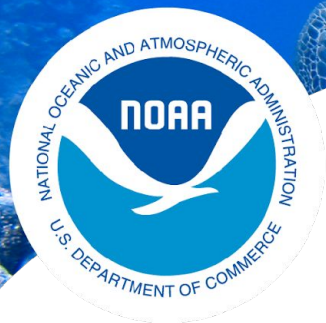




NOAA
FISHERIES

Ecosystem Status Report for the U.S. Caribbean

Southeast Fisheries Science Center
Integrated Ecosystem Assessment Team

Caribbean EBFM Technical Advisory Panel Meeting
August 1-2, 2024



INTEGRATED ECOSYSTEM ASSESSMENT

What is an Ecosystem Status Report?

Challenges, Opportunities and Future Directions to Advance NOAA Fisheries Ecosystem Status Reports (ESRs):

Report of the National ESR Workshop

Wencheng L. Slater, Geret DePiper, Jamison M. Gove, Chris J. Harvey, Elliott L. Hazen, Sean M. Lucey, Mandy Karnauskas, Seann D. Regan, Elizabeth C. Siddon, Ellen M. Yasumiishi, Stephani G. Zador, Margaret M. Brady, Michael D. Ford, Roger B. Griffis, Rebecca L. Shuford, Howard M. Townsend, Todd D. O'Brien, Jay O. Peterson, Kenric E. Osgood, and Jason S. Link



U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-F/SPO-174
September 2017

“Ecosystem Status Reports (ESRs) are synthesized scientific products that provide information on the past and possible future conditions of marine ecosystems based on suites of indicators.

This information provides vital context for a range of decisions affecting marine ecosystems and supports an ecosystem approach to marine resource management” (Slater et al. 2017).

Two types of indicators

1) Tracking progress on fishery management objectives

Food production and
stock sustainability



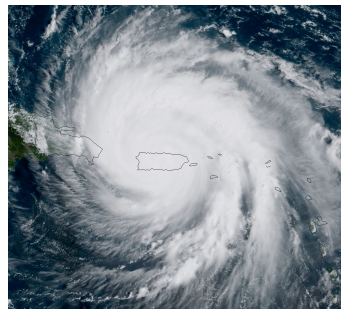
Protection of ecosystems
and trophic integrity



Engagement and
participation



2) Risks to meeting fishery management objectives



Two types of indicators

1) Tracking progress on fishery management objectives

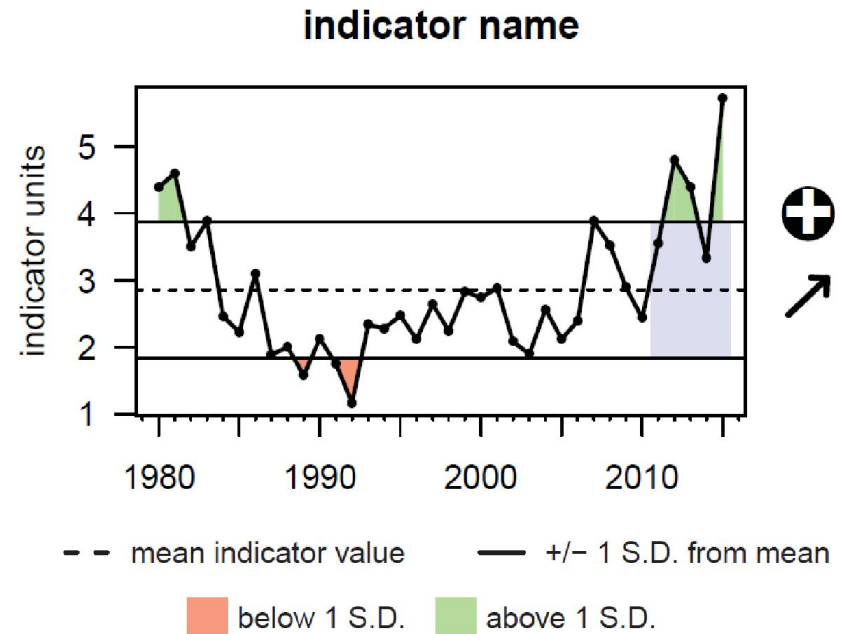
↳ Broad categories of objectives derived from Island-based Fishery Management Plans, indicators with available data matched to objectives

2) Risks to meeting fishery management objectives

↳ Derived from conceptual models created by Caribbean Fishery Management Council, indicator scoring process, expert working groups

Input we are looking for from the EBFM TAP

- Are the indicators representative of the concepts and objectives listed?
- Are the interpretations correct?
- Are there better data sources we could use?
- Any concepts or indicators we are missing?



Indicators tracking risks to meeting fishery management objectives

Degree heating weeks

Ocean acidification

Hurricane activity

Turbidity

Ocean temperature

Marine debris

Land-based pollution

Primary productivity

Coastal development

Major earthquakes

Market disturbances

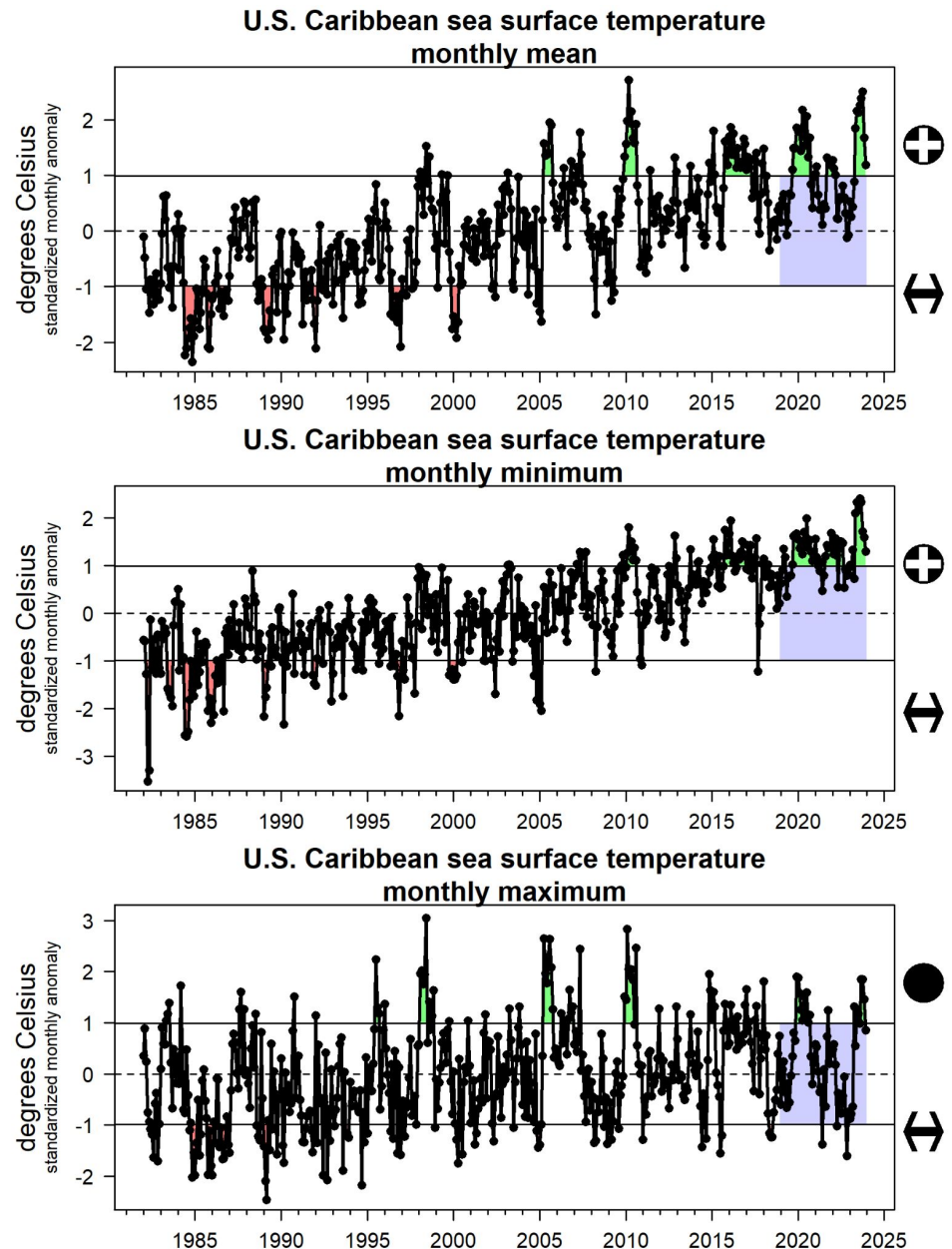
Sargassum inundation

Tourism activity

Human population density

Sea surface temperature

- Mean temperature increasing over time (average rate = 0.25°C per decade)
- Last 5 years, mean (top) is above average, monthly minima (center) are > 1 S.D. above average
- No trend last two decades in monthly maxima (bottom), but $\uparrow$ anomalies in 2005 and 2010

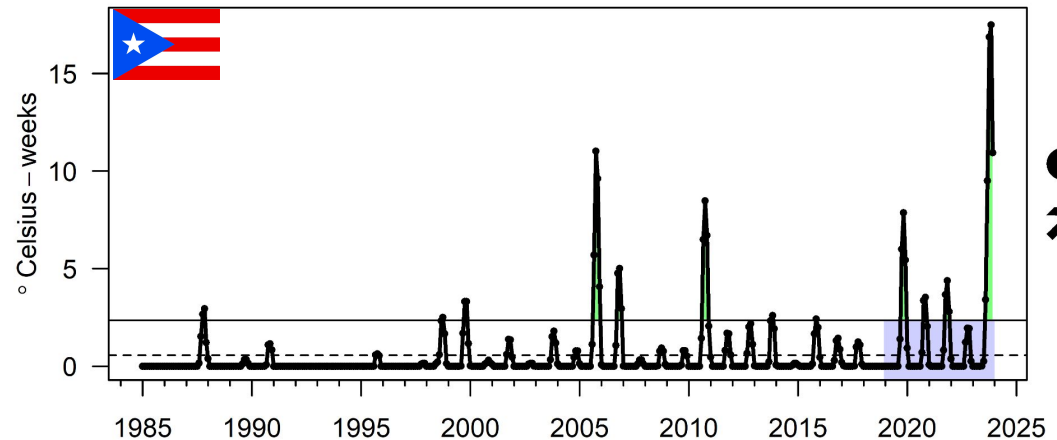


Coral bleaching stress

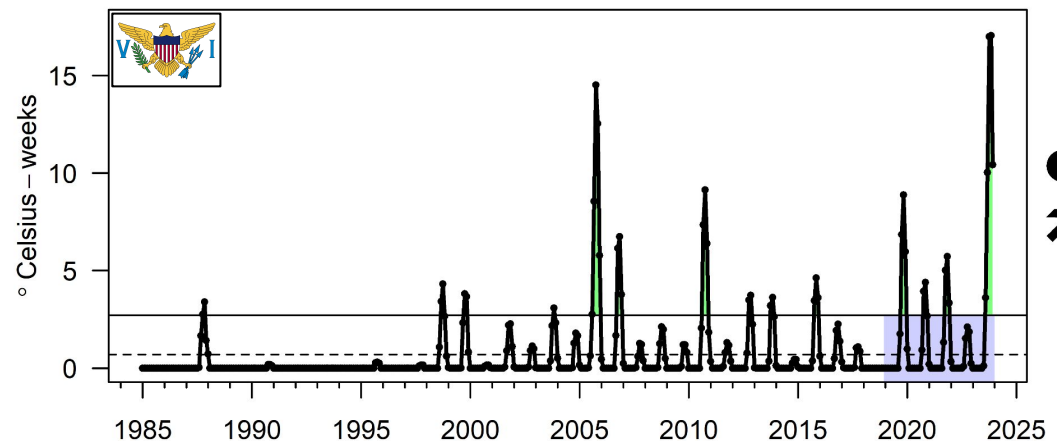
- Generally below average until 2004, then sudden near-record peak in 2005
- Last 5 years average, but



Average monthly degree heating weeks
Puerto Rico

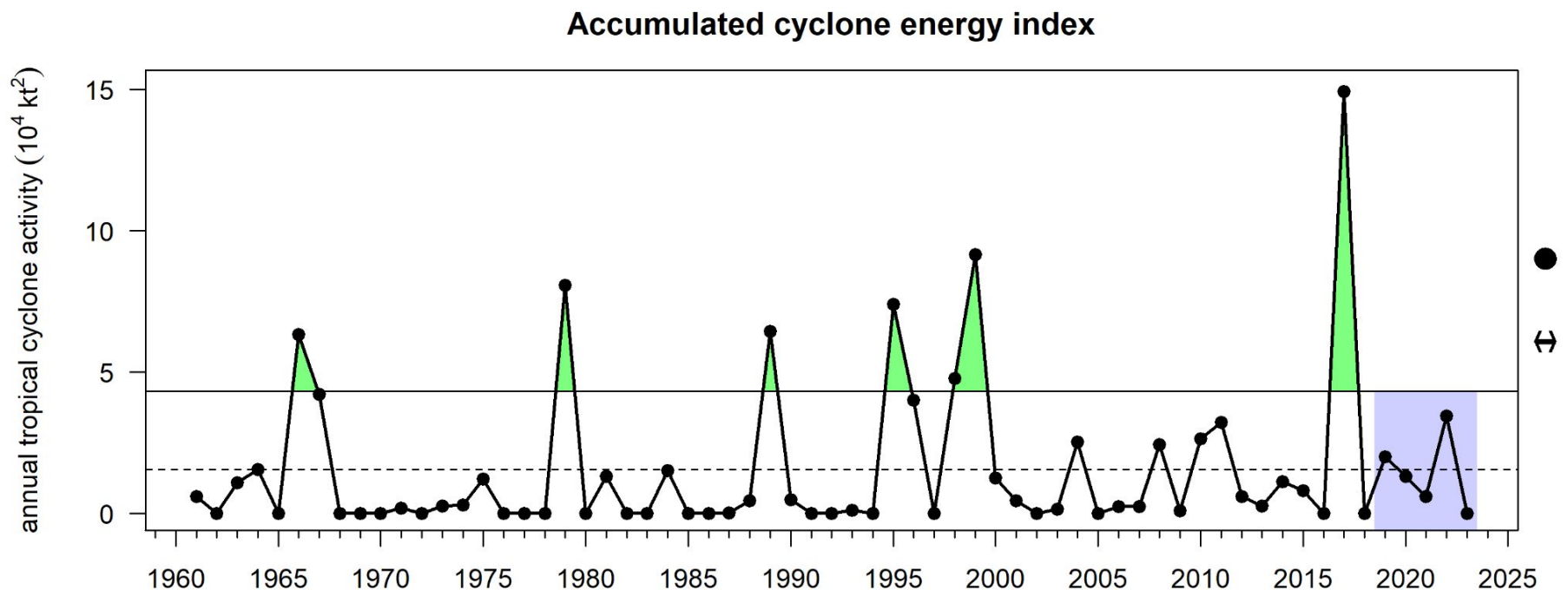


Average monthly degree heating weeks
USVI



Hurricane activity

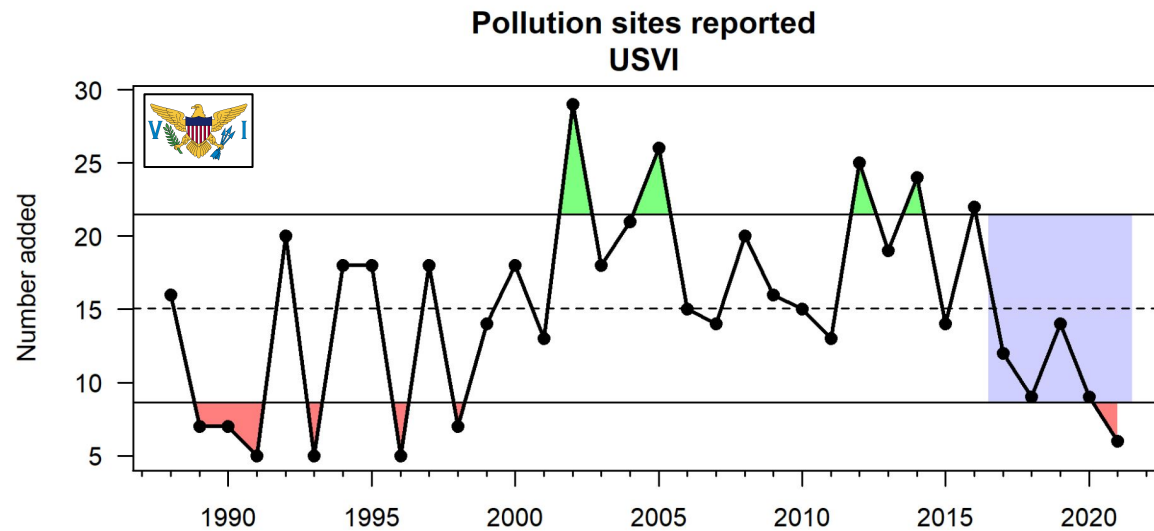
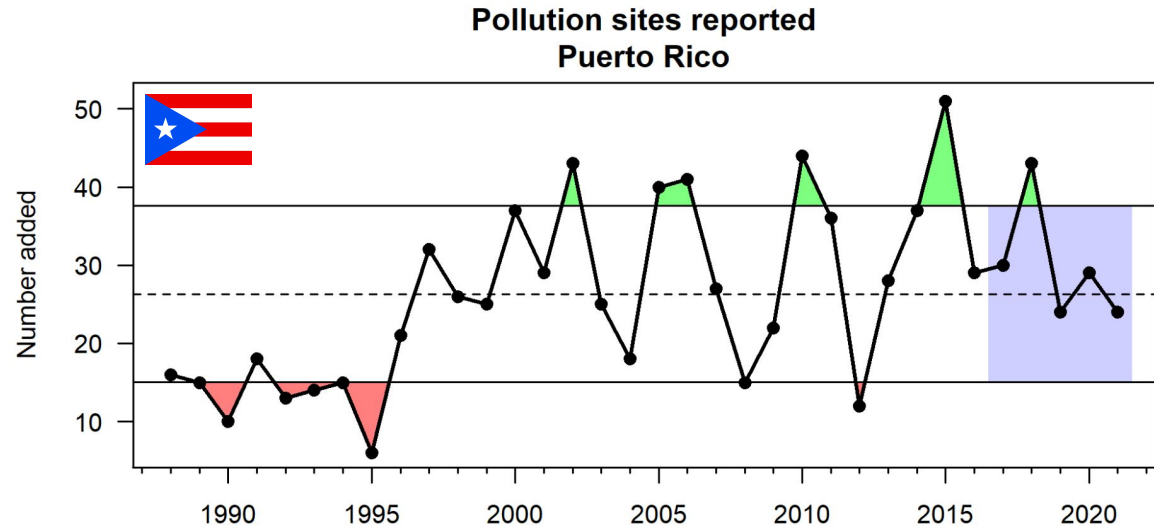
- Generally below average last two decades, but year 2017 was an all-time high across 6 decades of data



Annual accumulated cyclone energy index, calculated as the sum of squared 6-hourly reported wind speeds for storms tracking through the U.S. Caribbean region (16.7 - 19.6N, 63.5 - 68.9W)

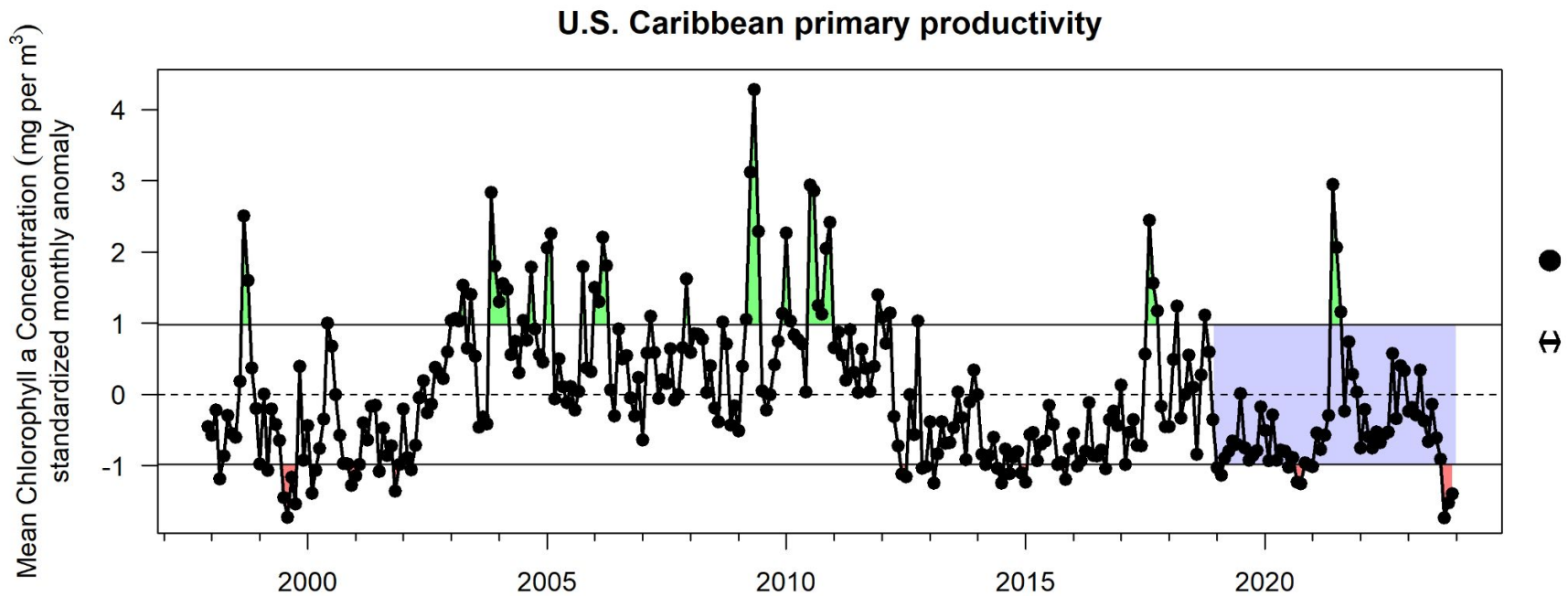
Pollution

- Reported sites include Superfund, brownfield sites and other reports to Integrated Compliance Information System (ICIS) and Toxic Release Inventory (TRI)
- Indicator does not represent timing of pollution, but rather timing of political action/attention



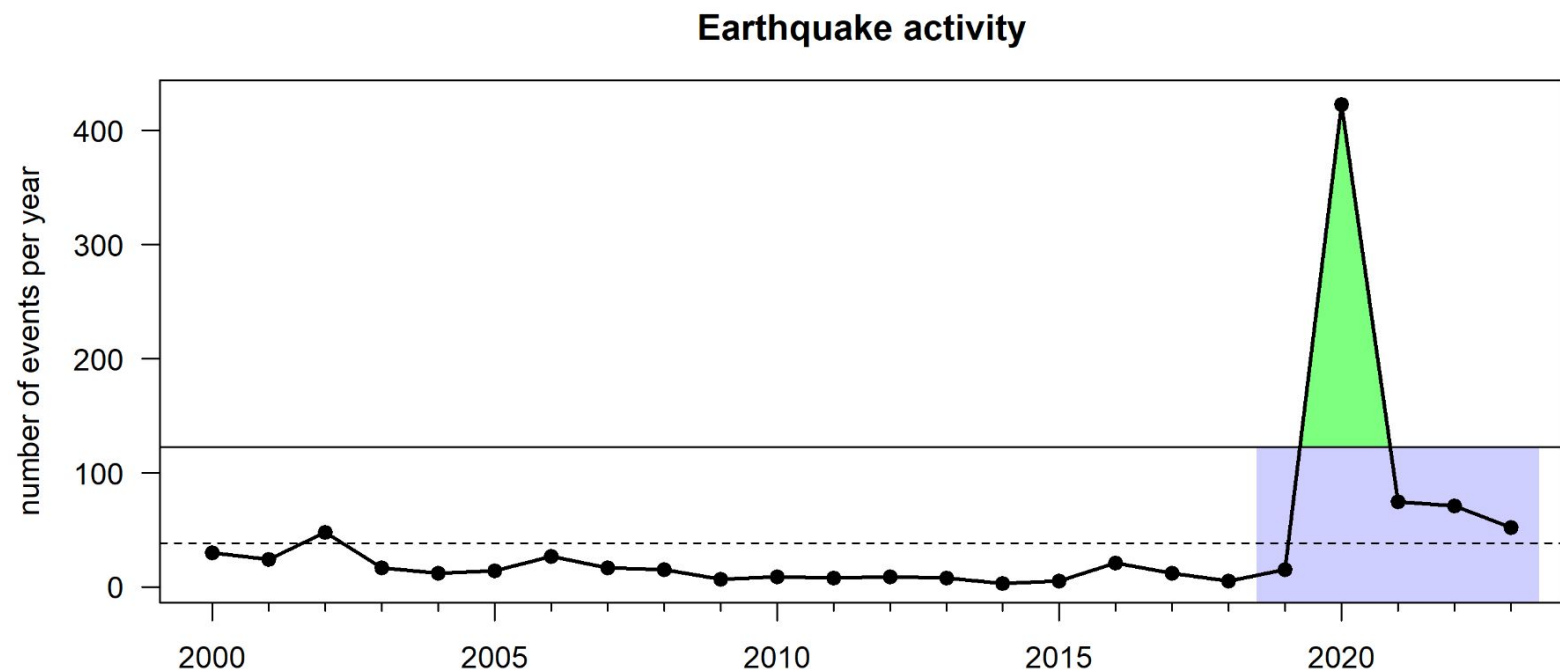
Primary productivity

- Seasonal cycles; plotted as standardized monthly anomaly to view long-term trends
- Some decadal cyclical patterns; no recent trend



Earthquakes

- Significant “earthquake swarm” in SW Puerto Rico in 2020; over 400 events of magnitude 3.5+
- Timing with pandemic; impacts may be challenging to differentiate

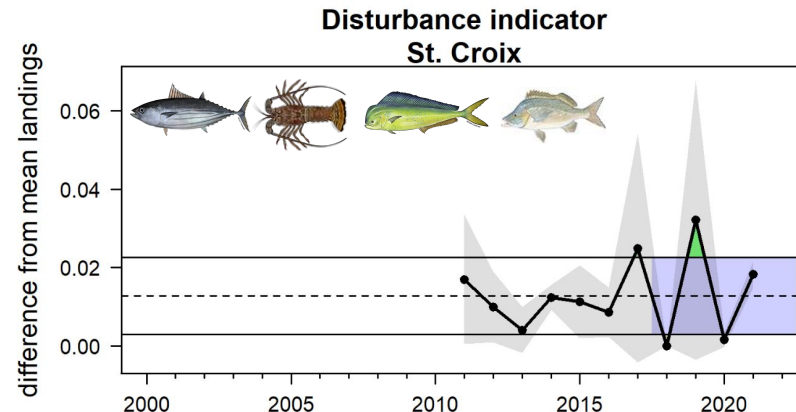
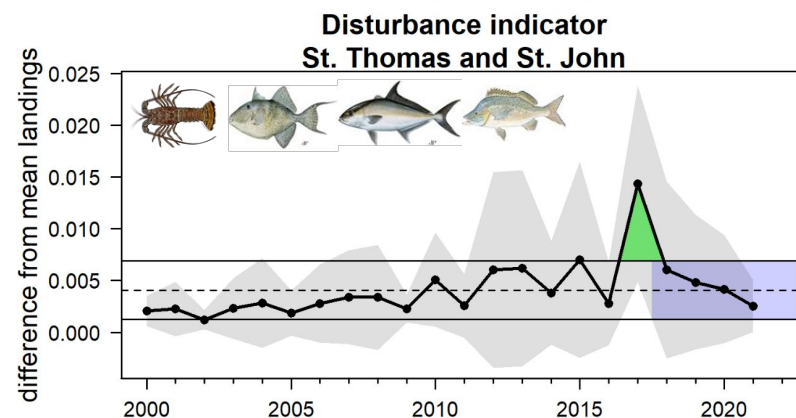
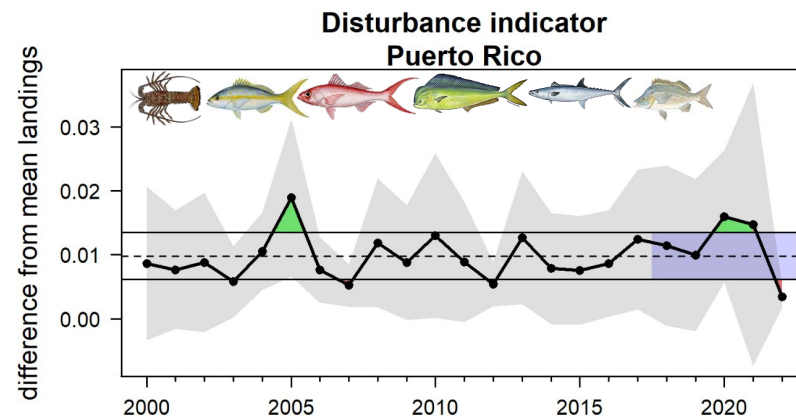


Market disturbances

- Disturbance level* shows more volatility across islands since 2017
- USVI impacted by 2017 hurricanes, but only STX shows impact from pandemic
- PR not highly impacted by 2017 hurricanes, but post-pandemic impacts

*For primary target species, calculate proportion of landings in each month, by year, then sum the square of deviations from the mean for each year

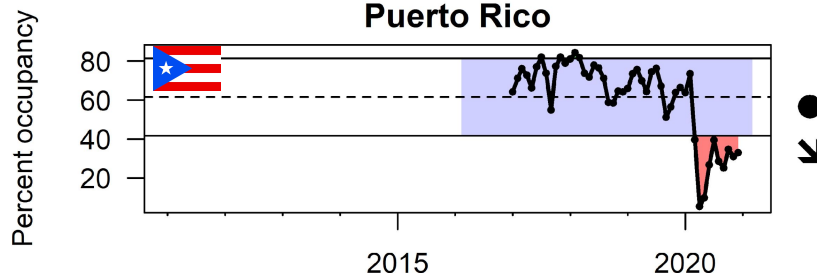
$$D_y = \sum_{m=1}^{12} (P_{m,y} - \bar{P}_m)^2$$



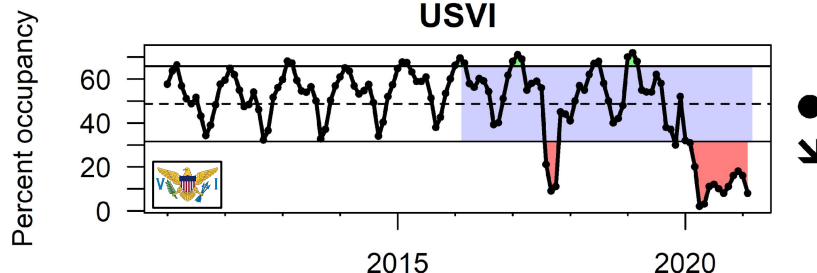
Human activity

- Clear impacts of 2017 hurricane and pandemic on tourism activity
- Overall decreasing human pressure on U.S. Caribbean

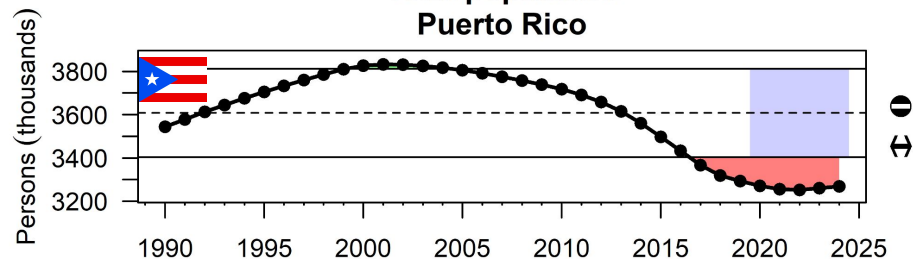
**Hotel occupancy rates
Puerto Rico**



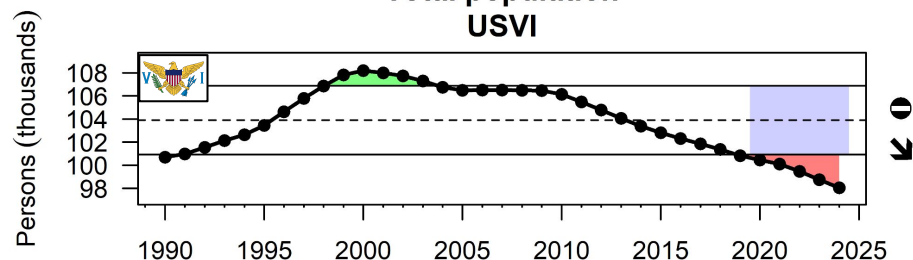
**Hotel occupancy rates
USVI**



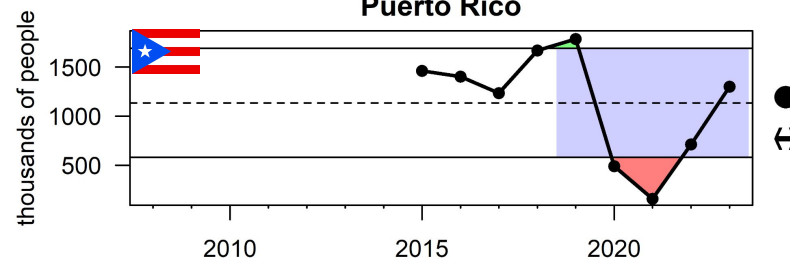
**Total population
Puerto Rico**



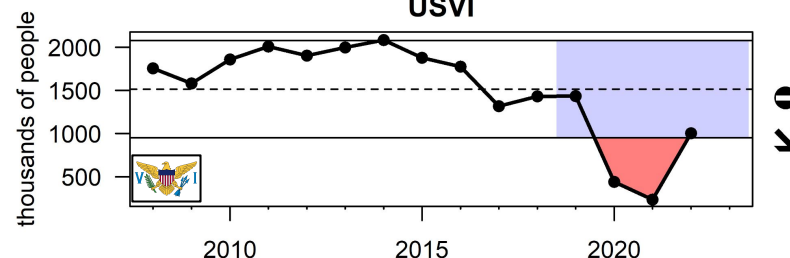
**Total population
USVI**



**Cruise passengers
Puerto Rico**



**Cruise passengers
USVI**

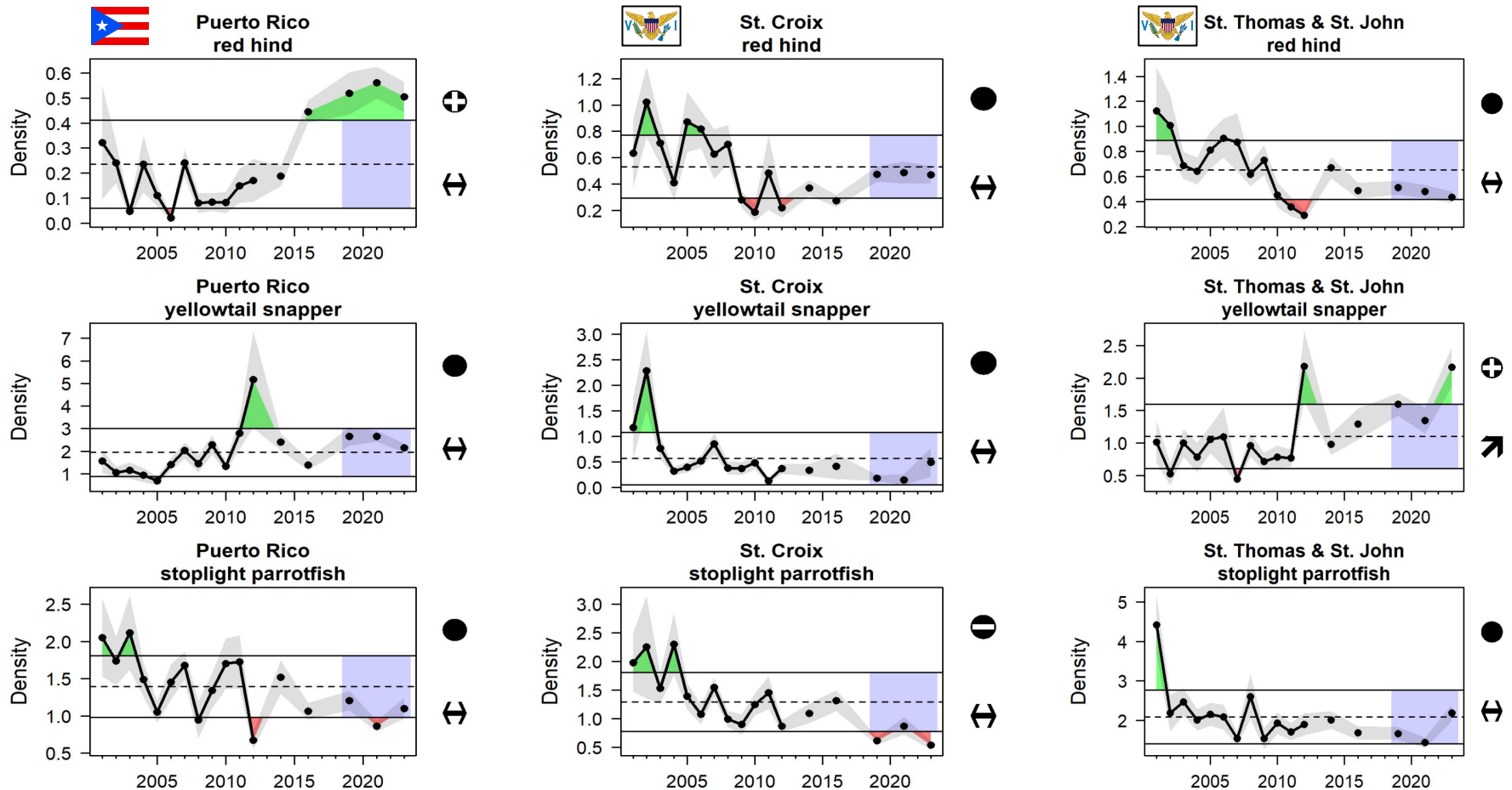


Indicators tracking progress toward fishery management objectives

- Food production and stock sustainability
- Socioeconomic health
- Engagement and participation
- Bycatch reduction
- Governance, outreach and enforcement
- Protection of ecosystems and trophic integrity

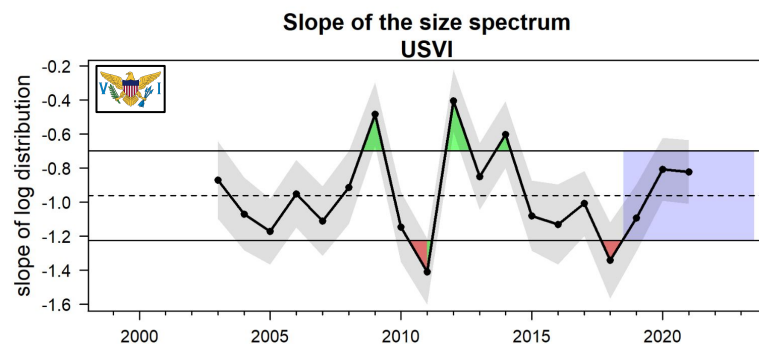
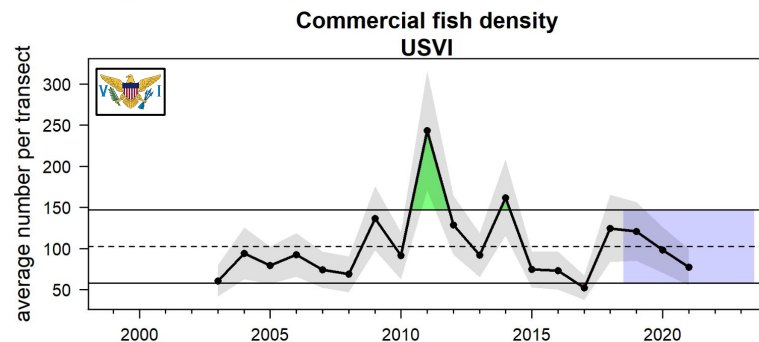
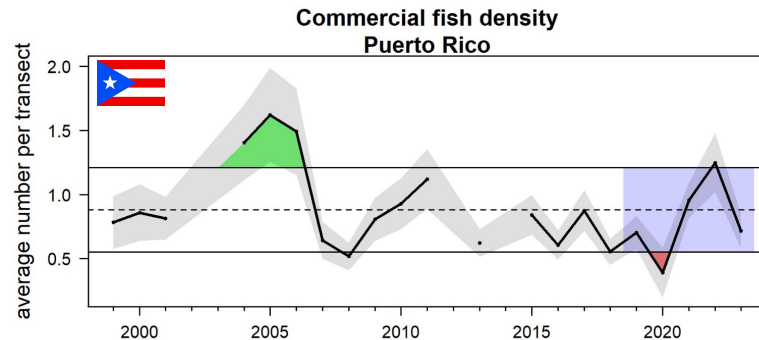
Food production: Fish abundance

- Fishery-independent relative abundance of key species



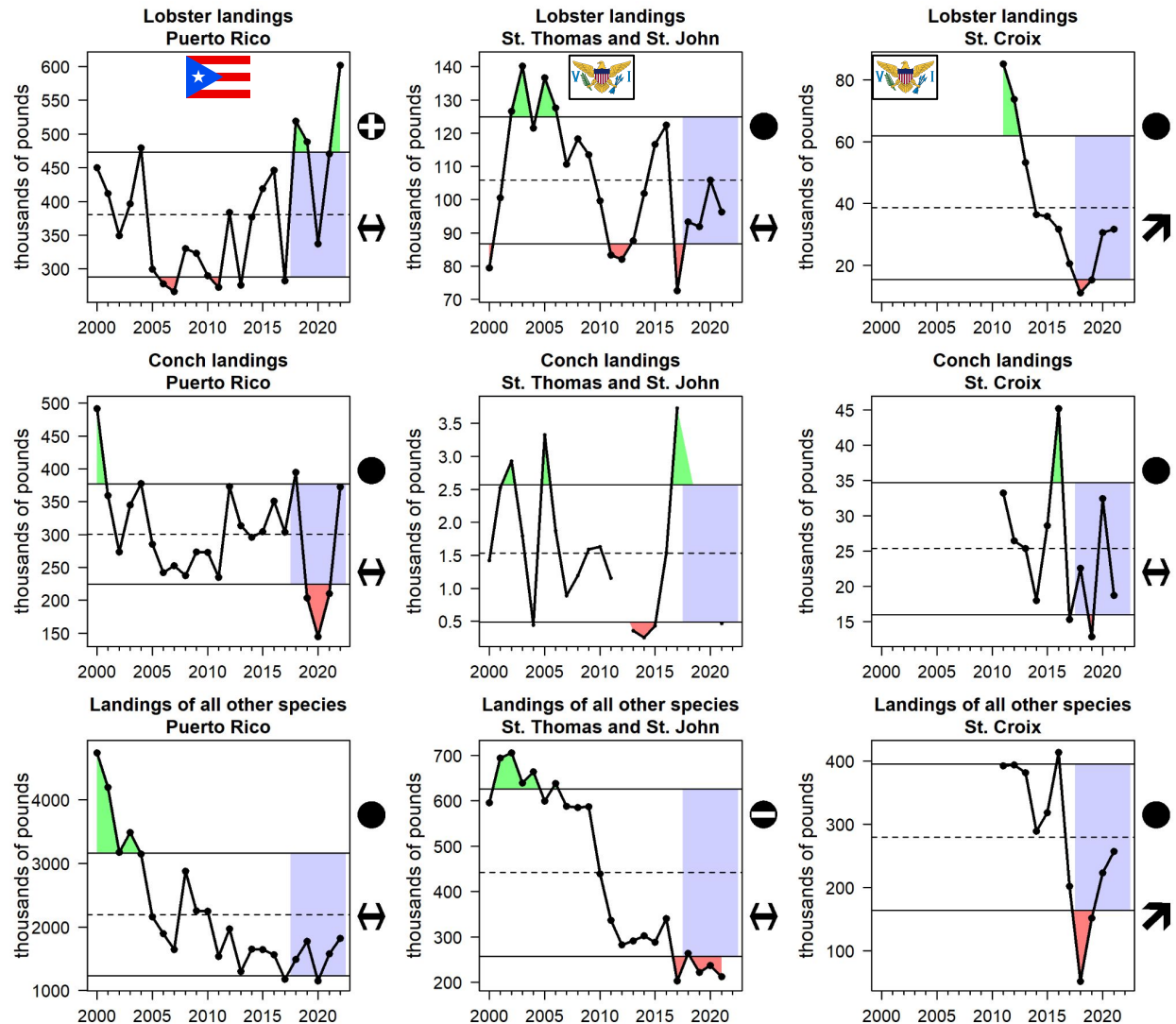
Food production: Fish community structure

- Calculated from fishery-independent PRCRMP and TCRMP programs (fixed monitoring stations)
- Noisy but stable trends over time
- Indicators show large recruitment event in 2011



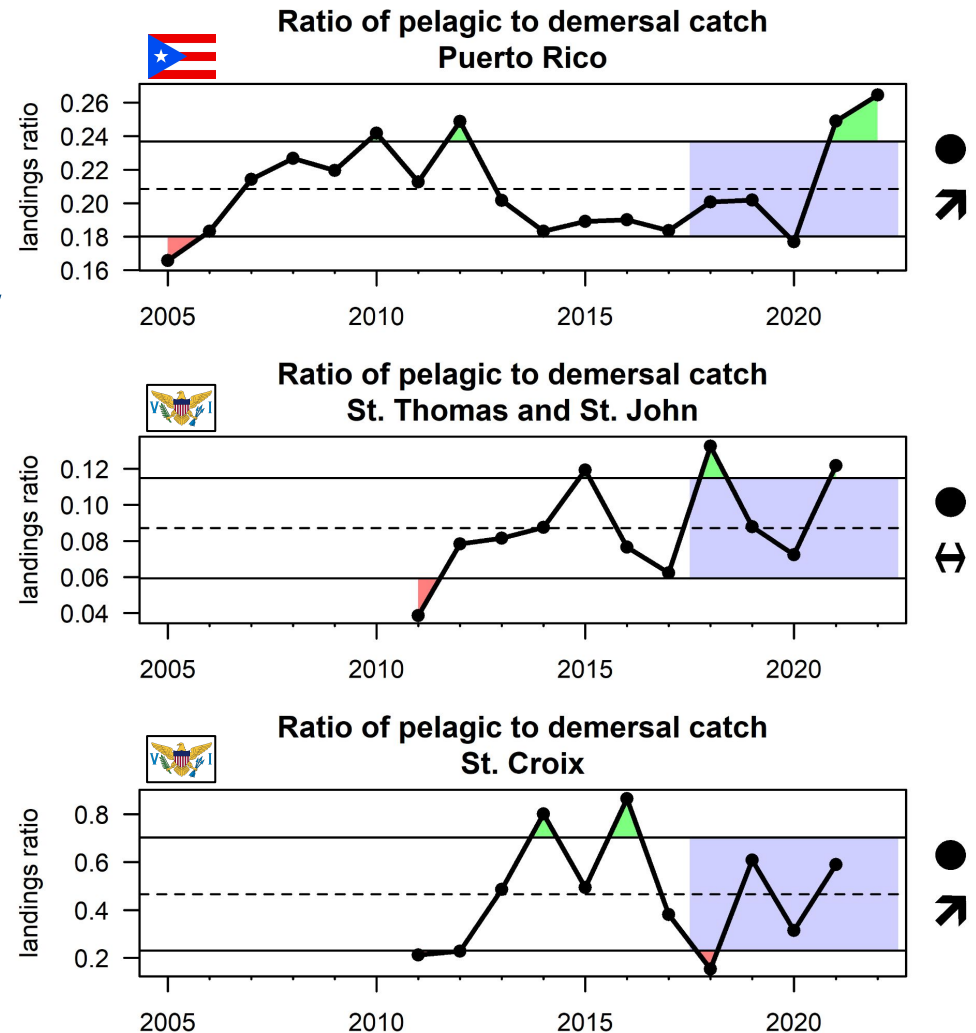
Food production: Total landings

- STT, STJ and STX are in fishing years (July 1 - June 30)
- Except for major species, landings declining over time
- Likely reflects changes in reporting



Food production: Pelagic to demersal ratio

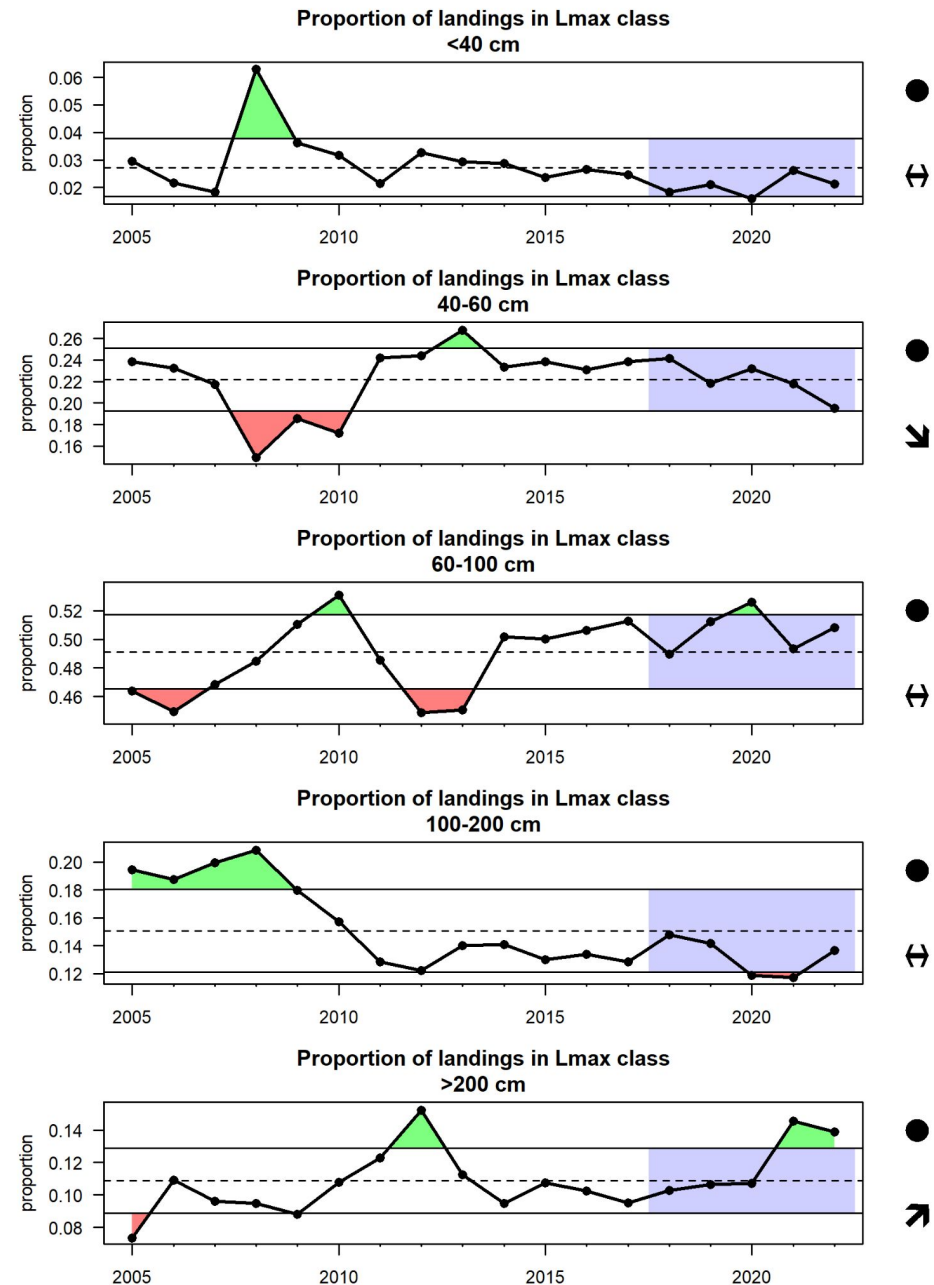
- Note large differences in y-axes; STX much more dependent on pelagic species
- Pelagic catch trends largely driven by dolphinfish, particularly in Puerto Rico; tunas also important in USVI
- Large shift to pelagics in STT and STJ in 2018 in could have resulted from hurricane- induced reef habitat loss; opposite response seen in STX



Food production: Lmax indicator

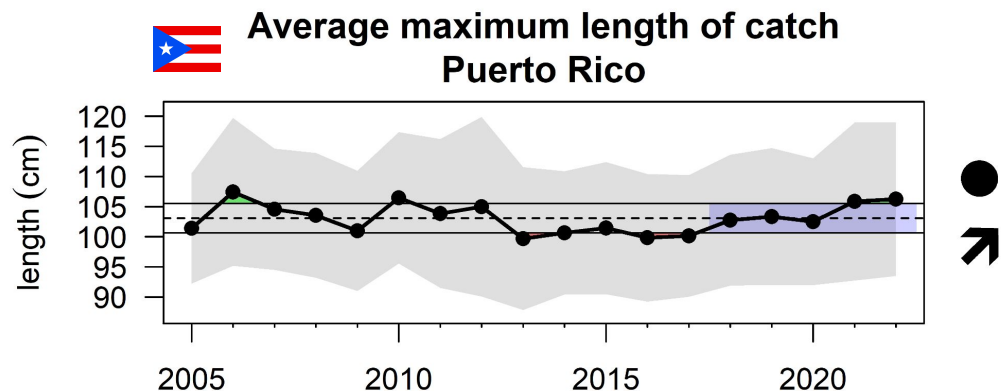
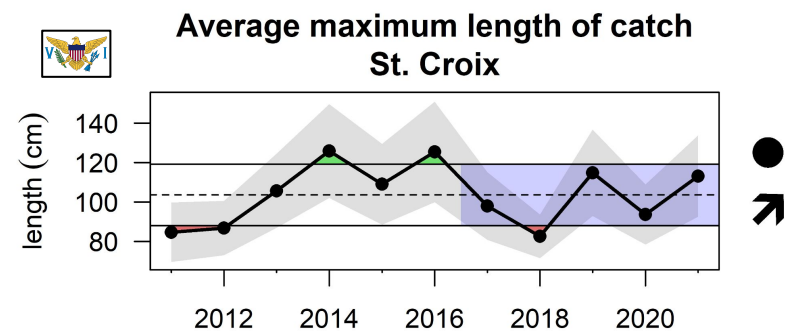
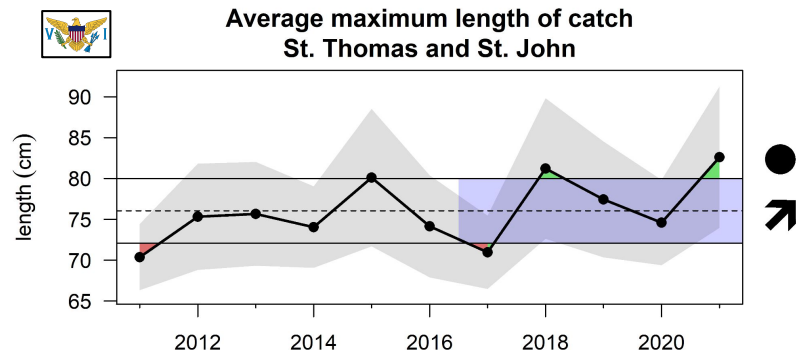


- Shows proportion of landings within size bins of species' maximum lengths (Puerto Rico)
- Overall increasing trend of "plate-sized" fish in the 60-100cm category (driven by deepwater snapper species, also yellowtail, hogfish and red hind)
- Decrease in the 100-200cm Lmax group is driven by declining catches of mackerels, large rare parrotfishes, tunas, and some large groupers



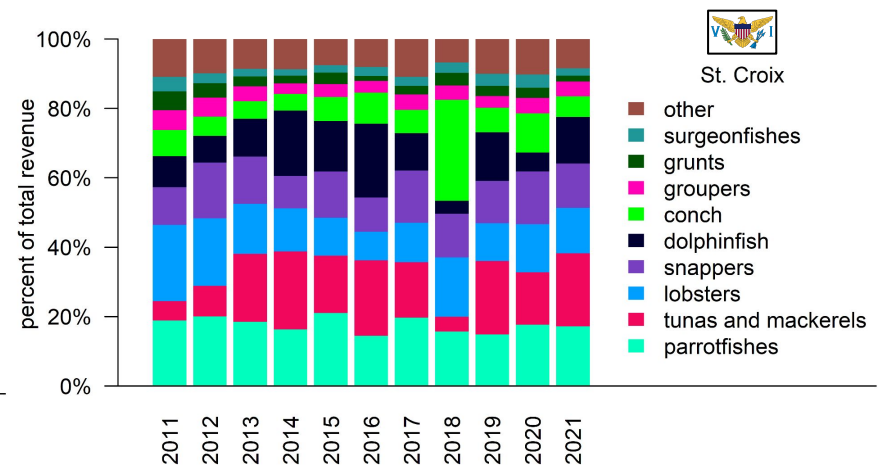
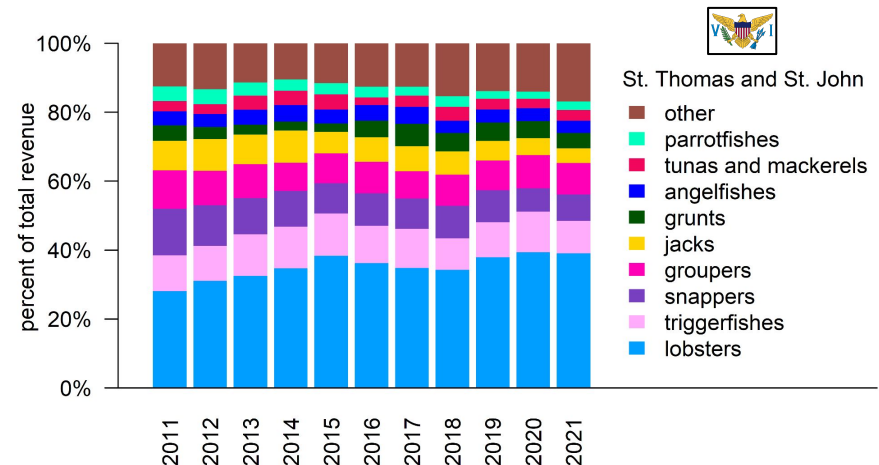
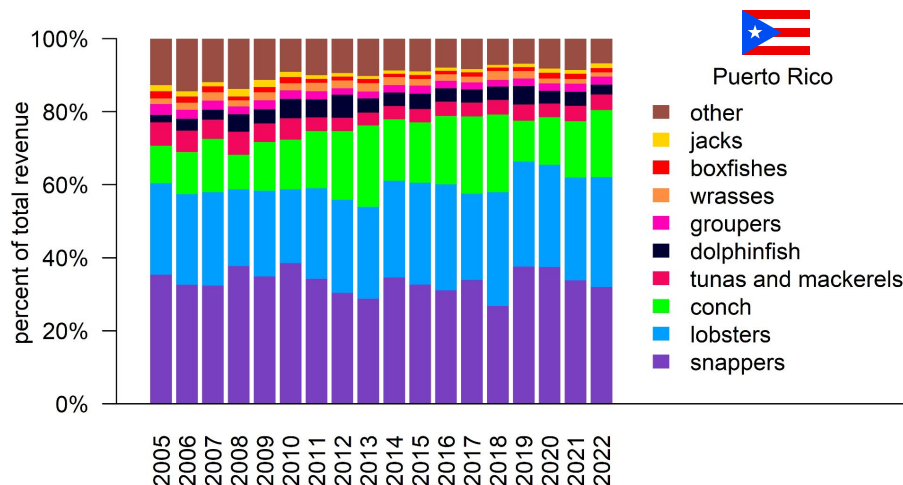
Food production: Mean Lmax indicator

- Can also calculate average maximum length of the catch (+/- standard error)
- Increasing trends across entire U.S. Caribbean in recent years
- Overall increasing trend across time series for STT & STJ; influenced by shift to pelagic species
- Suggests no evidence of “fishing down the food web”



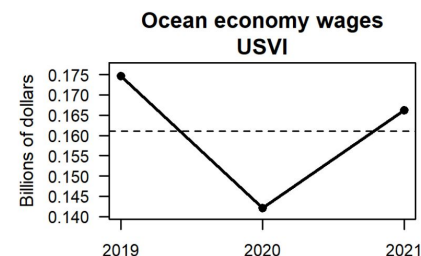
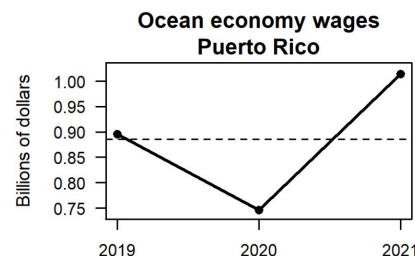
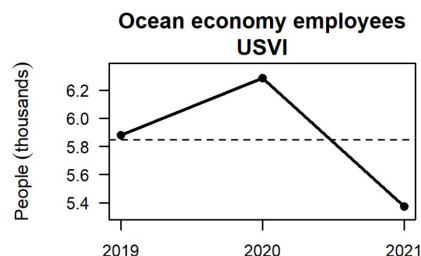
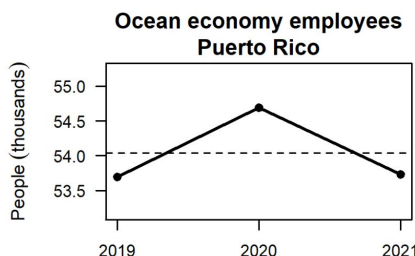
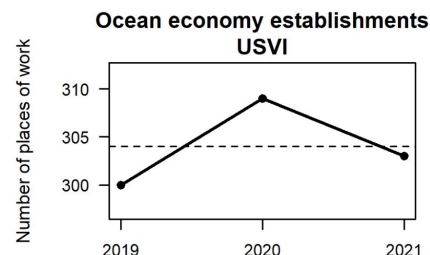
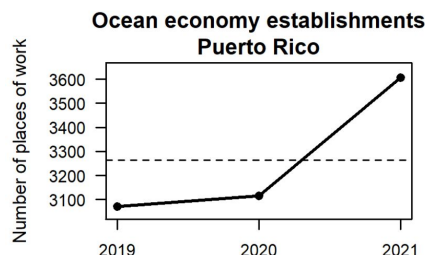
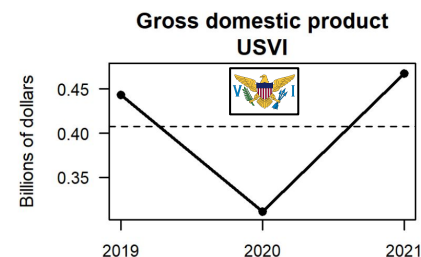
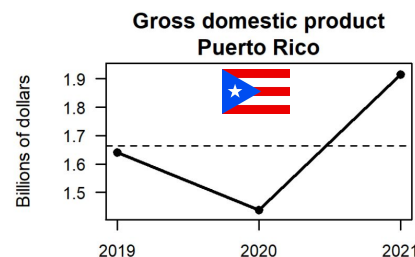
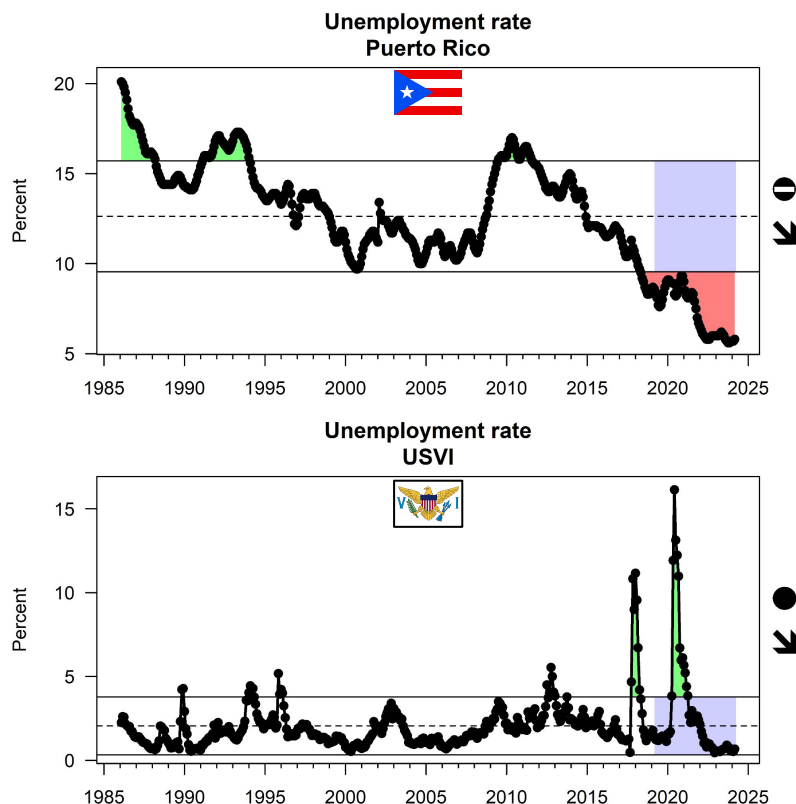
Socioeconomic health: Revenue contribution

- PR: increasing dependence on lobsters, and conch (up to 2017)
- STT and STJ: increasing dependence on lobster
- STX: more variability in species contributions; anomaly in 2018

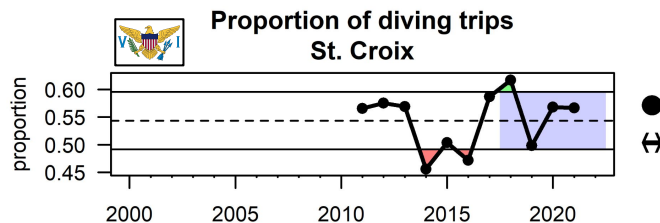
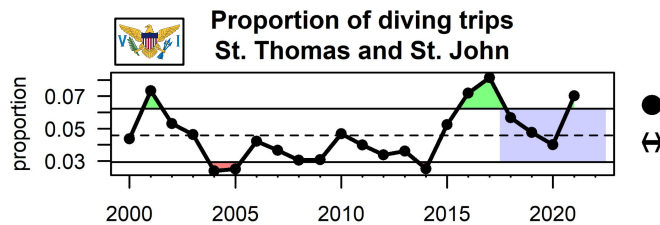
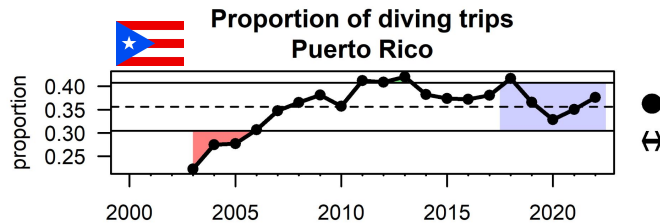
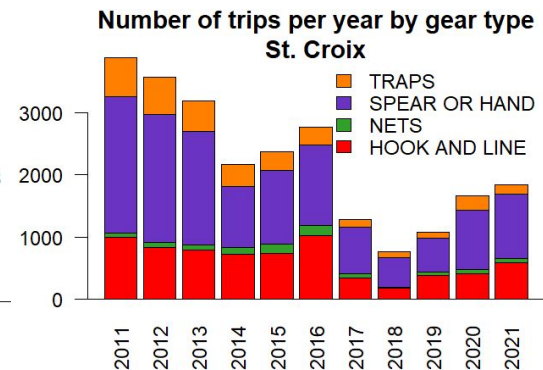
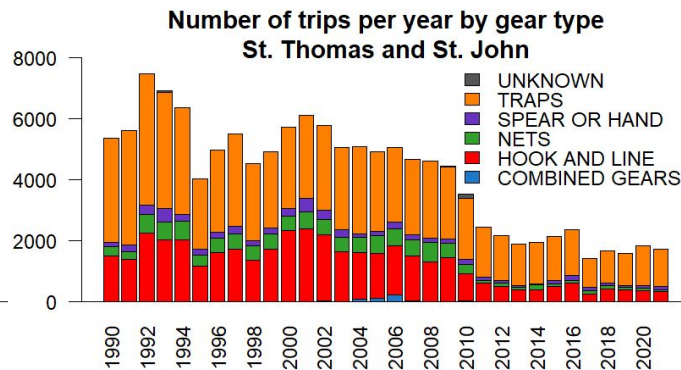
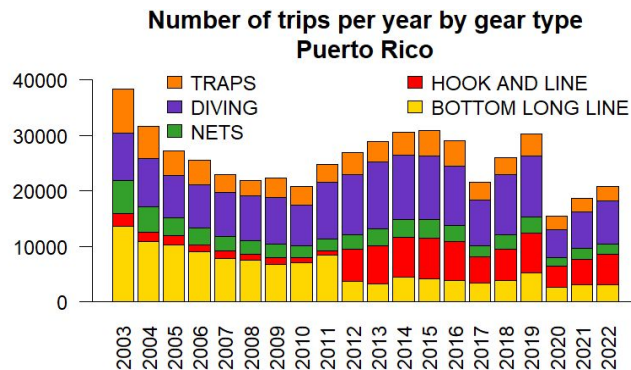


Socioeconomic health: Ocean economy

- Impacts from 2017 hurricanes and pandemic on local economies



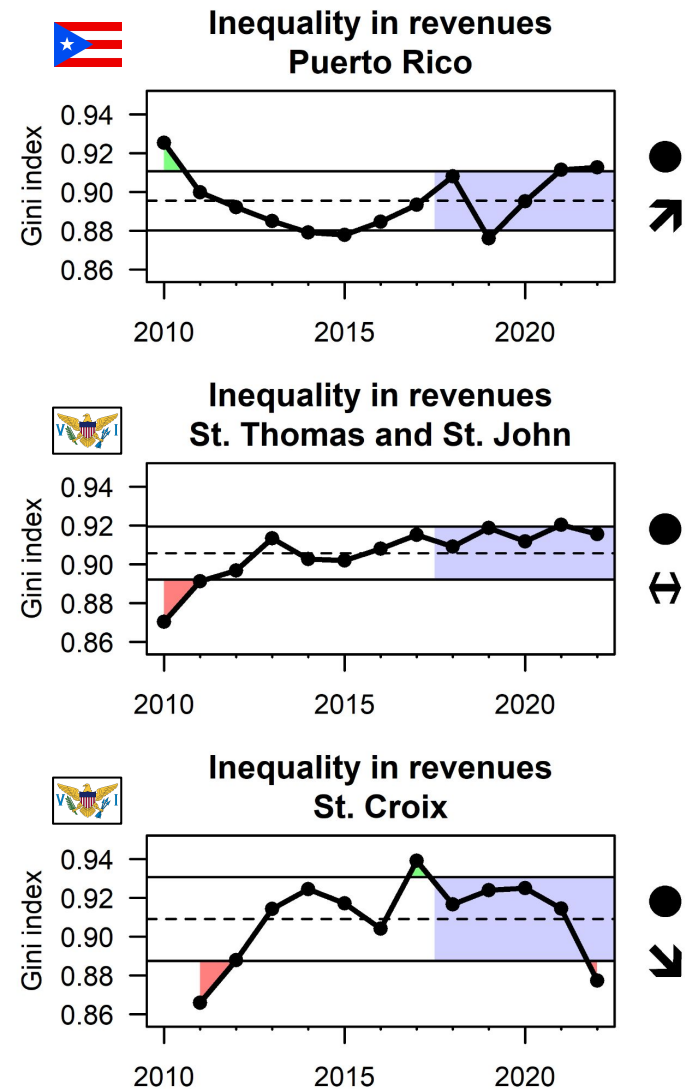
Socioeconomic health: Commercial trips



- Generally decreasing trip numbers across time likely due to reduced reporting; some shifts are due to changes in reporting forms
- More informative to look at composition
- Peaks in diving trips following major shocks (hurricanes, pandemic) could represent new or part-time fishermen seeking low-cost entry into the fishery

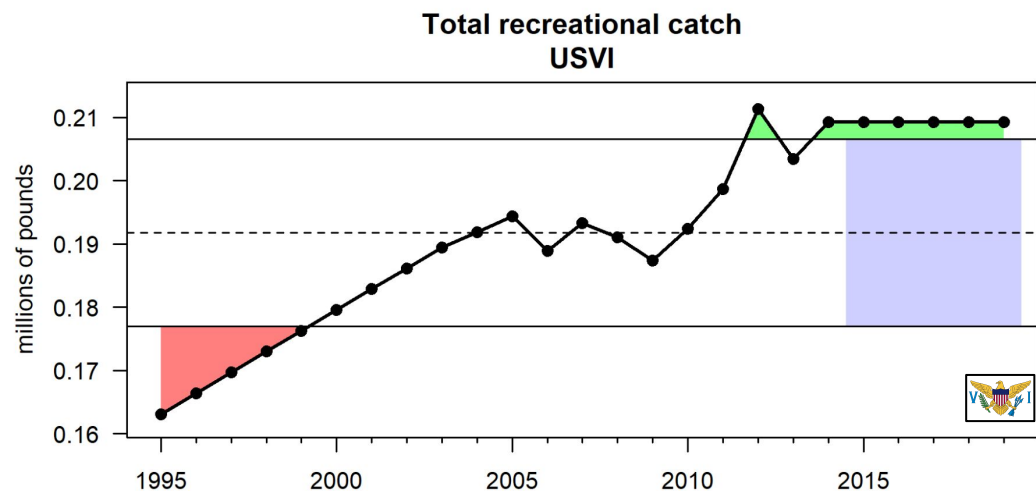
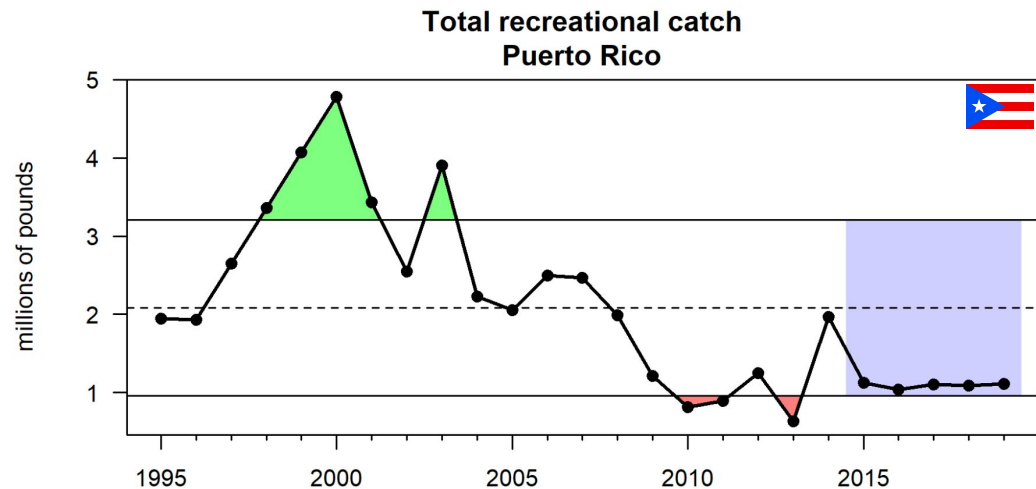
Socioeconomic health: Revenue distribution

- Gini index shows how revenue is distributed among participating vessels
- 1 = one person takes all;
0 = perfect equality
- Overall consolidation across the U.S. Caribbean is relatively high (reporting artifact?)
- STT and STJ shows gradual increase in Gini index
- PR and STX variable; inequality spike in the months following major hurricanes (2017 for STX, 2018 for PR)



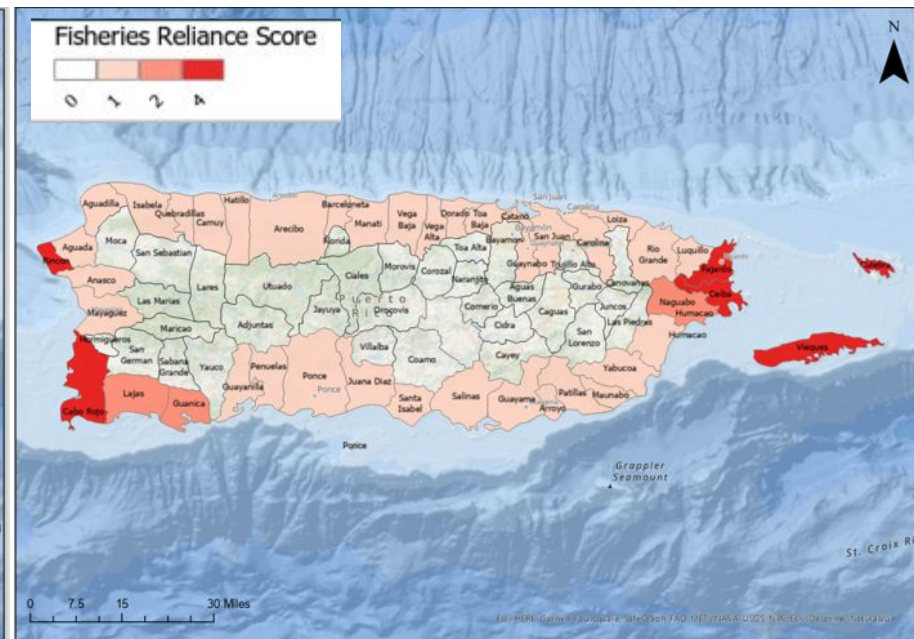
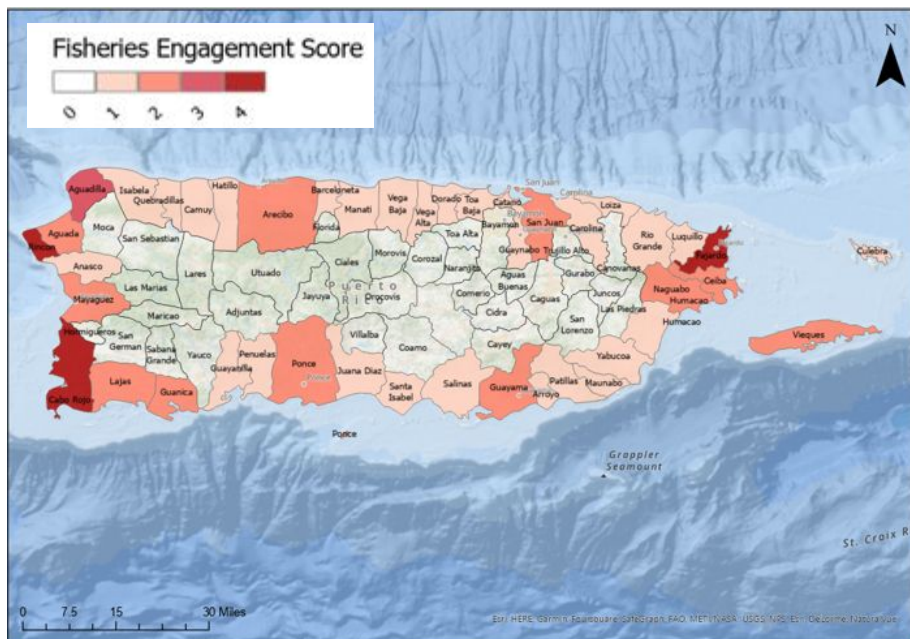
Engagement: Recreational catch

- Derived from Sea Around Us database; reported catches + estimated unreported catches
- Suggests overall decreasing catch in PR, increasing in USVI



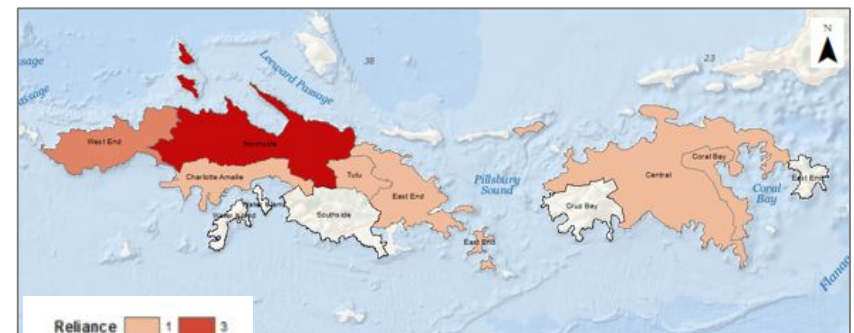
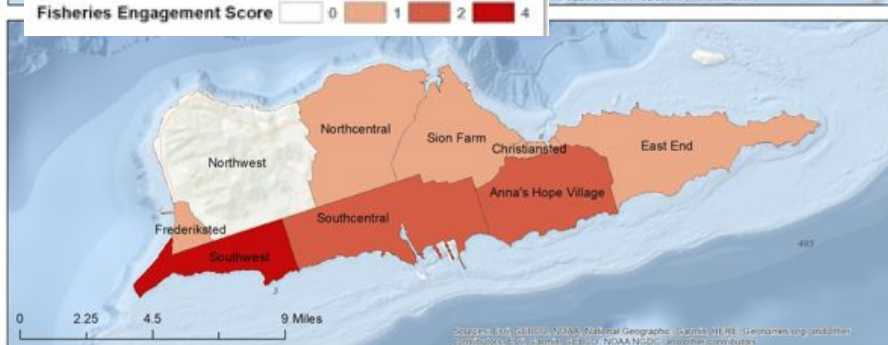
Engagement: Social indicators

- Commercial fishing engagement - presence of commercial fishing activity (permits, dealers, landings)
- Commercial fishing reliance - presence of commercial fishing in relation to the population size



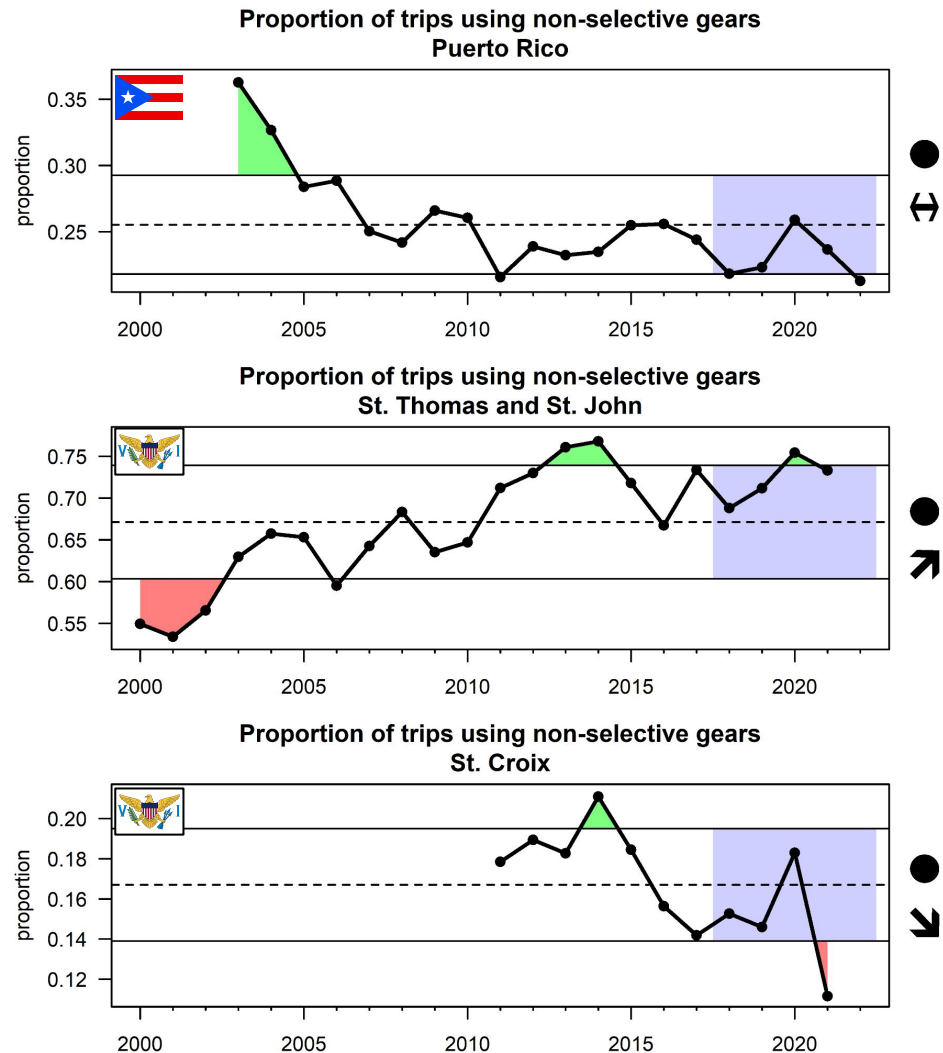
Engagement: Social indicators

- Commercial fishing engagement - presence of commercial fishing activity (permits, dealers, landings)
- Commercial fishing reliance - presence of commercial fishing in relation to the population size



Bycatch reduction: Changes in gear type

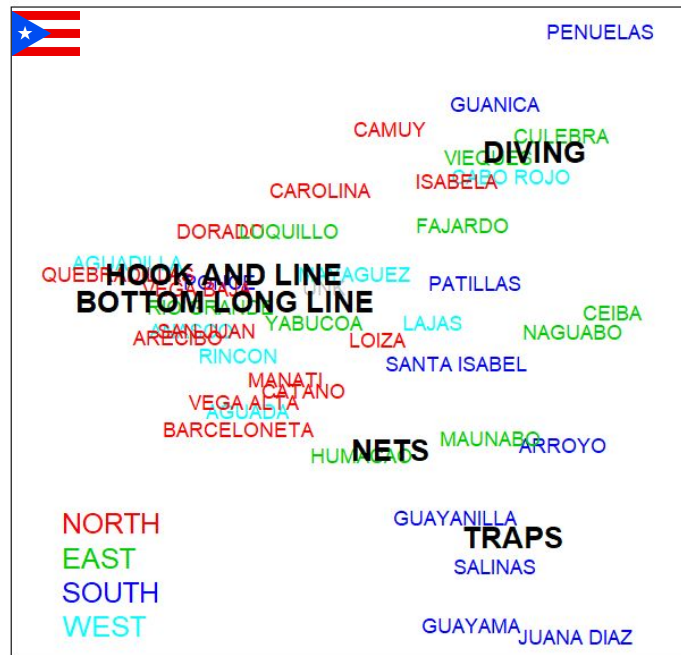
- Trip-level data on bycatch are lacking; also lack observer program data
- Can consider the fraction of trips using non-selective gears (traps, nets)
- Overall decreasing trend in use of these gears in PR and STX; opposite trend in STT and STJ



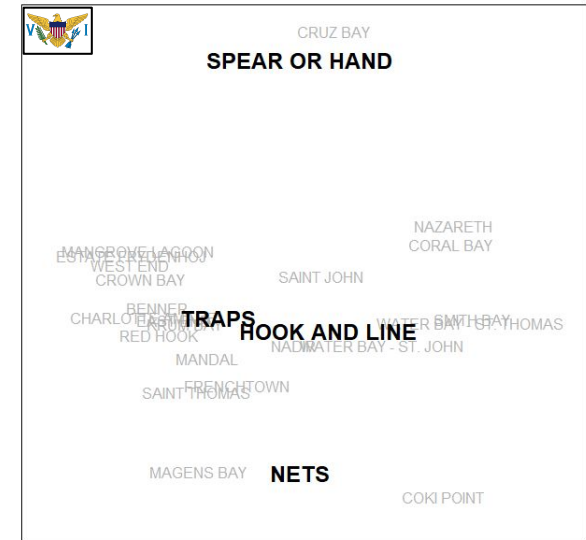
Bycatch reduction: Changes in gear type

Ordination
of gear
types by
landing
sites shows
how
regions
depend on
different
gear types

Ordination of gear type usage by landing sites
Puerto Rico



Ordination of gear type usage by landing sites
St. Thomas and St. John

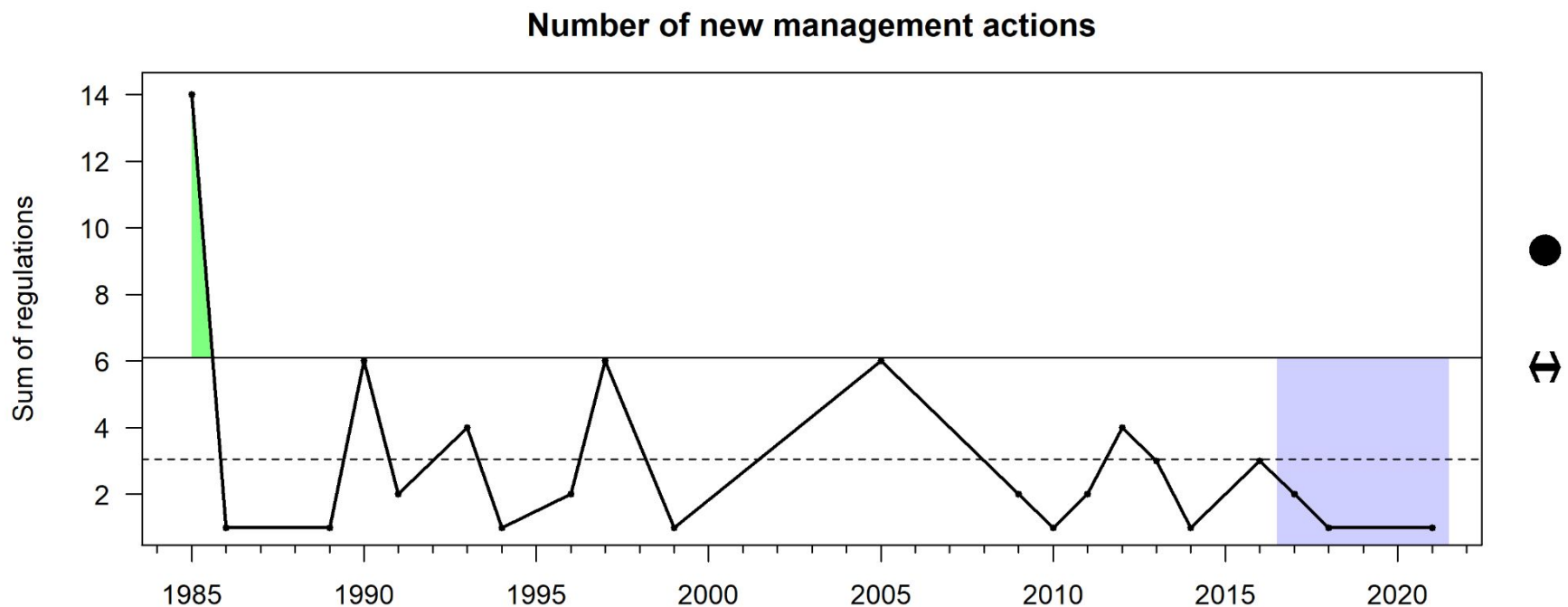


Ordination of gear type usage by landing sites
St. Croix



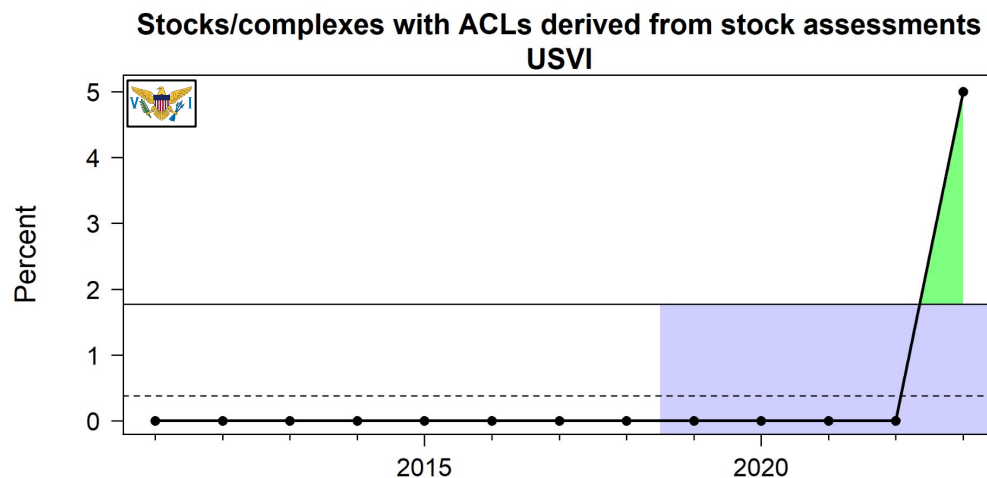
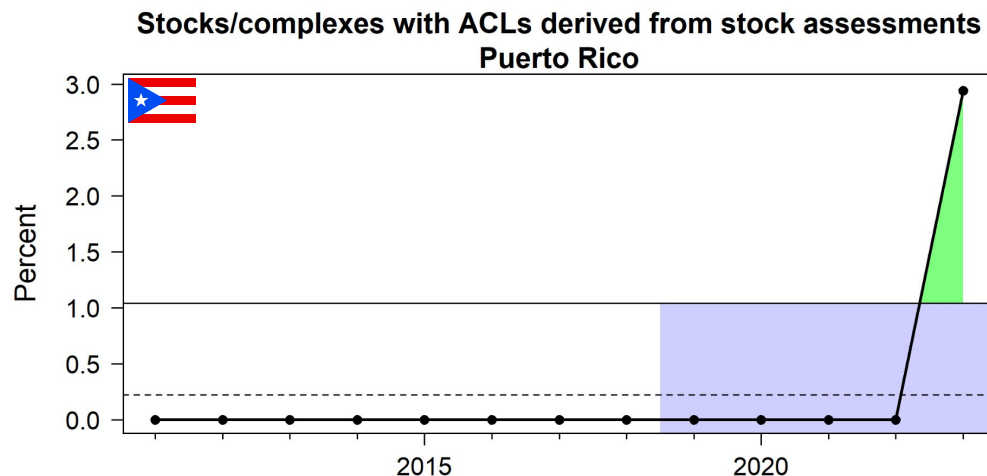
Governance: Efficacy of management

Management actions have occurred in waves over time, often increasing with changes to FMPs.



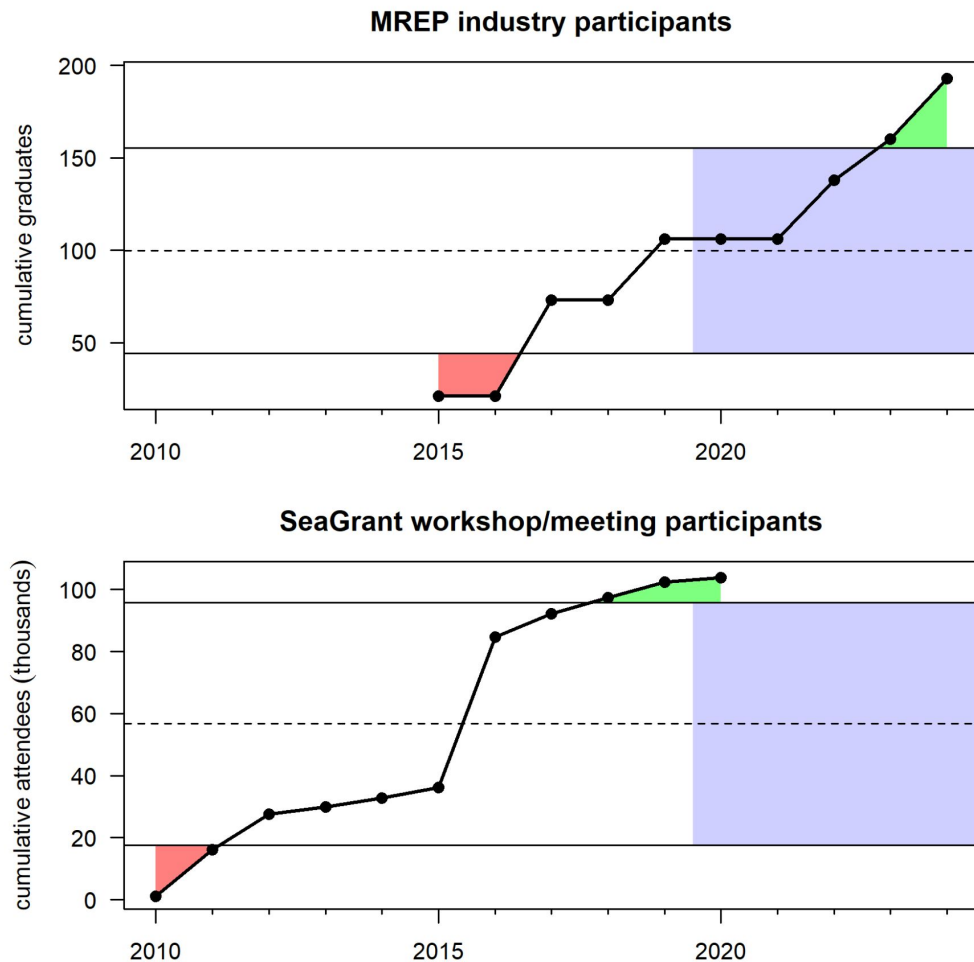
Governance: Percent assessed species

- Of stocks /complexes in FMPs (PR=34, USVI=20), only spiny lobster have had formal stock assessments accepted (triggerfish forthcoming)
- Conveys potential gains from an ecosystem approach



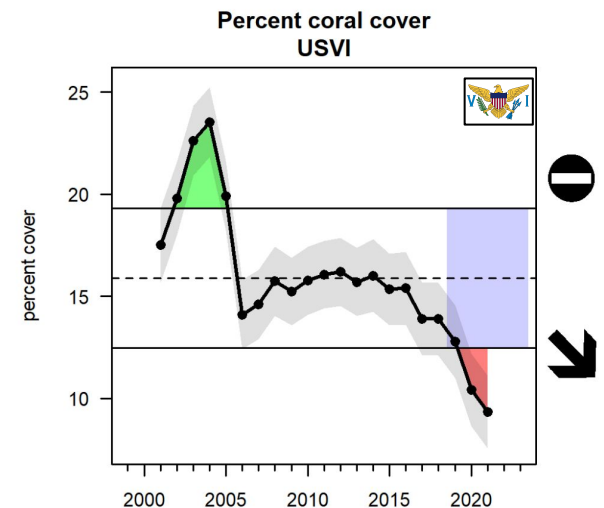
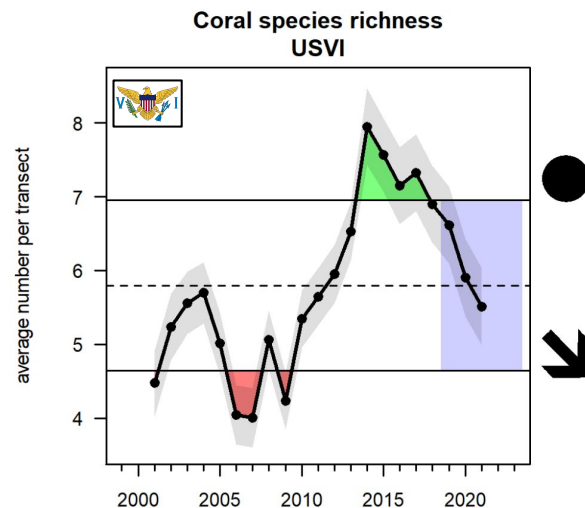
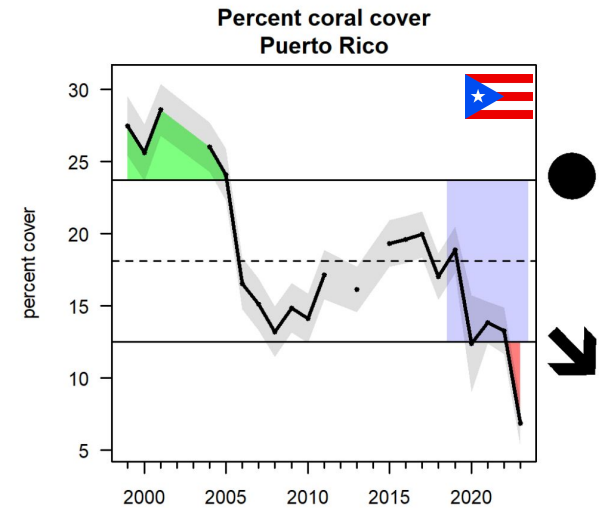
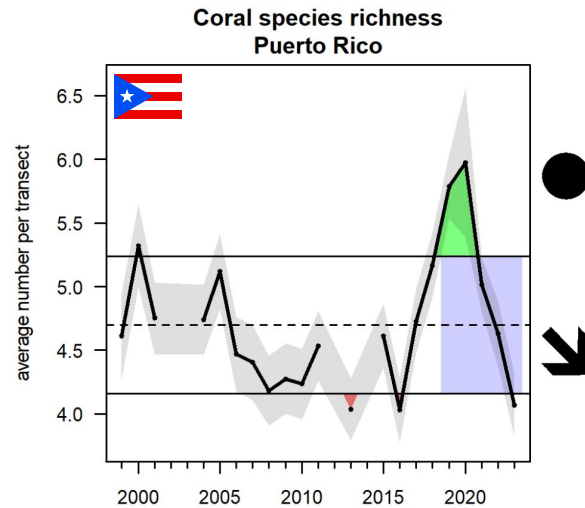
Governance: Education and outreach

Programs such as MREP (Marine Resource Education Program) and NOAA SeaGrant have made substantial gains in outreach and education



Ecosystem protection: Coral cover & diversity

- Based on PRCRMP and TCRMP (fixed stations)
- Trends in species richness are noisy
- Clear signal from coral bleaching events in coral cover trends



Final thoughts for now

- Risk indicators show some increasing stressors and major disturbances in last decade with high volatility in indicators
- Notable impacts from 2017 hurricane season and pandemic disturbances on social and economic indicators
- Impacts from major disturbances also influence fishing activity and manifest in fishery-dependent indicators
- Room for additional research (e.g. further exploration of size-based indicators with fishery-independent data, explore TIP data to compare with trends in landings data)
- Nearing full automation of report; only a select few indicators are tedious to update (e.g., ocean acidification, enforcement, engagement indices)



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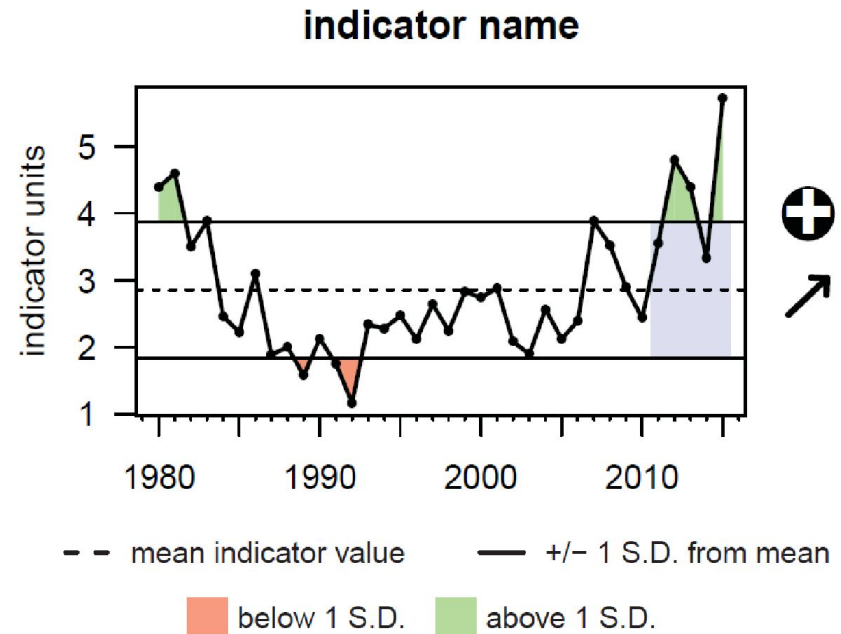
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Input we are looking for from the EBFM TAP

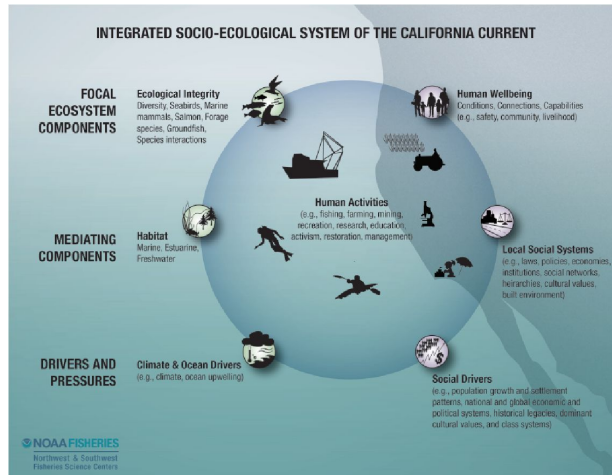
- Are the indicators representative of the concepts and objectives listed?
- Are the interpretations correct?
- Are there better data sources we could use?
- Any concepts or indicators we are missing?



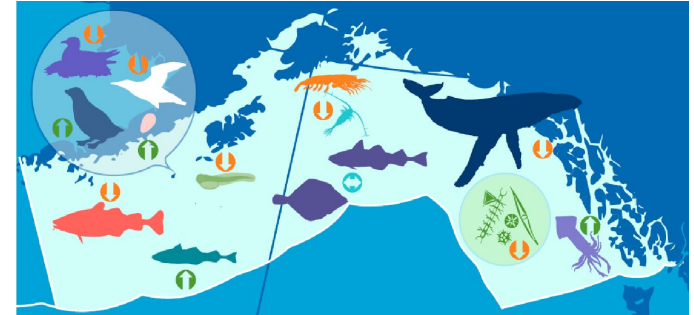
Extras



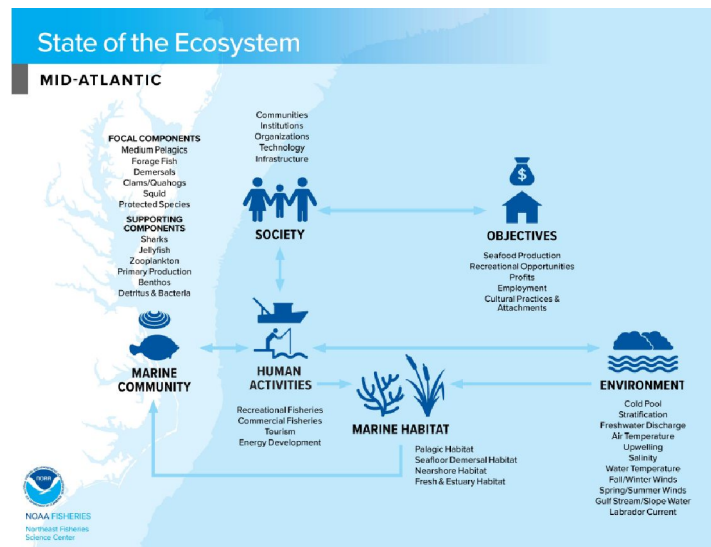
How are they used in management?



NPFMC: single-species quotas set in context of ecosystem information



PFMC: Fishery Ecosystem Plan requires an ESR describing status and trends, as context for decision-making



MAFMC: Indicators linked to specific management objectives

Fishery disturbances

- For primary target species*, calculate proportion of landings in each month, by year, then sum the square of deviations from the mean for each year
- Anomalies represent level of “disturbance” from typical patterns

*excluded species with seasonal closures implemented during time series

Distribution of landings throughout the year

