

**Stakeholder Assessment & Concept Mapping  
In support of Fishery Ecosystem Planning for the Gulf of Mexico:**

**Summary Project Report**



*Submitted to:*

Gulf of Mexico Fishery Management Council  
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*Submitted by:*

LGL Ecological Research, Inc.

*Produced by:*

Steven Scyphers, Savannah Swinea, Sarah Gibbs, and Will Heyman

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**Executive Summary**

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<sup>1</sup> Cover photo shows Captain Jay Mullins who has fished the Gulf of Mexico for over 40 years. Jay and other stakeholders are highly knowledgeable and maintain conceptual mental models about the status and trends in fisheries resources that can inform ecosystem based fishery management decisions.

This report provides a summary of the stakeholder assessment and concept mapping activities conducted as part of the development of a Fishery Ecosystem Plan for the Gulf of Mexico Fishery Management Council. Specifically, this report describes the following two tasks:

Task 1: Conduct a stakeholder assessment to develop a comprehensive list of the types and groups of individuals closely associated with Gulf of Mexico fisheries.

Task 2: Conduct and analyze semi-structured interviews using concept mapping with key informants representing diverse stakeholders in the Gulf of Mexico fisheries.

The first task was to conduct a stakeholder assessment to develop a comprehensive list of the types and groups of individuals closely associated with Gulf of Mexico fisheries. Through literature reviews and input from the Gulf Council, NOAA Fisheries, and the Council's Ecosystem Technical Committee, we produced a comprehensive list of stakeholder groups. While beyond the scope of Task 1, we also reviewed literature on stakeholder prioritization and selection and developed a draft stakeholder engagement template.

The second task was to conduct and analyze semi-structured interviews using concept mapping with key informants representing diverse stakeholders in the Gulf of Mexico fisheries. The goal of this task was to create concept maps of fisheries stakeholders' "mental models" of Gulf fisheries ecosystem processes including social and economic components and relationships. Considering the broader project direction towards developing the FEP through individual Fishery Ecosystem Issues (FEI's), this task was modified to be part of the pilot FEI of "Bycatch in the Eastern Gulf of Mexico".

**Context Note: The stakeholder assessment and conceptual modeling activities in this report were conducted solely for exploratory and demonstration purposes and not in the sequence or with the necessary timing for a realistic FEI.**

## 1. TASK 1 - STAKEHOLDER ASSESSMENT

Task 1: Conduct a stakeholder assessment to develop a comprehensive list of the types and groups of individuals closely associated with Gulf of Mexico fisheries.

### 1.1. Background

Defining, identifying, and engaging stakeholders are essential steps towards developing an effective and equitable Fishery Ecosystem Plan (FEP). However, this process is not simple, especially in the Gulf of Mexico, for several reasons. Defining and categorizing stakeholders is challenging because of the diverse, and often overlapping, ways that people interact with Gulf ecosystems and fisheries. We searched peer-reviewed literature, government documents, and websites to identify existing frameworks or lists of fisheries stakeholders. We focused these efforts on both general fisheries stakeholders, as well as those related to fisheries in the Gulf of Mexico.

#### Defining & Categorizing Stakeholders

Definitions of stakeholders range from general to fishery specific. For instance, a recent guidance document from NOAA's Office of Coastal Management provides a general definition of stakeholders as: *"those who have an interest in or are affected by a decision, or have influence or power in a situation. Stakeholders' interests in an issue can be monetary, professional, personal, or cultural, or can arise from a host of other motivations."* (NOAA 2015). Mikalsen and Jentoft (2001) provides a similar yet more fisheries-centric definition as someone: *"who has a legitimate stake in the management of living marine resources and therefore should have a say when decisions are made and enforced"* (Mikalsen and Jentoft 2001).

Approaches for categorizing stakeholders also range from general to fishery specific. The most widely applied stakeholder typology for fisheries is likely also Mikalsen and Jentoft (2001), which includes Fishers, Fish Processors, Bureaucrats (Managers), Enforcement Agencies, Scientists, Fish Workers (i.e., Crew), Indigenous peoples, Environmental groups, Local Communities, Citizens, the Media, Municipal Authorities, Future Generations, Banks, Consumers, Equipment Suppliers, Tourist Industries, and Sport Fishers.

Building on our review, we developed a stakeholder mapping framework (Figure 1) and draft tool (Appendix 1) for defining, categorizing and engaging stakeholders to develop an FEP or FEI. The initial list of stakeholder categories was compiled from the literature and refined through meetings with the Gulf Council, NOAA Fisheries, and the Council's Ecosystem Technical Committee.

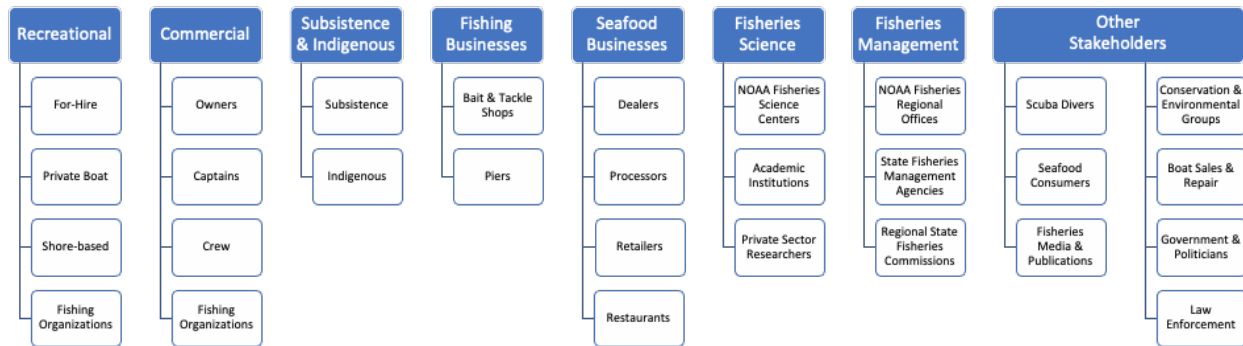


Figure 1. Tiered list of major stakeholders that could be considered for Gulf of Mexico fisheries ecosystem planning.

Below we briefly define each type of stakeholder and, to the extent possible, discuss their role in Gulf fisheries and ecosystems.

### **Recreational**

- **For-hire**: Also known as charter fishing; individuals or groups who pay a fee to be carried on a vessel for the opportunity to fish. For-hire trips in the Gulf of Mexico target many species, especially coastal migratory pelagics and reef fish.<sup>2</sup>
- **Private Boat**: Individuals who use either their own vessels or rent a vessel in order to fish. In the Gulf of Mexico, the majority of recreational fishers fall into this group (Figueira and Coleman 2010).
- **Shore-based**: Individuals fish from shore, beach, bank, or man-made structures such as seawalls and bridges. In the Gulf of Mexico, a large portion of recreational effort comes from shore-based stakeholders (NMFS 2021).
- **Fishing Organizations**: Nonprofit organizations whose goals are to increase participation and opportunities in recreational fishing. Examples include American Sportfishing Association and Recreational Boating & Fishing Foundation.<sup>3,4</sup>

### **Commercial**

- **Owners**: Individuals or companies owning or holding shares in a fishing vessel, quota, or license.
- **Captains**: Individuals who operate the fishing vessel.
- **Crew**: Individuals who work on fishing vessels.
- **Fishing Organizations**: Nonprofit organizations whose goals are to advocate for the safety and economic security of commercial fishers and promote conservation. Examples

<sup>2</sup>[https://media.fisheries.noaa.gov/dam-migration/species\\_per\\_permit\\_final\\_fixed\\_toc\\_error\\_\\_2feb2018.pdf](https://media.fisheries.noaa.gov/dam-migration/species_per_permit_final_fixed_toc_error__2feb2018.pdf)

<sup>3</sup> <https://asafishing.org/about/>

<sup>4</sup> <https://www.takemefishing.org/corporate/who-we-are/>

include Gulf Fishermen's Association and Gulf of Mexico Reef Fish Shareholders' Alliance.<sup>5,6</sup>

### **Subsistence & Indigenous**

- **Subsistence**: Individuals or groups who primarily fish for their own food or for sharing with others. While very few studies or statistics are available on subsistence fishing in the Gulf of Mexico, NOAA Fisheries' work on fishing community profiles concluded that fishing for food is of widespread importance, particularly in rural areas (Pettersen et al. 2006). Seasonal visitors to the Gulf Coast that travel south to fish for species like sheepshead could also be considered subsistence.
- **Indigenous**: As described by NOAA Fisheries: "Tribes and indigenous communities are not just another stakeholder group, but have unique and important legal and cultural status that requires additional engagement outside a typical stakeholder engagement process." In the context of Gulf of Mexico fisheries and ecosystems, Tribal communities are important stakeholders for land-use and water resources issues (Pettersen et al. 2006).

### **Fishing Businesses**

- **Bait & Tackle Shops**: Bait and tackle shops rely on fishing activity to support business and employment. Independently-owned bait & tackle shops in the Gulf of Mexico contributed approximately \$393 million in sales output and supported 2,873 jobs in 2013 (Hutt, Lovell, and Steinback 2015).
- **Piers**: Piers are popular shore-based fishing locations. Key stakeholders include pier users and owners. In the Gulf of Mexico, fishing piers are mainly used by recreational fishers (Pettersen et al. 2006).

### **Seafood Businesses**

- **Dealers**: Businesses that buy fresh or frozen seafood and sell it to retailers and restaurants. In 2017, seafood dealers in the Gulf of Mexico supported 4,136 jobs, a 15% increase since 2009 (NMFS 2021).
- **Processors**: Businesses that sort and prepare fish into sellable products. Gross annual income of processors totaled \$46.1 million and employed 8,038 workers in 2017 (NMFS 2021).
- **Retailers**: Seafood markets, grocery stores, and other stakeholders that rely on fisheries for seafood products to sell to customers. In 2017, gross annual income of seafood

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<sup>5</sup> <https://gulffishermens.org/>

<sup>6</sup> <https://shareholdersalliance.org/>

retailers in the Gulf of Mexico totaled \$66.9 million and supported 2,452 jobs (NMFS 2021).

- **Restaurants**: Businesses that purchase seafood from dealers or retailers and prepare meals for consumers.

### **Fisheries Science**

- **NOAA Fisheries Science Centers**: Provides scientific advice and data needed to effectively manage marine resources.<sup>7</sup>
- **Academic Institutions**: Colleges and universities that conduct fisheries science research.
- **Private Sector Researchers**: Private consulting firms that do conduct research under contract.

### **Fisheries Management**

- **Gulf of Mexico Fishery Management Council**: The Gulf Council, one of 8 regional fishery management councils, relies on sound science and public opinion to make fishery management recommendations that aim to balance competing interests and achieve the greatest overall benefit to the nation<sup>8</sup>.
- **NOAA Fisheries Regional Offices**: Works with regional management councils and fishery scientists to maintain healthy fish stocks and conserve essential habitats.<sup>9</sup>
- **State Fisheries Management Agencies**: Collects data and makes recommendations for the management of marine resources within a state.<sup>10</sup>
- **Regional State Fisheries Commission**: Joint commission of states to manage shared fishery species across state borders.<sup>11</sup>

### **Other Stakeholders**

- **Scuba Divers**: Scuba diving represents an important industry and group of stakeholders who highly value marine ecosystems and fisheries. For some fish species, such as Goliath Grouper and sharks, diving represents high economic value and demand.
- **Seafood Consumers**: Individual residents and tourists that purchase and consume seafood at home or at restaurants.
- **Fisheries Media & Publications**: Newsletters or magazines that promote and report both commercial and recreational fishing.

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<sup>7</sup> <https://www.fisheries.noaa.gov/about/southeast-fisheries-science-center>

<sup>8</sup> <https://gulfcouncil.org/>

<sup>9</sup> <https://www.fisheries.noaa.gov/about/southeast-regional-office>

<sup>10</sup> <https://myfwc.com/about/inside-fwc/mfm/>

<sup>11</sup> <http://www.asmfrc.org/about-us/program-overview>

- Conservation & Environmental Groups: Non-profit or charity foundations that work to protect the environment. Examples include the Gulf Coast Preservation Society and Ocean Conservancy.
- Boat Sales & Repair: Businesses that sell and repair fishing vessels. This industry employs more people in the Gulf of Mexico than in any other in the marine transport sector (NMFS 2021).
- Government & Politicians: Governments and politicians (across scales and jurisdictions) are key stakeholders in fisheries science and management by developing regulations, funding, and research priorities.
- Law Enforcement: Enforces and promotes compliance of NOAA Fisheries mandates via patrols, monitoring, and investigations<sup>12</sup>.

### *Prioritizing and Directly Engaging Stakeholders*

While beyond the scope of Task 1, we also reviewed literature on stakeholder prioritization. After key stakeholders are defined and identified, another major challenge involves effectively and equitably prioritizing and engaging the most appropriate groups and individuals (Mitchell et al. 1997; Mikalsen and Jentoft 2001; Sharpe et al. 2021). Direct engagement of stakeholders is critical for maximizing the diversity of stakeholder groups represented since voluntary pathways, such as public comment, are often not representative of broader populations (Einstein et al. 2019) and may not include the stakeholders most directly impacted by the issue at hand (Golden 1998).

There is extensive literature on stakeholder prioritization, including applications in fisheries management. Among the most widely applied approaches, which was used in the Mikalsen and Jentoft study described above, was described by Mitchell and colleagues (1997) and involved scoring three criteria for selecting stakeholders:

- a) *power*, both real and potential, of the stakeholder to influence management,
- b) *legitimacy* of the stakeholder's relationship to the fishery and other stakeholders, and
- c) *urgency* with which the stakeholder treats the problem.

*Practicality*, or selecting stakeholders based on how easily they can be accessed, has been proposed as an additional fourth criteria<sup>13</sup> and has clear relevance for fisheries management, but could also lead to exclusion of groups that are underrepresented or difficult to engage.

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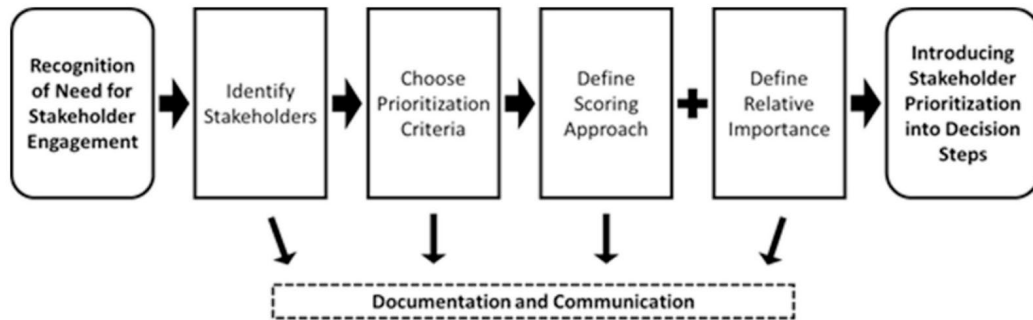
<sup>12</sup> <https://www.fisheries.noaa.gov/about/office-law-enforcement>

<sup>13</sup> <https://i2insights.org/2021/10/28/selecting-stakeholders/>

A more recent resource is a review by Sharpe and colleagues (2021) that proposes ten criteria to be considered for prioritizing stakeholders in environmental management decision-making:

- |   |                           |                                   |
|---|---------------------------|-----------------------------------|
| <i>Level of interest</i>                        | <i>Level of influence</i> | <i>Magnitude of impact</i>        |
| <i>Probability of impact</i>                    | <i>Proximity</i>          | <i>Economic interest</i>          |
| <i>Rights</i>                                   | <i>Fairness</i>           | <i>Urgency/temporal immediacy</i> |
| <i>Underrepresented/underserved populations</i> |                           |                                   |

Sharpe and colleagues also argue that approaches and criteria used to prioritize stakeholders should be concise and uncomplicated. Figure 2 below shows an example of a simple way of operationalizing criteria into the decision-making process.



*Figure 2. Schematic from Sharpe et al. (2021) showing a process for prioritizing and selecting stakeholders for engagement.*

#### Draft Template for Identifying & Engaging Stakeholders

We also developed a stakeholder mapping template including a detailed list of major categories of potential stakeholders for Gulf of Mexico fisheries. The template is designed to populate a list of highly knowledgeable stakeholders, or "key informants", for gaining insights on a fishery and developing Fishery Ecosystem Plans or Issues (FEP/FEIs). The spreadsheet is designed to be filled out through informal interviews or conversations aimed at identifying highly knowledgeable individuals associated with a fishery. These preliminary contacts may include Council staff, State or Federal fishery managers, Advisory Panel (AP) members, among others.

The list of Primary and Secondary groups is not intended to be comprehensive, and not all categories may apply to all fisheries. This list should be modified to meet the needs of the specific fisheries management context. While all individuals are assigned to a single stakeholder group, it should be noted that in general many individuals may represent multiple categories of stakeholders. Future work should explore potential ways to represent cross-group stakeholders.

## **2. TASK 2 - CONCEPT MAPPING**

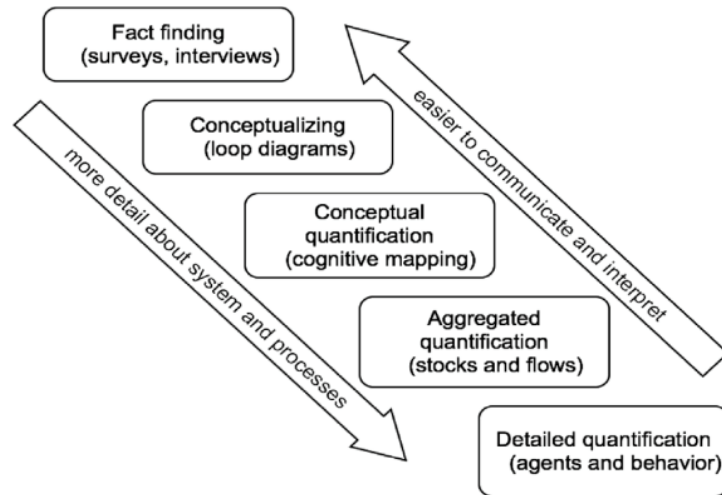
Task 2: Conduct and analyze semi-structured interviews using concept mapping with key informants representing diverse stakeholders in the Gulf of Mexico fisheries.

### **2.1. Background on Participatory Modeling & FEI Concept Maps**

Developing effective FEP's demands recognizing that fisheries are coupled social-ecological systems, with diverse stakeholders inextricably linked with ecosystems (Marshall et al. 2018; Levin et al. 2018). However, engaging diverse stakeholders in fisheries management is challenging and often falls short of achieving broad satisfaction (Crandall et al. 2019). One common issue is that the views or priorities of some stakeholder groups may be portrayed as conflicting with others, despite shared goals for effective management (Levin et al. 2018).

A second issue is that stakeholder input is typically a qualitative process, and often perceived as irreconcilable with the quantitative models relied on for management decisions (Gray et al. 2013). Participatory modeling that includes stakeholders can provide a semi-quantitative scientific process to: (1) decrease uncertainty of the dynamics of fisheries social-ecological systems through collaborative science; (2) harness the expertise and knowledge of stakeholders that rely on marine resources to better understand these systems; and (3) provide a venue for more inclusive forms of fisheries and ecosystem management decision-making (Gray and Scyphers 2017).

One specific approach to participatory modeling called "cognitive mapping" involves the development of cognitive maps (a form of concept mapping). Cognitive mapping can generate various types and levels of information including (1) abstract (e.g., satisfaction) and aggregate (e.g., water quality) variables, (2) models of simple relationships that are not known with certainty, and (3) models of complex relationships that include feedback loops and cross linkages among model components. Compared to narratives or ethnography, cognitive maps can also improve the ease and speed of obtaining and combining data sources (Voinov et al. 2018). Finally, and likely most importantly, participatory modeling provides a platform for visualizing scenarios or potential outcomes of policy options.



*Figure 3. Schematic from Voinov et al. (2018) that presents the tradeoffs between communication and complexity when choosing a participatory modeling method.*

For the context of developing FEP's, a rapidly growing body of literature describes the application and benefits of participatory modeling including: a) identifying research needs & hypotheses, c) providing robust models of complex social-ecological dynamics, and c) predicting fisheries, ecosystem, and management outcomes.

For instance, a study by Rushing and colleagues (2020) involved: 1) building conceptual models with stakeholders and other experts, 2) finalizing a set of hypotheses based on the primary literature, and 3) evaluating those hypotheses based on the qualitative value of information (i.e., potential influence on decision-making).

Another study by Stier and colleagues used mental modeling as a way to measure local ecological knowledge of food web dynamics and make predictions about ecosystem change (Stier et al. 2017). Focused on the herring in Haida Gwaii, BC, Canada, this study found that experts held highly variable perceptions of local food webs, leading to diverging predictions of ecosystem-level outcomes of herring recovery.

Lastly, a recent study by Aminpour et al. (2021) demonstrated that models integrating the knowledge of diverse stakeholders can be more accurate for representing the complex dynamics of a fisheries social-ecological system than models produced by groups of more homogenous stakeholders (Aminpour et al. 2021).

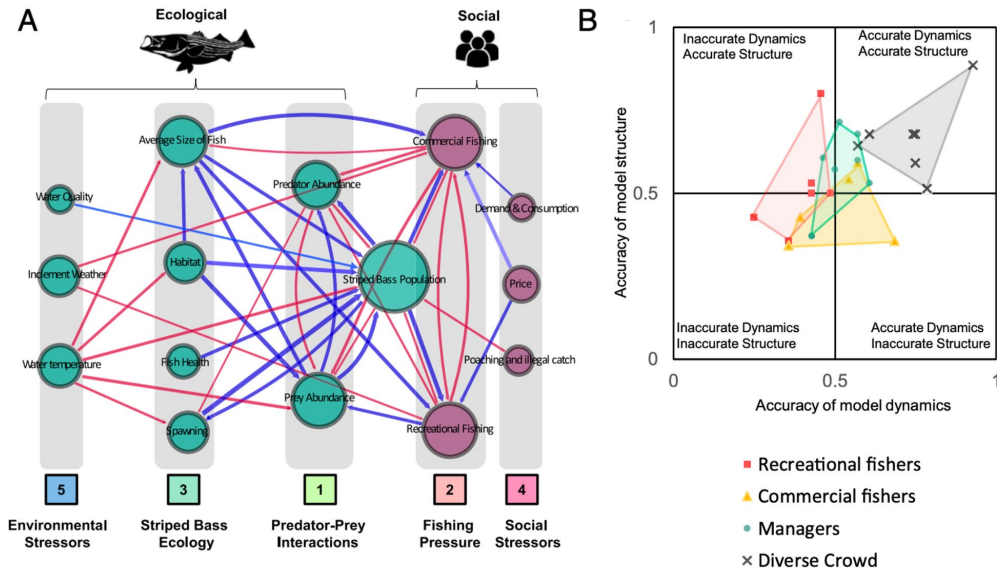


Figure 4. Figures from Aminpour et al. 2021 in PNAS showing a multi-stakeholder model of the striped bass social-ecological system (a) and expert evaluation of model accuracy (b).

## 2.2. General Methodology for Participatory Modeling

While there are several different approaches to participatory modeling, a typical cognitive mapping process involves four key steps (Özesmi and Özesmi 2004):

1. *Drawing cognitive maps (representing mental models) of individual stakeholders.*
2. *Merging individual maps into stakeholder or group maps.*
3. *Analyzing the structure of individual and group maps.*
4. *Simulating potential effects of different policy options through scenario analyses.*

The below box shows a general approach and interview script for participatory modeling that could be applied around the topic of FEI's.

### Fuzzy-cognitive Mapping Interview Script

**Step 1:** If necessary, complete signed (in-person) or unsigned (telephone) consent process.

**Step 2:** Briefly introduce yourself, the project, and the goal of the modeling exercise.

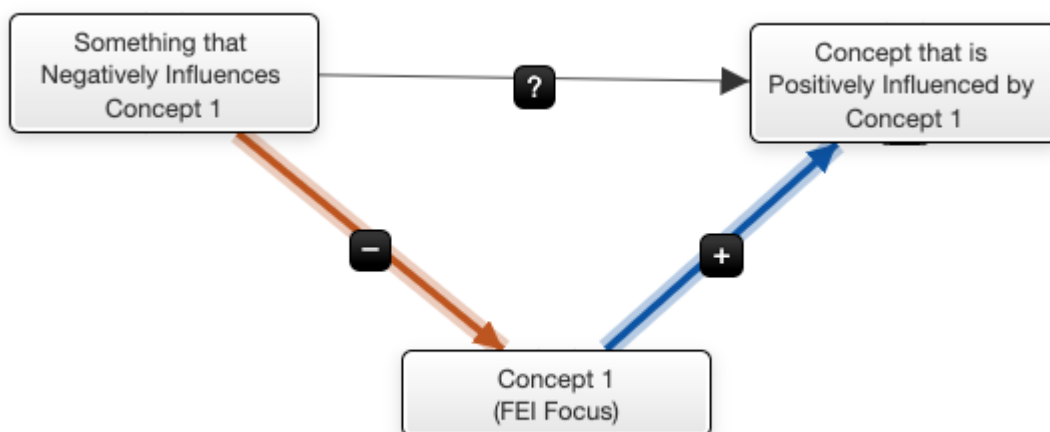
**Step 3:** Introduce participant(s) to Concept 1 (e.g., FEI focus, such as Bycatch) – defined in simple terms, the starting point of the interview.

**Step 3:** In a conversational manner, ask each participant to develop a list of factors (independent variables) that might be associated with (Concept 1). You may repeatedly prompt with “are there any other things that you think influence Concept 1” and “are there any other things that are influenced by Concept 1).

**Step 4:** Next, for each new concept, ask about the direction of the relationship, whether the effect is positive or negative. If possible, rate the strength on a scale of Weak (0.33), Moderate (0.67) or Strong (1.0). Alternative, you may simply score positive influences as 1.0 and negative influences as -0.1.

**Step 5:** Finally, ask a series of questions to cross-reference all of the shown concepts, remembering to include any new ones the participant might feel are important. Repeat Step 4, asking about the direction of the relationship, whether the effect is positive or negative, and rate the strength.

**[All interviews can be voice recorded, although notes will also be taken to record interesting points during the interview]**



Participatory modeling can be conducted visually using the stakeholder-focused online software program MentalModeler ([www.mentalmodeler.com](http://www.mentalmodeler.com)), hand-drawn on paper, or filled using a matrix-based approach in a spreadsheet.

The number of individual models needed for a study depends on the complexity of the issue being modeled and the diversity of stakeholder input desired. In general, interviews should be conducted to ensure that most or all major concepts are included in the overall model. This can be calculated by plotting the number of new concepts in each model and continuing to add participants until the number of new concepts asymptotes (Özesmi and Özesmi 2004).

### **3. PILOT STUDY: BYCATCH IN THE EASTERN GULF OF MEXICO**

The initial plan for Task 2 was to build conceptual models of the broader Gulf of Mexico fishery ecosystem with diverse stakeholders. However, as the project evolved to structure the FEP around geographically specific FEIs, we primarily used the pilot study as a demonstration of mental modeling. While we describe both the approach and key findings, it is important to consider that full implementation with sufficient stakeholders was beyond the scope, timeline, and resources available.

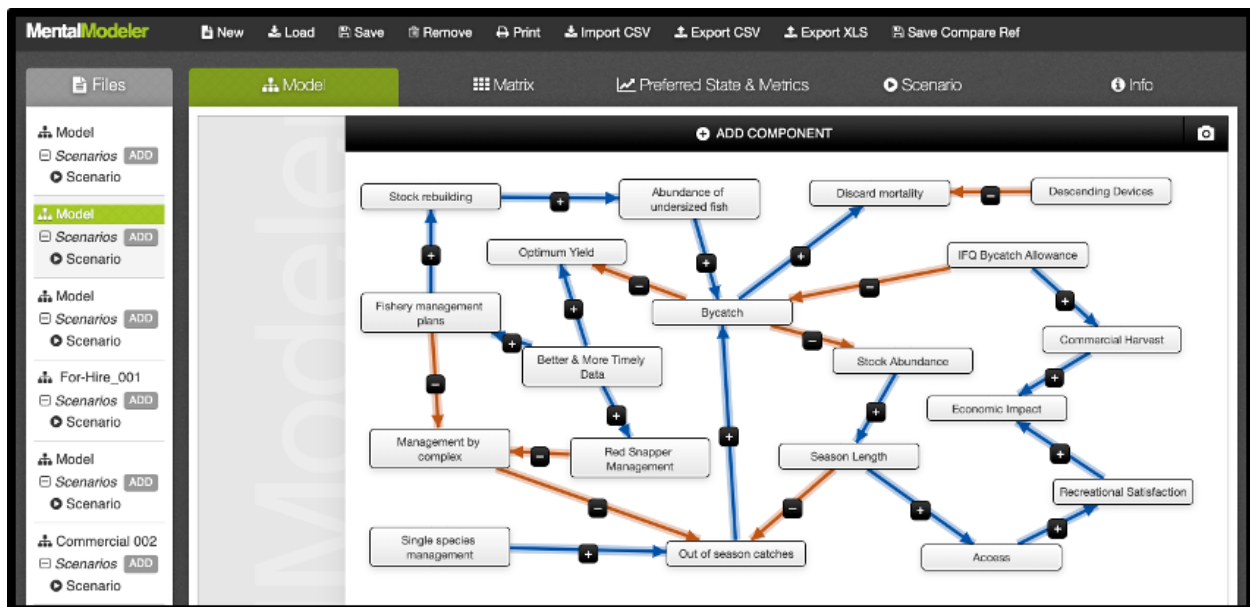
#### *Identifying & Recruiting Participants.*

In a full implementation of an FEI, we recommend using a structured and inclusive process for stakeholder prioritization and participant recruitment, such as the approaches outlined in Sharpe et al. 2021 and integrated into the Stakeholder Mapping Template. While we tested and evaluated earlier versions of these resources as part of the demonstration case, the project timeline and resources did not allow full implementation. In this demonstration case, stakeholder groups were prioritized by Council Staff. Modeling participants were nominated by FEP consulting team (LGL Ecological Associates), Gulf Council staff, NOAA Fisheries, and other interested parties who volunteered after an open invitation at the September 10 meeting of the Council's Ecosystem Technical Committee. All nominees were compiled into a comprehensive list, and additional names were added through snowball sampling during participatory modeling exercises. While all individuals were assigned to a single stakeholder group, it should be noted that in general many individuals represent multiple categories of stakeholders. Future work should explore potential ways to represent cross-group stakeholders.

Drawing cognitive maps (representing mental models) of individual stakeholders.

All modeling activities were conducted following the script shown above (Box 1) and using the online concept mapping software MentalModeler (Figure 5; Gray et al. 2013). In this demonstration FEI, we focus on models representing the following four stakeholder groups:

- Commercial Fisheries
- Recreational For-hire Captains
- Recreational Fishing Organizations
- Conservation & Environmental Groups



*Figure 5. Mental model of bycatch created in MentalModeler software. This specific model was produced by an individual from a Recreational Fishing Organization.*

Most participants actively watched the model building process via Zoom, while some joined only by phone and did not view the model building in real time. Each interview lasted 1-2 hours. All models were de-identified and assigned to the most appropriate stakeholder group category.

Analyzing the structure of individual models.

A great deal of insight can be gained by qualitatively evaluating and comparing individual models. Below are brief descriptions of key attributes across four stakeholder models.

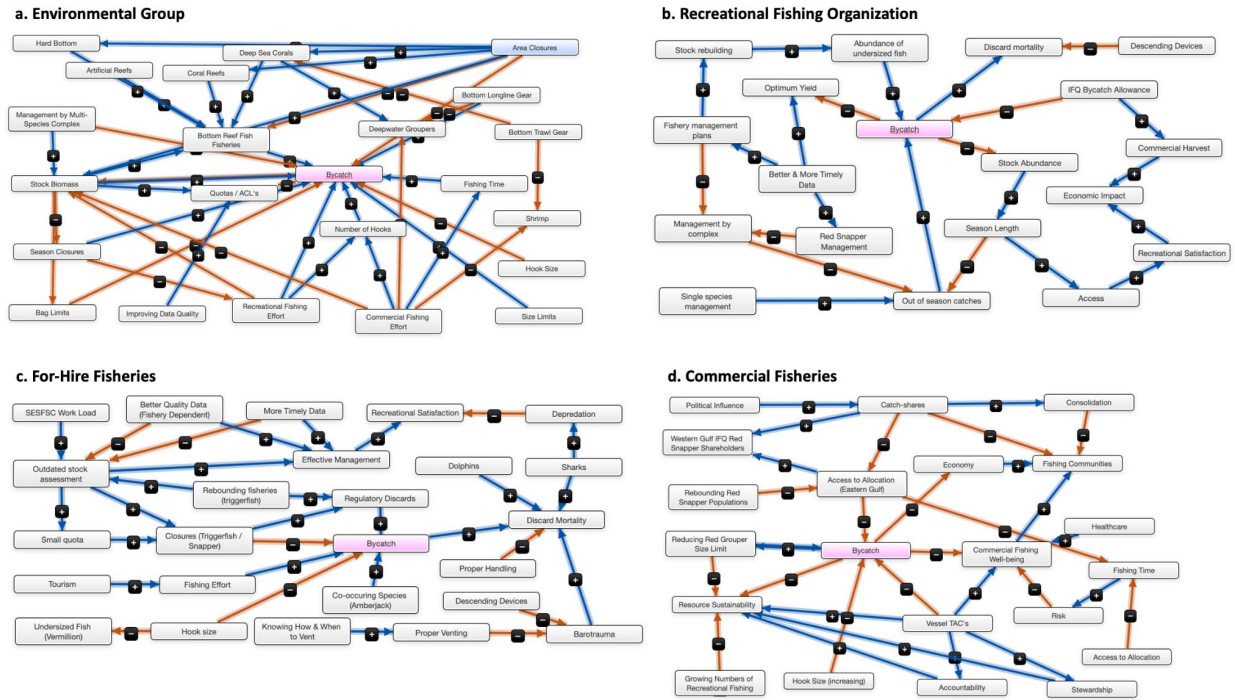


Figure 6. Example mental models representing the following groups: Environmental and Conservation Groups (a), Recreational Fishing Organizations (b), Recreational For-Hire Fisheries (c), and Commercial Fisheries (d).

*Environmental Organizations* (Figure 6a): Bycatch was driven by fishing effort, size limits, and seasonal closures; whereas, Quotas / Annual Catch Limit (ACL's), hook size, area closures, and managing fisheries by multi-species were mapped as potential pathways to decreasing bycatch. Notably, habitat-related issues were only mentioned by this stakeholder group and mapped as a positive influence on bottom reef fish fisheries.

*Recreational Fishing Organization* (Figure 6b): Rebuilding stocks were seen as increasing bycatch through two pathways: 1) out of season catches, and 2) abundant undersized fish. Bycatch was noted to negatively influence both stock abundance and optimum yield (OY). Modeling activities also routinely produced insights on other stakeholder groups, both positively and negatively. For instance, a Recreational Fishing Organization model proposed that Individual Fishing Quotas (IFQ) bycatch allowances for commercial fisheries could be a potential strategy for reducing bycatch while simultaneously increasing commercial harvests.

*Recreational For-Hire Fisheries* (Figure 6c): Key insights included that fisheries closures were described as both increasing and decreasing bycatch. Lower bycatch could be expected for closures that results in lowered fishing effort; however, closures resulting in greater regulatory discards was noted as increasing bycatch. Rebounding fisheries were noted as a contributor to regulatory discards as the abundance of fish outpaces increased catch rates. Discard mortality

and decreased fishing satisfaction were seen as major consequences of bycatch. Both for-hire modeling participants noted that discard mortality could be reduced by knowledgeable fishing practices, including fishing behaviors and proper handling.

For *Commercial Fisheries* (Figure 6d), regulatory discards, primarily resulting from low access to quota, was a primary driver of bycatch. Commercial Fisheries models also revealed conflict with recreational fisheries, which were mapped as increasing bycatch through the intentional catch-and-release of closed fisheries and high-grading. Commercial fisheries models included several consequences of bycatch, including negative impacts on the well-being of commercial fishermen, fishing communities, and the economy. Gear-related strategies to reduce bycatch were mapped as both positive and negative. For instance, one concept map noted increasing hook size as a pathway to decreasing bycatch. However, another map indicated that gear-related regulations could be anticipated to have negative impacts on the well-being of fishermen and fishing communities. IFQ-related issues were prevalent in both maps and often related to fishing access, concerns for consolidation, and impacts on fishing communities.

*Merging individual maps into stakeholder or group models.*

To demonstrate the process for merging individual models into multi-stakeholder models, we integrated a subset of four models representing the four stakeholder groups. Across these four models, modeling activities produced 88 different concepts related to bycatch (Table 2).

Initial List of Raw Concepts from 4 Stakeholder-Group Models			
Bycatch	Area Closures	Bycatch	Small quota
Access to Allocation	Artificial Reefs	Barotrauma	Tourism
Access to Allocation (Eastern Gulf)	Bag Limits	Better Quality Data (Fishery Dependent)	Undersized Fish (Vermillion)
Accountability	Bottom Longline Gear	Closures (Triggerfish / Snapper)	Bycatch
Catch-shares	Bottom Reef Fish Fisheries	Co-occurring Species (Amberjack)	Abundance of undersized fish
Commercial Fishing Well-being	Bottom Trawl Gear	Depredation	Access
Consolidation	Commercial Fishing Effort	Descending Devices	Better & More Timely Data
Economy	Coral Reefs	Discard Mortality	Commercial Harvest
Fishing Communities	Deep Sea Corals	Dolphins	Descending Devices
Fishing Time	Deepwater Groupers	Effective Management	Discard mortality
Growing Numbers of Recreational Fishing	Fishing Time	Fishing Effort	Economic Impact
Healthcare	Hard Bottom	Hook size	Fishery management plans
Hook Size (increasing)	Improving Data Quality	Knowing How & When to Vent	IFQ Bycatch Allowance
Political Influence	Management by Multi-Species Complex	More Timely Data	Management by complex
Rebounding Red Snapper Populations	Number of Hooks	Outdated stock assessment	Optimum Yield
Reducing Red Grouper Size Limit	Quotas / ACL's	Proper Handling	Out of season catches
Resource Sustainability	Recreational Fishing Effort	Proper Venting	Recreational Satisfaction
Risk	Season Closures	Rebounding fisheries (triggerfish)	Red Snapper Management
Stewardship	Shrimp	Recreational Satisfaction	Season Length
Vessel TAC's	Size Limits	Regulatory Discards	Single species management
Western Gulf IFQ Red Snapper Shareholders	Stock Biomass	SEFSC Work Load	Stock Abundance
Bycatch	Hook Size	Sharks	Stock rebuilding

*Table 2. Initial list of 88 concepts produced by four stakeholder group models.*

From this list of 88 concepts, we developed a coding scheme and binned them into a narrower set of 30 standardized concepts (Table 3).

Final List of Binned Concepts from 4 Stakeholder-Group Models			
Access	Commercial Fisherman Well-being	Fishing Gear	Recreational Satisfaction
Area Closures	Depredation	Habitat	Regulatory Discards
Bag Limits	Discard Mortality	Hook Size	Resource Sustainability
Better & More Timely Data	Economy	Management by Multi-Species Complex	Season Closures
Bycatch	Effective Management	Optimum Yield	SEFSC Work Load
Catch-share Issues	Fishery Closures (Triggerfish / Snapper)	Proper Handling (Venting / Descending / Stewardship)	Size Limits
Co-occurring Species (Amberjack)	Fishing Communities	Rebounding Fisheries (Red Snapper / Triggerfish)	
Commercial Fisheries	Fishing Effort	Recreational Fisheries	

Table 3. Final list of 30 standardized concepts produced by four stakeholder group models.

After re-coding the original models using the standardized list of 30 concepts, we then merged each stakeholder model into an overall Multi-Stakeholder Model through simple averaging (Figure 7).

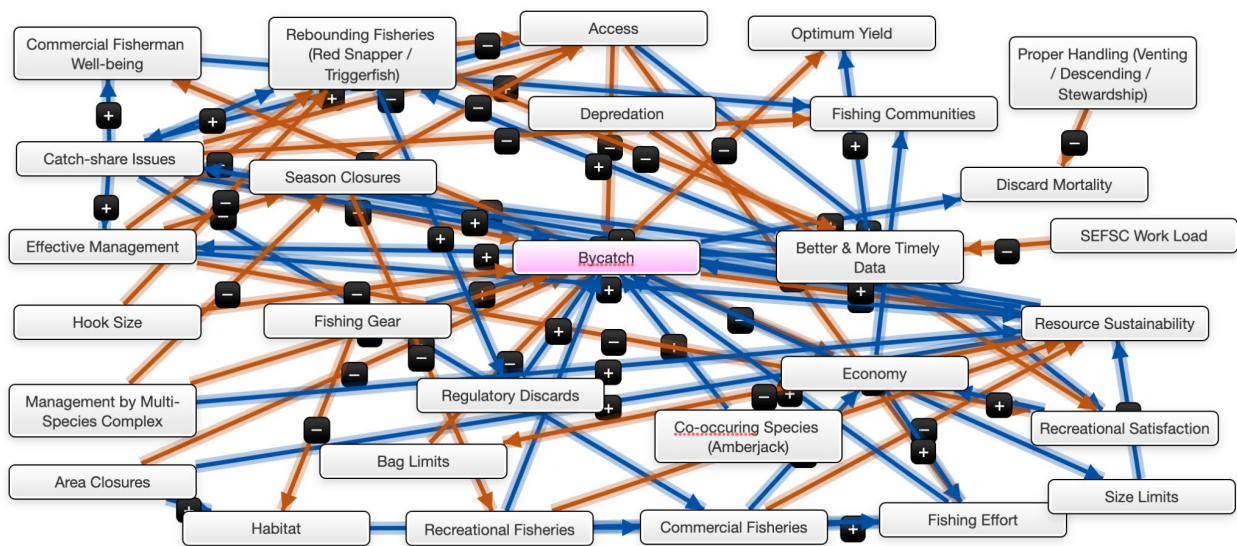
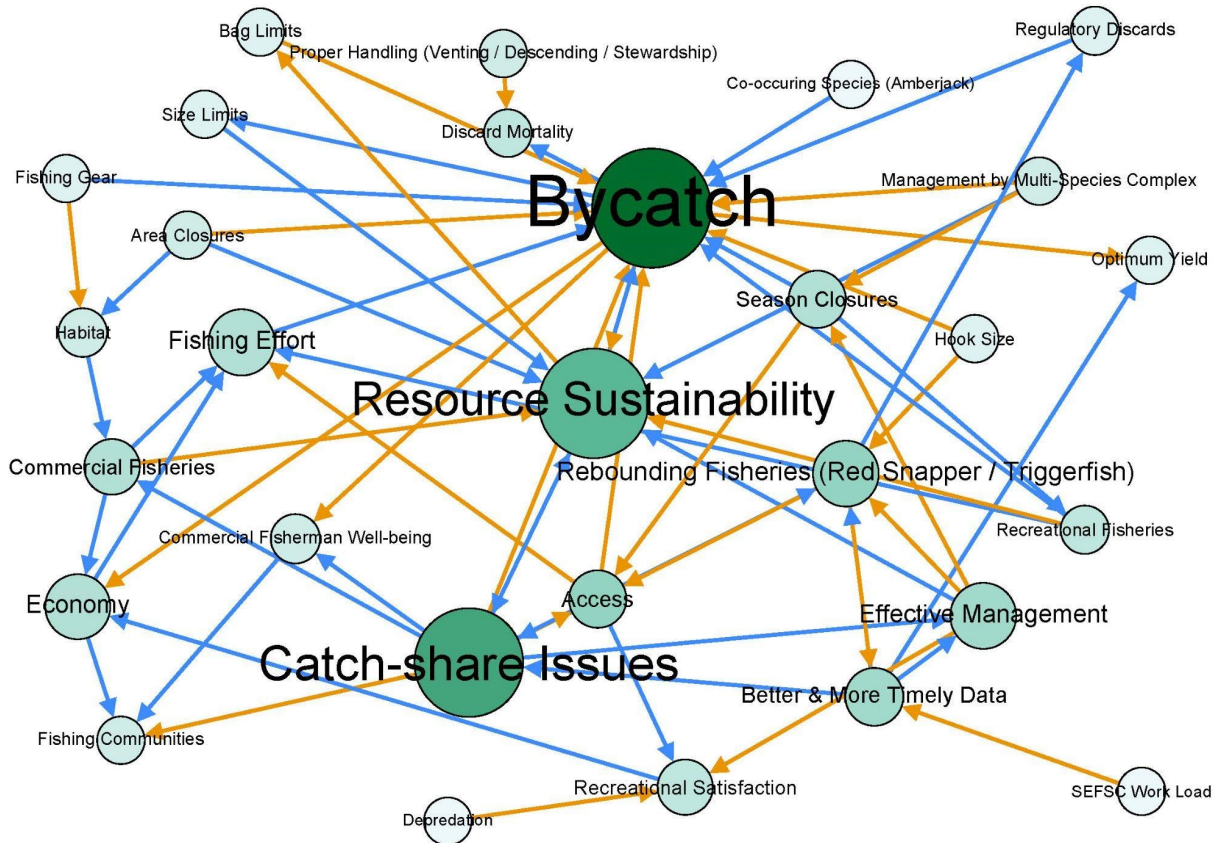


Figure 7. Overall Multi-Stakeholder Model of concepts related to bycatch.

We also graphed the final model in the network visualization software Gephi (Figure 8), with the major difference being a more clear picture of the concepts that are most influential within the model represented by node size.



*Figure 8. Overall Multi-Stakeholder Model of concepts related to bycatch. Larger, darker colored circles indicate more influential concepts than smaller, lighter colored ones.*

Simulating potential effects of different policy options through scenario analyses.

A major strength of mental modeling is the ability to run “what if” scenarios of management, policy, or ecosystem change. For demonstration purposes, we ran two stakeholder-driven scenarios that were motivated by stakeholder models, including proposed strategies to mitigate bycatch or its consequences. We used MentalModeler for all scenario analyses and reproduced the graphs in Excel.

### Stakeholder-Driven Scenario 1: Proper Handling, including Venting, Descending

Multiple participants noted that discard mortality, a major side effect of bycatch, could be mitigated through *Proper Handling* of released fish. *Proper Handling* was a composite concept that included specific concepts such as *Proper Handling*, *Proper Venting*, *Knowing How and When to Vent*, and *Stewardship*. As expected, a scenario simulating *Proper Handling* resulted in a predicted decrease in bycatch mortality in the overall model (Figure 9a). Interestingly, however, *Proper Handling* did not create any trade-offs within the model or impact any other variable besides *Discard Mortality*.

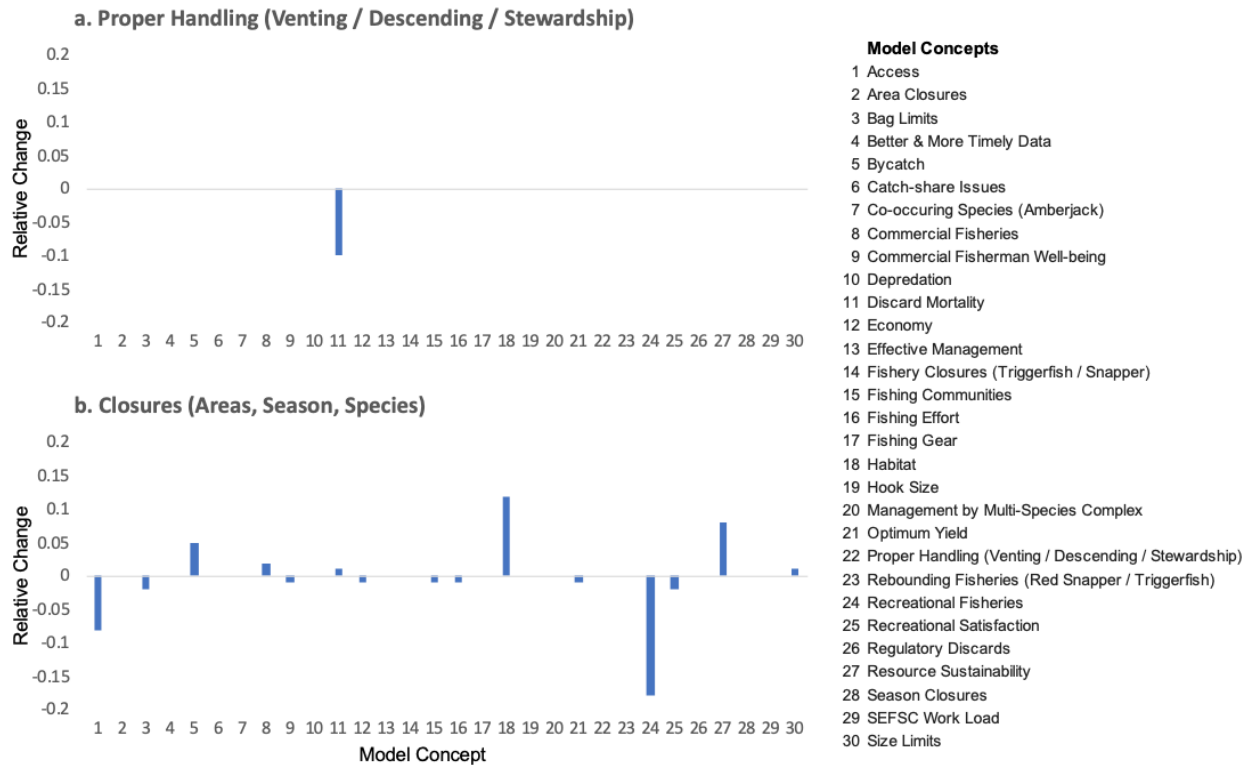


Figure 9. Example Scenarios of Proper Handling, including Venting, Descending, and Stewardship (a), and Areas, Seasons, and/or Species Closures (b).

### Stakeholder-Driven Scenario 2: Closures (Areas, Seasons, Species)

Fisheries closures, including species, seasonal, and area, were all seen as major components of the bycatch FEI (Figure 9b). When all closures were simulated in scenario analyses, a complex pattern of trade-offs emerged. For instance, closures positively affected *Habitat* and *Resource Sustainability*, the latter of which was a composite concept including *Stock Abundance*, *Biomass*, and other similar concepts. However, scenario analyses of closures also predicted negative impacts to *Access*, *Recreational Fisheries*, and an increase in *Bycatch*.

#### **4. TWO KEY MESSAGES WITH IMPLICATIONS FOR STAKEHOLDER ENGAGEMENT IN FEI'S**

- **Stakeholder Assessment Could Promote Diverse Engagement and Success of FEIs.** Considering the many, diverse stakeholders associated with Gulf of Mexico fisheries and ecosystems, a structured process for identifying, prioritizing, and engaging stakeholders is necessary to maximize inclusivity, success, and buy-in. Engagement efforts should include early stages, such as identifying and selecting FEI's, as well as later stages like interpreting outcomes of scenarios modeling potential management alternatives. However, there will always be practical limitations on engagement, thus considering how many and which stakeholders to prioritize will be important. While testing strategies for stakeholder engagement was beyond the scope of this project, our summary of recent literature and Stakeholder Mapping template laid the groundwork for further work in this important area.
- **Participatory Modeling Provides a Process for Stakeholder Engagement, Developing Research Priorities, and Predicting Management Trade-offs.** The semi-quantitative models produced by diverse stakeholders could provide many benefits for FEI planning and development. First, participatory modeling can represent stakeholder knowledge and produce testable hypotheses, such as that fishing behavior plays a major role in reducing bycatch. Stakeholder-level models can identify potential for conflict and cooperation, as well as help identify potential trade-offs of management actions, such as among multiple National Standards. For instance, while the demonstration case focused on bycatch (i.e., National Standard 9), participants added concepts representing Optimum Yield (National Standard 1) and the well-being of fishermen and fishing communities (National Standard 8). Finally, participatory modeling has been widely used to identify key research priorities for important areas with high uncertainty. These stakeholder-driven priorities could be considered by the Gulf Council and Southeast Fisheries Science Center for research agendas and developing funding RFP's.

**Appendix 1. Images of Stakeholder Mapping Template. The latest version is available for download at this [Link](#).**

FISHERY ECOSYSTEM PLAN - STAKEHOLDER PRIORITIZATION						
<p><b>Instructions:</b> This template is designed to prioritize categories of stakeholders for engagement for understanding and addressing specific fisheries issues. The First Step is to Score each Secondary Group for their Power, Legitimacy, and Urgency for the specific issue of interest. Power can be defined as a group's direct or potential influence on the issue. Urgency reflects the immediate importance of the issue for each stakeholder group. Legitimacy can be considered as the relative experience and potential insight each group could provide on the issue. Each criteria should be scored as Not Applicable (0), Low (1) Medium (3), or High (5). Next, select a final priority for each group based using the Total Score values.</p>						
PRIMARY GROUP	Secondary Group	Power	Urgency	Legitimacy	Total Score	Priority
Recreational	For-hire				0	
	Private boat				0	
	Shore-based				0	
	Fishing organizations (Enter other)				0	
Commercial	Owner				0	
	Owner Operator				0	
	Captains				0	
	Crew Fishing organizations (Enter other)				0	
Subsistence / Indigenous	Subsistence				0	
	Indigenous (Enter other)				0	
Fishing Businesses	Bait-n-tackle shops				0	
	Piers (Enter other)				0	
Seafood Businesses	Dealers				0	
	Processors				0	
	Retailers Restaurants (Enter other)				0	
Fisheries Science	NOAA Fisheries Science Centers				0	
	Academics / Universities				0	
	Private sector researchers (Enter other)				0	
Fisheries Management	NOAA Fisheries Regional Offices				0	
	State Fisheries Management				0	
	Regional State Fisheries Commissions (Enter other)				0	
Other Stakeholders	SCUBA divers				0	
	Fishing Media / Publications				0	
	Seafood consumers				0	
	Environmental & Conservation				0	
	Boat sales & repair				0	
	Governments & Politicians Law Enforcement (Enter other)				0	

## Appendix 1 (continued)

FISHERY ECOSYSTEM PLAN - STAKEHOLDER MAPPING TEMPLATE												
<b>Instructions:</b> This template is designed to populate a list of highly knowledgeable stakeholders, or "key informants", for gaining insights on a fishery and potentially developing fishery ecosystem plans (FEP). The spreadsheet is designed to be filled out through informal interviews or conversations aimed at identifying highly knowledgeable individuals associated with a fishery. These preliminary contacts may include Council staff, State or Federal fishery managers, Advisory Panel (AP) members, among others. The list of Primary and Secondary groups is not intended to be comprehensive, and not all categories may apply to all fisheries. This list should be modified to meet the needs of the specific fishery or FEP context.												
PRIMARY GROUP	Secondary Group	Priority	Key Informant - Name	Organization	Phone	Email	State	Location / Primary Port	Suggested By	Best Strategy to Contact	Notes	Website
Recreational	For-hire											
Recreational	Private boat											
Recreational	Shore-based											
Recreational	Fishing organizations											
Recreational												
Commercial	Owner											
Commercial	Owner Operator											
Commercial	Captains											
Commercial	Crew											
Commercial	Fishing organizations											
Commercial												
Subsistence / Indigenous	Subsistence											
Subsistence / Indigenous	Indigenous											
Subsistence / Indigenous												
Fishing Businesses	Bait-n-tackle shops											
Fishing Businesses	Piers											
Fishing Businesses												
Seafood Businesses	Dealers											
Seafood Businesses	Processors											
Seafood Businesses	Retailers											
Seafood Businesses	Restaurants											
Seafood Businesses												

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