustainability metrics from NCRMP locations where harvesting of reef fishes is likely to be negligible, either because of their remoteness or well enforced prohibition of fishing: The Northwestern Hawaiian Islands, Jarvis, Kingman & Palmyra, Howland & Baker, Mariana Trench Marine National Monument, and Norther Mariana Unpopulated Islands. We considered that value as a benchmark for relatively unfished reef fish stocks, and generated the sustainability score for each region by dividing the sustainability metric by that remote-location benchmark. Those scores were capped at 100%.



Diversity

Biodiversity is the complex variety of life within our ecosystems that forms the foundation for the vast array of ecosystem services that contribute to human well-being. Each of the many 1000s of species occupying coral reefs provide essential ecological functions that maintain ecosystem health. Since different related species often play similar and redundant functional roles but have levels of sensitivity to certain stressors, reefs with higher levels of biodiversity tend to have increased functional redundancy and likelihood of reef survival during episodic disturbance events, such as disease outbreaks or coral bleaching. Hence, biodiversity serves as a useful indicator of ecological resilience and the ability to survive or recover from disturbance events. At the time of the status report completion, we were not yet able to come to consensus on appropriate biodiversity thresholds that relate meaningfully to scores for ecosystem health. In future status reports, however, biodiversity will be an indicator that is scored and incorporated into the overall scores for each jurisdiction.

American Samoa

Field sampling included stationary point counts (SPC) at 765 sites and 226 towed diver surveys. For this status report, data are from 2010 to 2015.

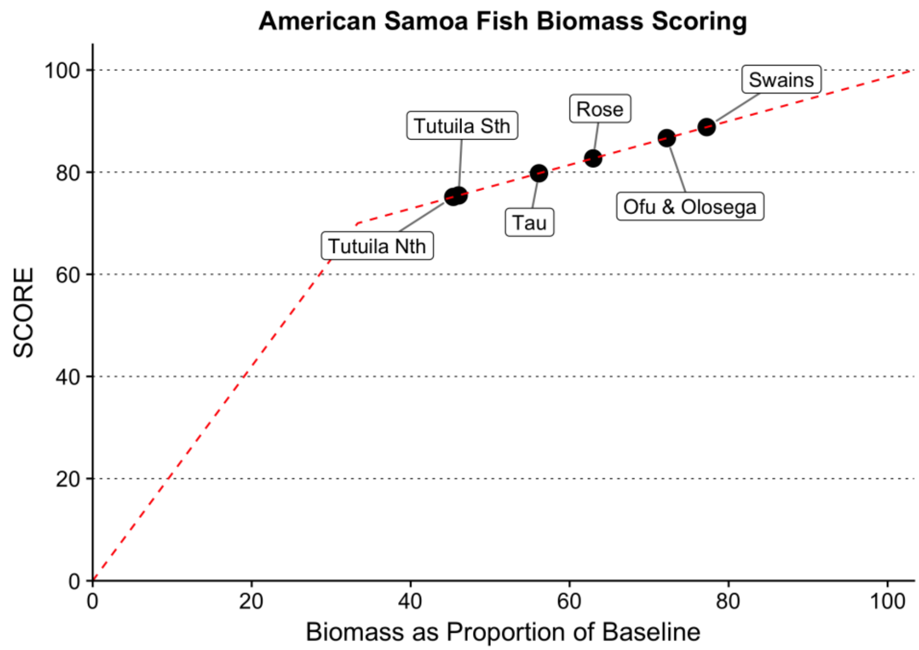
# of SPC sites and towed-diver surveys per Reporting Group

Reporting Unit	# SPC Sites	# Fish Towed Diver Surveys
Ofu & Olosega	112	34
Rose	94	23
Swains	94	25
Tau	92	39
Tutuila North	166	51
Tutuila South	207	54

Reef fish biomass assessment points and associated scoring. The score is determined using an equation that relates reef fish biomass percent of modeled baseline to a percent score. The graph below is a visual representation of the equations used to generate the scores.

% of Modeled Biomass	Score (%)	Equation
< 33.33%	0 – 60%	y = x*(70/33.33)
> 33.33%	60 - 100% (1)	y = 70 + ((x-33.33)*(80-33.33))

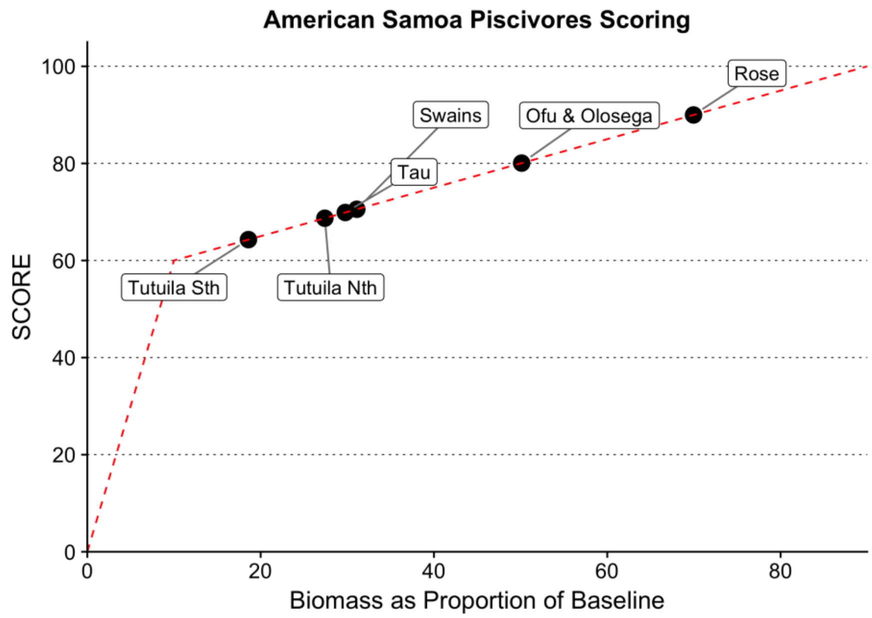
Notes: (1) Scores capped at 100%



Other predators assessment points and associated scoring. The score is determined using an equation that relates predator percent of modeled baseline to a percent score. The graph below is a visual representation of the equations used to generate the scores.

% of Modeled Biomass	Score (%)	Equation
< 10 %	0 – 60%	y = 6*x
> 10%	60 - 100% (1)	y = 60 + ((x - 10)*(40/80))

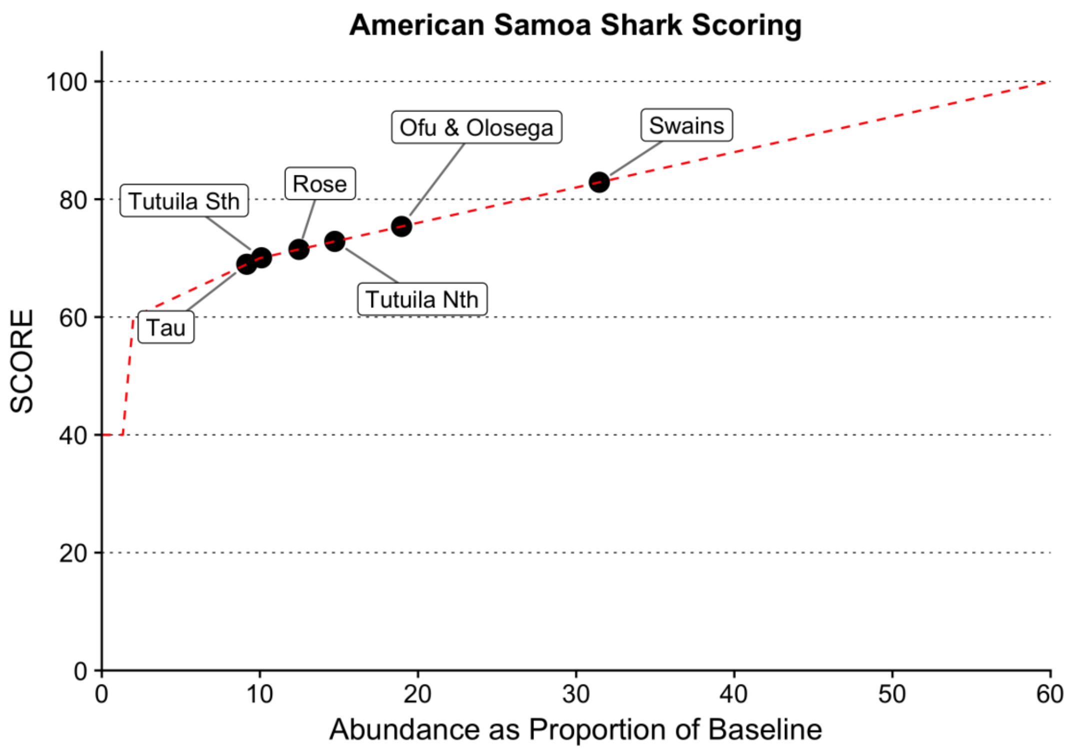
Notes: (1) Scores capped at 100%



Shark abundance assessment points and associated scoring. The score is determined using an equation that relates shark abundance percent of modeled baseline to a percent score. The graph below is a visual representation of the equations used to generate the scores. Shark abundance or 'other predator' biomass from surveys are represented as a proportion of baseline abundance or biomass for each island (x=axis), and those are converted into a score for this indicator (y-axis) using the functions shown by the red dashed line.

% of Modeled Density	Score (%)	Equation
< 2 %	40 – 60% (1)	y = 30*x
2 – 10 %	60 - 70%	y = 60 + ((x - 2)*(10/8))
> 10%	70 - 100% (2)	y = 70 + ((x - 10)*(30/50))

Notes: (1) Scores minimum set to 40% in recognition of fact that sharks are present in all locations, but difficult to survey by divers when they are not abundant and because large portions of their populations may be in waters deeper than can readily be surveyed by divers on SCUBA. (2) Scores capped at 100%



Sustainability

While there are different potential methods for evaluating sustainability, the method applied in American Samoa was the best available to date at the time of completion. Specifically, for each of the 25 most commonly captured reef species recorded by the Tutuila biosampling program, we estimate the mean size of that species of all fishes 15cm and above, that were larger than 30% of the species' maximum size. The size cut off is intended to ensure that the measured stocks are of fishable size classes and to prevent large recruitment pulses from bringing down the mean size (e.g., when there are many young of the year). The mean size of each species was then divided by the size at maturity of that species (L50), i.e., the size at which 50% of individuals are expected to be sexually mature.

L50 was derived from a published empirical relationships for teleost fishes: log10(L50) = -0.1189 + 0.9157 * log10(Lmax) [Binholand & Froese J Appl Ichthyology 2009]. That value for each species (mean size divided by L50) was cubed to represent biomass rather than size, as biomass better represent fecundity. Finally, the value was averaged across all 25 species for each reporting unit.

Top 25 species in catch recorded by American Samoa Biosampling Program. Note that all samples are of fishes caught around Tutuila:

Surgeonfishes
Acanthurus guttatus
Acanthurus lineatus
Acanthurus nigricans
Ctenochaetus striatus
Naso lituratus
Naso unicornis

Parrotfishes
Chlorurus japanensis
Scarus frenatus
Scarus globiceps
Scarus oviceps
Scarus rubroviolaceus

Snapper
Lutjanus gibbus
Lutjanus kasmira

Emperor
Lethrinus rubrioperculatus
Lethrinus xanthochilus

Grouper
Cephalopholis argus
Epinephelus melanostigma
Variola albimarginata

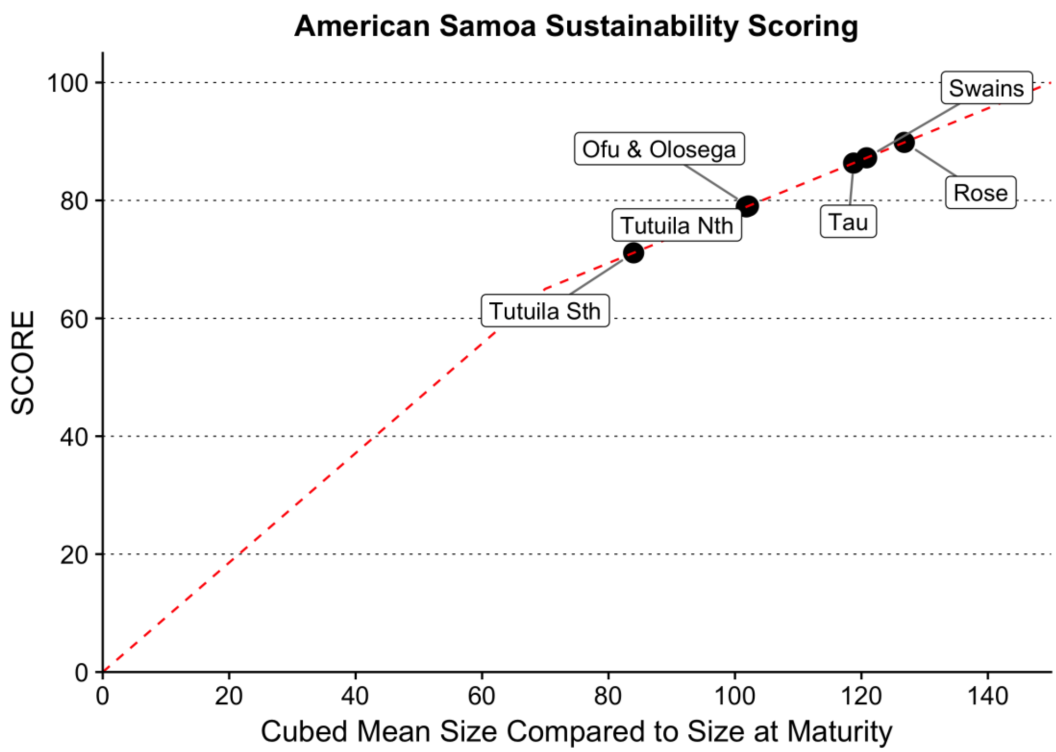
Goatfishes
Parupeneus insularis

A Pacific-wide comparison was not used to generate the scoring function because different regions have species assemblages and different target species preferences. Therefore, the scoring function used for American Samoa was generated subjectively.

Sustainability assessment points and associated scoring. The score is determined using an equation that relates sustainability to a percent score. The graph below is a visual representation of the equations used to generate the scores. The x-axis represents a measure of mean size relative to L50 for 25 targeted species in Samoa. This is converted into a score for this indicator (y-axis) using the function shown by the blue line above. American Samoan islands are shown as black circles.

% of Modeled Density	Score (%)	Equation
> 10%	65 - 100% (1)	y = 65 + ((x - 70)*(35/80))

Notes: (1) Scores set to range between 65% and 100%



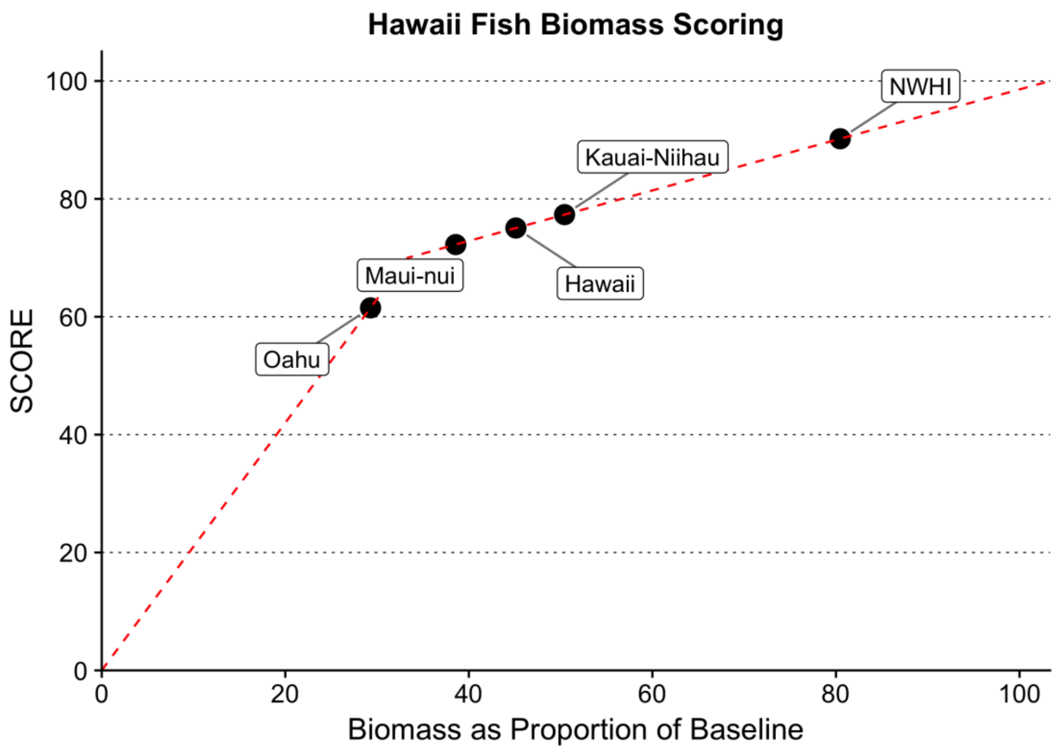
Hawaiian Archipelago

Field sampling included stationary point counts (SPC) at 1,850 sites and 334 towed-diver surveys for Hawaii. For this status report, fish data from 2010 to 2017 was used.

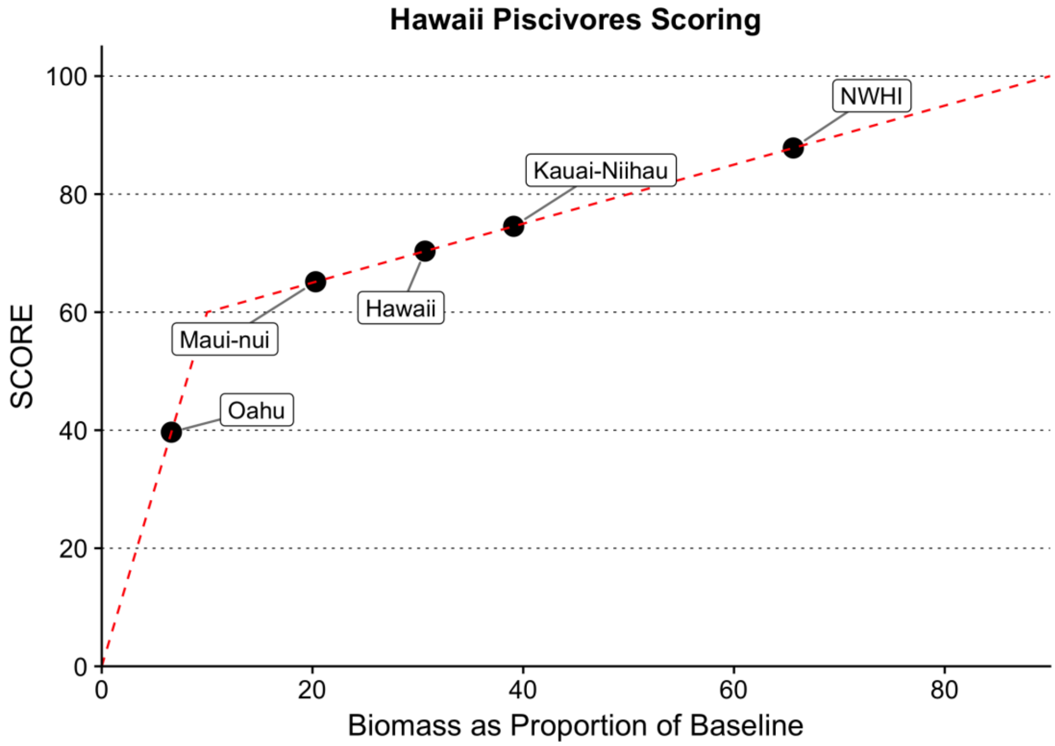
# of SPC sites and towed-diver surveys per Reporting Group

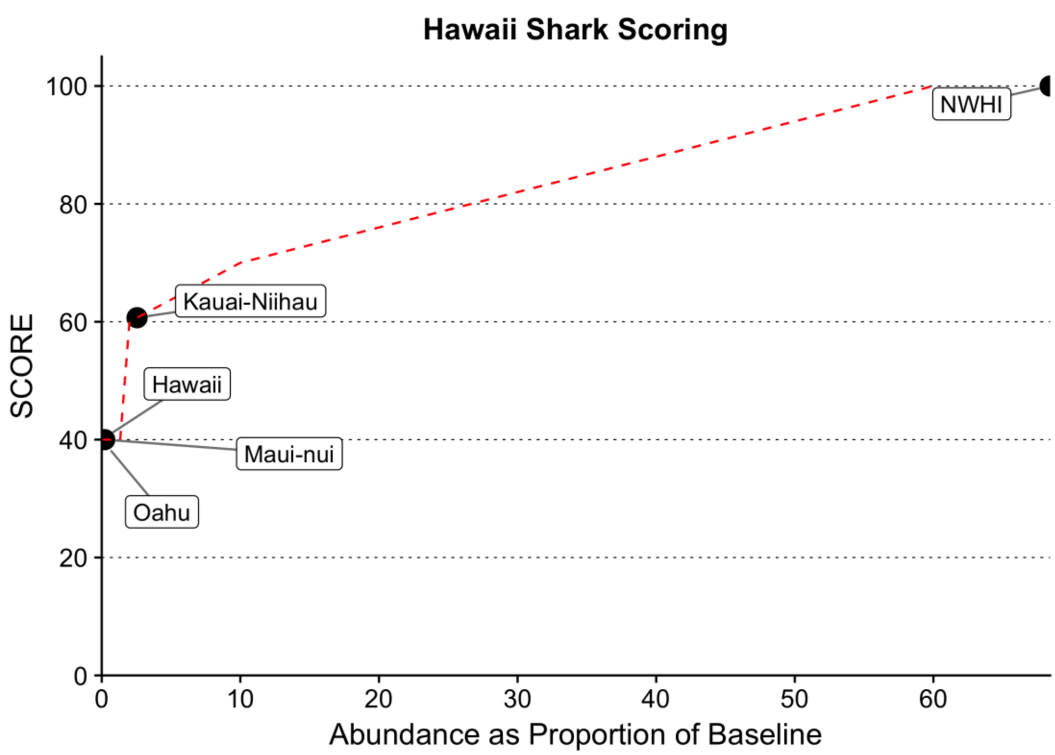
Reporting Unit	# SPC Sites	# Fish Towed Diver Surveys
Northwestern Hawaiian Islands	669	134
Hawaii	257	58
Kauai-Niihau	216	46
Maui-nui	481	82
Oahu	227	14

Reef fish biomass

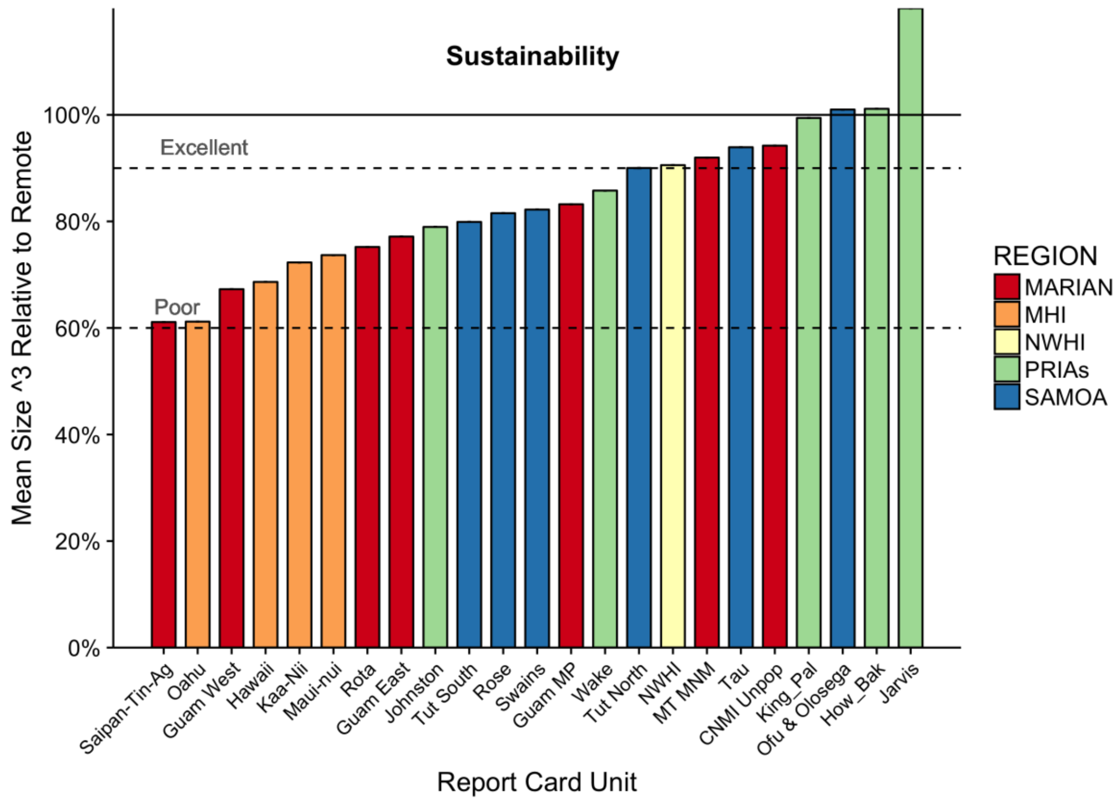


Predators


Hawaii Piscivores Scoring
SCORE
Biomass as Proportion of Baseline
0
20
40
60
80
100
0
20
40
60
80
NWHI
Kauai-Niihau
Hawaii
Maui-nui
Oahu


Hawaii Shark Scoring
SCORE
Abundance as Proportion of Baseline
0
20
40
60
80
100
0
10
20
30
40
50
60
NWHI
Kauai-Niihau
Hawaii
Maui-nui
Oahu

Sustainability



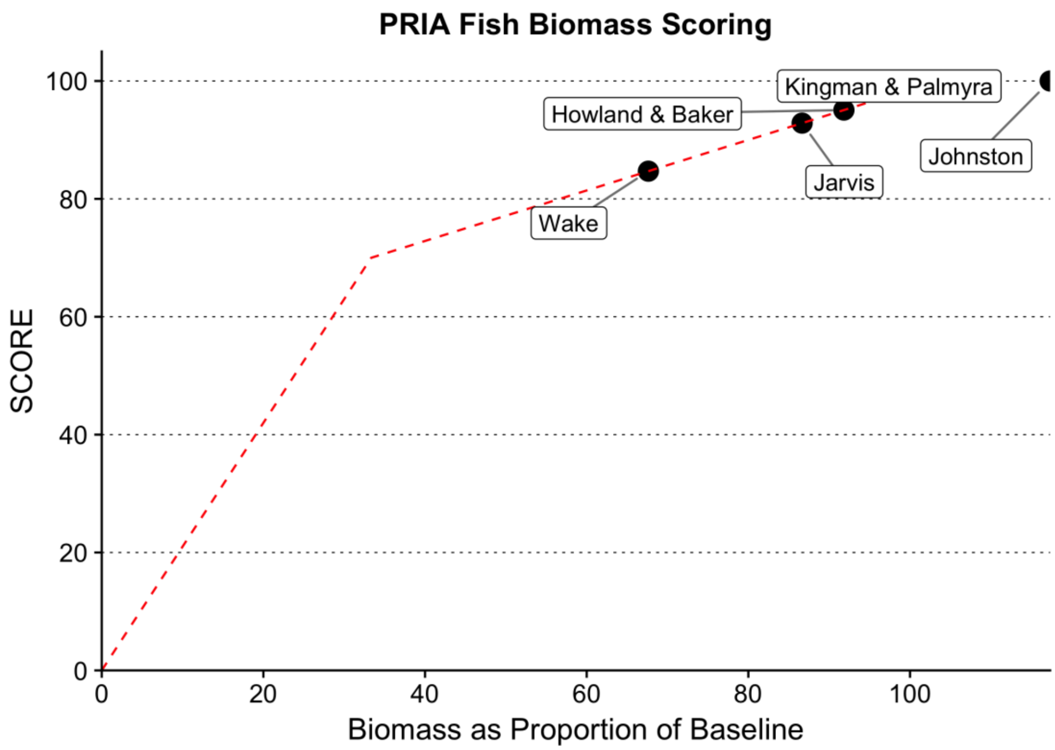
Pacific Remote Islands

For this status report, fish data from 2010 to 2017 was used.

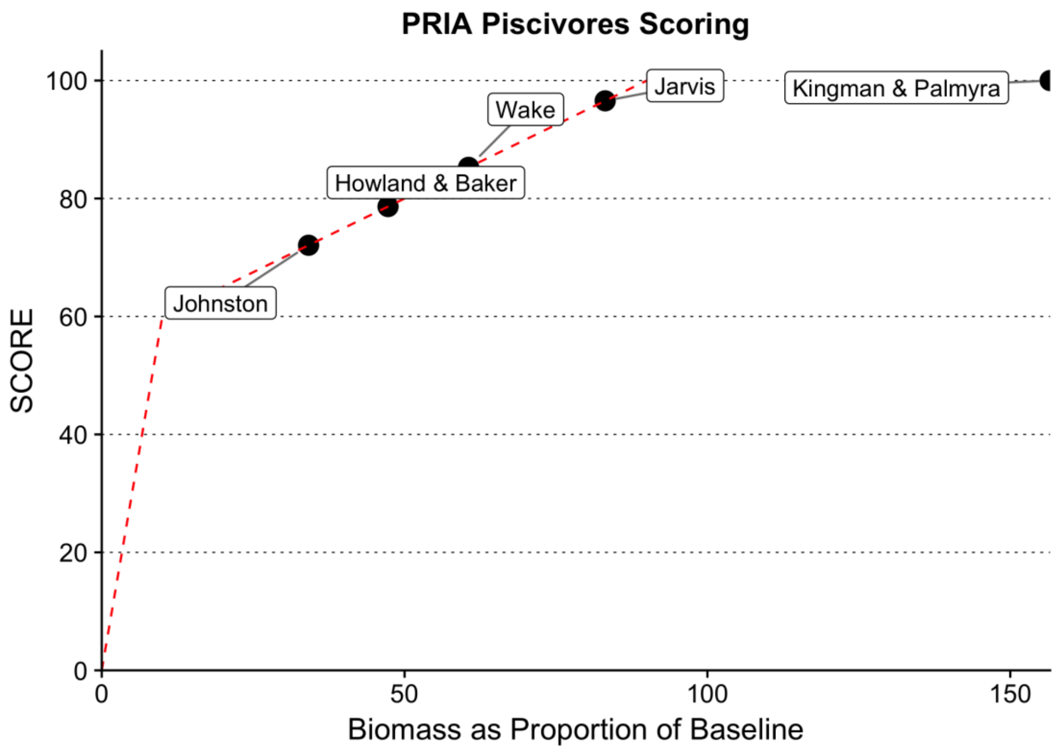
# of SPC sites and towed-diver surveys per Reporting Group.

Reporting Unit	# SPC Sites	# Fish Towed Diver Surveys
Howland & Baker	171	51
Jarvis	192	25
Johnston	63	40
Kingman & Palmyra	237	108
Wake	128	24

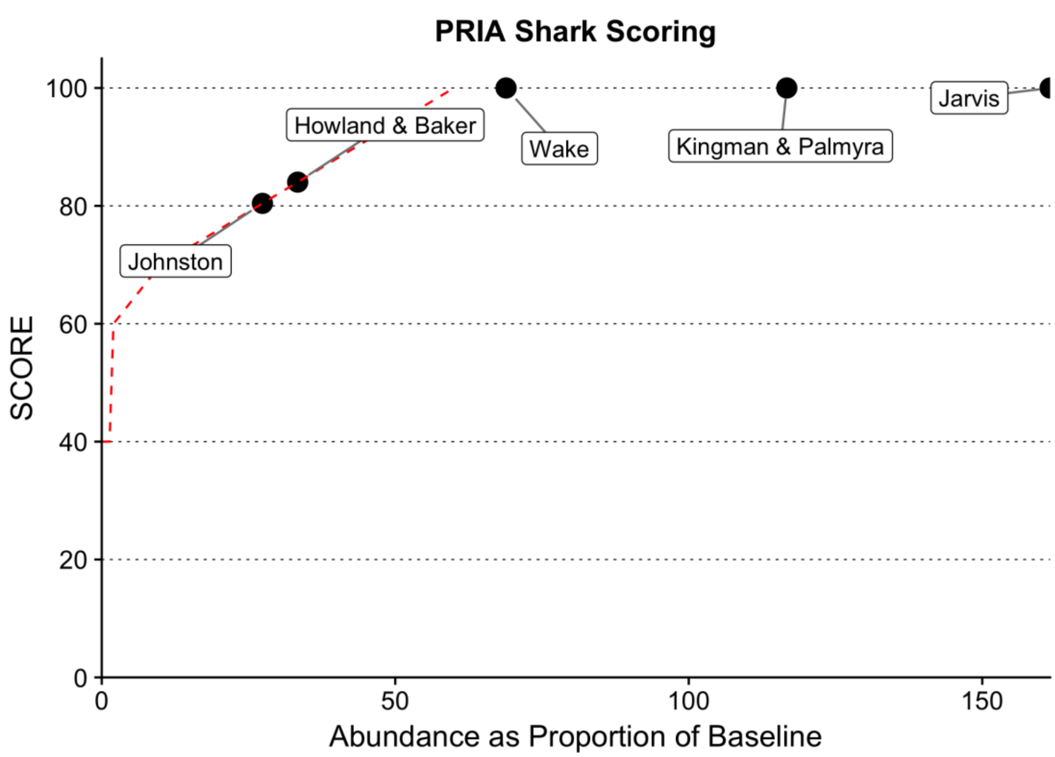
Reef fish biomass



Predators

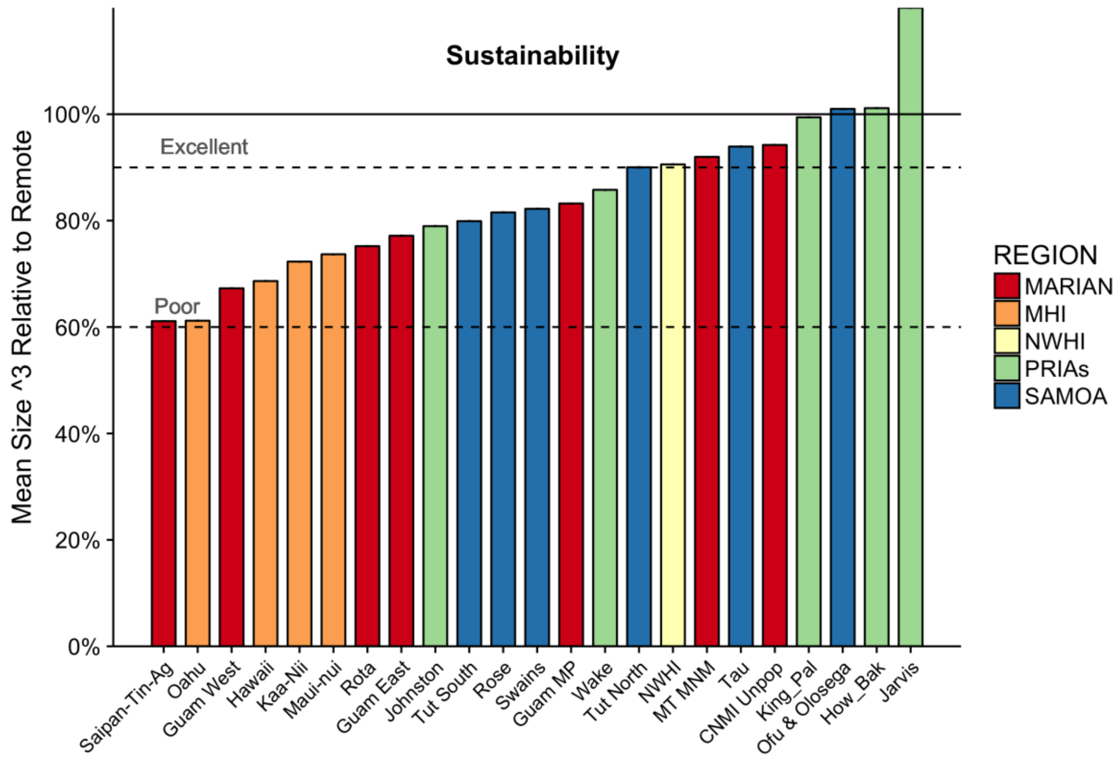


PRIA Piscivores Scoring
SCORE
Biomass as Proportion of Baseline
Johnston
Howland & Baker
Wake
Jarvis
Kingman & Palmyra
0
20
40
60
80
100
0
50
100
150



PRIA Shark Scoring
SCORE
Abundance as Proportion of Baseline
Johnston
Howland & Baker
Wake
Kingman & Palmyra
Jarvis
0
20
40
60
80
100
0
50
100
150

Sustainability



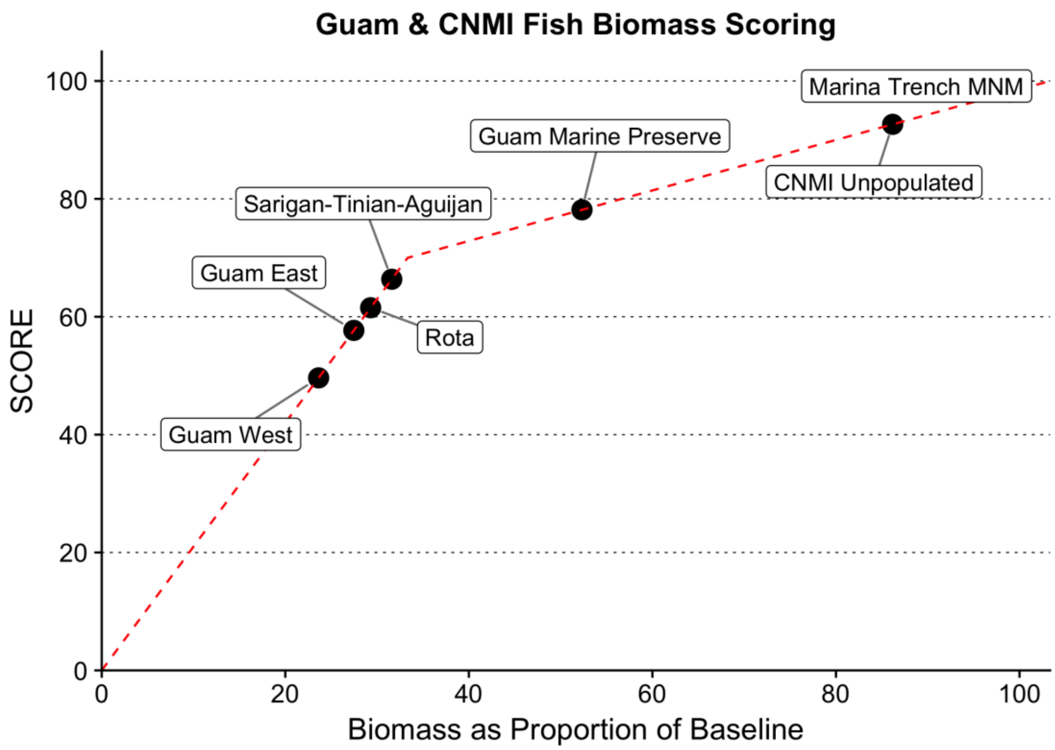
Guam & Northern Mariana Islands

For these status reports, fish data from 2010 to 2017 was used.

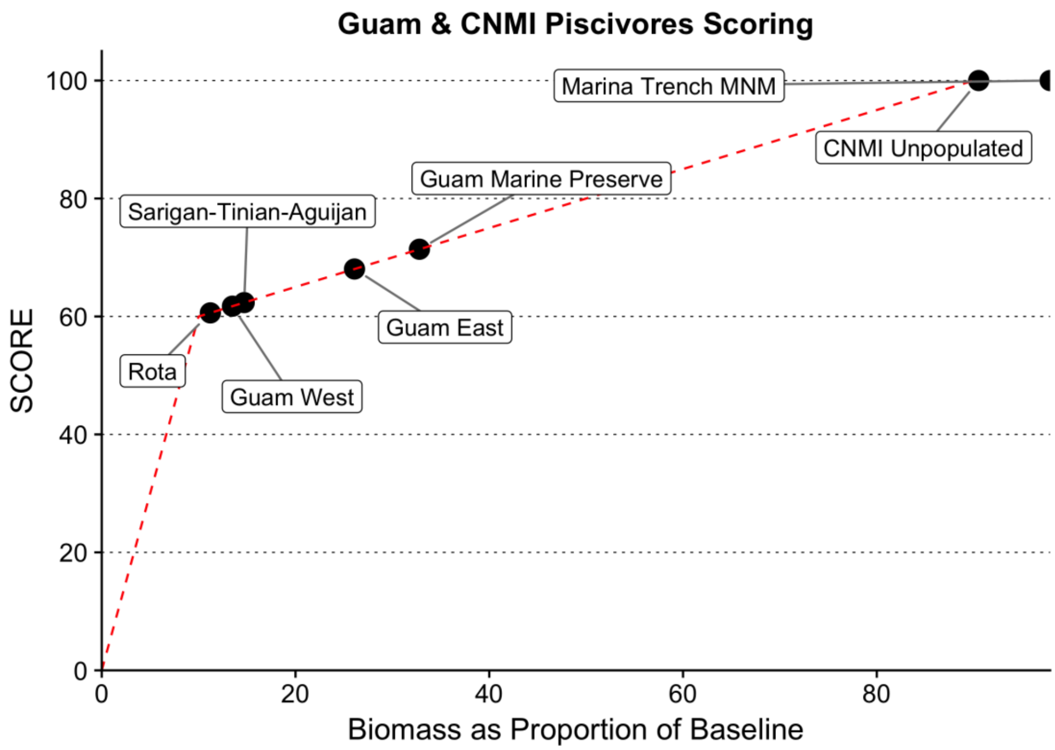
Table # of SPC sites and towed-diver surveys per Reporting Group.

Reporting Unit	# SPC Sites	# Fish Towed Diver Surveys
Mariana Trench MNM	207	34
NORTHERN MARIANA ISLANDSUnpopulated	235	56
Saipan-Tinian-Aguijan	217	58
Rota	80	19
Guam East	79	24
Guam West	106	25
Guam Marine Preserves	119	12

Reef fish biomass



Predators


Guam & CNMI Piscivores Scoring
Marina Trench MNM
CNMI Unpopulated
Guam Marine Preserve
Sarigan-Tinian-Aguijan
Guam East
Rota
Guam West
SCORE
0
20
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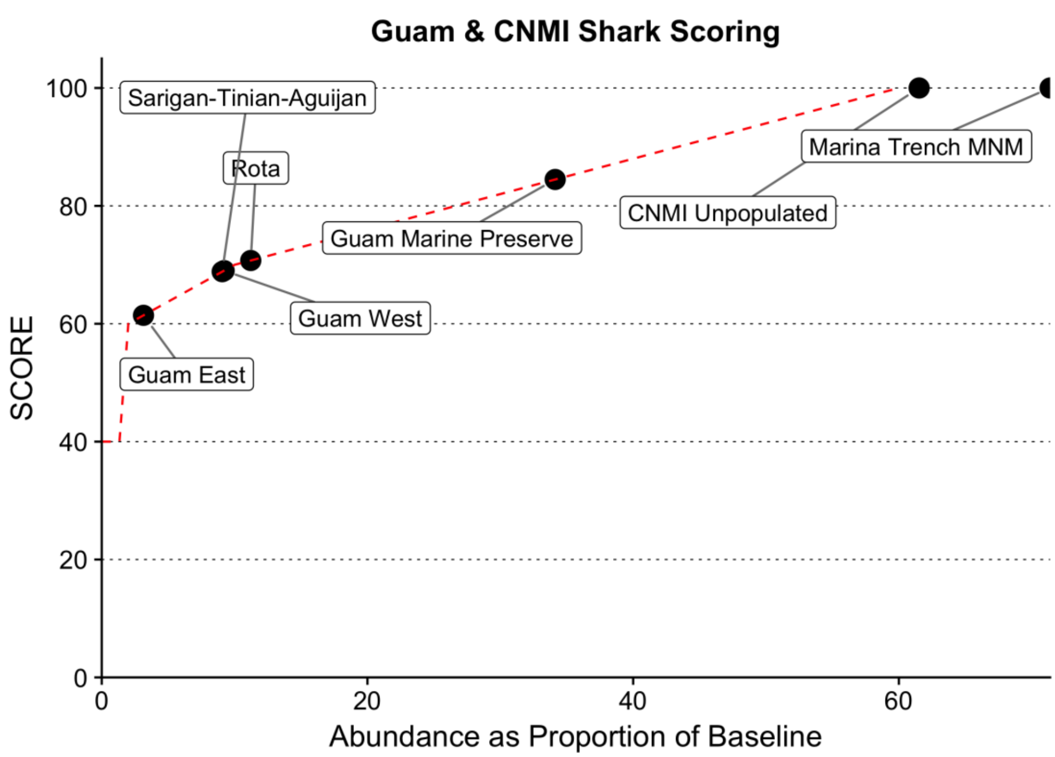
80
100
0
20
40
60
80
Biomass as Proportion of Baseline


Guam & CNMI Shark Scoring
Sarigan-Tinian-Aguijan
Rota
Marina Trench MNM
CNMI Unpopulated
Guam Marine Preserve
Guam West
Guam East
SCORE
0
20
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60
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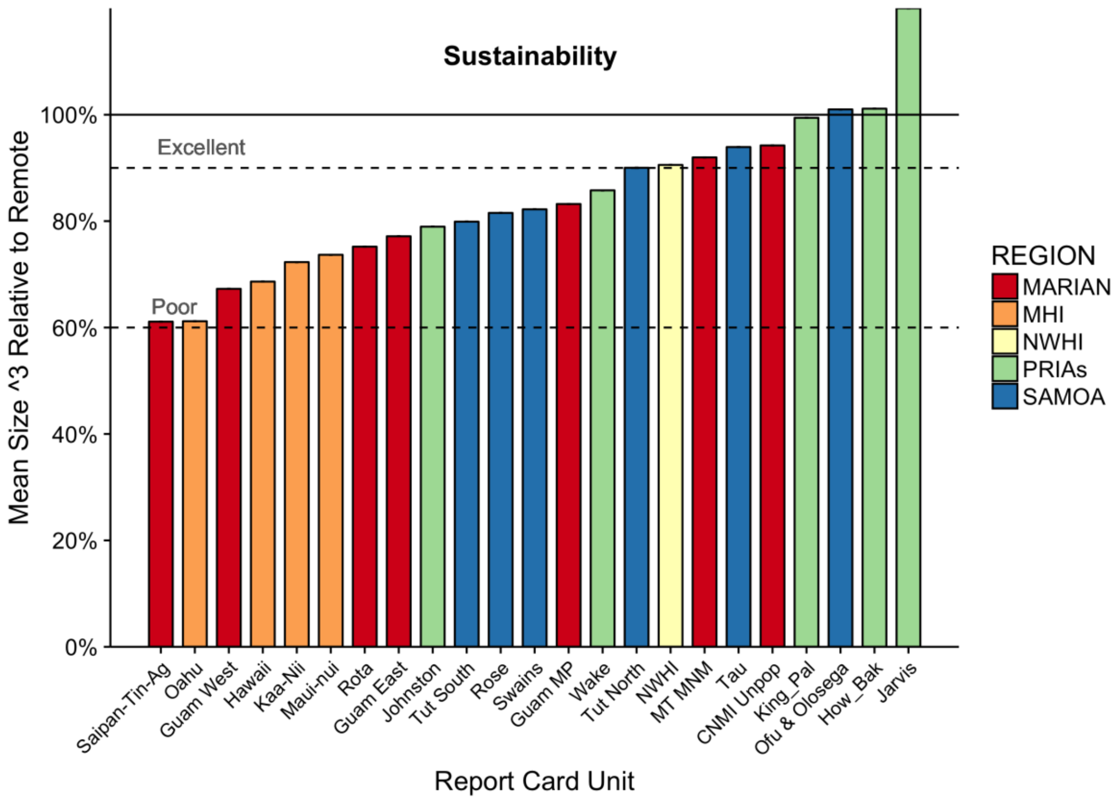
20
40
60
Abundance as Proportion of Baseline

Sustainability



Climate

The indicators for the climate theme are reef material growth, ocean acidification, and temperature stress. Each indicator has its own field methodology, which will be described in each section.

Reef material growth

The reef growth indicator directly measures the rate that calcium carbonate, i.e. the skeleton of corals and other reef organisms, accumulates in a given environment (Vargas-Angel et al. 2015). Data were collected by using Calcification Accretion Units (CAUS), a set of 5 stacks of 2 PVC plates per site out-planted for 3 years on a given reef. Units were recovered and the net weight of carbonate that accreted over the deployment period was recorded. Data presented here are from fore-reef sites. For jurisdictions with two years of data, reef material growth values for one year were scored (see threshold table below) and then averaged into an annual reef material growth score. Reef material growth values for the second year were scored (see threshold table below) and then averaged into an annual reef material growth score. The two scores were then averaged into an overall reef material growth score for the jurisdiction. For example, in American Samoa, reef material growth values for 41 sites in 2012 were scored and then averaged into an annual 2012 reef material growth score. Reef material growth values for 39 sites in 2015 were scored and then averaged into an annual 2015 reef material growth score. The 2012 and 2015 scores were then averaged into an overall American Samoa reef material growth score.

In American Samoa, 41 and 39 sites were averaged from 2012 and 2015, respectively. In the Main Hawaiian Islands and Northwestern Hawaiian Islands, 29 and 19 sites, respectively, were averaged from 2016. For the Northern Mariana Islands, Guam, and Wake Island, 37 and 41 sites were averaged from 2014 and 2017, respectively. For the Pacific Remote Islands, with the exception of Wake Island, 35 sites were averaged from 2015.

Years of collection and number of sites for each jurisdiction for reef material growth.

Jurisdiction	Years	# of sites
American Samoa	2012, 2015	41, 39
Main Hawaiian Islands	2016	29
Northwestern Hawaiian Islands	2016	19
Northern Mariana Islands, Guam, and Wake Island	2014, 2017	37, 41
Pacific Remote Islands except Wake Island	2015	35

Thresholds were guided by CAU data from throughout all Pacific jurisdictions, with specific thresholds coming from the log-transformed quantiles of Pacific CAU accretion rates. Confidence in using this as an indicator of climate effects on coral reefs is moderate, as we have a broad spatial database of similar metrics. However, this metric does not directly target coral accretion rates, but rather the more OA sensitive crustose coralline algae.

Reef material growth assessment points and associated scoring. The score is determined using an equation that relates reef material growth to a percent score.

RMG_Rate	Score	Justification
0.22615648	100	These breaks are based on the log distribution of RMG_Rate. Mean(Log(RMG)+2*sd(Log(RMG))
0.10991417	90	Mean(Log(RMG)+sd(Log(RMG))
0.05341932	80	Mean(Log(RMG)
0.02596229	70	Mean(Log(RMG)-sd(Log(RMG))
0.01261792	60	Mean(Log(RMG)-2*sd(Log(RMG))
0.0001	1	0; Less than 0.012 = functional zero.

Ocean acidification

The ocean acidification indicator measures if the water chemistry is suitable for the growth of corals and other reef calcifiers. Aragonite is a form of calcium carbonate that is used by corals to build the hard parts of the reef. The aragonite saturation state, which is unitless, measures the carbonate ion concentration in the water column. Data were collected by standard seawater sampling for carbonate measurements, using diver deployed Niskin bottle sampling at the surface immediately above focal coral reefs. For jurisdictions with two years of data, ocean acidification values for one year were scored (see threshold table below) and then averaged into an annual ocean acidification score. Ocean acidification values for the second year were scored (see threshold table below) and then averaged into an annual ocean acidification score. The two scores were then averaged into an overall ocean acidification score for that jurisdiction. For the current status reports, this only applies to American Samoa, where there is data from 2012 and 2015.

In American Samoa, 45 and 85 sites were averaged from 2012 and 2015, respectively. In the Main Hawaiian Islands and Northwestern Hawaiian Islands, 87 and 55 sites, respectively, were averaged from 2016. For the Northern Mariana Islands, Guam, and Wake Island, 106 sites were averaged from 2014. For the Pacific Remote Islands, with the exception of Wake Island, 73 sites were averaged from 2015.

Years of collection and number of sites for each jurisdiction for ocean acidification.

Jurisdiction	**Years**	**# of sites**
American Samoa	2012, 2015	45, 85
Main Hawaiian Islands	2016	87
Northwestern Hawaiian Islands	2016	55
Northern Mariana Islands, Guam, and Wake Island	2014	106
Pacific Remote Islands except Wake Island	2015	73

The thresholds for this indicator were determined by using ecologically and climatologically relevant thresholds (see table below) and were the same for both pilot areas. Past and future conditions Ω_{arag} estimated by keeping total alkalinity, salinity, and water temperature constant while altering the partial pressure of carbon dioxide. One annual mean Aragonite saturation value in each year was determined for each region from multiple sample values. That one mean Aragonite saturation value was compared against the threshold and scored. The scores for multiple years were then averaged for a regional score.

Ocean acidification assessment points and associated scoring. The score is determined using an equation that relates ocean acidification to a percent score.

Aragonite saturation	**Narrative**	**Score**	**Equation**
≥4.6	Pre-industrial	100	Y=100
4.28 - <4.6		90	Y=30.8x-41.5
3.95 - <4.28		80	Y=30.8x-41.5
3.63 - <3.95		70	Y=30.8x-41.5
3.3 - <3.63		60	Y=30.8x-41.5
<3.3	Double pre-industrial	0	Y=200x-600

Temperature stress

The temperature stress indicator grades corals' health based on the occurrence and severity of coral bleaching thermal stress they have experienced during the 4-year evaluation period. Mass coral bleaching due to anomalously warm water temperatures has occurred with increasing frequency and severity in recent decades and is now the most significant single contributor to the decline of coral reef ecosystems on a global scale. Coral mortality and disease outbreak often follow massive bleaching events, along with significantly reduced coral growth rate both during and after the bleaching and ability to fight off other stresses. NOAA Coral Reef Watch (CRW) has been using NOAA's operational near-real-time satellite sea surface temperature data to detect and monitor thermal stress conducive to mass coral bleaching globally since 1997 (Liu et al., 2013, 2014, 2017). Monitoring data for the status report target regions were extracted from CRW's global products and then statistical analysis was performed on the data to generate a grade. Data analysis follows these steps:

1. Determine the reporting period based on available satellite data. Scoring will be based on degree heating week event frequency and severity per 4-year period.
2. Define all the reef-containing data pixels for each area of interest and extract the daily time series of degree heating week values. For multi-pixel areas with 10 or more data pixels, the 90th percentile degree heating week (DHW) value is chosen for each time step in the series. For multi-pixel areas with less than 10 data pixels, the maximum degree heating week value is used for each time step.
3. Take the maximum degree heating week value for each year in the 4-year time series.
4. Use these 4 values along with the grading chart and find the corresponding score based on the frequency and severity values in the chart. The value resulting in the lowest score becomes the overall grade for that reporting period.

The scoring chart ranks thermal stress severity in 7 bins based on DHW ranges shown across the top of the chart. The frequency of events at these levels are shown below each bin and have varying distribution based on the relationship between DHW and coral bleaching and mortality. The corresponding score and an interpretation of what that score means are shown on the left hand side of the chart. Counting the number of times a DHW level is reached in a 4-year period and matching it to the proper severity column and frequency row will result in the corresponding score. The chart also takes into account consecutive years of high DHW events, which would have a greater impact on corals than non-consecutive events. These have their own frequency label of "2c". For example, during the period 2013-2016, if 2013 and 2015 saw DHW values of 9, the resulting grade would be 55%, but if 2013 and 2014 saw DHW values of 9 the resulting grade would be 45%.

Coral Reef Watch NCRMP Status report Scoring Table for a Four-Year Evaluation Period

%Bleached	%Dead	Score	0<N<4	4≤N<8	8≤N<12	12≤N<16	16≤N<20	20≤N<32	32≤N
<1%		100%	0	0	0	0	0	0	
1%		95%	1-2						
10%		85%	3-4	1					
20%		75%		2					
40%		65%		3	1				
60%	10%	55%		4	2	1			
80%	20%	45%			2c	2	1		
90%	40%	35%			3	2c	2		
100%	60%	25%			4	3	2c	1	
	80%	15%				4	3		
	90%	5%					4	2	
	100%	0%						3-4	1

Key

DHW Severity Ranges (N = DHW value)

Number of DHW occurrences in 4-Year period (2c = 2 years are consecutive)

Corresponding Score and Expected Impact on Corals

Human connections

The human connections theme of the NCRMP gathers and monitors a collection of socioeconomic variables, such as demographics in coral reef areas, human use of coral reef resources, as well as knowledge, attitudes, and perceptions of coral reefs and coral reef management. The overall goal of the human connections monitoring component is to track relevant information regarding each jurisdiction's population, social and economic structure, and interactions between coral reef ecosystems and adjacent human communities. The selection of indicators was determined through workshops and consultations with partners (local jurisdictions as well as federal agencies). The human connections indicators are: awareness, participation in pro-environmental behaviors, and support for management actions. To operationalize these three indicators, secondary data collected from the jurisdiction and data collected from an NCRMP survey of jurisdictional residents are used. Threshold goals for these indicators were established through consultation with coral reef managers, environmental education and outreach coordinators, and relevant federal, state, and local agency staff.

Scoring scale for Human Connections indicators

Percentage calculated by dividing indicator score by the established threshold	**Score**
90%+	Very good
80%-89.99%	Good
70%-79.99%	Fair
60%-69.99%	Impaired
<60%	Critical

American Samoa

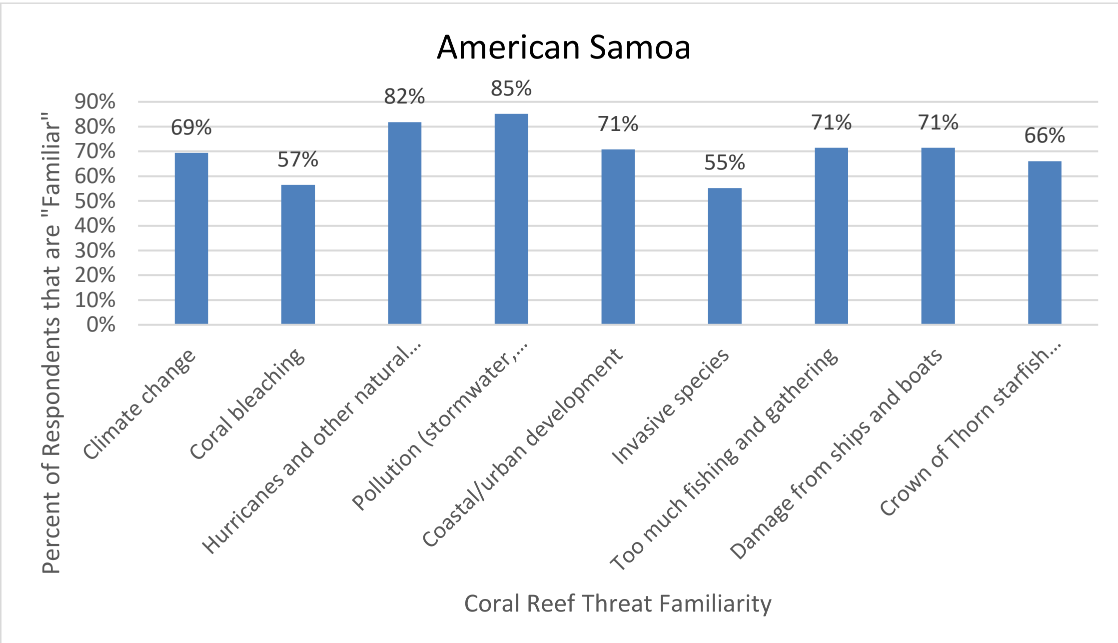
All indicators are evaluated at the jurisdictional level, not at the reporting region level. Due to resource constraints, the NCRMP team was not able conduct a survey of residents of the less populated Manuʻa Islands, although surveys in these locations are planned for future survey iterations. Thus, the indicators for awareness, support for management actions, and participation in pro-environmental behaviors reflect the most populated island of Tutuila. The score is the average of the three overall indicators – Awareness, Support for management actions, and Pro-environmental behavior.

Awareness

The Awareness indicator is an indicator of residents' familiarity with threats to and the importance of reefs. Three awareness metrics, obtained from the NCRMP jurisdictional resident survey, were averaged into an overall Awareness indicator score. The three metrics for American Samoa are: familiarity with threats to coral reefs; familiarity with Marine Protected Areas (MPAs); and, the value or importance respondents place on coral reefs.

Familiarity with threats to coral reefs

Survey respondents in American Samoa were asked to rate their familiarity with various threats posed to coral reefs on a scale of "very unfamiliar" to "very familiar." Familiarity with threats indicates local awareness of the need for management action. The percentage of respondents that were at least "familiar" was calculated for each of the nine threats that were proposed in the American Samoa survey. A threshold of two-thirds was established (i.e., a goal that at least two-thirds of respondents were at least "familiar" with the threat). Coral reef managers in American Samoa confirmed that this goal was appropriate (i.e., professional judgement).

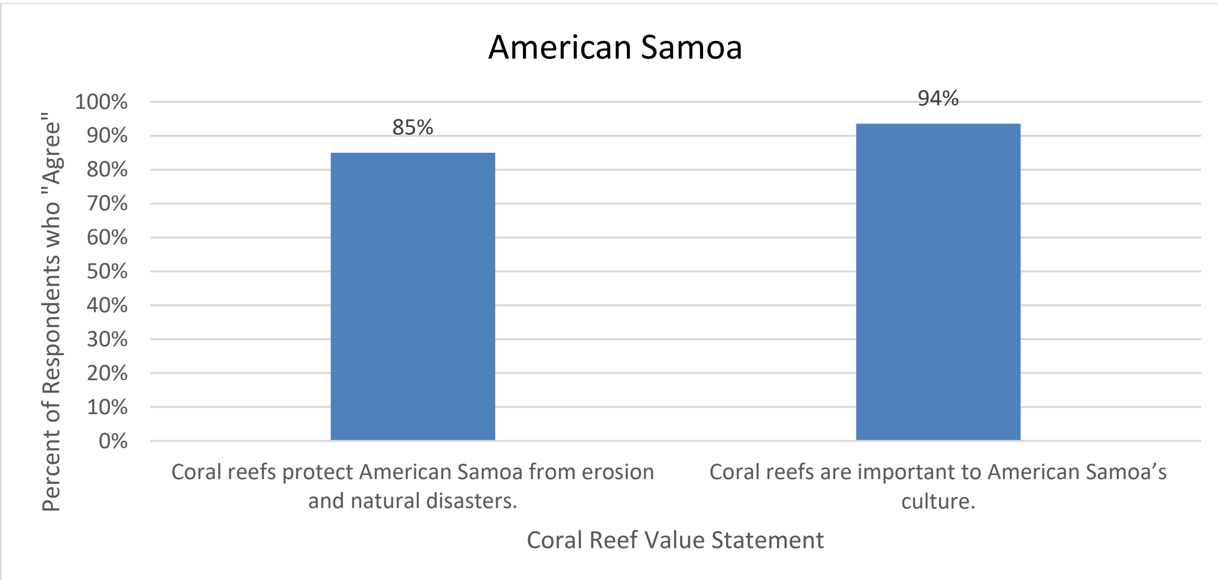


Familiarity with Marine Protected Areas

Survey respondents in American Samoa were asked to rate their familiarity with MPAs on a scale of "very unfamiliar" to "very familiar." Familiarity with MPAs indicates success of jurisdictional education and outreach campaigns and understanding of marine regulations. The percentage of respondents that were at least "familiar" with MPAs was calculated. A threshold of two-thirds was established (i.e. a goal that at least two-thirds of respondents were at least "familiar" with MPAs). Coral reef managers in American Samoa confirmed that this goal was appropriate (i.e., professional judgement).

Value or Importance of coral reefs

The value or importance that respondents in American Samoa place on coral reefs was examined. This section of the survey contained four questions in which statements were proposed and respondents were asked to rate how much they "agree" with the statements on a scale of "strongly disagree" to "strongly agree." Two of these statements were ambiguous in their interpretation ("Coral reefs are only important to fishermen, divers and snorkelers" and "Healthy coral reefs attract tourists to American Samoa"). Since agreement with these aforementioned statements can either be considered good or bad, they were not analyzed in this section. However, the other two questions in this section were analyzed ("Coral reefs protect American Samoa from erosion and natural disasters" and "Coral reefs are important to American Samoan cultures"). Agreement with these statements can be interpreted as positive indicators. A threshold of two-thirds in agreement with the protection and culture statements was established after consultation with coral reef managers in American Samoa.

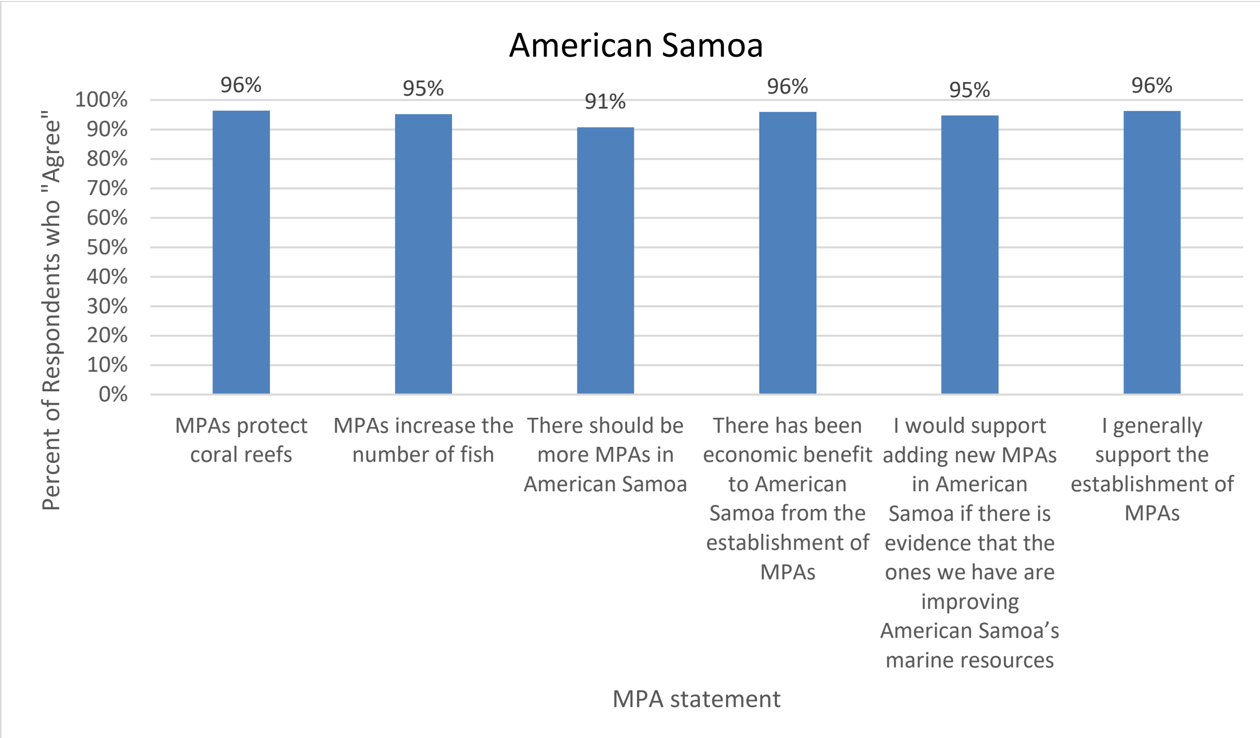


Support for management actions

The support for management indicator measures the level of support that respondents to the NCRMP jurisdictional resident survey indicate for coral reef management activities. The American Samoa survey asks two sets of questions (agreement with various Marine Protected Area functions and support for coral reef management rules and regulations). After consultation with local partners, the threshold for both indicators was set at two-thirds of the respondents in agreement, or supportive.

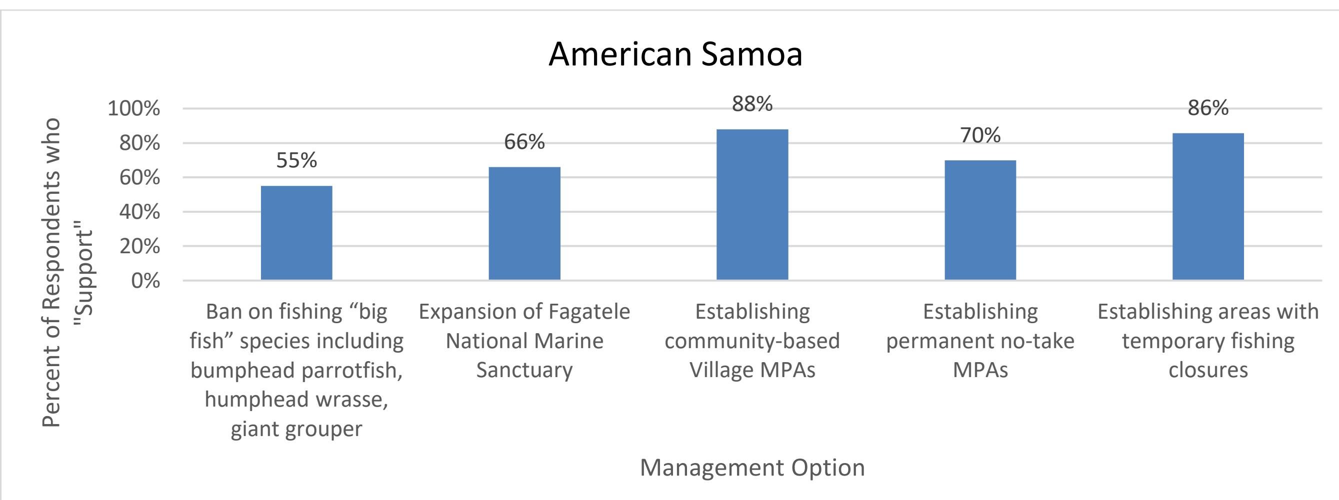
Agreement with marine protected area functions

The marine protected area question section contained nine statements, and respondents were asked to rate how much they "agree" with the statements on a scale of "strongly disagree" to "strongly agree." Three of these statements were left out of this analysis due to the ambiguous nature of interpretation ("There should be fewer MPAs in American Samoa," "Fishermen's livelihoods have been negatively impacted from the establishment of MPAs in American Samoa," and "MPAs help increase tourism in American Samoa"). The first two of these aforementioned statements can be considered as negative sentiments toward MPAs, and the third statement does not necessarily indicate agreement with MPA functions. The other statements in this section can all be considered agreement with the intended functions of MPAs ("MPAs protect coral reefs," "MPAs increase the number of fish," "There should be more MPAs in American Samoa," "There has been economic benefit to American Samoa from the establishment of MPAs," "I would support adding new MPAs in American Samoa if there is evidence that the ones we have are improving American Samoa's marine resources," and "I generally support the establishment of MPAs"). Therefore, only these "positive sentiment" statements are analyzed in this section. A threshold of two-thirds agreement was established for the “positive” statements after consultation with coral reef managers in American Samoa to maintain consistency across the indicators.



Support for coral reef management rules and regulations

Respondents were asked to rate their support for various management initiatives on a scale of “strongly oppose” to “strongly support.” The same threshold goal of two-thirds of survey respondents in support with the proposed management initiatives was set after consultation with coral reef managers.



Pro-environmental behavior

The pro-environmental behavior indicator measures residents' (active) participation in activities, such as beach clean-ups, volunteering with an environmental group, recycling, etc. to protect the environment. NCRMP survey respondents in American Samoa were asked to rate their frequency of participation in any pro-environmental behaviors on a scale of "not at all" to "several times a month or more." Through discussion with coral reef managers, a goal of 70% participation was established (i.e., researchers wanted to observe that at least 70% of respondents participated in any form of pro-environmental behavior and at any frequency).

Hawaiian Archipelago

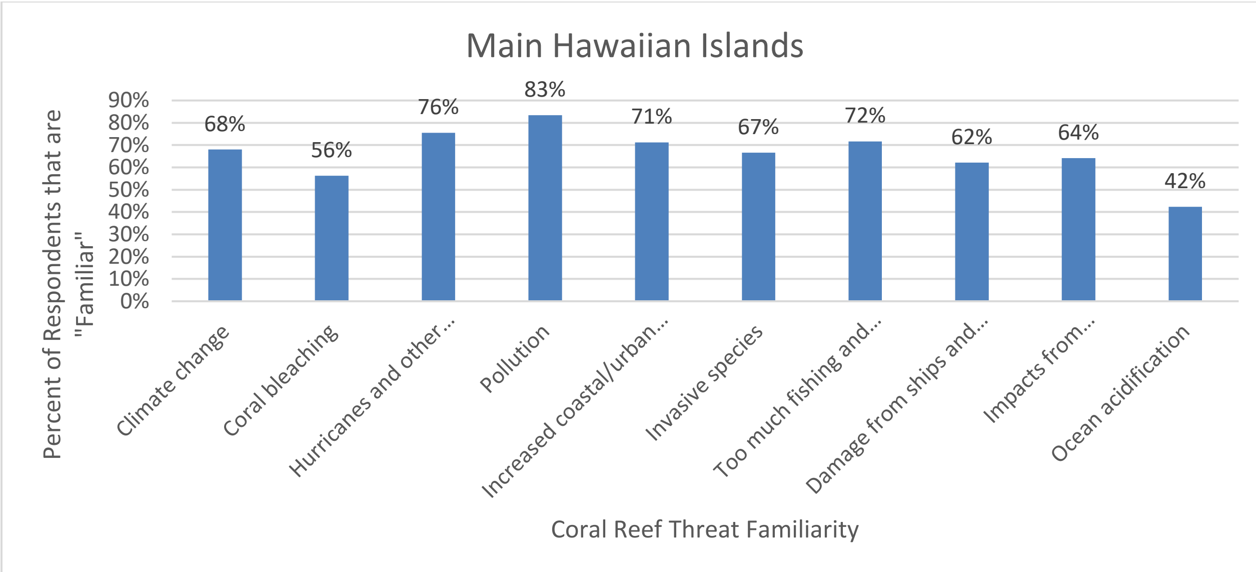
All indicators are evaluated for the Main Hawaiian Islands, at the jurisdictional level, as well as the reporting region level. Human Connections data were not collected for the Northwest Hawaiian Islands, as they are not populated by people. Thus, the indicators for awareness, support for management actions, and participation in pro-environmental behaviors reflect the Main Hawaiian Islands as a whole, as well as Hawaiʻi Island, Oʻahu, Kauaʻi, and Maui Nui.

Awareness

The Awareness indicator is an indicator of residents' familiarity with threats to and the importance of reefs. Three awareness metrics, were averaged into an overall Awareness indicator score. The three metrics for Hawaiʻi are: familiarity with threats to coral reefs; familiarity with MPAs; and, the value or importance respondents place on coral reefs.

Familiarity with threats to coral reefs

Survey respondents in Hawaiʻi were asked to rate their familiarity with various threats posed to coral reefs on a scale of "very unfamiliar" to "very familiar." Familiarity with threats indicates local awareness of the need for management action. The percentage of respondents that were at least "familiar" was calculated for each of the ten threats that were proposed in the Hawaiʻi survey. A threshold of two-thirds was established (i.e., a goal that at least two-thirds of respondents were at least "familiar" with the threat). Coral reef managers in Hawaiʻi confirmed that this goal was appropriate (i.e., professional judgement).

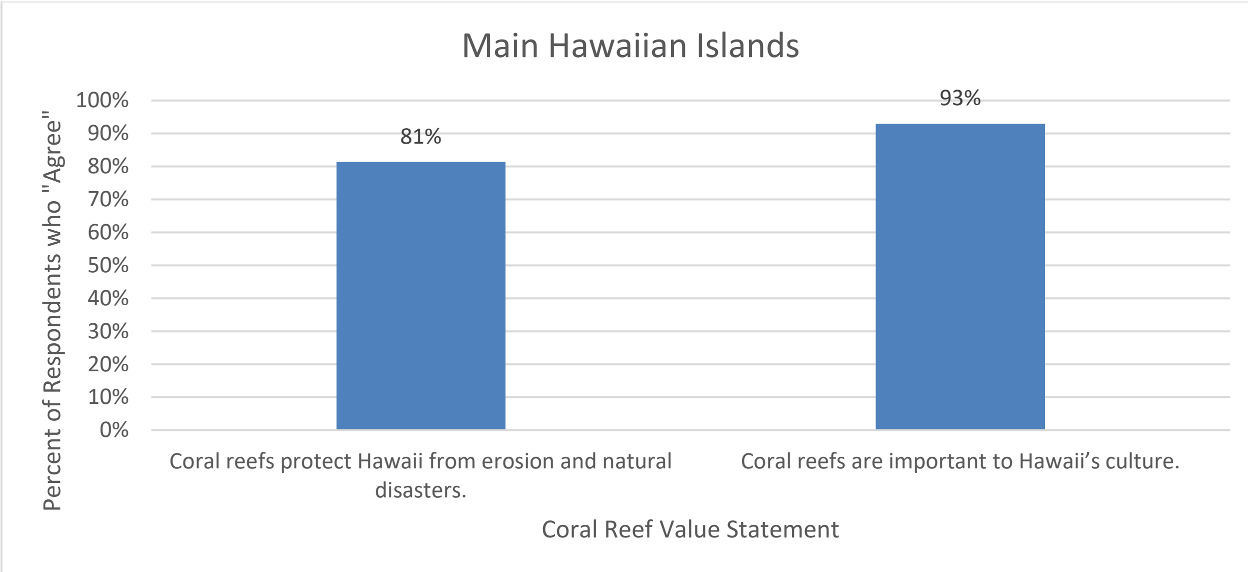


Familiarity with Marine Protected Areas

Survey respondents in Hawaiʻi were asked to rate their familiarity with MPAs on a scale of "very unfamiliar" to "very familiar." Familiarity with MPAs indicates success of jurisdictional education and outreach campaigns and understanding of marine regulations. The percentage of respondents that were at least "familiar" with MPAs was calculated. A threshold of two-thirds was established (i.e. a goal that at least two-thirds of respondents were at least "familiar" with MPAs). Coral reef managers in Hawaiʻi confirmed that this goal was appropriate (i.e., professional judgement).

Value or Importance of coral reefs

The value or importance that respondents in Hawaiʻi place on coral reefs was examined. This section of the survey contained four questions in which statements were proposed and respondents were asked to rate how much they "agree" with the statements on a scale of "strongly disagree" to "strongly agree." Two of these statements were ambiguous in their interpretation ("Coral reefs are only important to fishermen, divers and snorkelers" and "Healthy coral reefs attract tourists to Hawaiʻi"). Since agreement with these aforementioned statements can either be considered good or bad, they were not analyzed in this section. However, the other two questions in this section were analyzed ("Coral reefs protect Hawaiʻi from erosion and natural disasters" and "Coral reefs are important to Hawaiian culture"). Agreement with these statements can be interpreted as positive indicators. A threshold of two-thirds in agreement with the protection and culture statements was established after consultation with coral reef managers in Hawaiʻi.

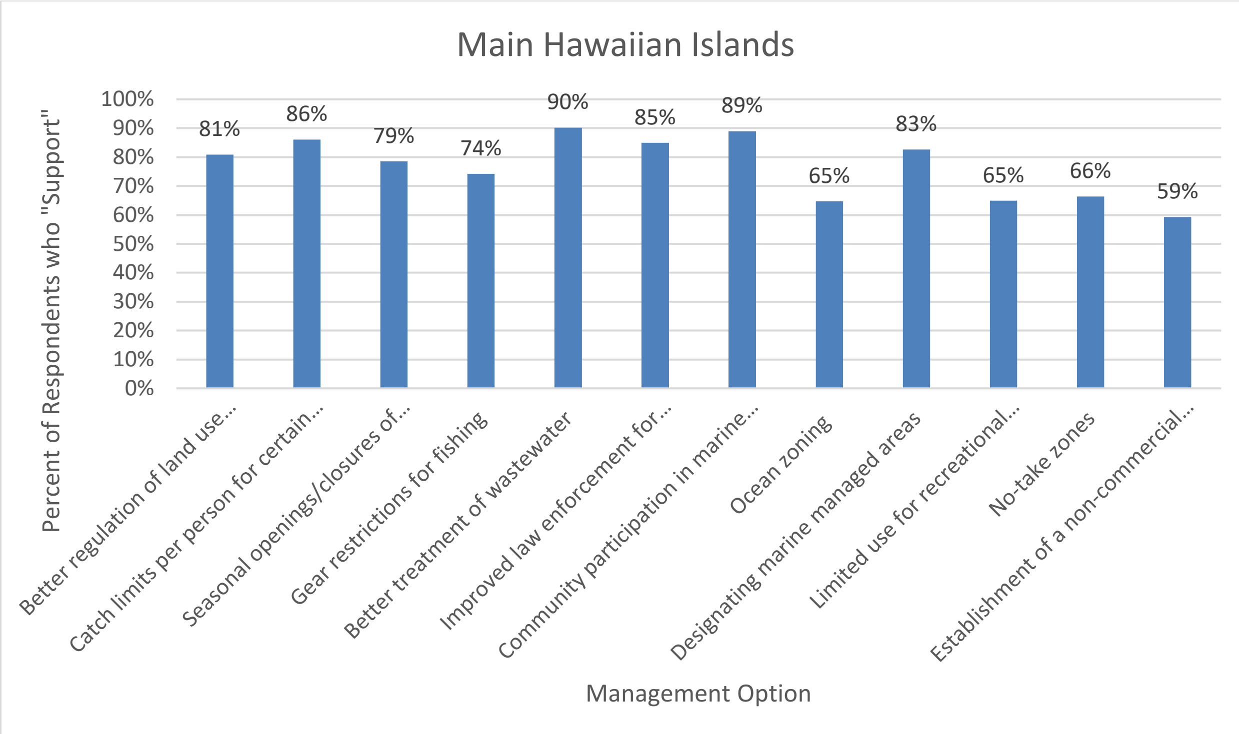


Support for management actions

The support for management indicator measures the level of support that respondents to the NCRMP jurisdictional resident survey indicate for coral reef management activities. The Hawaiʻi survey asks one set of questions related to support for coral reef management rules and regulations. After consultation with local partners, the threshold for the indicator was set at two-thirds of the respondents in support.

Support for coral reef management rules and regulations

Respondents were asked to rate their support for various management initiatives on a scale of "strongly oppose" to "strongly support." The same threshold goal of two-thirds of survey respondents in support with the proposed management initiatives was set after consultation with coral reef managers.



Pro-environmental behavior

The pro-environmental behavior indicator measures residents' (active) participation in activities, such as beach clean-ups, volunteering with an environmental group, recycling, etc. to protect the environment. NCRMP survey respondents in Hawaiʻi were asked to rate their frequency of participation in any pro-environmental behaviors on a scale of "not at all" to "several times a month or more." Through discussion with coral reef managers, a goal of 70% participation was established (i.e., researchers wanted to observe that at least 70% of respondents participated in any form of pro-environmental behavior and at any frequency).

Guam

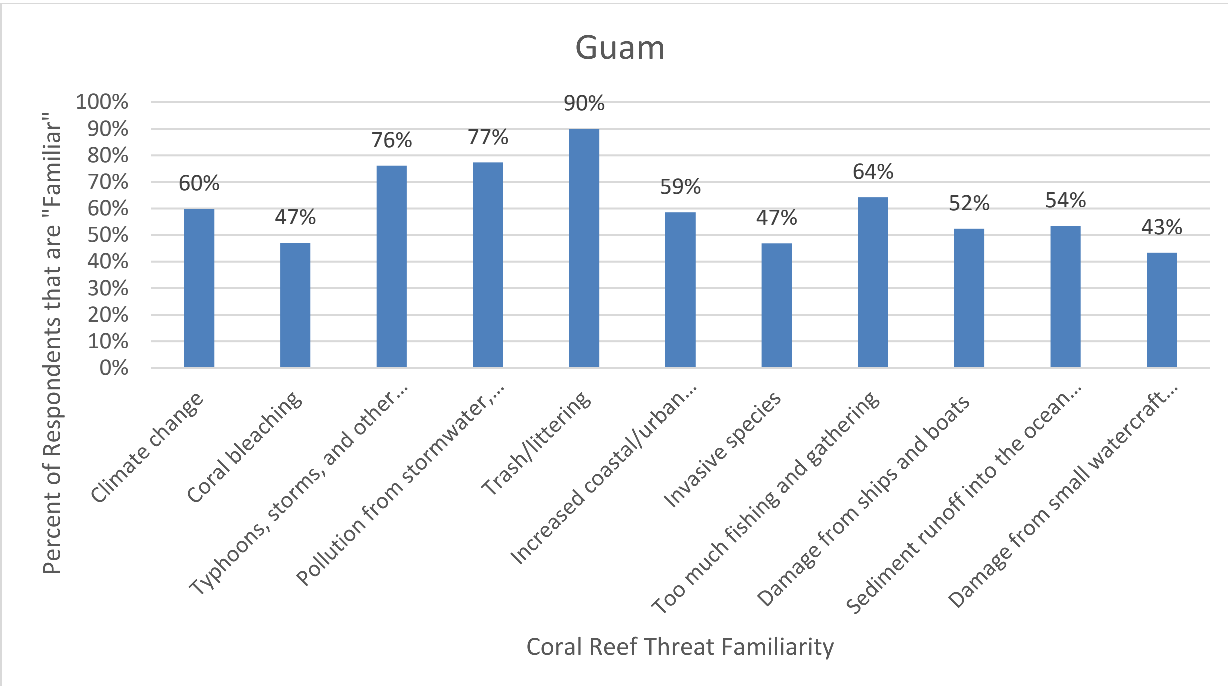
All indicators are evaluated at the jurisdictional level, not at the reporting region level. Due to resource constraints, the NCRMP team was not able collect representative samples from Eastern and Western Guam. Thus, the indicators for awareness, support for management actions, and participation in pro-environmental behaviors reflect the status of Guam as a whole.

Awareness

The Awareness indicator is an indicator of residents' familiarity with threats to and the importance of reefs. Three awareness metrics, were averaged into an overall Awareness indicator score. The three metrics for Guam are: familiarity with threats to coral reefs; familiarity with MPAs; and, the value or importance respondents place on coral reefs.

Familiarity with threats to coral reefs

Survey respondents in Guam were asked to rate their familiarity with various threats posed to coral reefs on a scale of "very unfamiliar" to "very familiar." Familiarity with threats indicates local awareness of the need for management action. The percentage of respondents that were at least "familiar" was calculated for each of the eleven threats that were proposed in the Guam survey. A threshold of two-thirds was established (i.e., a goal that at least two-thirds of respondents were at least "familiar" with the threat). Coral reef managers in Guam confirmed that this goal was appropriate (i.e., professional judgement).

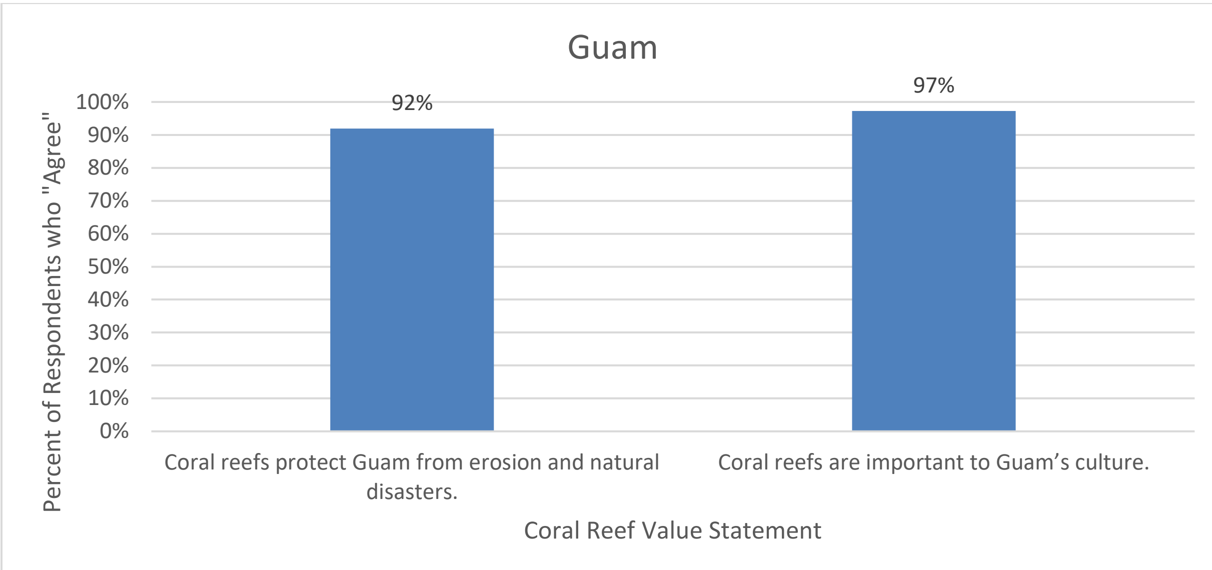


Familiarity with Marine Protected Areas

Survey respondents in Guam were asked to rate their familiarity with MPAs on a scale of "very unfamiliar" to "very familiar." Familiarity with MPAs indicates success of jurisdictional education and outreach campaigns and understanding of marine regulations. The percentage of respondents that were at least "familiar" with MPAs was calculated. A threshold of two-thirds was established (i.e. a goal that at least two-thirds of respondents were at least "familiar" with MPAs). Coral reef managers in Guam confirmed that this goal was appropriate (i.e., professional judgement).

Value or Importance of coral reefs

The value or importance that respondents in Guam place on coral reefs was examined. This section of the survey contained four questions in which statements were proposed and respondents were asked to rate how much they "agree" with the statements on a scale of "strongly disagree" to "strongly agree." Two of these statements were ambiguous in their interpretation ("Coral reefs are only important to fishermen, divers and snorkelers" and "Healthy coral reefs attract tourists to Guam"). Since agreement with these aforementioned statements can either be considered good or bad, they were not analyzed in this section. However, the other two questions in this section were analyzed ("Coral reefs protect Guam from erosion and natural disasters" and "Coral reefs are important to Guam's culture"). Agreement with these statements can be interpreted as positive indicators. A threshold of two-thirds in agreement with the protection and culture statements was established after consultation with coral reef managers in Guam.

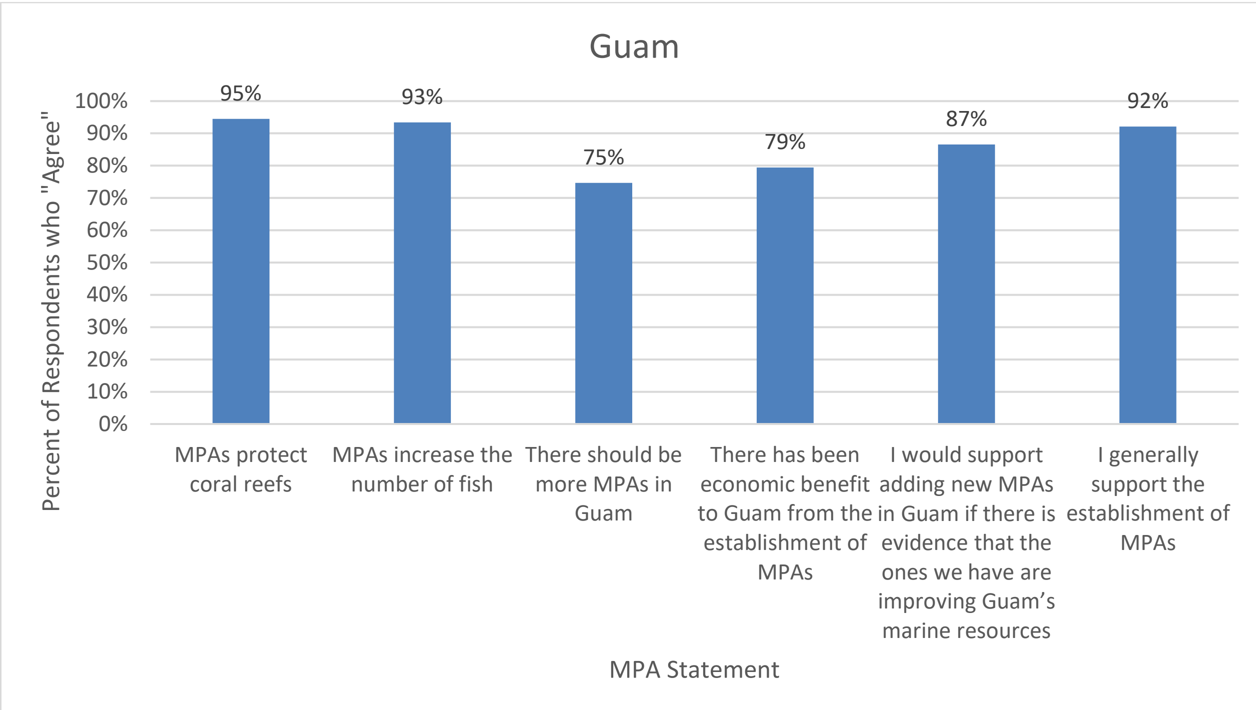


Support for management actions

The support for management indicator measures the level of support that respondents to the NCRMP jurisdictional resident survey indicate for coral reef management activities. The Guam survey asks two sets of questions (agreement with various Marine Protected Area functions and support for coral reef management rules and regulations). After consultation with local partners, the threshold for both indicators was set at two-thirds of the respondents in agreement, or supportive.

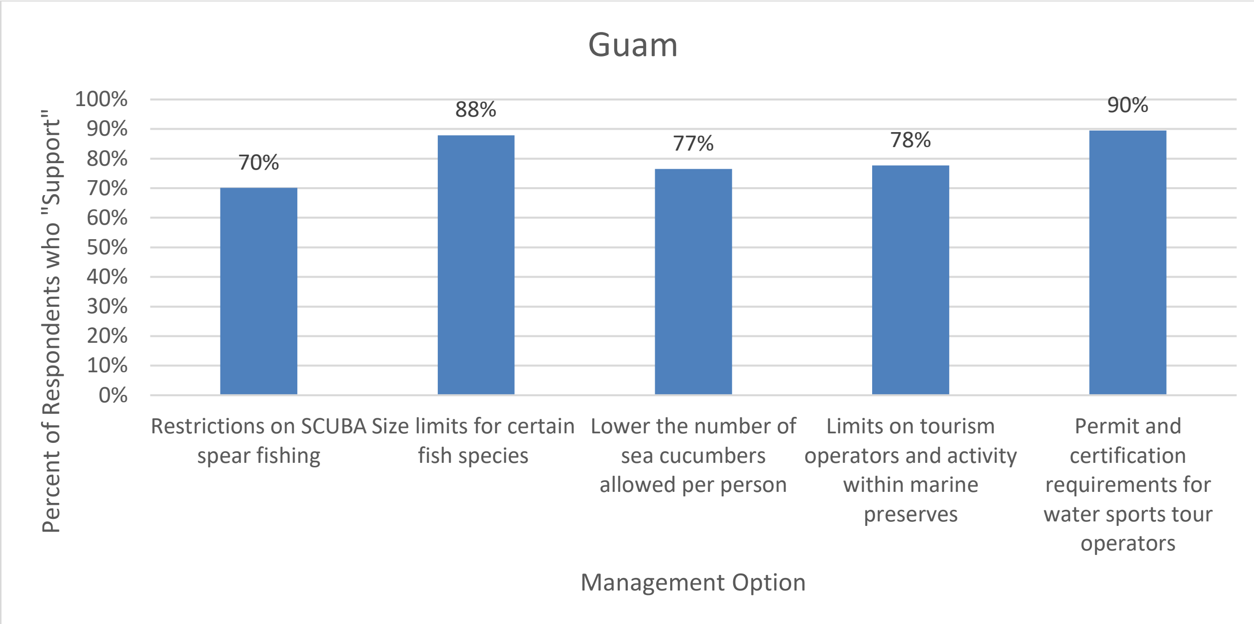
Agreement with marine protected area functions

The marine protected area question section contained ten statements, and respondents were asked to rate how much they "agree" with the statements on a scale of "strongly disagree" to "strongly agree." Four of these statements were left out of this analysis due to the ambiguous nature of interpretation ("There should be fewer MPAs in Guam," "Fishermen's livelihoods have been negatively impacted from the establishment of MPAs in Guam," "The establishment of MPAs increases the likelihood that people will vacation in Guam," and "MPAs help increase tourism in Guam"). The first two of these aforementioned statements can be considered as negative sentiments toward MPAs, and the last two statements do not necessarily indicate agreement with MPA functions. The other statements in this section can all be considered agreement with the intended functions of MPAs ("MPAs protect coral reefs," "MPAs increase the number of fish," "There should be more MPAs in Guam," "There has been economic benefit to Guam from the establishment of MPAs," "I would support adding new MPAs in Guam if there is evidence that the ones we have are improving Guam's marine resources," and "I generally support the establishment of MPAs"). Therefore, only these "positive sentiment" statements are analyzed in this section. A threshold of two-thirds agreement was established for the “positive” statements after consultation with coral reef managers in Guam to maintain consistency across the indicators.



Support for coral reef management rules and regulations

Respondents were asked to rate their support for various management initiatives on a scale of “strongly oppose” to “strongly support.” The same threshold goal of two-thirds of survey respondents in support with the proposed management initiatives was set after consultation with coral reef managers.



Pro-environmental behavior

The pro-environmental behavior indicator measures residents' (active) participation in activities, such as beach clean-ups, volunteering with an environmental group, recycling, etc. to protect the environment. NCRMP survey respondents in Guam were asked to rate their frequency of participation in any pro-environmental behaviors on a scale of "not at all" to "several times a month or more." Through discussion with coral reef managers, a goal of two thirds participation was established (i.e., researchers wanted to observe that at least two thirds of respondents participated in any form of pro-environmental behavior and at any frequency).

Northern Mariana Islands

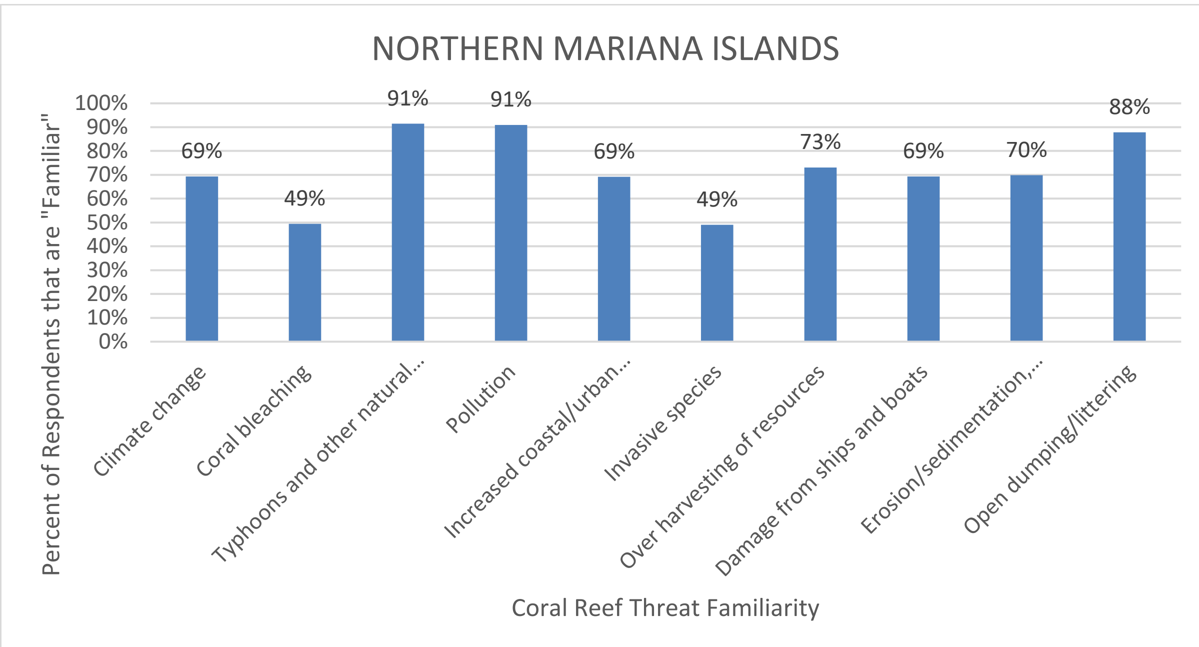
All indicators are evaluated at the jurisdictional level, not at the reporting region level. Due to resource constraints, the NCRMP team was not able collect representative samples from Tinian and Rota, although responses from residents of those islands are still included in the overall figures for the Northern Mariana Islands. Thus, the indicators for awareness, support for management actions, and participation in pro-environmental behaviors reflect the status of the Northern Mariana Islands as a whole.

Awareness

The Awareness indicator is an indicator of residents' familiarity with threats to and the importance of reefs. Three awareness metrics, were averaged into an overall Awareness indicator score. The three metrics for the Northern Mariana Islands are: familiarity with threats to coral reefs; familiarity with MPAs; and, the value or importance respondents place on coral reefs.

Familiarity with threats to coral reefs

Survey respondents in Northern Mariana Islands were asked to rate their familiarity with various threats posed to coral reefs on a scale of “very unfamiliar” to “very familiar.” Familiarity with threats indicates local awareness of the need for management action. The percentage of respondents that were at least “familiar” was calculated for each of the ten threats that were proposed in the Northern Mariana Islands survey. A threshold of two-thirds was established (i.e., a goal that at least two-thirds of respondents were at least “familiar” with the threat). Coral reef managers in Northern Mariana Islands confirmed that this goal was appropriate (i.e., professional judgement).

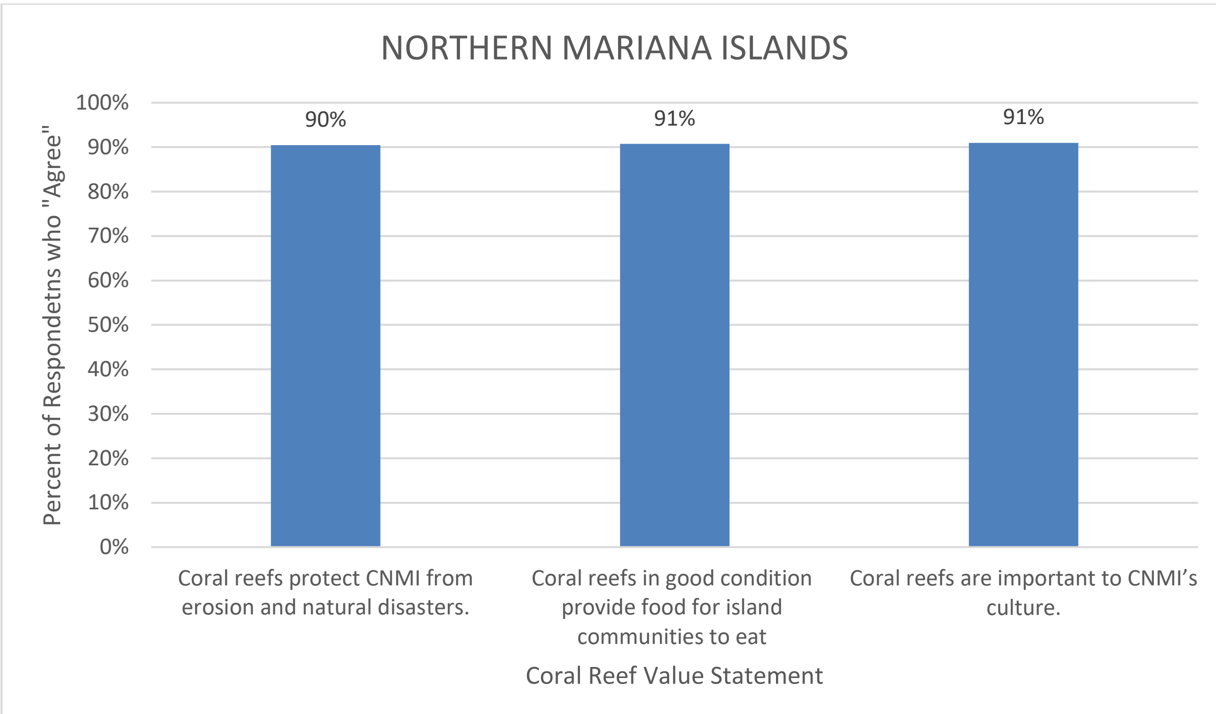


Familiarity with Marine Protected Areas

Survey respondents in Northern Mariana Islands were asked to rate their familiarity with MPAs on a scale of “very unfamiliar” to “very familiar.” Familiarity with MPAs indicates success of jurisdictional education and outreach campaigns and understanding of marine regulations. The percentage of respondents that were at least “familiar” with MPAs was calculated. A threshold of two-thirds was established (i.e. a goal that at least two-thirds of respondents were at least “familiar” with MPAs). Coral reef managers in Northern Mariana Islands confirmed that this goal was appropriate (i.e., professional judgement).

Value or Importance of coral reefs

The value or importance that respondents in Northern Mariana Islands place on coral reefs was examined. This section of the survey contained four questions in which statements were proposed and respondents were asked to rate how much they “agree” with the statements on a scale of “strongly disagree” to “strongly agree.” One of these statements was negative in terms of its interpretation (“Coral reefs are only important to fishermen, divers and snorkelers”). Since agreement with this aforementioned statement can be considered good or bad, is was not analyzed in this section. However, the other three questions in this section were analyzed ("Coral reefs protect Northern Mariana Islands from erosion and natural disasters," "Coral reefs in good condition provide food for island communities to eat," and "Coral reefs are important to Northern Mariana Island's culture"). Agreement with these statements can be interpreted as positive indicators. A threshold of two-thirds in agreement with the protection, provisioning, and culture statements was established after consultation with coral reef managers in Northern Mariana Islands.

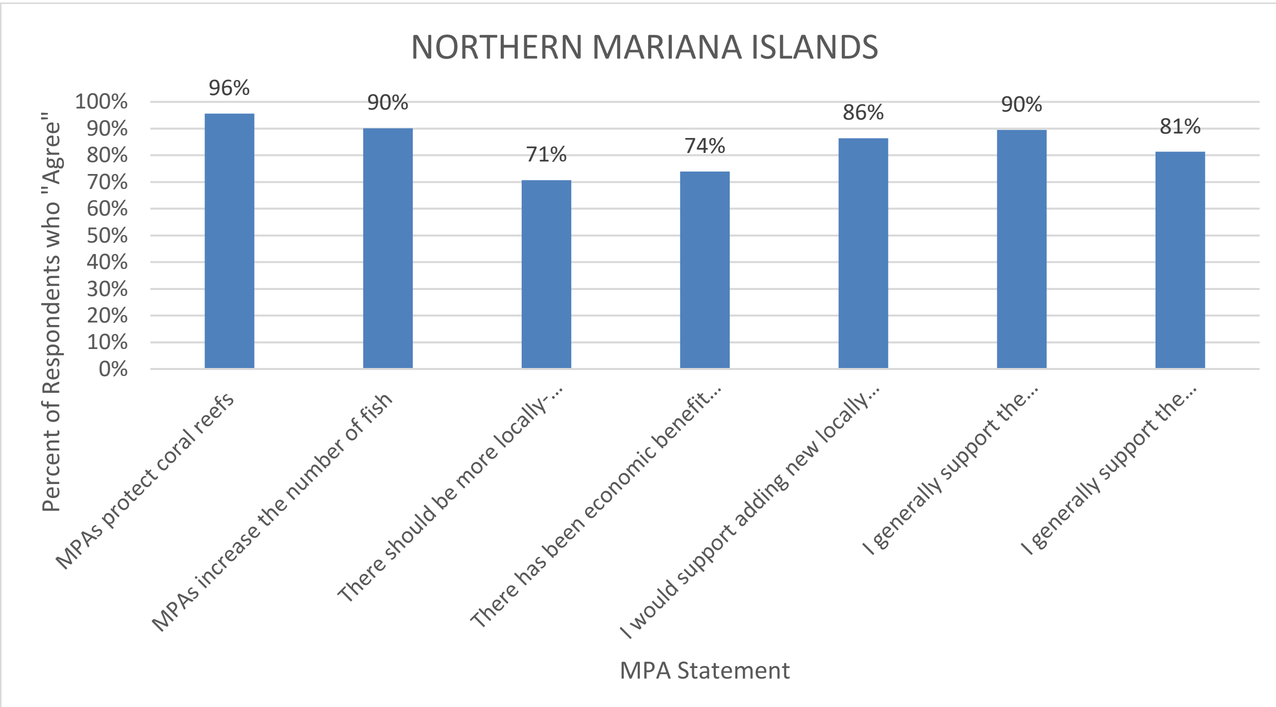


Support for management actions

The support for management indicator measures the level of support that respondents to the NCRMP jurisdictional resident survey indicate for coral reef management activities. The Northern Mariana Islands survey asks two sets of questions (agreement with various Marine Protected Area functions and support for coral reef management rules and regulations). After consultation with local partners, the threshold for both indicators was set at two-thirds of the respondents in agreement, or supportive.

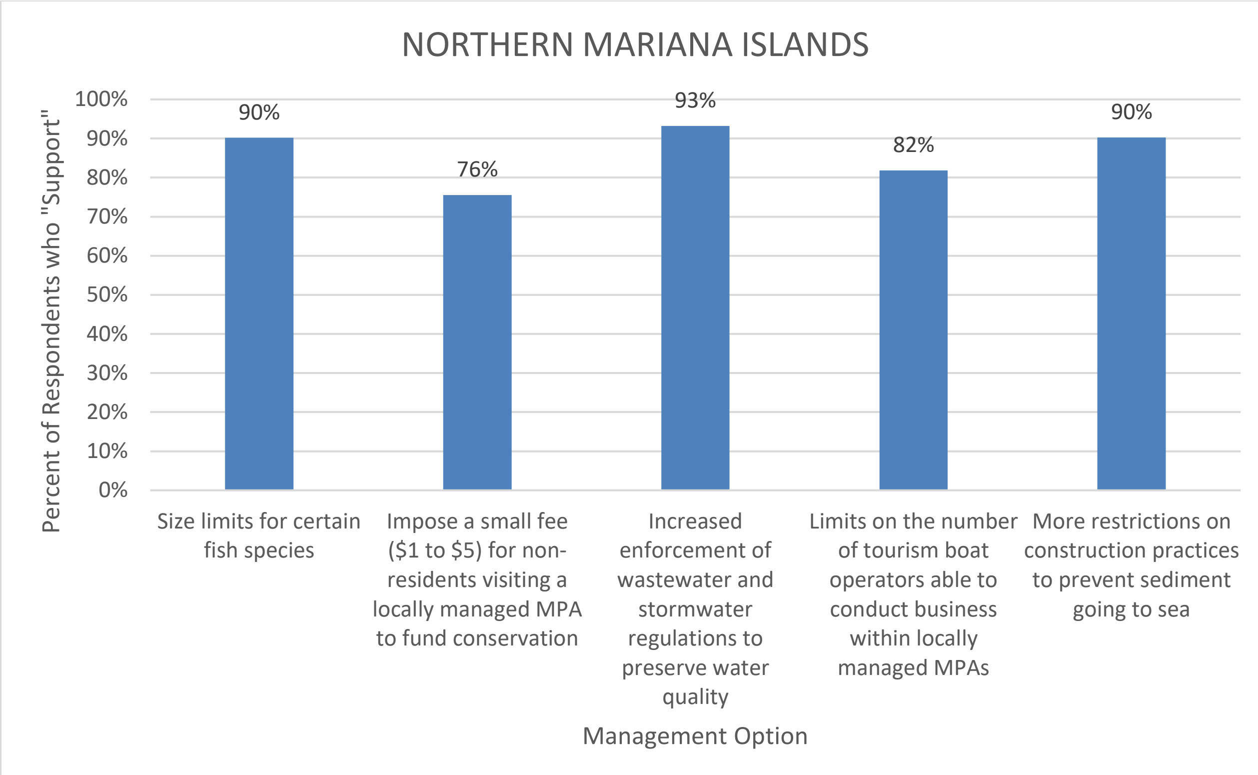
Agreement with marine protected area functions

The marine protected area question section contained eleven statements, and respondents were asked to rate how much they "agree" with the statements on a scale of "strongly disagree" to "strongly agree." Three of these statements were left out of this analysis due to the ambiguous nature of interpretation ("There should be fewer MPAs in Northern Mariana Islands," "Fishermen's livelihoods have been negatively impacted from the establishment of MPAs in Northern Mariana Islands," "The establishment of MPAs increases the likelihood that people will vacation in Northern Mariana Islands," and "MPAs help increase tourism in Northern Mariana Islands"). The first two of these aforementioned statements can be considered as negative sentiments toward MPAs, and the last two statements do not necessarily indicate agreement with MPA functions. The other statements in this section can all be considered agreement with the intended functions of MPAs ("MPAs protect coral reefs," "MPAs increase the number of fish," "There should be more MPAs in Northern Mariana Islands," "There has been economic benefit to Northern Mariana Islands from the establishment of MPAs," "I would support adding new MPAs in Northern Mariana Islands if there is evidence that the ones we have are improving Northern Mariana Islands's marine resources," "I generally support the establishment of MPAs," and "I generally support the establishment of the federally managed Marina Trench Marine National Monument"). Therefore, only these "positive sentiment" statements are analyzed in this section. A threshold of two-thirds agreement was established for the "positive" statements after consultation with coral reef managers in Northern Mariana Islands to maintain consistency across the indicators.



Support for coral reef management rules and regulations

Respondents were asked to rate their support for various management initiatives on a scale of "strongly oppose" to "strongly support." The same threshold goal of two-thirds of survey respondents in support with the proposed management initiatives was set after consultation with coral reef managers.



Pro-environmental behavior

The pro-environmental behavior indicator measures residents' (active) participation in activities, such as beach clean-ups, volunteering with an environmental group, recycling, etc. to protect the environment. NCRMP survey respondents in Northern Mariana Islands were asked to rate their frequency of participation in any pro-environmental behaviors on a scale of "not at all" to "several times a month or more." Through discussion with coral reef managers, a goal of two thirds participation was established (i.e., researchers wanted to observe that at least two thirds of respondents participated in any form of pro-environmental behavior and at any frequency).

Frequently asked questions

Quality assurance and quality control

All NCRMP data goes through rigorous quality assurance and quality control protocols specific to its data type. References to specific standard operating procedures can be found in each indicator section.

Confidence

While we can report confidence in our current data, it is not as straight-forward to calculate confidence after scores are calculated - therefore scores should be taken as an estimate rather than a precise value. The scores are reported as a percentage as a science communication tool, rather than expressing scientific precision.

Why did you choose “pristine” or “pre-human” as a reference point/baseline and is it attainable?

Two options were seriously considered during discussions regarding reference/baseline values for each biophysical indicator: 1) pristine/pre-human and 2) a value reflecting an “attainable” state given human presence and impacts. We concluded that although an “attainable” value might be more practical and useful, it was too subjective at this time and the science doesn’t support what that value should be. We were also aware of the concept of shifting baselines and thought there could be value in not losing those historical values, even if it is unlikely to ever be attained again, at least in the foreseeable future.

Local monitoring data

The data used in this status report effort is restricted to NCRMP data. Localized data, such as those collected by jurisdictional agencies, are not included in the scoring of indicators. This is because blending data that are collected under different sampling designs and/or different sampling methodologies is difficult. In the absence of a targeted calibration exercise that would allow for integrating disparate datasets, we focus here on the NCRMP data that is designed to monitor coral reefs at a jurisdictional scale. It is a goal of future efforts to include this other data in indicator scoring. However, local long-term data products are included when possible as a time-series or highlight story. Highlight stories are meant to message locally relevant information.

Water quality

Water quality is critical to the condition and resiliency of reefs. While we would ideally like to include water quality indicators such as nutrients and sediments, NCRMP does not collect this information. There is also not spatially reliable water quality data from another source available. If spatially robust water quality data becomes available in the future, we can consider including it.

V. References

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