SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

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POLICY CONSIDERATIONS FOR SOUTH ATLANTIC FOOD WEBS AND CONNECTIVITY AND ESSENTIAL FISH HABITATS
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Introduction

This document provides guidance from the South Atlantic Fishery Management Council (SAFMC) regarding South Atlantic Food Webs and Connectivity and the protection of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (EFH-HAPCs) supporting the Council's move to Ecosystem Based Fishery Management. The guidance is consistent with the overall habitat protection policies of the SAFMC as formulated and adopted in the Habitat Plan (SAFMC 1998a), the Comprehensive EFH Amendment (SAFMC 1998b), the Fishery Ecosystem Plan of the South Atlantic Region (SAFMC 2009a), Comprehensive Ecosystem-Based Amendment 1 (SAFMC 2009b), Comprehensive Ecosystem-Based Amendment 2 (SAFMC 2011), Fishery Ecosystem Plan 2 (SAFMC, 2018), the Habitat Blueprint (SAFMC, 2023), and the various Fishery Management Plans (FMPs) of the Council.

For the purposes of policy, the findings assess potential threats and impacts to managed species EFH and EFH-HAPCs and the South Atlantic ecosystem associated with changes in food webs and connectivity and processes that could improve those resources or place them at risk. The policies and recommendations established in this document are designed to address such impacts in accordance with the habitat policies of the SAFMC as mandated by law. The SAMFC may revise this guidance in response to 1) changes in conditions in the South Atlantic region, 2) applicable laws and regulatory guidelines, 3) new knowledge about the impacts or 4) as deemed as appropriate by the Council.

For the sake of clarity, the following terms are to be defined as:

- Essential Fish Habitat (EFH): The aquatic habitat where fish spawn, breed, feed, and grow to maturity. This includes the physical, chemical, and biological properties of aquatic areas as well as their associated benthic habitats.
- Habitat Areas of Particular Concern (HAPC): subsets of EFH that are considered important to ecosystem function and are vulnerable to degradation or human impact e.g. spawning areas, nursery areas, pupping grounds, etc.

Policy Considerations

A key tenet of ecosystem-based fisheries management (EBFM) is the consideration of potential indirect effects of fisheries on food web linkages when developing harvest strategies and management plans. Examples of unintended consequences include the over exploitation of predators, an increase in abundance of their prey, and a decline of organisms two trophic levels below them, a phenomenon known as a trophic cascade (Carpenter et al. 1985). Alternatively, fishing on lower trophic level species, planktivorous "forage" fishes for example, may ultimately lead to predator population declines due to food limitation (e.g. Okey et al. 2014;

Walters and Martell 2004). Food web linkages connect different components of the larger ecosystem, such as pelagic forage fishes and their piscivorous predators or demersal carnivores. This connectivity between food webs over space, time, and depth creates multiple energy pathways that enhance ecosystem stability and resilience. Food web models are increasingly being utilized by fisheries managers as ecological prediction tools because they provide the capability to simulate the entire ecosystem from primary producers to top predators to fisheries. Food web models can serve to inform single species assessment and management and are capable of generating reference points (Walters et al. 2005) and ecosystem-level indicators (Coll et al. 2006; Fulton et al. 2005).

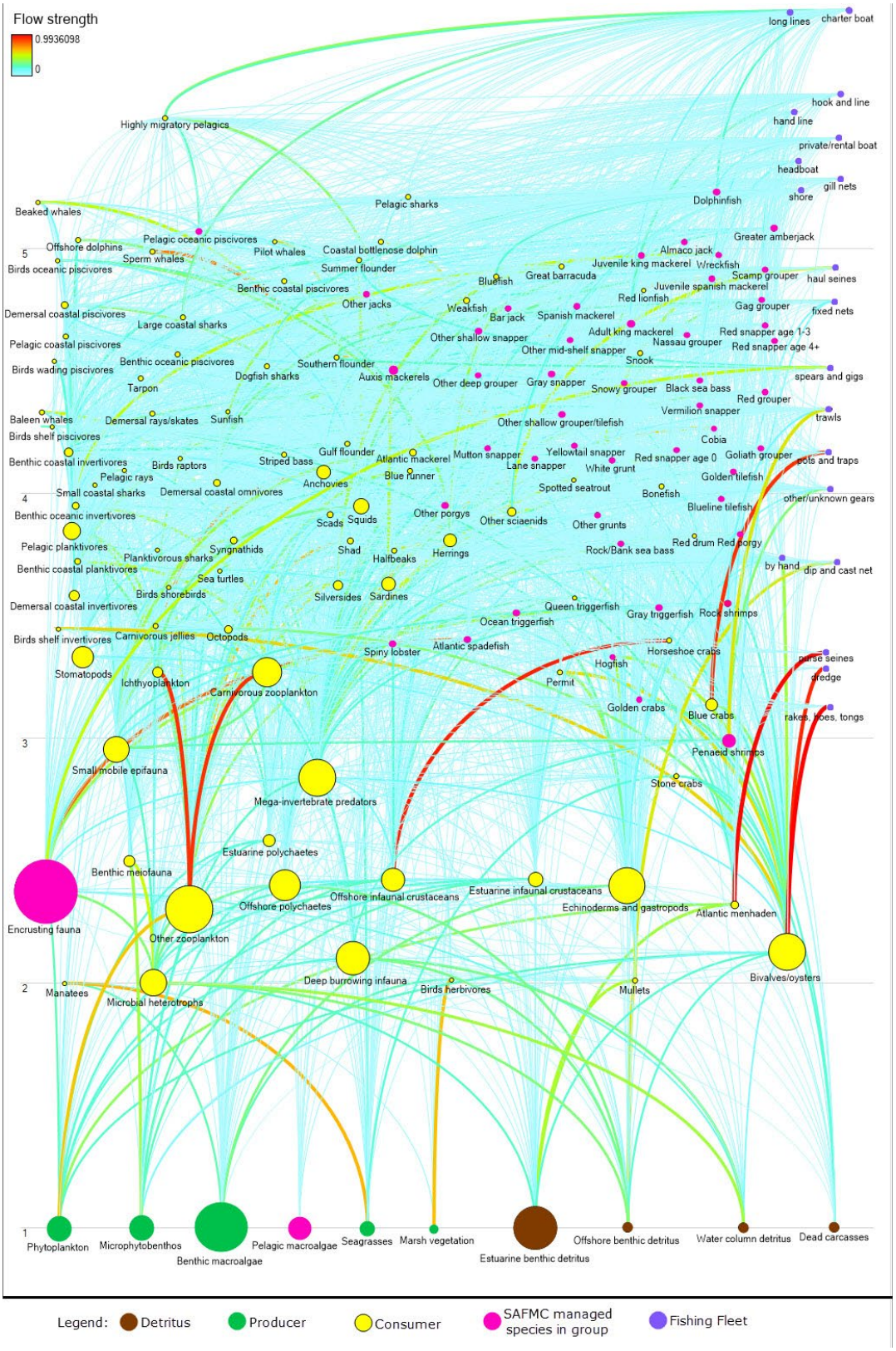

Figure 1-1. The marine food web of the South Atlantic, based on the latest iteration of the SA Ecopath with Ecosim model (SAFMC 2022). Nodes are colored based on type (see legend above). The pink nodes identify groups that include SAFMC managed species or are a managed species. The flow strength varies from Blue (weakest) to red (strongest). Each circle represents a group in the ecosystem and its size is logarithmically proportional to its biomass. Each line is a trophic interaction between two groups. The width of each line represents the flow proportion. The light grey horizontal lines indicate trophic levels. Diagram produced by Lauren Gentry, FWC-FWRI September 2024.

Threats to EFH and EFH-HAPCs from Changes in South Atlantic Food Web and Connectivity

The SAFMC finds that negative impacts to EFH and EFH-HAPCs can change South Atlantic food webs and connectivity for managed species. Table 1 following food webs and connectivity policy and research recommendations, presents a summary of South Atlantic fisheries and their designated EFH and EFH-HAPCs as presented in the SAFMC EFH User Guide (SAFMC 2024)

SAFMC Policies Addressing South Atlantic Food Webs and Connectivity

The SAFMC establishes the following policies to address South Atlantic food webs and connectivity, and to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment and Fishery Ecosystem Plan (SAFMC 1998a; SAFMC 1998b; SAFMC 2009a).

General Policies:

1. **Forage Fisheries** [1] - Managers should consider forage fish (Defined in footnote one as invertebrate and vertebrate species) stock abundances and dynamics, and their impacts on predator productivity, when setting catch limits to promote ecosystem sustainability. To do so, more science and monitoring information are needed to improve our understanding of the role of forage fish in the ecosystem. This information should be included in stock assessments, ecosystem models, and other fishery management tools and processes in order to support the development of sustainable harvest strategies that incorporate ecosystem considerations and trade-offs.
   Note: Initial preliminary definition and potential list of forage species and forage fish species presented in Appendix A.

2. **Prey importance-** Diet data used to describe the importance of forage species in food web models may contain certain biases depending on the metric used to inform the relative contribution to the diet, and due to other challenges involved such as varying rates of digestion for different prey (Hyslop, 1980). Therefore, the evaluation of prey importance should consider a suite of appropriate indicators including mass, occurrence, and degree of overlap as a shared resource among multiple predators. Prey that are identified as important should be recognized as ecosystem component species, and considered within the appropriate fishery-management plan.

3. **Food Web Indicators** – Food web indicators have been employed to summarize the state of knowledge of an ecosystem or food web and could serve as ecological benchmarks to inform future actions.

4. **Food Web Connectivity** – Separate food webs exist in the South Atlantic, for example inshore-offshore, north-south, and benthic-pelagic, but they are connected by species that migrate between them such that loss of connectivity could have impacts on other components of the ecosystem that would otherwise appear unrelated

[1] NOAA defines Fishery as "Generally, a fishery is an activity leading to harvesting of fish. It may involve capture of wild fish or raising of fish through aquaculture. A unit determined by an authority or other entity that is engaged in raising or harvesting fish. Typically, the unit is defined in terms of some or all of the following: people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, and purpose of the activities. The combination of fish and fishers in a region, the latter fishing for similar or the same species with similar or the same gear types". and fish as a "Used as a collective term, includes mollusks, crustaceans and any aquatic animal which is harvested."(United States, 2005)

and must be accounted for.

5. **Trophic Pathways** – Managers should aim to understand how fisheries production is driven either by bottom-up or top-down forcing and attempt to maintain diverse energy pathways to promote overall food web stability.

6. **Food Web Models** – Food web models can provide useful information to inform stock assessments, screen policy options for unintended consequences, examine ecological and economic trade-offs, and evaluate performance of management actions under alternative ecosystem states. A full Ecopath with Ecosim (EWE) model and a snapper grouper simplified model has been developed for the South Atlantic Region to be used as a tool for management decisions. (SAFMC, 2022)

7. **Ecosystem Component Species** – Ecosystem component species are species that do not require conservation and management under a federal fishery management plan, but are included in order to achieve ecosystem management objectives.

8. **Invasive Species** – Invasive species, most notably lionfish (*Pterois spp.*), are known to have negative effects on ecologically and economically important reef fish species through predation and competition and those effects should be accounted for in management actions.

9. **Contaminants** – Bioaccumulation of contaminants in food webs can have sub- lethal effects on marine fish, mammals, and birds and is also a concern for human seafood consumption.

Research and Information Needs Addressing South Atlantic Food Webs and Connectivity

1. Scientific research and collection of data to further understand the impacts of climate variability on the South Atlantic ecosystem and fish productivity must be prioritized. This includes research on species distribution, habitat, reproduction, recruitment, growth, survival, predator-prey interactions and vulnerability.

2. Characterization of offshore ocean habitats used by estuarine dependent species, which can be useful in developing ecosystem models.

3. Scientific research and monitoring to improve our understanding of the role of forage species in the ecosystem, in particular abundance dynamics and habitat use.

4. Basic data are the foundation of ecosystem-based fisheries management thus, fixing existing data gaps in the South Atlantic must be addressed first in order to build a successful framework for this approach in the South Atlantic.

5. NOAA in cooperation with regional partners should develop and evaluate an initial suite of products (Climate Vulnerability Assessment; Region Habitat Assessment) at an ecosystem level to help prioritize the management and scientific needs in the South Atlantic region taking a systemic approach to identify overarching, common risks (i.e., climate change, rising sea level, changes in ocean current patterns and strength, etc.) across all habitat, taxa, ecosystem functions, fishery participants and dependent coastal communities.

6. NOAA in cooperation with regional partners should develop risk assessments to evaluate the vulnerability of South Atlantic species with respect to their exposure and

sensitivity to ecological and environmental factors affecting their populations.

7. NOAA should coordinate with ongoing regional modeling and management tool development efforts to ensure that ecosystem management strategy evaluations (MSEs) link to multispecies and single species MSEs, inclusive of economic, socio-cultural, and habitat conservation measures.

8. NOAA should develop ecosystem-level reference points (ELRPs) and thresholds as an important step to informing statutorily required reference points and identifying key dynamics, emergent ecosystem properties, or major ecosystem-wide issues that impact multiple species, stocks, and fisheries. Addressing basic data collection gaps is critical to successful development of ELRPs.

9. Continued support of South Atlantic efforts to refine EFH and HAPCs is essential to protect important ecological functions for multiple species and species groups in the face of climate change.

Habitats designated as EFH and EFH-HAPCs by the SAFMC (Table 1), if negatively impacted, can change South Atlantic food webs and connectivity for managed species.

Table 1. Habitats designated as Essential Fish Habitat (EFH), their associated managed fisheries/species, and EFH-HAPCs (Source: SAFMC EFH Users Guide 2024).

Essential Fish Habitat	Fisheries/Species	EFH- Habitat Areas of Particular Concern
Wetlands		
Estuarine and marine emergent wetlands	Shrimp, Snapper Grouper	Shrimp: State designated nursery habitats Mangrove wetlands
Tidal palustrine forested wetlands	Shrimp	
Submerged Aquatic Vegetation		
Estuarine and marine submerged aquatic vegetation	Shrimp, Snapper Grouper, Spiny lobster	Snapper Grouper, Shrimp
Shell bottom		
Oyster reefs and shell banks	Snapper Grouper	Snapper Grouper
Coral and Hardbottom		
Coral reefs, live/hardbottom, medium to high rock outcroppings from shore to at least 600 ft where the annual water temperature range is sufficient.	Snapper Grouper, Spiny lobster, Coral, Coral Reefs and Live Hard/bottom Habitat	The Point, Ten Fathom Ledge, Big Rock, MPAs; The *Phragmatopoma* (worm reefs) off central east coast of Florida and nearshore hardbottom; coral and hardbottom habitat from Jupiter through the Dry Tortugas, FL; Deepwater CHAPCs
rock overhangs, rock outcrops, manganese-phosphorite rock slab formations, and rocky reefs		Snapper-grouper [blueline tilefish]
Artificial reefs	Snapper Grouper	Special Management Zones
Soft bottom		
Subtidal, intertidal non-vegetated flats	Shrimp	
Offshore marine habitats used for spawning and growth to maturity	Shrimp	
Sandy shoals of capes and offshore bars	Coastal Migratory Pelagics	Sandy shoals; Capes Lookout, Fear, Hatteras, NC; Hurl Rocks, SC;
troughs and terraces intermingled with sand, mud, or shell hash at depths of 150 to 300 meters		Snapper-grouper [golden tilefish]
Water column		
Ocean-side waters, from the surf to the shelf break zone, including Sargassum	Coastal Migratory Pelagics	
All coastal inlets	Coastal Migratory Pelagics	Shrimp, Snapper-grouper
All state-designated nursery habitats of particular importance (e.g., PNA, SNA)	Coastal Migratory Pelagics	Shrimp, Snapper-grouper
High salinity bays, estuaries	Cobia in Coastal Migratory Pelagics	Spanish mackerel: Bogue Sound, New River, NC; Broad River, SC
Pelagic Sargassum	Dolphin	
Gulf Stream	Shrimp, Snapper-grouper, Coastal Migratory Pelagics, Spiny lobster, Dolphin-wahoo	
Spawning area in the water column above the adult habitat and the additional pelagic environment	Snapper-grouper	

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Appendix A. Below are the results of one method used to determine the top ten prey items of the predator species in each SAFMC Fishery Management Plan (FMP). The "Average %" value was calculated by the percent of each prey item in the FMP's species' diets averaged across all diets available for the species included in the FMP. For the Coastal Migratory Pelagic, Dolphin Wahoo, and Snapper grouper FMPs the top ten species for only fish prey was also calculated. These diets were primarily calculated from adult diet information and juvenile information was integrated in when possible. Due to the variety of data sources the only species with available adult and juvenile specific diet information Red Snapper, King Mackerel, and Spanish Mackerel.

Top 10 Prey Items: Coastal Migratory Pelagic FMP
If in diet, what's the average % that this prey makes up of the diet?

All prey	Average %	Fish prey	Average %
Anchovies	15.81	Anchovies	15.81
Herrings	15.23	Herrings	15.23
Mega-invertebrate predators	11.59	Sardines	10.49
Sardines	10.49	Shad	6.82
Shad	6.82	Halfbeaks	6.48
Halfbeaks	6.48	Scads	5.98
Scads	5.98	Benthic coastal invertivores	3.33
Benthic coastal invertivores	3.33	Demersal coastal invertivores	2.63
Rock shrimps	2.851	Pelagic coastal piscivores	2.40
Demersal coastal invertivores	2.63	Pelagic planktivores	1.91
Total % out of diet	81.2	Total % out of fish only diet	71.1

Dolphin Wahoo FMP
If in diet, what's the average % that this prey makes up of the diet?

All prey	Average %	Fish prey	Average %
Sardines	15.06	Sardines	15.06
Pelagic oceanic piscivores	14.31	Pelagic oceanic piscivores	14.31
Auxis mackerels	9.30	Auxis mackerels	9.30
Squids	8.65	Dolphinfish	6.88
Dolphinfish	6.88	Anchovies	6.25
Anchovies	6.25	Herrings	4.77
Mega-invertebrate predators	5.40	Demersal coastal omnivores	4.53
Herrings	4.77	Pelagic coastal piscivores	3.93
Demersal coastal omnivores	4.53	Blue runner	2.57
Penaeid shrimps	4.33	Pelagic planktivores	2.25
Total % out of diet	79.5	Total % out of fish only diet	69.9

Snapper Grouper FMP If in diet, what's the average % that this prey makes up of the diet?			
All prey	**Average %**	**Fish prey**	**Average %**
Mega-invertebrate predators	15.85	Benthic coastal invertivores	6.77
Benthic coastal invertivores	6.77	Demersal coastal omnivores	5.18
Echinoderms and gastropods	5.84	Herrings	4.87
Encrusting fauna	5.41	Other grunts	4.77
Squids	5.24	Benthic oceanic invertivores	3.13
Demersal coastal omnivores	5.18	Demersal coastal invertivores	1.65
Herrings	4.87	Benthic coastal piscivores	1.61
Other grunts	4.77	Scads	1.40
Bivalves/Oysters	3.32	Demersal coastal piscivores	1.18
Benthic oceanic invertivores	3.13	Other sciaenids	1.12
Total % out of diet	60.4	Total % out of fish only diet	31.7

Golden Crab FMP If in diet, what's the average % that this prey makes up of the diet?			
All prey	**Average %**	**Fish prey**	**Average %**
Bivalves/Oysters	30.3		
Dead carcasses	19.6		
Offshore infaunal crustaceans	11.4		
Offshore benthic detritus	9.09		
Octopods	9.01		
Benthic oceanic invertivores	5		
Echinoderms and gastropods	4.81		
Mega-invertebrate predators	3.36		
Squids	2.44		
Penaeid shrimps	2.44		
Total % out of diet	97.4		

Shrimp FMP If in diet, what's the average % that this prey makes up of the diet?			
All prey	**Average %**	**Fish prey**	**Average %**
Small mobile epifauna	21.95		
Mega-invertebrate predators	10		
Deep-burrowing infauna	9.79		
Bivalves/Oysters	9.75		
Offshore polychaetes	7.70		
Encrusting fauna	7.60		
Echinoderms and gastropods	6.80		
Estuarine benthic detritus	5.35		
Offshore benthic detritus	5.35		
Microphytobenthos	4.99		
Total % out of diet	89.3		

Spiny Lobster FMP If in diet, what's the average % that this prey makes up of the diet?			
All prey	**Average %**	**Fish prey**	**Average %**
Mega-invertebrate predators	20		
Offshore infaunal crustaceans	20		
Encrusting fauna	16		
Echinoderms and gastropods	10		
Bivalves/Oysters	10		
Offshore polychaetes	10		
Microbial heterotrophs	5		
Benthic macroalgae	5		
Carnivorous zooplankton	2		
Other zooplankton	2		
Total % out of diet	100		

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