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Institute of Water and Environment

FIU Southeast Environmental Research Center
Florida International University

Comprehensive Assessment of Coastal Fisheries Responses to Extreme Climate Events

RO Santos[1,2] *, *J Rehage*[1], *M Bhat*[1], *G Cook*[2], *R Huffaker*[3], *A Rios*[4], *J Osborne*[5], *C Kavanagh*[6]

[1]Florida International University, FL, USA
[2]University of Central Florida, Florida, USA
[3]University of Florida, Gainesville, FL, USA
[4]NOAA-Southeast Fisheries Science Center, Key Biscayne, FL, USA
[5]Everglades National Park, USNPS/SFNRC, Homestead, Florida, USA
[6] Everglades National Park, Florida Bay Interagency Science, Florida, USA

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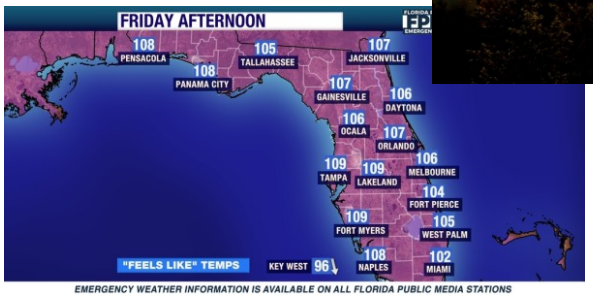
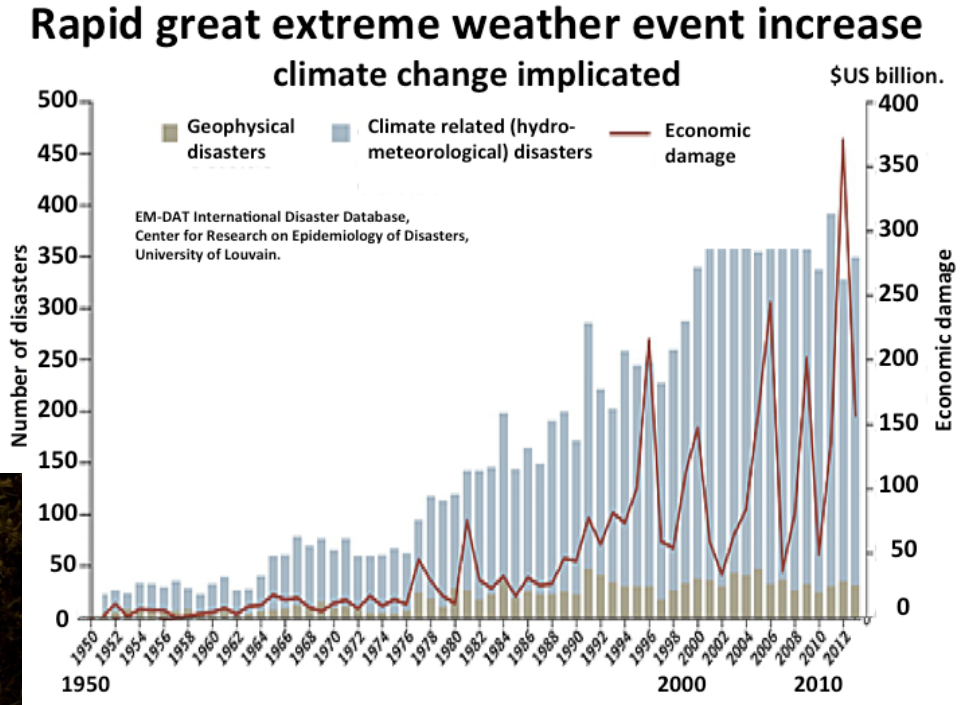
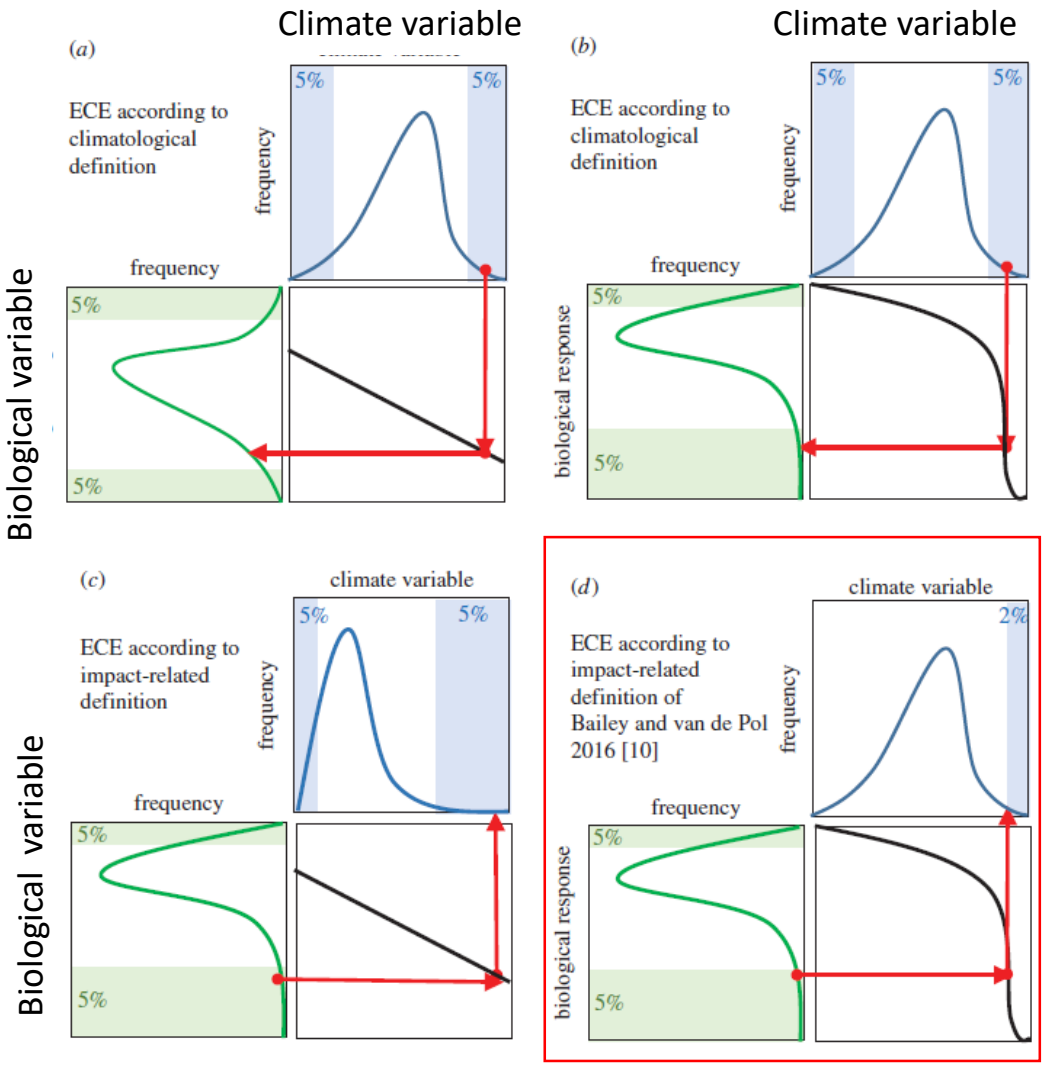
*email: rsantosc@fiu.edu

Extreme Climate Events





Extreme Climate Events

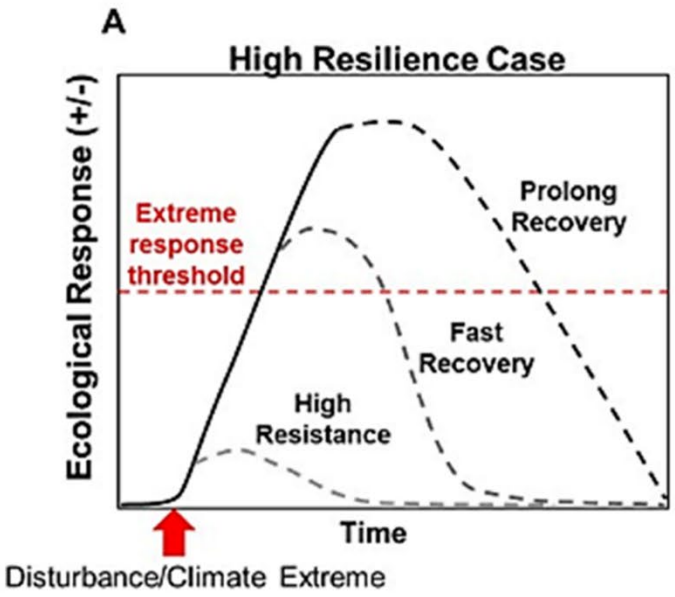


van de Pol M et al. (2017) Phil Trans R Soc

- Definitions:
  - A disturbance event is considered a ECE if there is both a **statistically rare climatic event** and **extreme ecological response**
  - Extreme responses cross **critical thresholds where community structure and ecosystem function** move outside their normal bounds

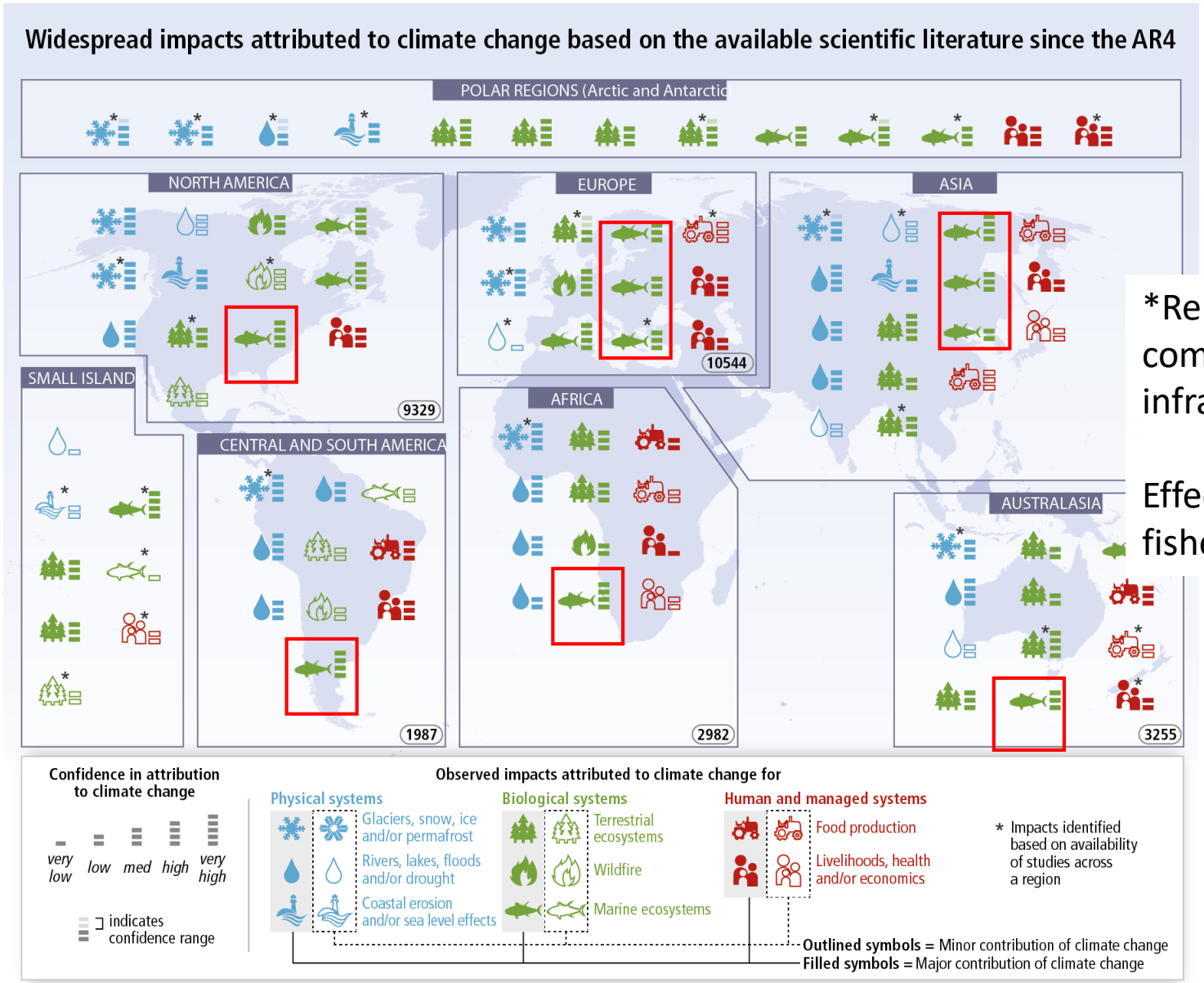
Jentsch et al. 2007, Smith 2011, van de Pol et al. 2017

Extreme Climate Events



R Santos et al. (2016) Ecosphere

Climate Change and Fisheries



*Reports mostly on commercial landings and infrastructure.

Effects on recreational fisheries overlooked

IPCC Synthesis Report 2014

Rationale

Fisheries Resilient or Prone to Collapse?

South Florida Recreational Fisheries

- FL - Highest number of recreational anglers, the most dollars spent on fishing in the US, and the highest quality of fishing worldwide

- Total economic impact (Fedler, 2013)
  - $5.2 billion- statewide saltwater angling

Questions

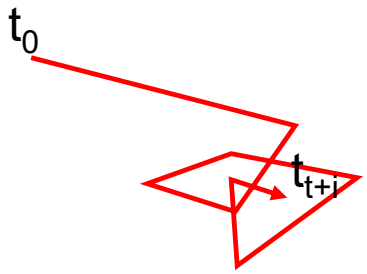
Fisheries Resilient or Prone to Collapse?

South Florida Recreational Fisheries

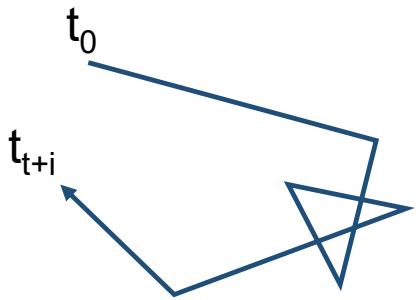
Q1: How are the catch structure trajectories from baseline conditions?

-Gradual or Stable

-Abrupt or Reversible



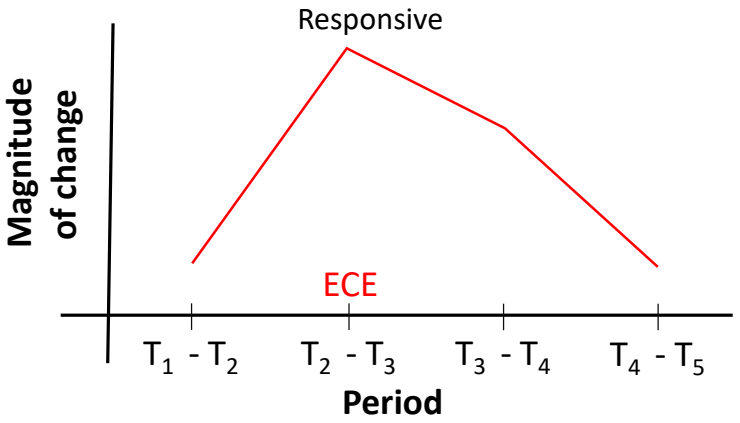
VS



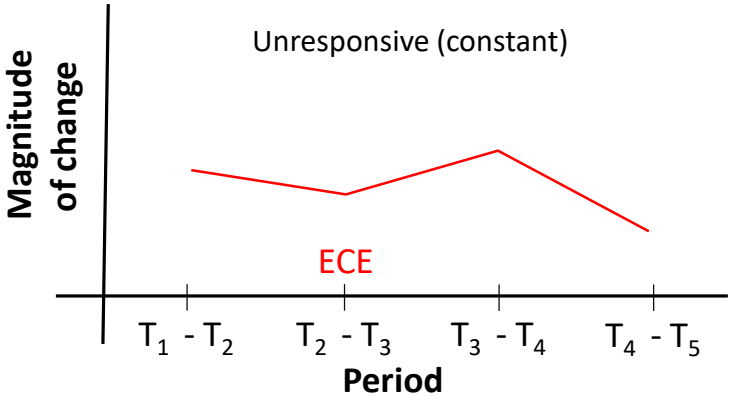
Q2: What is the temporal dynamic (inter-year) of catch structure change?

-Abrupt changes after ECEs?

-Distinct spatial rxn to ECEs?



VS

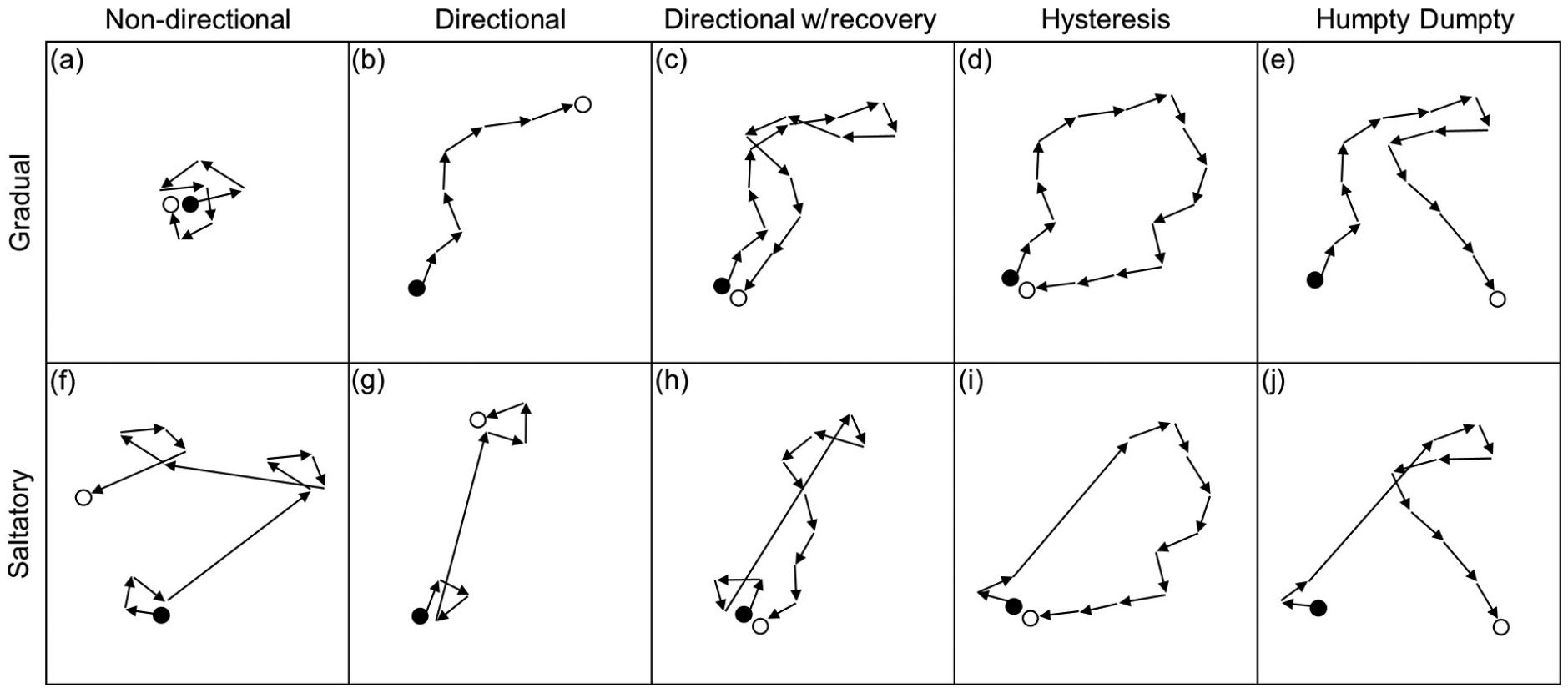


Methods

Fisheries Resilient or Prone to Collapse?

Adopt community ecology concepts

- Assess speed and direction of community changes
  - Responses to disturbances
- Trajectories of community change ≈ Resilience

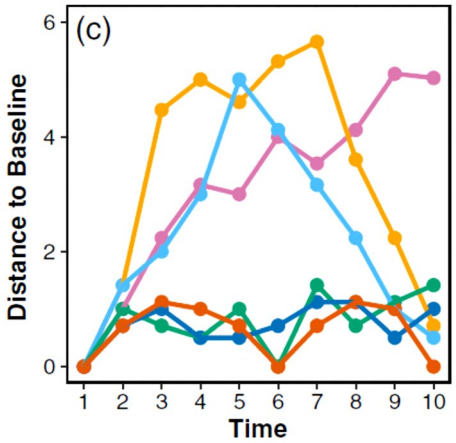


Lamothe et al. (2019) Ecosphere (fig); Caceres et al. (2019); Ecol Monog; Bagchi et al. (2017) Ecol Appl

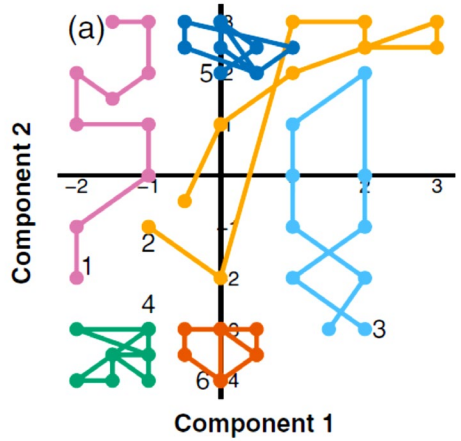
Methods

Fisheries Resilient or Prone to Collapse?

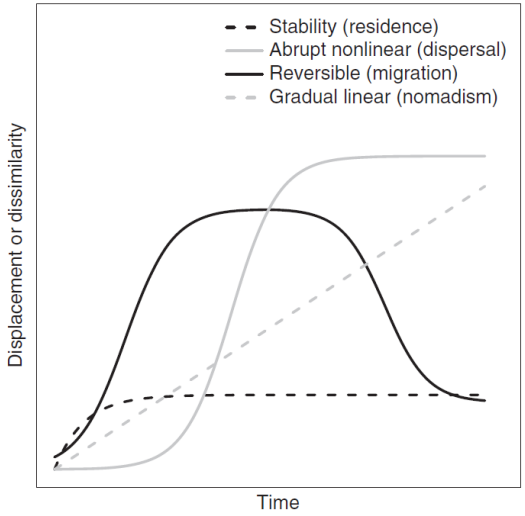
Adopt community ecology concepts

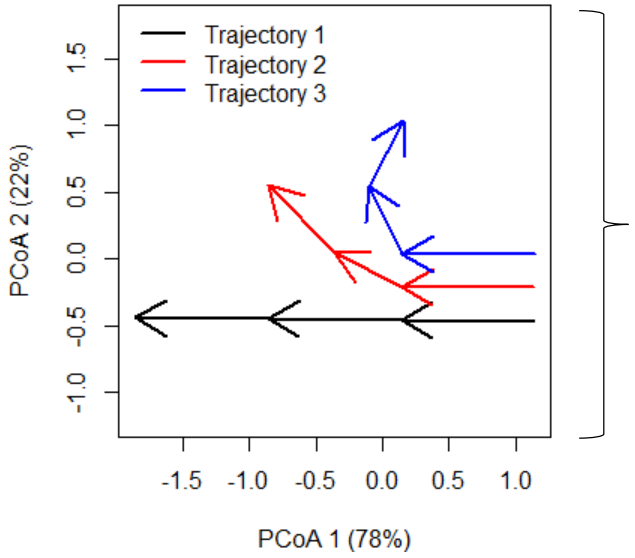


Models to capture community displacement from initial conditions



Geometric analyses to capture spatiotemporal dynamics of community tracks





Segment Lengths

$$L(\mathbf{T}) = \sum_{i=1}^{n-1} L(s_i) = \sum_{i=1}^{n-1} d(x_i, x_{i+1})$$

Speed of change

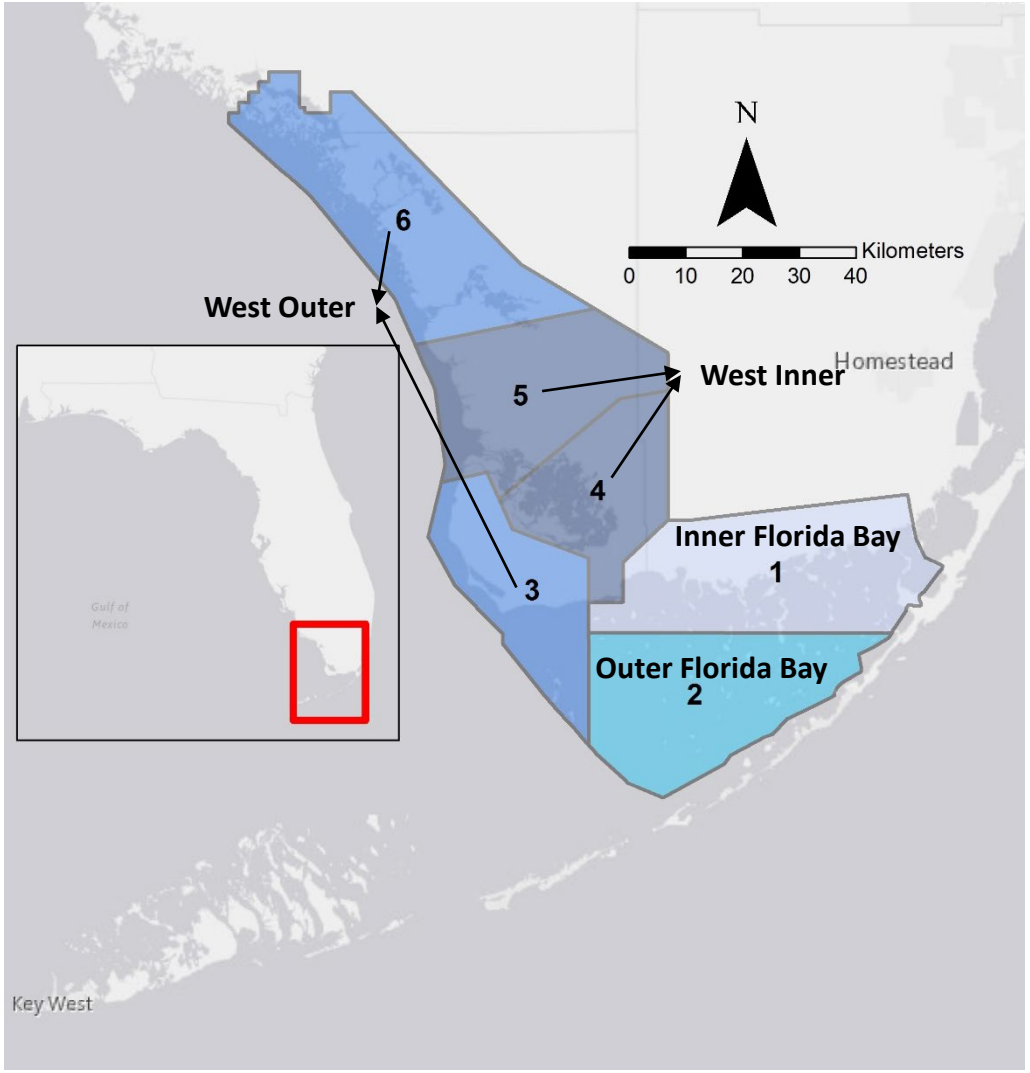
$$S(s_i) = \frac{L(s_i)}{t_{i+1} - t_i}$$

Lamothe et al. (2019) Ecosphere (fig - up); Caceres et al. (2019) (fig – down); Ecol Monog; Bagchi et al. (2017) Ecol Appl (fig – down)

Methods

Study Domain

Recreational Fisheries in ENP



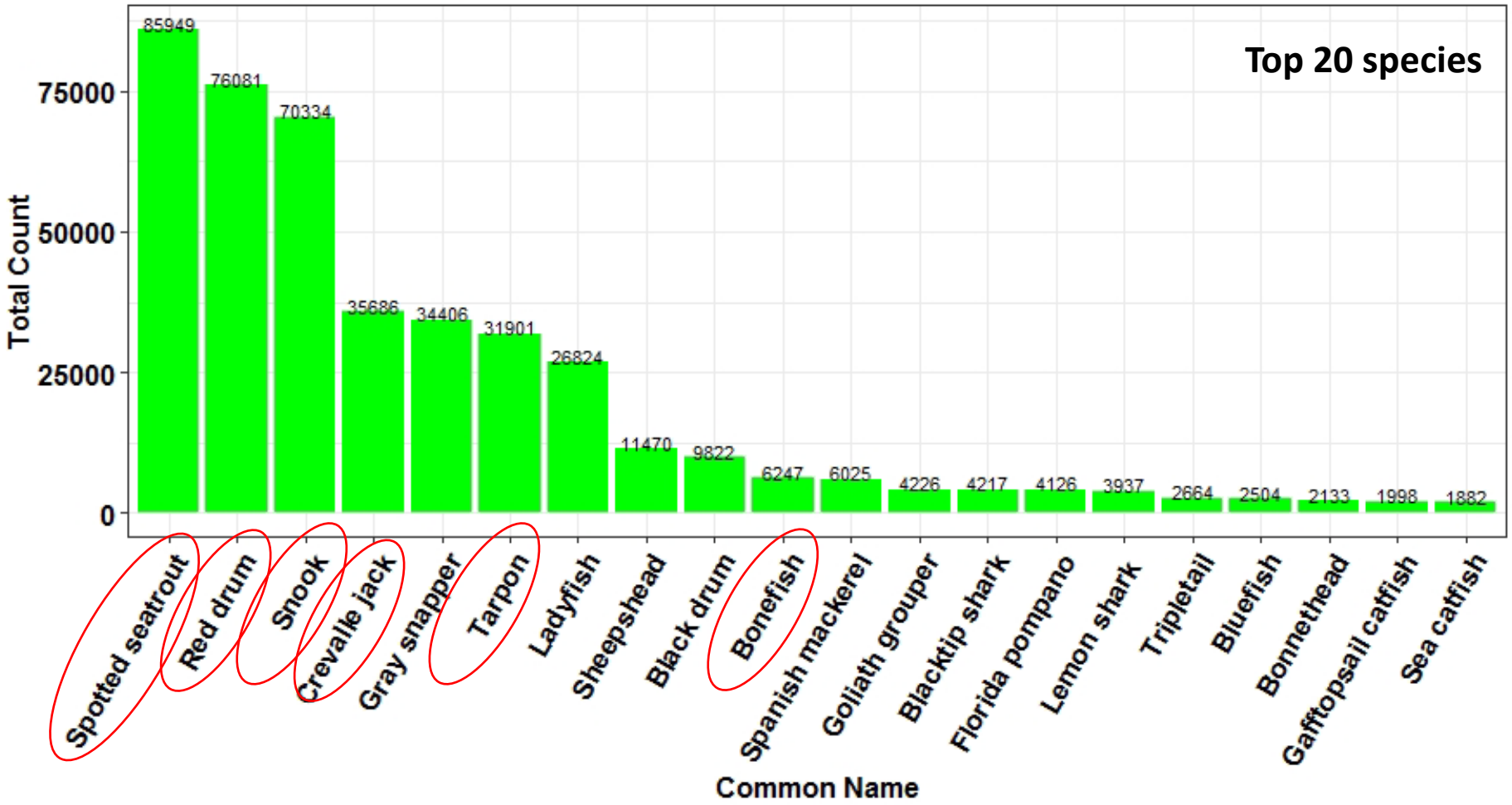
Fishery-Dependent Data (FDD)

- Fishing reports submitted by fishing guides to Everglades National Park:
  - **1986 to 2017**
  - **Useful for stock and ES assessments**
  - **Events: Hurricanes, Seagrass Die-off, Cold Spells**
  - **CPUE in 6 Fishing Areas**
    - **Merged into 4: (1) Inner Florida Bay/ (2) Outer Florida Bay/ (4, 5) West Inner/West Outer (3, 6)**
- We sum catch and effort across the months, and created average annual CPUE value
- We analyzed the catch structure based on a Bray-Curtis dissimilarity matrix of the average annual CPUE

Cass-Calay et al. (2009) Endangered Sp. Res
Carlson et al. (2007) Biol Conserv
R Santos et al. (2016) Ecosphere
R Santos et al. (2017) PlosOne

Study Domain

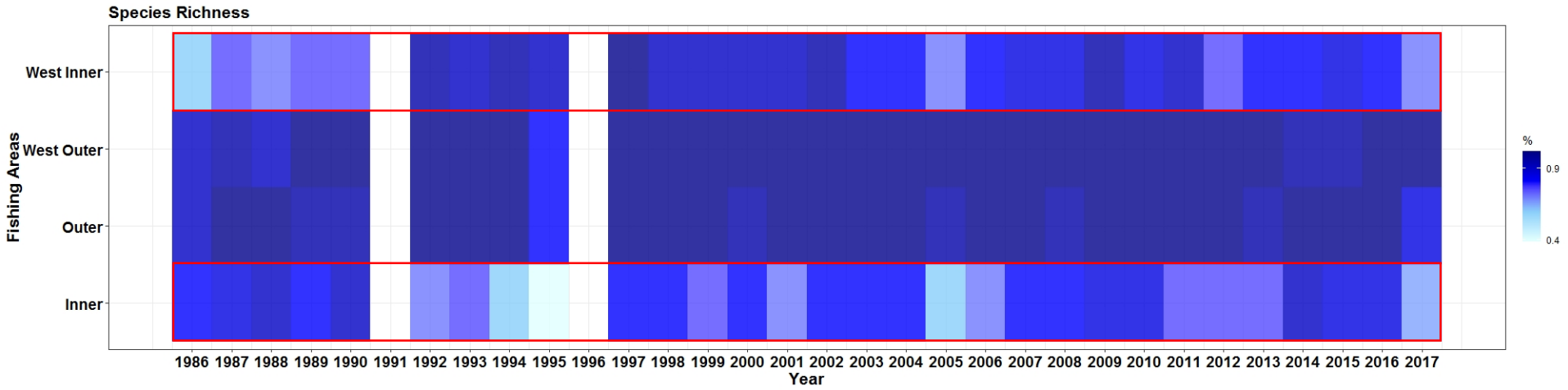
Recreational Fisheries in ENP

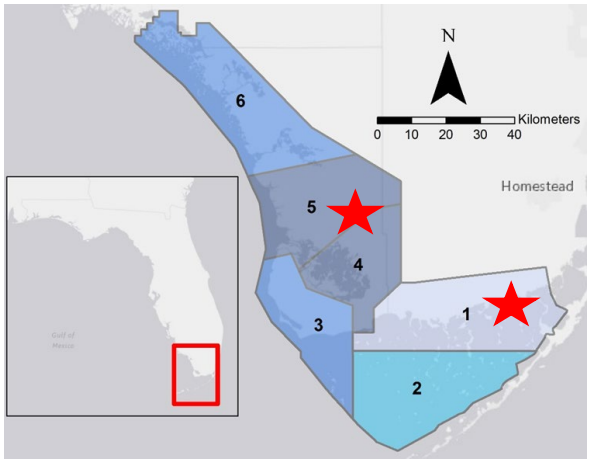


Results

Species Occurrence

Most species caught across all fishing areas

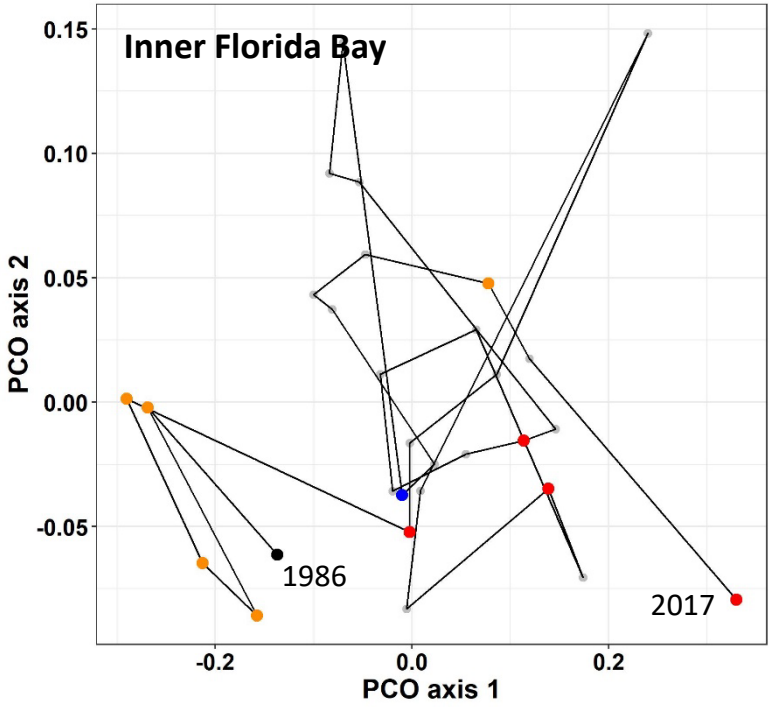


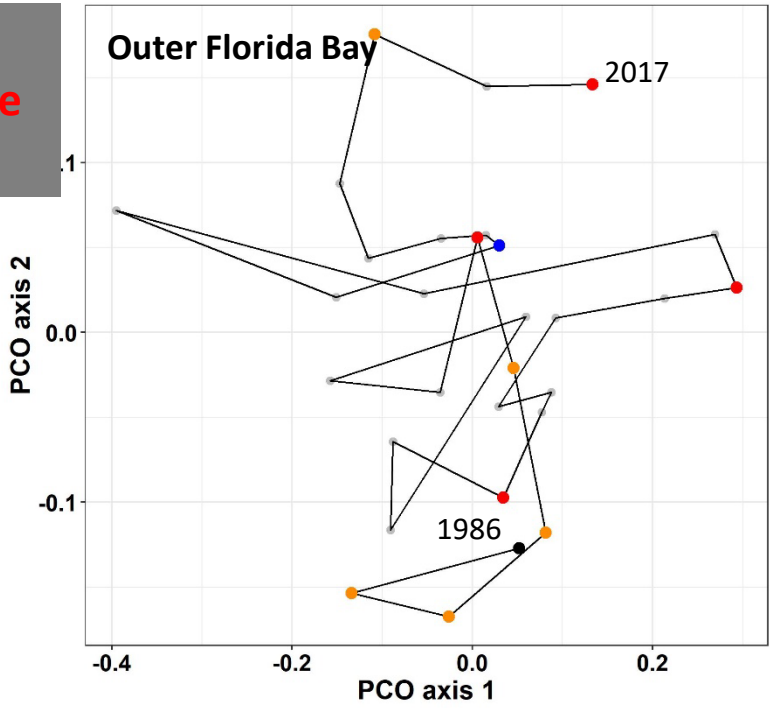


Species richness consistency was spatially dependent:

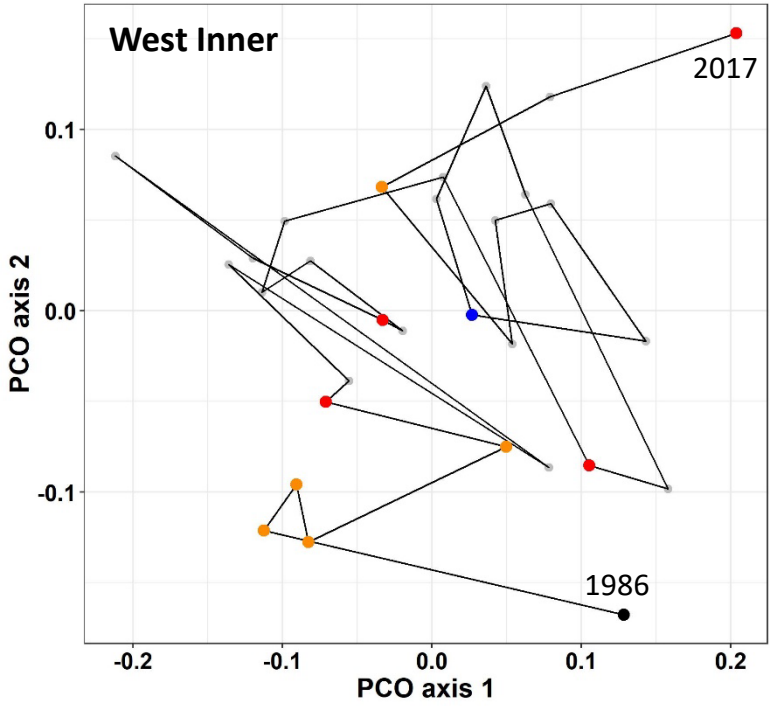
- S' relatively consistent across years in the "outer" fishing areas
- More variable at the "Inner" fishing areas

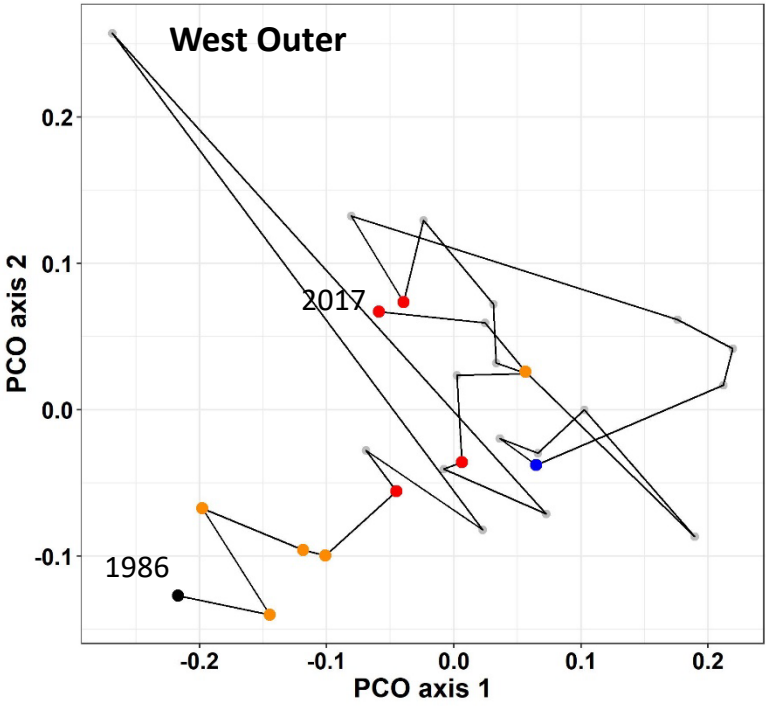
Results:
ordination space of the catch

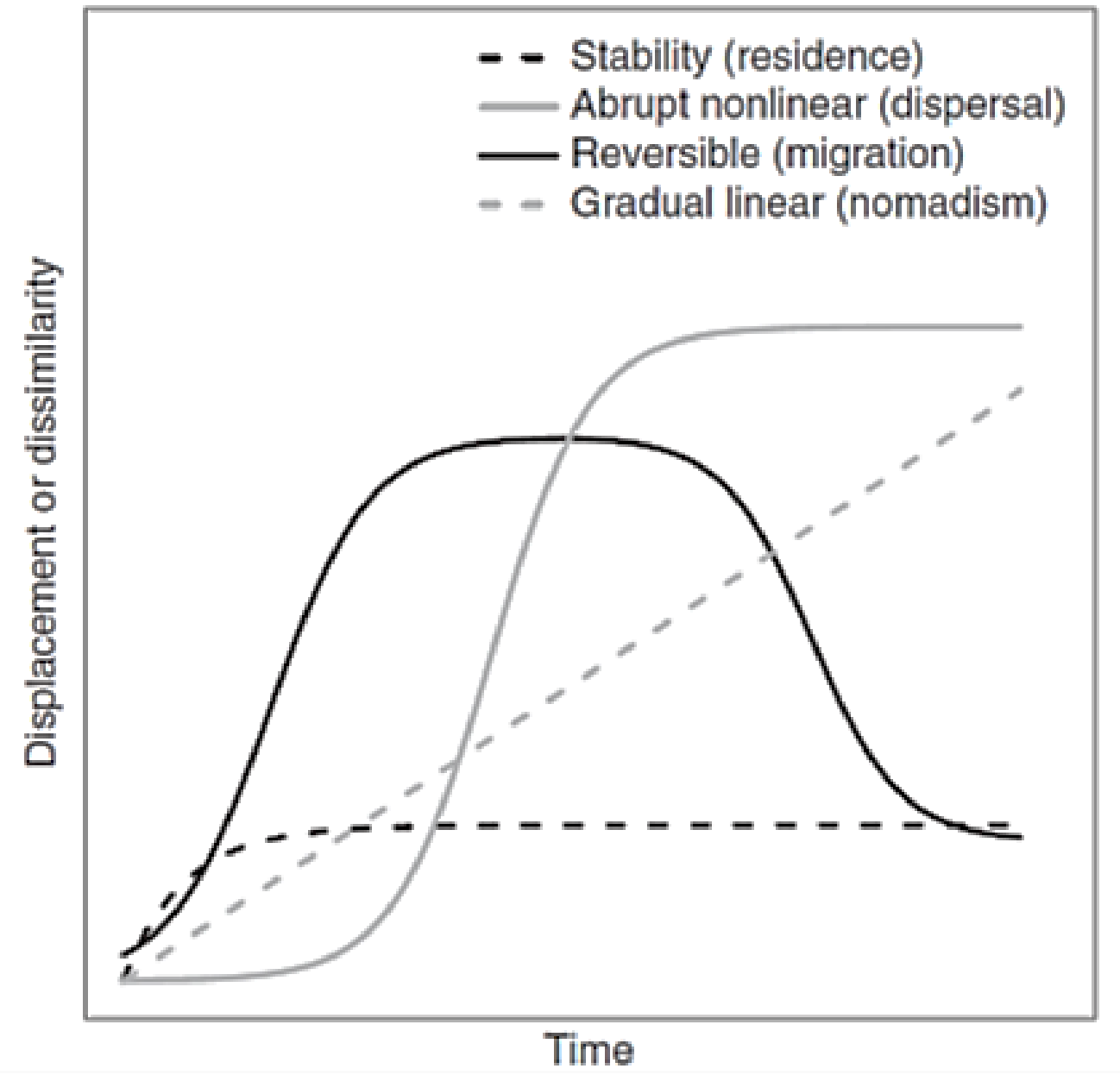




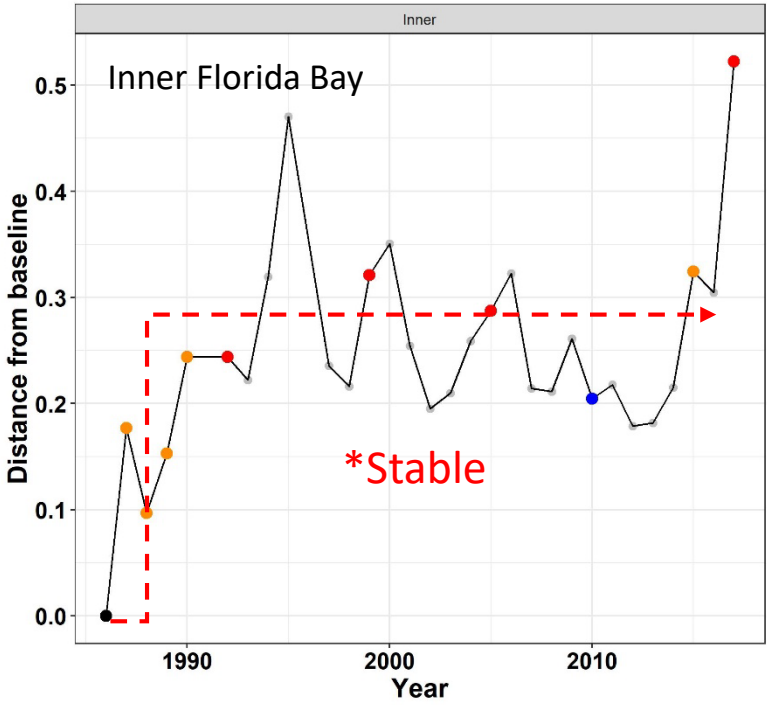
Event
- Baseline
- Seagrass Dieoff
- Hurricane
- Cold Spell

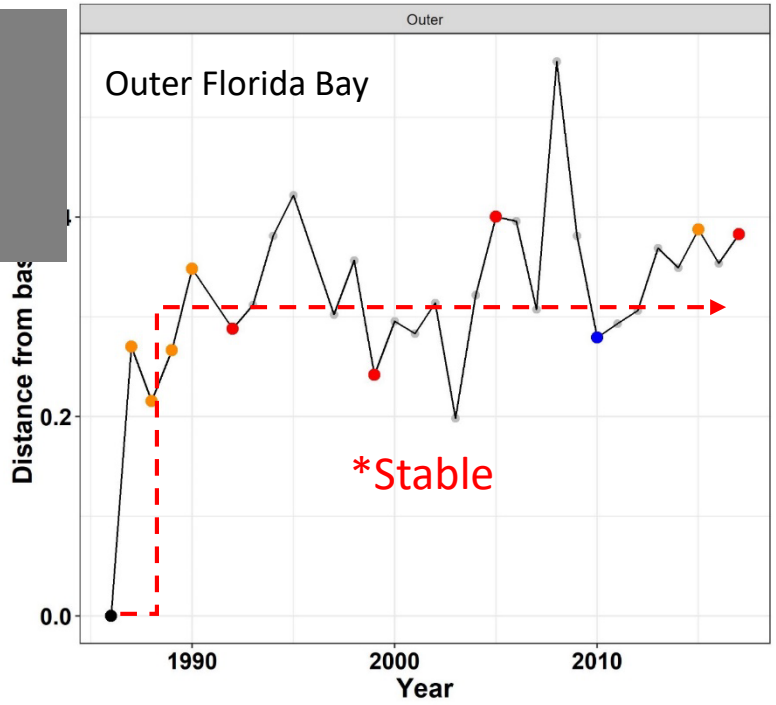


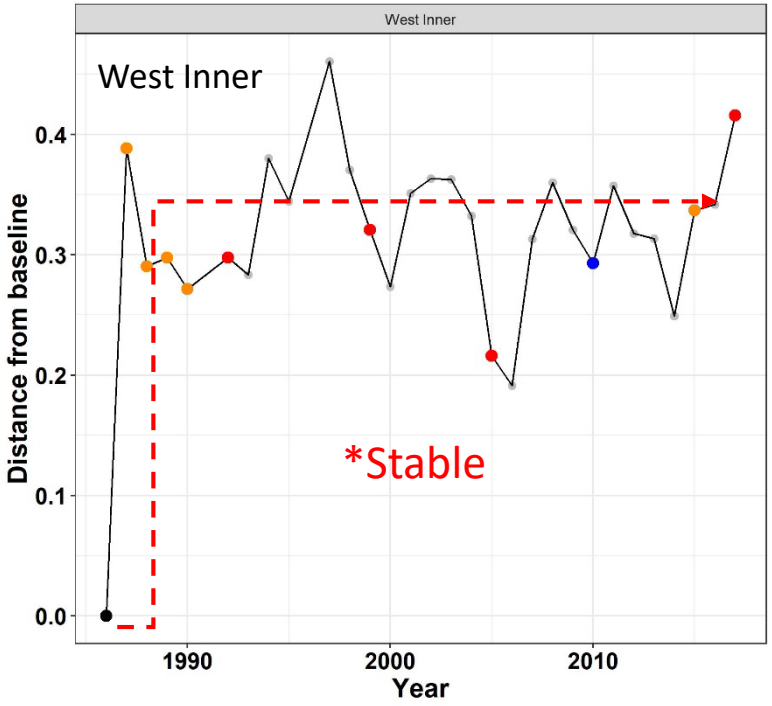


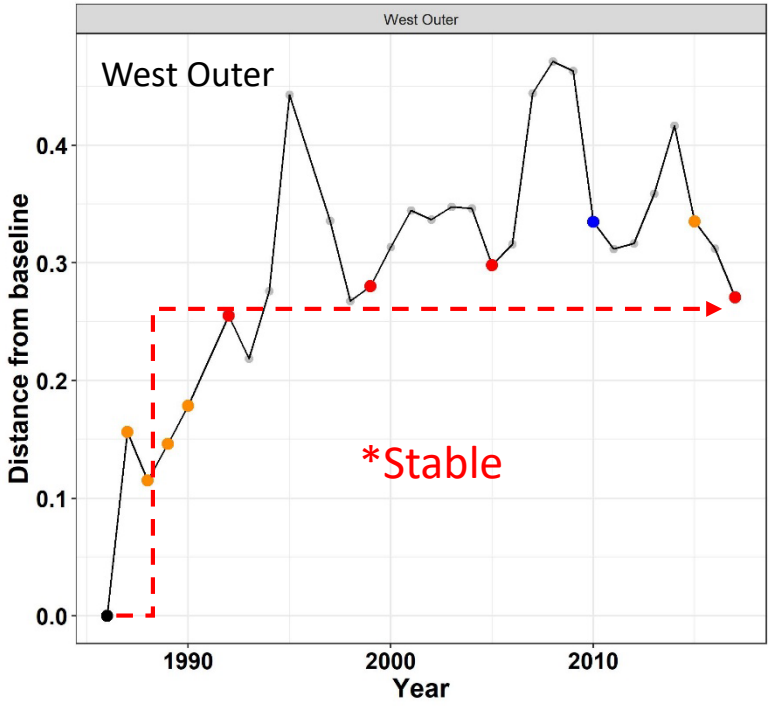

Stability (residence)
Abrupt nonlinear (dispersal)
Reversible (migration)
Gradual linear (nomadism)
Displacement or dissimilarity
Time

Results:
displacement from initial conditions









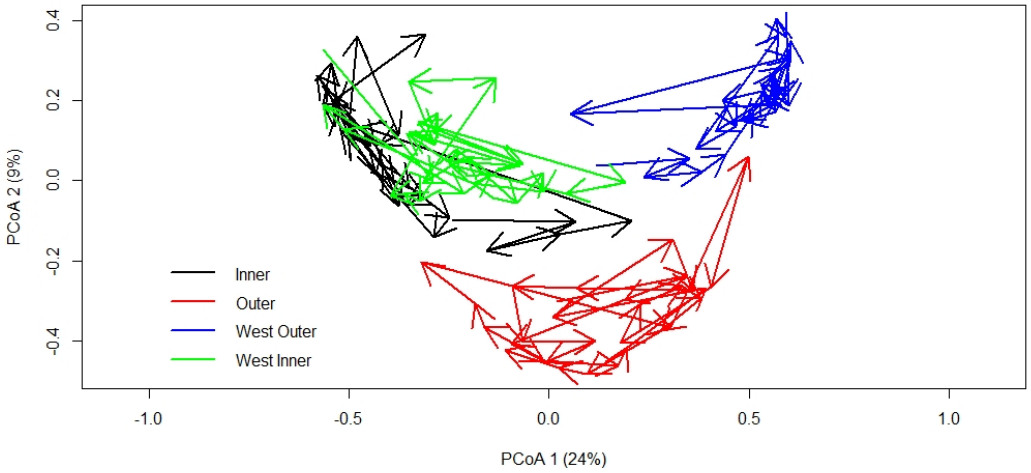
Event
- Baseline
- Seagrass Dieoff
- Hurricane
- Cold Spell

Results

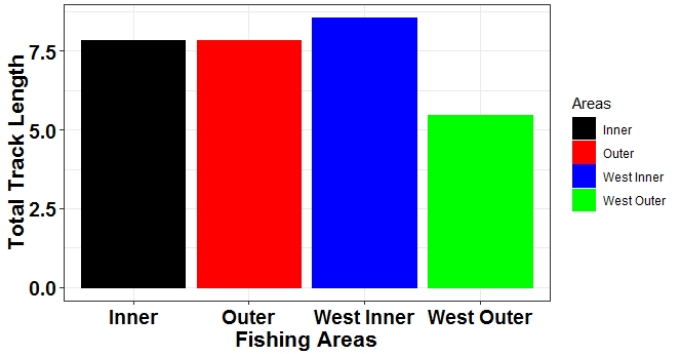
Geometric analysis

Similar catch structure temporal dynamics

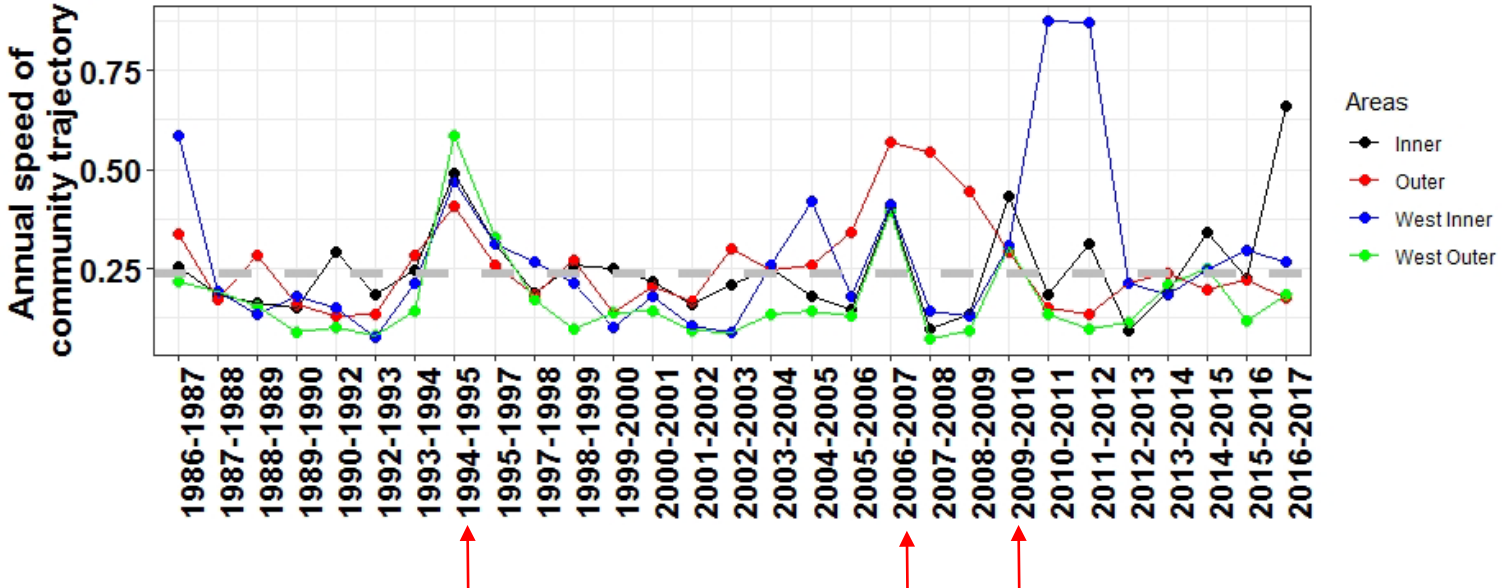
Catch structure more similar than others



The least of abrupt changes in West Outer



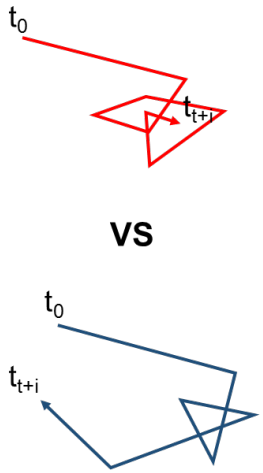
However, magnitude of change similar across periods

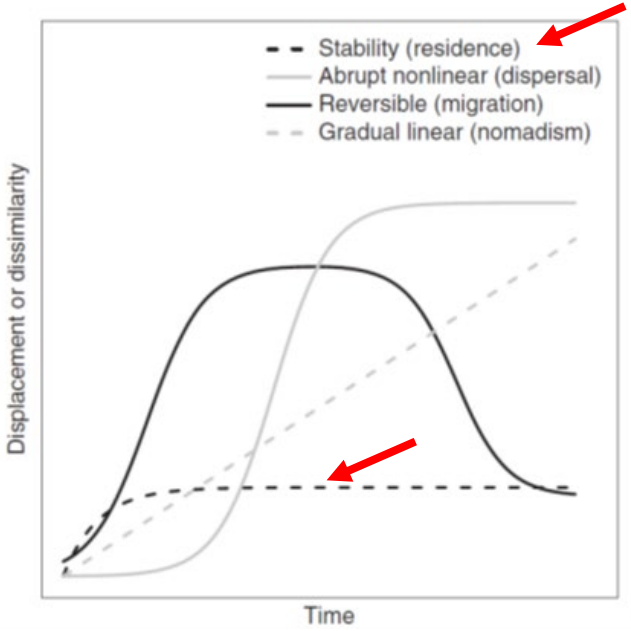


Resilience of Recreational Fisheries to ECE

Summary

- Q1: How are the catch structure trajectories from baseline conditions?
  - **Stable?**
- Catch vs Effort
- Anglers vs Guides
- Effects of data transformation and distance matrix

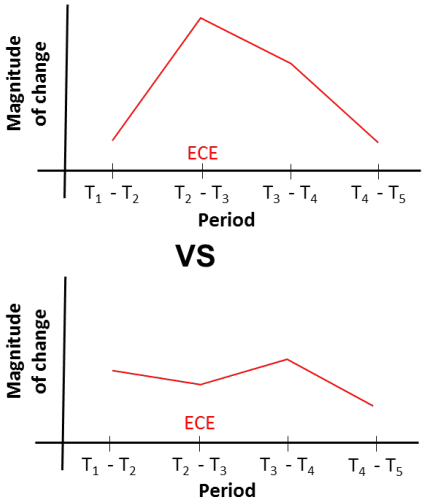


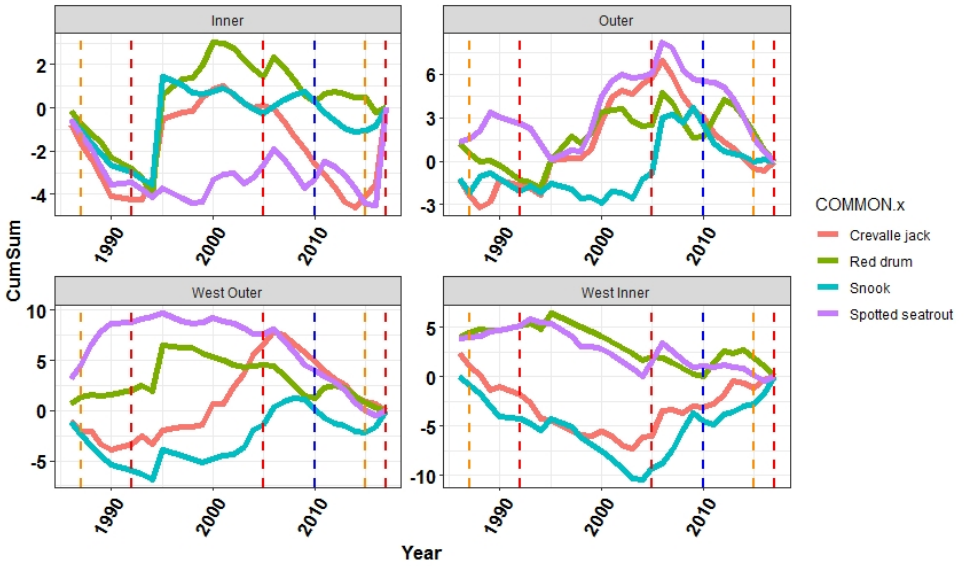


Resilience of Recreational Fisheries to ECE

Summary

- Q2: How is the temporal (inter-year) dynamic of catch structure change?
  - Overall, consistent magnitude of change across periods
  - Spatially explicit, limited responses to ECEs?
    - legacy/confounded effects
- Importance of species specific responses
  - Breakpoint analysis
  - Event coincidence analysis





Thank You!

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NOAA Fisheries