SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

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Habitat and Environmental Protection Advisory Panel Meeting

November 5-6, 2013

Florida Fish and Wildlife Research Institute (FWRI)
St. Petersburg, Florida

The Habitat and Environmental Protection Advisory Panel met November 5-6 2013 at FWRI in St. Petersburg, Florida. Issues addressed during the meeting included, 1) Continued Development of Redrafted Essential Fish Habitat Policy Statements, 2) Identify Priorities for 2014, 3) Introduction to Habitat Modeling and Integration of Oceanographic Information into Regional Stock Assessments, 4) Training on Use of SAFMC Habitat and Ecosystem Atlas, Digital Dashboard and Ecospecies Online Species Profile System, 5) Roundtable Discussion on Development of FEP II, 6) Update on Fishery Independent Monitoring Systems and Fish Habitat Characterization, 7) South Atlantic Forage Based Ecopath Model and Roundtable Discussion on Climate and Fisheries, and 8) Regional Collaboration in Developing State of SA Habitat and Refining EFH for FEP II.

Updated Policy Statement Overviews
The Panel was provided overviews of the following redrafted policy statements: Aquaculture Policy Statement by Christopher Elkins; Instream Flow Policy Statement by Alice Lawrence, USFWS; SAV Policy Statement by Anne Deaton, NCDMF; and Estuarine Invasives Policy Statement by Priscilla Wendt, SCDNR. The redraft was conducted by teams of Panel members and other regional experts and is viewed as essentially complete for the Instream Flow, Aquaculture and SAV policies. The intent is to provide the drafts to the Council with the intent to finalizing them for Council consideration and approval at the March 2014 meeting. The Panel is continuing to update the Invasives policy statements.

RECOMMENDATION: Merge the estuarine and marine policy statements to reduce duplication and address species like lionfish are now being found in both marine and estuarine habitats and the effort would significantly reduce duplication.

Policy Statement Redraft and Development Priorities for 2014
The Panel discussed completing redraft of outstanding policy statements including the Energy Transportation, Exploration and Development Policy Statement and Beach Dredging and Filling and

Large Scale Coastal Engineering Policy Statement. New Policy statements have been initiated by Panel members for Artificial Reef Habitat and Habitat Restoration.

RECOMMENDATION: Direct the Habitat and Environmental Protection Advisory Panel to expand the existing in-stream flow policy statement addressing excessive freshwater discharge, freshwater withdrawals, and diversions of flow into/from rivers, estuaries and marine systems and the impacts on fish, fish habitat and fisheries.

RECOMMENDATION: Direct the Habitat and Environmental Advisory Panel to explore development of a new EFH policy statement to address the impacts of anthropogenic sound on fish, fish habitat and fisheries.

Habitat Modeling for Fishery Independent Trap Surveys
Barbara Muhling, RSMAS made a presentation on habitat modeling as an avenue to integrate oceanographic information into regional stock assessments and habitat characterizations.

Election of New Advisory Panel Chair
Motion: Nominate Pat Geer as Habitat Advisory Panel Chairman - Anne Deaton
Second: Jenkins Mikell
Motion Approved Unanimously

Concurrent Sessions: The Panel was divided into two sub-groups to participate in:
1) **Training on access and use of SAFMC Habitat and Ecosystem Tools** including the South Atlantic Habitat and Ecosystem Atlas and Digital Dashboard, and the cloud based Ecospecies South Atlantic species profile system which was conducted by Tina Udouj, FWRI, Kathleen OKeife, FWRI, and David Reed, FWRI; AND

2) **Roundtable discussion on** the development, timing and vision for FEP II and EFH update in 2014/2015 including opportunities for regional collaboration in development of new sections of FEP II focused on Fisheries Oceanography; Climate and Fisheries; Regional Mapping Strategy; and Regional In-stream Flow.

Regional Research and Monitoring Needs in FEP II
In order to set the stage for updating the research and monitoring section to be included in FEP II, Marcel Reichert, SCDNR provided the Panel members with an update on Fishery Independent Monitoring Programs in the South Atlantic Region which supporting stock assessment. He also highlighted the SEAMAP web based data management system was almost complete and would be going live December 1, 2013. Todd Kellison, NOAA Fisheries SEFSC provided the Panel an overview of recent work being conducted in fish habitat characterization.

Climate and Fish, Fish Habitat and Fisheries in the South Atlantic
To initiate discussion on climate change in the South Atlantic region, the Panel was provided a presentation on exploring the trophodynamic value of forage species in the South Atlantic ecosystem and collaborative development of Ecopath Model. The Panel discussed regional efforts and opportunities for collaboration which would provide information to the Council which characterizes the ocean and changing climates impact on fish, fish habitat and fisheries. These opportunities include: Engaging the Southeast Coastal and Ocean Observing Regional Association (SECOORA) in an update and refinement of the Ocean Condition Section of the FEP and in the development of oceanographic characterizations of managed areas; collaborating with the South Atlantic Landscape

Conservation Cooperative (SALCC) and SE USGS Climate Science Center and Southeast Aquatic Resources Partnership (SARP) in modeling potential changes in distribution of EFH associated with climate change for managed species.

Roger Pugliese also highlighted a recent collaborative effort between the three Atlantic Councils, ASMFC and NOAA spearheaded by the Mid-Atlantic Council to plan the *East Coast Climate Change and Fisheries Governance Workshop* to be held in the Mid-Atlantic region March 2014.

State of the South Atlantic Fish Habitat Summary and Refinement of EFH
The Panel discussed opportunities to draw on recent and ongoing habitat and environmental condition evaluations and collaborate with regional partners through workshops and meetings in the refinement of EFH and development of a State of South Atlantic fish habitat summary as part of FEP II.

PRELIMINARY WORKING LIST (November 2013)
EFH, Ecosystem (FEP II Development) Meeting/Technical Workshops (2014)

Date	Meeting/Workshop	Location
January 23, 2014	EFH/FEP II Technical Workshops- 1) Benthic Habitat, GIS and Mapping Strategy: In Cooperation with SEAMAP Bottom Mapping and Species Characterization Workgroup	Charleston, SC (in conjunction with South Division AFS)
March 11-13, 2014 or (April 1-3, 2014)	Habitat Advisory Panel Meeting and EFH/ FEP II Technical Workshops- 1) Wetlands (Marsh & Oyster/Shell Habitat) and (SAV & Mangroves); 2) Pelagic Habitat (*Sargassum*, Water Column) and Fisheries Oceanography	Charleston, SC
2014	South Atlantic Ecosystem, Habitat and Climate Modeling Workshop	Charleston, SC, Beaufort, NC or Raleigh
November 4-6, 2014	Habitat Advisory Panel Meeting and EFH/ FEP II Technical Workshops: 1) Benthic Habitats; 2) Artificial Reefs; 3) Impacts of Fishing on Habitat; and 4) Research and Monitoring	St. Petersburg, FL

The Panel also discussed facilitating dialogue between the established and developing habitat programs of the three Atlantic Councils and ASMFC to highlight ongoing and future activities and possible opportunities for collaboration.

The following redrafted EFH Policy Statements addressing Alterations to Riverine, Estuarine and Nearshore Flows, Marine Aquaculture and Submerged Aquatic Vegetation will be finalized by the Habitat and Environmental Protection Advisory Panel for Council consideration and approval in March 2014:

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POLICIES FOR THE PROTECTION AND RESTORATION OF ESSENTIAL FISH HABITATS FROM ALTERATIONS TO RIVERINE, ESTUARINE AND NEARSHORE FLOWS (Redraft November 2013)

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, deepening of navigational channels and inlets, 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).

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 CoordinationAct.

4) .

5) 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.

6) 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 and
   c) nearshore oceanic habitats off estuary mouths.

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**,** 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)

   d) 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).
   e) black sea bass (various nearshore waters, including unconsolidated bottom and live hardbottom to 100 feet, and hardbottoms to 600 feet)

f) penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas, including the surf zone and inlets)
g) 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)
h) corals of various types (hard substrates and muddy, silt bottoms from the subtidal to the shelf break)
i) areas identified as EFH for Highly Migratory Species managed by the Secretary of Commerce (inlets and nearshore waters are importantpupping 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.

Threats to Riverine, Marine and Estuarine Resources from Hydrologically-Altering Activities

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, water withdrawals, and dredging. 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:

Dredging:

Methods:
Agitation dredging- dredge material is hydraulically or mechanically lifted into the water column and then tidal or river currents are used to carry the suspended sediments elsewhere.

Hopper dredging- dredge material is loaded onto a vessel via a suction pipe, distributed into one or more hoppers in the vessel, and carried to an offshore disposal site.

Hydraulic pipeline dredge– dredge material is moved via intake pipe directly through a discharge pipe into a disposal area, either an open-water disposal site or an upland confined disposal facility (CDF). If the disposal site is a CDF, there may or may not be an effluent from the settled dredged material into the adjacent waterbody.

Mechanical dredge- dredge material is scooped from the bottom and then placed into a waiting vessel or disposal area. The two main types of scooping buckets used are clamshell and dipper buckets

Impacts to aquatic species from the act of dredging could result from suspended sediments and any associated contaminants, lowered dissolved oxygen (DO), impingement and entrainment, as well as vessel collisions. Dredging channels can also result in long-term salinity impacts, potentially compressing the area of fresh and brackish waters and driving the higher salinity ocean water farther inland. Stronger salinity stratification can reduce mixing and result in lower DO in the deeper part of the water column. Higher salinity levels can reduce habitat suitability for anadromous fishes and can convert tidal freshwater marsh to brackish marsh.

Disposal:
Confined disposal- material is placed behind dikes, which contain and isolate it from the surrounding environment. A mixture of dredged material and water is pumped into an area, may be divided into several smaller areas called cells. As the water moves through the cells, the sediments settle out and water may be discharged from the site as effluent.

Ocean disposal- material is delivered via a hopper dredge or towed barge, which travels to a designated Ocean Dredged Material Disposal Site (ODMDS), where the material is released and deposited on the ocean floor.

Open-water disposal- material is placed in an open waterbody (e.g., river, lake, estuary, or nearshore ocean area). The selected disposal site may be in a high-energy dispersive area or a low-energy depositional area, depending on the project goals.

Capped disposal- material is placed on a level bottom or in deep pits or depressions and clean material is placed on top to isolate the dredged material and any associated contaminants.

Impacts to aquatic species and habitats from disposal activities could include vessel collisions with certain sensitive species, alterations to existing habitat due to the disposal of disposed materials, and potential exposure to any associated contaminants.

Flow alterations:

Water withdrawals:
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, saltwater intrusion, degradation of downstream water quality, and altered downstream flows. Saltwater intrusion occurs when reduced riverine freshwater flows allow more saline water to intrude farther inland. Increased salinities can alter emergent vegetation, reduce habitat suitability and growth rates of sensitive species, and increase the colonization of predators. 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. Minimum flows released from hydroprojects are permitted through the 401 Water Quality Certification Permitting process administered by SCDEHC. In the development of 401 permits, SCDHEC will consider recommendations from other State Agencies, such as the South Carolina Department of Natural Resources (SCDNR). SCDNR

established an instream flow policy for protection of fish and wildlife habitats in 1989. 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 (e.g., dredging, construction of intake structures) 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) Sediments to be dredged should be tested for contaminant levels prior to dredging to ensure they will not pose an unacceptable toxicological risk to fish, wildlife species, or their prey. Dredged material should not be placed in areas that would negatively affect EFH's, EFH-HAPCs, CHAs, Federal critical habitat, diadromous fishes, or state and federally-listed species. Effluent from upland CDFs should be monitored to ensure state and Federal water quality standards are not violated.

13) To minimize the potential for impacts to certain sensitive species during dredging and disposal activities, vessel speed restrictions, observers, timing restrictions, and other avoidance techniques may be employed.
14) 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.

15) 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.

16) 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.

17) 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.

18) 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.

19) 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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Policy Update Coordination History

November 15, 2012: Flow/Energy Policies Work Group discusses updates for these policies at the November 14-15, 2012 Habitat and Environmental Protection AP Meeting (Wilson Laney, John Ellis, Alice Lawrence, Jenks Michael, Tom Jones, Emily Greene).

May 7, 2013: Flow Policy Work Group discusses updates for this policy at the May 7-8, 2013 Habitat and Environmental Protection AP Meeting (Alice Lawrence, Anne Deaton, Jenks Michael, Mark Caldwell, Tom Jones, Steve Trowell).

June 25, 2013: Correspondence related to the Savannah Harbor Expansion Project (SHEP) forwarded to Alice Lawrence for background information pertaining to dredging activities by Bill Wikoff, USFWS contact for SHEP.

June 27, 2013: Draft dredging section sent out to the SAFMC Habitat and Environmental Protection AP work group participants listed above. Comments received from Priscilla Wendt on July 2, 2013.

July 3, 2013: Correspondence related to Plant Washington, Washington County, Georgia forwarded to Alice Lawrence for background information pertaining to water withdrawal activities by Jimmy Evans, GDNR-WRD.

July 10, 2013: Draft water withdrawal section sent out to the SAFMC Habitat and Environmental Protection AP work group participants listed above. Priscilla Wendt responded that she had no further comments on July 11, 2013.

July 10, 2013: Correspondence related to current instream flow policies in FL and SC forwarded to Alice Lawrence for background information pertaining to flow alteration by Jerry Ziewitz (USFWS) and Thomas McCoy (USFWS).

July 23, 2013: Conversation with Mary Davis (SARP) regarding instream flow recommendations. Correspondence forwarded to Alice Lawrence for background information pertaining to instream flows.

July 24, 2013: Draft dam operations, methods for flow protection, and current state flow policies sent out to the SAFMC Habitat and Environmental Protection AP work group participants listed above. Priscilla Wendt provided edits (Dick Christie, SCDNR) on July 26, 2013.

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POLICY CONSIDERATIONS FOR THE INTERACTIONS BETWEEN ESSENTIAL FISH HABITATS AND MARINE AQUACULTURE (Redraft - November 2013)

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) 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 selected for culture, the location and scale of the aquaculture operation, the experience level of the operators, 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 impacts of marine aquaculture.

The SAFMC recognizes that there are several types of environmental risks associated with marine

[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.

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. The use of local, native species can result in little to no impacts on EFH in the event that escapement does occur.

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 (*Oreochromis* spp.) 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 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), frequency of extreme weather events, and direct interactions with predators such as sharks, marine mammals, and birds. While a certain level of escapes 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 preventing the possibility 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 reduced market value, growth performance, and feed conversion. An accredited health professional should regularly inspect crops and perform detailed diagnostic procedures to determine if disease presents a risk. Veterinarians with expertise in fish culture, or qualified aquatic animal health experts, can assist with development of a biosecurity plan to prevent or control the spread of pathogens within a farm site, between aquaculture operations, or to wild populations.

The spread of pathogens from cultured organisms to wild populations is a risk to fisheries and EFH conservation. There are documented cases of mortality in wild populations caused by both endemic and exotic diseases (NAAHP 2008). The prevalence of disease in intensive aquaculture operations is influenced by many factors, including immune status, stress level, pathogen load, environmental conditions, nutritional health, 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 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).

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).

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 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. Aquaculture drugs, biologics, and other chemicals play an important role in the integrated management of aquatic animal 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). 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.

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, 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 vertebrates. 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 is theoretically possible yet an unproven concern. 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. Sea lice are natural ectoparasites of marine fish and the most prevalent parasites of cultured marine finfish. Effective mitigation, management, and control of parasitic infestations requires good husbandry. Chemicals used in the treatment of most parasitic infestations with 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. Research suggests that environmental impacts from parasiticide treatments are minor and restricted to the spatiotemporal scale of infestation and treatment (Burridge et al. 2010). The use of large quantities of drugs and chemicals for parasite control has the potential to be detrimental to fish health and EFH. Excessive use of paraciticides 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 disease or group of diseases. 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 microbial diseases. 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 parasite diseases do not exist. The efficacy and safety of a vaccine is species specific and requires detailed knowledge of pathogenesis of the disease, antigens for protection, and immune response. 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. Aquaculture operations should be sited in areas with an abundant and reliable supply of good water quality. The primary risks to water quality from marine aquaculture operations are increased organic loading and nutrient enrichment. Excess nutrients, organic matter, and suspended 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 following feeding high-density operations. These conditions rarely persist or present long-term risk to water quality.

At some farm sites, a phytoplankton response to nutrient loading has been reported, but generally this is a low risk and causal linkages to algal blooms are not evident. 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. At large scales, the occurrence of many anthropogenically derived nutrients in coastal marine waters makes it difficult to attribute increased primary productivity directly to aquaculture.

Environmental impacts will vary by location (*i.e.*, on-shore, near-shore, and offshore); therefore, careful section 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.*, EHF), responsible cleaning practices, integration of feed management strategies, use of optimally formulated diets, and other management measures to minimize nutrient discharge.

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-based, 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 from aquaculture operations. These impacts can affect EFH if aquaculture operations are not properly sited. 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. Benthic impacts are generally localized and ephemeral in nature.

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, circulation at a site, 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. In some cases, moderate discharge has been shown to enhance local productivity of marine species including algae and fish (Machias et al. 2004; Dempster et al. 2006; Wang et al. 2012). Benthic monitoring plans should be designed to allow for early detection of enrichment and deterioration of

[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.

benthic community structure. Additionally, nearby control sites should be established in order to collect data to differentiate between aquaculture effects and natural and seasonal variability, or non-aquaculture factors.

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 hardbottom (*e.g.*, reefs and live bottom) in shallow and deep waters;
c) submerged aquatic vegetation beds;
d) shellfish beds;
e) spawning and nursery areas;
f) coastal wetlands, and
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/hardbottom 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, and

[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.).

f) waters hydrologically and ecologically connected to waters that support EFH.

The environmental effects of shellfish and finfish aquaculture in coastal waters are well-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. Belle and Nash (2008) recommend the siting of cages in water at least twice as deep as the cage with minimum flows of 7cm/second. It is not common for increases in chlorophyll or algal production to be measureable near aquaculture operations, especially in well flushed areas. Therefore, algal blooms are not expected to result from nutrient enrichment from fish aquaculture operations where properly sited.

The most studied benefit from marine aquaculture operations is as fish attractants as wild fish use aquaculture cages for shelter, foraging on biofouling organisms, and consumption of 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.

Moderate nutrient loads discharged from aquaculture operations can also increase productivity of some marine environments. This is especially true in waters with low levels of nitrogen and phosphorus, where nutrients are quickly assimilated into the food web. The actual environmental interactions of these nutrient loads are difficult to study due to the high rate of nutrient flushing and assimilation by phytoplankton.

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 habitatsin 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 offshore aquaculture development.[8] Over twenty-five 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, and
d) waters hydrologically and ecologically connected to waters that support EFH.

The environmental effects of offshore shellfish and finfish aquaculture are not well-documented because few operations exist in the United States. 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 described 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

[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.

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

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.

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 or naturalized species should be used for aquaculture in federal waters of the South Atlantic unless best available science demonstrates use of non-native or other species would not cause undue harm to wild species, habitats, or ecosystems in the event of an escape.

5. The use of genetically engineered aquatic organisms should be considered separately, pending approval by FDA.

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 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) Red drum (unconsolidated bottoms in the nearshore);
d) 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);
e) Black sea bass (various nearshore waters, including unconsolidated bottom and live hardbottom to 100 feet, and hardbottoms to 600 feet);
f) Penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas);
g) 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);
h) Corals of various types and associated organisms (on hard substrates in shallow, mid-shelf, and deep water);
i) Muddy, silt bottoms from the subtidal to the shelf break, deep water corals and associated communities;
j) 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
k) Federal or state protected species.

Appendix B.

List of Potentially Affected Habitats

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 and red drum);
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.

Use 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, bacterial slime, 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, treatment or prevention of disease. In aquaculture, this includes compounds such as antibiotics, sedatives and anesthetics, and 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.

All drugs used to control mortality associated with bacterial diseases or infestation density of parasites, sedate or anesthetize fish, induce spawning, change gender, or in any other way change the structure or function of aquatic species must be approved by the FDA. 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) 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 laws 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

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SAFMC POLICIES FOR THE PROTECTION AND ENHANCEMENT OF ESTUARINE AND MARINE SUBMERGED AQUATIC VEGETATION (SAV) HABITAT

(Redraft November 2013)

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 ideal for their propagation. 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. SAV is critically important to numerous state managed species, and a diverse assemblage of fauna that are prey to federally managed species; SAV provide 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 threatens water quality in the coastal zone. The most recent synthesis of research describes 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.

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.
- 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.
- Evaluate water quality criteria needed to support SAV survival and growth and support policy making to manage quality and quantity of surface runoff.

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 is 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 water clarity in the area of restoration is inadequate. 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 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, 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 (DWQ 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. 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 have declined in area since the mid-twentieth century, and light limitation is the primary factor limiting SAV distribution (Bulthuis 1983; Orth and Moore 1983; Duarte 1991; Walker and McComb 1992; Short and Wyllie-Echeverria 1996). 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 were once abundant have experienced significant losses since the mid-twentieth century. In some areas, SAV occur 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 because stormwater runoff directly and indirectly (via phytoplankton blooms) 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 varies seasonally and interannually. 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 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 have rules 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	Not allowed. Can seek variance.	Proprietary – prohibited, beach compatible dredge	Prohibited	Locate to minimize impacts	Recommend against		Recommend against	Recommend against

material on SAV		material must be placed on beaches or within the nearshore sand system.						
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.		No new permits in existing SAV.				

		In practice, aquaculture leases have not been historically authorized over any areas containing SAV.						

SAFMC SAV Policy Statement- Appendix 4

(SAV Distribution Maps in 2009 SAFMC Fishery Ecosystem Plan)