

RESEARCH ARTICLE

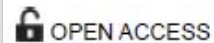
Development and analyses of stakeholder driven conceptual models to support the implementation of ecosystem-based fisheries management in the U.S. Caribbean

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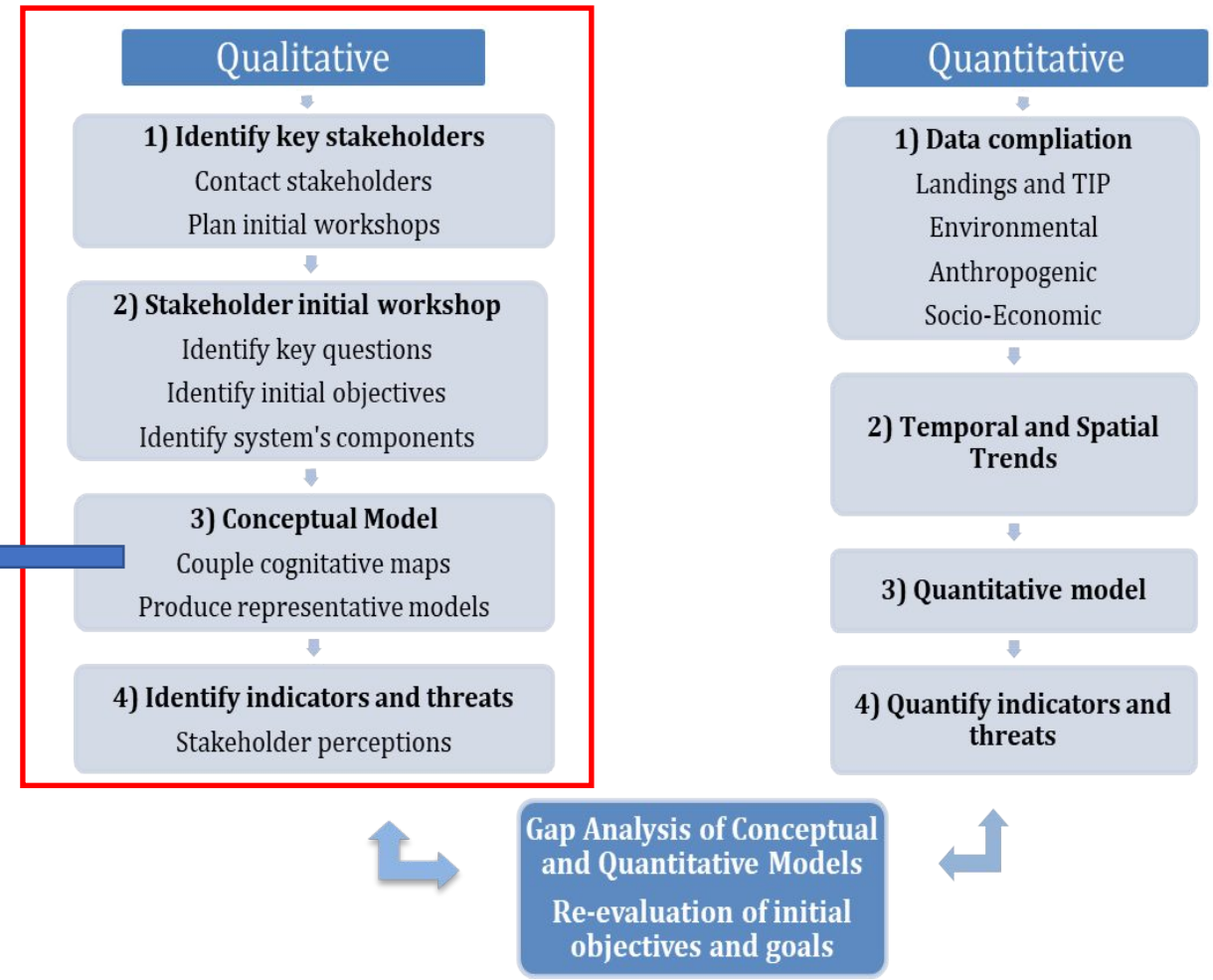
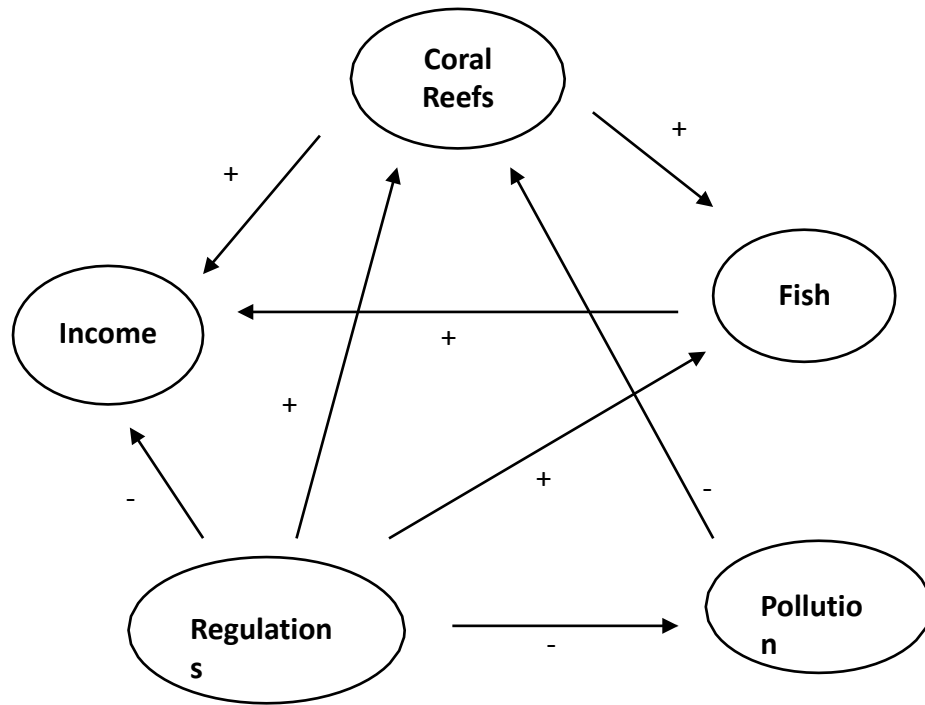


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<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0304101>

Methods

Simplified Conceptual Model
(Fuzzy Cognitive Maps) Scheme:



Data Collection

Development of Stakeholder Driven Conceptual Models

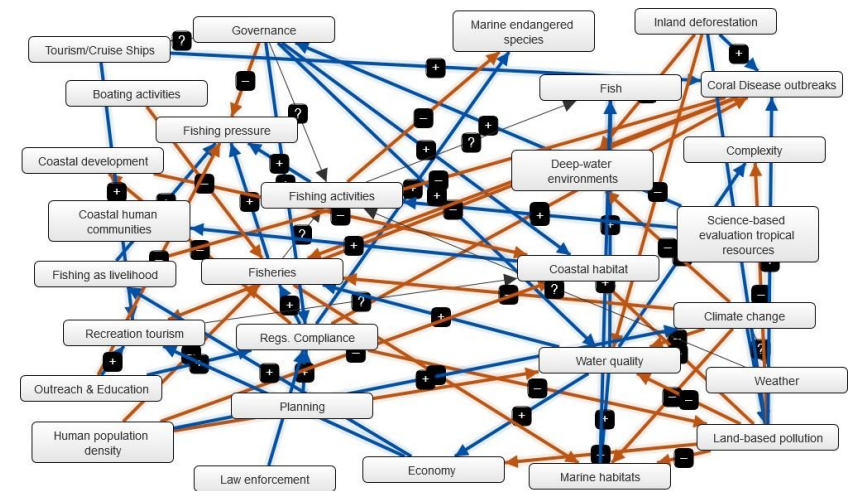
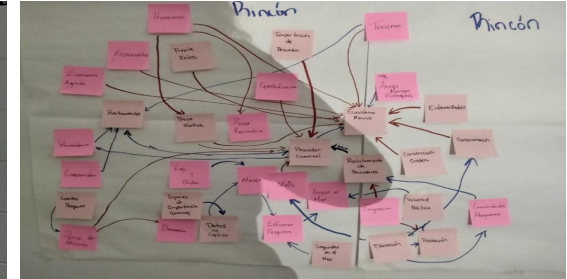
Stakeholder Group	# of Models	# of Participants	Island Grouping (# of Workshops)	Group Leading Workshops	Method	Year
Commercial Fishers	12	117	PR (10); STT (1); STX (1)	Cruz-Motta et al.	In person	21/22
Managers	3	9	PR (2); USVI (1)	Cruz-Motta et al.	Virtual	21
Academics	4	24	PR (3); USVI (1)	Cruz-Motta et al.	Virtual	21
Businesses	3	17	PR (1); STT (1); STX (1)	Mellivora Consulting	Virtual	21
NGOs	3	20	PR (1); STT (1); STX (1)	Mellivora Consulting	Virtual	21
DAPs	3	38	PR (1); STT (1); STX (1)	CFMC	In person	18
SSC	1	11	U.S. Caribbean	CFMC	In person/Virtual	18/19
Total	29	236	-	-	-	-



Fisher workshop in Puerto Rico

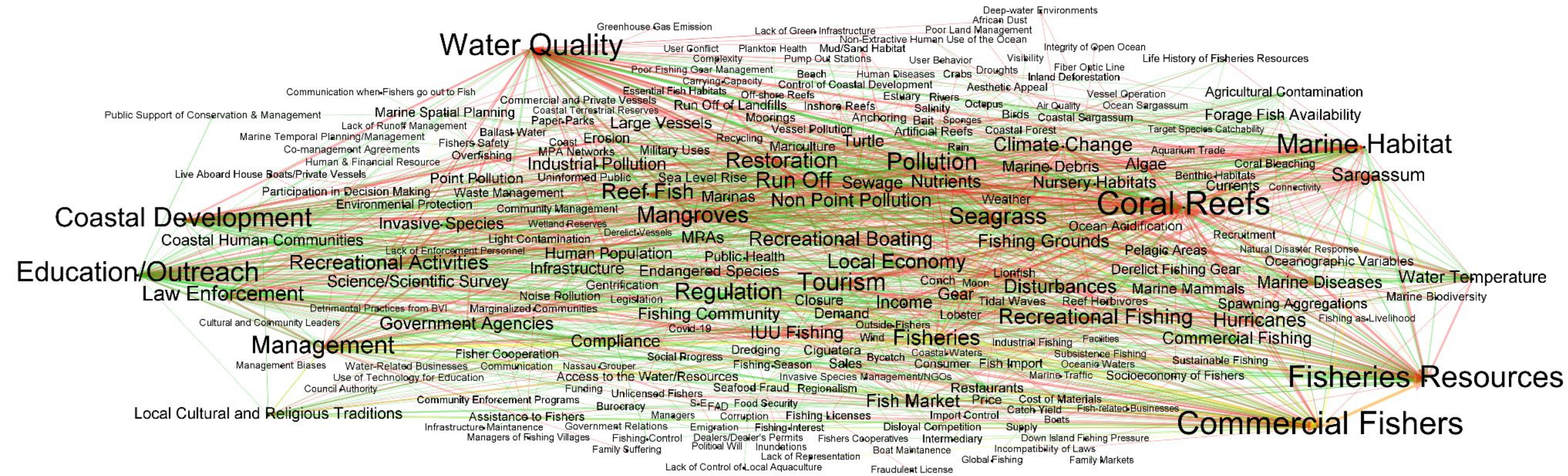


Fisher workshop in St. Croix USVI



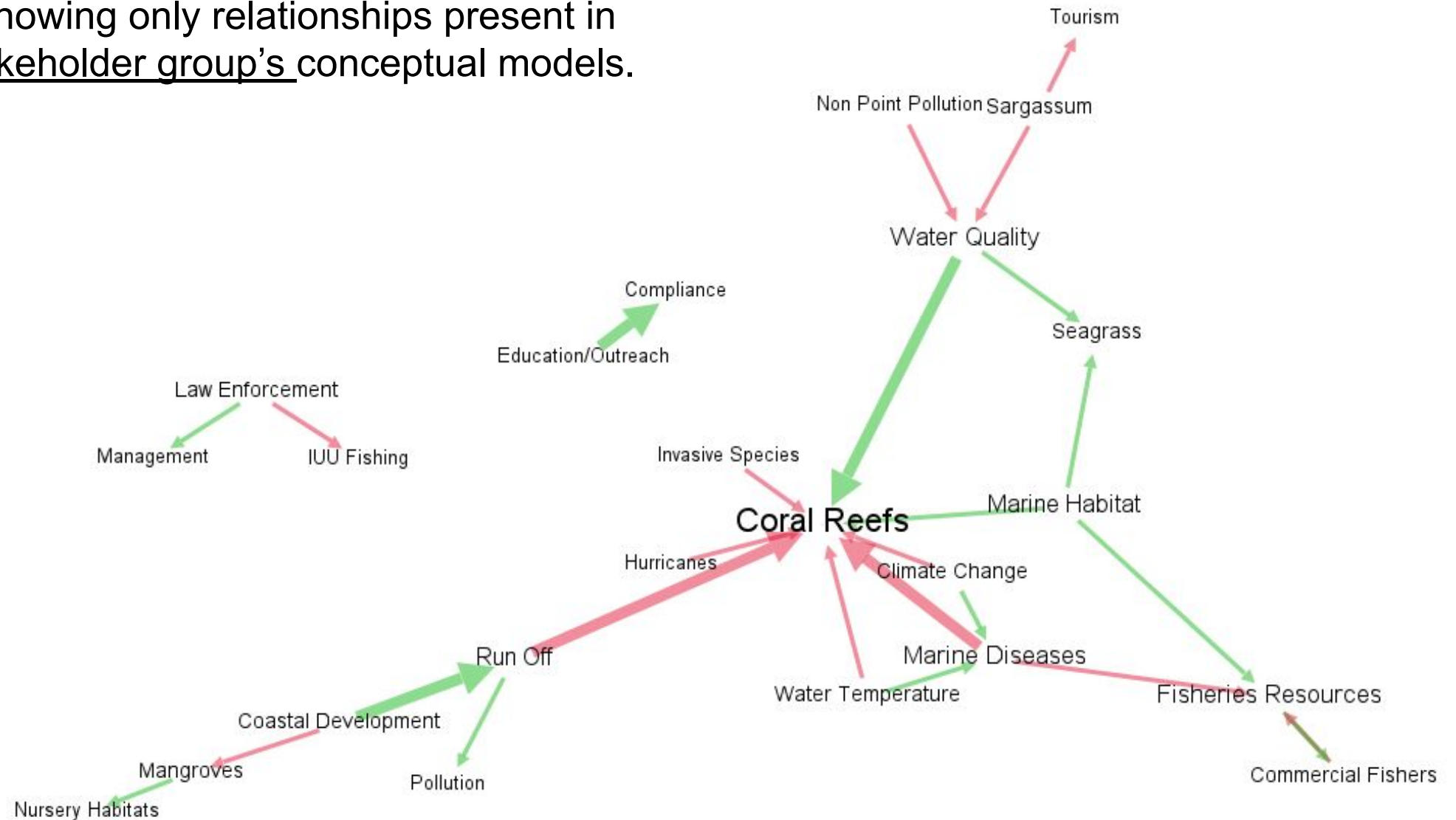
Conceptual Model built during virtual workshop

Development of consensus model



Relationship	Sign	MAN	EXP	DAPs	BUS	NGO	FISH	SSC	# of Groups
Run Off-Coral Reefs	-	1	1	0	1	1	1	0	5
Marine Diseases-Coral Reefs	-	0	1	1	1	1	1	0	5
Water Quality-Coral Reefs	+	0	1	1	1	1	0	1	5
Coastal Development-Run Off	+	0	1	0	1	1	1	1	5
Education/Outreach-Compliance	+	1	1	1	0	1	0	1	5
Invasive Species-Coral Reefs	-	0	1	1	0	1	1	0	4
Water Temperature-Coral Reefs	-	0	1	1	1	0	1	0	4
Non-Point Pollution-Water Quality	-	1	1	1	0	1	0	0	4
Coastal Development-Mangroves	-	0	1	0	1	1	1	0	4
Sargassum-Tourism	-	1	1	1	0	0	1	0	4
Commercial Fishers-Fisheries Resources	-	1	1	1	0	0	1	0	4
Sargassum-Water Quality	-	1	0	1	1	1	0	0	4
Marine Diseases-Fisheries Resources	-	1	1	1	0	0	1	0	4
Climate Change-Coral Reefs	-	0	1	0	1	1	1	0	4
Hurricanes-Coral Reefs	-	0	1	1	0	1	1	0	4
Law Enforcement-IUU Fishing	-	0	0	1	1	1	1	0	4
Water Temperature-Marine Diseases	+	0	1	1	0	0	1	1	4
Water Quality-Seagrass	+	0	1	0	1	1	0	1	4
Marine Habitat-Coral Reefs	+	1	1	1	0	0	0	1	4
Marine Habitat-Seagrass	+	1	1	1	0	0	0	1	4
Run Off-Pollution	+	0	1	1	1	0	0	1	4
Marine Habitat-Fisheries Resources	+	1	1	1	0	0	1	0	4
Fisheries Resources-Commercial Fishers	+	1	1	1	0	0	1	0	4
Climate Change-Marine Diseases	+	1	0	1	1	1	0	0	4
Law Enforcement-Management	+	0	1	1	0	1	1	0	4
Mangroves-Nursery Habitats	+	0	1	1	1	1	0	0	4

Sub-model showing only relationships present in at least 4 stakeholder group's conceptual models.



Stakeholder Group Similarity

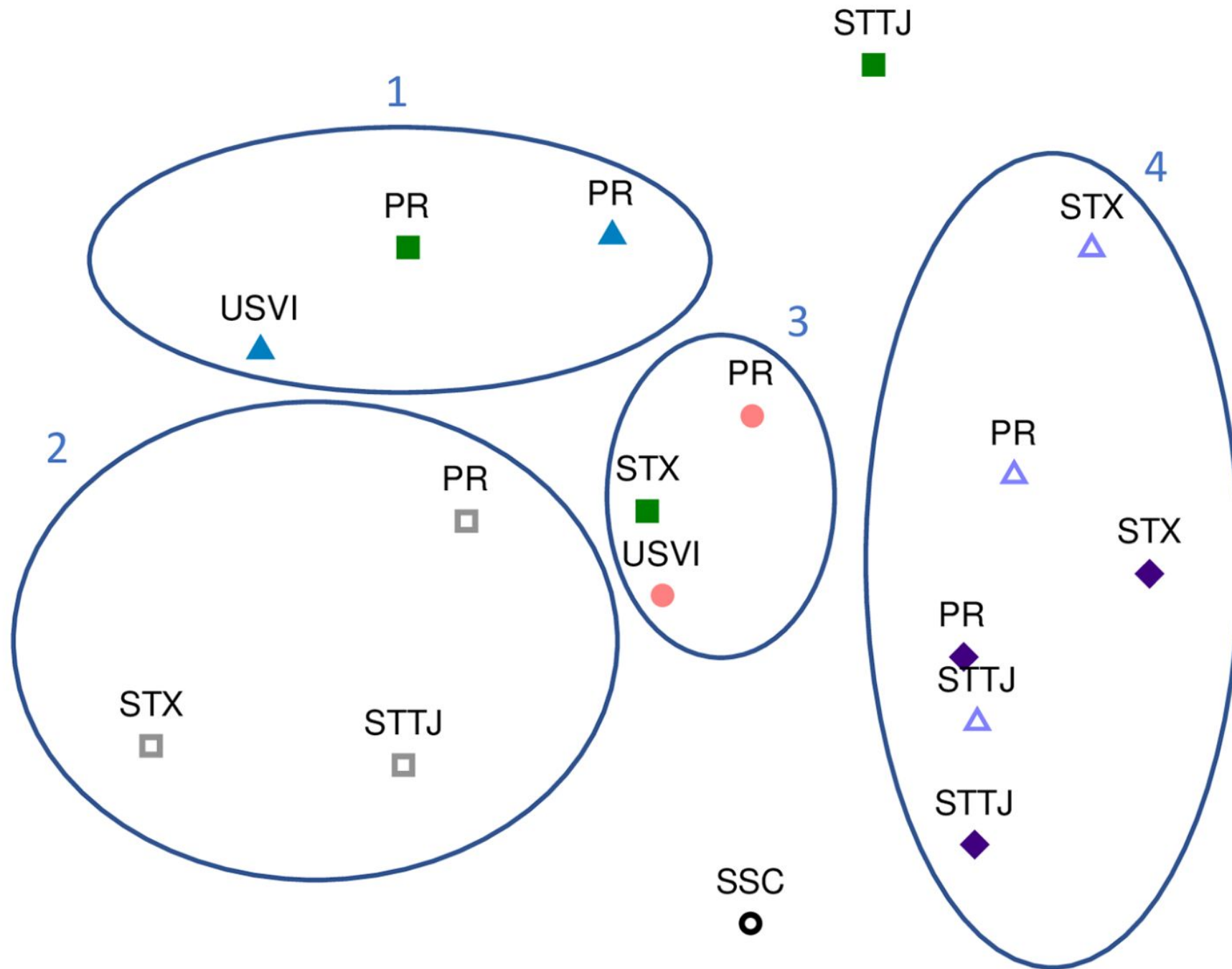
A presence/absence matrix containing all relationships between components and attributed to each stakeholder group by island/island group was used to analyze similarity between groups using multivariate ordinations.

- By stakeholder model unique approach allowed for the identification of common concerns among stakeholders regarding important ecosystem components and threats.

2D Stress: 0.2

Stakeholder

- ▲ MAN
- EXP
- DAP
- ◆ BUS
- △ NGO
- FISH
- SSC



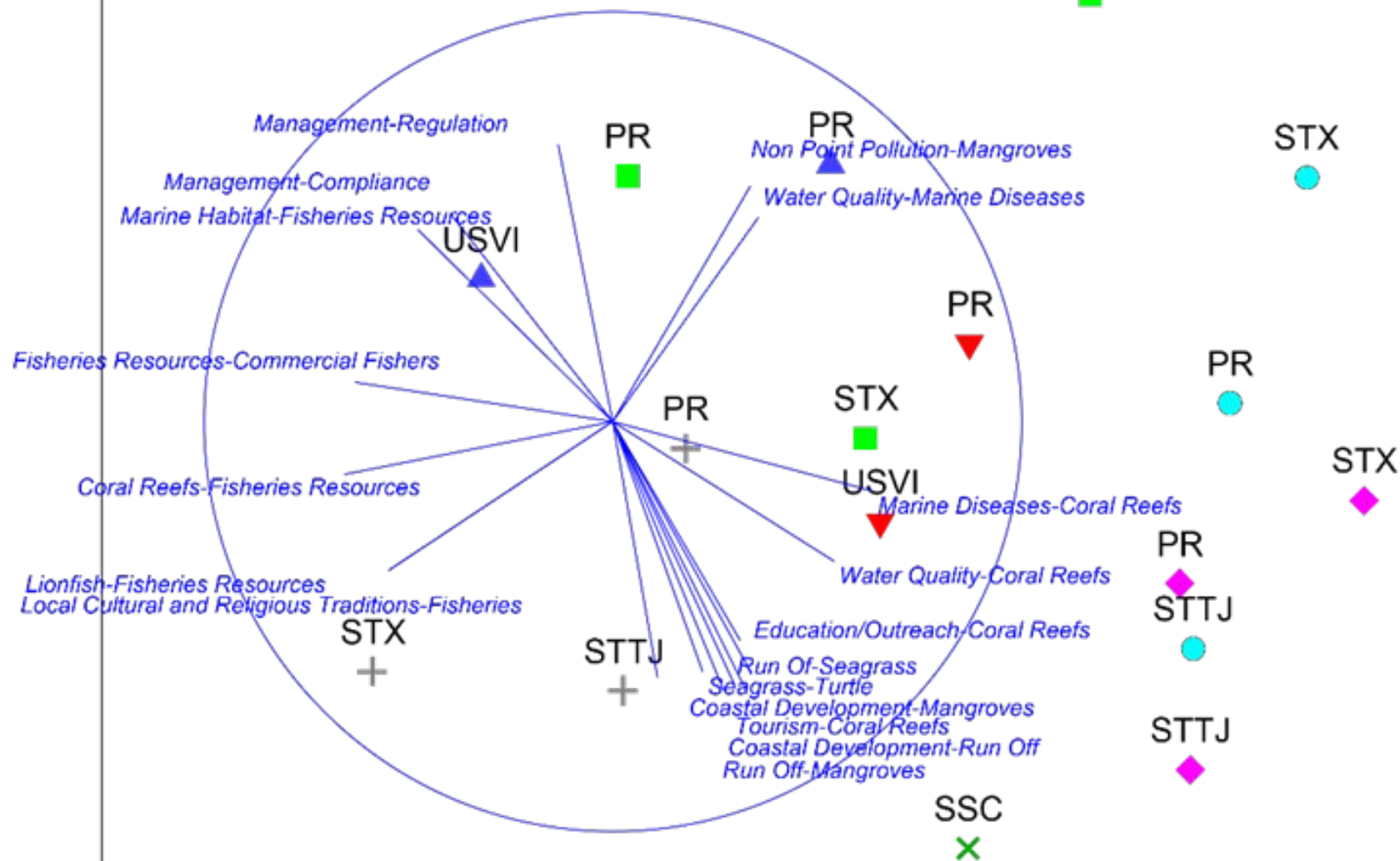
Non-metric MDS

Resemblance: S8 Sorensen

2D Stress: 0.2

Stakeholder

- ▲ MAN
- ▼ EXP
- DAP
- ◆ BUS
- NGO
- + FISH
- × SSC



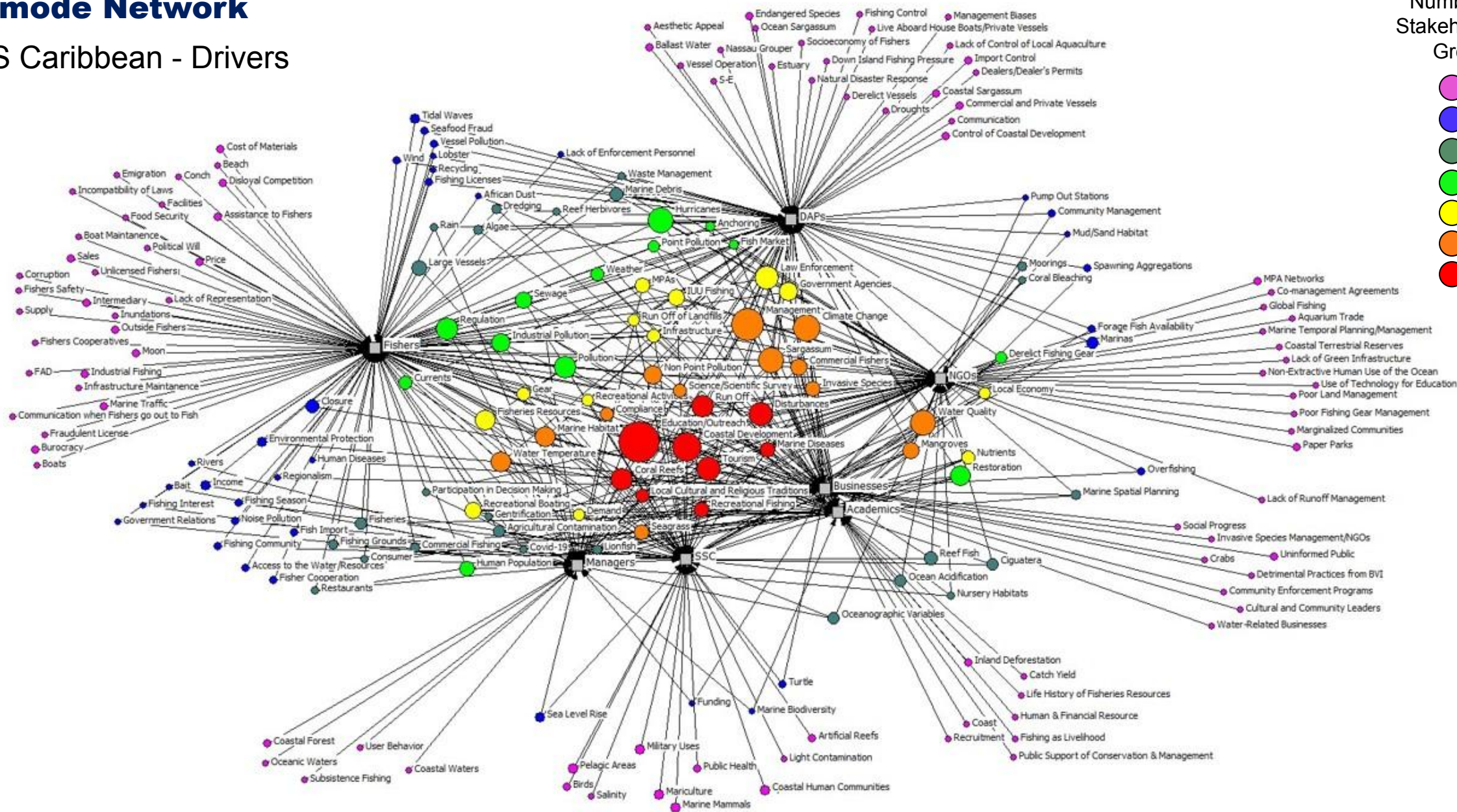
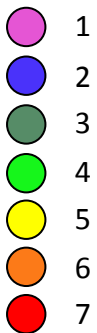
Identification of Priority Ecosystem Components

Two-mode social network analysis diagrams using UCINET and NetDraw to identify convergence and divergence between stakeholder groups with regard to ecosystem components identified as either drivers or receivers

2-mode Network

US Caribbean - Drivers

Number of
Stakeholder
Groups:



Ecosystem Components identified by all 7 stakeholder groups as important drivers and receivers:

Ecosystem Components

Recreational Fishing (D/R)

Coral Reefs (D/R)

Run-off (D/R)

Tourism (D/R)

Education/Outreach (D/R)

Marine Diseases (D/R)

Disturbances (D)

Coastal Development (D)

Local Cultural and Religious Traditions (D)

Water Quality (R)

Mangroves (R)

Seagrass (R)

Identification of Major Threats

Identified by at least 3 stakeholder groups*

*Except for Hurricanes-Recreational Fishing (2 groups)
and Tourism-Education/Outreach (1 group).

Major Threats	Components Affected
Run Off Climate Change	Coral Reefs
	Marine Habitat
	Water Quality
Hurricanes	Coral Reefs
	Recreational Fishing
Tourism	Marine Habitat
	Education/Outreach
Non-Point Pollution	Marine Habitat
	Water Quality
Marine Diseases Invasive Species Water Temperature	Coral Reefs
Coastal Development Disturbances Anchoring	Marine Habitat
Nutrients Erosion Point Pollution	Water Quality
Sargassum	Tourism

Main Discussion Points

- Analyses emphasized the importance of participatory methods and co-production of knowledge to better understand factors affecting the region's fisheries.
- The identification of similar elements and relationships among different conceptual models, provides a compelling method for prioritization to guide fisheries policy and management actions.

Current uses in FEP process include:

- Providing a conceptualization of the fishery ecosystem from the perspective of key stakeholders.
- Using ecosystem elements with high agreement to guide strategic objectives.
- Using elements and threats to ecosystem in development of risk assessment framework.
- Identify data gaps and guide the development of future research priority documents and allocation of funds.
- Create a baseline for future iterations and monitoring efforts while ensuring continuous engagement and representation – *process oriented*.

Thank you!

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