South Atlantic Fish and Shellfish Climate Vulnerability Assessment

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Climate Vulnerability Assessment

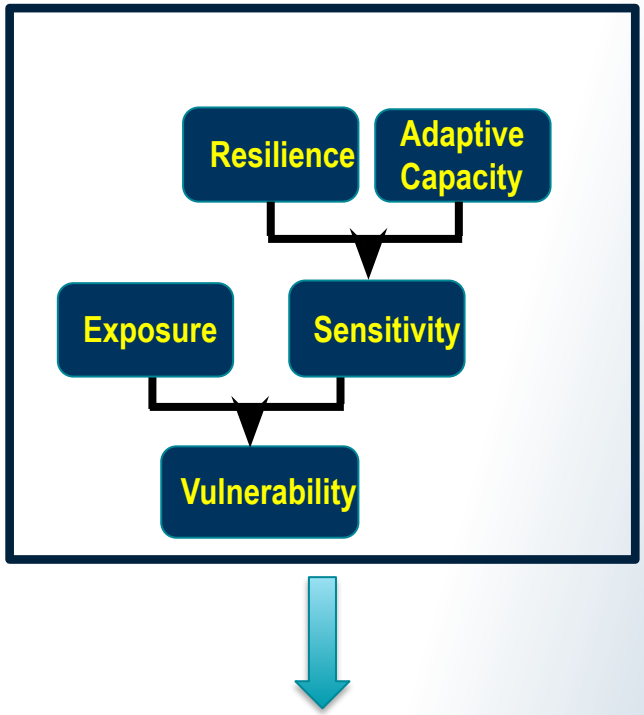
CVA – Tool to determine the likelihood that a species' productivity, abundance or distribution will be affected by a changing climate

CVAs identified as a priority action item in NOAA Fisheries Climate Science Strategy (NCSS)
(Link et al. 2015):
https://www.st.nmfs.noaa.gov/Assets/ecosystems/climate/documents/NCSS_Final.pdf

Also identified as a priority under the South Atlantic Climate Science Regional Action Plan and South Atlantic EBFM Implementation Plan

Vulnerability Assessment Framework

- Used widely in terrestrial systems, but only a few examples from marine systems
- Uses currently existing knowledge and expert opinion
- Uses quantitative data when available, and qualitative information when data is lacking



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Steps in the CVA process

Identify a panel of expert volunteer scorers to assess species' sensitivity and exposure.

Expert Contributors

- NMFS– Burton, Munoz, Quinlan, Bacheler, Kellison, Gore, Johnson
- SAFMC –Collier*, Pugliese*
- ASMFC – Campfield*
- NCDMF – Poland, Rock
- SCDNR - Reichert
- GA DNR - Flowers
- FFWCC – Gentry, Brodie
- Academic partners – ECU-Morley; NCSU-Runde
- Retired experts (Laney, Sedberry, Smith)
- NOAA Affiliate – Nelson

*Provided input on species and reviewers

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Steps in the CVA process

Identify species (n=71) and compile detailed species-specific information (species profiles) addressing the sensitivity attributes

- Reef fishes
- Deepwater reef fishes
- Coastal fishes
- Diadromous species
- Coastal pelagics
- Pelagics
- Biomass / forage species
- Invertebrates
- Sharks

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Steps in the CVA process

Sensitivity attributes - **represent biological traits indicative of the ability or inability of a species to respond to environmental change**

These twelve attributes represent the breadth of a species life history and are constant across all regional CVAs:

- Complexity in Reproduction
- Spawning Cycle Specifics
- Dispersal of Early Life Stages
- Early Life History Survival and Settlement Requirements
- Habitat Specificity
- Prey Specificity
- Adult Mobility
- OA Sensitivity
- Temperature Sensitivity
- Population Growth Rate
- Stock Size/Status
- Other stressors (e.g., HABs, invasive species, pollution, habitat alteration)

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Steps in the CVA process

Identify exposure factors & compile time series of data from ESRL portal:

- Sea Surface Temperature
- Air temperature - proxy for water temperature for riverine/estuarine water
- Salinity
- pH (ocean acidification)
- Precipitation
- Currents / upwelling - qualitative
- Sea level rise – qualitative

Exposure - the degree to which a species will experience change in that factor under changing climate.

- Exposures generated from a suite of models (11-35, depending on variable)
- RCP 8.5, the status quo projection of GHG emissions, was used
- Climate modeling was done using standard anomalies (future minus past)
- Exposure to currents/sea level rise evaluated through literature review/experts

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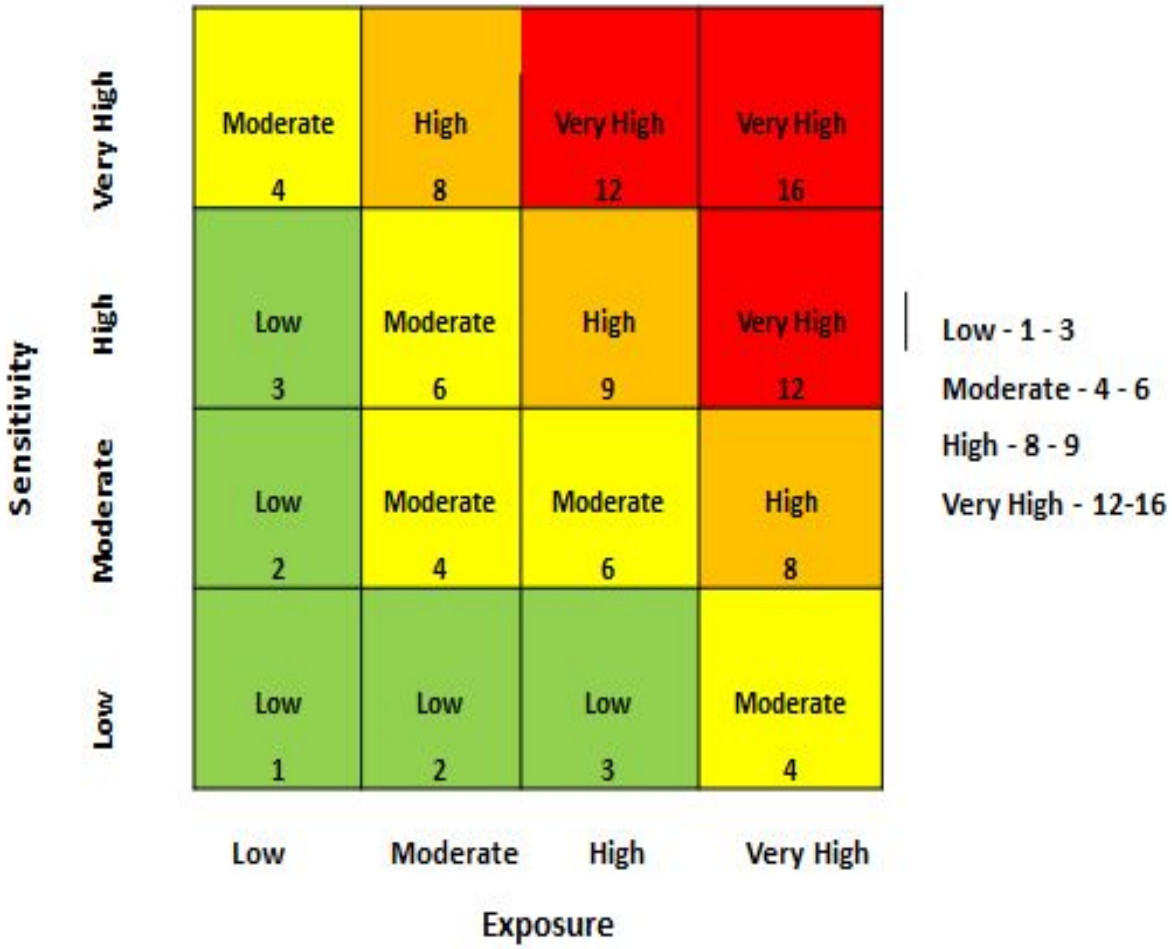
Scorers Assessed:

Overall Vulnerability to Climate Change – product of sensitivity and exposure

Potential for species distribution change – based on adult mobility, larval dispersal, habitat specificity and temperature sensitivity

Vulnerability Scoring Rubric



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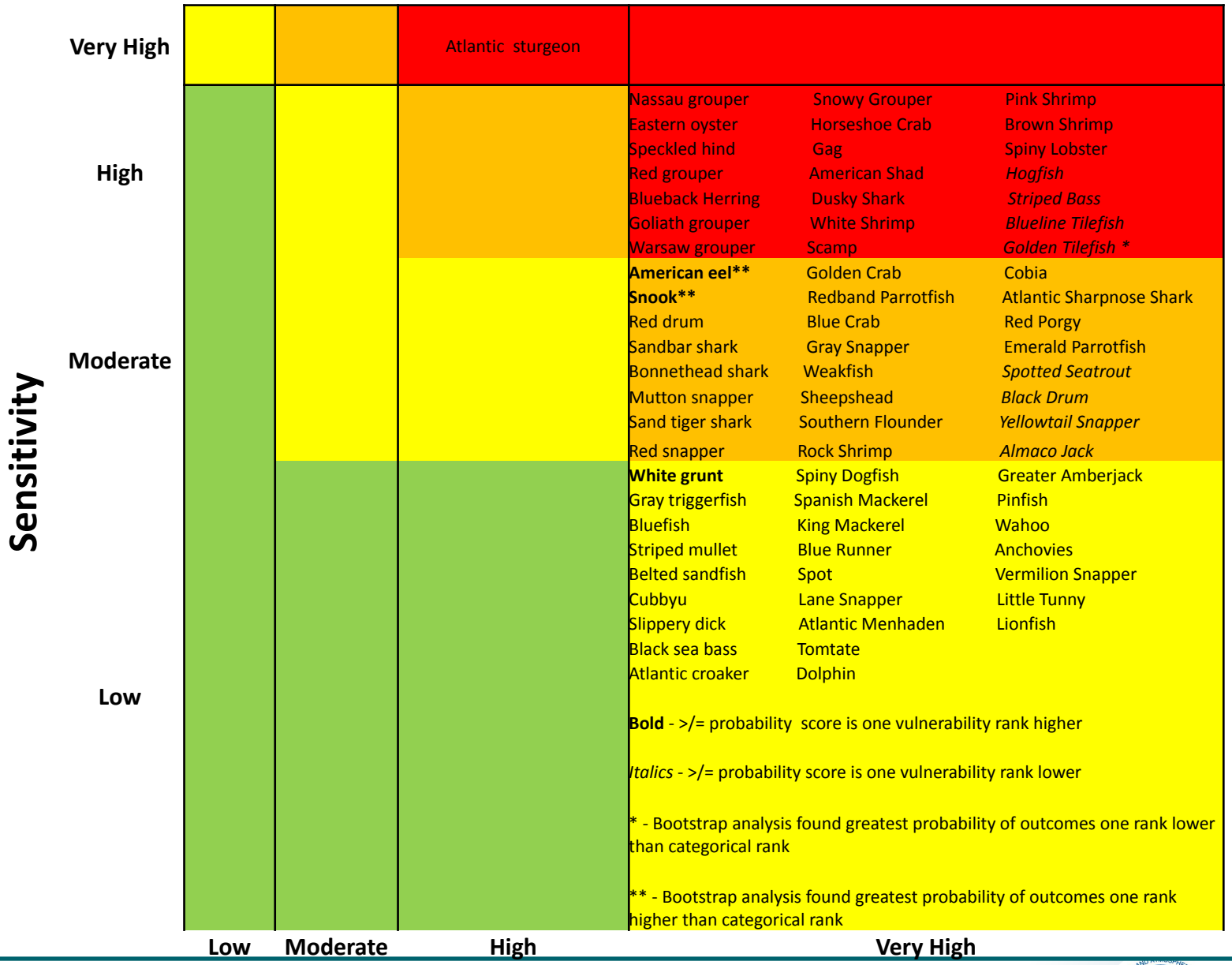
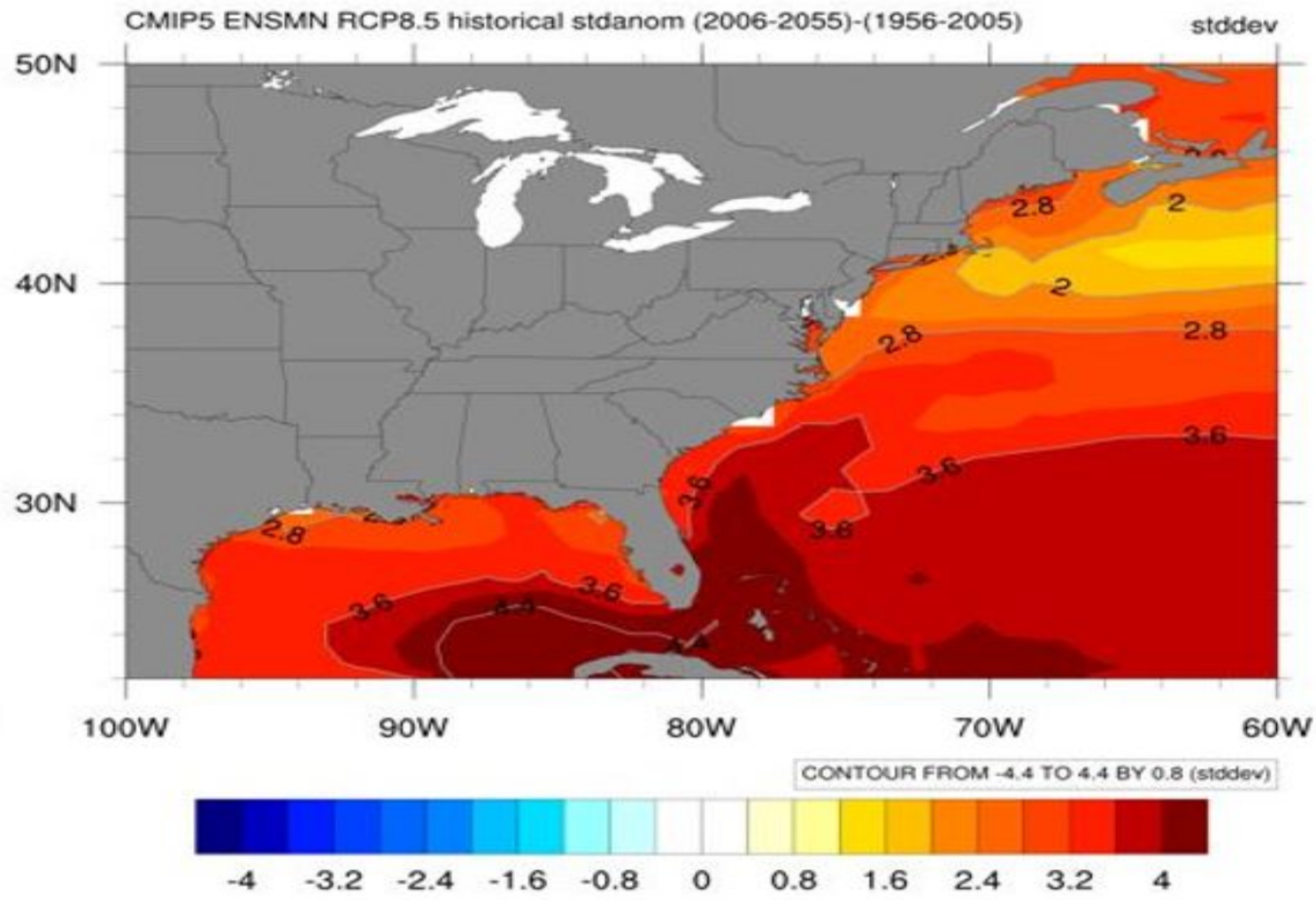

Very High
High
Moderate
Low
Sensitivity
Atlantic sturgeon
Nassau grouper
Eastern oyster
Speckled hind
Red grouper
Blueback Herring
Goliath grouper
Warsaw grouper
Snowy Grouper
Horseshoe Crab
Gag
American Shad
Dusky Shark
White Shrimp
Scamp
Pink Shrimp
Brown Shrimp
Spiny Lobster
Hogfish
Striped Bass
Blueline Tilefish
Golden Tilefish *
American eel**
Snook**
Red drum
Sandbar shark
Bonnethead shark
Mutton snapper
Sand tiger shark
Red snapper
Golden Crab
Redband Parrotfish
Blue Crab
Gray Snapper
Weakfish
Sheepshead
Southern Flounder
Rock Shrimp
Cobia
Atlantic Sharpnose Shark
Red Porgy
Emerald Parrotfish
Spotted Seatrout
Black Drum
Yellowtail Snapper
Almaco Jack
White grunt
Gray triggerfish
Bluefish
Striped mullet
Belted sandfish
Cubbyu
Slippery dick
Black sea bass
Atlantic croaker
Spiny Dogfish
Spanish Mackerel
King Mackerel
Blue Runner
Spot
Lane Snapper
Atlantic Menhaden
Tomtate
Dolphin
Greater Amberjack
Pinfish
Wahoo
Anchovies
Vermilion Snapper
Little Tunny
Lionfish
Bold - >/= probability score is one vulnerability rank higher
Italics - >/= probability score is one vulnerability rank lower
* - Bootstrap analysis found greatest probability of outcomes one rank lower than categorical rank
** - Bootstrap analysis found greatest probability of outcomes one rank higher than categorical rank
Low
Moderate
High
Very High
Exposure

Sea Surface Temperature - Std Anomaly



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Potential for Species Distribution Change

Key Results

- Most Impactful Exposure Factors – SST, Salinity*, Ocean Acidification
- 22 species Very High Vulnerability - Anadromous, Invertebrates, Deep-water Demersals
- 24 species High Vulnerability - Coastal and Reef Fishes
- 25 species Moderate Vulnerability - Pelagics, Forage, Coastal and Reef Fishes
- Distribution Change – Majority have Very High or High potential for change
- CVAs intended to be conducted iteratively, can be updated in future yrs

*Salinity Anomaly – Climate change predicted to enhance the global water cycle, wet regions will get wetter and dry regions dryer. Subtropical ocean regions (dry to start with) projected to warm and enhance evaporation.

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Vulnerability Narrative - Cobia

Cobia – *Rachycentron canadum*

Overall Vulnerability Rank = High

Biological Sensitivity = Moderate
Climate Exposure = Very High

Data Quality = 100% of scores≥ 2

	Rachycentron canadum	Attribute Mean	Data Quality	Expert Scores Plots (tallies by bin)
Sensitivity Attributes	Habitat Specificity	2	2.6	
	Prey Specificity	2	2.6	
	Adult Mobility	1.4	2.8	
	Dispersal of Early Life Stages	2.5	2.2	
	Early Life History Survival and Settlement Requirements	2.8	2	
	Complexity in Reproductive Strategy	2.6	2.4	
	Spawning Cycle	2.6	2.8	
	Sensitivity to Temperature	1.7	2.8	
	Sensitivity to Ocean Acidification	2.5	2.2	
	Population Growth Rate	1.9	3	
	Stock Size/Status	1.8	2.8	
	Other Stressors	2.2	2.4	
	Sensitivity Score	Moderate		
Exposure Factors	Sea Surface Temperature	4	3	
	Air Temperature	1	0	
	Salinity	3.9	3	
	Precipitation	1	3	
	Ocean Acidification	4	2	
	Sea Level Rise	2.5	2.4	
	Currents	1.8	2.8	
	Exposure Score	Very High		
Overall Vulnerability Rank		High		

Low
Moderate
High
Very High

Climate Exposure: Very High. Three exposure factors ≥ 3.5 contributed to this score: Ocean Surface Temperature (4.0), Ocean Acidification (4.0) and Salinity (3.9). Exposure to all three factors occurs during the life stages. Cobia use coastal and nearshore habitats during all life stages.

Biological Sensitivity: Moderate. Five sensitivity attributes scored ≥ 2.5: Dispersal of Early Life Stages (2.5), Early Life History Survival and Settlement Requirements (2.8), Reproductive Complexity (2.6), Spawning Cycle (2.6) and Sensitivity to Ocean Acidification (2.5). Little is known of Cobia early life history survival and settlement requirements other than a frequent association with floating structures. Cobia are known to form spawning aggregations (Rodger and von Zharen 2012), which could make them susceptible to exploitation. They rely heavily on crustaceans in their diet, making them vulnerable to increasing ocean acidification.

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How CVA Results Can Be Used

Science:

- Identify stocks that can benefit from incorporating environmental parameters into stock assessments
- Identify gaps in information for use in setting research priorities
- Identify stocks that could benefit from increased monitoring to better quantify when expected climate impacts occur

Management:

- Provide information for use in EISs, BiOps, Risk Assessments and other decision making documents
- Identify potential management actions that might reduce vulnerability and increase stock resilience in a changing climate
- Results can be combined with social and economic data to build vulnerability assessments for fishing communities-ongoing

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How can a CVA be used by the SAFMC?

Risk assessments such as CVA can be used to prioritize EAFM analyses and research plans for future years:
https://www.frontiersin.org/articles/10.3389/fmars.2018.00442/full

Climate Change Scenario Planning – Multi-Region, Multi-Council efforts

e.g. – MAFMC used Ecosystem Status Report to identify indicators for Risk Elements: Ecological, Social, Community, Management, Food Production

Each indicator was scored from Low to High Risk in order to rank the highest risk issues

CVA rankings were applied directly as risk ranking criteria
https://www.mafmc.org/actions/climate-change-scenario-planning

Thank you!

Questions?