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

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Policy Context

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

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

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

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

found that two exotic mangrove species, introduced at a botanical garden, have spread and pose a threat to natural mangrove forests in south Florida (Fourqurean et al. 2010). In marine waters, the United States Geological Survey (2010), found more than 72 marine species, including those that occupy marine waters for at least one life-history stage, have been introduced in North Carolina (27), South Carolina (48), Georgia (23) and the Atlantic coast of Florida to Key West (22). Of these, the majority comprises marine crustaceans (29%), with fishes and mollusks accounting for an additional 49%. Invasions by fishes and invertebrates is considered highly significant, with the potential to displace native species and impact community structure and biodiversity of marine and estuarine ecosystems (e.g., Grozholz et al. 2000; Streftaris et al. 2005; Goren & Galil 2005; Dierking 2007; Albins & Hixon 2008; Rilov & Crooks 2009).

The SAFMC finds that:

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

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

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

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

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

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

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

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

Threats from Invasive Marine and Estuarine Organisms

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SAFMC Policies Addressing Marine and Estuarine Invasive Species

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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