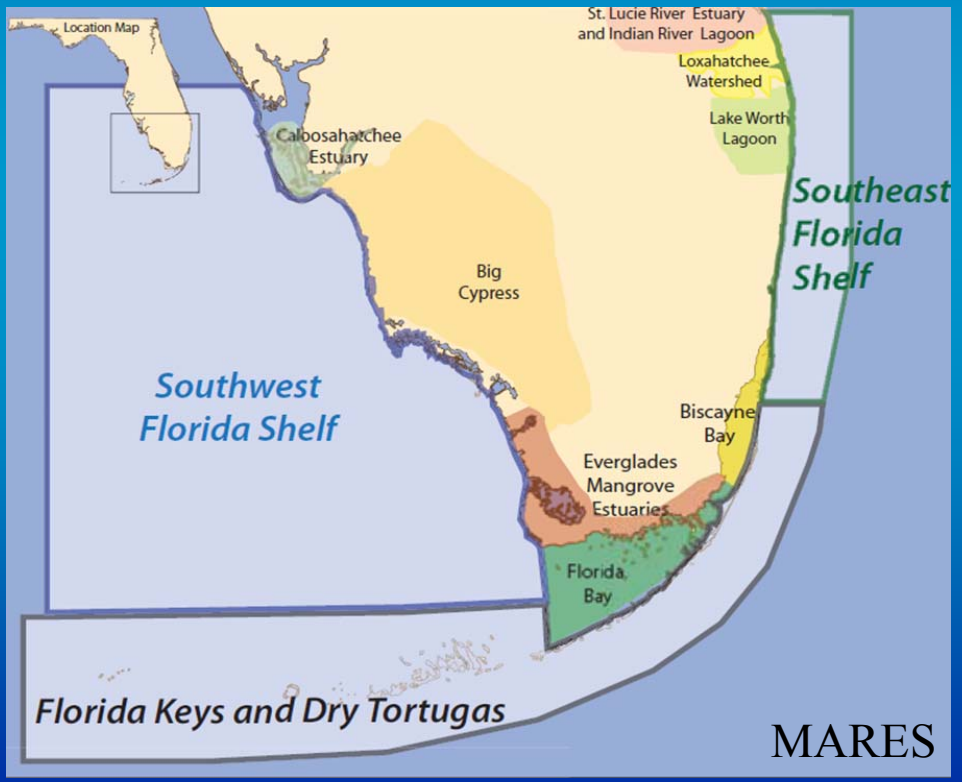
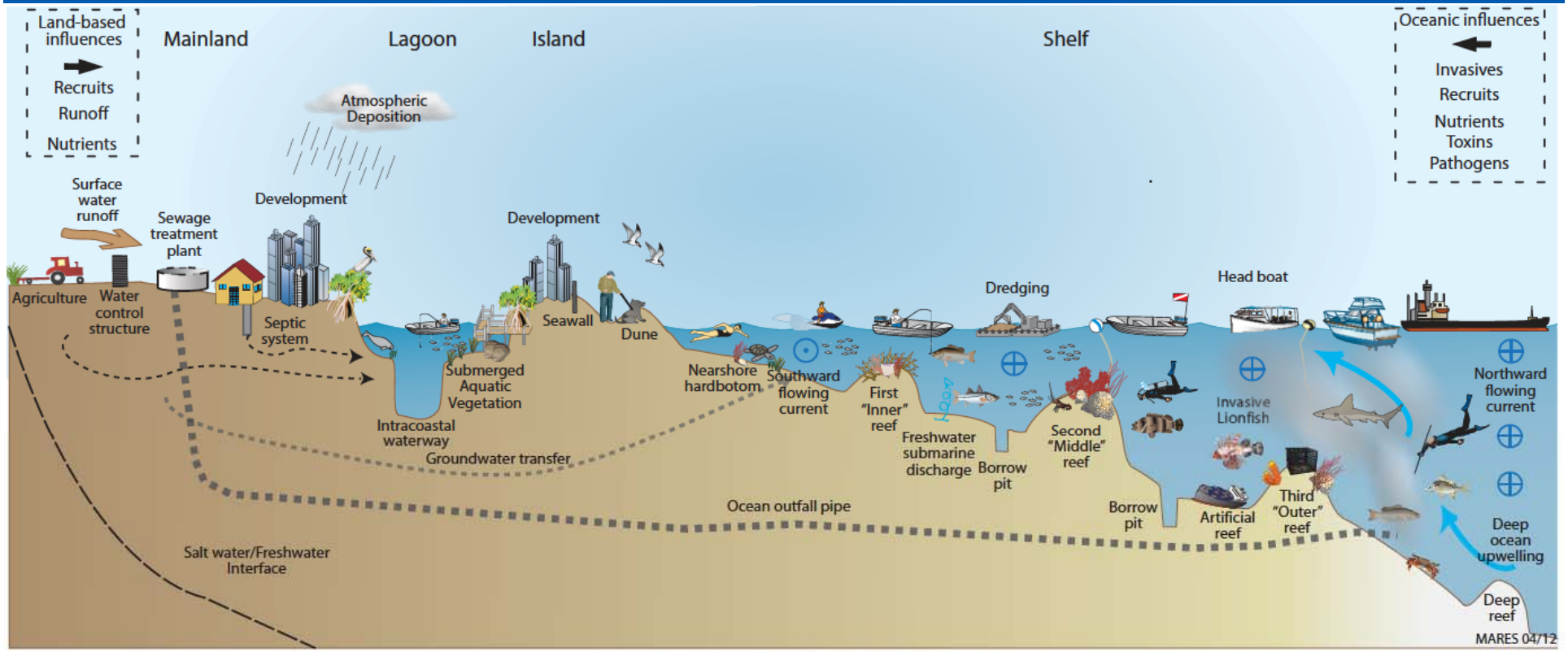
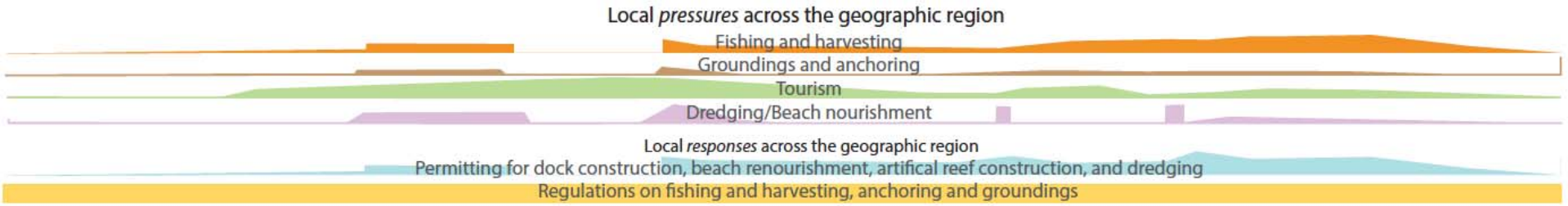
Ecosystem Service Sustainability in Coastal South Florida

How do you quantify and compare the relative impact of near- and far-field pressures on ecosystem services?



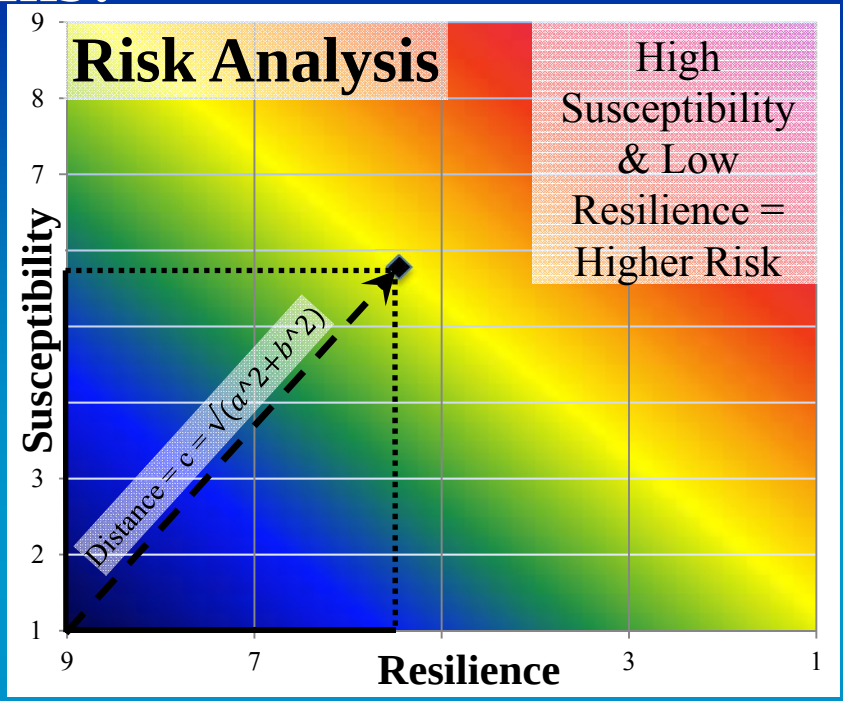
Identifying Threats in a Complex Coastal Ecosystem

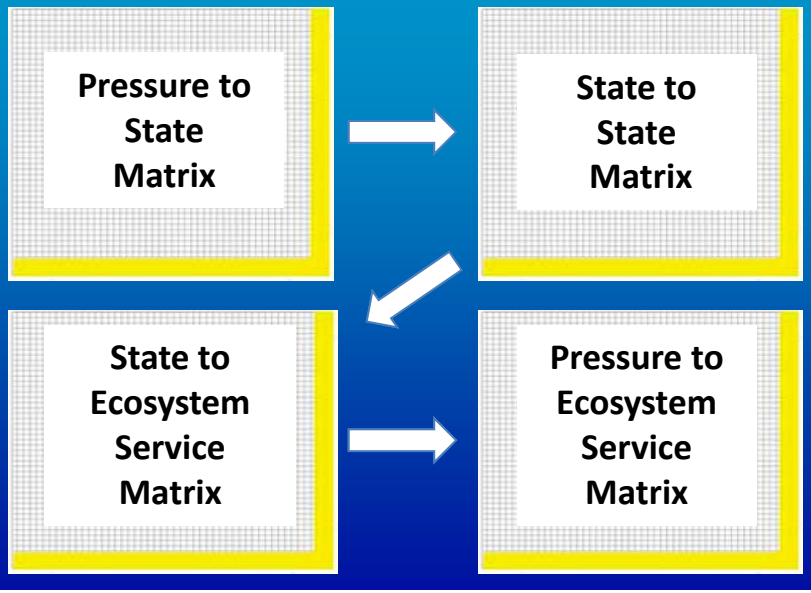




How do you quantify and compare risk in complex ecosystems?

- **Risk Analysis**
  - Individual ecosystem states
  - Susceptibility, Resilience, and Uncertainty
- **Complete Risk Assessment**
  - All ecosystem components
  - EBM-DPSER (Kelble et al 2013)
  - Matrix-based analyses (Cook et al 2014)
- **Modified Delphi**
  - Experts score relative risk and ecosystem linkages



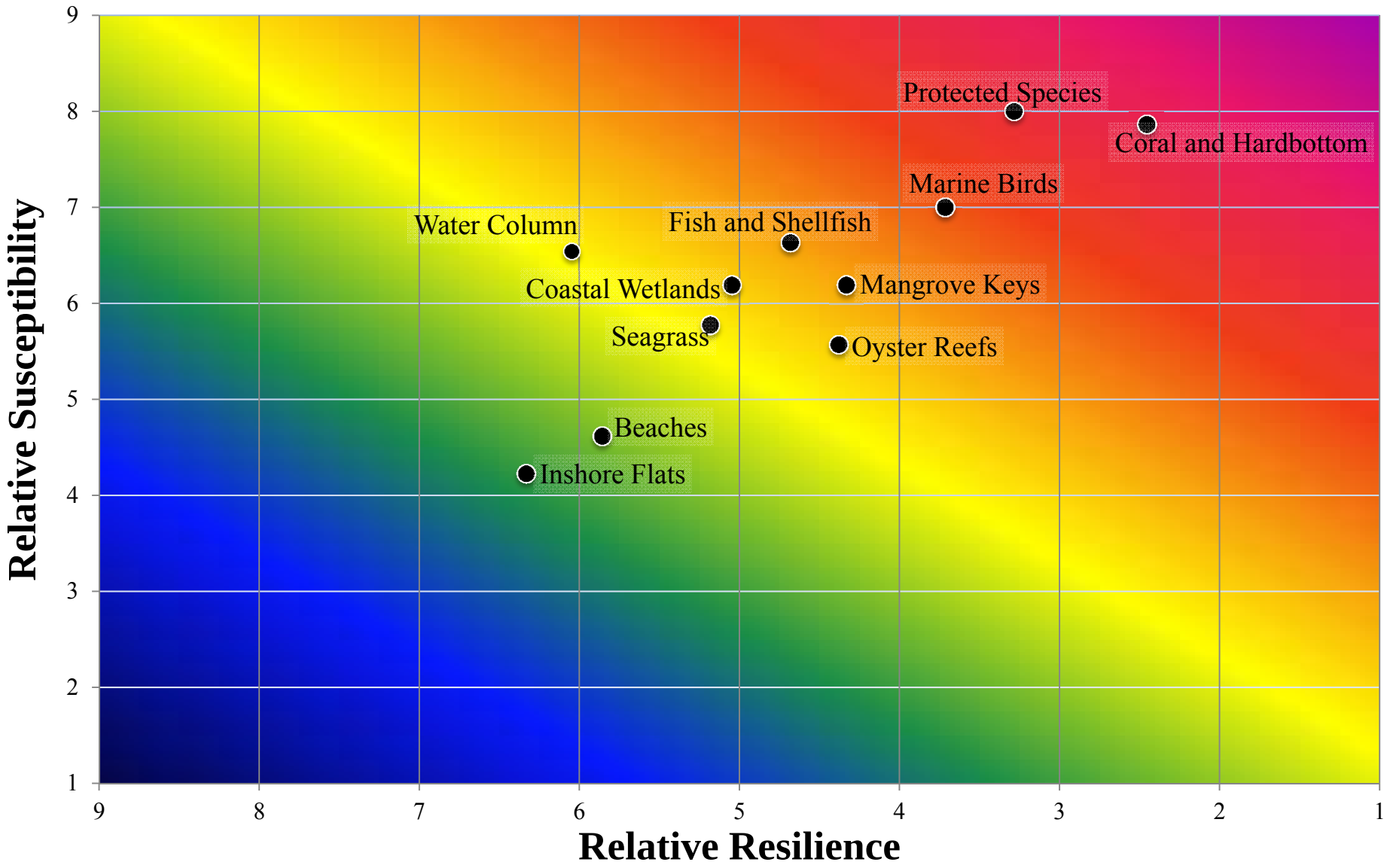


MARES Pressures and States

Ecosystem Pressures
Accelerated Sea Level Rise
Boating Activities
Climate Change (Temperature)
Climate Change (Weather)
Commercial Fishing
Disease
Freshwater Delivery
Invasive Species
Marine Construction
Marine Debris/Ghost Traps
Ocean Acidification
Recreational Fishing

Ecosystem States
Beaches
Coastal Wetlands
Coral and Hardbottom
Fish and Shellfish
Inshore Flats
Mangrove Keys
Marine Birds
Oyster Reefs
Protected Species
Seagrass
Water Column

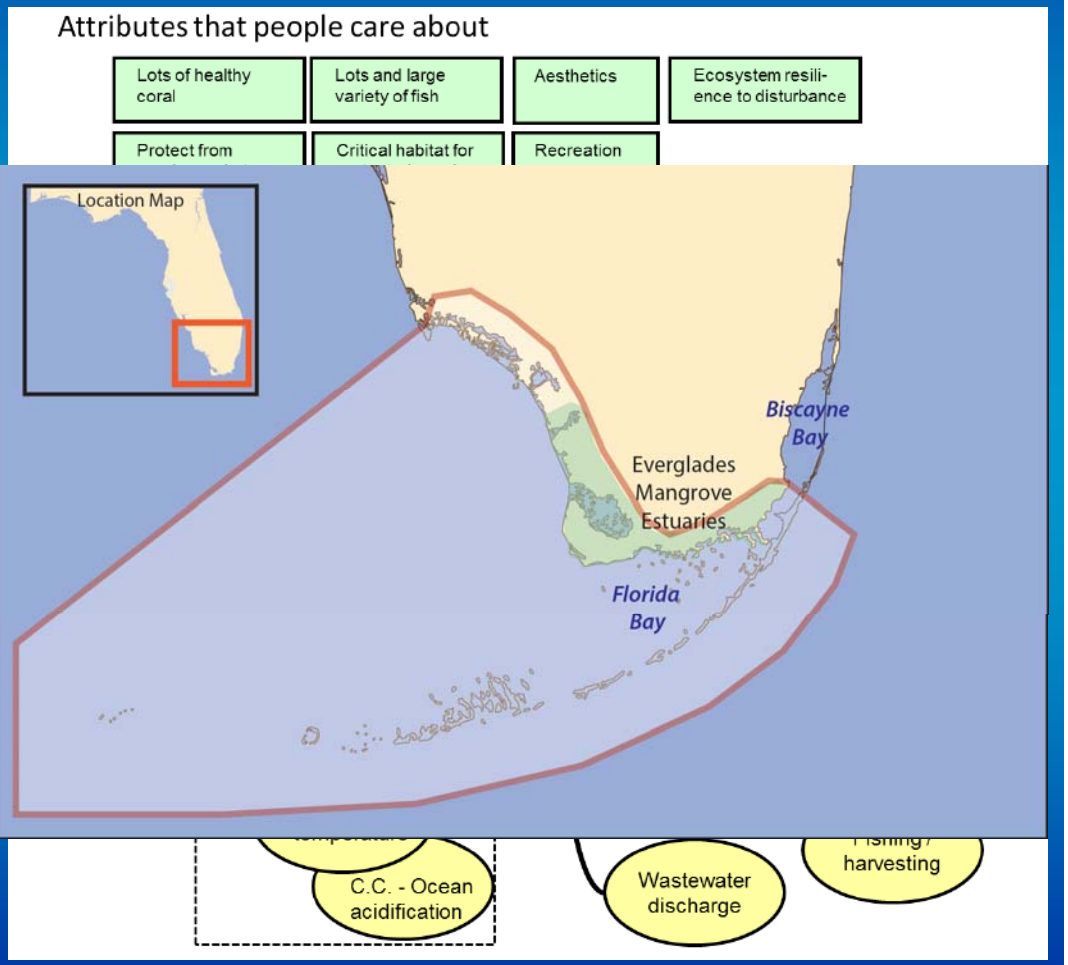
Risk Analysis – How do Ecosystem States compare?



Ecosystem Services Complete Risk Assessment

MARES Ecosystem States

- Beaches
- Coastal Wetlands
- Coral and Hardbottom
- Fish and Shellfish
- Inshore Flats
- Mangrove Keys
- Marine Birds
- Oyster Reefs
- Protected Species
- Seagrass
- Water Column



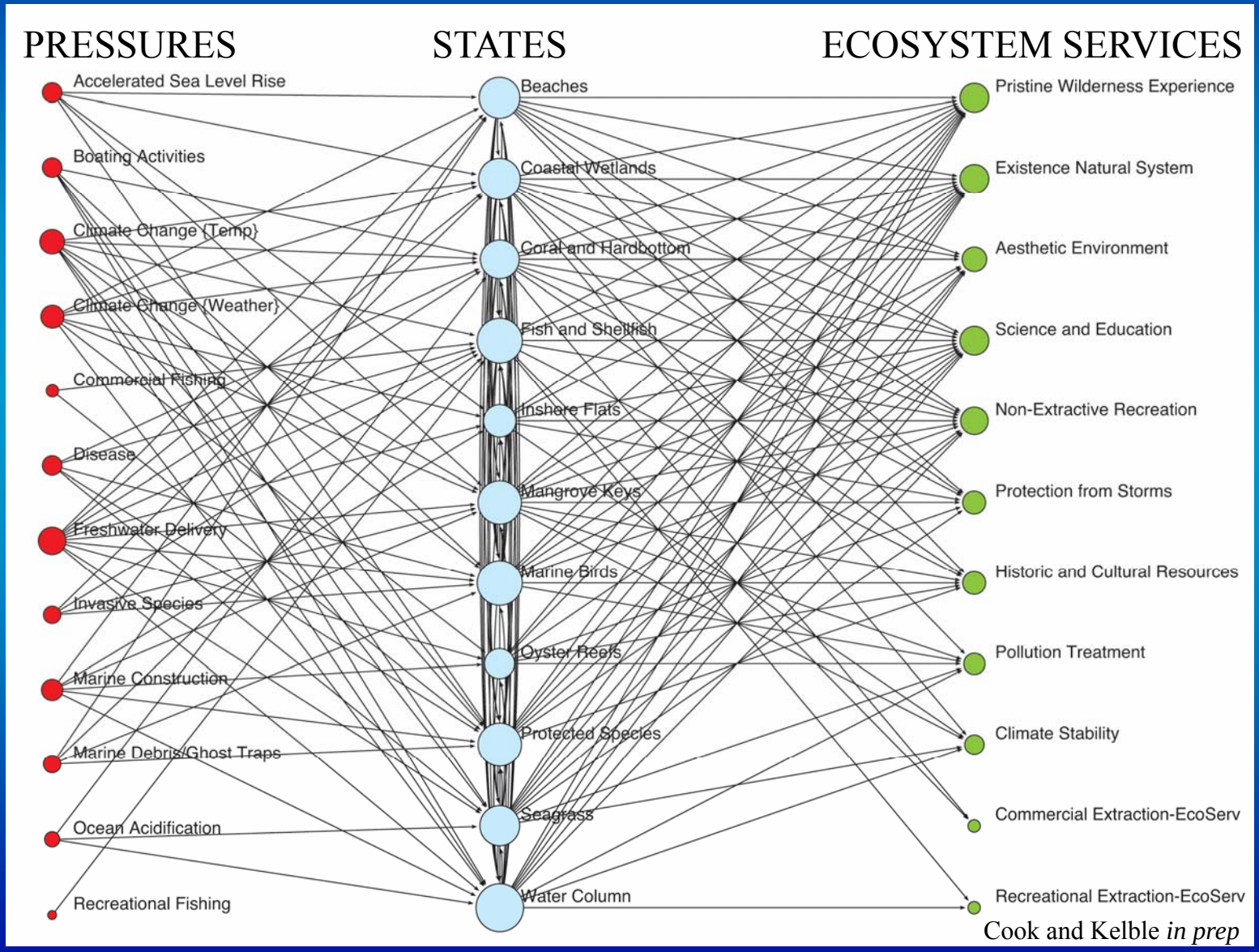
Coral and Hardbottom
Integrated Conceptual Ecosystem Model

Pressures and Ecosystem Services in Coastal South Florida

Pressures
Accelerated Sea Level Rise
Boating Activities
Climate Change (Temperature)
Climate Change (Weather)
Commercial Fishing
Disease
Freshwater Delivery
Invasive Species
Marine Construction
Marine Debris/Ghost Traps
Ocean Acidification
Recreational Fishing

Ecosystem Services
Aesthetic Environment
Climate Stability
Commercial Extraction
Existence Natural System
Historic and Cultural Resources
Non-Extractive Recreation
Pollution Treatment
Pristine Wilderness Experience
Protection from Storms
Recreational Extraction
Science and Education

Pressure – State – Ecosystem Service Network Model for Coastal South Florida



Cook and Kelble *in prep*

How do the Risk Analysis and Complete Risk Assessment Compare?

Risk Analysis

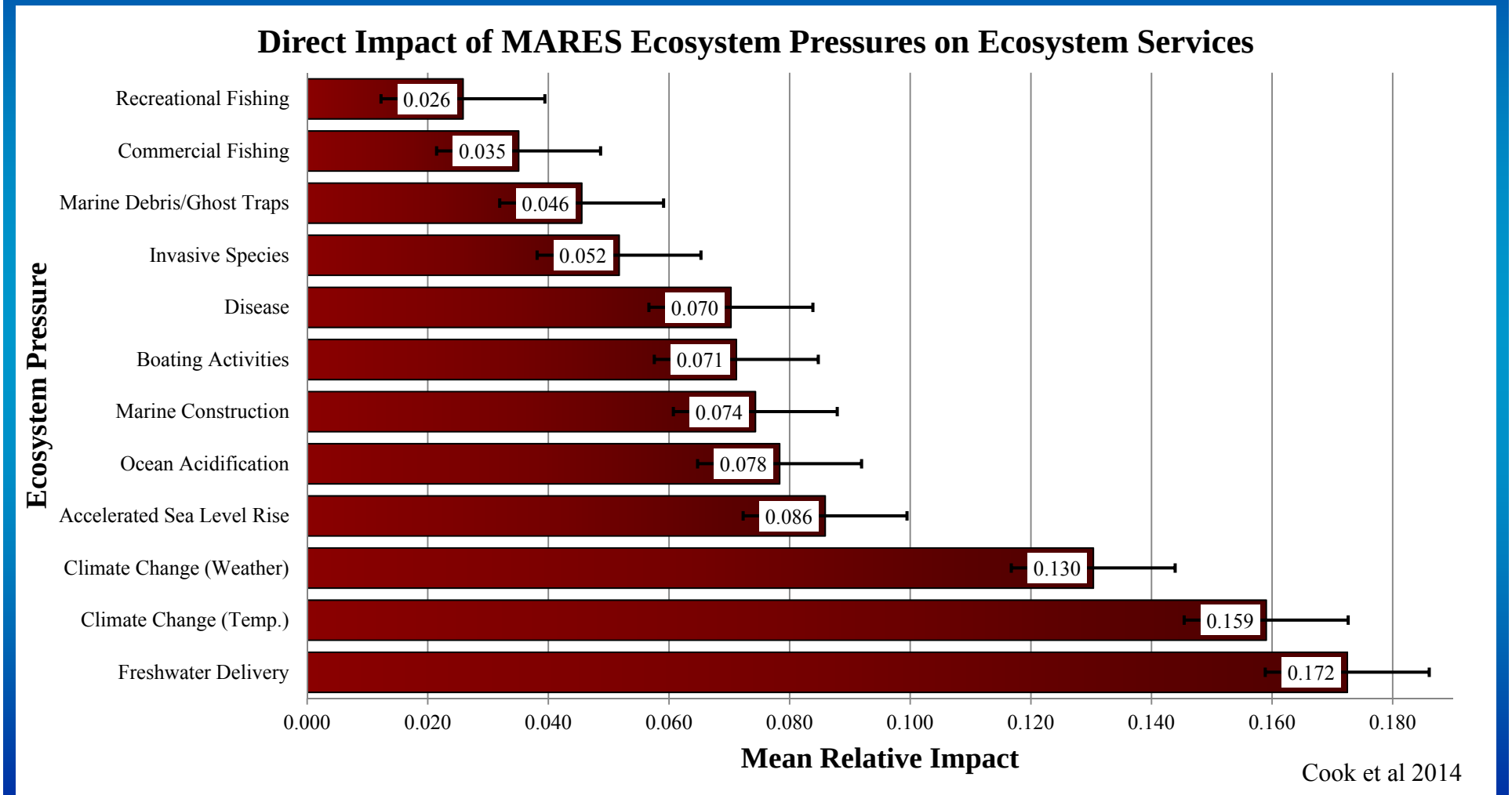
State	Relative Risk
	Higher Risk
	Intermediate Risk
	Lower Risk

Complete Risk Assessment

State	Relative Risk	Primary Pressure
		Climate Change (Temp)
		Commercial Fishing
		Ocean Acidification
		Accel. Sea Level Rise
		Climate Change (Weather)
		Ocean Acidification
		Accel. Sea Level Rise
		Freshwater Delivery
		Climate Change (Temp)
		Accel. Sea Level Rise
		Freshwater Delivery

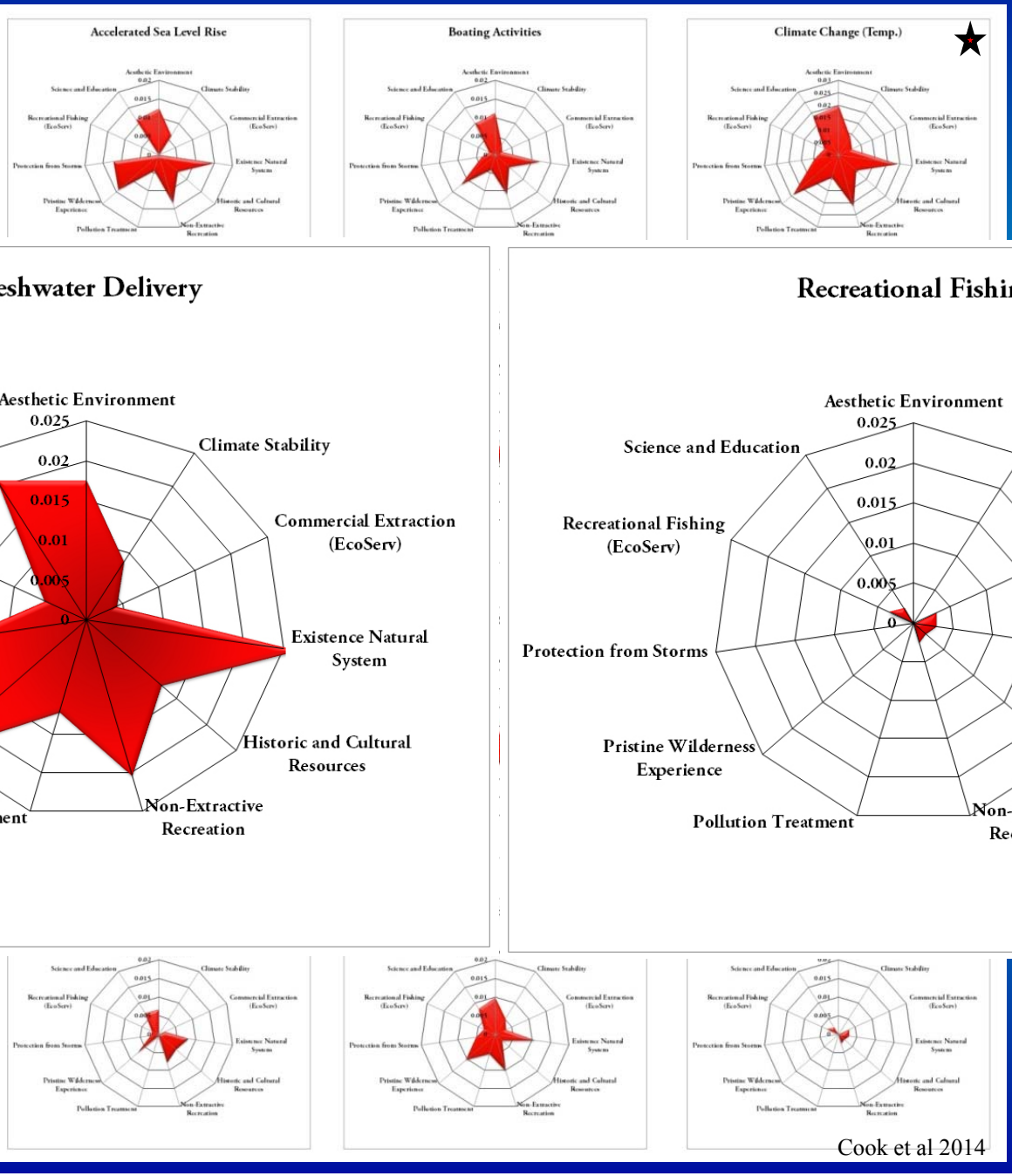
Cook et al 2014; Cook, Fletcher & Kelble *in prep*

Relative Impacts to Ecosystem Services



Cook et al 2014

How do individual Pressures impact Ecosystem Services?

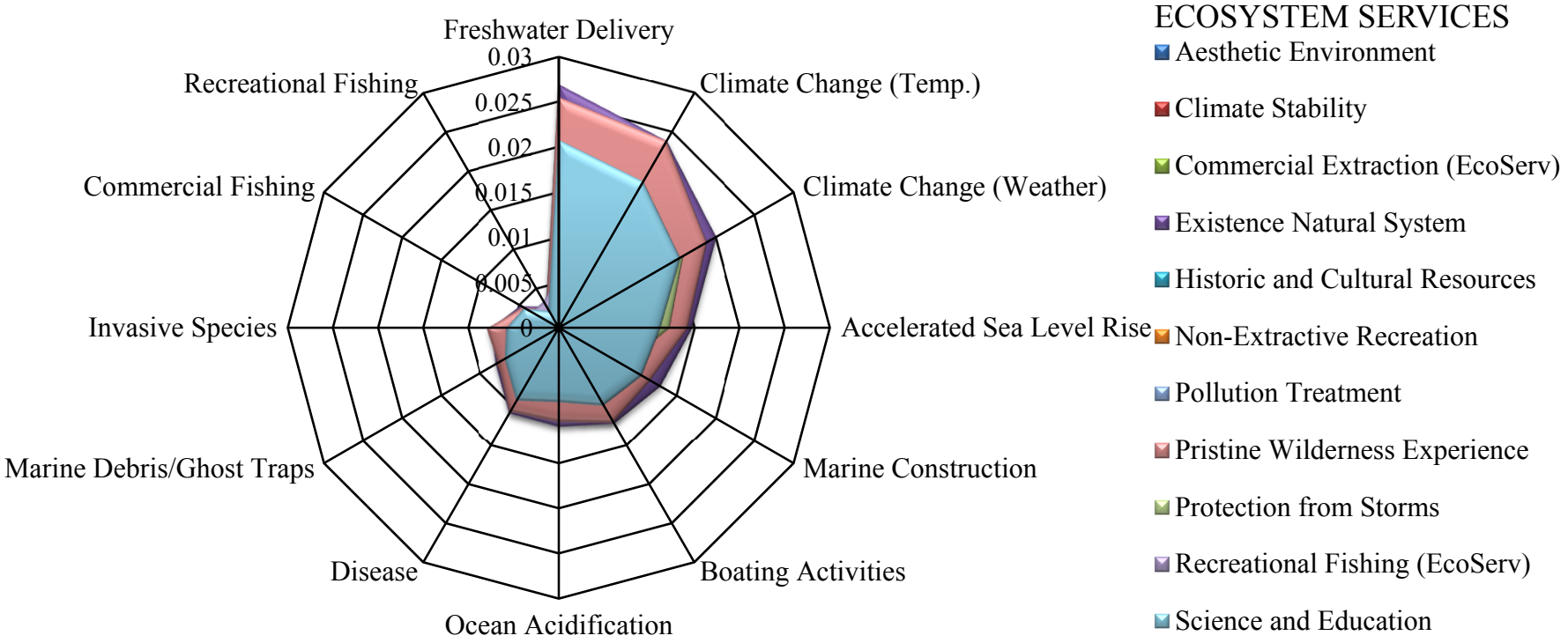


Cook et al 2014

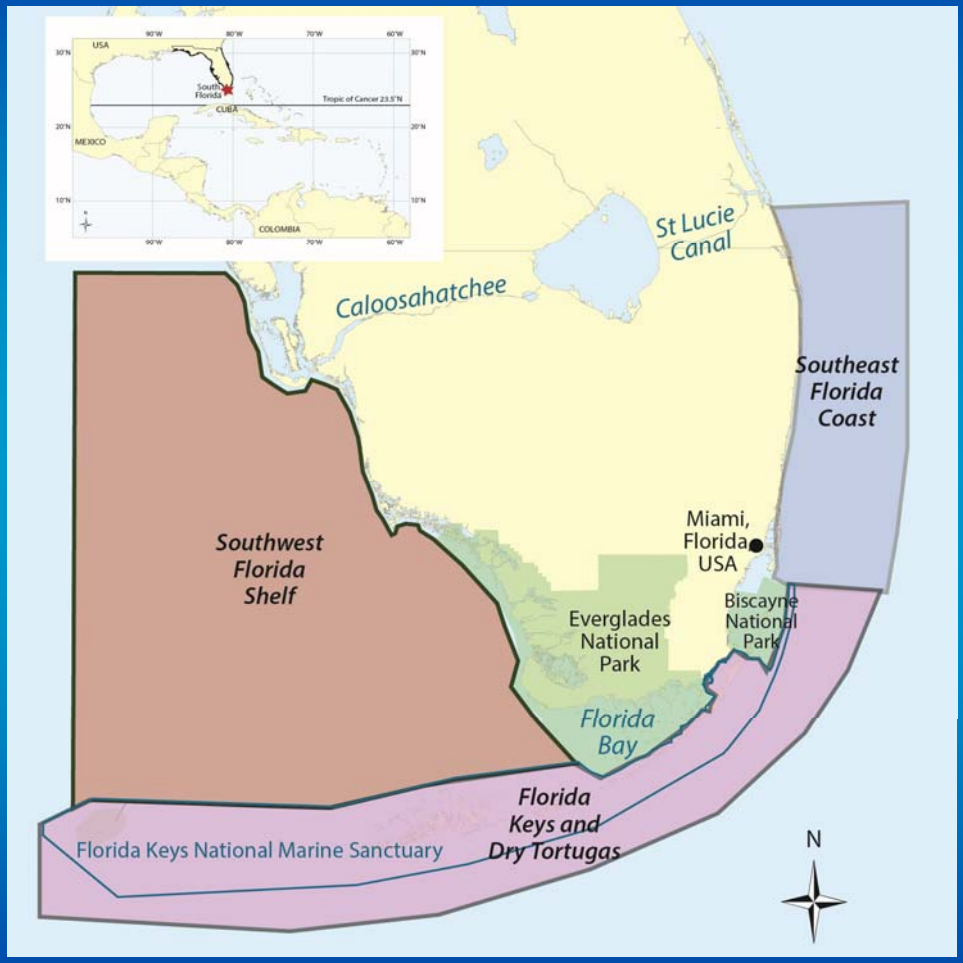
How can these results inform Management ?

- **From Complete Risk Assessment**
  - **ID greatest pressures, sources of risk to ecosystem, and trade-offs**
  - **Strategies influencing more pervasive pressures have ecosystem-wide effects**
  - **Targeting smaller pressures has more precise relatively limited effects**

Relative Impact of Ecosystem Pressures on Ecosystem Services



How do Multiple Interacting Pressures Impact Ecosystem Service Resilience in Coastal South Florida?



NOAA Climate Program Office – Coastal and Ocean Climate Applications

Award # - NA14OAR4310193

Co-PIs: Chris Kelble, Pamela Fletcher, Peter Ortner, Dave Rudnick, Cristina Carollo, David Yoskowitz

What is the Combined Effect of Climate and Urbanization on the Resilience of Coastal South Florida Ecosystem Services?

Drivers/Pressures

Climate

1. Sea Level Rise
2. Climate Change (Temp)
3. Climate Change (Precip)
4. Ocean Acidification

Interact with

Human Development

1. Boating Activities
2. Commercial Fishing
3. Disease
4. Freshwater Delivery
5. Invasive Species
6. Marine Construction
7. Marine Debris/Ghost Traps
8. Recreational Fishing

Ecosystem States

1. Beaches
2. Coastal Wetlands
3. Coral and Hardbottom
4. Fish and Shellfish
5. Inshore Flats
6. Mangrove Keys
7. Marine Birds
8. Oyster Reefs
9. Protected Species
10. Seagrass
11. Water Column

Impact

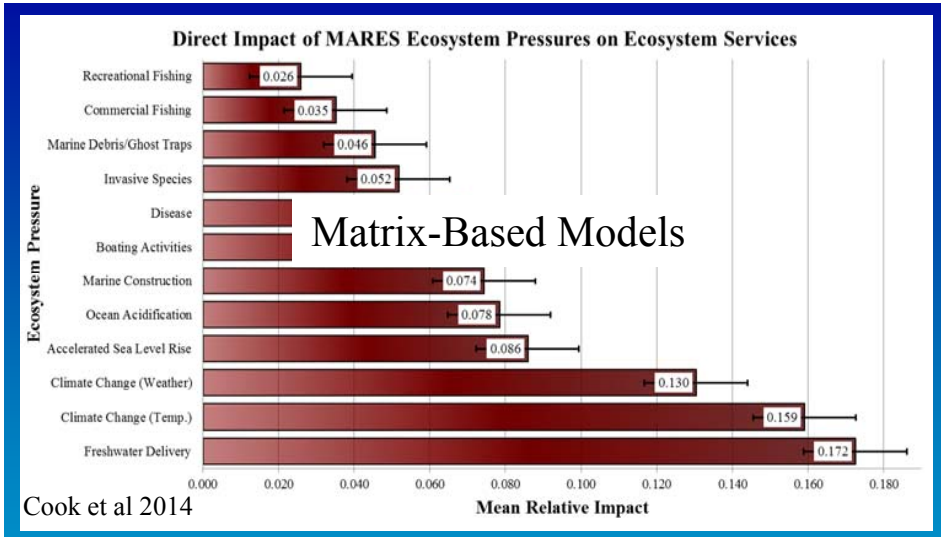
Ecosystem Services

1. Aesthetic Environment
2. Climate Stability
3. Commercial Extraction
4. Existence of Natural System
5. Historic and Cultural Resources
6. Non-Extractive Recreation
7. Pollution Treatment
8. Pristine Wilderness Experience
9. Protection from Storms
10. Recreational Fishing
11. Science and Education

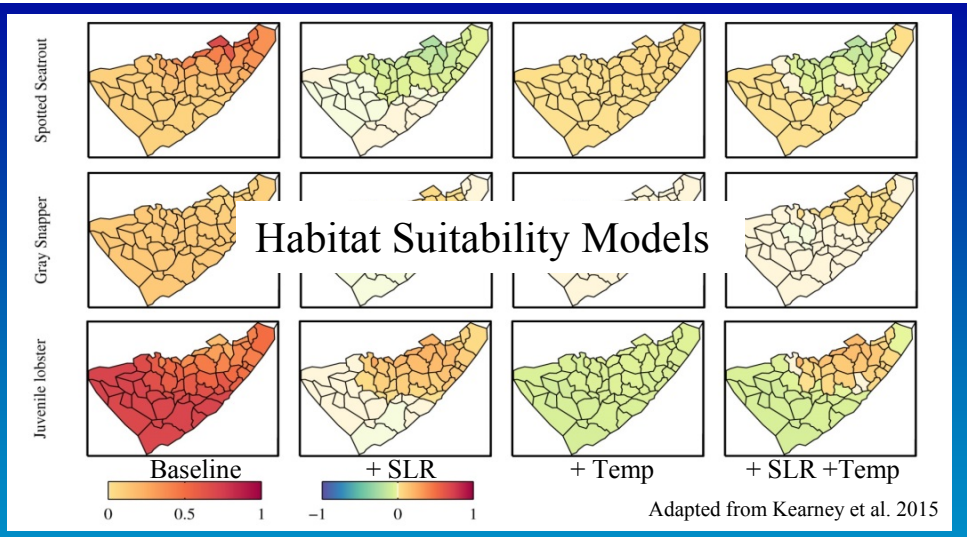
For each Urbanization zone explore Climate Forecasts

How are areal cover, abundance, and quality of Ecosystem States impacted?

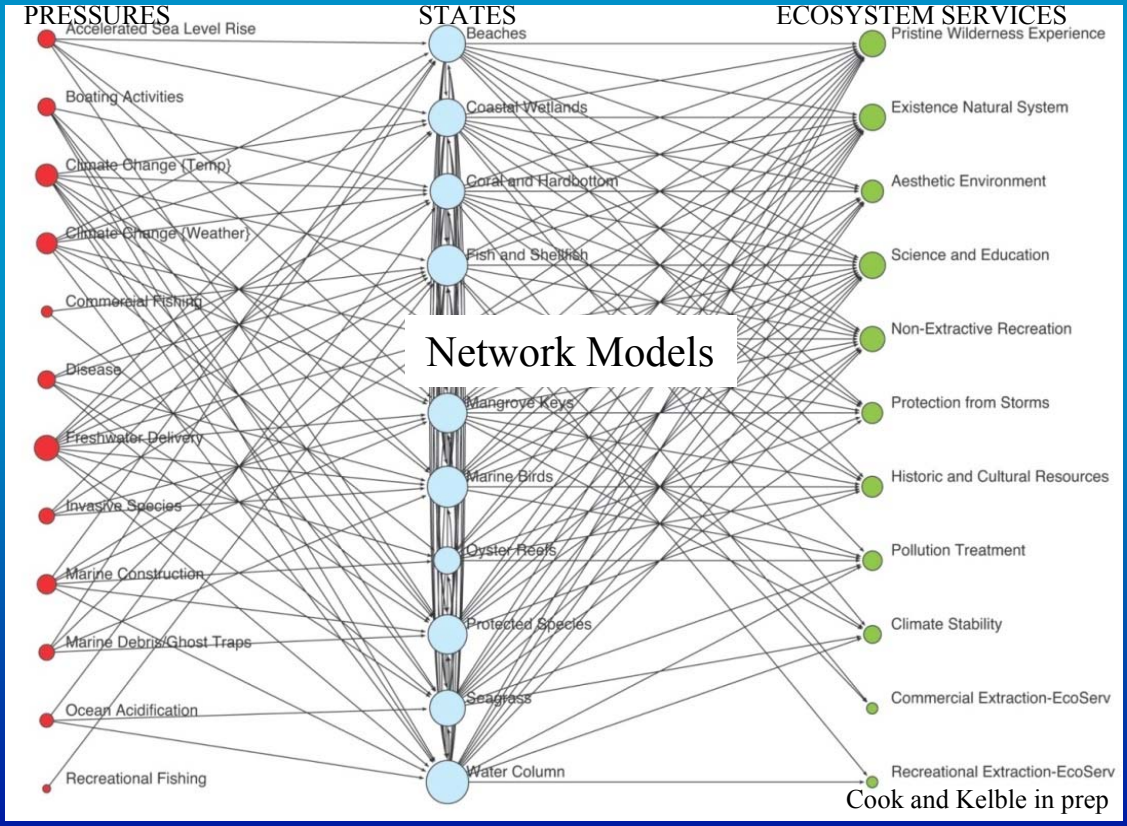
As Ecosystem States change, how are Ecosystem Services impacted?



Cook et al 2014



Adapted from Kearney et al. 2015



Cook and Kelble in prep

Conclusions

- **Understanding threats to ecosystem services within an integrated ecosystem assessment framework will better our ability to manage risks, highlight trade-offs, and move coastal marine ecosystems and communities toward sustainability**