SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

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POLICY CONSIDERATIONS FOR SOUTH ATLANTIC FOOD WEBS AND CONNECTIVITY AND ESSENTIAL FISH HABITATS
(December 2016)

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 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), 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.

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).

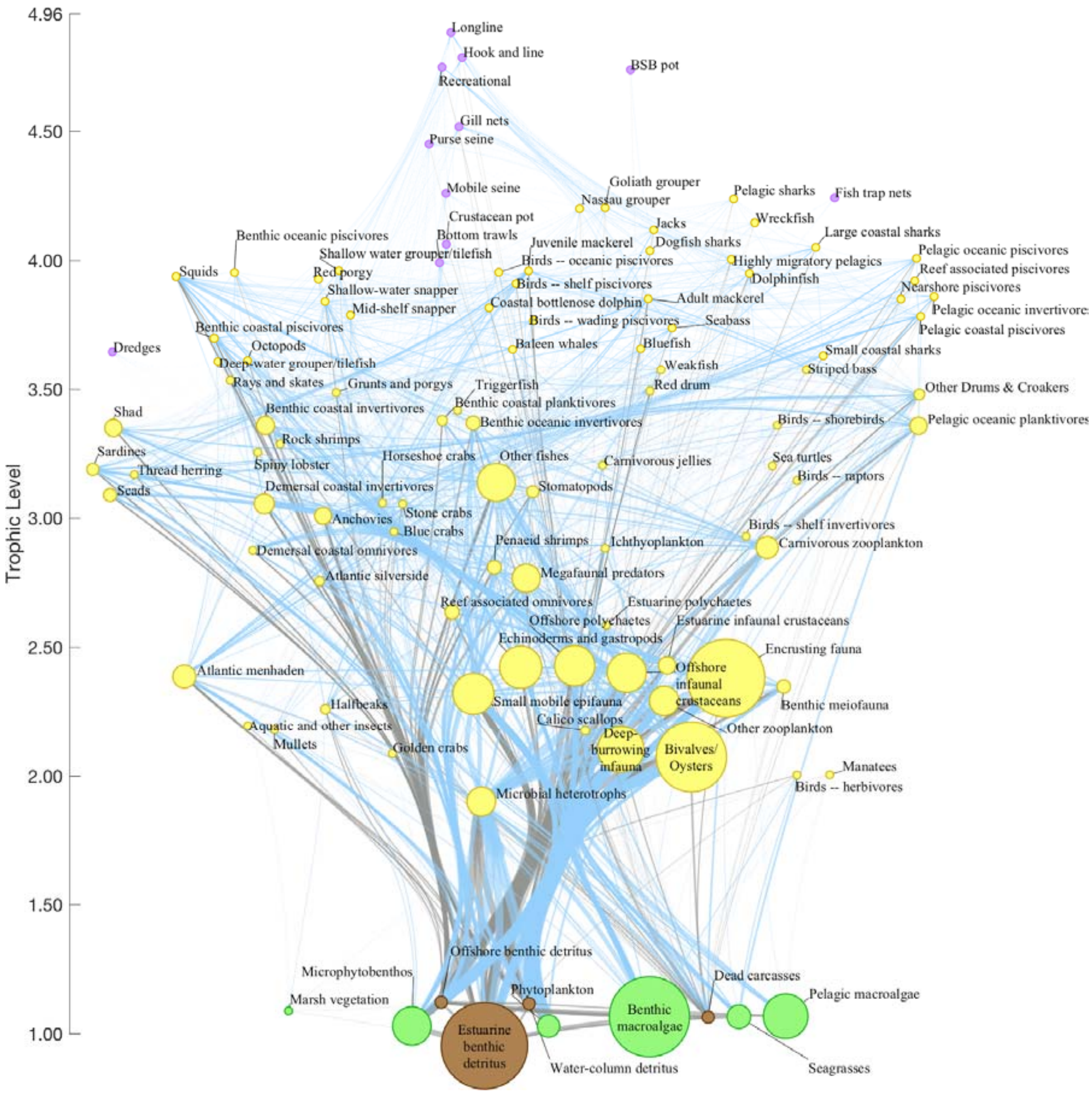

Figure 1-1. The marine food web of the South Atlantic Bight, based on the latest iteration of the SAB Ecopath model as described in Okey et al (2014), based originally on a preliminary model by Okey and Pugliese (2001). Nodes are colored based on type (green = producer, brown = detritus, yellow = consumer, purple = fleet). Blue for all edges except flows to detritus, which are gray. Diagram produced by Kelly Kearney, UW Joint Institute for the Study of the Atmosphere and Ocean and NOAA Alaska Fisheries Science Center, April 2015.

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 (http://safmc.net/download/SAFMCEFHUsersGuideFinalNov16.pdf).

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** – Managers should consider forage fish 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 fish species presented in Appendix A.

2. **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 and must be accounted for.

3. **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.

4. **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.

5. **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.

6. **Invasive Species** – Invasive species, most notably lionfish, 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.

7. **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 fish 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 develop and evaluate an initial suite of products 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 across all habitats, taxa, ecosystem functions, fishery participants and dependent coastal communities.

6. NOAA in cooperation with regional partners 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 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 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 2016).

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. Potential list of potential forage species and definition.

Note: Species highlighted constitute a preliminary list of non-managed forage fish species.

Final Report SEAMAP-SA — Period 05/01/2006 - 04/30/2011,

Table 2.5

Abundance, biomass, and occurrence by species. Values are for 2006-2010 calendar years. Ranking is by total number of individuals. Top 50 species of 215

CommonName	Species	Number Rank	Total Number	% of Total Abundance	Biomass (kg)	%of Total BioMass	Number of Occurrences	% of Occurences	CumPct Number	Rank Biomass	CumPct Biomasss
Atl bumper	Chloroscombrus chrysurus	1	1368597	35.34	18645.26	6.76	979	61.57	35.34	5	46.21
Atl croaker	Micropogonias undulatus	2	467821	12.08	24544	8.89	871	54.78	47.42	2	25.33
spot	Leiostomus xanthurus	3	342689	8.85	19807.84	7.18	1121	70.5	56.27	3	32.51
white shrimp	Litopenaeus setiferus	4	141041	3.64	3779.69	1.37	809	50.88	59.91	14	64.34
striped anchovy	Anchoa hepsetus	5	140732	3.63	1244.2	0.45	961	60.44	63.54	27	73.97
moonfish	Selene setapinnis	6	128782	3.33	2173.18	0.79	1001	62.96	66.87	20	69.92
cannonball jellyfish	Stomolophus meleagris	7	127957	3.3	45368.66	16.44	723	45.47	70.17	1	16.44
scup/porgy	Stenotomus sp.	8	120165	3.1	4249.36	1.54	505	31.76	73.27	11	59.99
pinfish	Lagodon rhomboides	9	87700	2.26	4134.76	1.5	623	39.18	75.53	12	61.49
banded drum	Larimus fasciatus	10	68273	1.76	5041.15	1.83	775	48.74	77.29	9	56.81
butterfish	Peprilus triacanthus	11	68083	1.76	1801.7	0.65	852	53.58	79.05	22	71.34
star drum	Stellifer lanceolatus	12	67465	1.74	1279.21	0.46	462	29.06	80.79	26	73.52
Southern kingfish	Menticirrhus americanus	13	63683	1.64	6310.79	2.29	1181	74.28	82.43	7	52.86
harvestfish	Peprilus paru	14	61621	1.59	2706.34	0.98	986	62.01	84.02	16	66.41
Atl thread herring	Opisthonema oglinum	15	56675	1.46	1427.48	0.52	977	61.45	85.48	25	73.06
brown shrimp	Farfantepenaeus aztecus	16	49209	1.27	759.13	0.28	548	34.47	86.75	32	75.62
breif squid	Lolliguncula brevis	17	48151	1.24	555.35	0.2	1263	79.43	87.99	33	75.82
Atl cutlassfish	Trichiurus lepturus	18	46126	1.19	2442.13	0.88	599	37.67	89.18	19	69.13
silver seatrout	Cynoscion nothus	19	43987	1.14	2448.59	0.89	659	41.45	90.32	18	68.25
northern searobin	Prionotus carolinus	20	38652	1	430.23	0.16	712	44.78	91.32	34	75.98
weakfish	Cynoscion regalis	21	35781	0.92	3000.54	1.09	670	42.14	92.24	15	65.43
Atl menhaden	Brevoortia tyrannus	22	27118	0.7	842.86	0.31	206	12.96	92.94	30	75.04
spider crab	Libinia dubia	23	23998	0.62	74.19	0.03	496	31.19	93.56	44	76.6
squid sp	Loligo spp.	24	21515	0.56	316.24	0.11	485	30.5	94.12	36	76.22
bay anchovy	Anchoa mitchilli	25	20415	0.53	31.27	0.01	442	27.8	94.65	49	76.69
bluefish	Pomatomus saltatrix	26	20169	0.52	1763.96	0.64	531	33.4	95.17	23	71.98
silver perch	Bairdiella chrysoura	27	19695	0.51	826.85	0.3	292	18.36	95.68	31	75.34
inshore lizardfish	Synodus foetens	28	19482	0.5	1537	0.56	830	52.2	96.18	24	72.54
pigfish	Orthopristis chrysoptera	29	14141	0.37	1086.03	0.39	418	26.29	96.55	28	74.36
spadefish	Chaetodipterus faber	30	7942	0.21	369.7	0.13	416	26.16	96.76	35	76.11
Spanish mackerel	Scomberomorus maculatus	31	7906	0.2	1008.44	0.37	781	49.12	96.96	29	74.73
Atl sharpnose shark	Rhizoprionodon terraenovae	32	7778	0.2	4522.38	1.64	973	61.19	97.16	10	58.45
lady crab	Ovalipes stephensoni	33	5630	0.15	45.44	0.02	421	26.48	97.31	47	76.66
shortfinger anchovy	Anchoa lyolepis	34	5515	0.14	19.94	0.01	225	14.15	97.45	50	76.7
irridescenct swimming crab	Portunus gibbesii	35	5165	0.13	47.12	0.02	462	29.06	97.58	46	76.64
Atl lookdown	Selene vomer	36	5078	0.13	183.14	0.07	408	25.66	97.71	38	76.37
hogchocker	Trinectes maculatus	37	4903	0.13	161.57	0.06	296	18.62	97.84	39	76.43
windowpane	Scophthalmus aquosus	38	4137	0.11	100.84	0.04	410	25.79	97.95	41	76.51
bullnose ray	Myliobatis freminvillei	39	3844	0.1	12041.15	4.36	330	20.75	98.05	6	50.57
lesser blue crab	Callinectes similis	40	3774	0.1	45.23	0.02	375	23.58	98.15	48	76.68
bonnethead shark	Sphyrna tiburo	41	3670	0.09	4091.41	1.48	561	35.28	98.24	13	62.97
butterfly ray	Gymnura micrura	42	3561	0.09	2626.05	0.95	470	29.56	98.33	17	67.36
fringed flounder	Etropus crossotus	43	3514	0.09	80.22	0.03	575	36.16	98.42	42	76.54
cownose ray	Rhinoptera bonasus	44	3437	0.09	19154.01	6.94	196	12.33	98.51	4	39.45
king mackerel	Scomberomorus cavalla	45	3216	0.08	218.23	0.08	280	17.61	98.59	37	76.3
bluntnose stingray	Dasyatis sayi	46	2896	0.07	5847.42	2.12	490	30.82	98.66	8	54.98
spotted hake	Urophycis regius	47	2827	0.07	76.87	0.03	189	11.89	98.73	43	76.57
ocellated flounder	Ancylopsetta quadrocellata	48	2599	0.07	102.39	0.04	414	26.04	98.8	40	76.47
leopard sea robin	Prionotus scitulus	49	2498	0.06	62.75	0.02	284	17.86	98.86	45	76.62
clearnose skate	Raja eglanteria	50	2410	0.06	2138.9	0.77	300	18.87	98.92	21	70.69

(Source: SEAMAP-SA Report Project: NA06NMF435002: September 2012)

Forage species: fish—small, short-lived and fast growing mid-trophic level species—are primary energy pathways in many marine food webs, and that they support other valuable fish stocks and many species of marine birds and mammals. Forage fish are presumed to be important in the SAB because they are food for valuable commercial and recreational species in this ecosystem, in addition to supporting other species in the broader biological community. SAB forage fish groups include Atlantic menhaden(*Brevoortia tyrannus*), halfbeaks (*Hemiramphus spp., Hyporhamphus unifasciatus*), anchovies (*Anchoa spp., A. mitchilli, A. hepsetus, Engraulis eurystole*), sardines (*Harengula jaguana*, *Sardinella aurita*), Atlantic silverside (*Menidia menidia*), scads (*Decapterus punctatus*, *Trachurus lathami*, *Selar crumenophthalmus*), shad (*Alosa spp.*), Atlantic thread herring (*Opisthonema oglinum),* mullets (*Mugil spp.*), and other pelagic oceanic planktivores such as lanternfish (*Diaphus spp.*), antenna codlet (*Bregmaceros atlanticus*), striated argentine (*Argentina striata*), chub mackerel (*Scomber japonicus*), and flyingfish (Exocoetidae).

Note: Squids (*Illex illecebrosus*, *Loligo pealei*) and shrimps (rock shrimps and penaeid shrimps) in this system also serve as forage (Pauly 1998, Anderson and Piatt 1999, Okey 2006), as do krill (Euphausiacea). These forage groups exhibit widely varying importance, *e.g*., interaction strengths, in the presently modelled context. (Source: Exploring the Trophodynamic Signatures of Forage Species in the U.S. South Atlantic Bight Ecosystem to Maximize System-Wide Values. Thomas A. Okey, Andrés M. Cisneros-Montemayor, Roger Pugliese, Ussif R. Sumaila)

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Introduction

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Policy Considerations

The marine environment is constantly in flux and today, many parts of the ocean are changing quickly due to such factors as varying temperatures and salinities, fluctuating productivity, rising sea levels, ocean acidification and growing coastal populations. While the extent and types of changes occurring vary from region to region, these changes are a major driver of ecosystem dynamics and the impacts are already being observed by scientists, managers, and fishermen in the South Atlantic.

Fish populations can react to changing ocean conditions. For example, as the ocean warms, many fish species are expanding their range or shifting their distributions toward the poles or into deep areas to find cooler waters[1][2]. Changes in spawning location and timing could have cascading effects, such as changes in population size, stock structure and population connectivity[3]. Research indicates that winter severity is also emerging as an important factor shaping fish assemblages and distribution patterns in this region[4]. In the South Atlantic, black sea bass are being caught further south off Florida and Walker (2016) documented an increase in probability of occurrence in recent years around Cape Canaveral Florida which could be related to cooler near surface water resulting from more frequent upwelling events in recent years. Such events need to be investigated comprehensively. Scientists are also observing changes in the distribution of cobia which are shifting northwards during their spring migration[5]. As conditions change and fluctuate, other South Atlantic fish populations could follow suit. Changing ranges are particularly important as fish movements into other jurisdictions can affect existing management plans and perhaps require modification of the existing management strategies.

Along with north-south (latitudinal) changes in distribution, vertical (depth) changes in the distribution of fish are affecting the catchability of the resources in terms of availability and vulnerability. These changes are particularly important for fishermen and the stock assessment process, for which changes in catch rates are assumed to be linearly related to changes in abundance. The effects of environment on stock dynamics need to be parsed into those which affect catchability – which tend to obscure true abundance signals – and those factors which actually lead to change stock abundance. Differentiating between these effects involves the changes in development of quantitative catchability coefficients derived from environmental data, and is becoming increasingly important with climate change.

Changing ocean conditions have the potential to alter existing fisheries and create opportunities for new fisheries in different regions and in the South Atlantic region. Sometimes this can happen before managers have an opportunity to assess impacts of the new fishery on the ecosystem and legislate appropriate management measures. For example, there is a developing fishery for cannonball jellyfish off the South Atlantic coast but there is little information on the possible ecosystem impacts of these fisheries[6]. As climate variability leads to range expansions and distribution shifts, new opportunities may develop and exploiting these opportunities could have a cascading effect on other fish species and habitats, highlighting the need for a precautionary approach.

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[6] http://coastalgadnr.org/sites/uploads/crd/pdf/FMPs/CannonballFMP.pdf

Changing ocean chemistry, in particular the impact of ocean acidification, has the potential to change food webs in the region. Ocean acidification appears likely to have significant consequences because many species which depend on calcium metabolism serve as prey or provide habitat, including mollusks, diatoms, soft and hard corals, and crustacean larvae; indeed direct impacts in other regions have already included shellfish mortality.

Around the nation, scientists and managers are formulating management strategies for changing ocean conditions[7]. In 2009, the North Pacific Fishery Management Council banned all commercial fishing in the changing Arctic until more scientific information is available and the Council is able to evaluate potential impacts. In 2014, the Mid-Atlantic Fishery Management Council, in coordination with the South Atlantic Fishery Management Council, New England Fishery Management Council, and Atlantic States Marine Fisheries Council, held a workshop to examine the potential impacts of climate change and the associated management implications. They underscored the importance of fostering ecological resilience to develop "climate-ready" fisheries, fishing communities, stock assessment, and management strategies[8]. The 2015 National Science and Statistical Committee meeting also focused on incorporating climate variability into stock assessments and fisheries management as one of its meeting themes[9]. Currently, NOAA is developing Regional Action Plans (RAPs) to guide and increase the use of climate-related information necessary to manage marine resources[10]. The extent and degree of changes expected in the South Atlantic are not fully known and the consequences of these changes cannot always be predicted. Such changes have implications for both stock assessments and fisheries management decisions.

Threats to EFH and EFH-HAPCs from Climate Variability

The SAFMC finds that climate variability in the South Atlantic impacts EFH and EFH-HAPCs and fisheries for managed species. Table 1 following climate variability policy and research recommendations, presents a summary of fisheries and habitat designations potentially affected by climate variability in the South Atlantic as presented in the SAFMC EFH User Guide (http://safmc.net/download/SAFMCEFHUsersGuideFinalNov16.pdf).

SAFMC Policies Addressing South Atlantic Climate Variability and Fisheries

The SAFMC establishes the following policies to address South Atlantic climate variability and fisheries, 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).

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7 M. L. Pinsky and N. J. Mantua, 2014. Emerging Adaptation Approaches for Climate-Ready Fisheries. Oceanography 27(4): 147-159.
8 MAFMC 2014. A Workshop Report: East Coast Climate Change and Governance Workshop Report. March 19-21, 2014. Washington, DC.
9 http://www.wpcouncil.org/wp-content/uploads/2015/01/DRAFT-2015-National-SSC-Workshop-Timed-Agenda.pdf
10 https://www.st.nmfs.noaa.gov/ecosystems/climate/rap/index

General Policies:

1. As species expand/shift their distributions due to changing ocean conditions and/or market demands, it is the Council's policy that the SAFMC will proactively work with:
    a. State agencies, other Councils, Atlantic State Fishery Commission, NOAA Fisheries to manage species that span multiple jurisdictions.
    b. South Atlantic LCC, NOAA RISAs, Southeast Climate Science Center, and other multi-organizational partnerships.
    c. The fishing industries, fishing communities, and other interested civil stakeholders.

2. A priority list of climate indicators should be developed by NOAA or regional partners or selected that likely track ecological, social, and economic trends and status. The Council requests annual summaries of these indicators, species likely to be influenced, and fisheries trends that appear to be due to changing ocean environmental conditions in the South Atlantic ecosystem.

3. Climate change requires the consideration of tradeoffs. Changing ocean conditions necessitate responses ranging from increasing buffers due to a higher level of uncertainty to adjusting quotas upward or downward to account for predicted and realized increases or decreases in productivity.

4. Given the uncertainty of climate impacts, the precautionary principle should be invoked as possible for future management decisions on issues that can be influenced by climate change.

5. Careful scientific and management evaluation should be undertaken as new fisheries develop, including consideration of how to avoid harmful impacts on essential fish habitat.

Research Needs Addressing Climate Variability

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 vulnerabilities in terms of distribution, habitat, reproduction, recruitment, growth, survival, and predator-prey interactions.

2. As appropriate, climate data and the effects of climate variability should be integrated into stock assessments. Climate impacts could also be a focus of the new proposed stock assessment research cycle.

3. More three dimensional ocean observations of ocean conditions are needed to characterize the coastal- estuarine – ocean habitats.

4. Management Strategy Evaluations are desired to allow the Council to analyze potential regional climate scenarios and determine whether current harvest strategies are robust to future changes.

5. Greater understanding of the socio-economic impacts and fisheries responses to climate variability is needed.

6. Characterization of offshore ocean habitats used by estuarine dependent species which may be useful in developing ecosystem models.

Many habitats in the South Atlantic Region that are susceptible to the effects of climate variability have been designated as EFH and EFH-HAPCs by the SAFMC (Table 1).

Table 1. Habitats designated as Essential Fish Habitat (EFH), their associated managed fisheries/species, and EFH-HAPCs (Source: SAFMC EFH Users Guide 2016).

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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POLICY FOR THE PROTECTION AND RESTORATION OF ESSENTIAL FISH HABITATS FROM ENERGY EXPLORATION AND DEVELOPMENT ACTIVITIES
(December 14, 2015)

Introduction

This document provides guidance from the South Atlantic Fishery Management Council (SAFMC) regarding the protection of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (EFH-HAPCs) from impacts associated with energy exploration and development activities as described in the "Threats to Marine and Estuarine Resources" section of this policy. This document also provides guidance regarding mitigation of those impacts, including avoidance, minimization and compensatory mitigation. 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), and the various Fishery Management Plans (FMPs) of the Council.

For the purposes of policy development, the types of activities within the scope of this document include wind; oil and gas; methane hydrate mining; estuarine and marine hydrokinetic; liquefied natural gas (LNG) regasification, pipelines, and offshore and on-shore facilities; and onshore power plants. The findings assess potential impacts to EFH and EFH-HAPCs posed by activities related to energy exploration and development in offshore and coastal waters, riverine systems and adjacent wetland habitats, and the processes that could improve those resources or place them at risk. The policies and recommendations established in this document are designed to avoid and minimize impacts and optimize benefits from these activities, in accordance with the general habitat policies of the SAFMC as mandated by law. The SAMFC may revise this guidance in response to changes in the types and location of energy exploration and development activities in the South Atlantic region, applicable laws and regulatory guidelines, and knowledge about the impacts of energy exploration and development on habitat.

EFH At Risk from Energy Exploration and Development Activities

The SAFMC finds that:

1. Energy exploration or development has the potential to occur within or in proximity to EFH including – but not limited to – coral, coral reefs, and live/hardbottom habitat at all depths in the Exclusive Economic Zone (EEZ); EFH-HAPCs; or other special biological resources essential to commercial and recreational fisheries under SAFMC jurisdiction.

2. Energy development activities have the potential to cause impacts to a variety of habitats across the shelf and to nearshore, estuarine, and riverine systems and wetlands, including:
   a) waters and benthic habitats in or near drilling and disposal sites, including those potentially affected by sediment movement and by physical disturbance associated with drilling activities and site development;
   b) waters and benthic habitats in or near LNG processing facilities or other energy development sites,
   c) exposed hardbottom (e.g. reefs, live bottom, deepwater *Lophelia* mounds) in shallow and deep waters,
   d) coastal wetlands
   e) coastal inlets and
   f) riverine systems and associated wetlands; and
   g) Intertidal oyster reefs

3. Certain offshore, nearshore, and riverine habitats are particularly important to the long-term viability of commercial and recreational fisheries under SAFMC management, and potentially threatened by oil, gas, wind and other energy exploration and development activities:
   a) coral, coral reef and live/hardbottom habitat, including deepwater coral communities,
   b) marine and estuarine water column habitat,
   c) estuarine wetlands, including mangroves and marshes,
   d) submerged aquatic vegetation (including seagrass),
   e) waters that support diadromous fishes, and their spawning habitats
   f) waters hydrologically and ecologically connected to waters that support EFH.

4. Siting and design of onshore receiving, holding, and transport facilities could have impacts on wetlands, shallow habitats such as oyster reefs and submerged aquatic vegetation, and endangered species' habitats if they are not properly located.

5. Sections of South Atlantic waters potentially affected by these projects, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC. Potentially affected species and their EFH under federal management include (SAFMC, 1998b):

a) Summer Flounder (various nearshore waters, including the surf zone and inlets; certain offshore waters),
b) Bluefish (various nearshore waters, including the surf zone and inlets),
c) many snapper and grouper species (live/hardbottom from shore to 600 feet, and – for estuarine-dependent species such as gag grouper and gray snapper – unconsolidated bottoms and live/hardbottoms in the estuaries,
d) Black Sea Bass (various nearshore waters, including unconsolidated bottom and live/hardbottom to 600 feet),
e) penaeid shrimp (estuarine emergent habitat, offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas, including the surf zone and inlets, live/hardbottom),
f) coastal migratory pelagics (e.g., King Mackerel, Spanish mackerel) (sandy shoals of capes and bars, barrier island ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream; all coastal inlets),
g) corals of various types and associated organisms (on hard substrates in shallow, mid-shelf, and deepwater),
h) royal red shrimp (upper regions of the continental slope from 180 meters (590 feet) to about 730 meters (2,395 feet), with concentrations found at depths of between 250 meters (820 feet) and 475 meters (1,558 feet) over blue/black mud, sand, muddy sand, or white calcareous mud),
i) rock shrimp (offshore terrigenous and biogenic sand bottom habitats from 18 to 182 meters in depth with highest concentrations occurring between 34 and 55 meters. This applies for all areas from North Carolina through the Florida Keys. Essential fish habitat includes the shelf current systems near Cape Canaveral, Florida which provide major transport mechanisms affecting planktonic larval rock shrimp),
j) golden crab (a flat foraminferan ooze habitat; distinct mounds, primarily of dead coral; ripple habitat; dunes; black pebble habitat; low outcrop; and soft-bioturbated habitat),
k) Pennatulacea (sea pens and sea pansies) muddy, silt bottoms from the subtidal to the shelf break, and deepwater corals and associated communities,
l) Highly Migratory Species (areas identified as EFH for managed by the Secretary of Commerce (e.g., inlets and nearshore waters, including shark pupping and nursery grounds), and
m) Diadromous species (riverine and offshore areas that support, including important prey species such as shad, herring and other alosines in addition to Shortnose and Atlantic sturgeon).

6. Many of the habitats potentially affected by these activities have been identified as EFH-HAPCs by the SAFMC. Each EFH-HAPC, type of activity posing a potential threat and FMP is provided as follows:

EFH-HAPC	Activity	FMP
Nearshore hardbottom	LNG regasification, pipelines and power plants	Snapper Grouper
Coastal inlets	estuarine hydrokinetic; LNG regasification, pipelines,	Shrimp, Snapper Grouper

EFH-HAPC	Activity	FMP
Spawning sites	estuarine hydrokinetic; LNG regasification and pipelines; and power plants	Shrimp, Snapper Grouper
Manganese outcroppings on the Blake Plateau	oil and gas; methane hydrate mining; marine hydrokinetic; LNG regasification and pipelines	Snapper Grouper, Golden Crab
Pelagic and benthic *Sargassum*	wind; oil and gas; marine hydrokinetic; LNG regasification and pipelines	Snapper Grouper, Dolphin Wahoo
Inshore and nearshore areas to the ends of the sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina; Hurl Rocks, South Carolina; and *Phragmatopoma* (worm reefs) reefs off the central coast of Florida and near shore hardbottom south of Cape Canaveral	wind; oil and gas; marine hydrokinetic; LNG regasification and pipelines	Coastal Migratory Pelagics
Atlantic coast estuaries with high numbers of Spanish mackerel and cobia from ELMR, to include Bogue Sound, New River, North Carolina; Broad River, South Carolina	estuarine hydrokinetic; LNG on-shore facilities; and power plants	Coastal Migratory Pelagics
Florida Bay, Biscayne Bay, Card Sound, and coral hardbottom habitat from Jupiter Inlet through the Dry Tortugas, Florida	wind; oil and gas; marine hydrokinetic; LNG regasification and pipelines	Spiny Lobster
Hurl Rocks (South Carolina); The *Phragmatopoma* (worm reefs) off central east coast of Florida; nearshore (0-4 meters; 0-12 feet) hardbottom off the east coast of Florida from Cape Canaveral to Broward County; offshore (5-30 meters; 15-90 feet) hardbottom off the east coast of Florida from Palm Beach County to Fowey Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary	wind; oil and gas; marine hydrokinetic; LNG regasification and pipelines	Coral, Coral Reef, and Live Hard/bottom
Council-designated Artificial Reef Special Management Zones (SMZs)	wind; oil and gas; methane hydrate mining; marine hydrokinetic; LNG regasification and pipelines	Snapper Grouper, Coastal Migratory Pelagics, Coral, Coral Reef, and Live Hard/bottom Habitat
Troughs and terraces intermingled with sand, mud, or shell hash at depths of 150 to 300 meters	wind; oil and gas; marine hydrokinetic; LNG regasification and pipelines	Snapper-grouper [golden tilefish]
Rock overhangs, rock outcrops, manganese-phosphorite rock slab formations, and rocky reefs	wind; oil and gas; marine hydrokinetic; LNG regasification and pipelines	Snapper-grouper [blueline tilefish]
HAPCs designated for HMS species (e.g., sharks) in the South Atlantic region – exploration and development	wind; oil and gas; marine hydrokinetic; LNG regasification and pipelines	Highly Migratory Species (NMFS FMP)

EFH-HAPC	Activity	FMP
Deepwater Coral HAPCs are designated as Snapper Grouper EFH-HAPCs: Cape Lookout Coral HAPC, Cape Fear Coral HAPC, Blake Ridge Diapir Coral HAPC, Stetson-Miami Terrace Coral HAPC, and Pourtalés Terrace Coral HAPC	wind; oil and gas; marine hydrokinetic; methane hydrate mining, LNG regasification and pipelines	Coral, Coral Reef, and Live Hard/bottom Habitat
Estuarine emergent and mangrove wetlands	estuarine hydrokinetic; LNG on-shore facilities; and power plants	Shrimp, Snapper Grouper
Seagrass	estuarine hydrokinetic; LNG on-shore facilities; and power plants	Shrimp, Snapper Grouper
State-designated nursery habitats (e.g., Florida Aquatic Preserves)	estuarine hydrokinetic; LNG on-shore facilities; and power plants	Shrimp, Snapper Grouper

7. Habitats likely to be affected by energy activities include many recognized in state level fishery management plans. Examples of these habitats include Strategic Habitat Areas (SHAs) such as those established by the State Marine Fisheries Commissions via FMPs, coastal habitat protection plans, or other management provisions. North Carolina SHAs, are a "subset of the overall system that includes a representative portion of each unique habitat so that overall biodiversity and ecological functions are maintained." NCMFC has established 20 units for Region 1; 67 units for Region 2; and 48 units for Region 3.

Threats to Marine and Estuarine Resources from Energy Exploration and Development Activities

The SAFMC finds that energy exploration and development activities threaten or potentially threaten EFH through the following mechanisms:

1. Direct mortality and displacement of organisms at and near dredging (Clarke et al. 2000), drilling or trenching sites , in addition to the installation of facilities and operation of such facilities .

2. Deposition of fine sediments (sedimentation) and drilling muds down-current from drilling, dredging, trenching, and/or backfilling sites. In a review of over 77 published studies that examine the effects of sedimentation and turbidity with 89 coral species, Erftemeijer et al. (2012) concluded increased sedimentation cause smothering and burial of coral polyps, shading, tissue necrosis, and unhealthy high concentrations of bacteria in coral mucus. Turbidity and sedimentation also reduce the recruitment, survival, and settlement of coral larvae.

3. Chronic elevated turbidity in and near drilling, dredging, trenching, and/or backfilling sites, which can interfere with foraging by fish and shrimp and abrade their gills and other soft tissues (Lindeman and Snyder 1999).

4. Direct mortality of eggs and larvae of marine organisms from water intake (Gallaway et al. 2007); post-larvae, juveniles and adults of marine and estuarine organisms due to spills from pipelines, or from vessels in transit near or close to inlet areas.

5. Alteration of long-term shoreline migration patterns with complex ecological consequences due to the placement of facilities (nearshore/offshore.)

6. One of the risks associated with horizontal directional drilling (HDD) is the escape of drilling mud into the environment as a result of a spill, collapse of the drill hole or the rupture of mud to the surface, which is commonly known as a "frac-out". A frac-out is caused when excessive drilling pressure results in drilling mud leaching vertically toward the surface. Because HDD activities occur in proximity to sensitive habitats (e.g., seagrass, coral), burial of habitat could result from "frac-outs" associated with HDD.

7. Permanent conversion of soft bottom habitat to artificial hardbottom habitat through installing a hard linear structure (i.e., a pipe covered in articulated concrete mats) can occur and the ecological effects of this habitat conversion are not well-understood.

8. Impacts to benthic resources from placement and shifting of anchors (Rogers and Garrison 2001), cables (Messing 2011; Gilliam and Walker 2012), pipelines, and other types of direct mechanical damage such as damage from deployment of instrumentation (e.g., Acoustic Doppler Current Profiles).

9. Alterations in amount and timing of riverflow and significant blockage or reduction in area of critical spawning habitat resulting from damming or diverting rivers

10. Alteration of community diversity, composition, food webs and energy flow due to addition of structure (Sammarco, Paul W. 2014; Claisse et al. 2014).

11. Fish behaviour and health may be negatively impacted by anthropogenic sound depending on sound pressure levels and the duration of the sound producing activity (Popper et al 2014).

12. Operation of power plants can alter water quality The greatest risk to aquatic and estuarine ecosystems posed by power plant cooling systems is continuous exposure to sublethal stressors, such as changes in water quality, rather than the abrupt mortality of large numbers of organisms due to impingement and entrainment (Clark and Brownell 1973; Laws 2000; Kulkarni et al. 2011). Water quality (inclusive of temperature and salinity) is known to be a driver of fine scale spatial variation in nearshore fish communities, e.g., in Biscayne Bay (Serafy et al. 1997; 2003; 2005; Faunce and Serafy 2007).

13. The interactions among all effects (including lethal and sub-lethal; direct and indirect; short-term, long-term, and cumulative) affect the magnitude of the overall impacts. Such interactions may result in a scale of effect that is multiplicative rather than additive. The effects of those interactions are largely unstudied and almost completely unknown.

SAFMC Policies for Energy Exploration and Development Activities

The SAFMC establishes the following policies and best management practices (BMPs) related to energy exploration and development activities and related projects, to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment (SAFMC 1998a; SAFMC 1998b; SAFMC 2009a). The following is intended to include existing relevant guidance documents (e.g., *Alternative Energy Environmental Information Needs* (USDOI, MMS 2007a):

General Policies:

1. Projects should avoid, minimize, and – where possible – offset damage to EFH, EFH-HAPCs, and SHAs. This should be accomplished, in part, by integrating the best available and least damaging technologies into the project design.

2. Projects should avoid intersection or overlap with Allowable Fishing Areas within the Deepwater Coral HAPCs.

3. All facilities associated with energy exploration and development, should be designed to avoid or minimize to the maximum extent practicable impacts on coastal ecosystems and sand sharing systems.

4. Projects should comply with existing standards and requirements regulating domestic and international transportation of energy products including regulated waste disposal and emissions which are intended to minimize negative impacts on and preserve the quality of the marine environment.

5. Open-loop LNG processing facilities should be avoided in favor of closed-loop systems. Water intake associated with closed-loop should be minimized and the effects to fishery resources should be determined through baseline studies and project monitoring.

6. Pilot scale projects should not occur in areas where full-scale efforts are predicted to be environmentally unacceptable (e.g., MPAs, CHAPCs, and Spawning SMZs).

EFH Review, Administrative Policies, Licensing Policies and Best Management Practices:

1. EFH Assessments prepared for energy-related projects include the mandatory components set forth in 50 CFR Part 600, Subpart K:
    - A description of the proposed action;
    - An analysis of the effects, including cumulative effects, of the action on EFH, the managed species, and associated species by life history stage;
    - The Federal agency's views regarding the effects of the action on EFH; and
    - Proposed mitigation

2. Projects requiring expanded EFH consultation should provide a full range of alternatives, along with assessments of the relative impacts of each on each type of EFH, EFH-HAPC, and SHAs. Expanded EFH consultations allow NMFS and a Federal action agency the maximum opportunity to work together in the review of an activity's impact on EFH and the development of EFH conservation recommendations. Expanded consultation procedures must be used for Federal actions that would result in substantial adverse effects to EFH. Federal action agencies are encouraged to contact NMFS at the earliest opportunity to discuss whether the adverse effect of a proposed action makes expanded consultation appropriate.

3. Impact evaluations should include quantitative assessments for each habitat based on recent scientific studies, habitat characterizations, and the best available information. All EFH assessments should be based upon the best available science, be conservative, and follow precautionary principles as developed for various Federal and State policies. EFH Assessments are produced with information gathered from the best available technologies to map and characterize project sites (e.g., see Vinick et al. 2012). The methods used for habitat mapping and characterization work should reflect input from resource trustees and be performed with experienced personnel.

4. Existing transportation infrastructure (e.g., existing cables or pipelines) should be utilized wherever practicable in order to avoid or minimize environmental impacts.

5. The effects of sound from proposed projects on fish behaviour and health should be considered in EFH Assessments.

6. Compensatory mitigation should not be considered until avoidance and minimization measures have been duly demonstrated. Compensatory mitigation should be required to offset losses to EFH, including losses associated with temporary impacts, and should take into account uncertainty and the risk of the chosen mitigation measures inadequately offsetting the impacts. Mitigation

should be local, “up-front,” and “in-kind,” and include long-term monitoring to assess and ensure the efficacy of the mitigation program selected.

7. Modelling efforts should fully characterize assumptions applied and disclose any potential biases that may affect results

8. Determination of the physical and chemical oceanographic and meteorological characteristics of the area should be done through field studies by lead action agencies, cooperating agencies, academics, or the applicant. These characteristics include but are not limited to, on-site direction and velocity of currents and tides, sea states, temperature, salinity, water quality, wind storms frequencies, and intensities and icing conditions. Studies should also include a detailed characterization of seasonal surface currents and likely spill trajectories. Such studies must be conducted prior to approval of any Exploration Plan or Development and Production Plan in order to have adequate information upon which to base decisions related to site-specific proposed activities.

9. The Environmental Impact Statement (EIS), Environmental Assessment (EA) or EFH Assessment for any outer continental shelf oil and gas lease sale should address impacts, if any, from activities specifically related to natural gas production, safety precautions required in the event of the discovery of “sour gas” or hydrogen sulfide reserves and the potential for cross-shelf transport of hydrocarbons to nearshore and inshore estuarine habitats by Gulf Stream spin-off eddies. The EIS, EA, or EFH Assessment should also address the development of contingency plans to be implemented if problems arise due to oceanographic conditions or bottom topography, the need for and availability of onshore support facilities in coastal areas, and an analysis of existing facilities and community services in light of existing major coastal developments.

10. License or permit decisions for construction projects that penetrate or attach to the seabed should be based on geotechnical studies completed to ensure that the geology of the area is appropriate for the construction method and that geological risks are appropriately mitigated.

11. Adequate spill containment and clean-up equipment should be maintained for all development facilities, and, the equipment shall be available on-site or located so as to be on-site within the landing time trajectory.

12. Bonds must be required and must be adequate to assure that resources will be available for unanticipated environmental impacts, spill response, clean-up and environmental impact assessment.

13. Exploration and development activities should not disrupt or impede known migratory patterns of endangered and threated species, nor shall they disrupt or impede the breeding or nesting seasons of endangered and threatened species.

This may necessitate the imposition of seasonal, spatial, or other constraints on exploration and development activities.

14. Licenses and permits clearly should describe required monitoring before, during and after the project in sufficient detail to document pre-project conditions and the initial, long-term, and cumulative impacts of the project on EFH. Monitoring and, if necessary, for adaptive management shall be required for the life of the project. The monitoring methods should reflect input from resource trustees and be conducted by experienced personnel.

15. Third party environmental inspectors shall be required on all projects to provide for independent monitoring and permit compliance.

16. Hydrotest chemicals that may be harmful to fish and wildlife resources should not be discharged into waters of the United States.

17. Licenses or permits should require all project-related work vessels that traverse any reef system or sensitive habitat to be equipped with standard navigation aids, safety lighting and communication equipment. Equipment, such as tow lines, that could drag along the bottom and impact benthic habitat should be secured during transit. U.S. Coast Guard automated identification system (AIS) requirements must be followed.

18. Any anchor placement should completely avoid corals and be visually verified by diver or remote camera. In addition, measures to avoid anchor sweep should be developed and implemented.

19. Appropriate buffers should be designated around sensitive marine habitats.

20. A contingency plan should be required to address catastrophic blowouts or more chronic material losses from LNG facilities, including trajectory and other impact analyses and remediation measures and responsibilities.

21. Licenses and permits should require the development of resource sensitivity training modules specific to each project, construction procedures, and habitat types found within the project impact area. This training should be provided to all contractors and sub-contractors that are anticipated to work in or adjacent to areas that support sensitive habitats.

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POLICIES FOR THE PROTECTION AND RESTORATION OF ESSENTIAL FISH HABITATS FROM BEACH DREDGING AND FILLING, BEACH RENOURISHMENT AND LARGE-SCALE COASTAL ENGINEERING

Policy Context

This document establishes the policies of the South Atlantic Fishery Management Council (SAFMC) regarding protection of the essential fish habitats (EFH) and habitat areas of particular concern (EFH-HAPCs) impacted by beach dredge-and-fill activities, and related large-scale coastal engineering projects (e.g., beach scraping). The policies are designed to be 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) and Fishery Ecosystem Plan (SAFMC, 2009). This document is not intended to supersede any other applicable state or federal policy or regulation pertaining to beach dredge-and-fill projects, but intended to complement existing policies or regulations for the benefit of protecting essential fish habitat managed by the SAFMC.

The findings presented below assess the threats to EFH potentially posed by activities related to the large-scale dredging and disposal of sediments in the coastal ocean and adjacent habitats, and the processes whereby those resources are placed at risk. The policies established in this document are designed to avoid, minimize and offset damage caused by these activities, in accordance with the general habitat policies of the SAFMC as mandated by law.

EFH at Risk from Beach Dredge-and-Fill Activities

The SAFMC finds:

1) In general, the array of large-scale and long-term beach dredging projects and related disposal activities currently being considered for the United States southeast together constitute a real and significant threat to EFH under the jurisdiction of the SAFMC.

2) The cumulative effects of these projects have not been adequately assessed, including impacts on public trust marine and estuarine resources, use of public trust beaches, public access, state and federally protected species, state and federally designated habitat areas, SAFMC-designated EFH and EFH-HAPCs.

3) Individual beach dredge-and-fill projects and related large-scale coastal engineering activities rarely provide adequate impact assessments or consideration of potential damage to fishery resources under state and federal management. Historically, emphasis has been placed on the logistics of dredging and economics, with environmental considerations dominated by compliance with the Endangered Species Act for sea turtles, piping plovers and other listed organisms. Less emphasis has been placed on the hundreds of other species affected, many with direct and significant fishery value.

4) Opportunities to avoid or minimize impacts of beach dredge-and-fill activities on fishery resources, and mitigation for unavoidable impacts have rarely been proposed or implemented. Monitoring is rarely adequate to develop statistically appropriate impact evaluations.

5) Large-scale beach dredge-and-fill activities have the potential to impact a variety of habitats across the shelf, including:

   a) waters and benthic habitats in and near the dredging sites
   b) waters between dredging and filling sites
   c) waters and benthic habitats in and near the fill sites, and
   d) waters and benthic habitats potentially affected as sediments move subsequent to deposition in fill areas.

6) Certain nearshore habitats are particularly important to the long-term viability of commercial and recreational fisheries under SAFMC management, and potentially threatened by large-scale, long-term or frequent disturbance by dredging and filling:

   a) the swash and surf zones and beach-associated bars
   b) subtidal soft-sediment topographic features
   c) nearshore and offshore coral reefs, hardbottom, and worm reefs
   d) inlets
   e) Submerged Aquatic Vegetation (SAV)

7) Large sections of South Atlantic waters potentially affected by these projects, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC, Mid-Atlantic Fishery Management Council (MAFMC), and National Marine Fisheries Service - Highly Migratory Species (HMS). Potentially Affected species and their EFH under federal management include (SAFMC, 1998b):

   a) summer flounder (various nearshore waters, including the surf zone and inlets; certain offshore waters)
   b) bluefish (various nearshore waters, including the surf zone and inlets)

c) many snapper and grouper species (live hardbottom from shore to 600 feet, and – for estuarine-dependent species [e.g., gag grouper and gray snapper] – unconsolidated bottoms and live hardbottoms to the 100 foot contour).
d) black sea bass (various nearshore waters, including unconsolidated bottom and live hardbottom to 100 feet, and hardbottoms to 600 feet)
e) penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas, including the surf zone and inlets)
f) coastal migratory pelagics [e.g., king mackerel, Spanish mackerel] (sandy shoals of capes and bars, barrier island ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream; all coastal inlets)
g) corals of various types (hard substrates and muddy, silt bottoms from the subtidal to the shelf break)
h) areas identified as EFH for Highly Migratory Species (HMS) managed by the Secretary of Commerce (e.g., sharks: inlets and nearshore waters, including pupping and nursery grounds)

In addition, numerous species of crustaceans, mollusks, and annelids that are not directly managed, but form the critical prey base for most managed species, are killed or otherwise directly or indirectly affected by large dredge-and-fill projects (Greene, 2002).

8) Beach dredge-and-fill projects also potentially threaten important habitats for anadromous species under federal, interstate and state management (in particular, inlets and offshore overwintering grounds), as well as essential overwintering grounds and other critical habitats for weakfish and other species managed by the Atlantic States Marine Fisheries Commission (ASMFC) and the states.

9) Many of the habitats potentially affected by these projects have been identified as EFH-HAPCs by the SAFMC. The specific fishery management plan is provided in parentheses:

a) all nearshore hardbottom areas (SAFMC, snapper grouper).
b) all coastal inlets (SAFMC, penaeid shrimps, and snapper grouper).
c) near-shore spawning sites (SAFMC, penaeid shrimp).
d) benthic *Sargassum* (SAFMC, snapper grouper).
e) from shore to the ends of the sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina; Hurl Rocks, South Carolina; *Phragmatopora* (worm reefs) reefs off the central coast of Florida and nearshore hardbottom south of Cape Canaveral (SAFMC, coastal migratory pelagics).
f) Atlantic coast estuaries with high numbers of Spanish mackerel and cobia from ELMR, to include Bogue Sound, New River, North Carolina; Broad River, South Carolina (SAFMC, coastal migratory pelagics).
g) Florida Bay, Biscayne Bay, Card Sound, and coral hardbottom habitat from Jupiter Inlet through the Dry Tortugas, Florida (SAFMC, Spiny Lobster)
h) Hurl Rocks (South Carolina), The *Phragmatopoma* (worm reefs) off central east coast of Florida, nearshore (0-4 meters; 0-12 feet) hardbottom off the east coast of Florida from Cape Canaveral to Broward County; offshore (5-30 meters; 15-90 feet) hardbottom off the east coast of Florida from Palm Beach County to Fowey

Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary (SAFMC, Coral, Coral Reefs and Live Hardbottom Habitat).

i) EFH-HAPCs designated for HMS species (e.g., sharks) in the South Atlantic region (NMFS, Highly Migratory Species).

10) Habitats likely to be affected by beach dredge-and-fill projects include many recognized in state-level natural resource management plans. Examples of these habitats include Critical Habitat Areas (CHAs) established by the North Carolina Marine Fisheries Commission, either in species-specific Fishery Management Plans (FMPs) or in the North Carolina Coastal Habitat Protection Plan (Deaton *et al.*, 2010).

11) Research conducted in east Florida has documented important habitat values for nearshore, hardbottom habitats, which are often buried by beach dredging projects (CSA International, Inc., 2009). These habitats are used by over 500 species of fishes and invertebrates, including juveniles of many reef fishes. Equivalent scientific work is just beginning in other South Atlantic states, but life histories suggest that similar habitat use patterns will be found.

<u>Threats to Marine and Estuarine Resources from Beach Dredge-and-fill Activities and Related Large Coastal Engineering Projects</u>

The SAFMC finds that beach dredge-and-fill activities and related large-scale coastal engineering projects (including inlet alteration projects) and disposal of material for navigational maintenance, threaten or potentially threaten EFH through the following mechanisms:

1) Direct mortality, displacement, and altered community structure of benthic organisms at and near sediment dredging sites (Van Dolah *et al.*, 1992; Wilber and Stern, 1992; Van Dolah *et al.*, 1994; Jutte *et al.*, 1999a and b; Greene, 2002; Byrnes *et al.*, 2004a and b; Diaz *et al.*, 2004; Bergquist *et al.*, 2009)

2) Direct mortality of fish larvae, as well as other planktonic and nektonic organisms at and near sediment dredging sites due to entrainment and decreased water quality. (Olney and Bilkovic, 1998; Wilber and Clarke, 2001, Greene, 2002).

3) Direct mortality, displacement, and altered community structure of organisms at initial sediment fill sites (Rakocinski *et al.*, 1996; Peterson *et al.*, 2000a; Greene, 2002; Posey and Alphin, 2002; Peterson *et al.* 2000b; Peterson *et al.* 2006; Colosio *et al.*, 2007; Leewis *et al.*, 2012; Schlacher *et al.* 2012; Speybroeck *et al.*, 2006; Van Tomme *et al.*, 2013)

4) Elevated turbidity and deposition of fine sediments down-current from dredging sites (Dodge *et al.*, 1974; Jordan *et al.*, 2010)

5) Alteration of seafloor topography and associated current and waves patterns and magnitudes at dredging areas (Greene, 2002; Blake *et al.*, 1996; Byrnes *et al.* 2004a and b; Maa *et al.*, 2004; Finkl and Hobbs, 2009)

6) Alteration of seafloor sediment size-frequency distributions at dredging sites, with secondary effects on benthos at those sites (Van Dolah *et al.*, 1992; Van Dolah *et al.*, 1994; Van Dolah *et al.*, 1998; Jutte and Van Dolah, 1999 and 2001; Jutte *et al.*, 2001; Greene, 2002; Jutte *et al.*, 199a and b; Diaz *et al.*, 2004; Nairn *et al.*, 2004; Bergquist *et al.*, 2009; Xu *et al.*, 2014)

7) Decreased primary productivity at dredged sites due to greater depths and increased turbidity (Greene, 2002)

8) Increased deposition of fine-grained sediments and organic matter in dredged areas, potentially resulting in decreased dissolved oxygen and increased hydrogen sulphide levels (Greene, 2002; Byrnes *et al.*, 2004a and b; Bergquist *et al.*, 2009)

9) Elevated turbidity in and near initial fill sites, especially in the surf zone, and deposition of fine sediment down-current from initial fill sites (Peterson *et al.*, 2000a and b; Greene, 2002; Speybroeck *et al.*, 2006)

10) Alteration of nearshore topography and current and wave patterns and magnitudes associated with fill (Greene, 2002; Benedet *et al.* 2004; Speybroeck *et al.*, 2006; Hartog *et al.*, 2008)

11) Movement of deposited sediment away from initial fill sites, especially onto hardbottoms (Nelson, 1989; Greene, 2002; Speybroeck *et al.*, 2006; Jordan *et al.*, 2010)

12) Alteration of large-scale sediment budgets, sediment movement patterns and feeding and other ecological relationships, including the potential for cascading disturbance effects (Peterson *et al.*, 2000a; Greene, 2002; Benedet *et al.*, 2004; Nairn *et al.*, 2004; Speybroeck *et al.*, 2006)

13) Alteration of large-scale movement patterns of water, with secondary effects on water quality and biota (Greene, 2002; Nairn *et al.*, 2004; Hartog *et al.*, 2008)

14) Alteration of movement patterns and successful inlet passage for larvae, post-larvae, juveniles and adults of marine and estuarine organisms (Greene, 2002)

15) Alteration of long-term shoreline migration patterns (inducing further ecological cascades with consequences that are difficult to predict) (Greene, 2002)

16) Exacerbation of transport and/or biological uptake of toxicants and other pollutants released at either dredge or fill sites (Greene, 2002)

In addition, the interactions between cumulative and direct (sub-lethal) effects among the above factors likely trigger non-linear impacts that are completely unstudied.

<u>SAFMC Policies for Beach Dredge-and-fill Projects and Related Large Coastal Engineering Projects</u>

Recommendations:

The SAFMC establishes the following general policies related to large-scale beach dredge-and-fill and related projects, to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment (SAFMC 1998a; SAFMC 1998b):

1) For each project, a comprehensive environmental document should be prepared based on the best available information, and should include:
   a) Defined areas of direct and indirect impact, using guidance provided in 40 CFR Section 1508.8 Effects. Areas of direct impact should at a minimum include the borrow sites (dredged or mined areas), the beach/nearshore sites (fill areas), and the Equilibrated Toe of Fill. Areas of indirect impact should at a minimum include the areas adjacent to direct impact areas that would be affected by indirect project impacts.
   b) Defined direct and indirect project impacts using guidance provided in 40 CFR Section 1508.8 Effects. Direct impacts should at a minimum include burial and smothering. Indirect impacts should at a minimum include turbidity and sedimentation.
   c) Baseline surveys designed with appropriate methodology to adequately document pre-project conditions for biological, physical and water resources in both direct and indirect impact areas. Baseline surveys should follow the BACI (Before-After, Control-Impact) sampling framework (Stewart-Oaten 1986). Biological resources at a minimum include benthic infauna and epifauna, SAV, hard bottom habitat, hard bottom-dependent species, coral reef habitat, and coral reef-dependent species (e.g., corals, octocorals). Physical and water resources at a minimum include topography, bathymetry, water quality (turbidity, sedimentation, total suspended solids and dissolved oxygen) and sediment characteristics (grain size, sorting, and mineralogy).
   d) A full range of alternatives, including alternatives that may minimize future need for additional nourishment activities (e.g., sand bypass).
   e) Impact assessment for each alternative using ecologically conservative assumptions and worst case scenarios, to include the following components:
      i. Identification of avoidance and minimization efforts.
      ii. Identification of the direct and indirect project impacts that cannot be avoided or minimized, using appropriately designed baseline surveys identified in c) above.
      iii. Identification of cumulative impacts that at a minimum includes impacts associated with other beach dredge-and-fill projects, as well as any other

large-scale coastal engineering projects that are both geographically and ecologically related.

f) A compensatory mitigation plan for the preferred alternative to include the following components:
    i. Calculation of the direct and indirect project impacts that cannot be avoided or minimized as identified in e) ii. above, and a detailed explanation of how direct and indirect project impact calculations were derived.
    ii. Calculation of cumulative impacts as identified in e) iii. above, and a detailed explanation of how cumulative impact calculations were derived.
    iii. Assessment of mitigation amounts for direct and indirect project impacts and cumulative impacts (based on impact calculations from f) i. and ii. above), determined by use of a functional assessment, ratio, or other tool. Include a detailed explanation of how mitigation amounts were assessed.
    iv. Identification of the compensatory mitigation actions that will be taken to compensate for project impacts. Compensatory mitigation actions should compensate for all reasonably predictable direct, indirect, and cumulative impacts on biological, physical and water resources, taking into account uncertainty about these effects, and should be local, up-front and in-kind.
    v. Monitoring plan for compensatory mitigation actions designed with appropriate methodology to adequately detect and document mitigation success.

g) A during-construction monitoring plan as deemed necessary for a specific project, designed with appropriate methodology to adequately detect and document both direct and indirect project impacts. Monitoring plans should follow the BACI sampling framework.

h) A post-construction monitoring plan for biological, physical and water resources designed with appropriate methodology to adequately detect and document both direct and indirect project impacts. Monitoring plans should follow the BACI sampling framework. Post-construction monitoring should include quantitative comparisons of abundance, biomass, species diversity, and community composition in direct and indirect impact area and reference (control) areas before and after dredge-and-fill operations.

2) Fill material should match the sediment characteristics of the recipient beach as closely as possible.

3) Dredging should be limited to bathymetric peaks (rather than depressions or level sea bottom) in areas characterized by strong currents and sand movement, in order to increase sediment infilling rates and decrease the duration of impacts to benthic habitats.

4) Dredging should be limited to the shallowest depths possible to minimize changes in wave energy and currents, thus reducing the likelihood of infilling with fine-grained sediments.

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POLICIES FOR THE PROTECTION AND RESTORATION OF ESSENTIAL FISH HABITATS FROM ALTERATIONS TO RIVERINE, ESTUARINE AND NEARSHORE FLOWS

(June 2014)

Policy Context

This document establishes the policies of the South Atlantic Fishery Management Council (SAFMC) regarding protection of the essential fish habitats (EFH) and habitat areas of particular concern (EFH-HAPCs) associated with alterations of riverine, estuarine and nearshore flows. Such hydrologic alterations occur through activities such as dam operations, water supply and irrigation withdrawals, and other modifications to the normative hydrograph. The policies are designed to be consistent with the overall habitat protection policies of the SAFMC as formulated and adopted in the Habitat Plan (October 1998) and the Comprehensive EFH Amendment (October 1998), Fishery Ecosystem Plan for the South Atlantic Region (SAFMC 2009a), Comprehensive Ecosystem-Based Management Amendment 1(SAFMC 2009b), Comprehensive Ecosystem-Based Amendment 2 (SAFMC 2011) and the various Fishery Management Plans (FMPs) of the Council.

The findings presented below assess the threats to EFH potentially posed by activities related to the alteration of flows in southeast rivers, estuaries and nearshore ocean habitats, and the processes whereby those resources are placed at risk. The policies established in this document are designed to avoid, minimize and offset damage caused by these activities, in accordance with the general habitat policies of the SAFMC as mandated by law.

EFH At Risk from Flow-Altering Activities

The SAFMC finds:

1) In general, the array of existing and proposed flow-altering projects being considered for the Southeastern United States for states with river systems that drain into the SAFMC area of jurisdiction together constitutes a real and significant threat to EFH under the jurisdiction of the SAFMC.

2) The cumulative effects of these projects have not been adequately assessed, including impacts on public trust marine and estuarine resources (especially diadromous species), use of public trust waters, public access, state and federally protected species, state critical habitat, SAFMC-designated EFH and EFH-HAPCs.

3) Individual proposals resulting in hydrologic alterations rarely provide adequate assessments or consideration of potential damage to fishery resources under state and federal management. Historically, emphasis has been placed on the need for human water supply, hydropower generation, agricultural irrigation, flood control and other human uses. Environmental considerations are dominated by compliance with limitations imparted by the Endangered Species Act for shortnose and Atlantic sturgeon, and/or through provisions of Section 18 of the Federal Power Act, as administered by the Federal Energy Regulatory Commission, which applies to the provision of passage for diadromous species, as well as the provisions of the Fish and Wildlife Coordination Act.

4) Hydrologic alterations have caused impacts to a variety of habitats including:

   a) waters, wetlands and benthic habitats near the discharge and withdrawal points, especially where such waters are used for spawning by anadromous species
   b) waters, wetlands and benthic habitats in the area downstream of discharge or withdrawal points
   c) waters, wetlands and benthic habitats in receiving estuaries of southeast rivers and
   d) waters and benthic habitats of nearshore ocean habitats receiving estuarine discharge.

5) Certain riverine, estuarine and nearshore habitats are particularly important to the long-term viability of commercial and recreational fisheries under SAFMC management, and threatened by large-scale, long-term or frequent hydrologic alterations:

   a) freshwater riverine reaches and/or wetlands used for anadromous spawning and foraging
   b) downstream freshwater, brackish and mid-salinity portions of rivers and estuaries serving as nursery areas for anadromous and estuarine-dependent species
   c) nearshore oceanic habitats off estuary mouths- and
   d) areas supporting submerged aquatic vegetation (please see SAFMC's SAV Policy for further information).

6) Large sections of South Atlantic waters potentially affected by these projects, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC**,** as well as the Mid-Atlantic Fishery Management Council (MAFMC) in the case of North Carolina. Potentially affected species and their EFH under federal management include, but are not limited to (SAFMC, 1998):

   a) summer flounder (various nearshore waters, including the surf zone and inlets; certain offshore waters)

b) bluefish (various nearshore waters, including the surf zone and inlets)
c) many snapper and grouper species (live hardbottom from shore to 600 feet, and – for estuarine-dependent species [e.g., gag grouper and gray snapper] – unconsolidated bottoms and live hardbottoms to the 100 foot contour).
d) black sea bass (various nearshore waters, including unconsolidated bottom and live hardbottom to 100 feet, and hardbottoms to 600 feet)
e) penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas, including the surf zone and inlets)
f) coastal migratory pelagics (e.g., king mackerel, Spanish mackerel) (sandy shoals of capes and bars, barrier island ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream; all coastal inlets)
g) corals of various types (hard substrates and muddy, silt bottoms from the subtidal to the shelf break)
h) areas identified as EFH for Highly Migratory Species managed by the Secretary of Commerce (inlets and nearshore waters are important pupping and nursery grounds for sharks)

8) Projects which entail hydrologic alterations also threaten important fish habitats for diadromous species under federal, interstate and state management (in particular, riverine spawning habitats, riverine and estuarine habitats, including state designated areas - e.g. Primary and Secondary Nursery Areas of North Carolina), as well as essential overwintering grounds in nearshore and offshore waters. All diadromous species are under management by the Atlantic States Marine Fisheries Commission and the states. The SAFMC also identified essential habitats of anadromous and catadromous species in the region (inlets and nearshore waters).

9) Numerous habitats that have been impacted by these projects causing hydrologic alterations have been identified as EFH-HAPCs by the SAFMC. The specific fishery management plan is provided in parentheses:

a) all nearshore hardbottom areas (SAFMC, snapper grouper).
b) all coastal inlets (SAFMC, penaeid shrimps, and snapper grouper).
c) nearshore spawning sites (SAFMC and penaeid shrimps).
d) benthic *Sargassum* (SAFMC, snapper grouper).
e) from shore to the ends of the sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina; Hurl Rocks, South Carolina; *Phragmatopora* (worm reefs) reefs off the central coast of Florida and nearshore hardbottom south of Cape Canaveral (SAFMC, coastal migratory pelagics).
f) Atlantic coast estuaries with high numbers of Spanish mackerel and cobia from ELMR, to include Bogue Sound, New River, North Carolina; Broad River, South Carolina (SAFMC, coastal migratory pelagics).
g) Florida Bay, Biscayne Bay, Card Sound, and coral hardbottom habitat from Jupiter Inlet through the Dry Tortugas, Florida (SAFMC, Spiny Lobster)
h) Hurl Rocks (South Carolina), The *Phragmatopoma* (worm reefs) off central east coast of Florida, nearshore (0-4 meters; 0-12 feet) hardbottom off the east coast of Florida from Cape Canaveral top Broward County); offshore (5-30 meters; 15-90

feet) hardbottom off the east coast of Florida from Palm Beach County to Fowey Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary (SAFMC, Coral, Coral Reefs and Live Hardbottom Habitat).

i) EFH-HAPCs designated for HMS species (e.g., sharks) in the South Atlantic region (NMFS, Highly Migratory Species).

10) Habitats likely to be affected by projects which alter hydrologic regimes include many recognized in state level fishery management plans. Examples of these habitats include Critical Habitat Areas (CHAs) established by the North Carolina Marine Fisheries Commission, either in FMPs or in Coastal Habitat Protection Plans.

<u>Threats to Riverine, Marine and Estuarine Resources from Hydrologically-Altering Activities</u>

The SAFMC finds that activities which alter normative hydrologic regimes of rivers, estuaries, inlets and nearshore oceanic habitats may include projects such as dam operations and water withdrawals. These actions may pose a threat to EFH, EFH-HAPCs, diadromous fishes, state and federally-listed species, Federal critical habitat, and CHAs through the following mechanisms:

<u>Water withdrawals:</u>
Impacts to aquatic species and habitats from water withdrawals for municipal, industrial, and agricultural purposes could potentially include impingement, entrainment, temporary and permanent alterations to habitat from construction activities, decreased downstream flows, and degradation of downstream water quality due to decreased downstream flows. Minimizing impingement and entrainment requires knowledge of the life history and behavioral traits of sensitive species in the project area, their sustained swimming speeds, and the sizes of their vulnerable life stages. In addition, projected approach and sweeping velocities at multiple flow scenarios need to be calculated during the project design phase. Approach velocity is the vector component perpendicular to the screen face as water passes through the screen mesh, measured approximately 3 inches from the screen surface. Sweeping velocity is the vector component parallel and adjacent to the screen face.

The most vulnerable life stages to water withdrawals are typically eggs, larvae, and juveniles. Protection devices need to prevent entrainment, prevent impingement, and guide sensitive species away from the facility. The first consideration is to separate the fish spatially and temporally from the intake. If intakes cannot be located away from habitats supporting sensitive species, reducing or eliminating withdrawals during the period these species are present can be an effective protection strategy.

Providing fish egress from the intake is important because without it they can eventually fatigue and become impinged. The preferred configuration is for the intake to be placed in open water, especially with a suitable sweeping velocity, because a bypass is therefore not required. However, when intakes are set into the bank, a bypass system with an entrance at the downstream end of the screen becomes necessary. Velocities at the bypass entrance should be high enough to provide efficient guidance for outmigrating fish.

Keeping the screen surface clean of debris is critically important for maintaining proper approach velocities because clogged screens tend to develop hot spots composed of higher velocities, significantly increasing rates of impingement.

Dam operations:

Impacts to aquatic species and habitats caused by flow alterations from dam operations include temporary and permanent alterations to habitat from construction activities, salinity changes that can alter emergent vegetation, reduce habitat suitability and growth rates of sensitive species, and increase the colonization of predators, degradation of downstream water quality, and altered downstream flows. Degraded downstream water quality associated with dam operations may include reduced dissolved oxygen, altered water temperature, increases in algal blooms, and reduced wastewater assimilation.

Flow modifications of natural hydrologic regimes caused by dams can greatly alter aquatic systems. The current environmental flows paradigm emphasizes the importance of the natural variability of flows and the concept that biota have evolved in response to critical components of variable flows. Components of natural river flows provide ecological functions and include baseflows, high pulse flows, and floods. For example, seasonal and annual variability in baseflows creates habitat diversity that results in diverse aquatic communities. Higher baseflows provide adequate habitat for aquatic organisms, maintain suitable water quality, keep fish eggs suspended, and enable fishes to move to feeding and spawning areas. Periodic naturally low baseflows can purge invasive species and concentrate prey into limited areas to benefit predators. High pulse flows shape physical habitat of river channels, determine the size of substrate, prevent riparian vegetation from encroaching into the channel, restore normal water quality conditions after prolonged low flows and flush away waste products and pollutants, aerate eggs, prevent siltation, and maintain suitable salinity in estuaries. Floods provide migration and spawning cues for fishes, enable fishes to access the floodplain for spawning and feeding and provide a nursery area for juvenile fishes, maintain the balance of species in aquatic communities, deposit gravel and cobbles in spawning areas, flush organic materials that serve as food and habitat structures into the channel, and purge invasive species.

Five critical components of flow regimes that regulate ecological processes in river ecosystems are recognized: magnitude, frequency, duration, timing, and rate of change. Alterations to each of these components of the natural flow regime can cause a wide range of detrimental ecological responses. As an example, the magnitude and frequency of high and low flows are common flow alterations as a result of dam operations. The extreme daily variations below peaking power hydroelectric dams represent an extremely harsh environment of frequent, unpredictable flow disturbance. Aquatic species living in these environments can suffer physiological stress, washout during high flows, and stranding during rapid dewatering. Frequent exposure can result in mortality of bottom-dwelling organisms and reductions in biological productivity. Many small fishes and early life stages are found in shallow shoreline or backwater areas, which can be impaired by frequent flow fluctuations. These flow modifications can lead to reductions in diversity and abundance of many fishes and invertebrates. Conversely, flow stabilization can also occur below dams, such as water supply reservoirs, that can result in artificially constant environments that lack natural extremes, decreased diversity, and reduced floodplain connectivity. Therefore, mimicking or ensuring the natural magnitude, frequency, duration, timing, and rate of change of baseflows, high pulse flows, and floods is preferable.

Methods of Instream Flow Protection:
Three types of approaches have been typically employed for setting environmental flow standards: minimum flow thresholds, statistically-based standards, and per cent of flow approaches. The most commonly applied approach has been to set a minimum flow to be maintained or minimum flows that vary seasonally. More recently, statistically-based standards have been used to maintain select characteristics of flow regimes. Increasingly, per cent of flow approaches are being used. Expanding upon the per cent of flow approach, bands of allowable alteration called sustainability boundaries can be placed around natural flow conditions as a means of expressing environmental flow needs. To do this, natural flow conditions are estimated on a daily basis at the points of interest, representing flows that would have existed in the absence of current flow alterations. Sustainable boundary limits can be set on the basis of allowable perturbations from the natural condition. Richter et al. (2011), citing well-supported case studies and regional analyses, suggest a high level of ecological protection will be provided when daily flow alterations are no greater than 10%, a moderate level of protection when daily flows are altered 11-20%, and alterations greater than 20% will likely result in moderate to major changes in natural structure and ecosystem functions, with greater risk associated with greater levels of daily flow alteration. It is recommended that when a single threshold value or standard is needed, a presumptive standard of protecting 80% of daily flows will maintain ecological integrity in most rivers and 90% may be needed to protect rivers with at-risk species and exceptional biodiversity. When local ecological knowledge indicates that more protective standards may be needed, adjustments to values should be considered. In addition, when applying this standard to hydropower-regulated rivers, the standard applied to daily flow averages may be insufficient to protect ecological integrity because of peaking power operations, which cause considerable fluctuation within a day.

Current State Policies:
North Carolina: Surface and groundwater withdrawers who meet conditions established by the General Assembly register and annually report their water withdrawals and surface water transfers with the State. Registrations are updated at least every five years. Water withdrawal permits contain conditions to meet site-specific instream flow requirements. Specifics of each project are used by the Division of Water Resources of North Carolina Department of Environment and Natural Resources to determine the appropriate instream flow recommendation. Some of these specifics include if the project is proposed or existing, presence or absence of a dam, purpose of the withdrawal, etc. Some flow recommendations may be a percentage of a low flow value while others may be variable, seasonally dependent flows based on fieldwork and consensus among numerous stakeholders.

South Carolina: Surface water withdrawals are regulated by the South Carolina Department of Health and Environmental Control (SCDHEC) under the Surface Water Permitting, Withdrawal, and Reporting Act, which was signed into law in June, 2010. Most facilities that have a dam and withdraw surface waters must abide by the regulations provided in this Act. However, hydropower is exempted from the permitting requirements, including the minimum flow requirements, identified in this Act. Dams, whether for hydropower or other purposes, typically require federal permits or licenses to be constructed and operated. Minimum flows at dam projects can be required by the 401 Water Quality Certification administered by SCDHEC. In the development of 401 certifications, SCDHEC will consider recommendations from other State Agencies, such as the South Carolina Department of Natural Resources (SCDNR). SCDNR flow recommendations are guided by policies of the South Carolina Water Plan, which includes an established 1989 instream flow policy for protection of fish and wildlife habitats, which says:

In the absence of a site-specific instream flow study, recommended minimum flows are as follows:

Piedmont Streams:
July-November = 20% of mean annual daily streamflow
January-April = 40% of mean annual daily streamflow
May, June, December = 30% of mean annual daily streamflow

Coastal Plain Streams:
July-November = 20% of mean annual daily streamflow
January-April = 60% of mean annual daily streamflow
May, June, December = 40% of mean annual daily streamflow

Georgia: A centralized permitting process is in place under the Georgia Department of Natural Resources- Environmental Protection Division (GDNR-EPD), which issues surface and groundwater withdrawal permits for any use greater than 100,000 gallons per day. GDNR-EPD implements its 2001 Interim Instream Flow Protection Strategy through provisions in surface water withdrawal permits. It is applicable to new, post-2001, non-farm surface water allocations of water and is applicable to any non-federal impoundment. Therefore exceptions to this policy are agricultural projects, Federal reservoirs, and withdrawals from highly regulated streams, such as the Savannah River, in which flows are significantly determined by the operation of Federal reservoirs. GDNR will work to identify a consensus approach to address minimum flow requirements for those seeking to withdraw water from highly regulated streams.

Pre-2001 withdrawal permit holders seeking increases in permit quantities are required to comply with the policy for the increased allocation only, not for the previously permitted withdrawal amount. Low flow protection for those projects using previous withdrawal amounts are governed by an annual 7Q10 or, if using pre-1977 withdrawal amounts, no minimum flow requirements. Under the 2001 Interim Instream Flow Protection Strategy, the permit applicant is able to select from one of three minimum stream flow options, outlined below:

1) Monthly 7Q10 Minimum Flow Option: The applicant is required to release the lesser of the monthly 7Q10 or inflow. The monthly 7Q10 is a statistical figure that reflects the lowest seven-day running average of a stream's flow for each calendar month with a recurrence frequency of once in ten years.

2) Site-Specific Instream Flow Study Option: A site-specific instream flow study may be performed to determine what minimum flow conditions must be maintained for protection of aquatic habitat.

3) Mean Annual Flow Options:
    a) 30% Mean Average Annual Flow for direct withdrawals, or inflow, whichever is less.
    b) 30/60/40% Mean Annual Flow for water supply reservoirs, or inflow, whichever is less. This translates to the lesser of 30% of the mean annual flow or inflow during July through November, 60% of the mean annual flow or inflow during January through April, and 40% of the mean annual flow or inflow during May, June, and December.

Florida: The five state Water Management Districts or the Florida Department of Environmental Protection (FDEP) are required to establish minimum flows and levels (MFLs) for aquifers, surface watercourses, and other surface waterbodies to identify the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area (Chapter 373.042, Florida Statutes). FDEP is given general supervisory authority over the districts and delegates water resources programs to the districts where possible. Minimum levels are developed for lakes, wetlands and aquifers, whereas minimum flows are developed for rivers, streams, estuaries and springs. MFLs are adopted into Water Management District rules (Chapter 40D-8, Florida Administrative Code) and used in each District's water use permitting program to ensure that withdrawals do not cause significant harm to water resources or the environment. Each District identifies waterbodies with adopted MFLs and those that they are currently targeting or planning to work on in the future.

The Districts collect and analyze a variety of data for each waterbody for application of methods that are used to develop specific MFL recommendations and to help define significant harm. If actual flows or levels are below established MFLs, or are expected to be below established MFLs within the next twenty years, the Districts develop and implement a recovery or prevention strategy (Chapter 40D-80, F.A.C.), in accordance with state law (Chapter 373.0421, Florida Statutes). The St. Johns River Water Management District and South Florida Water Management District are the two districts in Florida that drain into the South Atlantic region. These Districts often express MFLs as statistics of long-term hydrology incorporating return interval (years), duration (days), and magnitude (flow or level).

SAFMC Policies for Flow-altering Projects

The SAFMC establishes the following general policies related to projects resulting in hydrologic alterations, to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment (SAFMC 1998a; SAFMC 1998b):

1) Projects should avoid, minimize and where possible offset damage to EFH and EFH-HAPCs, diadromous fishes, state and federally-listed species, Federal critical habitat, and State Critical Habitat Areas (CHAs).

2) Projects should provide detailed analyses of possible impacts to EFH, EFH-HAPCs, diadromous fishes, state and federally-listed species, Federal critical habitat, and CHAs. This should include careful and detailed analyses of possible impacts, including short-term, long-term, population, and ecosystem-scale effects. Agencies with oversight authority should require expanded EFH consultation.

3) Projects should provide a full range of alternatives, along with assessments of the relative impacts of each on each type of EFH, EFH-HAPC, diadromous fishes, state and federally-listed species, Federal critical habitat, and CHAs.

4) Projects should avoid impacts on EFH, EFH-HAPCs, diadromous fishes, state and federally-listed species, Federal critical habitat, and CHAs that are shown to be avoidable through the alternatives analysis, and minimize impacts that are not.

5) Projects should include assessments of potential unavoidable damage to EFH and other marine resources.

6) Projects should be conditioned on the avoidance of impacts, and the minimization of unavoidable impacts. Compensatory mitigation should be required for all unavoidable impacts to EFH, EFH-HAPCs, diadromous fishes, state and federally-listed species, Federal critical habitat, and CHAs, taking into account uncertainty about these effects. Mitigation should be local, up-front and in-kind, and should be adequately monitored.

7) Projects should include baseline and project-related monitoring adequate to document pre-project conditions and impacts of the projects on EFH, EFH-HAPCs, diadromous fishes, state and federally-listed species, Federal critical habitat, and CHAs.

8) All assessments should be based upon the best available science.

9) All assessments should take into account the cumulative impacts associated with other projects in the same southeast watershed.

10) Projects should meet state and Federal water quality standards. For instance operational or structural modifications may be employed, if necessary, to improve downstream dissolved oxygen and/or water temperature.

11) To the extent that it is reasonably practicable, construction activities should not be scheduled to coincide with the spawning migrations or early development of sensitive species that are present in the proposed project areas.

12) Impingement and entrainment of sensitive species at water intakes should be avoided. Water intakes should not be placed in areas that would negatively affect EFH's, EFH-HAPCs, CHAs, Federal critical habitat, diadromous fishes, and state and federally-listed species.

13) When developing the intake design, intake screens in rivers and streams should be constructed away from the banks and within the flowing stream. If on the bank, the face should be continuous with the adjacent bank line to ensure a smooth transition to prevent eddies around the screen and a fish bypass system that returns fish to the main channel should be incorporated. Screens should be oriented so the angle between the face of the screen and the approaching flow is not more than 45 degrees off parallel. Anticipated sweeping and approach velocities of proposed projects should be compared to the known swimming speeds of sensitive species in the project area, egg size of sensitive species should be considered when deciding on mesh size, and the vertical distribution of sensitive species should be considered when deciding on the elevation of the intake. Approach velocities must be set lower than the sustained swimming speed of sensitive species. Sweeping velocities should be greater than the approach velocities. Using a non-withdrawal period or installing removable screens with reduced mesh size during the spawning and early development periods may also be options to avoid impingement and entrainment. Where possible, locate intakes where sufficient sweeping velocity exists to minimize sediment accumulation, facilitate debris removal, and encourage fish movement away from the screen face.

14) An on-going maintenance and repair program is necessary to ensure water intake facilities are kept free from debris and that screen mesh and other components are functioning correctly. Adequate facilities need to be in place for handling floating and submerged debris large enough to damage the screen.

15) Multiple years of post-construction monitoring should be used to study impingement and entrainment rates of sensitive species, and if a bypass system is included, for monitoring mortality through the bypass. Monitoring results need to confirm that the design criteria were met and that unexpectedly high mortality rates are not occurring. Monitoring results can then be used to improve the water intake structure, if needed.

16) Components of the natural flow regime should be altered as little as possible. Although achieving a natural hydrograph in its entirety may not be possible, restoration of some of the natural flow regime components can restore ecosystem elements that would be lost or reduced as a consequence of flow regulation.

17) For hydropower peaking projects, consider the implementation of ramping rate restrictions before and after the peaking operation and a non-peaking window during the critical reproductive and rearing periods of sensitive species.

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SAFMC Policy for Protection and Enhancement of Estuarine and Marine Submerged Aquatic Vegetation (SAV) Habitat

(June 2014)

The South Atlantic Fishery Management Council (SAFMC) and the Habitat Advisory Panel have considered the issue of the decline of Estuarine and Marine Submerged Aquatic Vegetation (SAV) or seagrass habitat in Florida and North Carolina as it relates to Council habitat policy. Subsequently, the Council's Habitat Committee requested that the Habitat Advisory Panel develop the following policy statement to support Council efforts to protect and enhance habitat for managed species.

Description and Function:
In the South Atlantic region, SAV is found primarily in the states of Florida and North Carolina where environmental conditions are more favorable than in South Carolina and Georgia . The distribution of SAV habitat is indicative of its importance to economically important fisheries: in North Carolina, total coverage is estimated to be 130,000 acres (Deaton et al. 2010); in Florida, the nearshore seagrass coverage is estimated to be 2.2 million acres with an additional 2-3 million acres offshore in the Gulf of Mexico (Yarbro and Carlson, 2013).

SAV is designated through Fishery Management Plans as Essential Fish Habitat for several federally managed species, including Penaeid shrimp, spiny lobster, snapper-grouper species, and cobia. It is also designated as Habitat Area of Particular Concern for snapper-grouper species and juvenile summer flounder. SAV is critically important to numerous state managed species, and a diverse assemblage of fauna that are prey to federally managed species; SAV provides valuable ecological and economic functions. Food and shelter afforded by SAV result in a complex and dynamic system that provides a primary nursery habitat for various organisms important both to the overall system ecology, to commercial and recreational fisheries, and to non-harvested fish, shellfish, manatees, and sea turtles. Using ecological services valuations of Costanza et al. (1997) and Orth et al. (2006), Florida seagrass ecosystems alone provide services worth more than $20 billion a year. For more detailed discussion, please see Appendix 1.

Threats and Status:

Natural events, human activities, and global climate change influence the distribution and quality of SAV habitat. Natural events may include regional shifts in salinity or light availability because of drought or excessive rainfall, animal foraging, storm events, cold temperatures, or disease. Human-related activities can affect SAV through physical disturbance or alteration of habitat or water quality degradation. SAV is extremely susceptible to physical disturbance because of its vulnerable location in shallow, nearshore waters. Activities such as dredging for navigational channels or marinas, propeller scarring, bottom-disturbing fishing activities, and shoreline alteration can inflict damage or mortality on SAV directly. SAV is also vulnerable to water quality degradation and in particular to suspended sediment and eutrophication, due to its relatively high light requirements. Changing land use and increasing population threaten water quality in the coastal zone. The most recent syntheses of research describe a global crisis for SAV ecosystems (Orth et al. 2006; Waycott et al. 2009). Climate change and sea level rise could cause large-scale losses of SAV habitat due to rising water levels and temperatures, changing weather patterns, and a collapse of barrier islands. The major anthropogenic threats include:

(1) light limitation due to
  (a) increased particles and colored dissolved organic matter (CDOM) in runoff from land;
  (b) increased phytoplankton in coastal waters due to elevated nutrient inputs from runoff;
  (c) sediment resuspension from wind, wave, or boat action.

(2) mechanical damage due to:
  (a) propeller damage from boats;
  (b) bottom-disturbing fish-harvesting techniques;
  (c) dredging and filling.

SAV habitat in both Florida and North Carolina has experienced significant losses over the last 65 years. However, conservation measures taken by regional, state and federal agencies have slowed, and in some areas reversed, the decline. For example, in both North Carolina and Florida, progress has been made to map, monitor, and assess change in seagrass distribution so that appropriate management actions can be taken. In Florida, several National Estuary Programs have worked collaboratively with local governments and industry to reduce nutrient inputs, especially nitrogen, to estuarine and coastal waters. These efforts have resulted in significant increases in SAV acreage. Other advancements in seagrass protection and enhancement have been made, such as prop scar restoration, establishment of no motorized vessel zones around shallow grass beds, and implementation of more stringent stormwater runoff rules. The threats to this habitat and the potential for successful conservation measures highlight the need to continue to address the causes of SAV decline. Therefore, the SAFMC recommends immediate and direct action be taken to stem the loss of this essential habitat and to restore SAV beds where feasible. For more detailed discussion, please see Appendix 2.

SAV POLICY

Because of the economic and ecological value of SAV ecosystems, the SAFMC considers it imperative to take directed and purposeful action to protect remaining habitat and to support actions to restore SAV in locations where they have occurred in the past. The SAFMC strongly recommends that a comprehensive adaptive management strategy be developed to address the decline in SAV habitat in the South Atlantic region, including the Indian River Lagoon which has suffered more than a 50% decline in SAV in since 2011 due to a large and persistent phytoplankton bloom. Furthermore, as a stepping stone to such a long-term protection strategy, the SAFMC recommends the adoption of a reliable status and trend survey methodology (mapping and monitoring) to verify the location, health, and coverage of SAV at sub-regional and/or local scales (e.g., Florida’s Seagrass Integrated Monitoring and Mapping Program and/or Virginia Institute of Marine Sciences’ annual mapping of Chesapeake Bay).

The SAFMC will encourage the South Atlantic states to assess the status and trends in SAV ecosystems and will consider establishing specific plans for protecting and revitalizing, where necessary, the SAV resources of the South Atlantic region. This action can be achieved by the following four integrated components:

Monitoring and Research:
Periodic mapping and monitoring of SAV in the region are required to determine how distribution has changed spatially over time, the progress toward the goal of a net resource gain, and what management actions are needed to reach established goals.

The SAFMC supports efforts to:

- Develop and standardize imagery acquisition and resource mapping protocols, with regional modification as necessary to achieve effective results (Yarbro and Carlson 2013).
- Develop and maintain a Geographic Information System database for essential habitat including SAV and use that information for assessment of trends in SAV extent (e.g., SIMM or OBIS-SEAMAP).
- Evaluate water quality criteria needed to support SAV survival and growth and support policy making to manage quality and quantity of surface runoff.
- Research and document causes and effects of SAV losses, including cumulative impacts, watershed runoff, shoreline development, shading associated with pier and dock, development, invasive species, and extreme weather conditions (drought, tropical storms, algal blooms, etc).
- Encourage states to minimize impacts to SAV by developing design criteria for docks and piers which establish minimum height, maximum width and materials.
- Investigate effective restoration techniques, including ecological function and cost/benefit.
- Research potential effect of climate change on SAV habitat.•

Planning:

Establishing goals, objectives, and measures of success is essential to evaluate progress and to provide a framework to direct future actions. The SAFMC supports:

- Watershed planning which incorporates SAV as an integral part of a healthy ecological system and utilizes change in SAV distribution as an indicator of system health.
- The regulatory definition of SAV habitat as: shallow water habitat with appropriate sediment, depth, light penetration and wave energy, including areas without existing SAV.
- Comprehensive planning initiatives as well as interagency coordination, partnerships, and planning to protect SAV habitat and increase awareness.
- The establishment of standardized SAV survey protocols for reviewing coastal development permit applications. This action includes survey windows, survey methods, and in-water work windows.
- The Habitat Advisory Panel members in actively seeking to involve the SAFMC in the review of projects which will impact, directly or indirectly, SAV habitat resources.

Management:

Based on assessment of monitoring data, research results and planning, management actions should be developed or modified as necessary to address primary issues affecting SAV habitat. Conservation and expansion of SAV habitat are critical to the maintenance of the living resources that depend on these systems. A number of federal and state laws and regulations apply to activities that eliminate or modify SAV habitat, either directly or indirectly (Appendix 3). However, state and federal regulatory processes have been uneven in their effectiveness to prevent or slow the loss of SAV acreage. While restoration results through repair of bottom topography and planting of SAV have improved, these efforts are extremely costly and unsustainable if the causes of SAV loss are not corrected (eg. Insufficient water clarity, continued prop scarring). Efforts to improve water clarity in areas where SAV was once abundant have resulted in the expansion and creation of SAV habitat on a much larger scale than is feasible through bottom recontouring and plantings alone. Declines in SAV acreage continue in a number of localities in the South Atlantic region (Yarbro and Carlson 2013) and it has often been difficult to implement effective resource management initiatives due to: the lack of adequate documentation of losses and specific cause/effect relationships, public resistance to additional coastal development regulations, and insufficient funding (for more detailed discussion, please see Appendix 3).

SAFMC supports:

- Review and modification of state and federal rules to ensure protection of SAV from impacts such as dredging, propeller scarring, marina and pier construction, and bottom-disturbing fishing activity.
- Review of state water quality standards and rules to determine if changes are needed to protect and enhance SAV.
- Development of SAV restoration guidelines for both high and low salinity SAV to accelerate successful, cost-effective SAV restoration.

Education and Enforcement:

Educating and engaging the public on the value of SAV habitat will aid in the protection of existing SAV habitat and garnish support for additional management measures that may be needed. Enforcing existing regulations to sustain SAV health minimizes the need for additional regulatory actions.

SAFMC supports:

- Design of education programs to heighten the public's awareness of the importance of SAV. An informed public will provide a firm foundation of support for protection and restoration efforts.
- Review of existing regulations and enforcement to determine their effectiveness.
- Coordination with state resource and regulatory agencies to ensure that existing regulations are being enforced.
- Development of economic analyses on the economic benefits of protecting and enhancing SAV habitat.

SAFMC SAV Policy Statement- Appendix 1

ECOSYSTEM SERVICES

Worldwide, submerged aquatic vegetation (SAV) constitutes a common shallow-water habitat type. These angiosperms have successfully colonized standing and flowing fresh, brackish, and marine waters in all climatic zones, and most are rooted in the sediment. Estuarine and marine SAV beds, or seagrasses, occur in the low intertidal and subtidal zones and may exhibit a wide range of habitat forms, from extensive collections of isolated patches to unbroken continuous beds. The bed is defined by the presence of either aboveground vegetation, its associated root and rhizome system (with living meristem), or the presence of a seed bank in the sediments, as well as the sediment upon which the plant grows or in which the seed back resides. In the case of patch beds, the unvegetated sediment among the patches is considered SAV habitat as well.

There are seven species of marine SAV or seagrass in Florida's shallow coastal areas: turtle grass (*Thalassia testudium*); manatee grass (*Syringodium filiforme*); shoal grass (*Halodule wrightii*); widgeon grass (*Ruppia maritima*); star grass (*Halophila engelmannii*); paddle grass (*Halophila decipiens*); and Johnson's seagrass (*Halophila johnsonii*) (See distribution maps in Appendix 4). *H. johnsonii* is listed by the National Marine Fisheries Service as a threatened plant species. Areas of seagrass concentration along Florida's east coast begin south of Daytona Beach and include Mosquito Lagoon, Banana River, Indian River Lagoon, Lake Worth and Biscayne Bay. In 2010, seagrasses in these estuaries covered about 241,000 acres; an additional 159,000 acres of seagrass occur on the Atlantic side of Key Biscayne (Yarbro and Carlson 2013). Florida Bay, located between the Florida Keys and the Everglades, also has an abundance of seagrasses (145,000 acres), and seagrasses in the Florida Keys National Marine Sanctuary, west and south of the Florida Keys, comprise 856,000 acres. Large-scale losses (47,000 acres) of seagrasses have occurred in the Banana River since 2011. Seagrass acreage in the Southern Indian River Lagoon, Florida Bay and Biscayne Bay are likely stable, but trends in acreage of beds on the ocean side of south Florida are unclear because current estimates date to 1992.

The three dominant SAV species found in North Carolina are shoalgrass (*Halodule wrightii*), eelgrass (*Zostera marina*), and widgeon grass (*Ruppia maritima*). Shoalgrass, a subtropical species, has its northernmost distribution at Oregon Inlet, North Carolina. Eelgrass, a temperate species, has its southernmost distribution in North Carolina. Areas of seagrass concentration in North Carolina are in southern and eastern Pamlico Sound, Core Sound, Back Sound, Bogue Sound and the numerous small southern sounds located behind the beaches in Onslow, Pender, Brunswick, and New Hanover Counties (See distribution maps in Appendix 4).

In addition meso- and oligohaline SAV species occur in shallow waters along the western shoreline of Pamlico Sound and the Neuse and Pamlico river tributaries. Widgeon grass is the dominant species in western Pamlico Sound due to its large tolerance to fluctuating salinity and water clarity conditions. In river tributaries, horned pondweed (*Zannichellia palustris*) is often the first species to emerge in the spring, and is replaced by widgeon grass or other species as water temperatures increase (NCDWQ 2007). Other species that occur in western Pamlico Sound and its tributaries include eelgrass, shoal grass, wild celery (*Vallsineria americana*), redhead pondweed (*Potamogeton perfoliatus*), and southern naiad (*Najas guadalupensis*). Many of the tributaries and shallow waters supporting lower salinity grass species are important nursery grounds for Penaeid shrimp, are designated Primary or Secondary Nursery Areas, and thus, are Essential Fish Habitat.

Marine SAV serve several valuable ecological functions in the marine estuarine systems where they occur. Food and shelter afforded by seagrasses result in a complex and dynamic system that provides a primary nursery habitat for various organisms that are important both ecologically and to commercial and recreational fisheries. Organic matter produced by seagrasses is transferred to secondary consumers through three pathways: herbivores that consume living plant matter; detritivores that exploit dead matter; and microorganisms that use seagrass-derived particulate and dissolved organic compounds. The living leaves of these submerged plants also provide a substrate for the attachment of detritus and epiphytic organisms, including bacteria, fungi, meiofauna, micro- and macroalgae, and macroinvertebrates. Within the seagrass system, phytoplankton are present in the water column, and macroalgae and microalgae are associated with the sediment. No less important is the protection afforded by the variety of living spaces in the tangled leaf canopy of the grass bed itself, and this is especially critical to the juvenile stages of many important fish. The structure of the beds can also provide a refuge from acoustic stressors in the adjoining water column, including dolphin whistles and boat noise (Wilson et al. 2013). In addition to biological benefits, seagrasses also cycle nutrients and heavy metals in the water and sediments, and dissipate wave energy (which reduces shoreline erosion and sediment resuspension).

Fish may associate with seagrass beds in several ways. Resident species typically breed and carry out much of their life history within the meadow (e.g., gobiids and syngnathids). Seasonal residents typically breed elsewhere, but predictably utilize seagrasses during a portion of their life cycle, most often as a juvenile nursery ground (e.g., sparids and lutjanids). Transient species can be categorized as those that feed or otherwise utilize seagrasses only for a portion of their daily activity, but in a systematic or predictable manner (e.g., haemulids).

In Florida, many economically important species utilize seagrass beds as nursery and/or spawning habitat: spotted seatrout (*Cynoscion nebulosus*), grunts (Heaemulids), snook (*Centropomus* spp.), bonefish (*Albulu vulpes*), tarpon (*Megalops atlanticus*) and several species of snapper (Lutianids) and grouper (Serranids). Densities of invertebrate organisms are many times greater in seagrass beds than in bare sand habitat. Penaeid shrimp, spiny lobster (*Panulirus argus*), bay scallops (*Argopecten irradians*), green sea turtles (*Chelonia mydas*) and manatees also depend on seagrass beds.

In North Carolina, 40 species of fish and invertebrates have been captured in seagrass beds. Larval and juvenile fish and shellfish including gray trout (*Cynoscion regalis*), red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), mullet (*Mugil cephalus*), spot (*Leiostomus xanthurus*), pinfish (*Orthopristis chrysoptera*), gag (*Mycteroperca microlepis*), white grunt (*Haemulon plumieri*), silver perch (*Bairdiella chrysoura*), summer flounder (*Paralichthys dentatus*), southern flounder (*P. lethostigma*), blue crabs (*Callinectes sapidus*), hard shell clams (*Mercenaria mercenaria*), and bay scallops (*Argopecten irradains*) utilize seagrass beds as nursery areas. Seagrasses are the sole nursery ground for bay scallops in North Carolina. Seagrass meadows are also frequented by adult spot, spotted seatrout, bluefish (*Pomatomus saltatrix*), menhaden (*Brevortia tyrannus*), summer and southern flounder, pink and brown shrimp, hard shell clams, and blue crabs. Offshore reef fishes, including black sea bass (*Centropristis striata*), gag (*Mycteroperca microlepis*), gray snapper (*Lutianus griseus*), lane snapper (*Lutjanus synagris*), mutton snapper (*Lutianus annalis*), and spottail pinfish (*Displodus holbrooki*), also spend a portion of their life cycles in seagrass beds. Ospreys, egrets, herons, gulls and terns feed on fauna in seagrass beds, while swans, geese, and ducks feed directly on SAV itself. Green sea turtles (*Chelonia mydas*) also utilize seagrass beds, and juveniles may feed directly on the seagrasses.

SAFMC SAV Policy Statement- Appendix 2

STATUS
SAV habitat is a valuable natural resource which is now threatened by overpopulation in coastal areas and nearby watersheds. Worldwide, SAV has declined in area since the mid-twentieth century, and light limitation is the primary factor limiting SAV distribution (Orth et al. 2006; Waycott et al. 2009). Several processes contribute to decreases in water clarity in estuarine and coastal regions; heightened nutrient inputs from coastal watersheds (due to development) fuel the growth of phytoplankton, which in turn reduce light available to benthic vegetation. Higher nutrient levels may also increase the biomass of epiphytes on SAV blades, reducing the light available for photosynthesis. Groundwater enriched by septic systems also may infiltrate the sediments, water column, and near-shore SAV beds with the same effect. Increases in the turbidity of overlying waters, resulting from sediment in runoff, dredging, channelization, boat traffic, and resuspension of bottom sediments, also may reduce the amount of light available to SAV. Changes in the timing and volume of river runoff due to climate change may also result in reduced light availability to coastal SAV. For example, increased and prolonged runoff from highly polluted/colored rivers, especially during spring and summer, appear to reduce light levels in Florida's Indian River Lagoon and jeopardize the survival of SAV. With excessive water column productivity, lowered dissolved oxygen concentrations may result and are detrimental to invertebrate and vertebrate grazers. Loss of these grazers may result in overgrowth by epiphytes and loss of food for predators. SAV losses resulting from reduced light availability can be more subtle and are often difficult to assess in the short term (months).

Although not caused by humans, disease ("wasting disease" of eelgrass in North Carolina) has historically impacted SAV beds. Activities that directly damage SAV beds, such as dredging and filling, bottom-disturbing fishing gear, propeller scarring and boat wakes are readily observed and are subject to regulations (See Appendix 3). Other indirect causes of SAV loss or change in SAV species may be ascribed to changing hydrology which may in turn affect salinity levels and circulation; reduction in flushing can cause an increase in salinity and the ambient temperature of a water body, stressing plants and ultimately changing the dominant SAV to more salt-tolerant species. Increases in flushing can mean decreased salinity, with possible species changes, and increased turbidity and near-bottom mechanical stresses which damage or uproot plants.

Large areas of Florida where SAV was once abundant have experienced significant losses since the mid-twentieth century. In some areas, SAV occurs at a fraction of historical areas. One of these depleted areas is Lake Worth in Palm Beach County where dredge and fill activities, sewage disposal, and stormwater runoff have almost eliminated this resource. Historically, North Biscayne Bay lost most of its SAV from urbanization and small losses continue. The Indian River Lagoon lost many SAV beds due to stormwater runoff directly and indirectly (via phytoplankton blooms) from reduced water clarity. Recent gains in the Northern Indian River Lagoon, due to concerted efforts to reduce nutrient and particle inputs, improved SAV acreage and brought a few locations close to historical levels; however, 47,000 acres of seagrass have recently disappeared due to a massive and recurring phytoplankton bloom. Many seagrass beds in Florida have been scarred from boat propellers disrupting the physical integrity of the beds. Florida's assessment of dredging/propeller scar damage indicates that Dade, Lee, Monroe, and Pinellas Counties have the most heavily damaged seagrass beds. Vessel registrations, both commercial and recreational, tripled from 1970-71 (235, 293) to 1992-93 (715,516). More people are engaged in marine activities, which affects the limited resources of fisheries and benthic communities.

In North Carolina, distribution and abundance of SAV vary seasonally and inter-annually. Growing seasons vary by species with peak abundance of high salinity species between April and October, and low salinity species between May and June. In North Carolina, total SAV coverage is conservatively estimated at 130,000 acres. This figure is based on an interagency coastwide mapping effort from 2006-2008 that identified 130,000 acres of seagrass. However, field groundtruthing verified that the delineation based on aerial imagery underestimated SAV occurrence in the meso- and oligohaline estuaries due to lower water clarity. However that mapping provided a baseline for future mapping events so that trends can be determined. Prior to that, SAV had not been remapped in comparable methodology to evaluate trends. NC Division of Marine Fisheries (NCDMF) now maintains an inventory of SAV mapping on the coast and the SAV Partnership, an interagency group of federal, state, and NGO representatives with interest in managing SAV, developed a monitoring plan that includes repeat mapping on 5 year cycles, staggered regionally. In 2012-2013, most of the marine SAV in high salinity waters were remapped (Currituck, eastern Pamlico, Core, and Bogue sounds) and the results are pending.

While quantified trends are not available, anecdotal information from resource agency staff on long term trends is available for some regions. Compared to North Carolina's low-moderate salinity SAV community, the high salinity seagrasses appear relatively stable. Mapping results of core areas of seagrass, such as behind the Outer Banks in Pamlico Sound and Core Sound, indicate there has not been a large change in coverage since the 1980s (D. Field/NOAA, pers. com, 2010). However, seagrass in Bogue Sound appears to have become less dense and patchier. In areas where SAV occurs to a lesser extent (Albemarle Sound, Neuse and Pamlico rivers, and waters south of Bogue Sound) SAV was reported to be more abundant in the 1970s, declined in the 1980s, and has been increasing since the early 2000s. These latter areas are located in closer proximity to riverine discharge and stormwater runoff. Under conditions of low rainfall and runoff, such as during droughts, improved water clarity and higher and less fluctuating salinity could be allowing expansion of distribution in these waters with less optimal water clarity conditions (Deaton et al. 2010). It is unclear how much influence sediment and nutrient loading from stormwater runoff or wastewater treatment effluent has on these fluctuations. In addition to weather related changes, seagrass habitat continues to be impacted by individually small, but cumulative, coastal development activities, such as dredging for navigational channels, marinas, and docks. Impacts from private projects are often reduced, but not always avoided. Several past and proposed North Carolina Department of Transportation projects related to ferry channels or bridges have impacted or will impact much larger areas of seagrass. Projects with a public benefit are allowed to have unavoidable SAV impacts, but mitigation is required. Bottom disturbing fishing activities, such as mechanical clam harvest, crab dredging, or shrimp trawling can damage SAV. A recommendation of the NC Coastal Habitat Protection Plan (CHPP) requires that habitat be protected from fishing gear damage through modifications to fishing boundaries and improved enforcement. The Division of Marine Fisheries, through the Fishery Management Plan process and rule changes, has moved shrimp trawling and oyster dredging boundaries to avoid impacting SAV.

SAFMC SAV Policy Statement- Appendix 3

PAST MANAGEMENT EFFORTS

Conservation of existing SAV habitat is critical to the maintenance of the organisms depending on these systems. A number of federal and state laws require permits for modification and/or development in SAV-bearing waters. These include Section 10 of the Rivers and Harbors Act (1899), Section 404 of the Clean Water Act (1977), and the states' coastal area management programs. Section 404 prohibits deposition of dredged or fill material in waters of the United States without a permit from the U.S. Army Corps of Engineers. The Fish and Wildlife Coordination Act gives federal and state resource agencies the authority to review and comment on permits, while the National Environmental Policy Act requires the development and review of Environmental Impact Statements. In addition to federal guidelines, states haverules related to development activities and SAV (Table 1). The Magnuson-Stevens Fisheries Conservation and Management Act was amended to require that each fishery management plan include a habitat section. The SAFMC's habitat subcommittee may comment on permit requests submitted to the Corps of Engineers when the proposed activity relates to habitat essential to managed species. State and federal regulatory processes have accomplished little to slow the decline of SAV habitat. Many of the impacts, especially those affecting water clarity, cannot be easily controlled by the regulations as enforced. For example, water quality standards are written so as to allow a specified deviation from background concentration; in this manner, standards allow a certain amount of degradation. An example of this is Florida's Class III water transparency standard, which defines the compensation depth to be where 1% of the incident light remains. The compensation depth for SAV is in well in excess of 10% and for some species is between 20 and 25%. The standard allows a deviation of 10% in the compensation depth which translates into 0.9% incident light or an order of magnitude less than what the plants require. Large-scale, direct mitigative measures to restore or enhance impacted areas have met with little success. Management of nutrient loads, especially nitrogen, from surface and ground waters is essential to restore the water clarity necessary to support SAV ecosystems. Where efforts have been successful, it has resulted from collaborative partnerships among industry, local and regional governments, and National Estuary Programs. Some of the approaches to minimize propeller scar damage to SAV beds include: education, improved channel marking, restricted access zones (complete closure to combustion engines, pole or troll areas), and improved enforcement. When SAV restoration and mitigation are undertaken, the SAFMC understands the need for extended monitoring, not only to determine success from plant's standpoint but also to assess the recovery of faunal populations and the functional attributes of the ecosystem as a whole. The SAFMC also encourages
long-term trend analysis of SAV distribution and abundance, using appropriate protocols and Geographic Information System approaches, to inform management and permitting decisions.

Table 1. Summary of guidelines for SAV protection used by the federal regulatory and commenting agencies, as well as the state agencies of Maryland and Virginia (Source: Orth et al. 2002; NC Department of Environment and Natural Resources; Fl Department of Environmental Protection)

Categories	North Carolina	Florida	Maryland	Virginia	US Army Corps of Engineers (Baltimore District)	US Environmental Protection Agency	US Fish and Wildlife Service	National Marine Fisheries Service
Dredging of new channels	Allowed if no significant adverse impact to SAV, PNAs, oyster beds, wetlands. Can seek variance.	Regulatory – allowed after impacts are avoided and minimized, and appropriate compensatory mitigation is provided for any remaining impacts that cannot be avoided or minimized. Proprietary - allowed if not contrary to public interest and appropriate compensatory mitigation is provided.	Not allowed in water ≤ 3 ft. at MLW.	Limit channels to minimum dimensions necessary; avoid SAV.	Not allowed in waters ≤ 2 ft. MLW in main channel. ≤ 1.5 ft. MLW in spurs; presence of SAV overrides these parameters	Generally, no new dredging except in historic channels.	Avoid shallow water habitats; not recommended in areas without piers & historical deepwater access.	Not recommended within existing SAV beds or adjacent shallows with potential for bed expansion
Dredging in SAV beds	No new dredging in SAV allowed. Can seek variance. Maintenance dredging is allowed.	Regulatory – allowed after impacts are avoided and minimized, and appropriate compensatory mitigation is provided for any remaining impacts that cannot be avoided or minimized. Proprietary - shall not be approved unless there is no reasonable alternative, project is not contrary to public interest and appropriate compensatory mitigation is provided for impacts.	Allowed in areas where there were historic channels	Usually not allowed.	Prohibited upstream of 1.5-2 ft. contour and in existing beds (see text for exceptions); channel dimensions may be restricted where slumping occurs.	Allowed in channels or historic channels only; not recommended otherwise.	Not recommended.	Not recommended.
Timing restrictions on dredging	Dredging moratoriums requested by resource agencies.	Dredging restrictions required by resource commenting agencies (e.g., presence of listed species).	Prohibited within 500 yards of SAV beds, April 15-October 15.	Restrictions may be placed if in proximity to living resources.	April 1- June 30; April 15-October 15 (species with two growing seasons).	March 31-June 15.	March-June	Species-dependent; April-October 15 for most species; April 1- June 30 for horned pondweed.
Dredging in areas that historically supported SAV	Not allowed if SAV habitat. DMF defines that to include areas documented to have SAV within past 10 years.	Considered during the application review process.	Not recommended where SAV occurred during the previous growing season.	Considered during the application review process.	Depends on depths and why SAV disappeared. Check soils.	Not recommended	Not recommended	Not recommended where SAV has been documented during the past 2-3 growing seasons.
Dredging near SAV beds/buffer zones	Reviewing agencies would consider on case by case basis .	Considered during the application review process. Addressed as part of the Secondary Impact Analysis.	See timing restrictions on dredging above.	Considered during the application review process.	3 ft. buffer/1 ft. dredged below existing bottom; 15 ft. buffer from MHW & for SAV w. dense tuber mats.	3 ft. buffer/1 ft. dredged	3 ft. buffer/1 ft. dredged below existing bottom.	Recommend buffers around existing beds; no dredging in areas with potential bed expansion.
Depositing dredged material on SAV	Not allowed. Can seek variance.	Proprietary – prohibited, beach compatible dredge material must be placed on beaches or within the nearshore sand systems.	Prohibited	Locate to minimize impacts	Recommend against		Recommend against	Recommend against

Table 1 (cont.). Summary of guidelines for SAV protection used by the federal regulatory and commenting agencies, as well as the state agencies of Maryland and Virginia (Source: Orth et al. 2002; NC Department of Environment and Natural Resources; Fl Department of Environmental Protection)

Pier Construction	Not allowed through GP process if water < 2 ft MLW. Could be permitted through major process – case by case	Minimal sized structures are exempt from permitting. Larger structures require full permit review (Regulatory – allowed after impacts are avoided and minimized, and appropriate compensatory mitigation is provided for any remaining impacts that cannot be avoided or minimized. Proprietary - allowed if not contrary to public interest and appropriate compensatory mitigation is provided.)	Pier out to avoid dredging of SAV beds; minimize pier dimensions.	Limit to minimum necessary for water access, locate to avoid SAV.	Pier out, construct community piers or mooring piles to avoid dredging of SAV beds; maintain suitable pier height above SAV.		Pier out to avoid dredging of SAV beds; construct community rather than multiple individual piers.	Maintain 1:1 ratio of deck width to deck height above MLW.
Marina development near SAV	Allowed if no significant adverse impact to SAV.	Regulatory – allowed after impacts are avoided and minimized, and appropriate compensatory mitigation is provided for any remaining impacts that cannot be avoided or minimized. Proprietary - allowed if not contrary to public interest and appropriate compensatory mitigation is provided.	Prohibited in areas ≤ 4.5 ft. unless dredged from upland and adverse impacts to SAV are minimized.	Undesirable near SAV, or in waters less than 3 ft. at MLW.	Avoid historical SAV beds for new marina construction; maintain buffer for marina expansion.	Avoidance of SAV recommended	Avoid	Recommend against new marinas or expansion in existing beds or adjacent shallows with potential for bed expansion.
SAV harvest	Permit required.	Permit required.	Permit required.	Permit required.				Limited harvest of hydrilla in the Potomac.
Fishing activity	Mechanical harvest of shellfish and trawling not allowed over SAV-through rule boundaries.	Mechanical harvest of shellfish limited to open shellfish harvesting areas, and prohibited over SAV through permit conditions. Shrimp trawling is prohibited in areas of Florida that are of high conservation value for SAV (e.g., Big Bend Region closed Areas).	No hydraulic clam dredging in existing SAV.	No clamming in water depths< 4 ft.				
Aquaculture activities	No new permits in existing SAV. Can renew if its grown into lease.	By rule, aquaculture activities on sovereignty submerged lands shall be designed to minimize or eliminate adverse impacts on sea grasses. In practice, aquaculture leases have not been historically authorized		No new permits in existing SAV.				

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SAFMC SAV Policy Statement- Appendix 4

Maps of SAV as EFH or EFH-HAPC for managed species are viewable through:
Links from the SAFMC Digital Dashboard: http://ocean.floridamarine.org/safmc_dashboard/ to
The SAFMC EFH Viewer: http://ocean.floridamarine.org/sa_efh/
The SAFMC Habitat and Ecosystem Atlas: http://ocean.floridamarine.org/safmc_atlas/

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POLICIES FOR THE PROTECTION OF SOUTH ATLANTIC MARINE AND ESTUARINE ECOSYSTEMS FROM NON-NATIVE AND INVASIVE SPECIES

(June 2014)

Policy Context

This document establishes the policies of the South Atlantic Fishery Management Council (SAFMC) regarding protection of South Atlantic estuarine ecosystems from potential impacts associated with invasive species. The policies are designed to be consistent with the overall habitat protection policies of the SAFMC as formulated in the Habitat Plan (SAFMC 1998a) and adopted in the Comprehensive EFH Amendment (SAFMC 1998b), Fishery Ecosystem Plan for the South Atlantic Region (SAFMC 2009a), Comprehensive Ecosystem-Based Management Amendment 1(SAFMC 2009b), Comprehensive Ecosystem-Based Amendment 2 (SAFMC 2011) and the various Fishery Management Plans (FMPs) of the Council.

The findings presented below assess potential impacts to the South Atlantic's marine and estuarine ecosystems posed by invasion of non-native species and the processes which could place those resources at risk. In adhering to a precautionary approach to management, the SAFMC establishes in this document policies and recommendations designed to avoid, minimize, and offset potential impacts to South Atlantic estuarine ecosystems.

According to Pimentel et al. (2000, 2005), the United States spends $137 billion annually on issues related to invasive species, including development of control strategies and removal as well as loss of revenue. Research indicates that non-native organisms may compete with native organisms, alter habitats (Mack et al. 2000; Kolar and Lodge 2001; Rahel 2002; Olden et al. 2004) and reduce biodiversity (Olden et al. 2004).

While the number of introduced non-native marine organisms is small compared to that of terrestrial and freshwater species, introductions have accelerated in recent decades mainly due to increase in coastal development and shipping (Morris & Whitfield 2009). According to the United States Geological Survey (2010), more than 27 estuarine species, including those that occupy estuarine waters during at least one life-history stage, have been introduced in North Carolina (18), South Carolina (17), Georgia (16) and Florida (17). Of these, the majority comprises fishes (63%), with crustaceans and mollusks accounting for an additional 15%. Invasions by fishes and invertebrates is considered highly significant, with the potential to displace native species and impact community structure and biodiversity of marine and estuarine ecosystems (e.g., Grozholz et al. 2000; Streftaris et al. 2005; Goren & Galil 2005; Dierking 2007; Albins & Hixon 2008; Rilov & Crooks 2009). Non-native plants also pose a threat to South Atlantic estuarine ecosystems. Recently, it has been found that two exotic mangrove species, introduced at a botanical garden, have spread and pose a threat to natural mangrove forests in south Florida (Fourqurean et al. 2010). In marine waters, the United States Geological Survey (2010), found more than 72 marine species, including those that occupy marine waters for at least one life-history stage, have been introduced in North Carolina (27), South Carolina (48), Georgia (23) and the Atlantic coast of Florida to Key West (22). Of these, the majority comprises marine crustaceans (29%), with fishes and mollusks accounting for an additional 49%. Invasions by fishes and invertebrates is considered highly significant, with the potential to displace native species and impact community structure and biodiversity of marine and estuarine ecosystems (e.g., Grozholz et al. 2000; Streftaris et al. 2005; Goren & Galil 2005; Dierking 2007; Albins & Hixon 2008; Rilov & Crooks 2009).

The SAFMC finds that:

1. Invasive organisms have the potential to cause adverse impacts to marine and estuarine habitats including:
a) submerged aquatic vegetation;
b) estuarine emergent vegetation, including mangroves;
c) shellfish beds;
d) spawning and nursery areas; and
e) exposed hard bottom (e.g. reef and live bottom) in shallow and deep waters.

2. Certain estuarine and marine ecosystems are particularly important to the long-term viability of commercial and recreational fisheries under SAFMC management, and are potentially threatened by invasive species, including:
a) estuarine waters;
b) estuarine wetlands, including mangroves and marshes;
c) submerged aquatic vegetation;
d) coral, coral reefs, and live/hard bottom habitat; and
e) marine waters.

3. Portions of the South Atlantic ecosystem potentially affected by invasive species, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC. Potentially affected species and their EFH under federal management include (SAFMC 1998b, SAFMC 2009a, SAFMC 2009b and SAFMC 2011):
a) for estuarine-dependent species (e.g., gag grouper and gray snapper) – unconsolidated bottoms and live hard bottoms to the 100 foot contour;
b) penaeid shrimp (waters connecting to inshore nursery areas);
c) muddy, silt bottoms from the subtidal to the shelf break, deepwater corals and associated communities; and
d) areas identified as EFH for Highly Migratory Species managed by the Secretary of Commerce (e.g., sharks: inlets and nearshore waters, including pupping and nursery grounds).

4. Scientists have documented important habitat values for East coast Florida nearshore hard bottom used by over 500 species of fishes and invertebrates, including juveniles of many reef fishes. On the continental shelf off Georgia and South Carolina, 598 species of invertebrates have been collected in trawls and dredge tows over hard bottom habitats, and 845 unique invertebrate taxa were found in benthic suction and grab samples in the same area (Wenner et al. 1984).

5. Invasive species present an unacceptable risk to the biological integrity of South Atlantic ecosystems and must be addressed. Moreover, South Atlantic ecosystems have been shown to be vulnerable to the establishment of non-indigenous species: 61% of the 104 marine or estuarine species reported as having been introduced into the SAFMC area of jurisdiction are considered to be established there (USGS 2010).

6. Stakeholder opposition and uncertainty about potential ecological effects were major considerations in a decision by the USACOE and the states of Maryland and Virginia to reject the idea of using the Asian oyster *Crassostrea ariakensis* in aquaculture or in efforts to revive wild oyster populations in the Chesapeake Bay.

7. The addition of invasive lionfish (*Pterois volitans* and *P. miles*), the nonindigenous orange cup coral (*Tubastraea coccinea*), and the invasive, bloom-forming macroalga *Caulerpa brachypus,* and cyanobacteria of the genus *Lyngbya* (Kuffner et al. 2005; Paul et al., 2005) could cause negative changes in coral reef ecosystems of the South Atlantic region.

8. The risk of transmission of viral diseases from introduced Asian tiger shrimp (*Penaeus monodon*) to native species of penaeid shrimp remains unknown, as does the source of their introduction.

Threats from Invasive Marine and Estuarine Organisms

The SAFMC finds the following to constitute potential threats to South Atlantic estuarine ecosystems:

1. In addition to lionfish, 37 species of non-native marine fish have been documented along Florida's Atlantic coast in the last decade. These species represent a "watch list" of potential future invaders. It is thought that most of these species are aquarium trade releases, similar to lionfish.

2. Potential impacts of the invasion of Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) in South Atlantic waters include:
a) reduction of forage fish biomass;
b) increase in algal growth due to herbivore removal;
c) competition with native reef fish;
d) cascading trophic impacts on economically important species under SAFMC management;
e) competition with native species could hamper stock rebuilding efforts for the Snapper Grouper Complex;
f) impacts on commercial and recreational fisheries, the aquarium trade, and coastal tourism industry; and
g) increase in frequency of envenomations of recreational swimmers, fishermen, and divers

3. The orange cup coral, *Tubastraea coccinea*, is a stony coral not native to the South Atlantic region.
a) Artificial structures are their preferred habitat in the South Atlantic region and *T. coccinea* is prolific on some artificial structures in the Caribbean, Gulf of Mexico, and off Florida.

b) While there have been no reports of orange cup coral on natural substrate in Florida, it has been observed in the northern Bahamas reefs and it may eventually colonize natural reef/hard bottom in the region.

4. The invasive, bloom-forming macroalga *Caulerpa brachypus* and cyanobacteria of the genus *Lyngbya* directly overgrow reefs, are generally unpalatable to herbivores, and can also physically and chemically inhibit coral recruitment (Kuffner et al. 2006; Paul et al. 2005).

5. In general, non-native estuarine organisms have the potential to cause cascading trophic impacts on economically important species under SAFMC management.

6. The apparent increase in the incidence of infection of American eels by the introduced parasitic nematode *Anguillicoloides crassus* may present an increased threat to an already declining population of American eels in the southeastern US, where *A. crassus* has been documented to have significant negative impacts (ASMFC 2002, 2008). This non-native swim bladder parasite may decrease the American eel's ability to swim and to reach its spawning grounds in the Sargasso Sea (ASMFC, 2011)

7. Studies describe high rates of survival and growth of *Crassostrea ariakensis* in subtidal habitats spanning a wide range of temperatures and salinities (see Kingsley-Smith et al., 2009). Most of its biological characteristics make *C. ariakensis* a strong candidate to become invasive, thus it is not advisable for use in aquaculture or in restoration activities in South Atlantic estuaries.

8. Invasive aquatic plants, such as hydrilla (*Hydrilla verticillata*) and non-native phragmites (*Phragmites australis*), can develop large, dense populations that displace desirable native vegetation.

9. The Eurasian watermilfoil (*Myriophyllum spicatum*) is known to out-compete *Vallisneria americana* beds (Hauxwell et al. 2004), which is EFH for white shrimp.

10. At least two species of Indo-Pacific mangroves (*Bruguiera gymnorrhiza* and *Lumnitzera racemosa*) have naturalized and spread in the mangrove forests of South Florida, showing that Atlantic mangrove forests are indeed susceptible to invasion. Given the importance of the mangroves of the tropical Atlantic to the functioning of the coastal seascape, the ecosystem functioning of the region's mangrove forests may change as a consequence of invasive species (Fourqurean et al., 2010).

11. The large tropical Eastern Pacific barnacle, *Megabalanus coccopoma*, also known as the titan acorn barnacle, is a gregarious settler, and since it reaches a much larger size than native species of barnacles in the region, it may require greater maintenance efforts on surfaces exposed to coastal and high salinity estuarine areas if it becomes established.

12. The isopod *Synidotea laevidorsalis*, now successfully established on the US South Atlantic, is generally found fouling buoy and crab pot lines and floating docks in mesohaline to polyhaline reaches of coastal waters.

13. The green porcelain crab, *Petrolisthes armatus,* is well-established in the Indian River system, Florida, and on rocky rubble, oyster reefs, and other shallow subtidal and intertidal habitats throughout Georgia and South Carolina.

14. The spiny hands crab, *Charybdis hellerii,* has been collected occasionally from shallow coastal waters of the South Atlantic Bight between Crescent Beach, Florida, and Core Banks, North Carolina. The greatest number of specimens in that region has been found in the Winyah Bay estuary of South Carolina and in shallow waters off Core Banks, North Carolina.

15. The Asian green mussel, *Perna viridis*, is a nuisance even within its native range in the Indo-Pacific. Impacts from this species have the potential to be severe. In addition to hampering the effectiveness of cooling systems, it is also notorious for fouling navigation buoys, floating docks, piers, and pilings. Ecological studies in Florida have shown that *P. viridis* is also detrimental to intertidal oyster reefs, where it displaces adult oysters and reduces the density of juvenile oysters.

16. The Charrua mussel, *Mytella charruana*, belongs to the same family as the invasive green mussel and several native marine mussels. *M. charruana* poses the potential problem of fouling structures submerged in seawater. Potential impacts include economic hardship due to its fouling ability, and ecological alteration due to competition with native shellfish species.

17. Two visually identical species of lionfish (*Pterois volitans* and *P. miles)* were introduced into the northwest Atlantic Ocean, Caribbean Sea and the Gulf of Mexico, probably through the US aquarium trade, in the 1980's. Lionfish have been established from Miami to North Carolina since 2002, and in the Florida Keys since 2009. On heavily invaded sites, lionfish have reduced fish prey densities by up to 90% and continue to consume native coral-reef fishes and crustaceans at unsustainable rates. More recently, lionfish have been reported in increasing numbers from inshore and estuarine waters as far north as Narragansett Bay, RI (Schofield et al., 2013)

18. Introductions of the Asian tiger shrimp (*Penaeus monodon*) into the southeastern US may be due to escapement from aquaculture facilities following flooding by storms and hurricanes; larvae released from Caribbean shrimp farms and transported north via the Gulf Stream; and/or migration from areas where tiger shrimp had previously become established in the wild. Evidence suggests that there has been an increase in abundance along the southeastern US coast over the past five years, indicating the likely presence of a breeding population. (Knott et al., 2013). The extent to which tiger shrimp are transmitting viral diseases or displacing native shrimp species through predation or competition for prey remains unknown.

SAFMC Policies Addressing Marine and Estuarine Invasive Species

The SAFMC establishes the following general policies related to invasive organisms:

1. In instances where an invasive species belongs to a group of organisms included in the Fishery Management Unit, the species would need to be excluded from the FMU via a plan amendment (or an existing framework) before a control or eradication strategy could be implemented.

2. The Council encourages NOAA Fisheries Habitat Conservation Division (HCD) to consider recommending removal of invasive species as a compensatory mitigation measure. When removal of an invasive species is proposed in designated EFH, EFH-HAPCs or CHAPCs, the Council and HCD will work together to evaluate proposed removal techniques to ensure the method selected will avoid or minimize environmental damage.

3. Regarding compensatory mitigation projects or restoration activities that have a planting component, a requirement that plant materials be obtained through local nurseries within a certain radius around the estuary should be considered. Studies have shown different growth patterns of *Spartina* reared from nurseries located on the east coast of Florida versus the west coast of Florida.

4. The Council supports the availability of grant funding to promote research targeting invasive species -- including prevention of introductions, evaluation of impacts, expansion control and removal -- through existing partnerships (*i.e.*, SARP) and in cooperation with state and federal agencies including NOAA's Invasive Species Program, the National Invasive Species Council and the Gulf and South Atlantic Regional Panel of the National Aquatic Nuisance Species Task Force.

5. The Council supports the availability of grant funding to promote education and outreach efforts targeting invasive species.

6. The Council will recommend to the National Aquatic Nuisance Species Task Force, as appropriate, that management plans be developed for potentially invasive species in South Atlantic waters (this does not imply plans developed by the Council).

7. The Council encourages the development of novel gears (other than those prohibited by the Council, such as fish traps) that effectively remove invasive species but do not compromise the integrity of South Atlantic habitats and ecosystems. The Council encourages consulting with appropriate law enforcement agencies to ensure compliance with existing regulations and to address possible enforceability challenges.

8. The Council strongly supports integrating monitoring of invasive species into existing fishery-independent and dependent programs.

9. The Council strongly suggests that permits for offshore placement of infrastructure for energy generation (e.g. oil platforms, windmills) include provisions for monitoring the settlement and dispersal of non-indigenous species on and among such structures and in potentially affected natural habitats.

10. The Council strongly suggests inspection and thorough cleaning of surfaces prior to placement of Fish Attracting Devices (FAD). The potential risk of inadvertently expanding the range of a non-native species through transport or establishment of new habitats should be carefully considered.

11. The Council supports programs to control invasive species' populations in areas of high ecological/economic importance. The Council supports harvest, eradication, and/or removal strategies that do not impact populations of managed species or their habitats.

12. The Council strongly discourages the use of any non-indigenous species in aquaculture operations in the South Atlantic region.

13. The Council supports its regional partners in their endeavor to promulgate regulations for ballast water and their efforts toward research and development to advance treatment technology for ballast water.

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POLICY CONSIDERATIONS FOR THE INTERACTIONS BETWEEN ESSENTIAL FISH HABITATS AND MARINE AQUACULTURE (June 2014)

Introduction

This document provides the South Atlantic Fishery Management Council (SAFMC) guidance regarding interactions of marine aquaculture with Essential Fish Habitat (EFH) and Essential Fish Habitat - Habitat Areas of Particular Concern (EFH-HAPCs). This guidance is consistent with the overall habitat protection policies of the SAFMC as formulated in the Habitat Plan (SAFMC 1998a) and adopted in the Comprehensive EFH Amendment (SAFMC 1998b), Fishery Ecosystem Plan for the South Atlantic Region (SAFMC 2009a), Comprehensive Ecosystem-Based Management Amendment 1(SAFMC 2009b),Comprehensive Ecosystem-Based Amendment 2 (SAFMC 2011) and the various Fishery Management Plans (FMPs) of the Council.

For the purposes of policy development, aquaculture is defined as the propagation and rearing of aquatic marine organisms for commercial, recreational, or public purposes. This definition covers all authorized production of marine finfish, shellfish, plants, algae, and other aquatic organisms for 1) food and other commercial products; 2) wild stock replenishment and enhancement for commercial and recreational fisheries; 3) rebuilding populations of threatened or endangered species under species recovery and conservation plans; and 4) restoration and conservation of aquatic habitat (DOC Aquaculture Policy 2011; NOAA Aquaculture Policy 2011). This guidance addresses concerns related to the production of seafood and other non-seafood related products (*e.g.*, biofuels, ornamentals, bait, pharmaceuticals, and gemstones) by aquaculture, but does not specifically address issues related to stock enhancement. The findings assess potential impacts, negative and positive, to EFH and EFH- HAPCs posed by activities related to marine aquaculture in offshore and coastal waters, riverine systems and adjacent wetland habitats, and the processes that could improve or place those resources at risk. The policies and recommendations established in this document are designed to avoid and minimize impacts and optimize benefits from these activities, in accordance with the general habitat policies of the SAFMC as mandated by law. The SAFMC may revise this guidance in response to changes in the types and locations of marine aquaculture projects in the South Atlantic region, applicable laws and regulatory guidelines, and knowledge about the impacts of aquaculture on habitat.

The recommendations presented apply to aquaculture activities that may impact EFH and EFH-HAPCs. Aquaculture activities have the potential to interact both positively and negatively with EFH and EFH-HAPCs when conducted in onshore, nearshore, and offshore environments. Current federal and state laws, regulations and policies differ for each of these environments. Additionally, aquaculture activities in nearshore and onshore environments may fall under multiple jurisdictions.

These recommendations should be factored into the FMPs in the region, either newly developed or amended to address offshore aquaculture as "fishing" under the Magnuson-Stevens Fishery and Conservation Management Act (MSFCMA).[1] In those cases where aquaculture activities remain outside of the jurisdiction of federal management, EFH protection mechanisms for "non-fishing" activities should be used to protect EFH, wherever possible.[2,3]

Habitats and species that could be impacted by marine aquaculture activities include those managed by state-level as well as interstate (*e.g.*, ASMFC) FMPs (see Appendices A and B). Examples of affected habitats could include state-designated Critical Habitat Areas (CHAs) or Strategic Habitat Areas (SHAs) such as those established by the State Marine Fisheries Commissions via FMPs, coastal habitat protection plans, or other management provisions.

Overview of Marine Aquaculture and EFH Interactions

The environmental effects of marine aquaculture can vary widely depending on the species and genetic stock selected for culture, the location and scale of the aquaculture operation, the experience level of the operators, the culture system and facility design, biosecurity procedures, and the production methods. The use of modern production technologies, proper siting protocols, standardized operating procedures, and best management practices (BMPs) can help reduce or eliminate the risk of environmental degradation from aquaculture activities. In recent years, marine aquaculture has been used to bolster EFH (*e.g.*, oyster cultch planting to rebuild oyster reefs) and in some instances, aquaculture has been used to mitigate eutrophication by sequestering nutrients in coastal waters (*e.g.*, shellfish and algae culture).

The following summary provides information on the types of environmental effects resulting from marine aquaculture activities that have been documented and includes references to various BMPs and other existing regulatory frameworks used to safeguard coastal resources. This summary is not an exhaustive literature review of scientific information on this complex topic, rather it is a synthesis of relevant information intended to provide managers with a better understanding of the environmental

[1] Based on a legal opinion by NOAA General Counsel, landings or possession of fish in the exclusive economic zone from commercial marine aquaculture production of species managed under FMPs constitutes "fishing" as defined in the MSFCMA [Sec. 3(16)]. Fishing includes activities and operations related to the taking, catching, or harvesting of fish.

[2] The reference to non-fishing activities is meant to clarify SAFMC's role to comment on aquaculture activities similar to the process that the SAFMC uses for "non-fishing" activities.

[3] While the MSFCMA currently defines aquaculture as "fishing", the Council applies the same EFH standards to both "fishing" and "non-fishing" activities.

impacts of marine aquaculture.

The SAFMC recognizes that there are several types of environmental risks associated with marine aquaculture both in terms of probability of occurrence and magnitude of effects. Federal, state, and local regulatory agencies should evaluate these risks as they develop and implement permitting and monitoring processes for the aquaculture industry. The SAFMC specifically recognizes the following potential interactions between marine aquaculture and EFH:

Escapement

Unintentional introductions and accidental releases of cultured organisms may have wide ranging positive or negative effects on EFH. Ecological damage caused by organisms that have escaped or been displaced, in the case of shellfish or algae, from aquaculture may occur in riverine, estuarine, and marine habitats (Waples et al. 2012). The potential for adverse effects on the biological and physical properties of EFH include: (1) introduction of invasive species, (2) habitat alteration, (3) trophic alteration, (4) gene pool alteration, (5) spatial alteration, and (6) introduction of pathogens and parasites that cause disease.

Aquaculture is recognized as a pathway for both purposeful and inadvertent introduction of non-native species in aquatic ecosystems. Most introduced species do not become invasive; however, naturalization of introduced non-native species that results in invasion and competition with native fauna and flora has emerged as one of the major threats to natural biodiversity (Wilcove et al. 1998; Bax et al. 2001; D'Antonio et al. 2001; Olenin et al. 2007). Some non-native species alter the physical characteristics of coastal habitats and constitute a force of change affecting population, community, and ecosystem processes (Grosholz 2002). In the southeast United States, the culture of non-native species is primarily confined to ornamental plant and fish species grown in inland productions systems such as ponds, greenhouses, and indoor facilities. There is limited culture of non-native species for food with notable exceptions including inland production of tilapia (Ciclidae) and shrimp (*Litopenaeus vannamei*).

Even through use of native species, escapees have the potential to alter community structure, disrupt important ecosystem processes, and affect biodiversity. Environmental impacts are augmented by competition for food and space, introduction or spread of pathogens and parasites, and breeding or interbreeding with wild populations. Excessive colonization by shellfish or other sessile organisms may lead to alterations of physical habitat and preclude the growth of less abundant species with ecological significance. Similarly, escapees that colonize specific habitats and exhibit territorial behavior may compete with and displace local species to segregated habitats.

Culture of native species presents genetic risk from escapees interbreeding with individuals in the wild. The magnitude of the genetic impact on the fitness of wild stock is somewhat unclear. Genetic introgression of cultured escapees into wild populations is strongly density-dependent and appears linked to the population size and health of native populations relative to the magnitude of the escapes. To make a genetic impact, escapees must survive and reproduce successfully in the wild and contribute offspring with sufficient reproductive fitness to contribute to the gene pool. The capability of escaped fish to do so can vary widely based on a multitude of environmental and biological factors (*e.g.*, predation, competition, disease). In general, fitness of captive-reared individuals in the wild decreases with domestication (*i.e.*, the number of generations in captivity). Some genetic risks are inversely correlated, such that reducing one risk simultaneously increases another. For example, creating an aquaculture population that is genetically divergent from the wild stock may reduce the chances that escapees can survive and reproduce. Still, under this scenario aquacultured organisms that do survive could potentially pass on maladapted genes to the wild population.

The likelihood of escapes from aquaculture operations will vary depending on the species being cultured, siting guidelines, structural engineering and operational design, management practices (including probability for human error), adequacy of biosecurity and contingency plans, frequency of extreme weather events, and direct interactions with predators such as sharks, marine mammals, and birds. While a certain level of escape may not be avoidable in all cases, risk assessments should be used to make informed regulatory decisions in an effort to account for potential impacts on EFH. Risk assessment tools are available and have been used to identify and evaluate risks of farmed escapes on wild populations (Waples et al. 2012). Many empirical models have been used to inform policy (ICF 2012; RIST 2009), and are readily available for use in permitting and project planning.

Good practices for monitoring, surveillance, and maintenance of the aquaculture operation are critical to minimizing the likelihood of escapes. An escape prevention and mitigation plan should be developed for each farm. Plans should contain a rationale for approaches taken and any recapture or mitigation activities that should be initiated when an escape occurs.

Disease in aquaculture

As with all animal production systems, disease is a considerable risk for production, development, and expansion of the aquaculture industry. The industry has experienced diseases caused by both infectious (bacteria, virus, fungi, parasites) and non-infectious (nutritional, environmental, pollution, stress) agents. In addition to mortality and morbidity, disease causes reduction in market value, growth performance, reproductive capacity, and feed conversion. An accredited health professional should regularly inspect stocks and perform detailed diagnostic procedures to determine if disease is present, to identify risks, and to assess the overall health of the aquacultured species. Veterinarians with expertise in fish culture, or qualified aquatic animal health experts, can assist with development of a biosecurity plan to minimize, prevent, or control the spread of pathogens within a farm site, between aquaculture operations, or to wild populations. Culture facilities should be required to report disease and mortality incidents to the proper state and federal agencies so that authorities can assess risk to wild stocks and habitats and determine if control or other management measures should be put in place.

The spread of pathogens from cultured organisms to wild populations is a risk to fisheries, natural resources, and EFH. There are documented cases of mortality in wild populations caused by both endemic and exotic diseases transferred from aquaculture stocks (Glibert et al. 2002, NAAHP 2008). The prevalence of disease in intensive aquaculture operations is influenced by many factors, including immune status, stress level, pathogen load, environmental conditions, water quality, nutritional health, life history stage, and feeding management. The type and level of husbandry practices and disease surveillance will also influence the potential spread of pathogens to wild stocks. International trade in live fish and shellfish and aquaculture products (e.g., discard of seafood processing waste) has led to the introduction of diseases to new areas. Once a pathogen or disease is introduced and becomes established in the natural environment, there is little possibility of eradication. However, increased awareness of disease risks, health control legislation, and better diagnostic methods, which have increased the ability to detect diseases and pathogens, are helping to reduce the frequency of introduction and the spread of diseases (NAAHP 2008). Improved facility design engineering and buffer zones between aquaculture facilities and natural stocks could also reduce the risk of disease transfer.

In some cases, the expansion and diversification of the marine aquaculture industry has resulted in parasite translocations (Shumway 2011). Because of this, many countries and regions have created compacts and agreements to include pathogen screening guidelines and certification programs for movement of germplasm, embryos, larvae, juveniles, and broodstock associated with marine aquaculture operations. In the United States, import and export certifications and testing for certain types of diseases falls under the jurisdiction of the USDA Animal and Plant and Health Inspection Service (APHIS). Most states have specific protocols that must be followed when transplanting cultured species into wild environments to minimize the incidence of disease transfer. In the case of aquaculture operations in federal waters, the Gulf of Mexico Fishery Management Council specified in their Fishery Management Plan for Regulating Offshore Marine Aquaculture that prior to stocking animals in an aquaculture system in federal waters of the Gulf, the permittee must provide NOAA Fisheries a copy of a health certificate signed by an aquatic animal health expert certifying cultured animals were inspected and determined to be free of World Organization of Animal Health reportable pathogens (OIE 2003,) or additional pathogens that are identified as reportable pathogens in the National Aquatic Animal Health Plan (GMFMC 2012).

The dynamics of communicable disease in aquaculture and the level of risk to the environment vary substantially with hydrography and the presence, concentration, and proximity of wild organisms susceptible to infection by introduced pathogens or that may serve as vectors or reservoir hosts. The operational categories onshore, nearshore, and offshore are useful in discussion of this topic:

1) Closed onshore systems: These systems have the least potential for transfer of pathogens between cultured and wild organisms and generally pose low risk to the environment. However, they may internally super-concentrate parasites or pathogens with direct life cycles and as such, can be a human health concern and management challenge. Generally effluent volume is minimal but periodic draining for maintenance or pathogen control may be expected and should be considered for development of regulations and BMPs.

2) Flow-through onshore systems: Effluent from such systems has the potential to contain exotic pathogens or high concentrations of native parasites or pathogens with direct life cycles. So these facilities pose at least some environmental risk. Of greatest concern is the introduction of non-native pathogens, which could have catastrophic effects on regional fisheries and aquaculture operations. Increased prevalence and intensity of infection by native pathogens near the facility is also a concern, particularly if the water body is poorly mixed with little flushing. However, high concentrations of wild pathogens are not likely present in influent water and parasites or pathogens with indirect life cycles are generally not able to proliferate inside the facility.
3) Inshore and nearshore cages and net pens: These operations have the greatest potential for exchange of pathogens between cultured and wild organisms. They bring cultured organisms into close contact with their wild cohorts, predators, prey, and a diverse community of potential intermediate hosts to parasites or pathogens, most importantly benthic invertebrates such as mollusks and polychaetes. These conditions provide an opportunity for parasites or pathogens with direct and indirect life cycles to proliferate in and near the pen where they may become major causes of disease in both wild and cultured hosts. Water depth and rate of flushing will vary greatly by location, but shallow embayments with poor mixing are generally the least suitable areas.
4) Offshore cages and net pens: Open ocean aquaculture operations benefit from high rates of water exchange and by extension rapid dilution of pathogens. Another hypothetical advantage, at least for fish culture, is that wild nektonic organisms and their pathogens are generally widely dispersed in offshore environments. However, wild fish and marine mammals congregate around cages and nets where they find refuge, graze on fouling organisms, consume uneaten culture food, or sometimes successfully prey on cultured stock. So, although the benthos is far removed and dilution is rapid, there is still some opportunity for pathogen exchange, particularly of those infectious agents with direct life cycles.

Climate change has been implicated in increasing the prevalence and severity of infectious pathogens that may cause disease originating from cultured or transplanted aquaculture stocks (Hoegu-Guldberg and Bruno 2010). The emergence of these diseases is likely a consequence of several factors, including shifting of pathogen ranges in response to warming, changes to host susceptibility as a result of increasing environmental stress, and the expansion of potential vectors. Classical examples are outbreaks of oysters infected with MSX (*Haplosporidium nelsoni*), Dermo (*Perkinsus marinus*), and *Bonamia* spp. (Ford and Smolowitz 2007, Soniat et al. 2009, Shumway 2011). In most cases, pathogens have undergone rapid ecological and genetic adaptation in response to climate change. Guidelines for management of these diseases are well-developed for shellfish and other aquatic species. Managing for disease outbreaks is a key aspect of climate adaptation to prevent adverse impact to EFH. Management guidelines include record keeping, isolation and quarantine, and strict regulations on stocking or transplanting species from infected areas. Following these management recommendations should yield protection and conservation benefits for EFH.

Use of drugs, biologics, and other chemicals

Disease control by prevention is preferable to prophylactic measures and curative medical treatment. However, aquaculture drugs, biologics, and other chemicals play an important role in the integrated management of aquatic species health. Aquaculture operations in the United States use these products for: (1) disinfectants as part of biosecurity protocols, (2) herbicides and pesticides used in pond maintenance, (3) spawning aids, (4) vaccines used in disease prevention, or (5) marking agents used in resource management (AFS 2011). Additionally, some chemicals may be used as antifouling biocides for nets, cages, and platforms. Despite the best efforts of aquaculture producers to avoid pathogen introductions, therapeutic drugs are occasionally needed to control mortality, infestations, or infections. The availability and use of legally approved pharmaceutical drugs, biologics and other chemicals is quite limited in marine aquaculture (FDA 2012). A list of FDA approved drugs for use in marine aquaculture is provided in Appendix C.

Just as in the case of biological pathogens, the potential environmental impact of chemicals used in aquaculture, and those occurring as normal byproducts of stock physiology, varies greatly with hydrology and the proximity of other susceptible organisms:

1) Closed onshore systems: Water is infrequently discharged from these systems, so they generally pose low risk to the environment. However, improper application of chemicals and failure to comply with requirements for withdrawal periods can more easily harm stock and in the case of food fish may pose some risk to human health.
2) Flow-through onshore systems: Discharge of chemicals from these systems will typically occur in shallow coastal waters or wetlands. The potential for downstream concentration of anthropogenic contaminants, nitrogenous waste products, therapeutics, etc. is relatively high. Further such coastal areas are frequently sensitive to insult and of high conservation priority.
3) Inshore and nearshore cages and net pens: These operations share most attributes of concern with Flow-through onshore systems but add the possibility of wild organisms coming into direct contact with medicated feed. Further, some mitigating practices such as detention ponds and effluent treatment are not options. Antifouling biocides may be employed. Shallow, low energy areas with poor mixing represent the least desirable locations.
4) Offshore cages and net pens: Rapid dilution of chemicals in these operations is a major advantage and concentrated aquaculture byproducts are unlikely to reach the benthos. One caveat is that external therapeutics may need to be administered in greater concentration and volume to be effective. Wild, nektonic organisms congregate around cages and so can come into direct contact with medicated feed. Additionally, antifouling biocides are likely to be needed to maintain functionality of offshore nets and cages.

While antibiotics are a commonly cited chemical therapeutant, the use of antibiotics in U.S. aquaculture is not common and strictly limited, and global use in aquaculture of antibiotics has declined in recent years, up to 95% in the culture of salmon and other species. This decline is largely attributed to improved husbandry and use of vaccines (Asche and Bjorndal 2011; Forster 2010; Rico et al. 2012). Antibiotics are characterized by low toxicity to nonbacterial organisms. The environmental risks of antibiotic use are minimal, especially with regards to impacts to fisheries and EFH. The transference of antimicrobial drug resistance among marine fish and shellfish pathogens is theoretically possible but has not yet been demonstrated. In a comprehensive review of the salmon aquaculture industry, no direct evidence of negative impact to wild fish health resulting from antibiotic use in salmon farming has been found (Burridge et al. 2010). With farms that use medicated feeds, some antibiotic compounds can persist in sediments around fish farms and therefore affect the microbial community. Laboratory and field studies have found that antibiotic persistence in sediment ranges from a few days to years depending on the drug in question and the geophysical properties of the water or sediment (Scott 2004, Armstrong et al. 2005, Rigos and Troisi 2005). At present, there are no approved antibiotics for use with marine aquatic species in the South Atlantic. A limited number of broad spectrum antibiotics and feed additives (*i.e.*, florfenicol and oxytetracycline) are allowed as part of the National Investigational New Animal Drug Program, which is regulated by FDA and managed through partnership with the U.S. Fish and Wildlife Service. Antibiotics like other medicines should be used sparingly with prescription and in accordance with approved protocol to minimize environmental interactions.

Cultured fish are susceptible to parasitic diseases. For example, protozoa, monogenetic trematodes and arthropod parasites such as copepods, caligids, and isopods are naturally present and relatively harmless in wild fish populations, but under culture conditions they may dramatically proliferate and cause major stock losses with the potential for more frequent and intense infections in wild fish populations. Effective mitigation, management, and control of parasitic infections requires good husbandry. Chemicals used in the treatment of most parasitic infections in netpen operations are subsequently released to the aquatic environment. These compounds have varying degrees of environmental impact, but many are lethal to non-targeted aquatic invertebrates. The use of large quantities of drugs and chemicals for parasite control has the potential to be detrimental to fish health and EFH. Also there is evidence that repeated use of chemotherapeutants has led to resistant strain of ectoparasites such as "sea lice" (*Lepeophtheirus*). Excessive use of parasiticides is of concern to the aquaculture industry and its regulators.

The most common biologics used for aquatic organisms are vaccines. A vaccine is any biologically based preparation intended to establish or improve immunity to a particular pathogen or group of pathogens. Vaccines have been used for many years in humans and agricultural livestock. They are considered the safest prophylactic approach to management of aquatic animal health and pose no risk to the environment or EFH. In aquaculture, the use of vaccines for disease prevention has expanded both with regard to the number of aquatic species and number of targeted pathogens. Vaccination has become a basis for good health for most finfish operations. Commercial vaccines can be administered by injection or immersion. Oral vaccines remain experimental. Vaccines have been successfully used to prevent a variety of bacterial diseases in finfish. Few viral vaccines are commercially available and vaccines for fungal and parasitic diseases do not exist. All vaccines for use on fish destined for human consumption must be approved by the USDA APHIS, the federal agency responsible for regulating all veterinary biologics, including vaccines, bacterins, antisera, and other products of biological origin.

Water quality impacts

Water quality is a key factor in any aquaculture operation, affecting both success and environmental sustainability. Extensive aquaculture operations should be sited in areas with an abundant and reliable supply of good water quality, and intensive operations face logistical husbandry and engineering challenges. The primary risks to water quality from marine aquaculture operations are increased organic loading, nutrient enrichment, and harmful algal blooms. Excess nitrogenous waste products and suspended organic solids in finfish aquaculture effluents can cause eutrophication in receiving water bodies when nutrient inputs exceed the capacity of natural dispersal and assimilative processes. Elevated nutrients and declines in dissolved oxygen are sometimes observed in areas near the discharge of high-density operations. These conditions rarely persist or present long-term risk to water quality; however acute damage to sensitive ecosystems may be dramatic and in the worst cases irreparable.

At some farm sites, a phytoplankton response to nutrient loading has been reported (Anderson et al. 2002) but generally this is a low risk. Because a change in primary productivity linked to fish farm effluents would have to be detected against the background of natural variability, it is difficult to discern effects unless they are of great magnitude and duration. Small, dispersed operations are probably of less consequence, but where large scale established aquaculture industry is concentrated in an area, anthropogenically derived nutrients could be of concern. However, contingency planning for harmful algal blooms and other natural perturbations should be considered, particularly in areas with known and frequent bloom events. Examples of mitigating practices include contingency planning for net pen relocation and development of a coordinated early warning system designed to detect early blooms, minimize economic loss and environmental impact.

Environmental impacts will vary by location (*i.e.*, on-shore, near-shore, and offshore); therefore, careful selection of sites is the most important tool for risk management. Operations appropriately sited in well-flushed, non-depositional areas may have little to no impact on water quality. The approach to limiting impacts to water quality will also vary by production format. For example, closed systems located onshore are able to directly control their discharges while production systems located offshore rely on best management practices, including siting aquaculture operations outside of nutrient sensitive habitats (*e.g.*, EFH), using responsible cleaning practices, integrating feed management strategies, using optimally formulated diets.

Aquaculture operations are regulated under the Clean Water Act, by the National Pollutant Discharge Elimination System (NPDES), a permitting system administered by the EPA for wastewater discharges into navigable waters.[4] NPDES permits contain industry-specific,

[4] Pursuant to the provisions of Section 402(a)(1); 40 CFR 122.44(k) of the Federal Water Pollution Control Act (Clean Water Act).

technology and water-quality-based limits, and establish pollutant monitoring and reporting requirements.[5] Aquaculture operations that qualify as concentrated aquatic animal production facilities (*i.e.*, produce more than 45,454 harvest weight kilograms of fish and feed) must obtain a permit before discharging wastes. A permit applicant must provide quantitative analytical data identifying the types of pollutants present in wastewater effluents. The permit will set forth the conditions and effluent limitations under which an aquaculture operation may make a discharge. NPDES permit limitations are based on best professional judgment when national effluent limitations guidelines have not been issued pertaining to an industrial category or process.

Benthic sediment and community impacts

Benthic impacts can result from deposition of organic wastes, chemicals, therapeutics, and biocides from aquaculture operations. These impacts can affect EFH if aquaculture operations are not properly sited or managed. Excess feed and feces are the predominant sources of particulate wastes from fish farms. Shellfish operations release pseudofeces, a byproduct of mollusks filtering food from the water column. If allowed to accumulate, particulate waste products may alter biogeochemical processes of decomposition and nutrient assimilation. At sites with poor circulation, waste accumulation can alter the bottom sediment and perturbate infaunal communities if wastes are released in excess of the aerobic assimilative capacity of the bottom. Under such conditions, sediments will turn anoxic and the benthic community will decline in species diversity.

Common indicators used to assess benthic condition include total organic carbon, redox potential, total sulfides, and abundance and diversity of marine life. Electro-chemical and image analysis methods are used to quantify video-recorded observations of benthic condition. These indicators guide BMPs for grading and stocking fish, fallowing, or adjusting feed rates. Fallowing is the practice of temporarily relocating or suspending aquaculture operations to allow the benthic community and sediments to undergo natural recovery from the impacts of nutrient loading. Under ideal conditions, farms should not require a fallowing period for the purpose of sediment recovery; however, this practice is widely and successfully implemented around the world as a management practice for preventing damage to the benthic environment and EFH (Tucker and Hargreaves 2008). Fallowing times range from a few months to several years depending on local hydrology and the level of accumulation (Brooks et al. 2003, Brooks et al. 2004, Lin and Bailey-Brock 2008).

Benthic accumulation of organic wastes can be reduced by siting aquaculture operations in well-flushed areas, or in areas where net erosional sediments can decrease or eliminate accumulation of wastes, thereby minimizing benthic effects. Benthic monitoring plans should be designed to allow for early detection of enrichment and deterioration of benthic community structure. Additionally, nearby control sites should be established in order to collect baseline data for natural variability.

[5] EPA issues effluent guidelines for categories of existing sources and sources under Title III of the Clean Water Act. The standards are technology-based (*i.e.*, they are based on the performance of treatment and control technologies); they are not based on risk or impacts upon receiving waters.

Location Specific Interactions with EFH

Onshore Aquaculture

Onshore aquaculture activities occur on-land in ponds, raceways, and tank-based systems. These systems can be used for multiple phases of aquaculture including broodstock holding, hatchery production, nursery production, grow-out, and quarantine. Water demand and usage varies from conventional pond systems to intensive recirculating aquaculture systems, which may employ sophisticated filtration components for water reuse. Onshore marine aquaculture operations have the potential to impact a variety of EFHs including:

a) waters and benthic habitats in or near marine aquaculture sites
b) exposed hard bottom (*e.g.*, reefs and live bottom) in shallow waters
c) submerged aquatic vegetation beds
d) shellfish beds
e) spawning and nursery areas
f) coastal wetlands
g) riverine systems and associated wetlands

The greatest impacts to EFH by onshore aquaculture involve escape of non-native species and nutrient discharge and its impact on water quality and bottom sediments. Onshore aquaculture activities affecting EFH are regulated by existing state and federal laws and requirements specified by EPA's National Pollutant Discharge Elimination System and coastal habitat protection plans.

Nearshore Aquaculture

Nearshore aquaculture activities are those that occur in rivers, sounds, estuaries and other areas that extend through the coastal zone.[6] Currently in the South Atlantic region, nearshore aquaculture is characterized primarily as shellfish aquaculture with hard clams *Mercenaria mercenaria* and oysters *Crassostrea virginica* comprising the most commonly cultured species.

While the relative risk of nearshore shellfish aquaculture to various EFHs is uncertain, the ranges of possible interactions include:

a) coral, coral reef and live/hard bottom habitat
b) marine and estuarine waters
c) estuarine wetlands, including mangroves and marshes
d) submerged aquatic vegetation
e) waters that support diadromous fishes, and their spawning and nursery habitats
f) waters hydrologically and ecologically connected to waters that support EFH

The environmental effects of shellfish and finfish aquaculture in coastal waters are well-

[6] The term "coastal zone" means the coastal waters strongly influenced by each other and in proximity to the shorelines of several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends seaward to the outer limit of State title and ownership under the Submerged Lands Act (43 U.S.C. 1301 et seq.).

documented (Naylor et al. 2006; Nash 2005; Tucker and Hargreaves 2008). Poorly sited and managed aquaculture activities can have significant impact on benthic communities, water quality, and associated marine life. While there are case studies documenting environmental impacts of practices used several decades ago, regulatory and management practices are reducing the likelihood of negative environmental effects (Price and Morris 2013).

In the case of cage culture, water quality and benthic effects are sometimes observed; however, these are typically episodic and restricted to within 30 m of the cages (Nash 2003). Long-term risks to water quality from offshore aquaculture activities are unlikely when operations are sited in well-flushed waters.

The most studied environmental benefit from marine aquaculture operations is as fish attractants. Wild fish use aquaculture cages for refuge and for foraging on biofouling organisms and uneaten feed. Wild fish can help distribute organic waste away from the cages and re-suspend organic compounds in sediments. As a result, overall fish abundance may increase in areas with aquaculture operations. Recreational and commercial fishers may benefit from increased fishing opportunities around marine aquaculture operations. Conversely, interactions with marine mammals that are attracted to the forage fish around cages are identified as potential long-term concern for management of protected species.

Potential interactions of nearshore shellfish aquaculture with EFH are changes to benthic habitat as a result of pseudofeces, the effects of mechanical harvesting, conversion of soft sediment habitat to hard bottom shellfish reef, displacement of cultured organisms, potential genetic transfer, sedimentation and loading of organic waste to the water column and benthic sediments, and disruption of the benthic community. Some changes could potentially impact SAV located near shellfish aquaculture operations, although this impact likely varies with species and production type.

In general, shellfish and algae aquaculture has positive impacts on EFH, providing ecosystem services and habitat related benefits in the estuary including mitigation of land-based nutrients and increased habitat for fish, shellfish, and crustaceans (Shumway 2011). Therefore, the positive and negative effects of shellfish culture activities to EFH need to be considered. The risk of nearshore aquaculture impacts to EFH can be minimized by including terms and conditions designed to protect sensitive habitats in permits issued under state and federal laws and regulations. Best management practices are now in place for shellfish aquaculture along the U.S. East Coast (Flimlin 2010).

Offshore Aquaculture

Offshore aquaculture activities occur in areas of the open ocean that extend from the seaward edge of the coastal zone through the exclusive economic zone.[7] In the South Atlantic region, offshore aquaculture may include the cultivation of macrophytic algae, molluscan shellfish, shrimp, or finfish. With exception of a few live rock aquaculture operations, there are currently no offshore aquaculture activities occurring in the South Atlantic region. It is feasible that co-siting aquaculture facilities with other offshore industries such as wind energy could facilitate

[7] The term 'offshore aquaculture' is often used to refer to aquaculture in waters under federal jurisdiction, which typically extend from 3-200 nautical miles from the shoreline.

offshore aquaculture development.[8] Over 25 laws exist to provide regulatory oversight of aquaculture in federal waters. Some examples include the Clean Water Act and the Coastal Zone Management Act.

While the relative threat of offshore aquaculture to EFHs varies widely depending on siting and management considerations, the ranges of possible interactions include:

a) coral, coral reef and live/hardbottom habitat, including deepwater coral communities
b) marine and estuarine waters
c) waters that support diadromous fishes and their spawning and nursery habitats
d) waters hydrologically and ecologically connected to waters that support EFH

The environmental effects of offshore shellfish and finfish aquaculture are not as well-documented for inshore waters. The information gleaned from coastal production sites, especially those with conditions similar to federal waters, provide some indications as to the potential effects of offshore aquaculture (see section on nearshore aquaculture).

Live Rock Aquaculture
Live rock is defined as living marine organisms or an assemblage thereof attached to a hard calcareous substrate, including dead coral or rock. In 1994, the SAFMC and GMFMC established a live rock aquaculture permitting system for state and federal waters off the coast of Florida under Amendment 2 to the Fishery Management Plan for Coral and Coral Reefs of the Gulf of Mexico and South Atlantic. The SAFMC further amended this program under Amendment 3 to the Coral FMP (1995), during which time the SAFMC received extensive public comment. This permitting system allows deposition and harvest of material for purposes of live rock aquaculture while maximizing protection of bottom habitat, EFH, and HAPC in federal waters of the South Atlantic.

SAFMC Policy for Marine Aquaculture in Federal Waters

The SAFMC supports the establishment and enforcement of the following general requirements for marine aquaculture projects authorized under the Magnuson-Steven Fishery Conservation Act (MSA) or other federal authorities, to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment (SAFMC 1998a; SAFMC 1998b):

1. Marine aquaculture activities in federal waters of the South Atlantic require thorough public review and effective regulation under MSA and other applicable federal statutes.

2. Aquaculture permits should be for at least a 10-year duration (or the maximum allowed if the applicable law or regulation sets a maximum less than 10 years) with annual reporting requirements (activity reports). Permits of 10 years or more should undergo a 5-year comprehensive operational review with the option for revocation at any time in the event there is no prolonged activity or there are documented adverse impacts that pose a substantial threat to marine resources.

[8] A notable exception is Live Rock Aquaculture, managed under Amendement 3 to the Coral Fishery Management Plan (1995).

3. Only drugs, biologics, and other chemicals approved for aquaculture by the FDA, EPA, or USDA should be used, in compliance with applicable laws and regulations (see Appendix for current list of approvals).

4. Only native (populations) species should be used for aquaculture in federal waters of the South Atlantic.

5. Genetically modified organisms should only be used for aquaculture in federal waters of the South Atlantic, pending FDA and/or other Federal approval, following a rigorous and documented biological assessment which concludes there is no reasonable possibility for genetic exchange with natural organisms or other irreversible form of ecological impact. Further, aquaculture of genetically modified organisms should be prohibited in federal waters of the South Atlantic when there exists a reasonable opportunity for escapement and dispersal into waters of any state in which their culture and/or commerce are prohibited by state rule or policy.

6. Given the critical nature of proper siting, the permitting agency should require the applicant to provide all information necessary to thoroughly evaluate the suitability of potential aquaculture sites. If sufficient information is not provided in the time allotted by existing application review processes, the permitting agency should either deny the permit or hold the permit in abeyance until the required information is available.

7. Environmental monitoring plans for projects authorized under MSA should be developed by the applicant/permit holder and approved by NOAA Fisheries with input from the Council.

8. Fishery management plans for aquaculture should require permittees to have adequate funds (*e.g.*, assurance bond) committed to ensure removal of organisms and decommissioning of facilities that are abandoned, obsolete, or storm-damaged or have had their permit revoked. The plans should also require that the amount of these funds be determined by NOAA Fisheries with input from the Council and that the funds be held in trust.

9. When issuing permits for aquaculture in federal waters, NOAA Fisheries should specify conditions of use and outline the process to repeal permits in order to prevent negative impacts to EFH. NOAA should take the appropriate steps to modify or revoke permits using its authority if permit conditions are not being met.

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Appendix A.

List of Potentially Affected Species Currently Identified by SAFMC and their EFH in the South Atlantic

Sections of South Atlantic waters potentially affected by these projects, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC. Potentially affected species and their EFH under federal management include (SAFMC, 1998b):

a) Summer flounder (various nearshore waters; certain offshore waters);
b) Bluefish (various nearshore waters);
c) Many snapper and grouper species (live hardbottom from shore to 600 feet, and – for estuarine-dependent species (*e.g.*, gag grouper and gray snapper) – unconsolidated bottoms and live hardbottoms to the 100 foot contour);
d) Black sea bass (various nearshore waters, including unconsolidated bottom and live hardbottom to 100 feet, and hardbottoms to 600 feet);
e) Penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas);
f) Coastal migratory pelagics (*e.g.*, king mackerel, Spanish mackerel; sandy shoals of capes and bars, barrier island ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream);
g) Corals of various types and associated organisms (on hard substrates in shallow, mid-shelf, and deep water);
h) Muddy, silt bottoms from the subtidal to the shelf break, deep water corals and associated communities;
i) Areas identified as EFH for Highly Migratory Species managed by the Secretary of Commerce (*e.g.*, for sharks this includes inlets and nearshore waters, including pupping and nursery grounds), and
j) Federal or state protected species.

Appendix B.

List of Potentially Affected Habitats Currently Identified by the SAFMC

Many of the habitats potentially affected by these activities have been identified as EFH- HAPCs by the SAFMC. Each habitat and FMP is provided as follows:

a) All hardbottom areas (SAFMC snapper grouper);
b) Nearshore spawning and nursery sites (SAFMC penaeid shrimps);
c) Benthic Sargassum (SAFMC snapper grouper);
d) From shore to the ends of the sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina; Hurl Rocks, South Carolina; and Phragmatopoma (worm reefs) reefs off the central coast of Florida and near shore hardbottom south of Cape Canaveral (SAFMC coastal migratory pelagics);
e) Hurl Rocks (South Carolina); the Phragmatopoma (worm reefs) off central east coast of Florida; nearshore (0-4 meters; 0-12 feet) hardbottom off the east coast of Florida from Cape Canaveral to Broward County; offshore (5-30 meters; 15-90 feet) hardbottom off the east coast of Florida from Palm Beach County to Fowey Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary (SAFMC coral, coral reefs and live hardbottom Habitat);
f) EFH-HAPCs designated for HMS species (e.g., sharks) in the South Atlantic region (NMFS Highly Migratory Species);
g) Oculina Bank HAPC and proposed deepwater coral HAPCs (SAFMC coral, coral reefs, and live hardbottom habitat), and
h) HAPCs for diadromous species adopted by the Atlantic States Marine Fisheries Commission (ASMFC).

Appendix C.

Regulation of Drugs, Biologics, and Other Chemicals

Several federal agencies are involved in regulating drugs, biologics, and chemicals used in aquaculture. Each federal agency has specific, congressionally mandated responsibilities to regulate the products under their jurisdictions. In the case of aquaculture, there is some overlap between these federal agencies, as well as with state and local regulatory bodies.

The U.S. Food and Drug Administration (FDA) regulates the use of animal drugs and animal feed in aquaculture, ensuring their safety and efficacy. The FDA is responsible for ensuring that drugs used in food-producing animals, including cultured seafood, are safe and effective and that foods derived from treated animals are free from potentially harmful drug residues.

The EPA regulates disinfectants, sanitizers, and aquatic treatments used solely for control of algae, biofilm or pest control (excluding pathogens in or on fish). As authorized by the Clean Water Act, EPA also administers NPDES permits, which regulates discharge of pollutants that include drugs and chemicals from aquaculture operations into U.S. waters.

The USDA Animal and Plant Health Inspection Service (APHIS) regulates all veterinary biologics, including vaccines, bacterins, antisera, diagnostic kits, and other products of biological origin. APHIS is responsible for testing, licensing, and monitoring of vaccines used in aquaculture. They insure that all veterinary biologics used for diagnosis, prevention, and treatment of aquatic diseases are pure, safe, potent, and effective.

The Federal Food, Drug, and Cosmetic Act (FFDCA) defines the term “drug” broadly to include articles intended for use in the diagnosis, cure, mitigation, and treatment or prevention of disease. In aquaculture, this includes compounds such as antibiotics, sedatives and anesthetics, gender manipulators, and spawning aids. Common household compounds are also considered drugs (*e.g.*, hydrogen peroxide, salt, ice). These products cannot be used on aquatic species unless they have been approved by FDA for the intended purpose.

- Disinfectants are compounds, which have antimicrobial properties that are generally applied to equipment and structures and are not intended to have a therapeutic effect on cultured animals.
- Pesticides are not widely used in aquaculture; however, herbicides can be an important part of aquatic weed management in pond production.
- Biologics include a range of products of biologic origin used in the diagnosis, prevention, and treatment of diseases. In aquaculture, the most commonly used biologics are vaccines used to immunize animals and prevent infections from occurring.

It is illegal to use (1) unapproved drugs for any purpose or (2) approved drugs in a manner other than that specified on the product label unless the drugs are being used under the strict conditions of an investigational new animal drug (INAD) exemption or an extra-label prescription issued by a licensed veterinarian. Some aquaculture producers may use drugs that are not approved for aquaculture, but considered to be of low regulatory priority (LRP) for purposes of enforcement. Examples include acetic acid, carbon dioxide, sodium bicarbonate, sodium chloride, and ice.

For more information visit:

1. **US FDA Animal and Veterinary Drugs for Aquaculture**

http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/Aquaculture/ucm132954.htm

2. **A Quick Reference Guide to: Approved Drugs for Use in Aquaculture**

http://www.fda.gov/downloads/AnimalVeterinary/ResourcesforYou/AnimalHealthLiteracy/UCM109808.pdf

3. **Guide to Using Drugs, Biologics, and Other Chemicals in Aquaculture**

http://www.fws.gov/fisheries/aadap/AFS-FCS%20documents/GUIDE_OCT_2011.pdf

Table 1. Approved and conditionally approved drugs for use in marine aquaculture.

Active Ingredient	Tradename	Indication(s)
Chorionic gonadotropin	Chorulon®	Aid to improve spawning function in broodstock
Formalin	Parasite-S®, Formalin-F®, Formacide-B®, Paracide-F®	Control of fungi and external parasites in all finfish and penaeid shrimp
Oxytetracycline hydrochloride	Pennox® 343, Tetroxy®	Mark skeletal tissues for tagging finfish
Oxytetracycline dihydrate	Terramycin® 200	Broad spectrum antibiotic to control ulcer disease, furunculosis, bacterial hemorrhagic septicemia, enteric redmouth, pseudomonas disease, and other gram negative systemic bacteria in marine fish, Mark skeletal tissues for tagging finfish
Tricaine methanesulfonate	Finquel®, Tricaine-S®	Anesthesia and immobilization of finfish and other aquatic poikilotherms

Table 2. Low regulatory priority aquaculture drugs for use in marine aquaculture.

Active Ingredient	Indication(s)
Acetic acid	Parasiticide for finfish
Calcium chloride	Used to aid in egg hardening, Used to aid in maintaining osmotic balance during holding and transport of aquatic animals
Calcium oxide	External protozoacide for finfish
Carbon dioxide gas	Anesthesia and immobilization of finfish and other aquatic poikilotherms
Fuller's Earth	Use to reduce the adhesiveness of fish eggs
Garlic (whole form)	Use to control heminth and sea lice infestations of marine finfish
Ice	Use to reduce the metabolic rate of aquatic poikilotherms during transport
Magnesium sufate	Used to treat external parasites (monogenic trematodes and crustaceans) in finfish
Onion (whole form)	Used to treat external parasites (sea lice and other crustaceans) in finfish
Papain	Used to reduce the adhesiveness of fish eggs
Potassium chloride	Used to aid in maintaining osmotic balance during holding and transport of aquatic animals
Providone iodine	Used to disinfect fish eggs
Sodium bicarbonate	Used to introduce carbon dioxide into water for anesthetizing aquatic animals
Sodium chloride (salt)	Used to aid in maintaining osmotic balance during holding and transport of aquatic animals; Parasiticide for aquatic animals
Sodium sulfite	Used to reduce the adhesiveness of fish eggs
Thiamine hydrochloride	Used to prevent or treat thiamine deficeincy in finfish
Urea and tannic acid	Used to reduce the adhesiveness of fish eggs

Table 3. Investigational new animal drug exemptions for use in marine aquaculture. Permits held by the U.S. Fish and Wildlife Service as part of the National INAD Program.

Active Ingredient	Tradename	Indication(s)
Common carp pituitary	-	Aid to improve spawning function in broodstock
Catfish pituitary	-	Aid to improve spawning function in broodstock
Chloromine-T	Halamid®, Actamide®	Control of bacterial gill disease and external flavobacteriosis in certain species of marine finfish
Florfenicol	Aquaflor®	Broad spectrum antibiotic to control ulcer disease, furunculosis, bacterial hemorrhagic septicemia, and pseudomonas disease in marine aquatic animals
Hydrogen peroxide	Perox-Aid®	Use to treat external parasites in marine finfish
Luteinizing hormone releasing hormone analogue (LHRHa)	-	Aid to improve spawning function in broodstock
Oxytetracycline hydrochloride	Pennox® 343	Broad spectrum antibiotic to control ulcer disease, furunculosis, bacterial hemorrhagic septicemia, enteric redmouth, pseudomonas disease, and other gram negative systemic bacteria in marine fish, Mark skeletal tissues for tagging finfish
Oxytetracycline dihydrate	Terramycin® 200	Broad spectrum antibiotic to control ulcer disease, furunculosis, bacterial hemorrhagic septicemia, enteric redmouth, pseudomonas disease, and other gram negative systemic bacteria in marine fish, Mark skeletal tissues for tagging finfish
Calcein	Se-Mark®	Mark skeletal tissues for tagging finfish

Table 3 continued. Investigational new animal drug exemptions for use in marine aquaculture. Permits held by the U.S. Fish and Wildlife Service as part of the National INAD Program.

Active Ingredient	Tradename	Indication(s)
Salmon ganadotropin releasing hormone analogue (sGnRHa)	Ovaprim®, Ovaplant®	Aid to improve spawning function in broodstock
Benzocaine	Benzoak®	Anesthesia and immobilization of finfish and other aquatic poikilotherms
Eugenol	Aqui-S® 20E	Anesthesia and immobilization of finfish and other aquatic poikilotherms
Emamectin benzoate	Slice®	Use to control sea lice and other external parasite infestations of marine finfish
Methyl testosterone	-	Use to produce populations comprising over 90% phenotypically male finfish

Appendix D.

Examples of Existing Federal Laws Designed to Minimize Environmental Risks Associated with Marine Aquaculture.

Coastal Zone Management Act
Endangered Species Act
Rivers and Harbors Act of 1899
Clean Water Act
National Marine Sanctuaries Act
National Invasive Species Act
National Aquaculture Act
Outer Continental Shelf Lands Act
National Sea Grant College and Program Act
Fish and Wildlife Coordination Act
E.O. 11987: Exotic Organisms
E.O. 12630: Takings
E.O. 13089: Coral Reef Protection
E.O. 13112: Invasive Species
E.O. 13158: Marine Protected Areas
Marine Mammal Protection Act
Magnuson-Stevens Fishery Conservation and Management Act
Animal Health Act of 2002