Co-Producing a Shared Characterization of Depredation in the Gulf of Mexico Reef Fish Fishery: 2022 Workshop Summary Report

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Co-Producing a Shared Characterization of Depredation in the Gulf of Mexico Reef Fish Fishery: 2022 Workshop Summary Report

May 2nd, 2022

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Executive Summary:

Depredation is defined as the partial or complete removal of a hooked fish by a non-target species (Gilman et al. 2008), and is a cryptic form of mortality that can have significant implications on the accuracy of stock assessments and species management efforts. Accounting for depredation interactions is crucial to minimize uncertainty in stock assessment models and to obtain accurate and reliable fisheries catch data. If these interactions are frequent, failure to properly quantify this form of cryptic mortality can lead to the underestimation of reef fish population removals and inappropriate harvest recommendations. However, quantifying depredation in a stock assessment remains impossible without first characterizing the problem.

In recent years, depredation interactions have escalated in the Gulf of Mexico (GoM). Bottom longline and vertical line (bandit gear) fisheries data from the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Reef Fish Observer Program demonstrate increased cases of depredation, particularly over the past few years (2017-2020, Duffin et al. unpublished data). These interactions, which result in decreased catch and profits, have become a prominent point of discussion during Gulf of Mexico Fishery Management Council (GMFMC) meetings, and anecdotally are becoming worse. Although GoM reef fishery stakeholders (fishermen) have actively pushed for resource managers to implement solutions to address these increasingly pervasive interactions, a comprehensive characterization of this issue is lacking, and trends surrounding GoM reef fish depredation – as well as factors that impact depredation – have not been adequately described or evaluated. Therefore, the project team worked to co-produce a shared characterization of the impacts of depredation in the GoM reef fish fishery. The results of this process will inform future efforts to quantify depredations and develop effective solutions.

Summary of Methods:

Data interpretation. – Co-producing a shared characterization of depredation in the GoM was the result of three phases. First, the project team gathered, analyzed, and interpreted an existing GoM depredation-related dataset (observer data from the GoM reef fish fishery) to characterize depredation in the GoM reef fish fishery. Analysis included the examination of temporal trends (seasonal and annual) in depredation, determining spatial variability in depredation using geospatial techniques, and testing for differences in depredation rates across gear types and field methods (bait type, soak time, haul time). The bulk of this work is summarized in a publication in prep (Duffin et al. unpublished data).

Survey design and analysis. – After compiling existing information on GoM reef fish depredation, the project team designed and implemented a comprehensive depredation-focused electronic survey of 1,000 GoM commercial and recreational fishermen. The survey was designed to measure participants' ecological knowledge of depredation through map-based questions of temporal and spatial depredation (participatory mapping) and to identify participants' attitudes towards the causes of, impacts of, and solutions to depredation. Survey questions also focused on measuring participants' perspectives on ecosystem change as a result of increases or decreases in depredation, reef fish populations, shark populations, and fisheries management effectiveness. Some examples of questions asked of participants are outlined below (**Table 1**).

Table 1: Key concepts and associated questions from the survey.

Concept	Question	Response Format/Choices
Angler perceptions of causes of depredation	What do you think causes depredation?	Free response
Angler perceptions of impacts of depredation	What do you think are outcomes or impacts of depredation?	Free response
Angler perceptions of possible solutions to depredation	What do you see as potential ways to reduce depredation?	Free response
Satisfaction with fisheries management	How would you describe your overall level of satisfaction with current fisheries management?	Very dissatisfied to very satisfied
Identification of the most common forms of depredation in the GoM	What form of depredation do you think is the most common?	Shark depredation, dolphin depredation, other fish depredation, not sure

Workshop design, development, and implementation. – Data synthesis and community models created from the first two project phases laid the groundwork for the development of a collaborative mental modeling workshop. This workshop, which was convened on April 4, 2022 in Gulf Shores, Alabama, served to: 1) allow stakeholders (n=22) to develop, assess, discuss, and refine regional GoM reef fish depredation community models; 2) facilitate in-person discussion and reciprocal learning among researchers, resource managers, and stakeholders

about GoM reef fish depredation; and 3) identify knowledge gaps concerning GoM reef fish depredation.

First, the reef fish depredation data syntheses were presented to workshop stakeholders. Stakeholders were then divided into three breakout groups (western GoM, central GoM, and eastern GoM) to develop regional depredation community models. Four core model concepts (depredation, angler satisfaction, reef fish populations, and fisheries management effectiveness) identified from the survey were presented to stakeholders during these breakout groups. Twenty additional concepts (also identified from the survey) were also presented in a word bank to encourage further discussion and to identify which components were most important to characterizing GoM reef fish depredation (**Figure 1**). Stakeholders were able to select components presented in the word bank and/or suggest components of their own to incorporate into regional community models. Community models were then created and finalized through moderated group discussion. Although attempts were made to adequately divide stakeholders by region, clear differences at the state level resulted in the creation of five breakout groups (TX, LA, MS, AL, FL) to accurately capture more fine-scale differences in depredation components and interactions within community models. Levels of agreement and confidence among all components and relationships within community models were identified and displayed in *Mental Modeler*, a cognitive mapping software designed to allow researchers, research managers, and stakeholders to construct semi-quantitative concept maps and illustrate hypothesized or known relationships (Gray et al. 2013). Scenario analysis was also completed within *Mental Modeler* to determine how increases or decreases in components within the models altered the remainder of the system. Additionally, stakeholder breakout groups contributed to participatory mapping exercises to determine temporal and spatial depredation trends. This process resulted in tangible products that incorporated stakeholder knowledge and perceptions of GoM depredation that can be used to better inform fisheries management and accurately capture changes and preferred states within a dynamic social-ecological system. Lastly, exit surveys were distributed to all stakeholders at the conclusion of the workshop to enable the project team to elicit feedback on workshop effectiveness and design and to determine future research directions. The human subjects research outlined in this report was approved by Northeastern University's Institutional Review Board (IRB #13-07-16), and informed consent was acquired from all stakeholders. The remainder of this report will focus on the results of the stakeholder workshop, the third and final phase of the project, and will be structured as follows:

- A brief summary of the results and discussion raised by workshop stakeholders.
- The workshop agenda attached as **Appendix A.**
- A full list of workshop attendees attached as **Appendix B**.
- State-specific community models developed at the workshop attached as **Appendix C**.
- State-specific scenario analyses based on the state-specific community models developed at the workshop attached as **Appendix D**.
- Regional hot-spot maps developed at the workshop attached as **Appendix E**.
- Workshop time-series graphs developed at the workshop attached as **Appendix F**.
- Workshop photos attached as **Appendix G**.

Figure 1: Concept word bank presented to breakout groups during the stakeholder workshop.

Results and Discussion:

Depredation trends. – Most stakeholders agreed that reef fish depredation in the GoM started increasing significantly in 2017, which agrees with the data synthesis portion of this project reflecting depredation temporal trends in the GoM (**Figures 2 and 3**). Stakeholders presented a number of potential contributing factors for this increase that ranged from changes in fisheries management and socio-economic dynamics to environmental and ecological alterations.

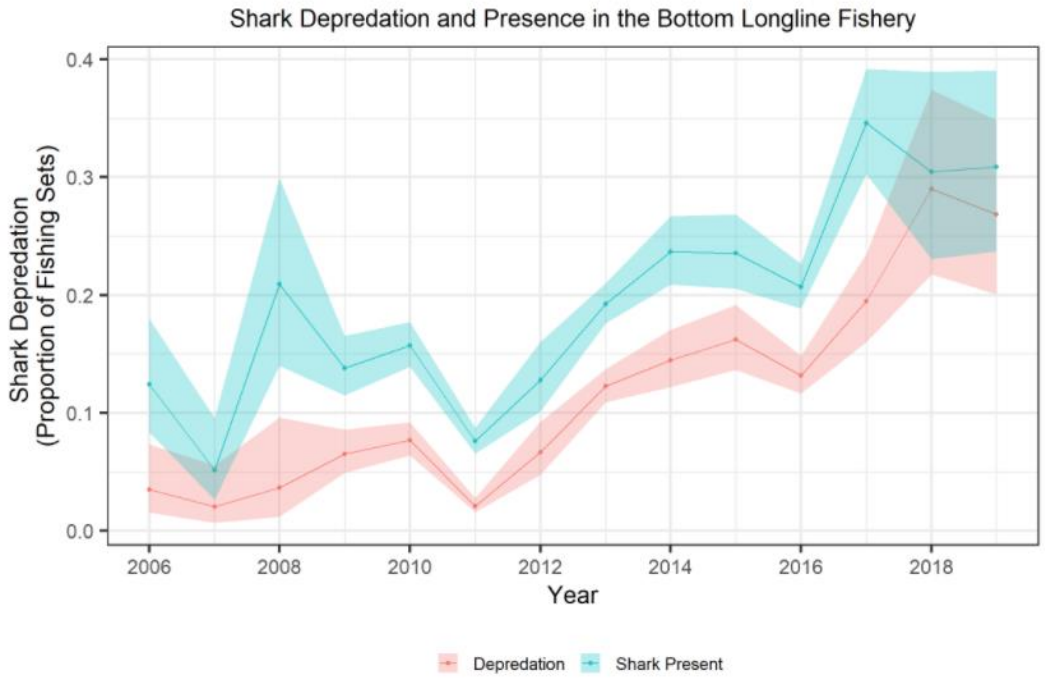


Figure 2: Temporal trends of shark presence and depredation in the Gulf of Mexico bottom longline reef fish fishery from 2006-2020 (from Duffin et al. unpublished data).

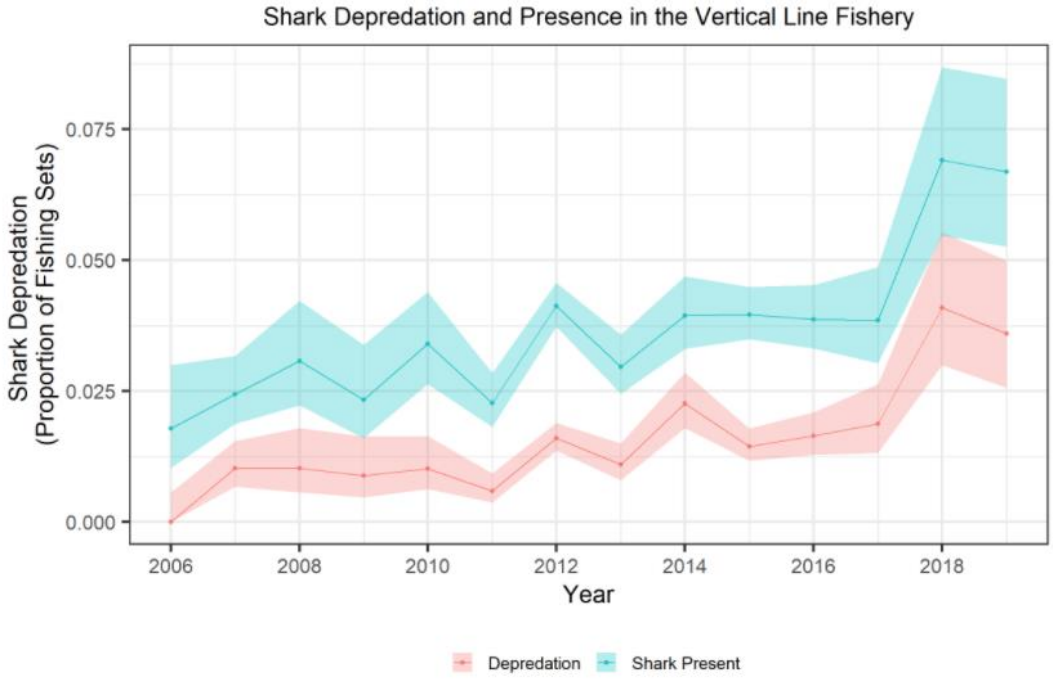


Figure 3: Temporal trends of shark presence and depredation in the Gulf of Mexico vertical longline reef fish fishery from 2006-2020 (from Duffin et al. unpublished data).

Regional dynamics of reef fish depredation in the GoM. – Depredation-related knowledge and beliefs that were captured during breakout groups were used to construct community models to describe regional dynamics of reef fish depredation in the GoM. Relationships between concepts are connected via directional arrows that indicate the influence (positive/negative) one component has on another. For each community model, variables were categorized as driver, receiver, or ordinary to assess each variable's role within the model. Depredation drivers are listed for each community model and are defined as having positive outdegrees and zero indegrees within the *Mental Modeler* software.

Scenario analysis. – While the majority of stakeholders agreed that instances of depredation are increasing, there was division among stakeholders on whether GoM shark populations have significantly increased or decreased in recent years, and whether fisheries management efforts are responsible for the rise in depredation interactions. Because these two concepts were identified to be of high importance among breakout group discussions compared to other system components, they were selected for use in scenario analyses to determine how each regional community model would be altered by changes in shark populations and fisheries management effectiveness. Changes in these two components resulted in different outcomes for each stakeholder group.

Species responsible. – Although some stakeholders attributed the rise in depredation interactions to increased shark populations, there was no consensus on which shark species are predominantly responsible. Ridgeback shark species (specifically sandbar sharks, *Carcharhinus plumbeus,* silky sharks, *Carcharhinus falciformis,* and dusky sharks, *Carcharhinus obscurus*) and bull sharks (*Carcharhinus leucas*) were frequently mentioned as primary depredators, along with bottlenose dolphins (*Tursiops truncatus*). Goliath grouper (*Epinephelus itajara*) and amberjack (*Seriola* spp.) were also mentioned as depredator species, although these species were not discussed in detail. Regional depredation hot-spot maps were developed from workshop participatory mapping exercises. A Gulf-wide model of depredation hot-spots is displayed below.

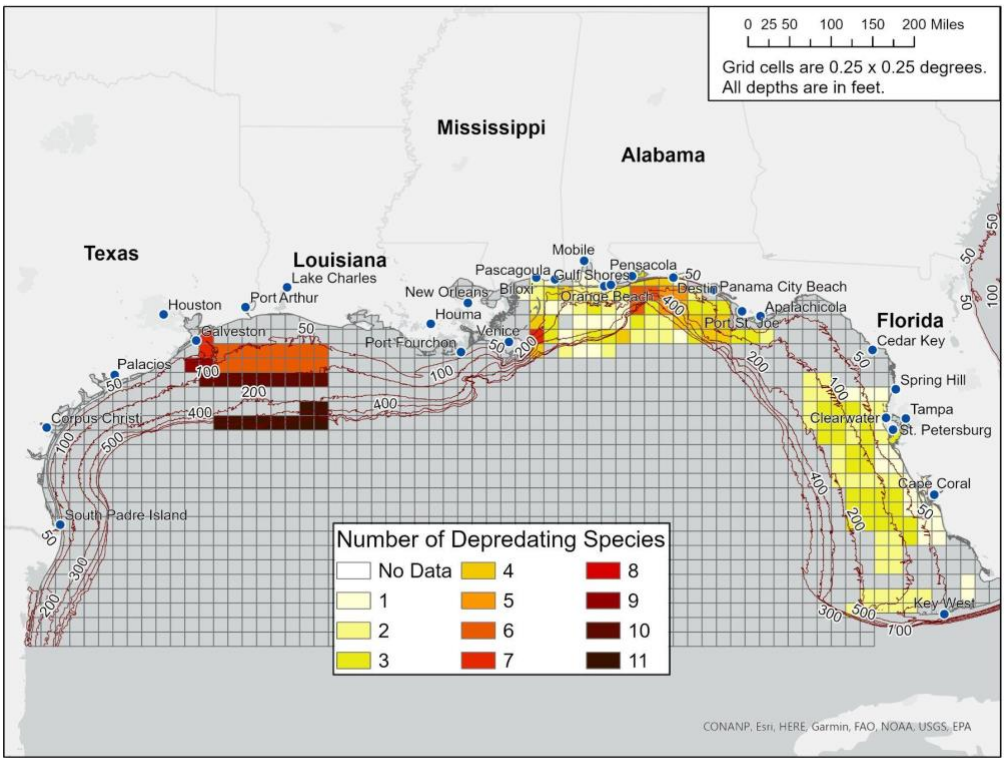


Figure 4: Reef fish depredation hot spots throughout the Gulf of Mexico.

Depredation solutions. – Potential solutions to increased reef fish depredation in the GoM were divided and mirrored stakeholder opinion on shark population status. If stakeholders felt that shark populations have increased and recovered, they felt that the implementation of a directed and expanded shark fishery was a viable solution to decrease the negative impacts of depredation. Others felt a multifaceted approach would be more appropriate and effective. Many stakeholders recognized that changing public perception and depending on consumers to support a shark market may simply not be feasible. Deterrents seemed to have moderate support among these stakeholders, with the use of the Zeppelin and shark necromones mentioned specifically. Some stakeholders who have used deterrents seemed to agree that although deterrents may be effective initially, their effectiveness declines over time. Despite this, stakeholders maintained interest in using shark necromones as a possible deterrent and showed support for more collaborative research on their effectiveness in minimizing depredation interactions.

Workshop effectiveness. – Overall, stakeholders rated the workshop highly, with 100% of stakeholders agreeing or strongly agreeing that the workshop purpose was clear, the workshop achieved its objectives, the workshop was a valuable use of time, and the workshop fostered active participant involvement and interaction. Detailed stakeholder input on workshop effectiveness is summarized below (**Table 2**).

Table 2: Effectiveness of workshop organization and delivery.

	Percentage of Respondents				
Rating Categories	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
The workshop fostered active participant involvement and interactions.				30.43	69.57
I feel my contributions to the workshop influenced the final decisions.			13.04	47.83	39.13
The workshop provided opportunities to learn about and discuss Gulf of Mexico reef fish depredation.				26.09	73.91
The mental models generated from the workshop accurately portray reef fish depredation in the Gulf of Mexico.		4.35	4.35	39.13	52.17
Knowledge gaps concerning Gulf of Mexico reef fish depredation were adequately described and documented.			8.70	30.43	60.87
Information about Gulf of Mexico reef fish depredation identified during this workshop will be used in future research and management initiatives.			13.04	39.13	47.83

References:

Gilman E, Clarke S, Brothers N, Alfaro-Shigueto J, Mandelman J, Mangel J, Petersen S, Piovano S, Thomson N, Dalzell P, Donoso M, Goren M, Werner T. 2008. Shark interactions in pelagic longline fisheries. Marine Policy 32(1):1-18.

Gray SA, Gray S, Cox L, Henly-Shepard S. 2013. Mental Modeler: a fuzzy-logic cognitive mapping tool for adaptive learning management. In 2013 46th Hawaii International Conference on System Sciences, pp. 956-973.

Appendix A: Workshop Agenda

Co-Producing a Shared Characterization of Depredation in the Gulf of Mexico Reef Fish Fishery

Monday, April 4th, 2022, 9am-5pm
The Lodge at Gulf State Park
21196 East Beach Blvd.
Gulf Shores, AL 36542
(251) 540-4000

Workshop Purpose:
To co-produce a shared characterization of depredation in the Gulf of Mexico reef fish fishery through discussion and reciprocal learning among researchers, resource managers, and stakeholders.

Workshop Objectives:
1. Present the reef fish depredation data synthesis and the core concepts of the mental models from the reef fish depredation survey to stakeholders.
2. Allow stakeholders to develop, assess, discuss, and refine regional mental models.
3. Identify additional knowledge gaps concerning Gulf of Mexico reef fish depredation.

Workshop Agenda:

Time	Topic
9:00-9:40am	**Session 1**: Welcome and introductions
9:40-10:00am	**Session 2**: Characterizing the problem: Project phases and workshop goals
10:00-10:15am	Break
10:15-12:00pm	**Session 3**: Stakeholder engagement: Developing regional reef fish depredation mental models and contributing to the participatory mapping process
12:00-2:00pm	Lunch (offsite)
2:00-3:30pm	**Session 4**: Stakeholder engagement: Managing depredation, assessing hypothesized impacts, and discussing research recommendations and subsequent actions
3:30-4:00pm	Break
4:00-4:30pm	**Session 5**: Workshop summary and concluding thoughts
4:30-5:00pm	**Session 6**: Exit surveys and depart

Appendix B: Workshop Attendees

Project Team

Marcus Drymon, *Lead Investigator*, Mississippi State University and Mississippi-Alabama Sea Grant Consortium
Angela Collins, *Co-investigator*, Florida Sea Grant
Bryan Fluech, *Co-investigator*, Georgia Sea Grant
Steven Gray, *Co-investigator*, Michigan State University
Mandy Karnauskas, *Co-resource Manager*, NOAA Fisheries
Steven Scyphers, *Co-investigator*, Northeastern University
Ana Osowski, Mississippi State University and Mississippi-Alabama Sea Grant Consortium
Alena Anderson, Mississippi State University
Danielle McAree, Mississippi State University
Carissa Gervasi, University of Miami, CIMAS
Evan Prasky, Northeastern University
Savannah Swinea, Northeastern University
Sarah Gibbs, Northeastern University
Laura Picariello, Texas Sea Grant
Butch Ayala, Florida Fish and Wildlife Conservation Commission

Reef Fish Fishery Representatives

Texas: Greg Ball, Shane Cantrell, Bubba Cochrane, Scott Hickman
Louisiana: Brett Falterman, Joey Maciasz
Mississippi: Chris Barlow, Ryan Bradley, Clarence “C-Bo” Seymour, Chance Seymour
Alabama: Gary Bryant, Troy Frady, Kurt Tillman, Dale Woodruff
Florida: John Black, Jason DeLaCruz, Dylan Hubbard, Gary Jarvis, Larry Lemieux, Alicia Paul, Ed Walker, Bob Zales

Appendix C: State-Specific Community Models

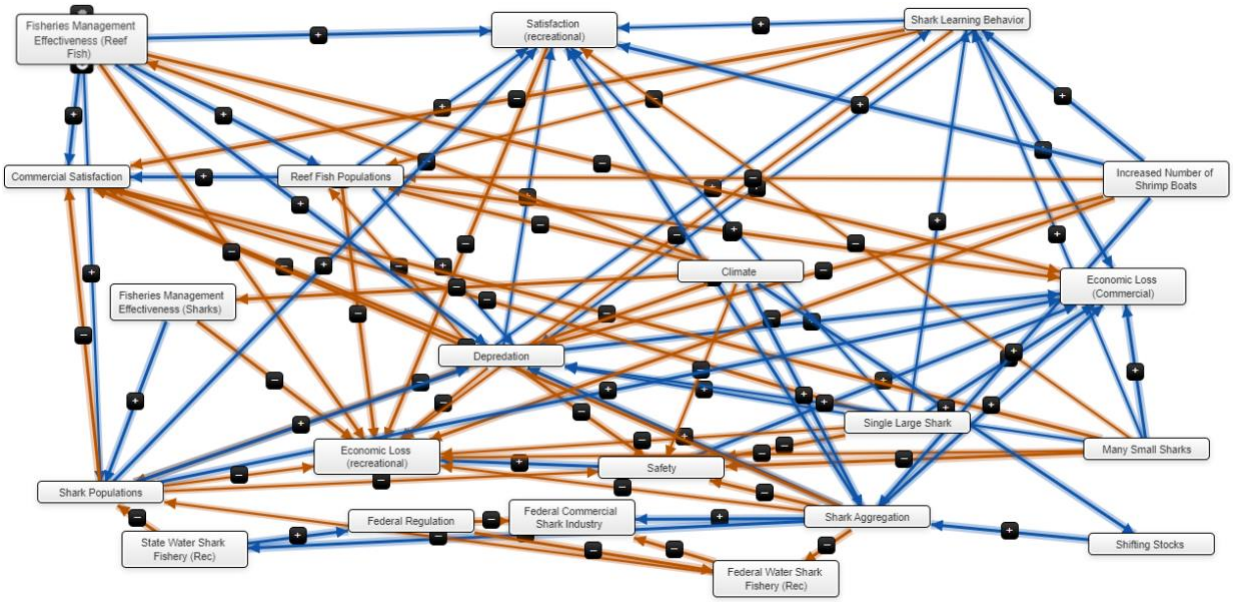


Figure 5: Texas community model developed in *Mental Modeler* based on breakout group discussion. Depredation drivers include climate, increased number of shrimp boats, and the composition of shark depredation interactions (single large shark, many small sharks).

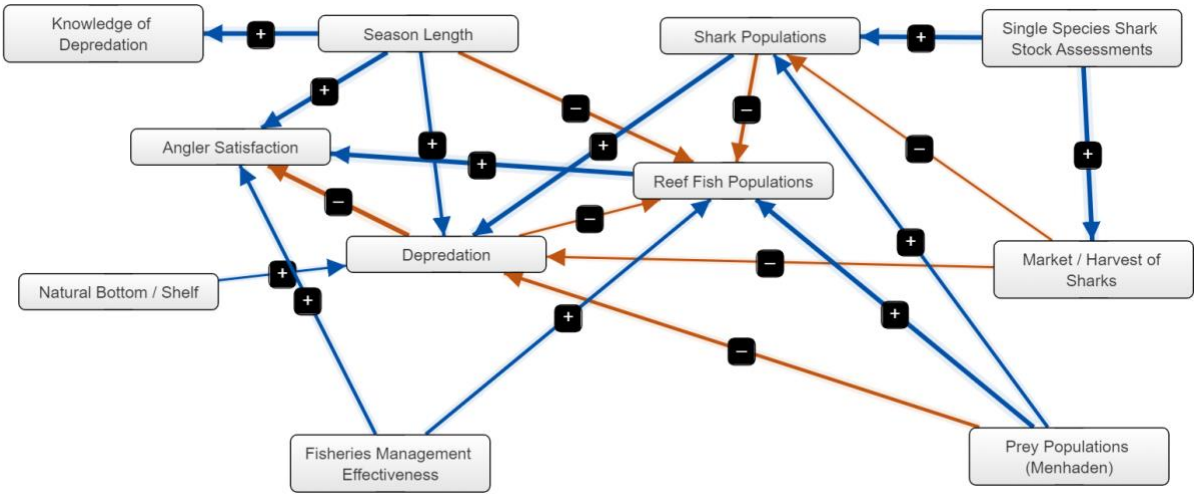


Figure 6: Louisiana community model developed in *Mental Modeler* based on breakout group discussion. Depredation drivers include season length, prey populations (menhaden), single species shark stock assessments, and fisheries management effectiveness.

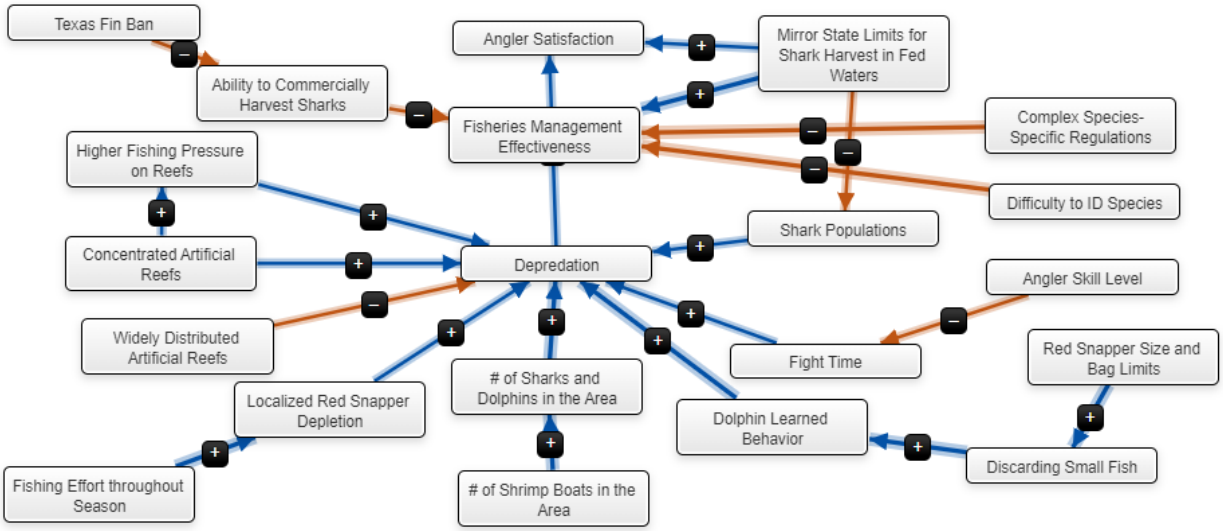


Figure 7: Mississippi community model created in *Mental Modeler* based on breakout group discussion. Depredation drivers include mirror state limits for shark harvest in federal waters, fishing effort throughout the season, red snapper size and bag limits, difficulty to ID species, the number of shrimp boats in the area, and concentrated artificial reefs.

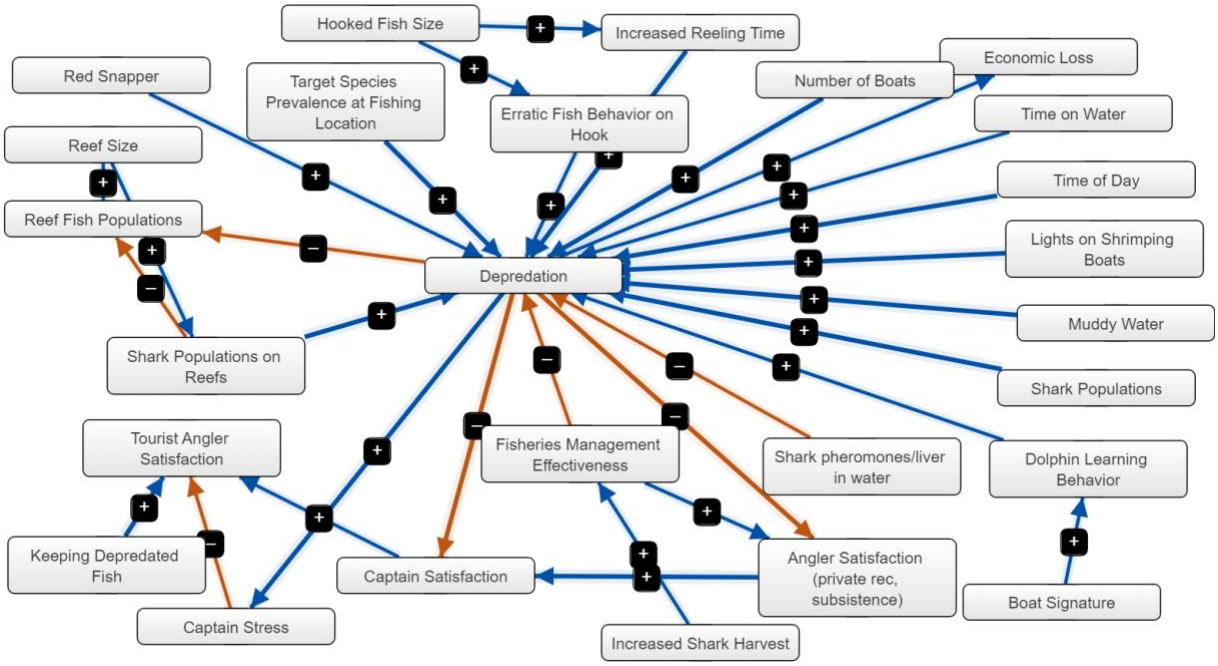


Figure 8: Alabama community model created in *Mental Modeler* based on breakout group discussion. Depredation drivers included the number of boats, hooked fish size, shark populations, and water clarity.

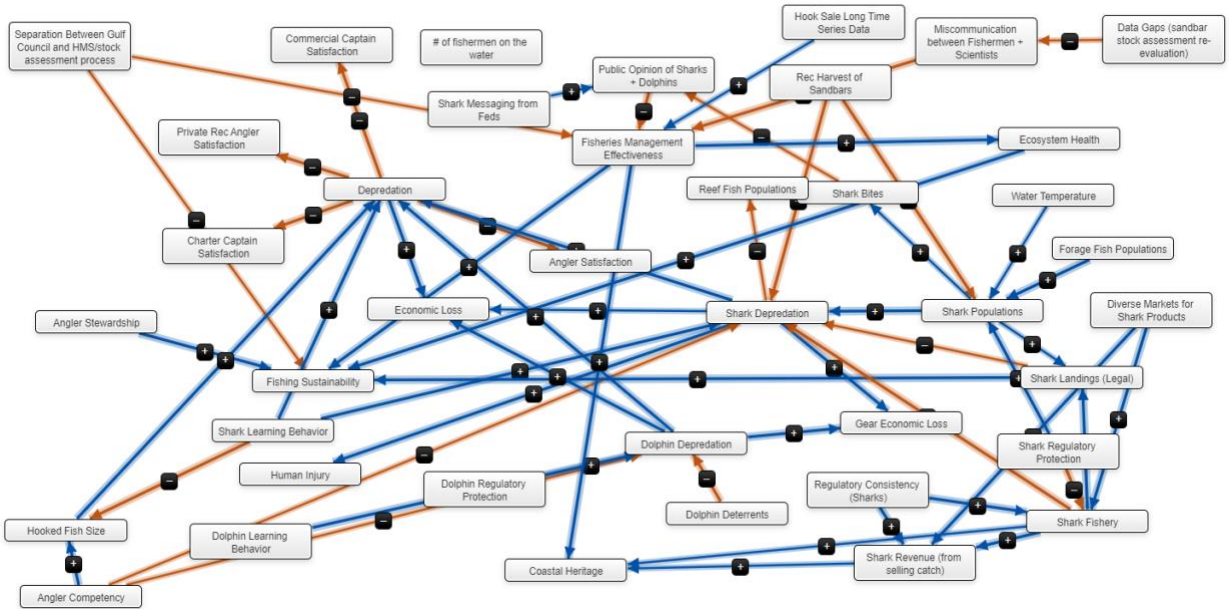


Figure 9: Florida community model created in *Mental Modeler* based on breakout group discussion. Depredation drivers included shark learning behavior, regulatory consistency, diverse markets for shark products, and angler competency.

Appendix D: State-Specific Scenario Analyses

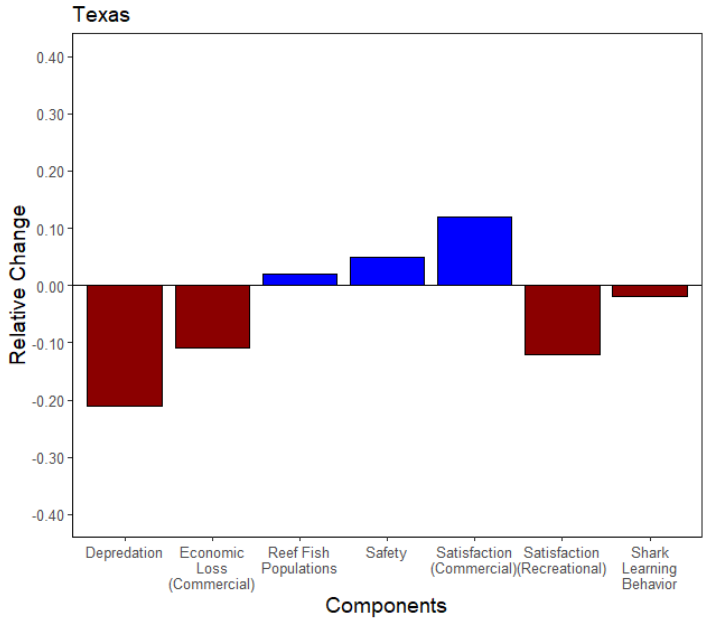


Figure 10: Reef fish populations, safety, and satisfaction (commercial) increased relative to decreases in shark populations and increases in fisheries management based on the Texas community model, while decreases were seen in depredation, economic loss (commercial), satisfaction (recreational), and shark learning behavior.

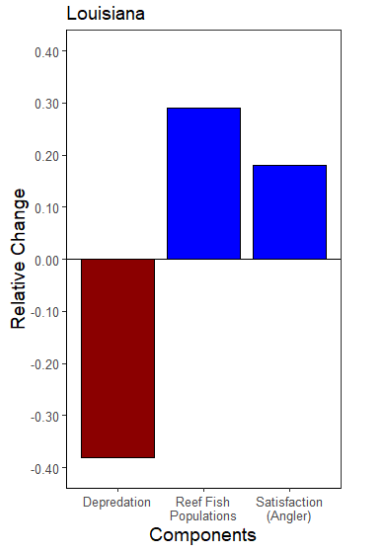


Figure 11: Reef fish populations and satisfaction (angler) increased and depredation decreased relative to decreases in shark populations and increases in fisheries management effectiveness based on the Louisiana community model.

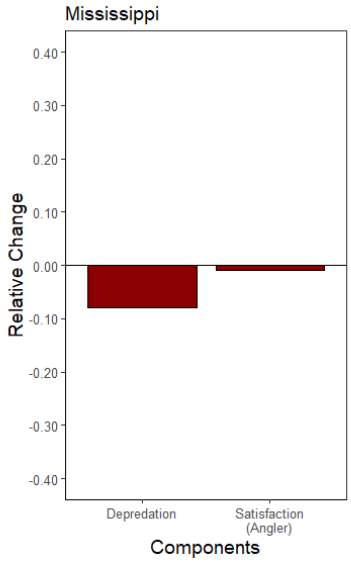


Figure 12: Depredation and satisfaction (angler) both decreased relative to decreases in shark populations and increases in fisheries management effectiveness based on the Mississippi community model.

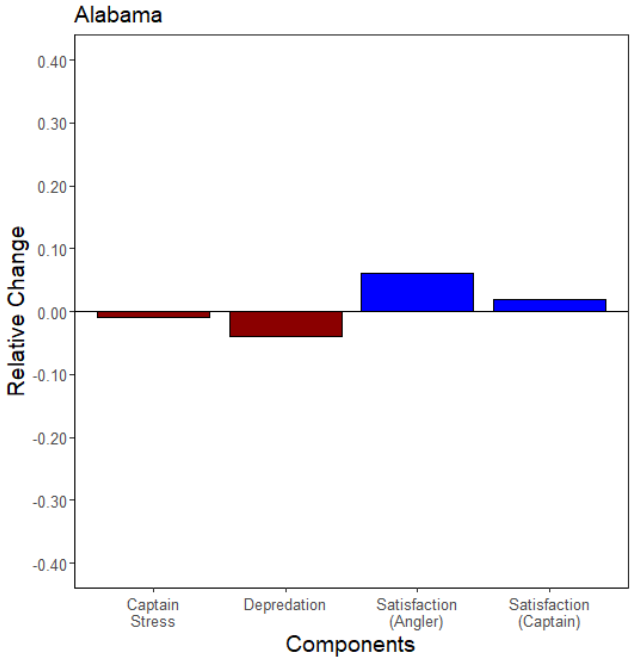


Figure 13: Depredation and captain stress both decreased relative to decreases in shark populations and increases in fisheries management effectiveness based on the Alabama community model, while satisfaction for both anglers and captains increased.

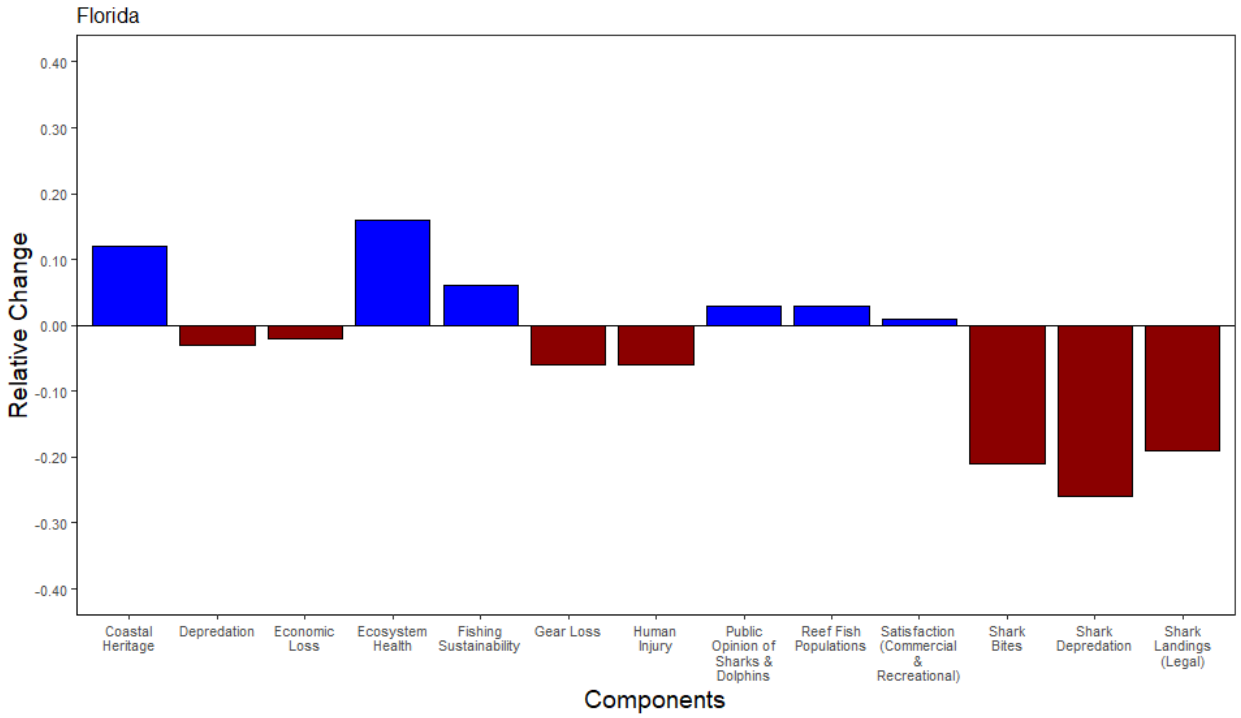


Figure 14: Coastal heritage, ecosystem health, fishing sustainability, public opinion of sharks and dolphins, reef fish populations, and satisfaction (commercial and recreational) all increased relative to decreases in shark populations and increases in fisheries management effectiveness based on the Florida community model. Depredation, economic loss, gear loss, human injury, shark bites, shark depredation, and shark landings (legal) all decreased relative to changes in shark populations and fisheries management effectiveness.

Appendix E: Regional Hot-Spot Maps

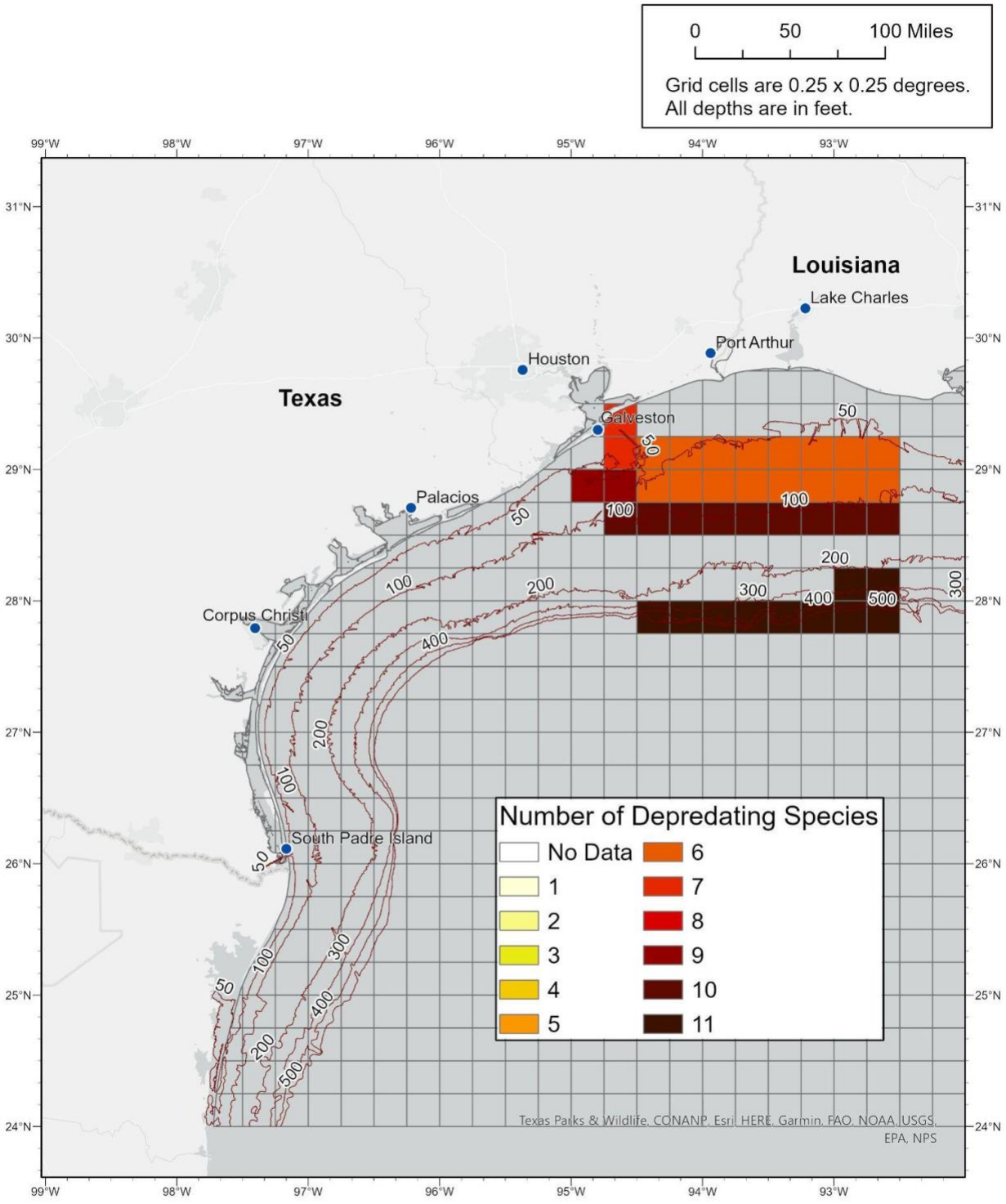


Figure 15: Texas depredation hot-spot map developed from breakout group discussion.

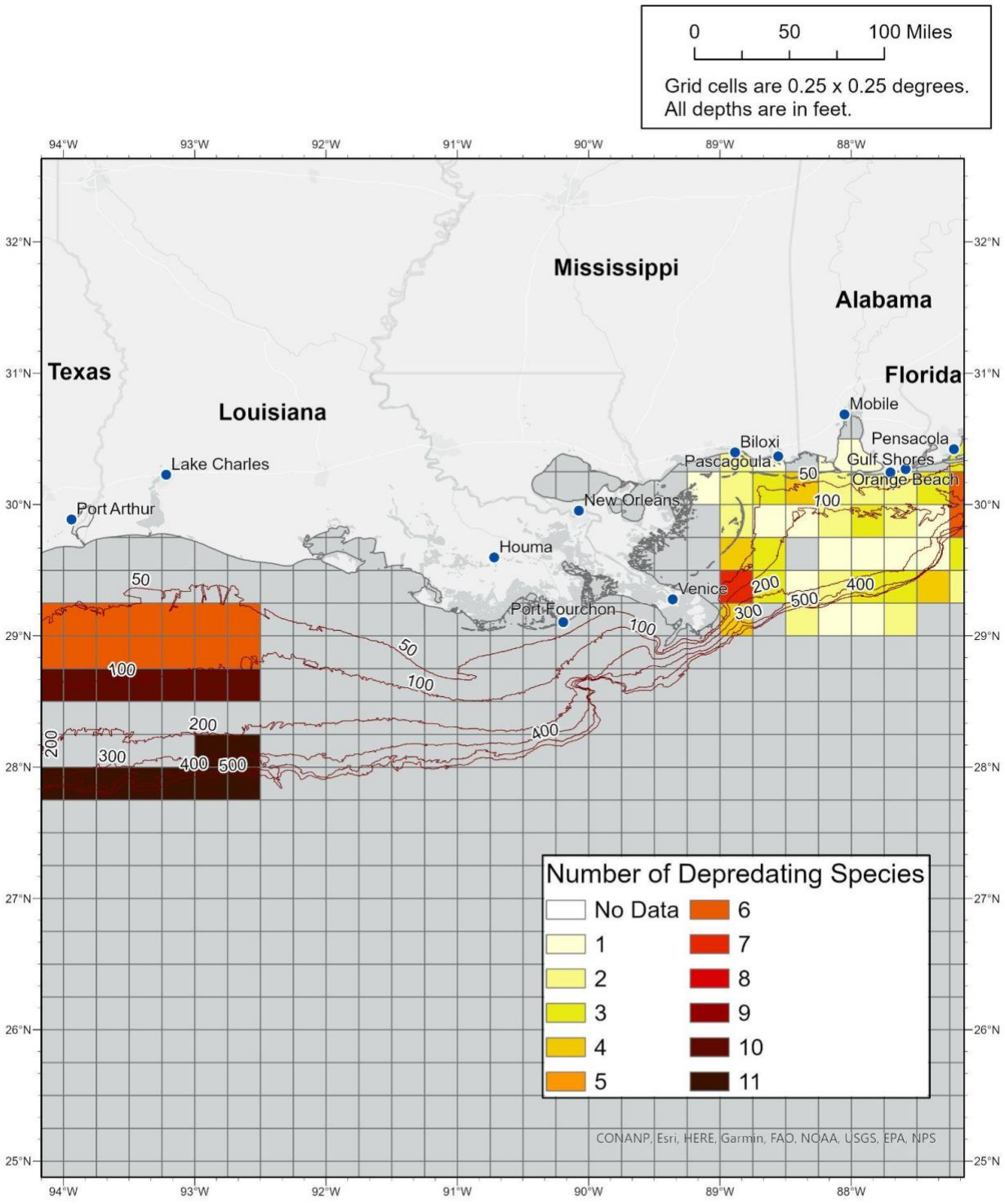


Figure 16: Depredation hot-spot maps for Louisiana, Mississippi, and Alabama developed from breakout group discussion.

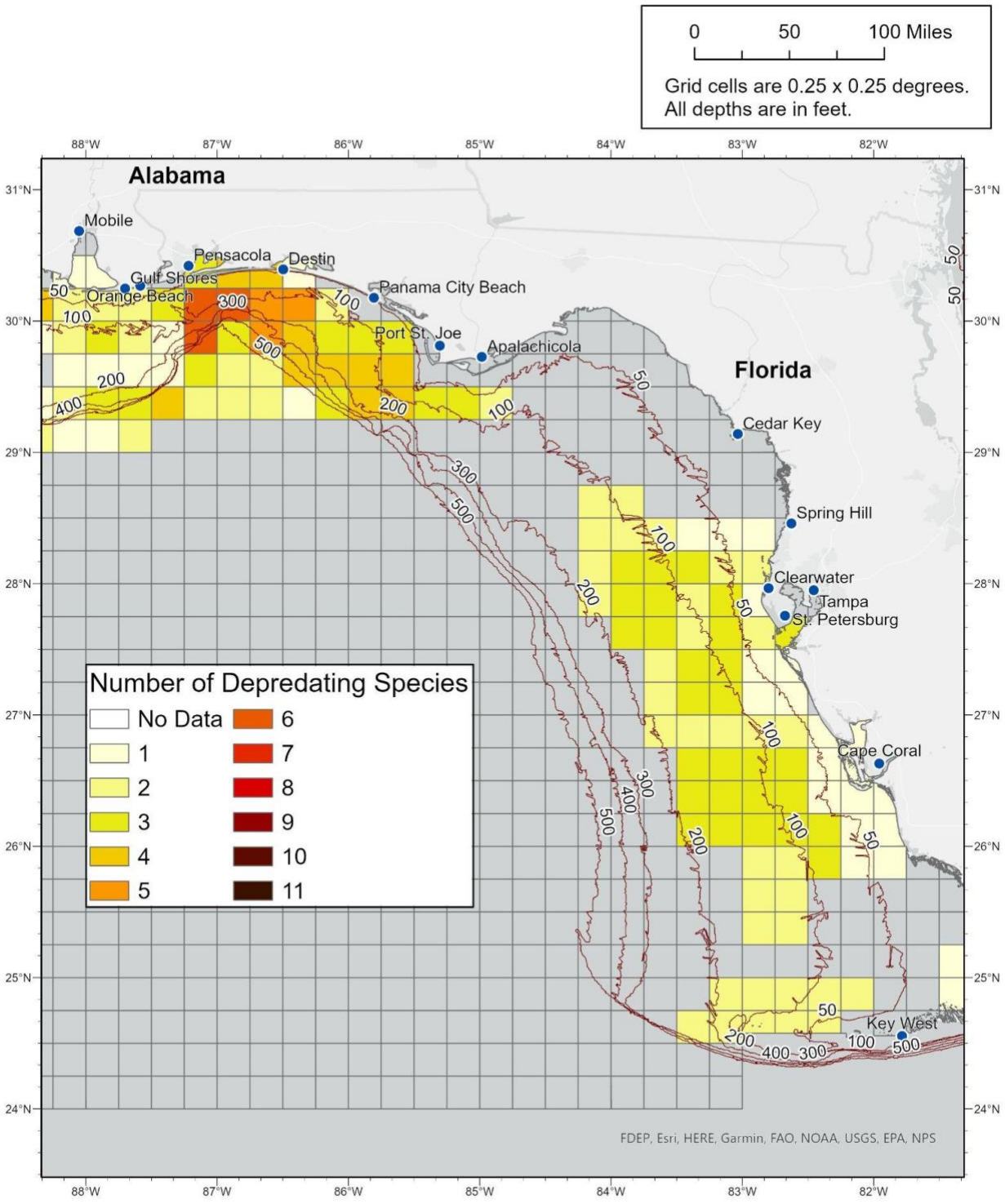


Figure 17: Depredation hot-spot map for the west coast of Florida developed from breakout group discussion.

Appendix F: Workshop Time Series Graphs

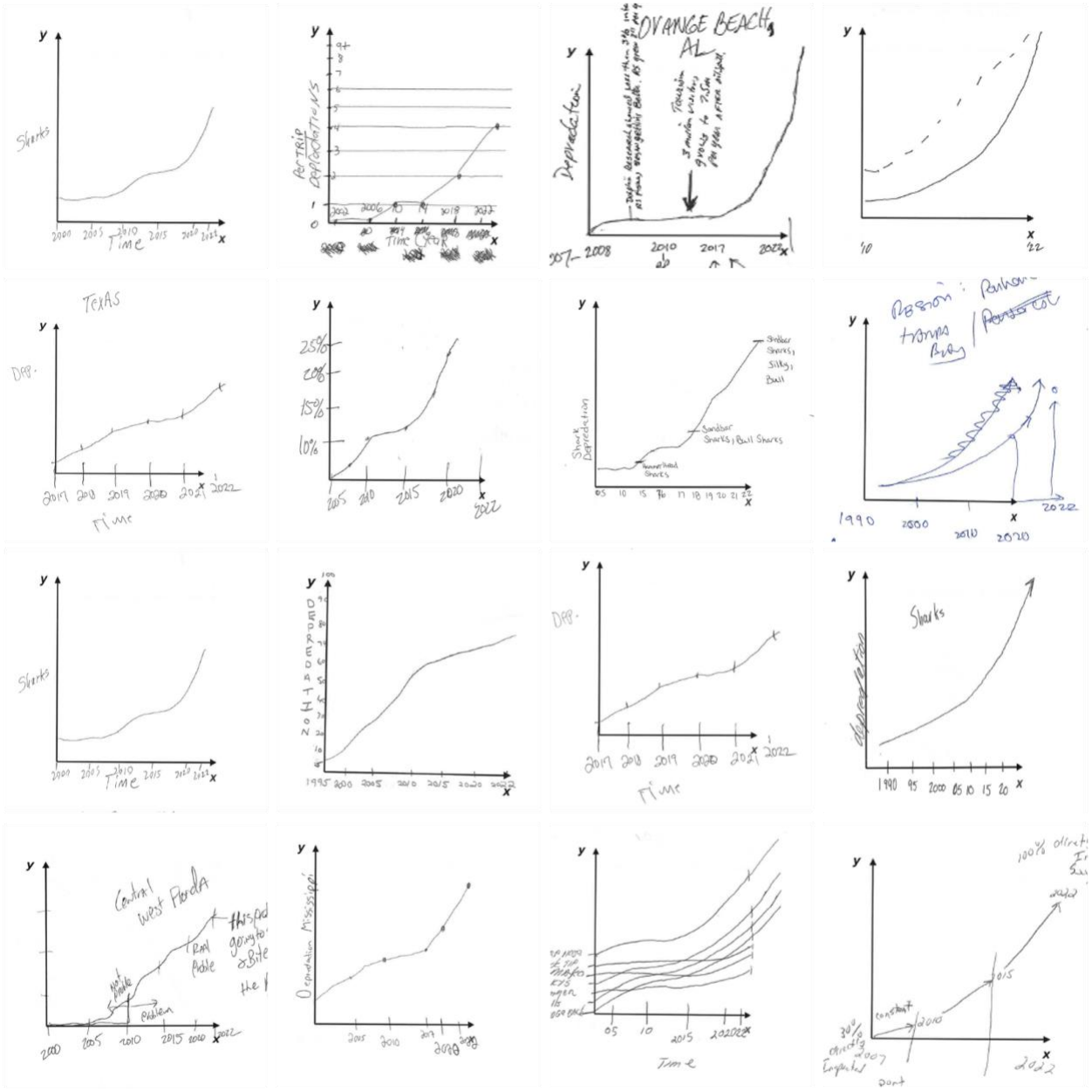


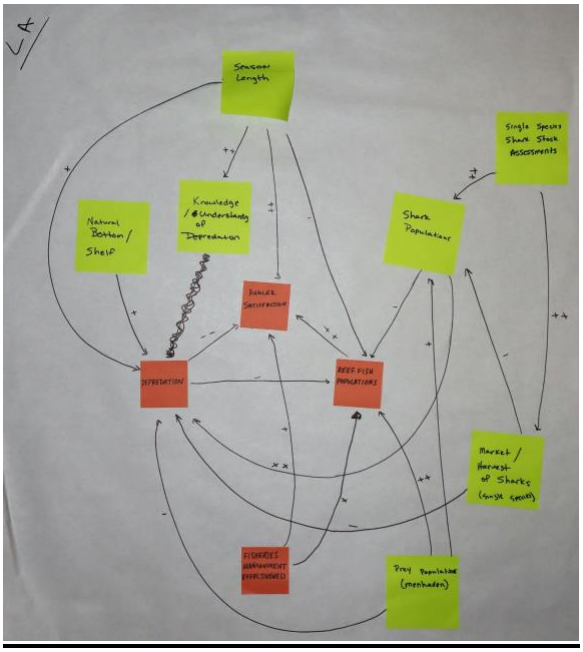
Figure 18: Times series plots (shark depredations/trip) provided by captains during the workshop.

Appendix G: Workshop Photos

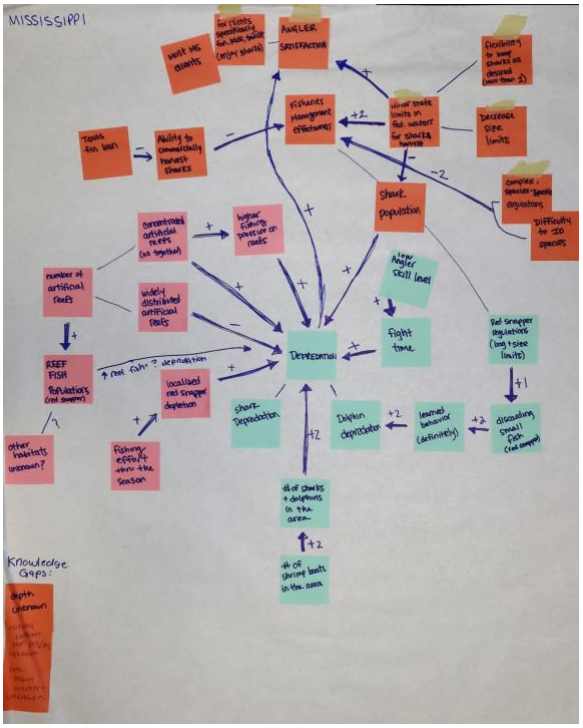
Dr. Marcus Drymon begins the workshop by encouraging each captain to introduce themself.

Captains Dale Woodruff of Orange Beach (left) and Gary Bryant of Fort Morgan (right) contribute to the Alabama breakout group discussion.

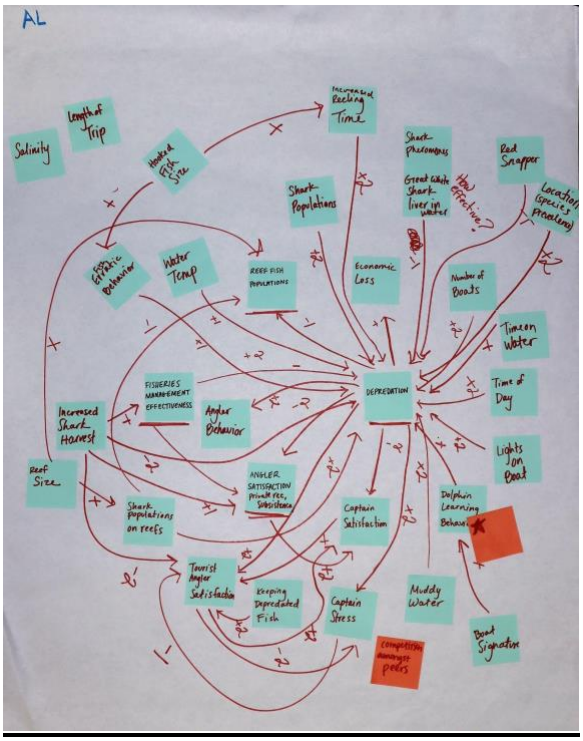
A photo of the Texas participatory model generated during breakout group discussion.



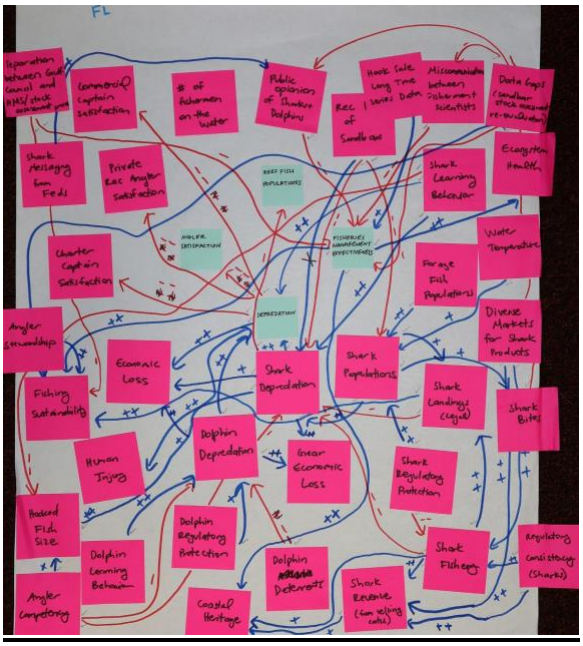
A photo of the Louisiana participatory model generated during breakout group discussion.



A photo of the Mississippi participatory model generated during breakout group discussion.



A photo of the Alabama participatory model generated during breakout group discussion.



A photo of the Florida participatory model generated during breakout group discussion.


Dr. Marcus Drymon details the *Mental Modeler* outputs created from the participatory models.