Ecosystem Status Report for the U.S. Caribbean

Carissa Gervasi[1], Kelly Montenero[1] and Mandy Karnauskas[2]

1. University of Miami, Cooperative Institute for Marine and Atmospheric Studies, 4600 Rickenbacker Cswy, Miami, FL 33149
2. NOAA Fisheries, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Key Biscayne, FL 33149

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
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1. Executive Summary

Here is where we will paste the executive summary

2. Introduction

Ecosystem-based management of fisheries and other marine resources has emerged as a priority in the U.S. (EPAP 1999, Fluharty et al. 2006, McFadden and Barnes 2009, NOAA 2016) and elsewhere (Browman et al. 2004, Sainsbury et al. 2014, Walther and Möllmann 2014, Long et al. 2015). The NOAA National Marine Fisheries Service (NOAA Fisheries) defines ecosystem-based fisheries management (EBFM) as 'a systematic approach to fisheries management in a geographically specified area that contributes to the resilience and sustainability of the ecosystem; recognizes the physical, biological, economic, and social interactions among the affected fishery-related components of the ecosystem, including humans; and seeks to optimize benefits among a diverse set of societal goals' (NOAA 2016).

2.1 Indicator selection

This report relied on both previously identified proposed indicators as well as expert vetting to select a suite of indicators that best address the fishery management plan (FMP) objectives for the U.S. Caribbean. The CFMC's Science and Statistical Committee, as well as the region's Ecosystem-Based Fishery Management Technical Advisory Panel (EBFM TAP), recently completed a series of conceptual models linking key components of the ecosystem and human activities related to fishing. This report used these conceptual models as a starting list of proposed indicators and matched the indicators to answer FMP objectives when possible. For those objectives that did not have an immediate conceptual model-identified indicator, this report used a decision matrix process for expert vetting (Figure 1).

This decision matrix was composed of a list of proposed indicators compiled from the conceptual models as well as proposed indicators provided via expert input. These potential indicators were vetted and edited by expert small working groups, who then scored a decision matrix (Figure 2) of potential indicators against the following decision criteria: long term data availability, measurability, sensitivity to environmental changes, specificity, spatial and temporal scalability, relevance to specific FMP objectives, and responsiveness to management actions.

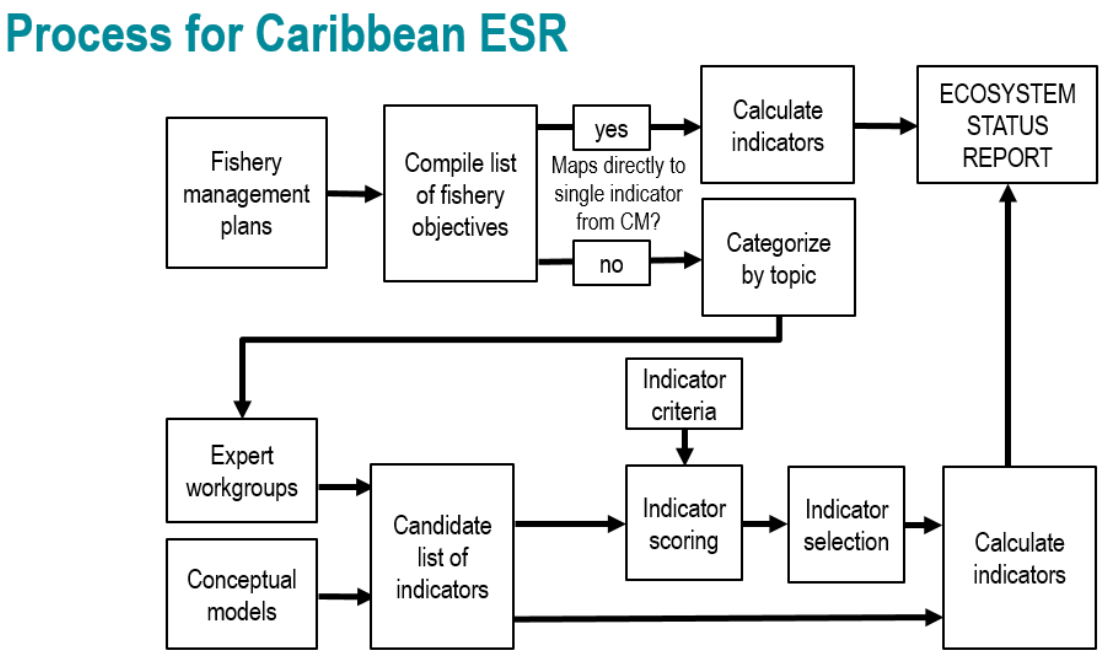


Figure 1: Process for selecting indicators for the U.S. Caribbean Ecosystem Status Report

2.2 Notes on interpreting time series figures

Time series data are plotted in a standardized format for ease of interpretation (e.g., Figure 2). The x-axis represents the temporal dimension, which may be monthly, yearly, or irregular time steps, and the y-axis represents the indicator value in units specified in the axis label. The dashed horizontal line represents the mean indicator value across the entire time series, and the solid horizontal lines denote the mean plus or minus one standard deviation. Red shaded areas and green shaded areas show years for which the indicator value is below or above one standard deviation from the mean, respectively. The blue vertical shaded box highlights the last five years of indicator values, over which additional metrics are calculated. Black circles to the right of each figure indicate whether the indicator values over the last five years are greater (plus sign), less than (minus sign), or within (solid circle) one standard deviation from the mean of the overall time series. Arrows to the right of each figure indicate whether the least squares linear fit through the last five years of data produces a positive or negative slope that is greater than one standard deviation (upward or downward arrows respectively), or less than one standard deviation (left-right arrow).

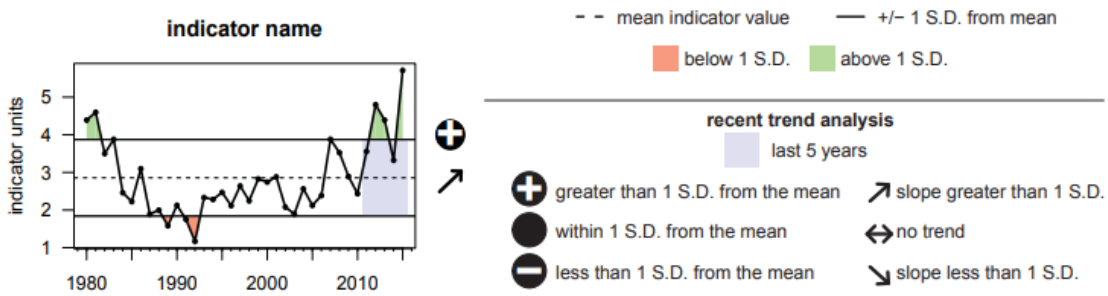


Figure 2: Example time series plot, showing an indicator plotted with its mean and standard deviation, and trend analysis for the most recent five years of data. See text for more detailed description of specific calculations.

3. Fishery management plan objectives and conceptual models

This report's indicator selection process sought to select indicators that corresponded to the island based fishery management plan (FMP) objectives in order to track performance, and also selected indicators related to risks to meeting these management objectives. The following figure shows indicators selected per FMP objective. Indicators were also sourced and considered from the conceptual model exercise completed by the Council's Science and Statistical Committee and District Advisory panels, which began in 2019. Top scored connections in ecosystem components were considered in the ESR indicator suite as well (Rivera et al, in publication).

FMP Objective	Col2	Col3	Col4	Col5	Col6
Objective 1: Provide for long-term sustainable use of fisheries resources within the limits of local ecosystem production using a precautionary, ecosystem-based approach to management that accounts for uncertainty and relevant biological, ecological, economic, and social factors in the fishery, including the benefits of **food production**, **recreational opportunities, and protection of marine ecosystems**. **Prevent overfishing, rebuild overfished stocks, and achieve OY on a continuing basis.**	Total commercial landings, lobster landings, conch landings	Sustainability of economically important reef fish-FID from RVC on mutton, yellowtail, red hind, and queen triggerfish			
Objective 2: Reduce bycatch and waste in the fishery.					
Objective 3: Ensure the metrics upon which OY is based are derived from the best available scientific information and are updated continuously every five years to respond to changing ecological, biological, economic, and social conditions.					
Objective 4: Promote international and domestic cooperation in the management of pan-Caribbean stocks.					

FMP Objective	Col2	Col3	Col4	Col5	Col6
Objective 5: Minimize conflicts between stakeholders by promoting **effective marine spatial planning**					
Objective 6: Promote **fair and equitable use of fishery resources**, recognizing the importance of those resources to fishing communities within the context of differences in local environment, culture, markets, user groups, gears, and seafood preferences.					
Objective 7: Establish resource access permits as necessary and appropriate to facilitate data collection, sustainability, and long-term yield.					
Objective 8: Provide flexibility in the management process which minimizes regulatory delay and allows for rapid adaptation to **changing resource abundance, availability, health, or preference**, using the best available scientific and socio-economic information.					

FMP Objective	Col2	Col3	Col4	Col5	Col6
Objective 9: Devise a regulatory framework that maximizes the **efficiency and efficacy of enforcement efforts** within and across jurisdictional boundaries while promoting the safe conduct of fishing operations.					
Objective 10: Promote **awareness of laws and regulations governing marine resource management** and the science and social obligations that support that management, and to ensure informed public input into the management process.					
Objective 11: Ensure the **socioeconomic health of the fishing communities** dependent on federal fishery resources.					
Objective 12: **Protect spawning aggregations and, when needed, the habitats** supporting those aggregations to ensure the future health of the resource.					

FMP Objective	Col2	Col3	Col4	Col5	Col6
Objective 13: **Describe and identify EFH, adverse impacts on EFH, and other actions to conserve and enhance EFH**. Adopt management measures that minimize adverse impacts from fishing on EFH and promote habitat conservation, including designation of specific habitat areas of particular concern within EFH for more focused management action. Objective 14: **Map, define, and manage habitat** upon which the resource depends, with particular emphasis on coral reef resources throughout the region. Objective 15: Ensure **continued provision of ecosystem services derived from living marine resources**, including adequate abundance of forage resources to ensure a healthy and diverse trophic web. Objective 16: Account for **ecological relationships and functional roles of species in the fishery** that contribute to a healthy ecosystem, such as grazers, forage fish, habitat-builders, and top predators.					

FMP Objective	Col2	Col3	Col4	Col5	Col6
Objective 17: Require essential scientific data is gathered and analyzed in advance to guide the development of new fisheries to ensure they are sustainable from the start.					
Objective 18: Promote measures to develop and sustainably manage underutilized marine fishery resources.					

4. Risks to meeting fishery management objectives

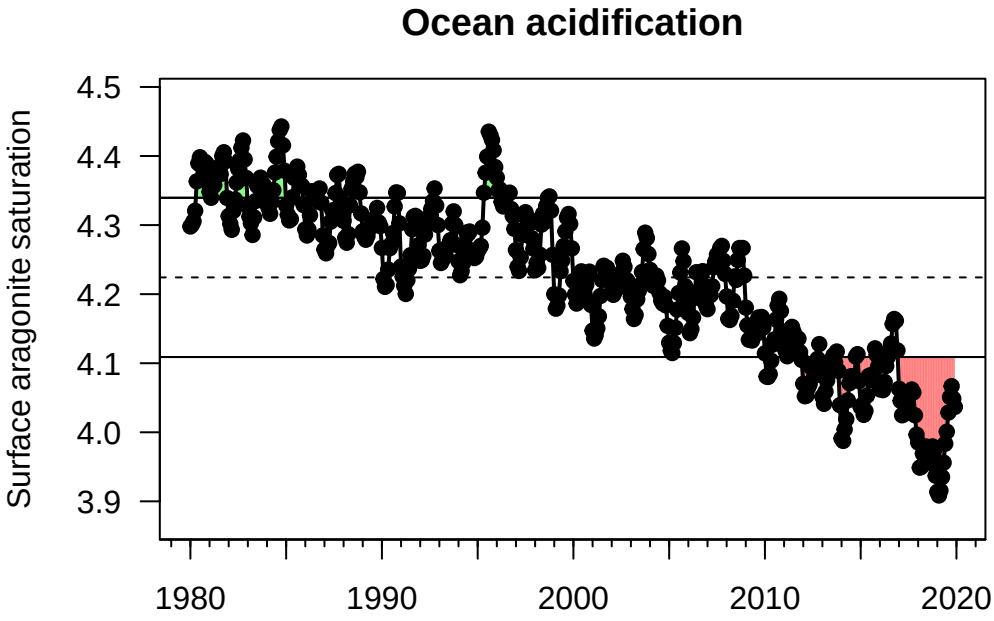
Degree heating weeks

Indicator 1

DegreeHeatingWeeks.RData doesn't work

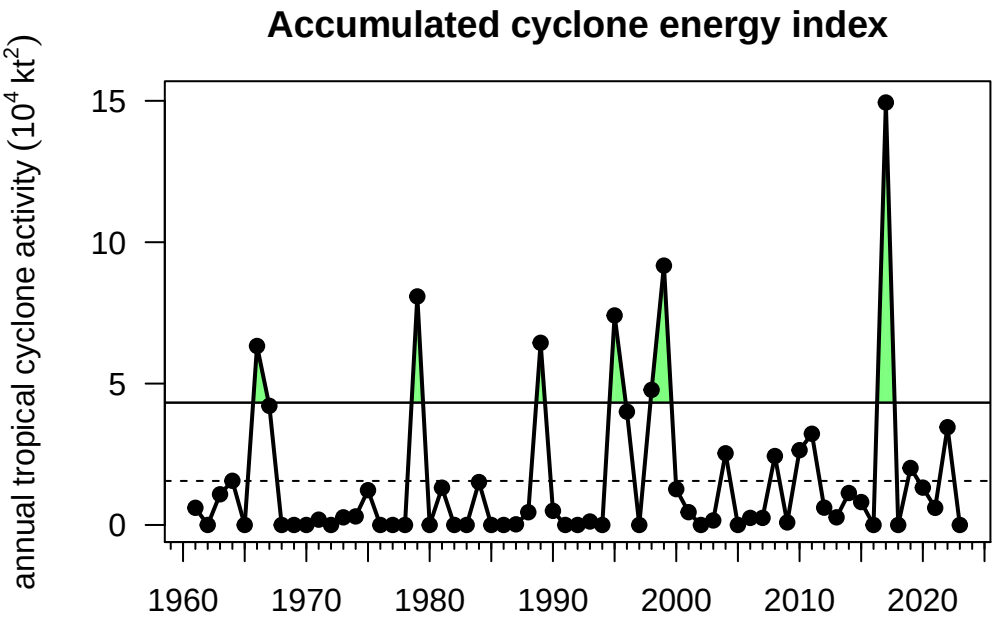
Ocean acidification via aragonite saturation state

Indicator 2



Hurricane activity

Indicator 3



Turbidity

Indicator 4

turbidity.RData doesn't work

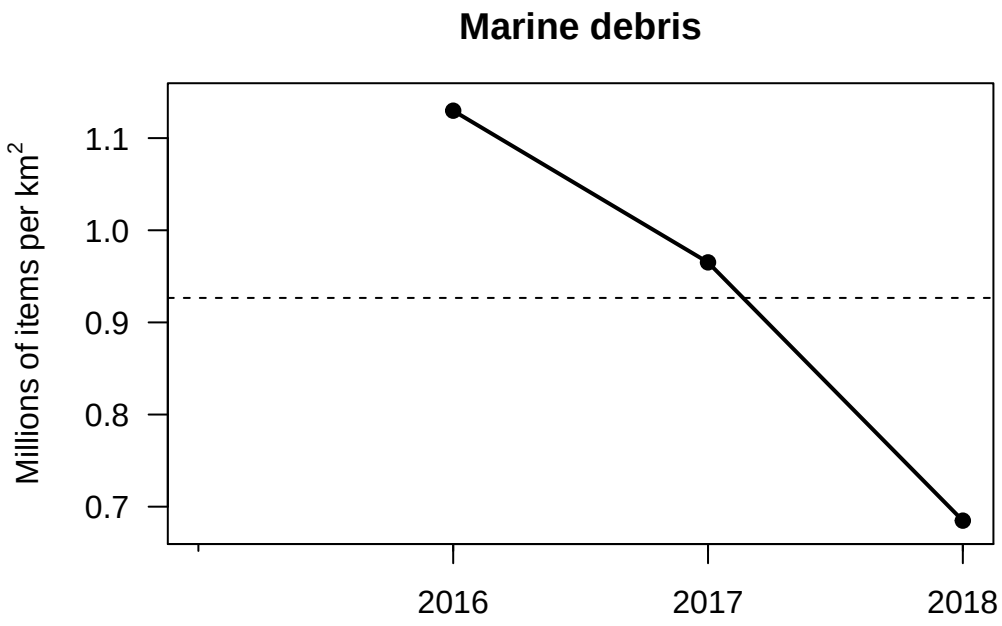
Sea surface temperature

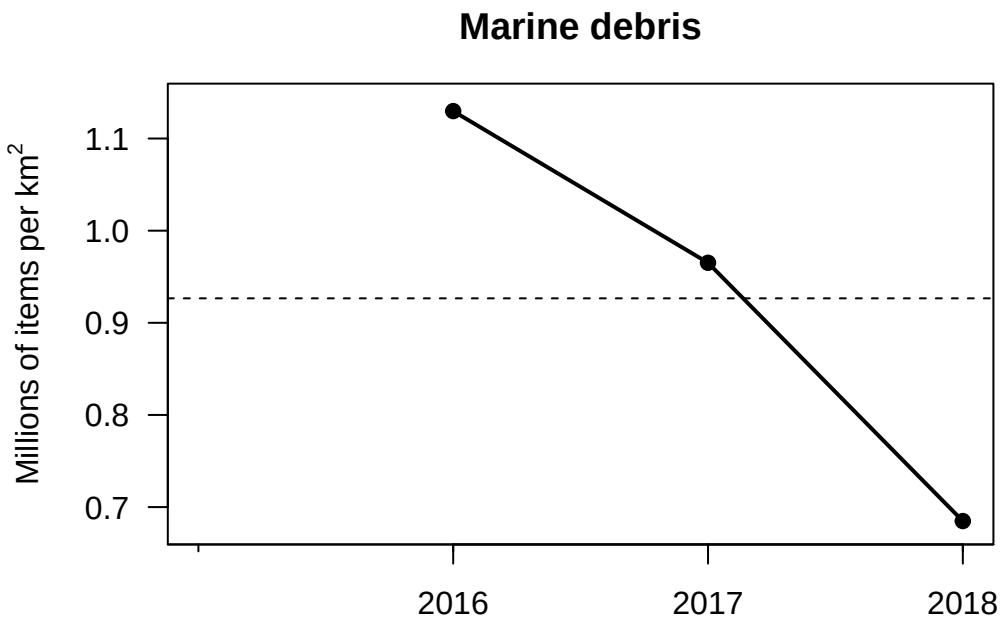
Indicator 5

No RData file for SST

Marine debris

Indicator 6





Identified point source pollution sites

Indicator 7

Primary productivity via ocean color

Indicator 8

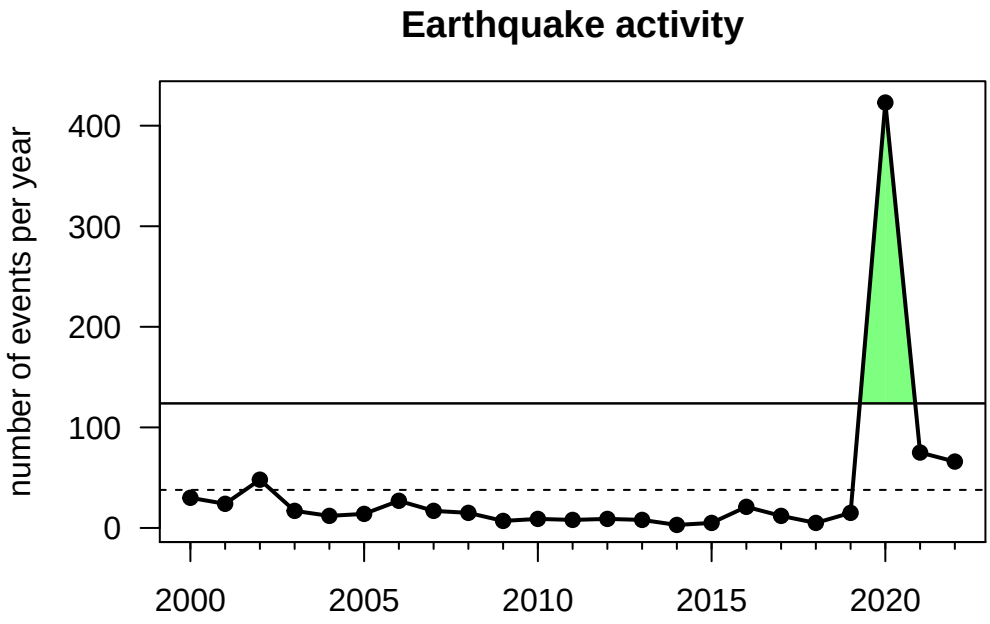
carib_Chl.RData doesn't work

Coastal development via land cover

Indicator 9

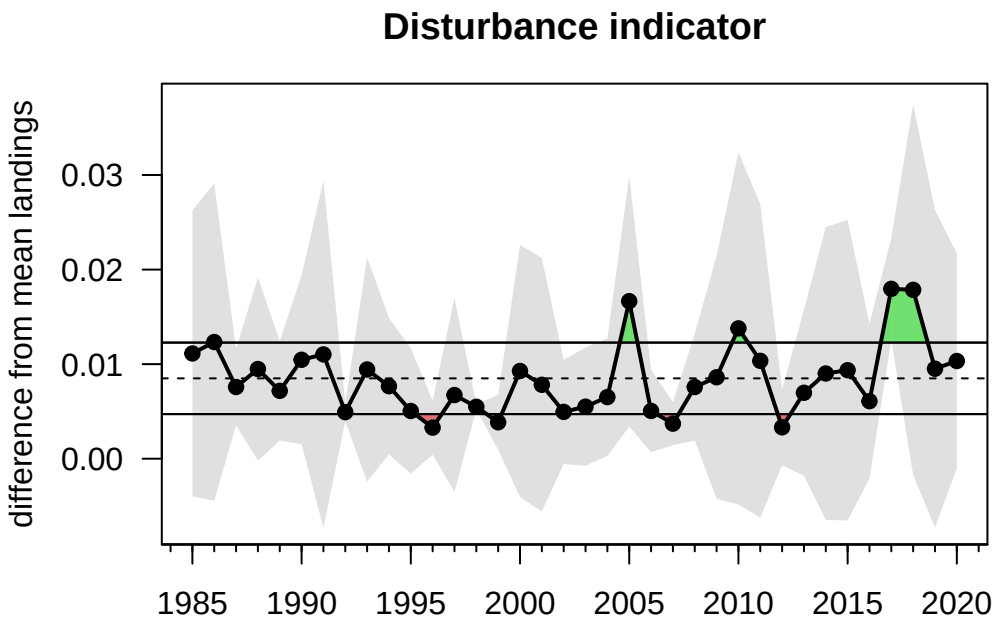
Number of major earthquakes

Indicator 10



Fishery/market disturbance indicator (maybe belongs in socioeconomic health)

Indicator 11



Sargassum inundation

Indicator 12

doesn't work

load("indicator_objects/Sargassum.RData") plotIndicatorTimeSeries(inddata, coltoplot = 1:2, plotrownum = 2, trendAnalysis = F, sublabel = T)

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Tourism via hotel occupancy

Indicator 13

doesn't work

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load("indicator_objects/hotel_occupancy.RData") plotIndicatorTimeSeries(inddata, trendAnalysis = F)

Population density

Indicator 14

Population change

Indicator 15

5. Tracking performance toward fishery management objectives

5.1 Food production

Fishery independent surveys of economically important species

Indicator 16

Commercial landings

Indicator 17

Maximum length and size structure

Indicator 18

Changes in target species / landing composition

Indicator 20

5.2 Socioeconomic health

Total, lobster and conch revenues

Indicator 21

Total, lobster and conch trips

Indicator 22

Ocean economy employment and wages

Indicator 23

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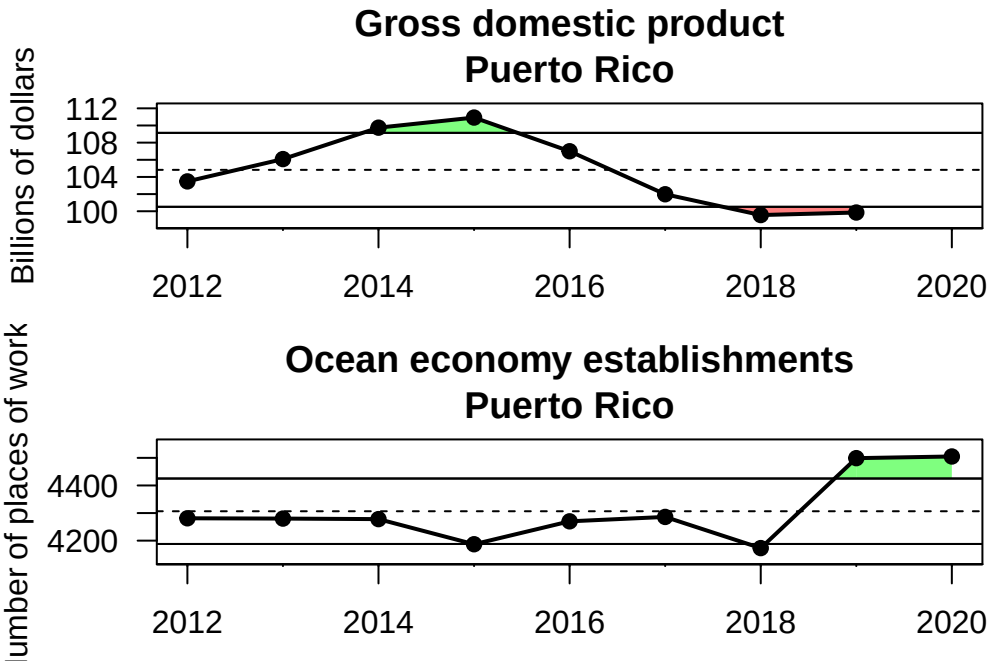


GDP

Indicator 24

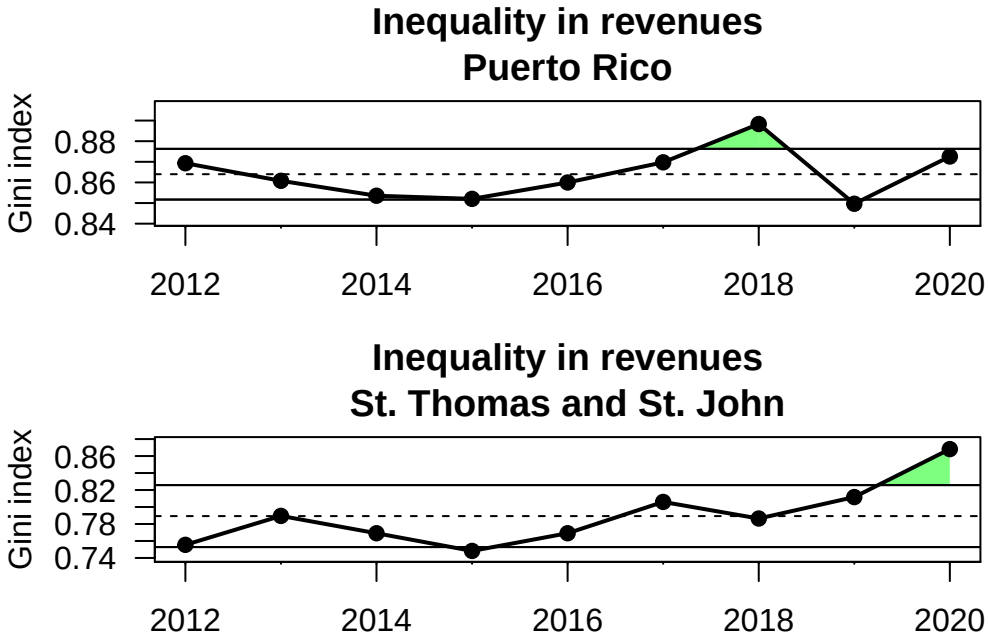
Unemployment

Indicator 25

5.3 Equity

Gini coefficient for distribution of landings and revenue

Indicator 26



Commercial fishing community engegement and reliance

Indicator 27

5.4 Engagement and participation

Recreational fishing engagement and participation

Indicator 28

Commercial fishing engagement and participation

Indicator 29

5.5 Bycatch reduction

Changes in gear type

Indicator 30

5.5 Governance

Number of seasonal closures implemented

Indicator 31

Number of education and outreach events

Indicator 32

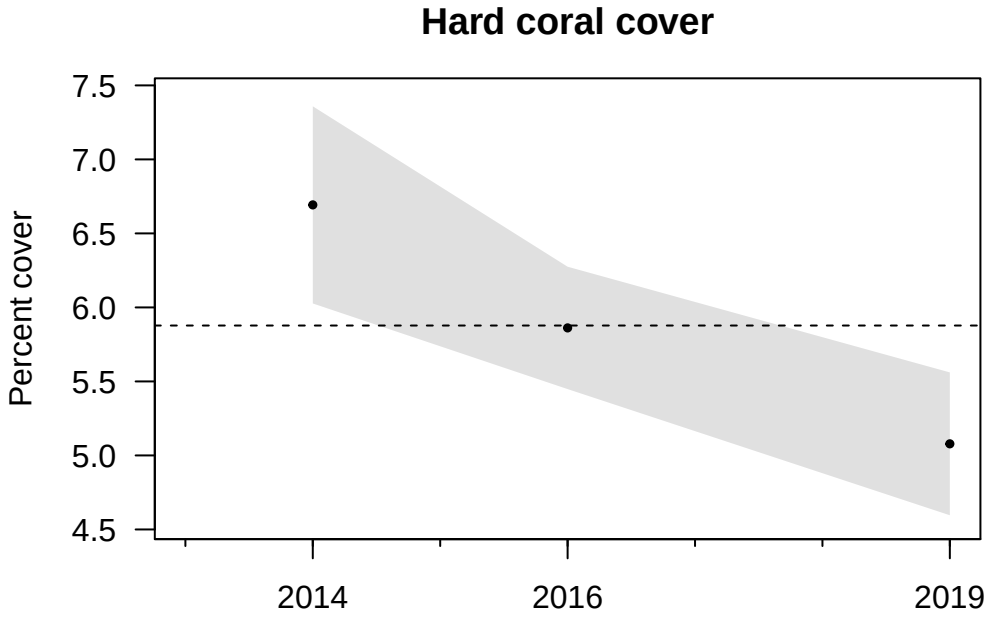
Number of enforcement actions

Indicator 33

5.6 Protection of ecosystems

Percent coral cover and coral species richness

Indicator 34



Coral species diversity

Indicator 35

6. Integrated ecosystem perspectives

Stoplight plot

7. Research Recommendations

Data gaps

8. Acknowledgements

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10. Data source table