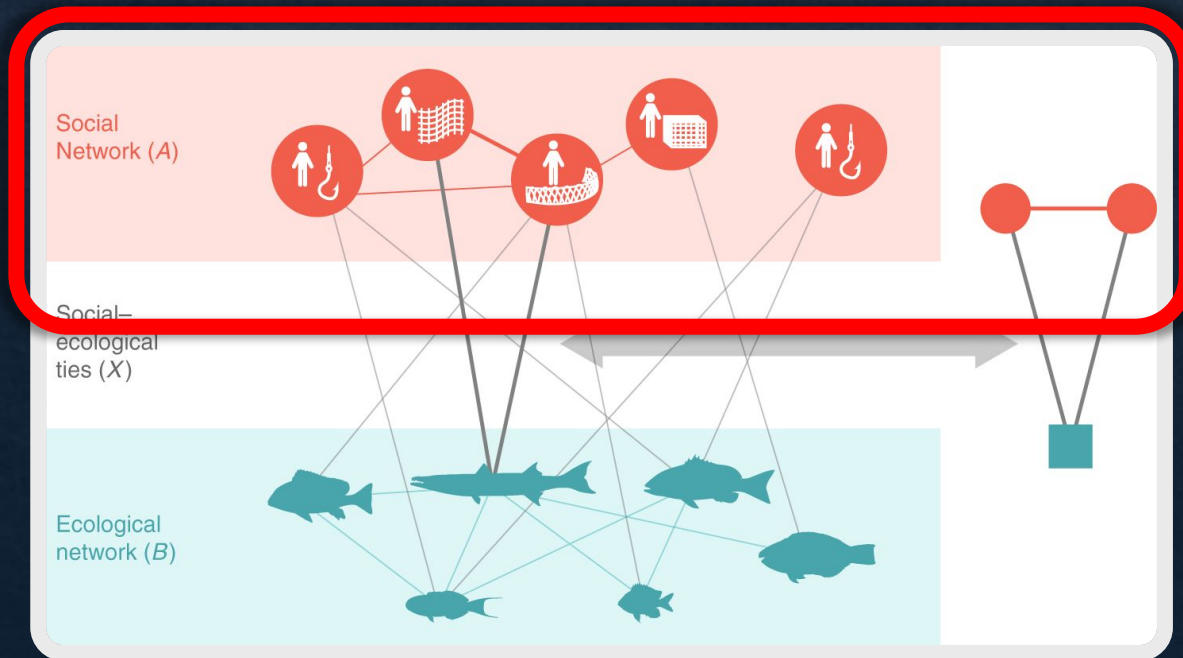# Unlocking Connections: Using Social Science to Meet Fishing Community Needs

By Veronica Malabanan Lucchese (vlucchese@umces.edu)
PhD Candidate and NOAA LMRCSC Fellow II

Socio-Ecological Network Analysis can help measure and manage invasive fishery connections.

Social Network (A)

Social–ecological ties (X)

Ecological network (B)

Measures the influence of and connections between people and/or species

Data
- Web-scraping
- Survey
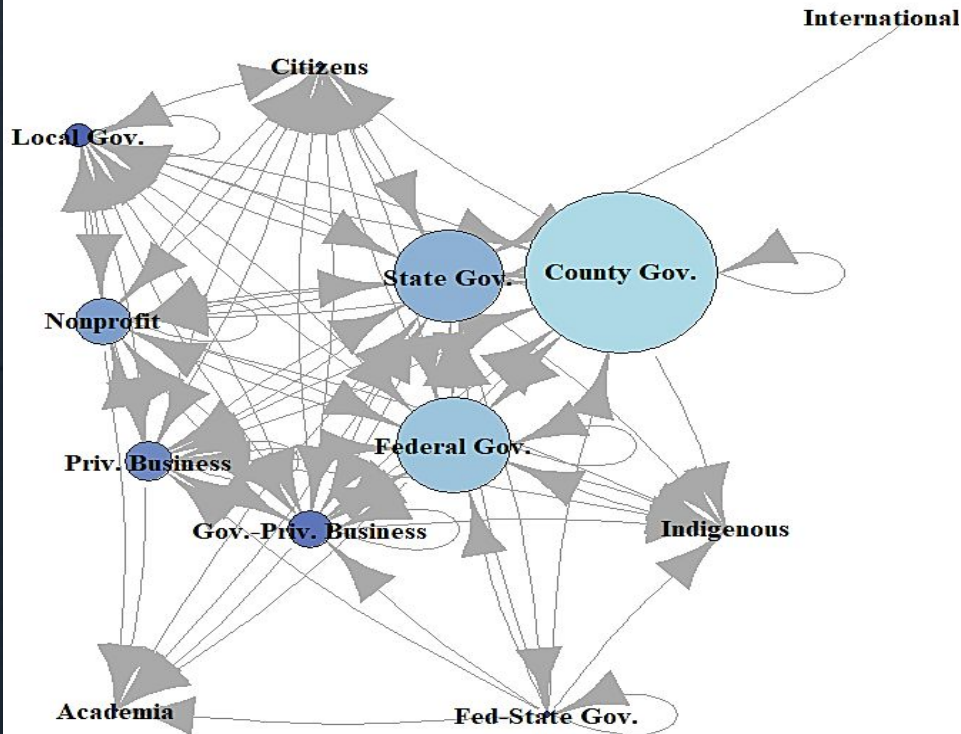
Study Sites (Sub-Watersheds)
- York
- Rappahannock
- Patapsco

Quantitative and Qualitative Outputs
- Centrality Metrics (statistics)
- Network Maps (visualization)

Social Network Analysis (SNA) can inform best management practices.

Social Network Map of Patuxent Management Actors

Degree Centrality
Measures the importance of a node by the number of its direct connections.

Betweeness Centrality
Measures the number of shortest paths between nodes. Identifies bridges or flows of information.
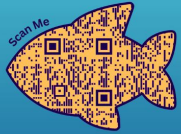
Eigenvector Centrality
Measures a node's connection to other highly connected nodes. Indicates influence.

Community surveys capture social and ecological connections

HELP THE PATAPSCO RIVER
*REMOVE INVASIVE FISH AND EARN REWARDS*

EJJI REEL REWARDS

Scan Me

Frequently Caught Species in the Middle Branch Harbor, Patapsco River

Factors That Shape Environmental Awareness in the Patapsco River

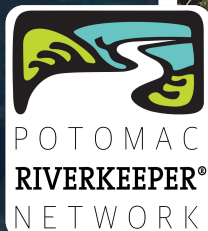| Response	Frequency (%)
Web / Social Media	31
Business and Industry	13
Other People	11
Pollution Prevalence	10
Government	9
Nonprofit	9
Water Quality Changes	9
News	5
Do Not Know	4
Academia	0

Striped Bass/Blue Crabs
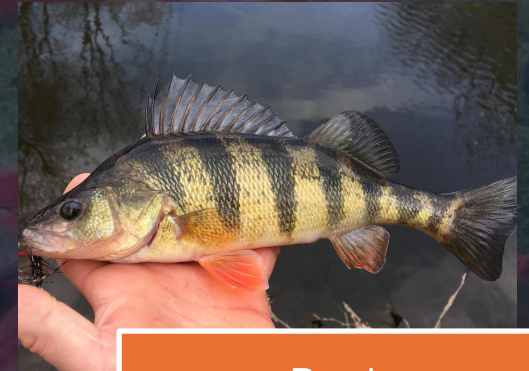
Perch

Spot Croaker

Blue Catfish

Ongoing surveys and community outreach will improve research breadth and relevance.

Join us for Aug 2ⁿᵈ Event!

Managing the Potomac
Featuring the Patawomeck Tribe of Virginia
A film by Veronica Malabanan Lucchese

POTOMAC RIVERKEEPER® NETWORK

Managing the Potomac: Featuring the Patawomeck Tribe of Virginia on YouTube | https://tinyurl.com/PotomacSNA

Share Your Experience:
Blue Catfish and Chesapeake Fisheries

Calling all Chesapeake Bay fishery stakeholders! We need your insights! Participate in our survey about the impact of **blue catfish**, **striped bass**, and **blue crab** on our local ecosystems.

Not only will you contribute to vital research, but you'll also have a chance to win a $50 virtual Visa gift card!

Click the link below to participate: [Insert survey link here]

Interested in sharing your story? Join us for filmed interviews that highlight the voices of those affected by these species. Sign-ups available in the survey!

Questions? Contact Veronica Lucchese at VLUCCHESE@UMCES.EDU

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
INTEGRATION AND APPLICATION NETWORK

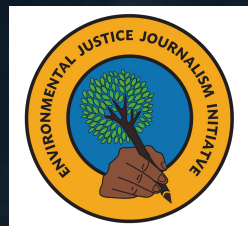# Acknowledgements

Thank you to…

Advisors: Dr. Bill Dennison and Dr. Vanessa Vargas-Nguyen

NOAA Mentor: Bruce Vogt, Chesapeake Bay Office

Additional acknowledgments: Dr. Eric Schott, Donzell Brown, and Christien Martin

Unlocking Connections: Using Social Science to Meet Fishing Community Needs

By Veronica Malabanan Lucchese (vlucchese@umces.edu)
PhD Candidate and NOAA LMRCSC Fellow II

(Visit https://tinyurl.com/bmorefish or scan QR code for YouTube links and References)

Exponential Random Graph Models (ERGMs) can establish baselines for future studies.

Degree Distribution (Log-Log Scale)
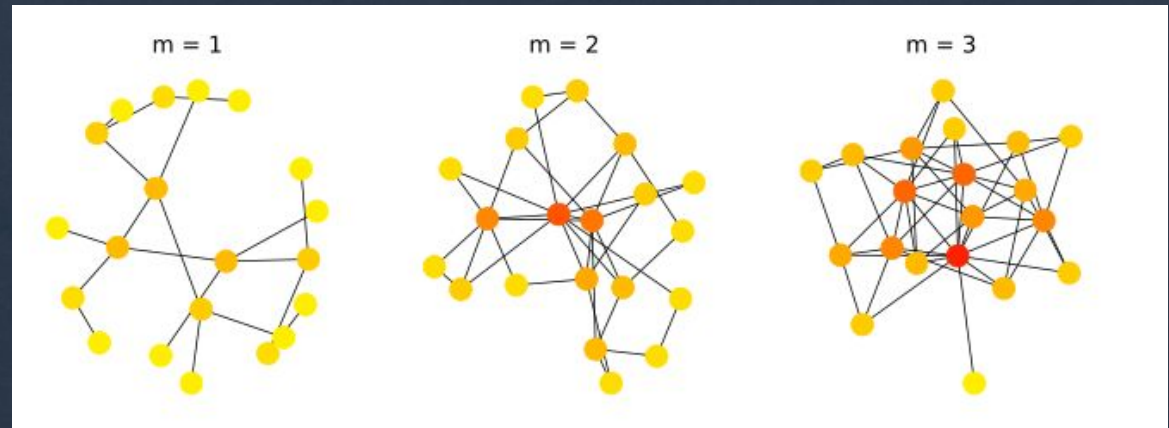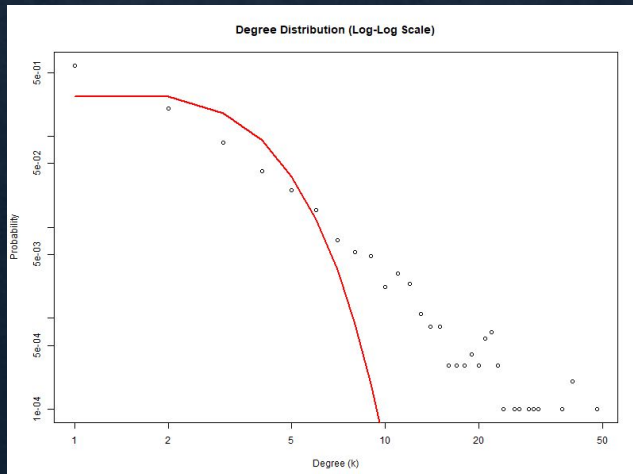
Exponential Random Graph Models (ERGMs)

- Creating baseline networks using real-world parameters (24, 27, 34, 40-42).
  Identifying structures influenced by chance versus those shaped by dependencies.
- igraph package in R Studio (43).

Barabási-Albert (BA) Model and Hubs

- Identifying influential hubs: "rich-get-richer" principle (27, 44).
- Generating at 100 BA models for robust comparisons (45).

Modularity: Community Detection

- Network tendencies to form smaller subgroups (46).
- Comparing modularity between real-world and BA models (27, 41, 42, and 46).

(24) Bodin et al., 2014; (27) Newman, 2018; (34) Munguia-Vega et al., 2022; (40) Barnes et al., 2017; (41) Martin et al., 2017; (42) Packer et al., 2020; (43) Csárdi et al., 2025; (44) Taylor & Suthers, 2021; (45) Weissman, 2020; (46) Bodin et al., 2006

Ethnographic films can lend academic credibility to underrepresented groups in fisheries management.

Powerful research tool that documents and represents cultural practices.

Visual representative of human behaviors and social systems.

Capture non-verbal cultural aspects, preserve local knowledge, and fosters collaboration (36).

Valuable for research, education, advocacy, and community empowerment (47, 48).
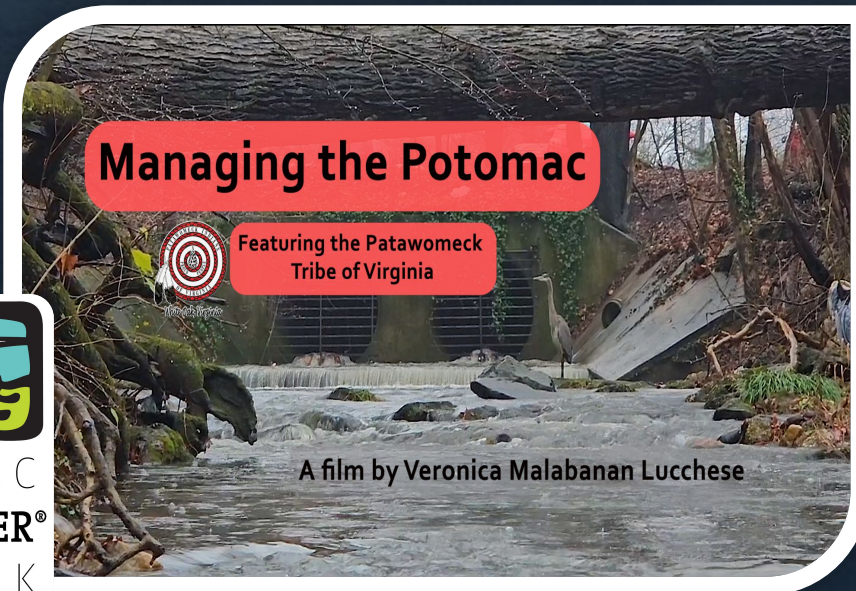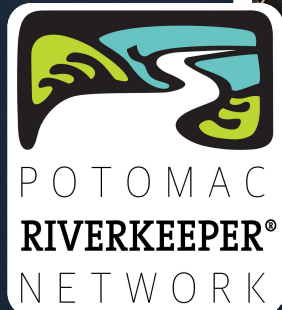
Managing the Potomac: Featuring the Patawomeck Tribe of Virginia on YouTube | https://tinyurl.com/PotomacSNA

Baltimore Angler Stories: Danaz Williams on YouTube | https://bit.ly/anglerstories

(36) Van Dolah et al., 2020; (47) Kaufman et al., 2021; (48) Hasty et al., 2022

Ongoing surveys and community outreach will improve research access and relevance

Focus on invasive blue catfish in Chesapeake Bay sub-watersheds
- **York River**
- **Rappahannock River**
- **Patapsco River**

Conduct surveys and interviews with Blue Catfish stakeholders
- **2025 NOAA NERTO Program**
- **Chesapeake Bay Office**

Environmental Management of Baltimore Harbor
Learning from the past, Planning for the future

Scientific journal publication on socio-ecological network methods

Managing the Potomac
Featuring the Patawomeck Tribe of Virginia
A film by Veronica Malabanan

POTOMAC RIVERKEEPER® NETWORK

Ethnographic film featuring underrepresented stakeholders

Effective invasive fisheries management accounts for social and ecological factors

Marketing
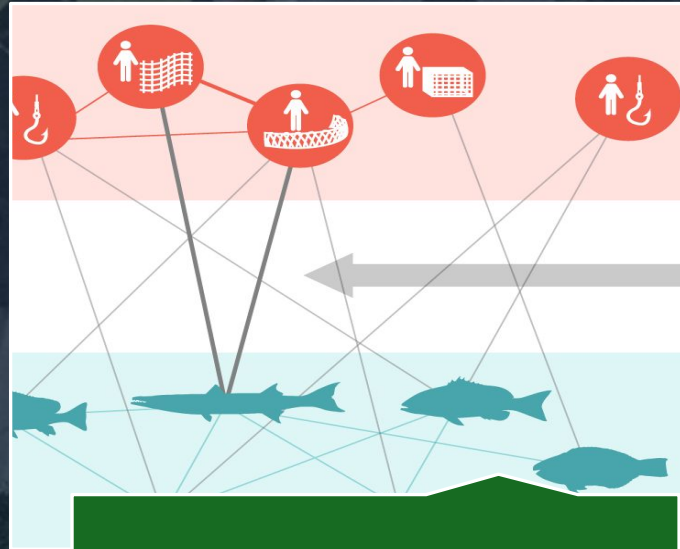
Science Synthesis

Community Engagement
• Recreational Fishing

There are a diversity of fisheries stakeholders.

GOVERNMENT ENTITIES

NONPROFIT ORGANIZATIONS

PRIVATE BUSINESS

CITIZENS AND COMMUNITY GROUPS

INDIGENOUS GROUPS

ACADEMIA
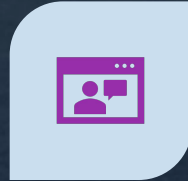
MEDIA ENTITIES

MILITARY ENTITIES

Visualizing SNA metrics as maps will enhance our understanding of network complexities, informing effective management.

Communication and visuals are required for effective management (47, 48).

- Network maps are accessible (47).

Rappahannock, York, and Patapsco River watersheds, as well as species like blue catfish, blue crab, and striped bass:

- Two network maps generated using networkD3 package in R Studio (49):
  - Web-scraped data
  - Survey data

These maps will improve resiliency and responsiveness:

- Illustrate relationships and gaps in the management system (50, 51).
- Help stakeholders identify communication breakdowns and forge better connections (33).

(33) Jedd & Bixler, 2015; (47) Kaufman et al., 2021; (48) Hasty et al., 2022; (49) Gandrud, 2014; (50) Crona & Bodin, 2006 ; (51) Janssen et al., 2005

Socio-Ecological Network Analysis (SENA) can help address blue catfish management issues.

Blue catfish are a significant invasive species in the Chesapeake Bay, negatively impacting socio-ecological systems (1-3).
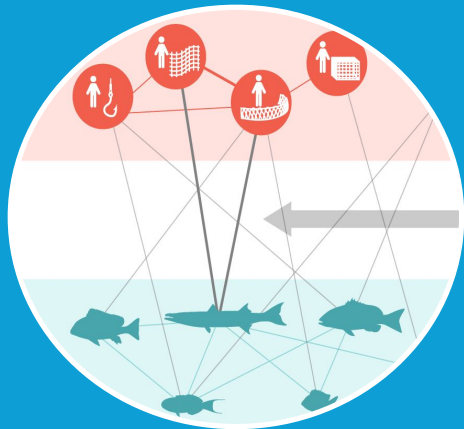
Provide holistic quantitative and qualitative analyses of social and ecological networks.

Focus areas include:
- Community engagement
- Technological advancement
- Coordination among governing authorities
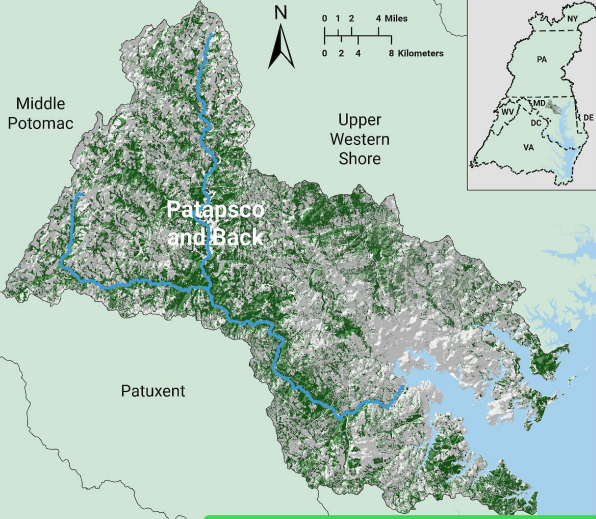
Methods include:
- Coding
- Literature review
- Web analysis
- Surveys
- Interviews
- Ethnographic film

Goal: Connect disparate groups affected by environmental stressors to develop sustainable and collaborative management strategies

(1) Moore, 2023; (2) CBP, 2020(a); (3) Robertson et al., 2024.
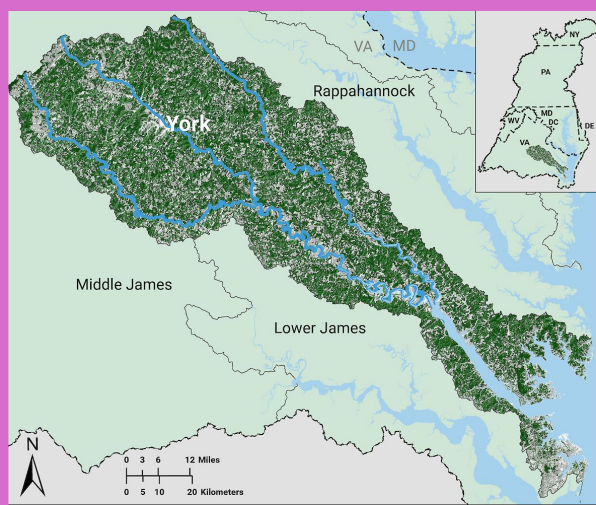
Blue catfish are spreading throughout the bay.

Virginia Department of Wildlife and Recreation introduced blue catfish (4,5)

Last stocking by Virginia Department of Wildlife and Recreation

Blue catfish predation impacts recognized by states (11-13).

Spread into the upper bay. Over 4.2 million Lbs. (14)

1960s — 1974 — 1985 — 2010 — 2014 — 2020 — 2023

VA DWR stocked 300,000 blue catfish in the James and Rappahannock rivers (6,7).

Blue catfish populations surge account 75% of the biomass in southern bay (8-10).

Over 100 million Chesapeake blue catfish (10).

(4) U.S. Fish & Wildlife Service, 2020; (5) Houck, 2024; (6) CBP, 2012; (7) CBP, 2020 (a); (8) Fabrizio et al., 2021; (9) DeFrancesco, 2022; (10) Liu & Fisher, 2020; (11) Lockwood, 2024; (12) Bilkovic & Ihde, 2014; (13) Fleming, 2024; (14) Moore, 2023

The Patapsco, Rappahannock, and York Rivers have unique tributary-specific dynamics.

River Watershed	Length/ Area (sq. miles)	Population	Key Features	Fish Species
Patapsco	630	Over 1.5 million	• Highly urbanized • Low-action, shallow, rocky areas with boulders and deep pools	Native species: shad, striped bass, American eel, river herring, and others
Rappahannock	2,700	241,000	• Limited access points; urbanization increasing. • Above fall line: fast, clear waters; below fall line: murky waters suitable for largemouth bass and anadromous species	Diverse species including striped bass, catfish, white perch, largemouth bass, and smallmouth bass
York	3,254	630,000	• Includes mountains, tidal freshwater, salt marshes; features the Pamunkey and Mattaponi Rivers	200 fish species present including striped bass, sturgeon, and shad.

The study sites have long and diverse cultural histories.

Patapsco

- **Years of Inhabitation**: Over 12,000

- **Tribes**: Piscataway, Cherokee, Lumbee, Susquehannock

- **Colonial Period**: 1600s, English settlers exploited resources for industry, agriculture, and urbanization.

- **Historical Notes**: Waterman opportunities for African Americans; late 19th-century industrial growth caused heavy pollution.

Rappahannock

- **Years of Inhabitation**: Over 15,000

- **Tribes**: Rappahannock, Nanzatico, Patawomeck, Mattaponi, Pamunkey

- **Colonial Period**: 1640s, illegal English settlements forced Indigenous relocation; became a major shipping port.

- **Historical Notes**: Civil War remnants; tribes preserved traditions despite oppression.

York

- **Years of Inhabitation**: Over 15,000

- **Tribes**: Mattaponi, Pamunkey, Upper Mattaponi

- **Colonial Period**: Early Virginia Colony settlements; significant events in the Revolutionary and Civil Wars.

- **Historical Notes**: Tribes maintain traditional practices and conservation efforts through fish hatcheries.

Urbanization and pollution are impacting all three watersheds.

Patapsco

- **Land Use**: Over 50% of the land is urban, primarily in Baltimore City.

- **Environmental Issues**: Stormwater runoff, historic pollution, and habitat degradation from urbanization.

- **Socio-Economic Impact**: Closed beaches and swimming advisories.

Rappahannock

- **Land Use**: 66% high-quality forest and agricultural land amid expanding urban centers and data centers.

- **Environmental Issues**: Pollution from agriculture, urban development, erosion, fracking, and timbering.

- **Socio-Economic Impact**: Supports tourism; Faces challenges from climate change and construction impacting local species.
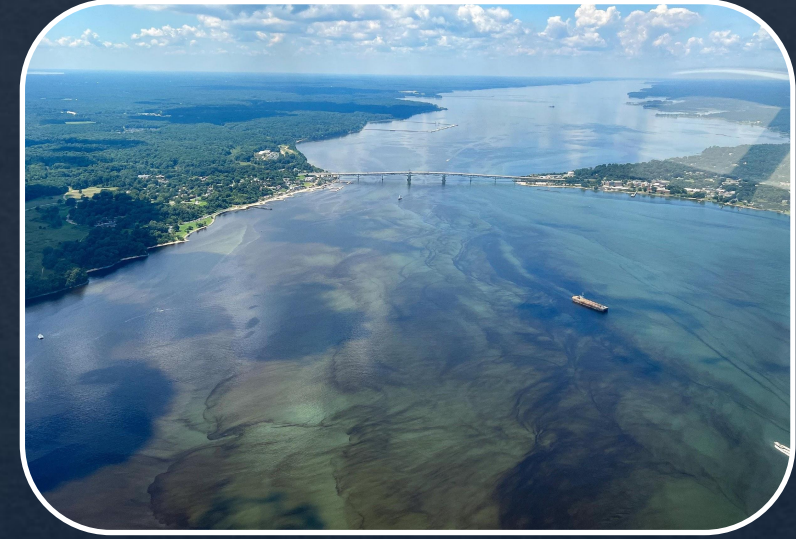
York

- **Land Use**: Over 70% of the land is a mix of forests, residential areas, and agriculture.

- **Environmental Issues**: Excess sediment, nutrient loading, and contamination from agriculture runoff.

- **Socio-Economic Impact**: Revolutionary War tourism, fishing, and seafood industries impacted by declining infrastructure and pollution.

Blue catfish are negatively impacting the fisheries of all three study sites.

Patapsco

- **Community Programs**
  - Great Chesapeake Invasive Count
  - Reel Rewards Invasive Fish Bounty Program
- **Key Species and Impacts**
  - Blue catfish, mud crabs, juvenile oysters, clams, mussels, small fish.
  - Anthropogenic pressures may aid blue catfish spread.

Rappahannock

- **Community Programs**
  - Great Chesapeake Invasive Count
  - VA DWR encourages harvest and consumption
- **Key Species and Impacts**
  - Blue catfish dominant, replacing channel catfish.
  - Impacts hickory shad and striped bass runs.

York

- **Community Programs**
  - Chartered trips targeting blue catfish
  - VA DWR encourages harvest and consumption
- **Key Species and Impacts**
  - Blue catfish altered tribal fishing practices
  - Trophy blue catfish in lower tidal sections

Established blue catfish populations can persist despite ecological changes.

Eutrophication from agricultural and urban runoff.

Climate change
- Rising temperatures, changing salinities, and increased flooding (15-17).

Removal of dams improving connectivity.

Native fishery restoration improving juvenile fish stocks.

(15) Chesapeake Bay Program (CBP), 2020 (a); (16) Fuller et al., 2018; (17) Schmitt et al., 2021

States are implementing policies and programs to address the invasion of blue catfish.

2014

Blue catfish impacts recognized by both Virginia and Maryland.

2021

Maryland:
- Congressional resolution to transfer oversight from the USDA to the FDA.
- Catfish Fishery Management Plan

2024

Maryland:
- Federal Fisheries Disaster Declaration for issues caused by blue catfish (denied in 2025).

Virginia:
- Grant program to support blue catfish processing infrastructure (up to $250,000).

2025

Maryland:
- Pilot programs were launched to promote higher removals of blue catfish from charters.

Virginia:
- House Bill 2782 - lift certain blue catfish limitations.

The 2020 Invasive Catfish Management Strategy identifies priorities from fishery experts.

Invasive Catfish
Management Strategy
August 2020
Chesapeake Bay Program
Science. Restoration. Partnership.
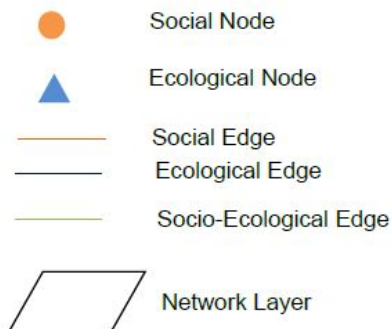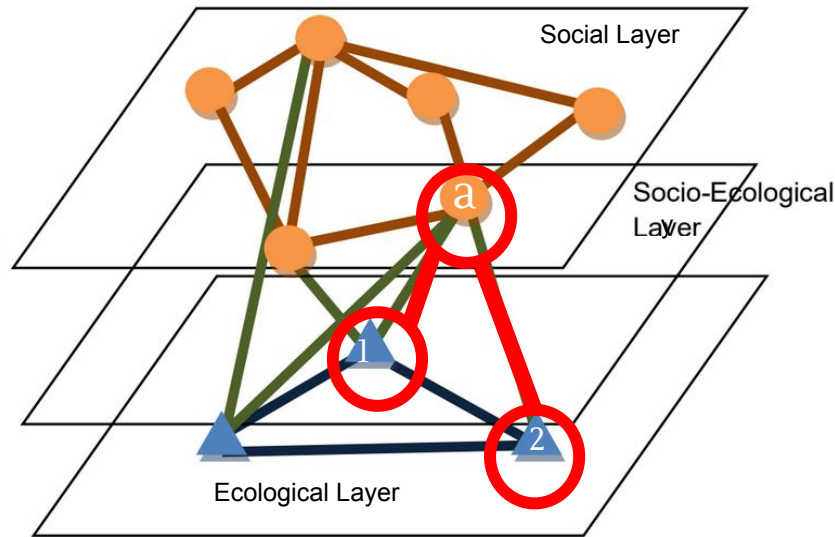
Takeaways
- Human dimensions research are top priority (22).
- Understanding and sharing information about contaminants for marketing
- Effective coordination and communication among jurisdictions and stakeholders
- Clear messaging outreach and marketing.

Priority management and fishery needs for addressing invasive blue catfish:
- Assess impacts
- Expand marketing and education
- Outreach
- Common management strategy
- Balance stakeholder interests
- Increase staff capacity and funding

Analyzing multi-level, socio-ecological systems can reveal their network dynamics.

- Social Node
- Ecological Node
- Social Edge
- Ecological Edge
- Socio-Ecological Edge
- Network Layer

Social Layer

Socio-Ecological Layer

Ecological Layer

No single network structure suits all invasive species management (23).

Tributary-specific research (15)

Transdisciplinary approach helps with participant diversity and authority diffusion (24-26).

Mixed-method approach to track diversity, equity, and inclusion (DEI) (25, 27).

Literature reviews
Surveys/Interviews
Graph theory

(15) CBP, 2020 (a); (23) Barnes et al., 2017; (24) Bodin et al., 2014; (25) Bodin et al., 2020; (26) Ashlander et al., 2022; (27) Newman, 2018
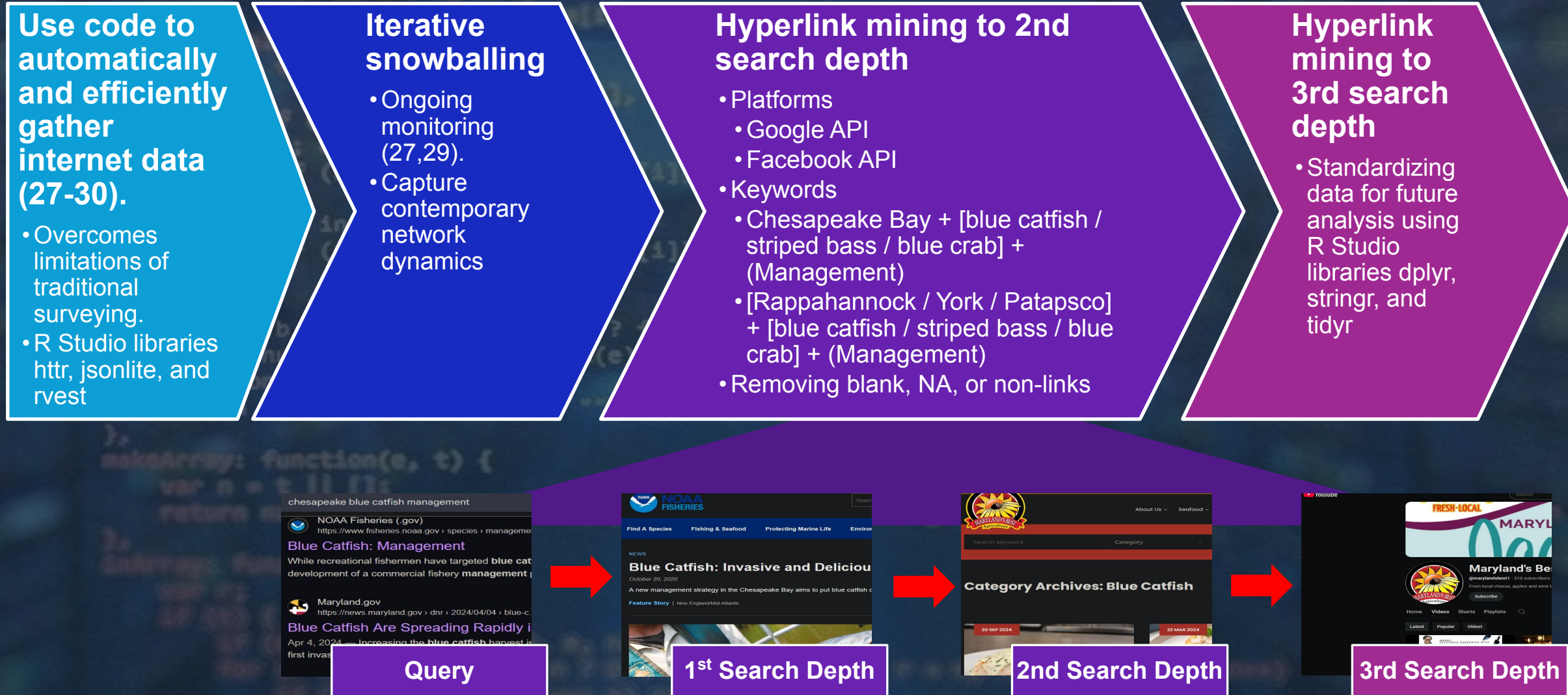
The first iteration of the SNA data will be collected using web scraping and hyperlink mining techniques.

Use code to automatically and efficiently gather internet data (27-30).

- Overcomes limitations of traditional surveying.
- R Studio libraries httr, jsonlite, and rvest

Iterative snowballing

- Ongoing monitoring (27,29).
- Capture contemporary network dynamics

Hyperlink mining to 2nd search depth

- Platforms
  - Google API
  - Facebook API
- Keywords
  - Chesapeake Bay + [blue catfish / striped bass / blue crab] + (Management)
  - [Rappahannock / York / Patapsco] + [blue catfish / striped bass / blue crab] + (Management)
- Removing blank, NA, or non-links

Hyperlink mining to 3rd search depth

- Standardizing data for future analysis using R Studio libraries dplyr, stringr, and tidyr

Query

1st Search Depth

2nd Search Depth

3rd Search Depth

(27) Newman, 2018; (28) Bradley & James, 2019; (29) Kreakie et al., 2016; (30) Sayles et al., 2022

Additional SNA data will be collected through interviews and surveys to better understand blue catfish management.

Surveys and interviews:
- Engage diverse demographics.
- Provide qualitative and quantitative context (31-36).
- Uncover tributary-specific fisheries management network data.

Participant selection will consider:
- Literature review
- Web-scraped SNA
- Preliminary results
- Expert recommendations

Survey Structure
- Introduction – Project Overview
- Survey questions:
  - Demographic data and filter respondents.
  - Assess fisheries connections and blue catfish impacts
  - Gather management feedback and desired changes (37-39).

(31) Bodin et al., 2017; (32) González Mon et al., 2019; (33) Jedd & Bixler, 2015; (34) Munguia-Vega et al., 2022; (35) ten Brink, 2024; (36) Van Dolah et al., 2020; (37) Vagias, 2006; (38) Chaudhary & Warner, 2015; (39) World Resources Institute, 2018
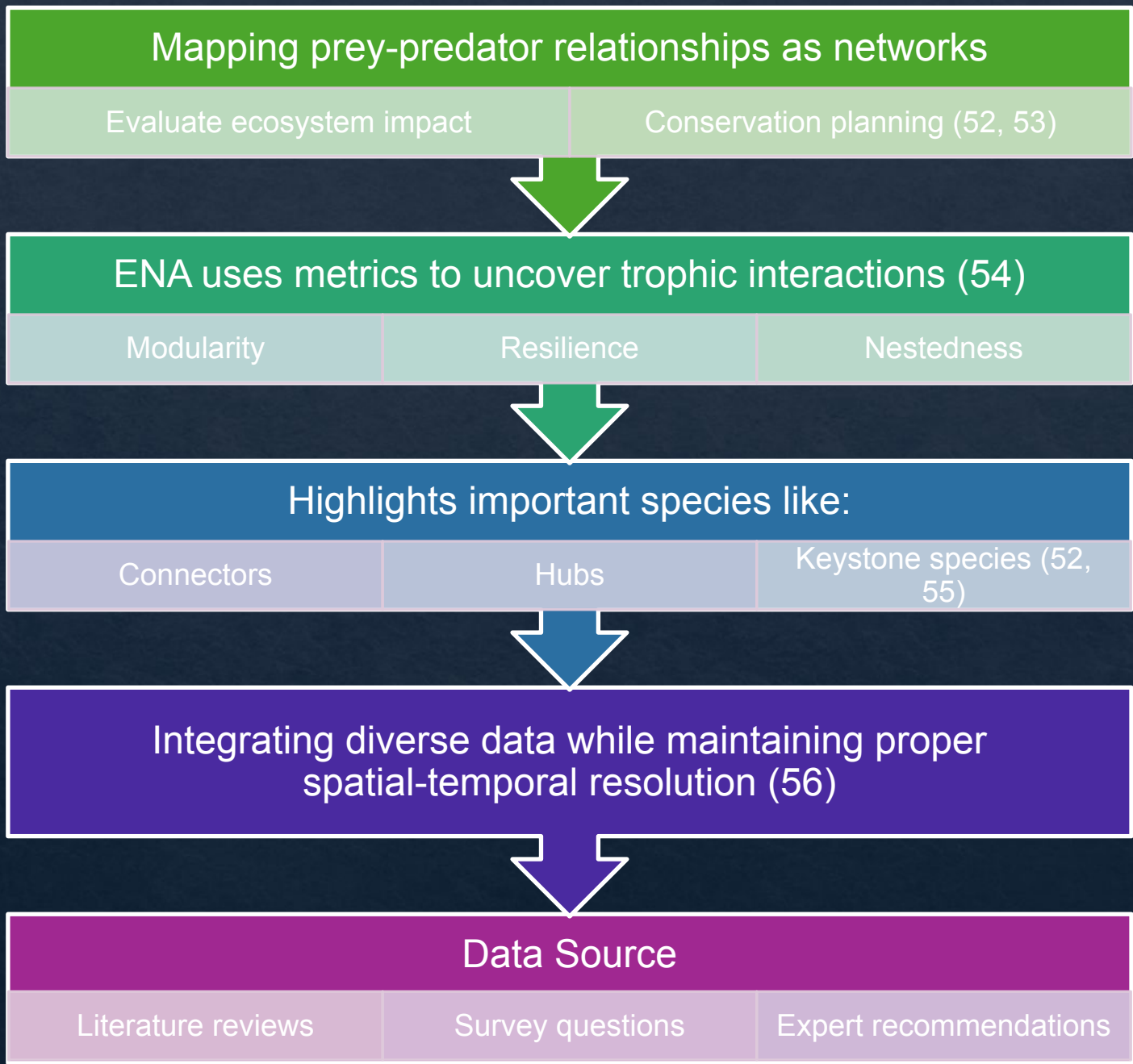
Ecological Network Analysis (ENA) can elucidate the impacts of blue catfish on native fisheries using gut content data.

Mapping prey-predator relationships as networks

Evaluate ecosystem impact	Conservation planning (52, 53)

ENA uses metrics to uncover trophic interactions (54)

Modularity	Resilience	Nestedness

Highlights important species like:
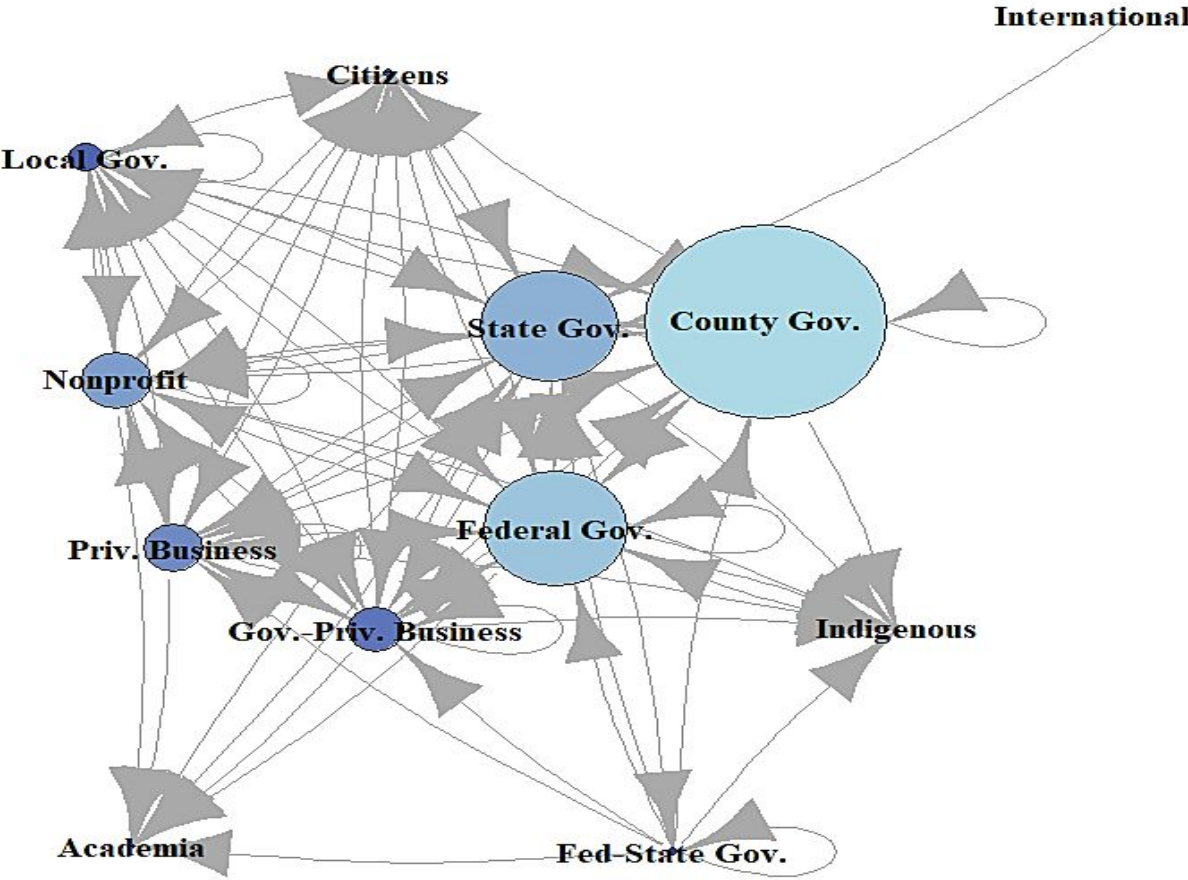
Connectors	Hubs	Keystone species (52, 55)

Integrating diverse data while maintaining proper spatial-temporal resolution (56)

Data Source

Literature reviews	Survey questions	Expert recommendations

(52) Meyer et al., 2020; (53) Costa & Angelini, 2020; (54) Sander et al., 2017; (55) Yang et al., 2017; (56) Hashemi et al., 2024

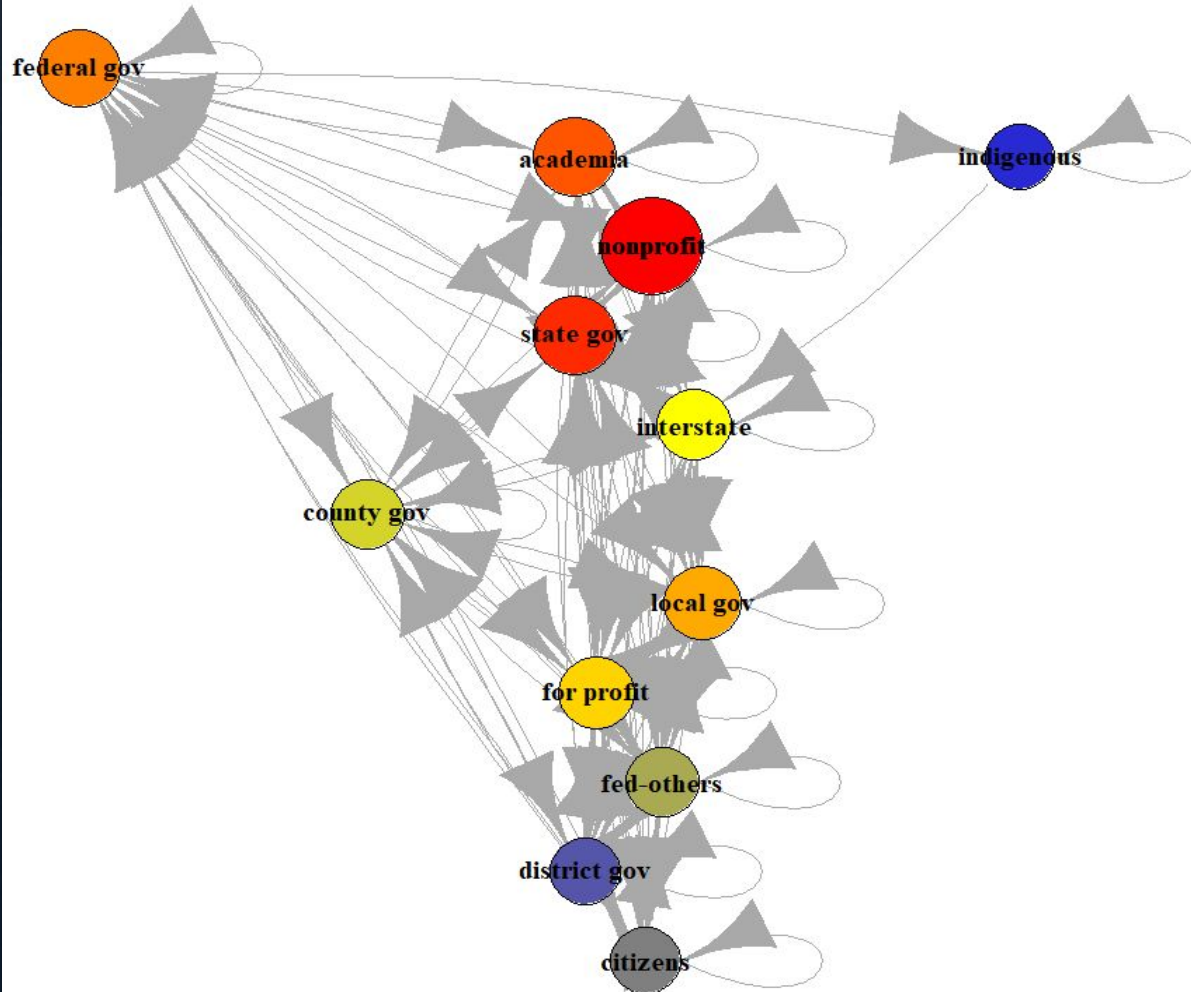# Web-scraped SNA shows that the <u>Patuxent River Watershed</u> is also highly centralized

Social Network Map of Patuxent Management Actors

Influence	Actor Types	Degree Centrality	Eigenvector Centrality	Betweeness Centrality
Most	County Government	21%	26%	1%
	Federal Government	20%	20%	31%
	State Government	15%	16%	62%
Least	Citizens	2%	2%	0%
	Academia	1%	1%	0%
	Indigenous Groups	1%	1%	0%

Web-scraped SNA shows that the Potomac River Watershed is highly centralized

Social Network Map of Potomac River Actor Types

Influence	Actor Types	Degree Centrality	Eigenvector Centrality	Betweeness Centrality
Most	Nonprofits	33%	33%	2%
	State Government	14%	13%	23%
	Academia	14%	14%	0%
	Federal Government	12%	12%	30%
Least	Citizens	1%	1%	0%
	District Government	1%	1%	0%
	Indigenous Groups	0%	0%	0%

The data from Web sources indicate that both State and Federal governments play key, well-connected roles in the Potomac and Patuxent regions.

Central actors have a powerful influence on management and other actors.

- Central actors have historically been barriers to diversity and inclusion in water management.

Actors with high betweenness centrality are key for facilitating future change.

- They are the glue that holds the network together.

Underrepresented groups, or least connected nodes, like citizens and Indigenous groups are not properly included in Potomac or Patuxent River management decisions.

Preliminary results address the research questions and support hypotheses.

Do all Chesapeake Bay blue catfish management stakeholders have equitable representation in decision-making?

Hypothesis: No, underrepresented communities in Chesapeake Bay region are not appropriately represented.

Preliminary Results: No, web-scraped SNA and survey results show that underrepresented communities are disconnected from decision-makers.

Currently, who are the most powerful stakeholders in this fishery?

Hypothesis: Government entities are highly central and influential in the Blue Catfish management network.

Preliminary Results: Federal and state government are the most influential and bridging actors in Chesapeake management networks.

Are stakeholders from other bay fisheries relevant to blue catfish management?

Hypothesis: Yes, management requires collaboration across different fisheries including highly impacted blue crab and striped bass.

Preliminary Results: Yes, literature review and survey results identify striped bass, blue crab, and other native species as being impacted by this invasive.

How can academia help capture the voices of marginalized communities in blue catfish management?

Hypothesis: An ethnographic film study of blue catfish management stakeholders makes marginalized communities' experiences accessible and are supported by quantitative SNA metrics.

Preliminary Results: Ethnographic films of the Patawomeck tribe and Baltimore anglers have influenced management planning and funding.