

Clam Dredge Framework Adjustment

Framework 5 to the Atlantic Herring FMP
Framework 31 to the Atlantic Sea Scallop FMP
Framework 11 to the Monkfish FMP
Framework 60 to the Northeast Multispecies FMP
Framework 2 to the Red Crab FMP
Framework 7 to the Skate Complex FMP

Including an Environmental Assessment
and an
Initial Regulatory Flexibility Analysis



Images from FishWatch.gov

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Prepared by the
New England Fishery Management Council
in consultation with
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Mid-Atlantic Fishery Management Council



Clam Dredge Framework

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1 EXECUTIVE SUMMARY

This framework adjustment would allow surfclam and mussel dredging under restrictive conditions in the Great South Channel Habitat Management Area (GSC HMA). It is a trailing action to the Omnibus Essential Fish Habitat Amendment 2 (OHA2), which became effective April 9, 2018. The purpose of OHA2 was to update essential fish habitat (EFH) designations for species managed by the New England Fishery Management Council (NEFMC) and implement measures to minimize the impacts of fishing on designated EFH to the extent practicable. As part of OHA2, the GSC HMA was designated, which overlaps Nantucket Shoals. The purpose of the HMA is to minimize, to the extent practicable, the adverse effects of regional fisheries on EFH. The HMA contains benthic habitats identified in OHA2 as vulnerable to the hydraulic dredges and other mobile bottom-tending gears.

To minimize the impacts of fishing on habitats in the GSC HMA, OHA2 closed the area to all mobile bottom-tending gears, except that within most of the HMA a one-year exemption was granted to hydraulic clam dredge vessels in the surfclam fishery. This exemption, which expired on April 9, 2019, was granted to allow time for the Council to develop a longer-term exemption program within the HMA. This action is needed to identify areas where fishing for surfclams with hydraulic dredges would have only minimal and temporary impacts on the habitats in the HMA. The purpose of this action is to evaluate potential suitable areas within the GSC HMA using metrics related to habitat and fishing characteristics, for example sediment type, area swept, and fishery revenues. Additional management background is provided in section 3. Background information relevant to the Council's decision making is in the affected environment (section 5).

This framework includes five alternatives (section 4). Under Alternative 1/No Action, the clam dredge exemption expired on April 9, 2019. There are four alternatives for clam dredge exemption areas, each of which includes enhanced monitoring. Two of them also would exempt mussel dredges and two include a sub-option for doing so. The areas included in the four alternatives are based on locations recommended by the surfclam industry in August 2018. The four exemption area alternatives are summarized below.

- **Alternative 2:** Five exemption areas encompassing 7 of 9 areas recommended by the clam industry, but with modified boundaries to facilitate enforcement. Clam and mussel dredges would be authorized in the areas for five years. Enhanced monitoring including 5-minute VMS polling required. The Council would develop a research agenda to be funded by clam industry with results within 3 years.
- **Alternative 3:** One of the exemption areas recommended by the clam industry (Rose and Crown), with modified boundaries to facilitate enforcement. Clam dredges would be authorized with no sunset date; mussel dredges could also be authorized under a sub-option. Enhanced monitoring including 5-minute VMS polling required.
- **Alternative 4:** Four exemption areas encompassing 5 of the 9 areas recommended by the clam industry with modified boundaries to facilitate enforcement. Clam dredges would be authorized with no sunset date; mussel dredges could also be authorized by selecting a sub-option. Enhanced monitoring including 5-minute VMS polling required.

- **Alternative 5 (preferred):** Three exemption areas encompassing 5 of the 9 areas recommended by the clam industry, with modified boundaries to facilitate enforcement. Both clam and mussel dredges would be authorized. Enhanced monitoring including 5-minute VMS polling required. Within two additional areas, only exempted fishing would be permitted through the exempted fishing permit process. Scientific research could also occur in these areas and throughout the HMA.

When comparing the four action alternatives, the Council discussed habitat characteristics and vulnerability of the various exemption areas in comparison to the portions of the HMA that would remain closed to fishing. The Council also discussed recent distributions of surfclam dredging activity within the exemption areas, dependence of certain surfclam vessels on the HMA, and the potential for a mussel dredge fishery to resume on Nantucket Shoals. The possibility that some sections of the HMA function as cod spawning habitat was also acknowledged and accounted for in the seasonal closure aspects of certain alternatives. All four action alternatives include enhanced monitoring requirements, and after reviewing data from fall 2018 surfclam trips that trialed 5-minute VMS polling, the Council agreed that the identified exemption areas would be enforceable at this polling rate.

Ultimately Alternative 5 provides relatively limited access to surfclam grounds while protecting the majority of the HMA. While Alternatives 3 and 5 are similar in terms of amount of the HMA exempted vs. closed to fishing (7.5% and 6.9% of the HMA exempted, respectively), Alternative 5 does not create exemptions within those areas most clearly identified as containing complex and vulnerable habitats, i.e. the Rose and Crown (included in Alternatives 2 and 3) and to a lesser extent Davis Bank East (included in Alternatives 2 and 4). However, acknowledging that a more detailed characterization of the effects of fishing on the habitats in the HMA could be obtained through further scientific study, the Council's preferred alternative recommends development of a prioritized list of research needs concerning Rose and Crown and Davis Bank East. The intent is to work towards a research program for these areas, where fishing activity is only allowed under an exempted fishing permit. The Council's intent was that this research could support the potential development of additional exemptions in the future.

The potential impacts of these alternatives on managed species and EFH, human communities, and protected resources Valued Ecosystem Components (VECs) are described in section 6 and summarized below (Table 1). Differential magnitudes of impacts among alternatives are related to both the fraction of the HMA that would be open to fishing (ranging from 0 for No Action to 17.7% for Alternative 2; the preferred alternative opens 6.9% of the HMA) and the characteristics of areas selected for exemption. Generally, restrictions on mobile bottom-tending gears are expected to have positive impacts on essential fish habitats and the species dependent on those habitats (see 6.2). Fisheries for species using these habitats are also expected to benefit indirectly over the long-term as habitat protection improves production of target resources.

Fisheries for target species, namely Atlantic surfclams and blue mussels, are expected to be negatively affected by closure of the HMA but will derive some economic benefits from exemptions. When reviewing the impacts analysis, it is important to understand the baseline condition of the VECs to establish the context of the impact. As noted above, Alternative 1/No

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Action is a complete closure of the HMA, as established via OHA2. In the case of the Atlantic surfclam fishery, almost the entire HMA was open to fishing with hydraulic clam dredges until April 9, 2019. Thus, compared to the past seven plus years (data from 2011-2017 were analyzed to support decision making), all alternatives would reduce fishing effort in the HMA and therefore have a negative impact on the surfclam fishery. However, any of the exemption alternatives would have a positive impact on the fishery relative to No Action, because they provide some access to the HMA vs. complete closure of the area. This recent surfclam fishing activity has influenced the current state of habitats within the HMA.

The baseline condition of the mussel fishery in the GSC HMA is very different. There has not been an active commercial mussel fishery within the HMA for many years, but exploratory effort occurred prior to closure of the area under OHA2. Exemptions afforded via this framework, including the proposed action, thus represent a positive opportunity for the mussel fishery, relative to No Action. Because the distribution of commercial density mussel beds in the HMA is poorly understood, the extent of the fishing opportunities afforded by the proposed exemption areas is somewhat speculative and thus the magnitude of positive impacts is uncertain.

Impacts of the alternatives on protected resources are likely to be neutral to, at worst, low negative. The operation of clam dredges in the HMA is not expected to pose an interaction risk to any protected species of marine mammals, sea turtles, or fish. Mussel dredges are like scallop dredges but fished at slower speeds. Since ESA listed species of hard-shelled sea turtles and Atlantic sturgeon have been observed in scallop dredge gear, and mussel and scallop dredges are similar, there is a risk this gear type could interact with these listed species. However, assuming the magnitude of effort with mussel dredges is likely small, overall interaction risk is likely low.

Table 1 – Summary of impacts on valued ecosystem components.

Valued ecosystem component	Sub-element of VEC	Alternative 1/No Action	Alternative 2	Alternative 3	Alternative 4	Alternative 5 (Preferred)
Benthic habitats, EFH, and managed species	Benthic habitats/EFH	Positive	Negative relative to No Action	Low negative to negative relative to No Action	Low negative to negative relative to No Action	Low negative relative to No Action
	Managed species	Positive	Negative relative to No Action	Low negative to negative relative to No Action	Low negative to negative relative to No Action	Low negative relative to No Action
Human communities	Surfclam fishery	Negative; no further access opportunities provided to GSC HMA	Positive relative to No Action; more positive than Alternatives 3-5	Positive relative to No Action	Positive relative to No Action	Positive relative to No Action

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Valued ecosystem component	Sub-element of VEC	Alternative 1/No Action	Alternative 2	Alternative 3	Alternative 4	Alternative 5 (Preferred)
	Mussel fishery	Neutral relative to baseline conditions; no access opportunities provided to GSC HMA	Low positive relative to No Action; access to areas with known mussel beds	With exemption, low positive relative to No Action; access to areas with known mussel beds; without exemption, neutral to No Action	With exemption, slightly to low positive relative to No Action; status of mussel beds in exemption areas unknown; without exemption, neutral to No Action	Slightly to low positive relative to No Action; status of mussel beds in exemption areas unknown
	Other fisheries	Low positive via habitat-related enhancement of resource production	Low positive via habitat-related enhancement of resource production	Low positive via habitat-related enhancement of resource production	Low positive via habitat-related enhancement of resource production	Low positive via habitat-related enhancement of resource production
	Communities	Negative to low positive	Low negative to low positive	Low negative to low positive	Low negative to low positive	Low negative to low positive
Protected resources	Large cetaceans	Neutral	Neutral	Neutral	Neutral	Neutral
	Small cetaceans	Neutral	Neutral	Neutral	Neutral	Neutral
	Pinnipeds	Neutral	Neutral	Neutral	Neutral	Neutral
	Turtles	Neutral	Neutral (surfclam fishery); low negative (mussel dredge fishery)	Neutral (surfclam fishery); low negative (mussel dredge fishery with exemption); neutral (mussel dredge fishery without exemption)	Neutral (surfclam fishery); low negative (mussel dredge fishery with exemption); neutral (mussel dredge fishery without exemption)	Neutral (surfclam fishery); low negative (mussel dredge fishery)
	Atlantic salmon	Neutral	Neutral	Neutral	Neutral	Neutral

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Valued ecosystem component	Sub-element of VEC	Alternative 1/No Action	Alternative 2	Alternative 3	Alternative 4	Alternative 5 (Preferred)
	Atlantic sturgeon	Neutral	Neutral (surfclam fishery); low negative (mussel dredge fishery)	Neutral (surfclam fishery); low negative (mussel dredge fishery with exemption); neutral (mussel dredge fishery without exemption)	Neutral (surfclam fishery); low negative (mussel dredge fishery with exemption); neutral (mussel dredge fishery without exemption)	Neutral (surfclam fishery); low negative (mussel dredge fishery)

Table 2 – Habitat analysis metrics and impacts determinations. For Alternatives 2-5, habitat metrics are in relation to exemption areas that would be open to clam and/or mussel dredging (under Alternative 1, the entire HMA would be closed). Information for the entire GSC HMA is provided for comparison purposes.

		Entire HMA	Alt. 1 No Action	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Description of alternative	Exemption areas	N/A	None	McBlair, Old South Rose & Crown, Davis Bank East, Fishing Rip	Rose & Crown	McBlair, Old South, Davis Bank East, Zone A	McBlair, Old South, Fishing Rip
	Mussel dredges allowed in exemption areas?	N/A	N/A	Yes	Yes, under Sub-Option 1	Yes, under Sub-Option 1	Yes
	Seasonal closures	N/A	N/A	Old South closed Nov-Apr, Rose & Crown S. closed May-Oct	No	Old South closed Nov-Apr	Old South closed Nov-Apr
Habitat metrics for	Area (km ²) that is cobble- or boulder-dominated	434 km ² *	N/A	112 km ²	105 km ²	58 km ²	11 km ² **
	Percent of drop camera stations that indicate complex habitat	67% *	N/A	87%	89%	84%	86%**
	Percent of observations	44% *	N/A	65%	76%	68%	24%**

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	Entire HMA	Alt. 1 No Action	Alt. 2	Alt. 3	Alt. 4	Alt. 5
indicating stable sediment						
Occurrence of mussel beds	Yes, known in Rose & Crown region, historically in McBlair region	N/A	Yes, known in Rose & Crown region, historically in McBlair region	Yes, known in Rose & Crown region	Historically in McBlair region	Historically in McBlair region
Occurrence of cod spawning habitat	Yes, along western and eastern edges of HMA	N/A	Yes, in Old South	No	Yes, in Old South	Yes, in Old South
Clam dredge swept area (annual average 2010-2017)	107 km ²	N/A	54 km ²	27 km ²	26 km ²	19 km ²
Clam dredge swept area ratio	4%	N/A	12%	14%	11%	11%
Conclusions	N/A	Positive impacts on EFH and managed species	Negative impacts on EFH and managed species	Low negative to negative impacts on EFH and managed species; more negative if mussel dredges are exempted (Sub-Option 1)	Low negative to negative impacts on EFH and managed species; more negative if mussel dredges are exempted (Sub-Option 1)	Low negative impacts on EFH and managed species

* For reference, these are the values for the entire HMA, including the northeastern corner which was closed under OHA2

** Low sample sizes associated with this Alternative and metric

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2.5 Acronyms

ASMFC – Atlantic States Marine Fisheries Commission
ASSRT – Atlantic Sturgeon Status Review Team
BOEM – Bureau of Ocean Energy Management
DHRA – Dedicated Habitat Research Area
EFH – Essential Fish Habitat
EA – Environmental Assessment
F – Fishing mortality
FMP – Fishery Management Plan
GARFO – Greater Atlantic Regional Fisheries Office
GB – Georges Bank
Gulf of Maine – Gulf of Maine
GSC – Great South Channel
HAPC – Habitat Area of Particular Concern
HCD – Habitat Conservation Division (NMFS)
HMA – Habitat Management Area
ITQ – Individual Transferable Quota
LNG – Liquefied Natural Gas
MAB – Mid-Atlantic Bight
MAFMC – Mid-Atlantic Fishery Management Council
MBTG – Mobile bottom-tending gear
MSA – Magnuson-Stevens [Fishery Conservation and Management] Act
MSY – Maximum sustainable yield
BMSY – Biomass at MSY
FMSY – Fishing mortality rate at MSY
NMFS – National Marine Fisheries Service
NEFMC – New England Fishery Management Council
NEPA – National Environmental Policy Act
NLCA – Nantucket Lightship Closed Area
NPFMC – North Pacific Fishery Management Council
PDT – Plan Development Team
SASI – Swept Area Seabed Impact
SIA – Social Impact Assessment
SNE – Southern New England

3 BACKGROUND AND PURPOSE

3.1 Purpose and Need for Action

The Council developed this framework to evaluate and possibly designate areas where hydraulic clam dredging might continue in the Great South Channel Habitat Management Area (GSC HMA). The purpose of the HMA is to minimize, to the extent practicable, the adverse effects of regional fisheries on essential fish habitat (EFH). This action is needed to identify areas where fishing for surfclams with hydraulic dredges would have only minimal and temporary impacts on the habitats in the HMA. The purpose of this action is to evaluate potential suitable areas within the GSC HMA using metrics related to habitat and fishing characteristics, for example sediment type, area swept, and fishery revenues.

3.2 Management Background

The Council worked to identify and minimize impacts to essential fish habitat through the Omnibus Essential Fish Habitat Amendment 2 (OHA2). OHA2, including designation of the GSC HMA, was partly approved in January 2018 and implemented on April 9, 2018. The GSC HMA was designated as a closure to all mobile bottom-tending gears (MBTG). MBTG are defined in the fishery regulations for the northeastern United States as “gear in contact with the ocean bottom, and towed from a vessel, which is moved through the water during fishing in order to capture fish, and includes otter trawls, beam trawls, hydraulic dredges, non-hydraulic dredges, and seines (with the exception of a purse seine).” OHA2 granted a one-year exemption from this restriction only for hydraulic dredges, which expired on April 9, 2019, one year from the effective date of the OHA2 final rule.

Rationale for designation of the HMA and subsequent Council action was specified in the Omnibus Habitat Amendment 2 FEIS, the NMFS Record of Decision (ROD; NMFS 2018a), and the OHA2 Final Rule (NMFS 2018b). The ROD acknowledges the work of the Council to develop “a follow-up framework action that would restrict [clam dredge] gear to less vulnerable habitat types within the [GSC HMA]”. In September 2015, following June 2015 final action on OHA2, the Council developed its own problem statement for the follow-up clam framework action:

“The surfclam/ocean quahog fishery will be granted a one-year exemption for the GSC HMA following implementation of OHA2, which will allow the Council to consider development of an access program for this fishery. The Council intends through this action to identify areas within the HMA that are currently fished or contain high energy sand and gravel that could be suitable for a hydraulic clam dredging exemption that balances achieving optimum yield for the fishery with the requirement to minimize adverse fishing effects on habitat to the extent practicable and is consistent with the underlying objectives of OHA2.”

4 MANAGEMENT ALTERNATIVES

The Great South Channel HMA went into effect on April 9, 2018. Clam dredges were exempt from the mobile bottom-tending gear restrictions associated with the HMA for one year after this date. These gear restrictions prohibit the use of all other mobile bottom-tending gears, including mussel dredges, scallop dredges and bottom trawls. Under Alternative 1/No Action, the exemption for hydraulic dredges expired on April 9, 2019, and mussel dredges will continue to be prohibited. Under Alternatives 2-5, the Council would designate subsets of the GSC HMA where clam dredges and/or mussel dredges¹ would be permitted, for either five years (Alternative 2) or without a specific end date (Alternatives 3, 4, and 5), with fishing subject to specific monitoring requirements.

Coordinates for potential exemption areas: Coordinates for exemption areas are in Table 3. After final action by the Council, names of areas included in the preferred alternative were simplified (East Door/Old South to Old South) or geographically referenced to make them more meaningful (Area D to Davis Bank East, Area A-B to Fishing Rip). The original names are provided here given reference to them in analyses prepared by the PDT during development of the framework. This document uses the updated names.

Table 3 – Coordinates for potential exemption areas in degrees, decimal minutes

Area name	Alternatives	Point	Longitude	Latitude
McBlair	2, 4, 5	1	-69° 46.951' W	41° 25.872' N
		2	-69° 46.951' W	41° 19.34' N
		3	-69° 49.164' W	41° 19.34' N
		4	-69° 49.23' W	41° 25.883' N
Old South (East Door/Old South)	2, 4, 5	1	-69° 47' W	41° 7' N
		2	-69° 47' W	41° 11' N
		3	-69° 49.084' W	41° 11' N
		4	-69° 49.155' W	41° 12.5' N
		5	-69° 47' W	41° 12.5' N
		6	-69° 47' W	41° 15' N
		7	-69° 44' W	41° 15' N
		8	-69° 44.22' W	41° 10.432' N
		9	-69° 45.007' W	41° 7.01' N
Rose and Crown North	2	1	-69° 43.5' W	41° 20' N
		2	-69° 39.54' W	41° 19.949' N
		3	-69° 35.324' W	41° 12.601' N
		4	-69° 41.436' W	41° 13.773' N
		5	-69° 43.5' W	41° 18.711' N
Rose and Crown South	2	1	-69° 35.324' W	41° 12.601' N
		2	-69° 41.388' W	41° 5.009' N
		3	-69° 43.5' W	41° 5' N
		4	-69° 43.254' W	41° 10.431' N
		5	-69° 41.436' W	41° 13.773' N

¹ The mussel industry first voiced to the Council their interest in fishing in the HMA in January 2018, upon learning that the area would close to mussel dredges upon final implementation of OHA2.

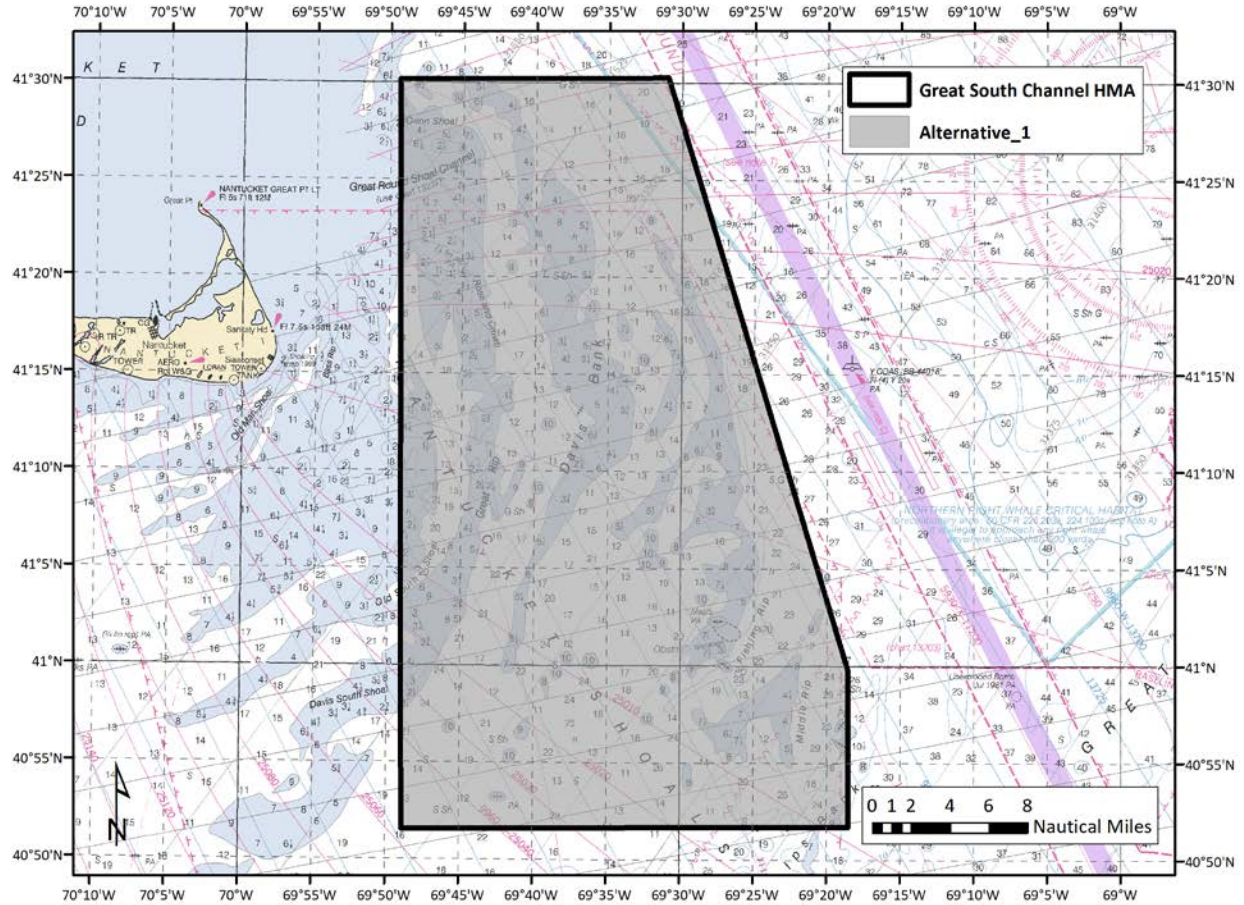
Clam Dredge Framework

Area name	Alternatives	Point	Longitude	Latitude
Davis Bank East (Zone D)	2, 4, 5	1	-69° 35.999' W	41° 20' N
		2	-69° 32.311' W	41° 19.988' N
		3	-69° 30.493' W	41° 18.009' N
		4	-69° 30.508' W	41° 11.997' N
		5	-69° 33.561' W	41° 12' N
Fishing Rip (Zone A-B)	2, 5	1	-69° 29.311' W	41° 6.699' N
		2	-69° 27.034' W	41° 6.609' N
		3	-69° 27.376' W	41° 3.198' N
		4	-69° 29.905' W	41° 1.297' N
		5	-69° 32.579' W	41° 5.368' N
		6	-69° 31.193' W	41° 7.356' N
		7	-69° 28.829' W	41° 10.963' N
		8	-69° 27.106' W	41° 10.485' N
Rose and Crown	3, 5	1	-69° 43.5' W	41° 20' N
		2	-69° 39.54' W	41° 19.949' N
		3	-69° 35.324' W	41° 12.601' N
		4	-69° 41.388' W	41° 5.009' N
		5	-69° 43.5' W	41° 5' N
		6	-69° 43.254' W	41° 10.431' N
		7	-69° 41.436' W	41° 13.773' N
		8	-69° 43.5' W	41° 18.711' N
Zone A	4	1	-69° 29.311' W	41° 6.699' N
		2	-69° 27.034' W	41° 6.609' N
		3	-69° 28.222' W	41° 4.516' N
		4	-69° 32.816' W	41° 3.306' N
		5	-69° 32.579' W	41° 5.368' N
		6	-69° 31.193' W	41° 7.356' N
		7	-69° 28.829' W	41° 10.963' N
		8	-69° 27.106' W	41° 10.485' N

4.1 Alternative 1/No Action

Under Alternative 1/No Action, no exemption areas would be designated, and the entire GSC HMA will continue to be closed to all types of mobile bottom-tending gears, as it has been since April 9, 2019 (Map 1).

Map 1 – Alternative 1. Grey shaded area closed to MBTG.



4.2 Alternative 2

Exemption areas: Under Alternative 2 (Map 2), five exemption areas would be designated for both surfclam and mussel dredges²: (1) McBlair, (2) Old South, (3) Rose and Crown, (4) Davis Bank East, and (5) Fishing Rip. Old South would be closed for six months from November 1-April 30. The southern part of Rose and Crown, which is near Old South, would be closed from May 1-October 31. The areas would be in place for five years, starting from the effective date of the final rule for the framework.

Monitoring requirements: All vessels fishing in the exemption areas would be required to use clam or mussel dredges and to request an annual letter of authorization to fish under the exemption program. The purpose of the letter of authorization would be to identify the vessels interested in accessing the HMA to ensure that the vessels have the necessary permits and correct Vessel Monitoring System (VMS) unit. Vessels would be required to use a type-approved VMS unit capable of being triggered remotely by the NOAA Office of Law Enforcement (NOAA OLE) to send positions every 5 minutes beginning when the vessel approaches the GSC HMA boundary. This rate is an increase from the normal 60-minute rate (30-minutes for any vessels with scallop permits). Based on preliminary analysis of 5-minute data from four clam dredge vessels, a distance buffer of 3 nm from the outer HMA boundary appears to be suitable for the automatic trigger. Vessels participating in the program would automatically send 5-minute data any time they cross the 3-nm boundary line.

Vessel operators would be required to declare into the GSC HMA fishery using the VMS system for any trip where fishing within the exemption areas is anticipated. A trip-level declaration via VMS will alert NOAA OLE to monitor vessel speed and position in real time. Vessels would be allowed to fish within multiple sub-areas per trip, accounting for any open and closed seasons, but clam or mussel dredges would need to be on deck while transiting between areas. Hydraulic hoses used with clam dredges could remain in the water during transit between areas. The alternatives do not set any fishing or transit speed requirements. As a best practice, vessels would be encouraged to transit the closed portions of the HMA at higher speeds and report extended low-speed, non-fishing activities along the boundaries of the exemption areas to NOAA Office of Law Enforcement.

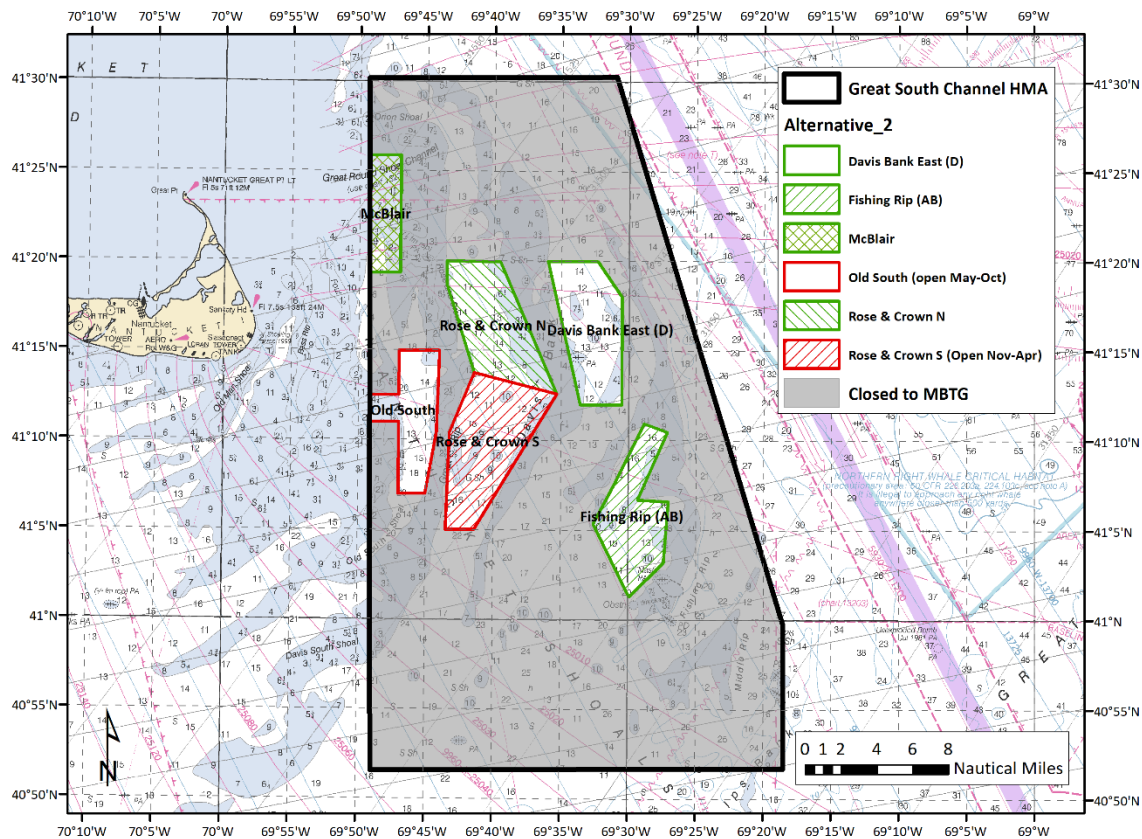
Any mussel dredge vessel fishing in the exemption areas within the GSC HMA would be required to have a surfclam permit, because there is no federal mussel permit. The requirement that vessels hold a surfclam permit would trigger VMS requirements, as well as VTR requirements. A separate VMS declaration would be established for fishing in the exemption areas with mussel dredge gear. Existing regulations associated with the Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area, which fully encompasses the exemption area considered in this alternative, specify that mussel dredges may be no wider than 8 ft (2.4 m) measured at the widest point in the bail of the dredge. The Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area also requires that vessels do not fish for, harvest, possess, or

² Unlike Alternatives 3 and 4 which consider exemptions for mussel dredges as a sub-option, Alternative 2 would allow use of both clam and mussel dredges.

land any species other than mussels and sea urchins. This maximum gear width is adopted for this exemption program as well, such that it would be maintained even if the Mussel and Urchin Dredge Exemption Area is altered or removed. In addition, under this exemption program vessels may not fish for, harvest, possess, or land any species other than mussels when on a declared mussel exemption trip.

Research agenda: The Council would convene a series of discussions, within the first year after the effective date of this action, to outline a research agenda for the GSC HMA, and the clam industry would commit to providing funding for reasonable research costs. The goal of this research program would be to improve the scientific foundation for management of the area. The expectation is that results would be available within three years of the effective date, to inform Council consideration of extending or altering the exemption program before its expiration after five years. The research program could include before-after-control-impact studies of dredging effects, including an evaluation of habitat recovery at multiple time steps, and acoustic or other types of fine-scale habitat mapping.

Map 2 – Alternative 2. Year-round exemption areas are outlined in green, seasonal exemption areas are outlined in red. The rest of the HMA would be closed to all mobile bottom-tending gears.



4.3 Alternative 3

Exemption area: Under Alternative 3 (Map 3), a single exemption area would be designated for surfclam dredges, the Rose and Crown area. This area would be open year-round.

Monitoring requirements: See Alternative 2; measures apply to surfclam dredges, and to mussel dredges if a mussel dredge exemption is adopted.

Research agenda: None specified.

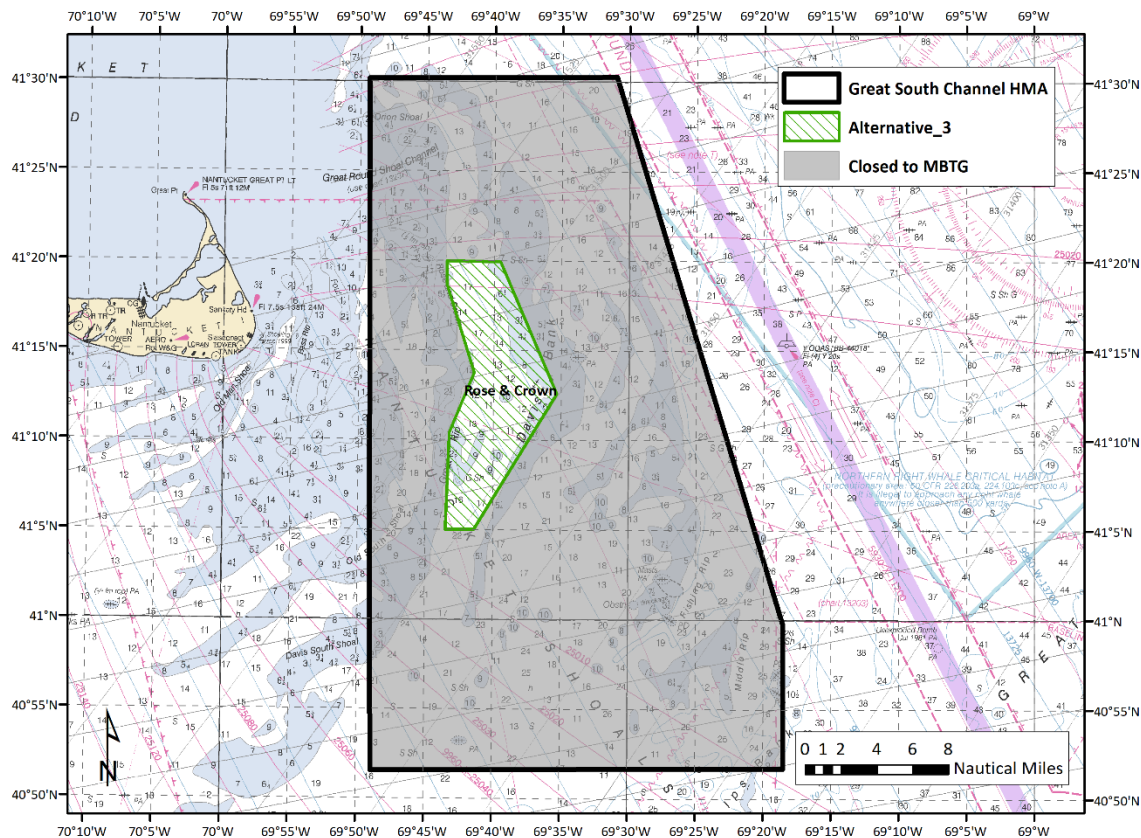
4.3.1 Sub-option 1– Mussel Dredges Exempted

Under this sub-option, vessels using mussel dredges would also be authorized to fish within the exemption area. All monitoring requirements under Alternative 2 would apply to mussel dredge vessels.

4.3.2 Sub-option 2 – Mussel Dredges Not Exempted

Under this sub-option, vessels using mussel dredges would not be authorized to fish within the exemption area.

Map 3 – Alternative 3. The year-round Rose and Crown exemption area is outlined in green and hatched. The rest of the HMA would be closed to all mobile bottom-tending gears.



4.4 Alternative 4

Exemption areas: Under Alternative 4 (Map 4), four exemption areas would be designated for surfclam dredges: (1) McBlair, (2) Old South, (3) Davis Bank East, and (4) Zone A. Old South would be closed for six months from November 1-April 30.

Monitoring requirements: See Alternative 2; measures apply to surfclam dredges, and to mussel dredges if a mussel dredge exemption is adopted.

Research agenda: None specified.

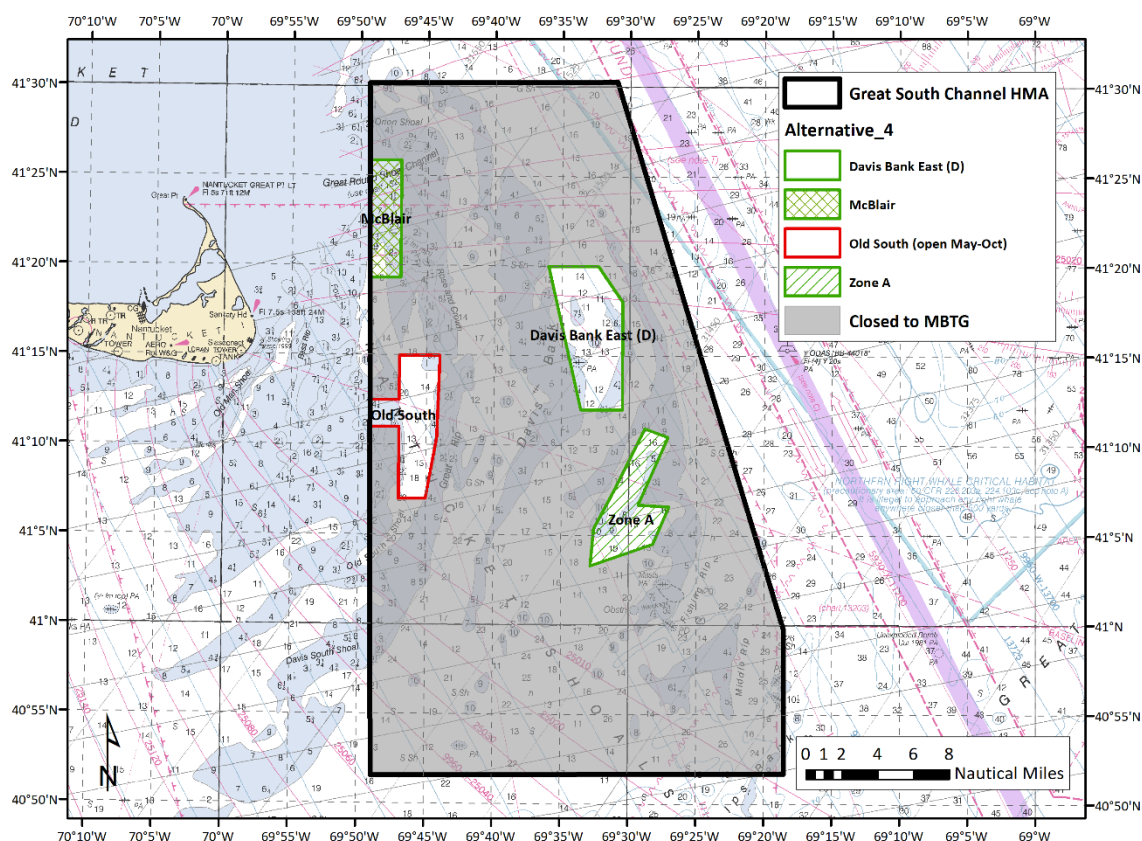
4.4.1 Sub-option 1– Mussel Dredges Exempted

Under this sub-option, vessels using mussel dredges would also be authorized to fish within the exemption area. All monitoring requirements under Alternative 2 would apply to mussel dredge vessels.

4.4.2 Sub-option 2 – Mussel Dredges Not Exempted

Under this sub-option, vessels using mussel dredges would not be authorized to fish within the exemption area.

Map 4 – Alternative 4. Year-round exemption areas are outlined in green, and the seasonal exemption area is outlined in red. The rest of the HMA would be closed to all mobile bottom-tending gears.



4.5 Alternative 5 (preferred)

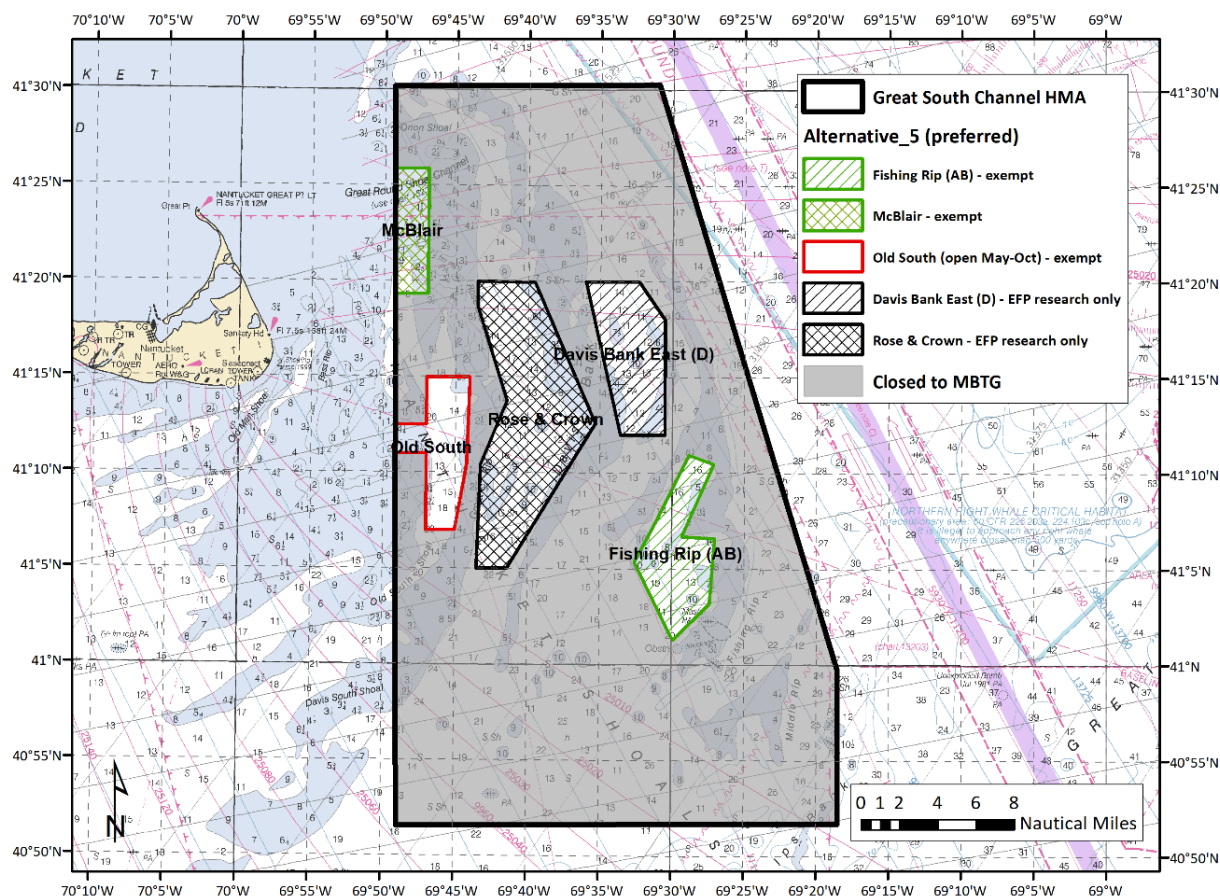
Alternative 5 designates exemptions in a subset of the areas included in Alternatives 2 and 4.

Exemption areas: Under Alternative 5 (Map 5), three exemption areas would be designated for both surfclam and mussel dredges: (1) McBlair, (2) Old South, and (3) Fishing Rip. Old South would be closed for six months from November 1-April 30 to reduce overlaps between clam dredging and cod spawning activities.

Monitoring requirements: See Alternative 2; requirements apply to both surfclam and mussel dredges.

Research agenda: The Council would develop a prioritized list of research needs concerning Rose and Crown and Davis Bank East. The intent is to work towards a research program for these areas, where fishing activity is only allowed under an exempted fishing permit. The Council's intent was that this research could support the potential development of additional exemptions in the future.

Map 5 – Alternative 5 (preferred). Year-round exemption areas are shown in green, and the seasonal exemption area is shown in red. Rose and Crown and Davis Bank East outlined in black would potentially be open to research; but only under an exempted fishing permit. The rest of the HMA (shaded grey) would be closed to all mobile bottom-tending gears.



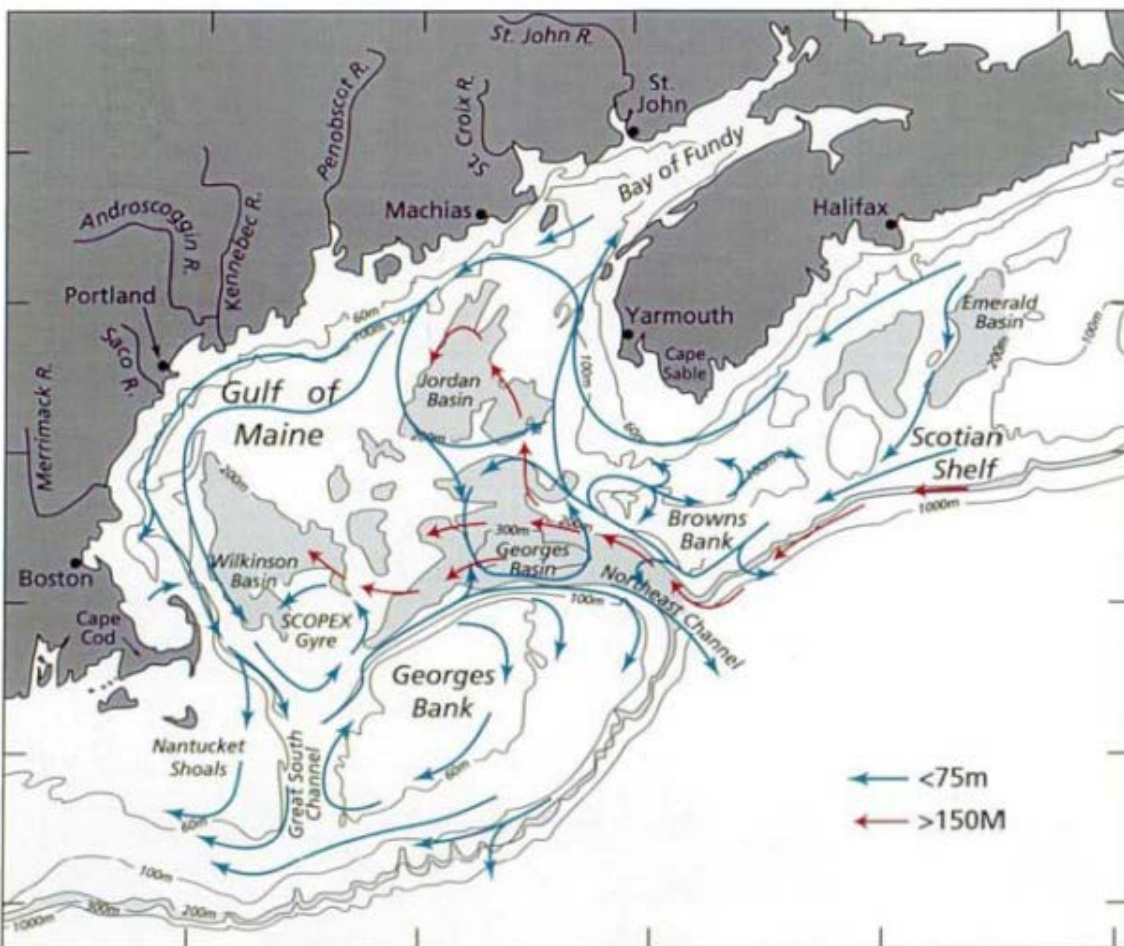
5 AFFECTED ENVIRONMENT

This information builds on the OHA2 FEIS, Volume 1, section 4, but focuses on the habitats and species found in and around the Great South Channel HMA, which are expected to benefit from habitat conservation measures, and on the surfclam and mussel fisheries that would be authorized to fish under the exemption alternatives and would benefit from them.

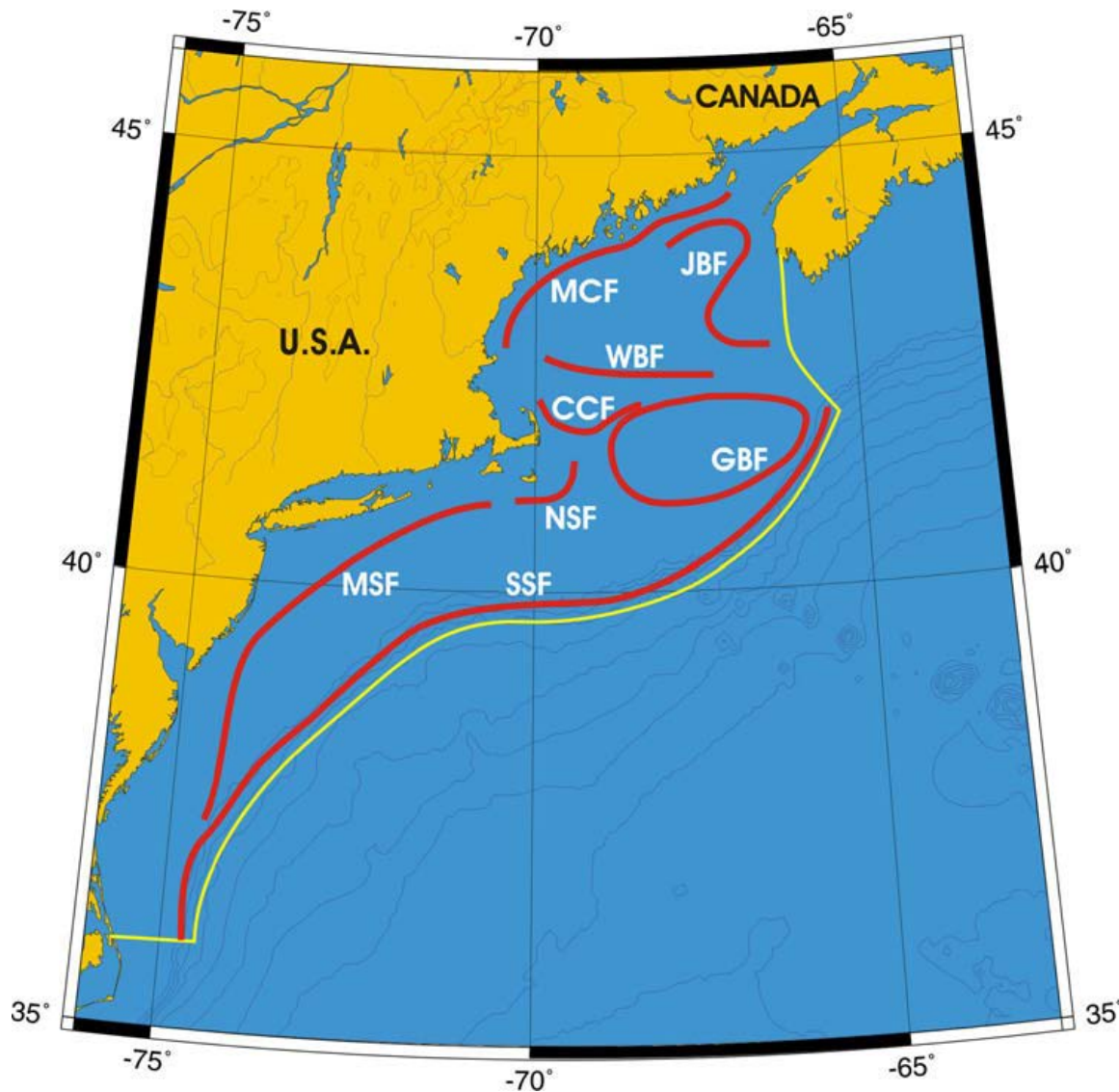
5.1 Physical Setting Including Benthic Habitats

The Great South Channel is an undersea channel between the shallower Nantucket Shoals to the west and Georges Bank to the east. A steady, coastal current flows south along the east coast of Cape Cod and into the Great South Channel (Miller et al 1998, Map 6). Some of the current flows south around Nantucket Shoals, while some turns east and joins the northeastward flow along the northern flank of Georges Bank. Strong currents are driven by a combination of winds and tides. There are three large marine ecosystem persistent fronts in the region (Belkin et al 2009; Map 7).

Map 6 – Ocean currents of the Georges Bank-Gulf of Maine region. Source: Miller et al. 1998.



Map 7 – Fronts of the Northeast US Continental Shelf Large Marine Ecosystem. The Cape Cod Front, Nantucket Shoals Front, and Georges Bank Front occur in the Great South Channel region. Source: Belkin et al 2009.



The function of the Great South Channel Habitat Management Area HMA as fish habitat is related partly to benthic habitat characteristics, including sediments and bedforms (geological features) as well as biota (biological features). Further information about habitat types found throughout New England and the Mid-Atlantic is in OHA2, Volume 1, section 4.2.1. Appendix A to this framework details the approach used to assess benthic habitat distributions in the HMA based on drop camera image data that was analyzed specifically for this framework action.

Our understanding of the distribution of habitat types within the HMA is not substantially different from that presented in the OHA2 FEIS. New data needed for this action regarding the occurrence and distribution of specific benthic features in the HMA was generated by conducting

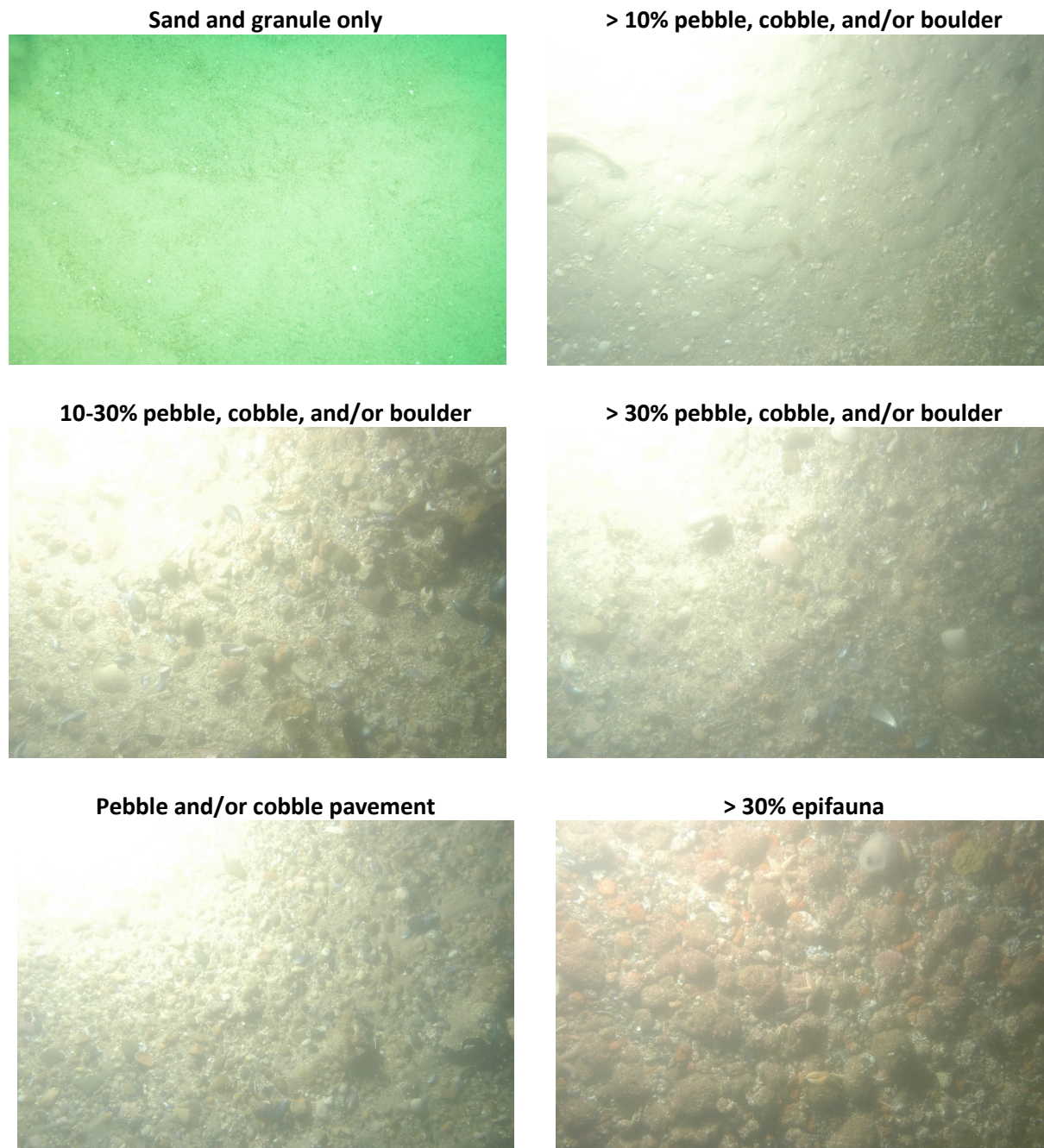
a more detailed spatial analysis of benthic drop camera imagery collected between 2006 and 2015 by the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST; methods in Appendix A). In summary, the new analysis examined digital still camera images to confirm the presence or absence of sand, pebble, cobble, or boulder. When one or more size classes of gravel were present, percent cover of all gravels combined was estimated. Percent cover was assessed as <10% coverage, 10-30% coverage, and >30% coverage. The PDT classified each survey station as having an absence vs. presence of complex habitat using the following criteria:

- Absence = all quadrats have < 10% coverage of gravels, and no cobble or boulder present, or
- Presence = at least one of the four quadrats has > 10% coverage of pebble/cobble/boulder substrate, OR cobble is present at the station, OR boulder is present at the station.

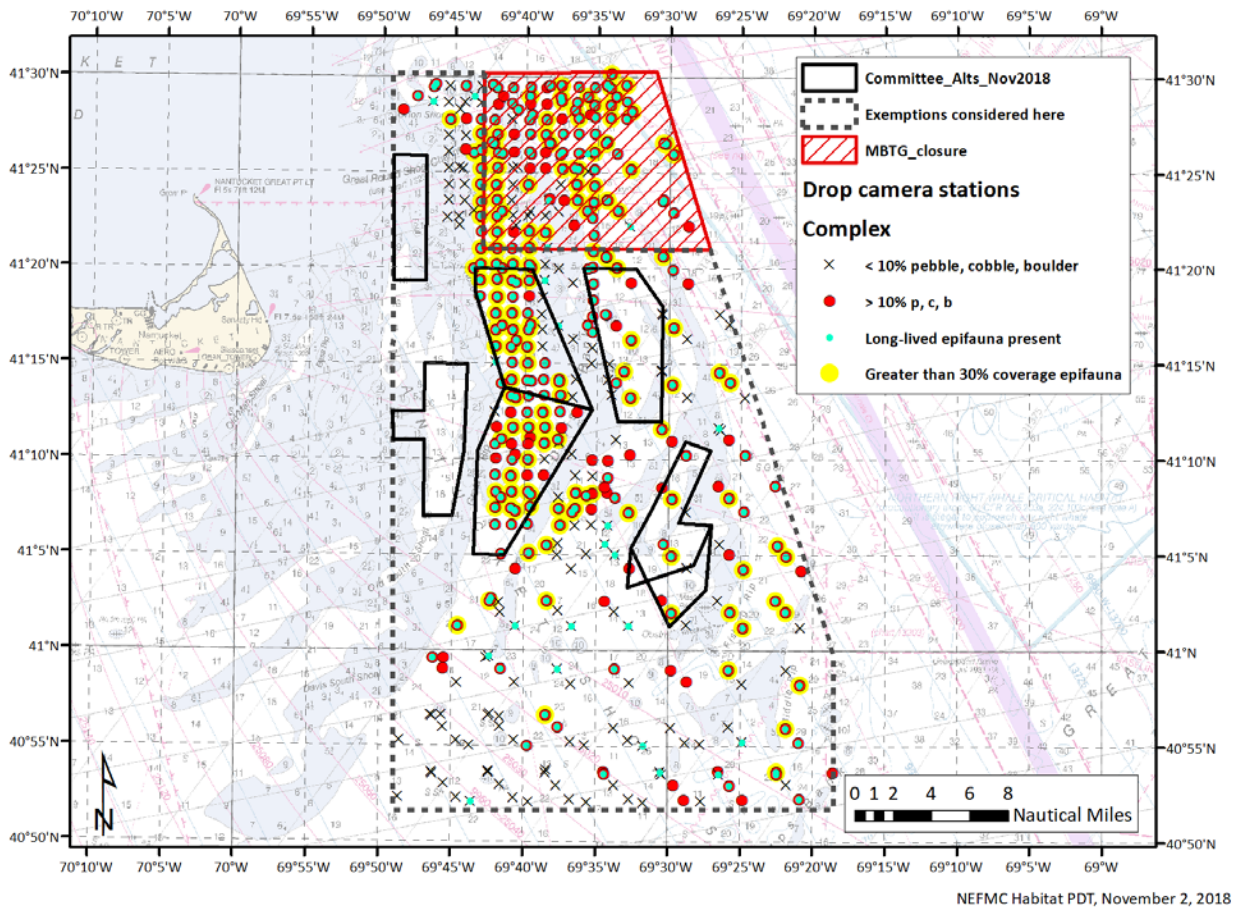
Areas of gravel pavement with cover >80% were also noted. The PDT also confirmed the presence of specific epifauna types in each image (species living on the surface of the seabed or attached to sediments) and identified stations where specific long-lived taxa were present, and/or with a very high density of epifauna (>30%). Epifauna assessed anemones, ascidians (tunicates), barnacles, bryozoans, hydroids, macroalgae, epifaunal bivalve mollusks, tube-dwelling polychaete worms, and sponges. Bryozoans, coralline algae, sponges including *Polymastia* spp. and *Isodyctia* spp., tunicates including *Boltenia ovifera*, and anemones were flagged as long-lived taxa.³ These complex geological and biological features are concentrated in certain locations, but generally occur throughout the HMA. Example images of different habitat types are shown in Figure 1. Stations with complex habitat and long-lived or high percent cover of epifauna are shown on Map 8.

³ Coral occurrence was evaluated and none were present in the images. Corals would have been considered a long-lived taxa.

Figure 1 – Example sediment and epifauna classifications (SMAST drop camera survey data).

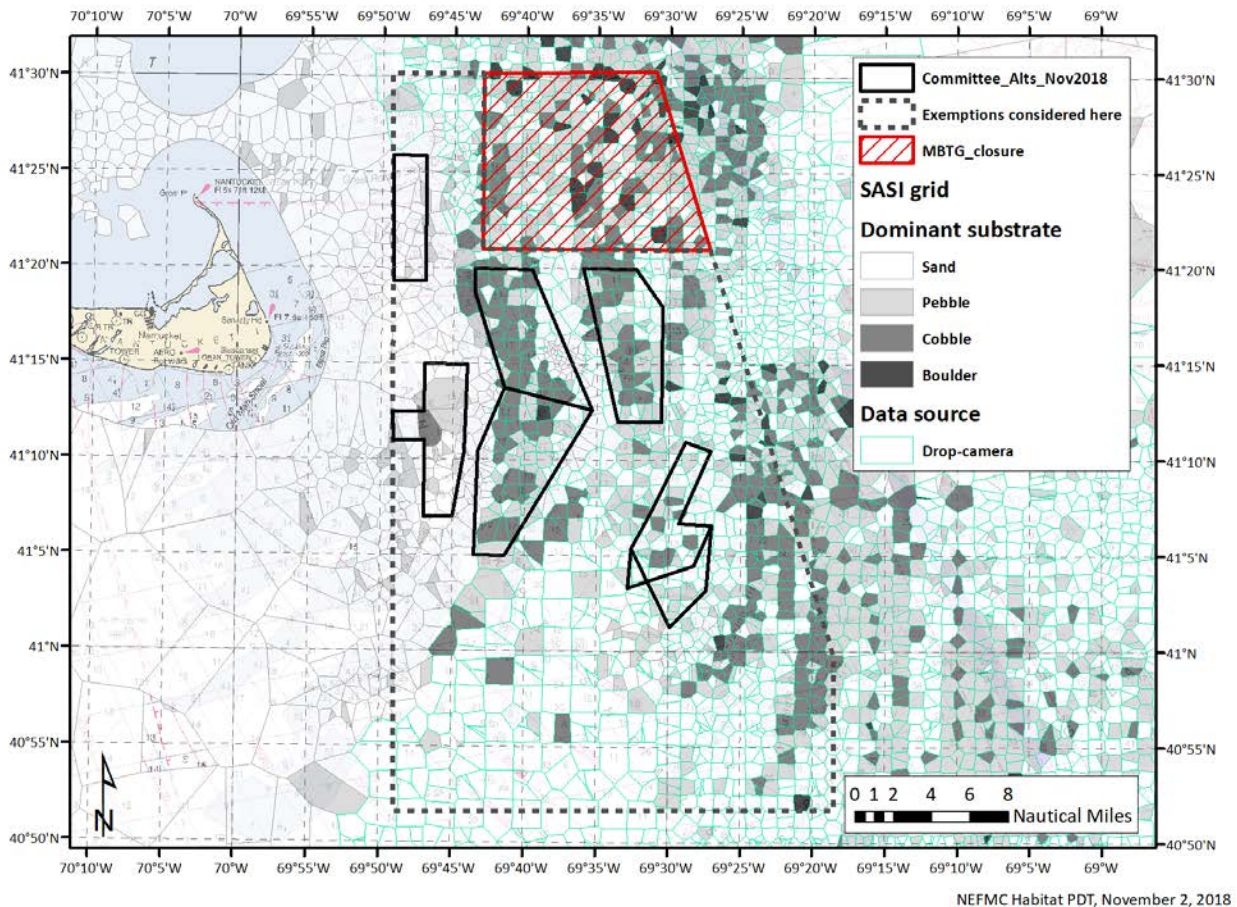


Map 8 – Stations with complex habitat and long lived and/or high coverage of epifauna, based on reanalysis of drop camera images (SMAST drop camera survey data).



Sediment data from a larger and slightly different time series of SMAST survey stations were classified according to dominant substrate and used in the sediment base map for the SASI model used to support OHA2 (Map 9). As opposed to presence in at least one image at a station which was used in the recent analyses, ‘dominant’ sediment type refers to the largest sediment grain size occurring at all quadrants at a station. Thus, for a given grain size, dominance is a more conservative classification metric (potentially less likely to indicate coarser sediments) than mere presence at the station used in the recent analysis.

Map 9 – Dominant sediments in the GSC HMA (SASI model base grid).

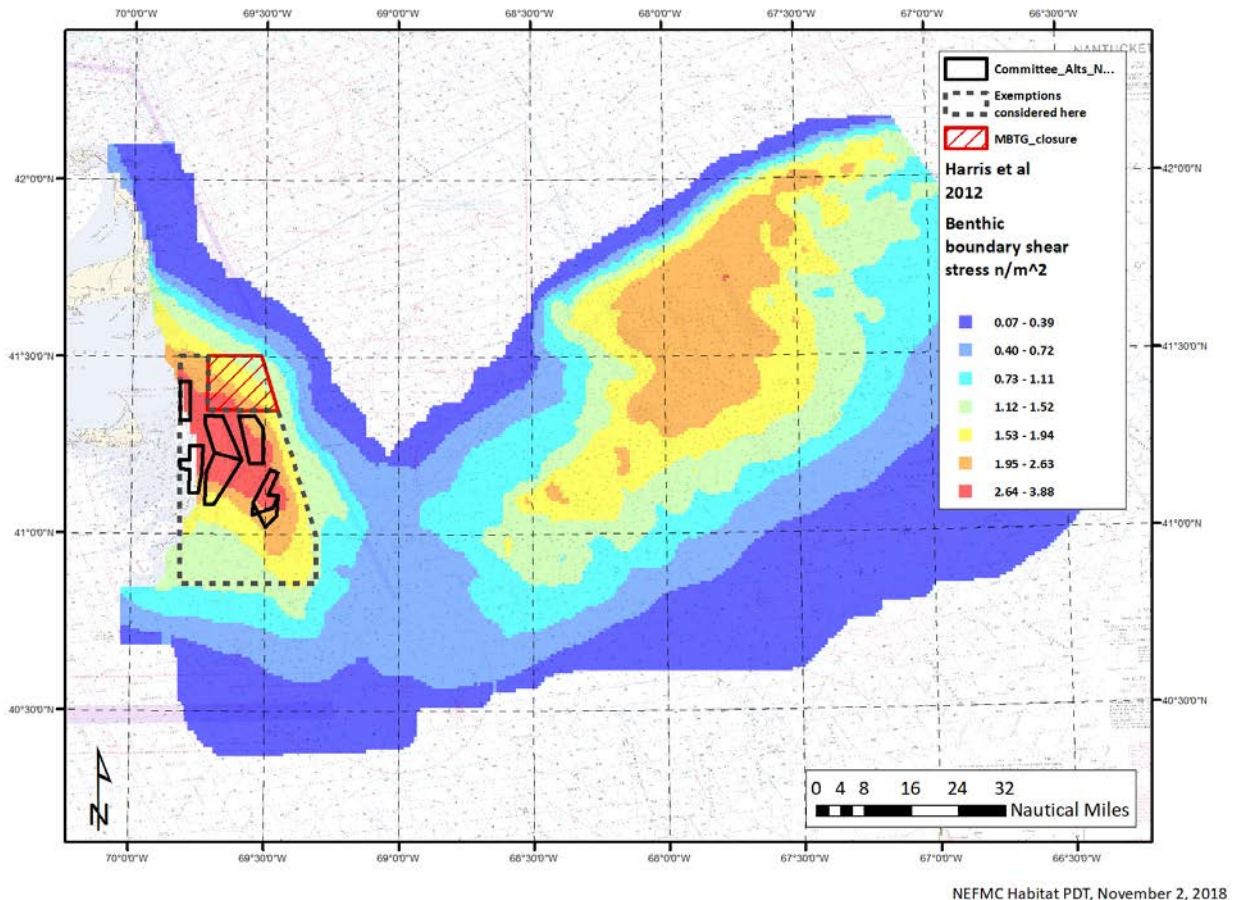


The Habitat Amendment FEIS also examined sediment stability in the HMA. Benthic boundary shear stress ($N \cdot m^{-2}$) refers to the force per unit area exerted on the seabed by flowing water. These values are relatively high within the GSC HMA relative to Georges Bank overall (Map 10). Critical shear stress is the force needed to move a particle of a given size (sand, pebble, cobble, etc.). The ratio of shear stress to critical shear stress was used by Harris et al. (2012) to map stable benthic sediments on Georges Bank (Map 11). A ratio less than 1 indicates stable sediment, because the shear stress exerted during maximum tidal flow would be less than the critical shear stress, thus creating stable points for the attachment of structure forming organisms. Sediments are predicted to be more stable in the mobile bottom-tending gear closure, with an average sediment stability index of 0.69 ($< 1 = \text{stable}$) vs. an average index of 2.0 in the clam exemption area.

A similar analysis of bottom shear stress was developed by Dalyander et al. (2013). Unlike the analysis by Harris et al., this analysis included the effects of storm waves at the bottom, as affected by depth. In a study region that spanned from Nantucket Shoals to south of Cape Hatteras, NC, they found Nantucket Shoals had the highest median wave-current bottom stress. During summer as well as winter, both wave and tidal current stress were important contributors to overall wave-current bottom stress on Nantucket Shoals, although tidal current stress was

somewhat more influential. A comparison with sediment texture data indicated that higher stress areas including Nantucket Shoals tended to be coarser, suggesting that fine particles are winnowed away in these high stress environments. The critical stress threshold for mobility on Nantucket Shoals was exceeded over 75% of the year.

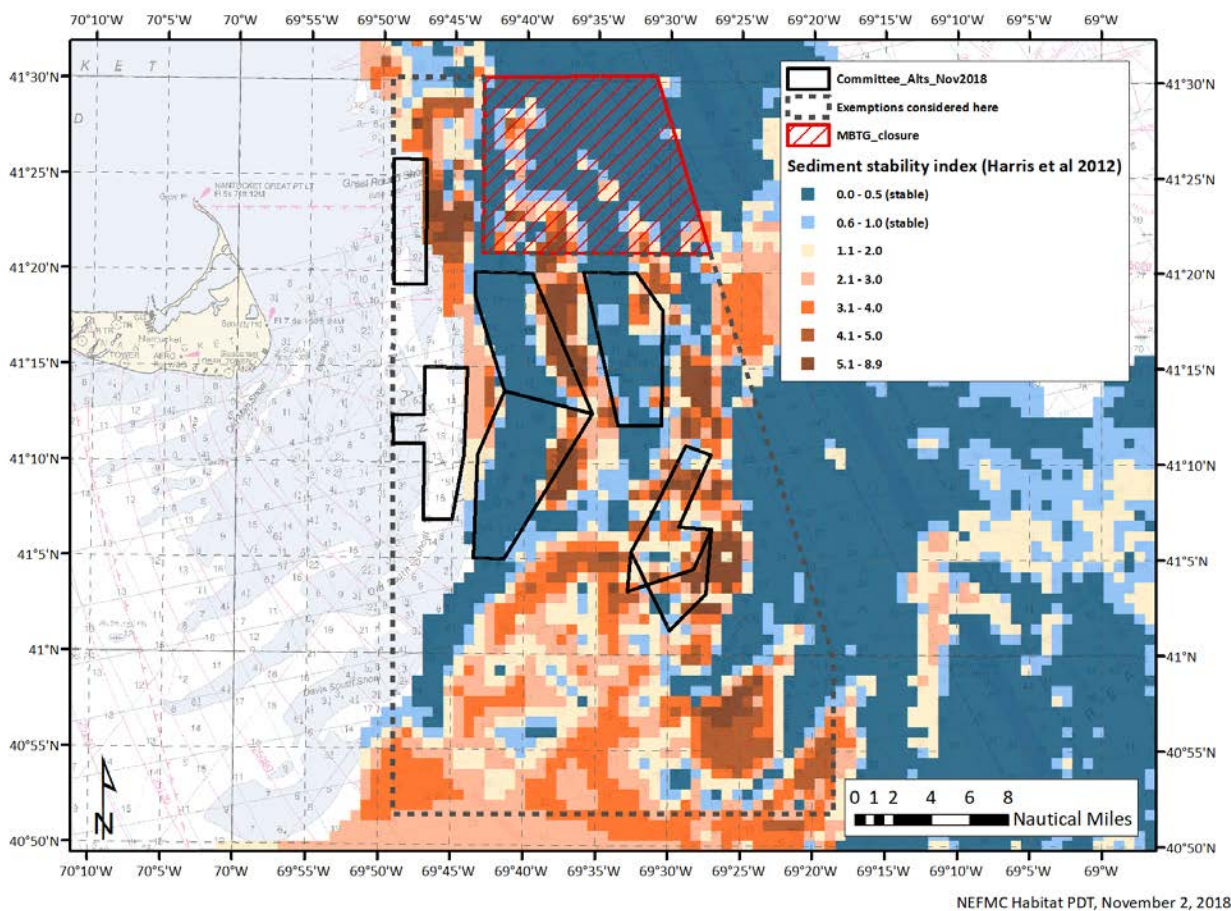
Map 10 – Benthic boundary shear stress (Harris et al. 2012).



The Harris et al. analysis relies on the assumption that stability in a location is related to its dominant sediment type. If these larger grain sizes are present, and not expected to be mobile given local benthic boundary shear stress values, the habitat is considered stable. In actuality, mixed bed stability is not so straightforward. Throughout the GSC HMA, larger substrate types such as pebbles, cobbles, and boulders occur within a matrix of sand which has a lower critical shear stress threshold, i.e. sand will be moved at a lower flow rate than the coarser grain sizes. The question then is, how do mixed sediment habitats respond to a particular rate of water flow at the seabed? At one extreme, the larger grain sizes are expected to confer stability to the bed, even if other size fractions are mobile. At the other extreme, all size fractions are expected to move independently, such that even if pebbles, cobbles, and boulders are too large to be redistributed by bottom currents and turbulence caused by storms, sands can be redistributed, altering the habitat. The actual behavior of mixed grain size beds is likely in between these extremes, and larger grain sizes (particularly cobbles and boulders) are assumed to provide stable

attachment points for epifauna even if the surrounding sands are mobile. They may also “anchor” the surrounding sand to some extent by interrupting water flow. Partly buried cobbles and boulders, some with attached organisms, were observed in some of the drop camera survey images, indicating that in some locations exposed to certain bottom disturbance conditions, sand does move in areas dominated by pebbles, cobbles, and boulders.

Map 11 – Sediment stability. Values of 1 or less (shown in blue) indicate stable sediments. Source: Harris et al., 2012.



A new information source generated post-OHA2 is an industry-based clam dredge survey conducted during August 2017 in the northern part of the GSC HMA (Powell et al. 2018, including two appendices). Abundance and size distribution of surfclams are arguably the most important elements of this survey. In addition to surfclams, sediments, shell, and other infaunal and epifaunal organisms were quantified at each station. The industry-based survey is unique among data sets examined for this action in that it is the only one where both the target species (surfclams) and habitat components are captured simultaneously. While smaller pebbles are expected to drop through the dredge bars (based on a bar spacing of 1.875 in. on the top, bottom and knife shelf, and 1.75 in. on the sides), cobbles and surfclams are of similar size and both were caught at most stations, except for two stations where only cobbles were caught and three

where only surfclams were caught. There is likely close to 100% catchability of surfclams ≥ 120 mm (= “market” sized clams), with a lower catchability for smaller clams (Powell et al. 2018, p. 3). The report notes that cobbles retained in the gear tended to have limited attached fauna (Powell et al. 2018, p. 13), but it is impossible to tell from the survey if these cobbles were at the surface of the seabed or within the sediment, and to what extent the action of dredging removes epifauna.

In late March, a sub-panel of the Council Scientific and Statistical Committee reviewed the initial survey report (but not the two appendices, which were provided in early October 2018). On the relationship between surfclams and benthic habitat features, the SSC sub-panel concluded:

“Given the heterogeneity of this habitat, it is not possible to identify specific areas where clam dredges could operate without impacting complex habitat. A finer-scale survey would be required to determine whether clam dredges could operate without impacting complex habitat within this area. Because the hydraulic dredge that was used in the two surveys, by itself, is insufficient for characterizing habitat complexity and because treatment of the survey data as point data is appropriate given the high degree of spatial heterogeneity, interpolation between the point samples would not be justified. Therefore, the surveys are not informative for identifying areas where clam dredges could operate without impacting complex habitat.”

Given this finding, it is necessary to use overlays between different sources of information to understand the spatial relationship between fishing activity and benthic habitat features. When assessing these relationships, issues of spatial and temporal scale are important. Drop camera survey stations range from less than one to about five km apart, depending on the location within the HMA. Data were collected between 2006 and 2015, not evenly across years and not returning to the same stations for repeat assessments to assess persistence of habitat features. (For comparison, the industry-based clam dredge survey stations are around 5.6 km apart, gridded on a diagonal across the HMA.) Fishing events in this region have been described as tows of around 5 minutes duration at speeds of 2.5 knots, which indicates tow lengths of 0.2 nm (0.37 km). Tow width is equal to the dredge width, or up to about 10 ft (~3 m). Individual tow tracks are not routinely available in the fishery dependent data, and clam dredge trips are rarely observed by scientific personnel, owing to relatively minimal bycatch of fishes and other stocks of interest to managers. Considering the spatial and temporal resolution of both habitat and fishing effort data, it is not possible to determine precise relationships between habitat characteristics and the presence or absence of dredging, i.e. are certain habitat types avoided entirely. Section 6.2.1.3 discusses expectations about vessel behavior in relation to complex habitat in further detail.

5.2 Linkages Between Habitat and Fish Productivity

The HMA designations developed in OHA2 were based on the understanding that structured habitats enhance groundfish resource productivity by increasing the survival and growth of juveniles (see OHA2 FEIS, Volume 1 Section 4.1.1). Complex, highly structured benthic habitats are relatively rare in continental shelf waters and are used by many species to reduce

predation risk and provide food (Caddy 2008; 2013). Field studies conducted in shallow water show that survival rates of juvenile cod were higher in more structured habitats (e.g., in vegetation or rocky reefs and on cobble bottoms) where they find refuge from predators (Linehan et al. 2001; Tupper and Boutilier 1995). Laboratory experiments performed in habitat types of varying complexity with and without predators present have confirmed that juvenile cod, especially young-of-the-year juveniles, survive better in more structured habitats where they are less susceptible to predation (e.g., Borg et al. 1997; Gotceitas et al. 1995; Lindholm et al. 1999).

Evidence that complex habitats enhance the survival of juvenile fish in other habitat types is also provided by research done in sandy bottom habitats in the Mid-Atlantic Bight. Similar habitat types exist on Georges Bank and in southern New England and in areas of sandy sediment in the Gulf of Maine (Auster et al. 1995; Auster et al. 1998; Langton et al. 1995). In these habitats, structure is provided by bedforms (sand waves) of various heights and biogenic structure such as animal tubes, shell and shell aggregation, or pits created by various species (Steves & Cowen 2000; Sullivan & Cowen 2006). Diaz et al. (2003) found more fish associated with larger bedforms that had some biogenic structure. Proximity of complex and simple habitats was important in providing refuge from predators in more complex habitats during the day and foraging opportunities in simpler habitats at night. Such diel patterns of habitat use would be expected to enhance survival and growth.

Various studies have documented the ecological importance of mussel beds for associated invertebrate and fish species. An ASMFC report (Coen and Grizzle 2007) describes blue mussel beds as one type of biogenic reef that performs several habitat functions. Primarily, mussel beds create hard substrate and complex vertical structure that aid in larval settlement, provide refuge from predators, and enhance vertical mixing of the water column, all contributing to an increase in species richness (Borthagaray and Carranza 2007). Deposits of empty shells or shell fragments aid in the formation of these complex benthic areas. In addition, mussels are efficient filter feeders on suspended organic matter and transfer materials and energy from the water column to the benthos. Dolmer and Frandsen (2002) observed that realized filtration of a large mussel bed is less than the total potential filtration of all individuals due to intraspecific food competition, indicating that removal of individuals may not reduce water quality or energy transferal. Norling and Kautsky (2007) examined community structure and ecosystem functioning in both live mussel beds and experimentally manipulated fields of mussel shells and live mussels. The experimental fields of shells had similar species richness to the experimental field of live animals, suggesting that the physical structure of shells alone is very important, but abundance and biomass of associated fauna were higher in live mussel beds, and species composition varied. This indicated that the action of the mussels themselves in nutrient regeneration is important to the ecological function of the beds.

5.3 Fishing Gear Interactions with Benthic Habitats

This section summarizes our understanding of how hydraulic clam dredges and mussel dredges interact with benthic habitats.

5.3.1 Hydraulic Clam Dredges

Hydraulic clam dredges are used to capture surfclams and ocean quahogs by injecting highly pressurized water into the sediment to a depth of 8-10 inches. Pressure can vary, from 50 pound per square inch (psi) in coarse sand to 110 psi in finer sediments. These dredges have negative impacts on benthic habitats that are more than minimal and not temporary.

In terms of effects on geological features of the seabed, the dredge creates a trench up to 30 cm deep and as wide as the dredge with mounds along the sides. Sediments in the trench are re-sorted, with larger grain sizes at the bottom and fine sediments at the top, with the loss of burrows and tubes created by infaunal invertebrates. During dredging, fine sediments are re-suspended in the water column, creating a turbidity cloud that dissipates quickly. Gilkinson and coauthors conducted a series of related studies to understand the effects of hydraulic dredging on a deep (70-80 m) sand bank on the Scotian Shelf (Gilkinson et al. 2003, 2005, 2015). These studies are noteworthy in that they investigate recovery of geological and biological seafloor features at multiple time intervals following impact. Their study sites are deeper than the GSC HMA, and at these sites the upper layers of sediment affected by dredging are only periodically reworked during major storms. In terms of geological features, the immediate effects of dredging were to generate furrows in the seabed and remove biogenic burrows (Gilkinson et al. 2003). While dredge tracks were difficult to detect visually after the first year, they could be detected acoustically for at least three years, indicating altered sediment structure in the tracks, and a dramatic decline in burrow density remained apparent at the three-year mark (Gilkinson et al. 2003). Tracks were faintly detectable at five years and almost completely eradicated in ten years (Gilkinson et al. 2015). Sediment properties had generally returned to pre-dredging conditions after 10 years; likely influenced by annual fall/winter storms capable of generating 20-30 cm mobile sediment layers (Gilkinson et al. 2015).

In terms of effects on organisms, benthic animals are dislodged from the sediment, or damaged by the dredge, significantly reducing the numbers, biomass, and species diversity of invertebrates in dredge tracks over the short term (Gilkinson et al. 2005). The benthic biological community was still found to be in the 'recovery' phase two years after dredging, with some opportunistic species at much higher abundance as compared to pre-dredging levels, and target bivalve species showing ongoing reductions in biomass (Gilkinson et al. 2005). When the sites were revisited after 10 years, abundance of commercially fished bivalve species remained low (Gilkinson et al. 2015). The authors posited that changes to infaunal habitat structure at the site (i.e. removal of deep burrows) might be contributing to poor recruitment in propellerclams over both the medium (2 years) and long term (10 years), noting that bivalve recruitment has been shown to be episodic across various species and locations.

Published studies of the habitat effects of hydraulic clam dredges focus on infaunal species in soft bottom habitats, but the Council's gear effects evaluations have focused on structure-forming epifauna living at or above the surface of the seabed. See OHA2 (Volume 1, Section 4.1.1 and Section 4.2.2; Swept Area Seabed Impact Analysis, Appendix D), Grabowski et al. 2014, and Appendix B to this document for more information on clam dredge effects. The Habitat PDT's scoring of habitat vulnerability for the SASI model focused on these epifaunal

invertebrates, not infauna. Given the focus of the literature on infauna, some of the susceptibility and recovery indices for epifauna/hydraulic dredges required inference from other gear types such as trawls or scallop dredges, and this assessment relied heavily on knowledge of the life histories of organisms that would likely be affected by the gear in sand and gravel habitats (e.g., soft vs hard-bodied, height off the bottom, growth rates, and longevity). The PDT ranked the severity of hydraulic clam dredge impacts well above those associated with other types of fishing gear. Impacts from a single dredge tow were estimated to cause, on average across all habitat features, a 50-75% loss in habitat functionality, with recovery times for geological features of 1.5-2.5 years in sand and 2-4 years in gravel, and 3-4.5 years for biological habitat features. Susceptibility scores were high because the gear has such a disruptive effect on the bottom. Recovery times were only slightly higher for hydraulic clam dredges operating in sand and gravel habitats than for bottom trawls and scallop dredges.

It is important to reiterate that the impacts of hydraulic dredge gear in the mixed gravel and sand habitats of the GSC HMA have not been studied specifically. Gear effect studies specific to the HMA, including observations that allow for an assessment of habitat recovery and a comparison with the effects of natural disturbance, are an obvious area for future scientific work. It is known which species of epifauna occur in the HMA and generally how susceptible they are to hydraulic clam dredges, how long they live and how fast they grow if damaged or removed by the gear. What is unknown is how susceptible they are to natural disturbance in the HMA. It is possible that recovery dynamics vary across locations within the HMA because natural disturbance varies spatially, with reduced benthic boundary shear stress in some locations vs. others.

5.3.2 Mussel Dredges

Because mussel dredges have not been used to any great extent in federal waters in recent years, their effects were not evaluated during development of OHA2. However, there is a body of scientific literature on the effects of mussel dredging. In particular, several studies of the direct habitat impact of mussel dredging were done in a large, shallow brackish water sound (the Limfjorden) in Denmark in the 1990s where blue mussels have been harvested commercially since the beginning of the 20th century. At that time, the fishery was restricted to about half of the sound (750 km²) in depths >2-3 meters on mussel beds growing on soft sediment. The gear used is the Dutch mussel dredge (1.8 m wide, 250 kg). It is unclear if this type of dredge has teeth that dig into the bottom.

Dolmer et al. (2001) described the impacts inside a single dredge track compared to the edges of the track and in a nearby unaffected area, and the impacts of experimental dredging compared with control areas. Dolmer (2002) compared benthic habitat conditions in areas open and closed to commercial fishing. At each study site, mussel beds 1-15 m² in size were interrupted by bare mud flats of about the same size. In both studies, there were fewer polychaetes in the dredge track than outside it and, aside from the removal of mussels (50% removed), a significantly lower number of species inside the mussel beds immediately after experimental dredging. This effect lasted for at least 40 days when sampling ended. The dredging process formed 2-5 cm deep furrows in the seabed. In the open-closed area study, there were significant short-term effects of dredging on epifauna that attach to or live among mussel shells. The density of several

taxa (sponges, echinoderms, anthozoans, mollusks, crustaceans, and ascidians) was either reduced or they were not observed four months after fishing ended. In one of the two long-term study sites, significant differences in species composition were still detected four years after fishing ended.

5.4 Managed Resources and Their Essential Fish Habitat

The managed resources described here are those that may be impacted by the alternatives under consideration, either because they are harvested using hydraulic clam dredges or mussel dredges, or because their Essential Fish Habitat overlaps the areas of the alternatives (Table 4). This expands upon and updates the overview in OHA2, Volume 1, section 4.3. Species with a moderate or high degree of overlap between their designated EFH and the HMA include Atlantic cod, windowpane flounder juvenile, winter flounder, yellowtail flounder, little skate, winter skate, Atlantic sea scallop, and Atlantic herring (see Table 4 for information about the habitats used by these species).

These species, particularly Atlantic cod which is associated with structured habitats, are expected to benefit from gear restrictions provided by the GSC HMA. Despite general knowledge that relationships between habitat and survival and growth exist, determining the appropriate spatial extent of habitat management areas to be protected to improve resource productivity is not straightforward. There are many reasons, but one is that stock production rates by habitat are not generally known, such that increases in stock production associated with a certain type of habitat management cannot be quantified. Nonetheless, patterns of species occurrence in the Great South Channel HMA are known, as are the basic habitat requirements of these species.

5.4.1 Species Targeted by Potentially Exempted Fisheries

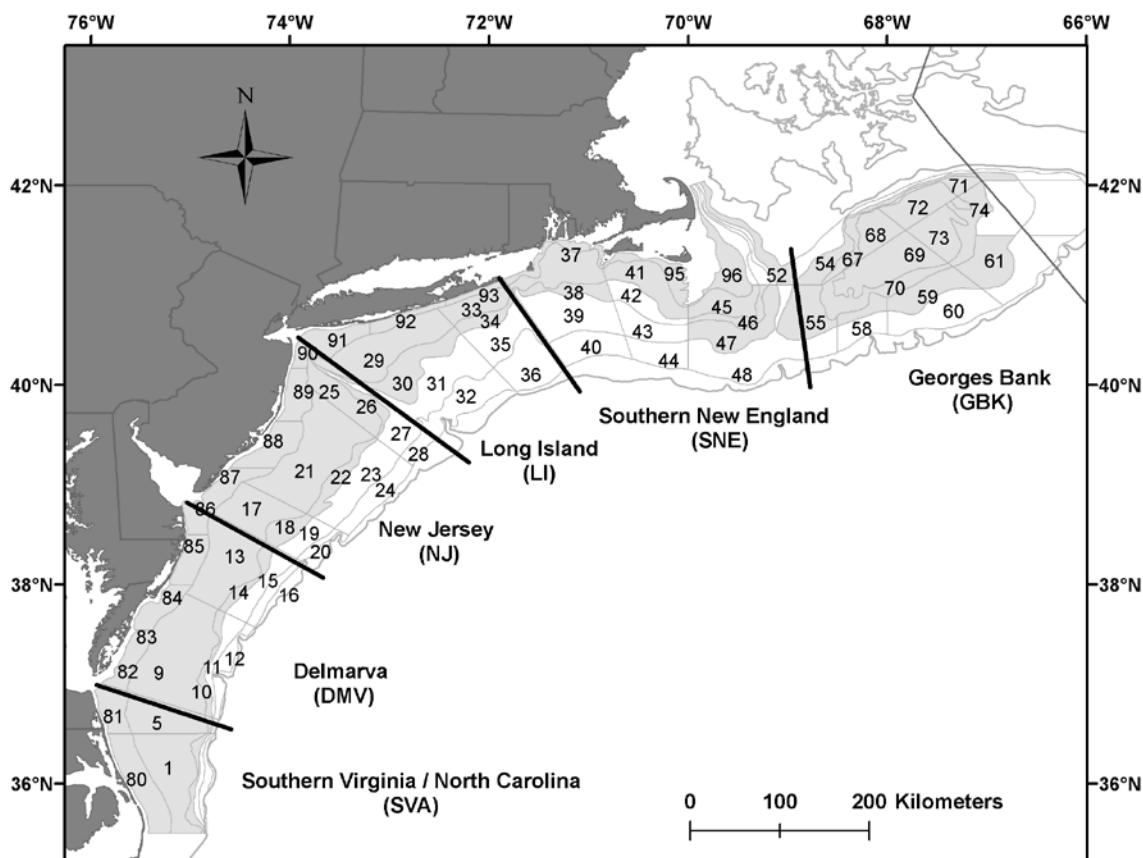
Target species for the mussel and clam dredge fisheries include Atlantic surfclams and blue mussels.

5.4.1.1 Atlantic Surfclam

Distribution and life history: The Atlantic surfclam (*Spisula solidissima*) is a bivalve mollusk distributed along the western North Atlantic Ocean from the southern Gulf of St. Lawrence to Cape Hatteras. Surfclams occur in both the state territorial waters (≤ 3 mi from shore) and within the EEZ (3-200 miles from shore; Map 12). Commercial concentrations are found primarily off New Jersey, the Delmarva Peninsula, and on Nantucket Shoals and Georges Bank. In the Mid-Atlantic region, surfclams are found from the intertidal zone to a depth of about 60 meters (197 ft), but densities are low at depths below 40 meters (131 ft).

Information on Atlantic surfclam biology is in the document, “Essential Fish Habitat Source Document: Surfclam, *Spisula solidissima*, Life History and Habitat Requirements” (Cargnelli et al. 1999) and at: <http://www.fishwatch.gov>.

Map 12 – Surfclam stock assessment regions and NEFSC shellfish survey strata



Notes: The shaded strata are where surfclams are found.

Source: Dan Hennen Pers. Comm., NEFSC 2018, as cited in MAFMC (2018a).

The greatest concentrations of surfclams are usually found in well-sorted, medium sand, but they may also occur in fine sand and silty fine sand. Surfclams can live to over 30 years of age and 15 to 20-year-old clams are common. The maximum size of surfclams is about 22.5 cm (8.9 inches) shell length, but surfclams larger than 20 cm (7.9 inches) are rare. Surfclams are capable of reproduction in their first year of life, although full maturity may not be reached until the second year. Eggs and sperm are shed directly into the water column. Recruitment to the bottom occurs after a planktonic larval period of about three weeks.

Atlantic surfclams are suspension feeders on phytoplankton and use siphons which are extended above the surface of the substrate to pump in water. Predators of surfclams include certain species of crabs, sea stars, snails, and other crustaceans, as well as fish predators such cod and haddock.

Population status: The Atlantic surfclam stock was last assessed in July 2016 (SAW 61; NEFSC 2017a). A statistical catch at age and length model called Stock Synthesis was used. Reports on “Stock Status,” including assessment and reference point updates, SAW reports, and Stock Assessment Review Committee (SARC) panelist reports are available online at

<http://www.nefsc.noaa.gov/saw>. The Great South Channel HMA is within the Southern New England region described in the assessment, although parts of the HMA are not sampled in the federal survey used to inform that assessment. As noted in section 5.1, the central and northern portions of the Great South Channel HMA were surveyed in August 2017 (Powell et al. 2018).

Overall, SAW 61 indicated that the Atlantic surfclam resource continues to remain above its biomass target, and fishing mortality remains below the F_{MSY} threshold. In other words, Atlantic surfclams are neither overfished nor subject to overfishing (NEFSC 2017a). Based on recommended reference points for the whole stock which use spawning stock biomass (SSB), estimated $SSB_{2015}/SSB_{Threshold} = 2.54$ (probability overfished < 0.01). For surfclam, SSB is almost equal to total biomass. For the whole stock, relative SSB ($SSB/SSB_{Threshold}$) declined during the last fifteen years but is still above the target. Overfishing did not occur in 2015 (NEFSC 2017a). Based on new recommended reference points, estimated $F_{2015}/SSB_{Threshold} = 0.295$ (probability overfished < 0.01). Trends expressed as the ratio $F/F_{Threshold}$ are more reliably estimated than absolute fishing mortality rates. For the whole stock the trend in relative F ($F/F_{Threshold}$) generally increased during the last fifteen years (despite recent declines in the south) but is still below the threshold.

The relationship between depth and biological parameters for surfclam was explored during SAW 61 and the results are described in section 1.6 of the assessment report (NEFSC 2017a). The report comments that the distribution and biology of Atlantic surfclam may be changing as ocean temperatures increase, and effects are expected to be strongest in the southernmost regions (Southern Virginia, Delmarva, and New Jersey), where water temperatures are warmer and closer to the upper tolerance of the clams. Habitat for surfclams has declined in Delmarva, increased in the New Jersey and Long Island areas, and varied without trend in Southern New England and Georges Bank. These results seem to be related to temperature, and temperature and depth preferences for surfclams seem to be ‘relatively consistent’ over time. Temperature shifts may be affecting biological parameters in surfclams, with declines in average maximum length in Delmarva and NJ and decreases in growth rates off NJ and in Southern New England. Habitats suitable for surfclams vs. quahogs were also compared for the assessment because the fishery performs best in areas of low co-occurrence. Over the period 1982-2011 in Southern New England, co-occurrence decreased almost linearly. This suggests that while there are some changes occurring in Southern New England, there are larger shifts in habitat availability further south. Thus, the impacts of habitat changes in surfclams on the Southern New England fishery are mostly indirect and result more from shifts in effort towards northern areas.

Essential Fish Habitat: EFH for surfclams was designated in 1998 via Amendment 12 to the FMP (MAFMC 1998), described as: throughout the substrate, to a depth of three feet below the water/sediment interface, within federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90% of all the ranked ten-minute squares for the area where surfclams were caught in the Northeast Fisheries Science Center surfclam and ocean quahog dredge surveys. Surfclams generally occur from the beach zone to a depth of about 200 feet, but abundance is low below about 125 feet. The EFH

map designations include selected waters from Cape Hatteras to Georges Bank, with a slightly smaller footprint associated with the designation for adults versus juveniles.

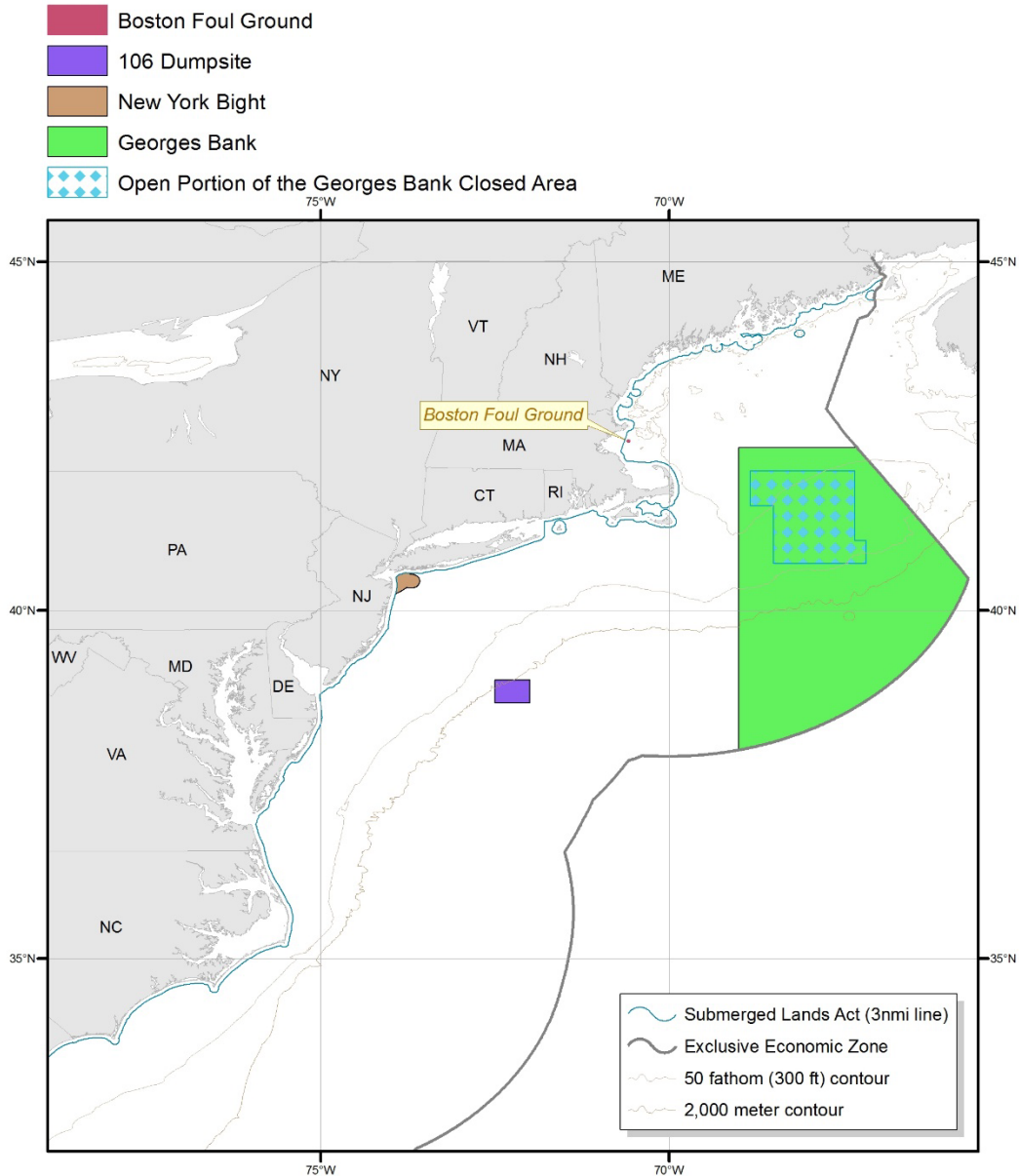
Distribution within the HMA: The industry-based Nantucket Shoals survey is the best information source on surfclam abundance and distribution in the GSC HMA. Smaller surfclams are most abundant in mid-depths throughout the central portion of the HMA, while larger animals are more abundant in the western part of the HMA and in the area outside the HMA to the west. Clams from two shallow and two mid-depth stations were aged to determine if the mid-depth surfclams have different (i.e., slower) growth rates compared to clams in shallower waters to the west, or if the mid-depth clams were simply smaller because they are younger. This analysis is in the first appendix to Powell et al. (2018). The results suggest that smaller clams in the mid-depths of the HMA are in fact younger, not slower growing. The size and age distribution of clams in these depths is truncated compared to the size distribution at the shallower stations, and the data suggest that recruitment in the mid-depth stations began around 2000. The oldest animals from these stations grew more slowly in the early 2000s, but their growth rates were not distinguishable from clams at shallower stations in recent years. It was hypothesized that the conditions were not optimal for clam growth during the early 2000s but that growth rates have risen with temperature. Genetic analyses are planned to investigate whether two different species of clams occur in the HMA (September 18 PDT summary, p. 8). *Spisula solidissima similis* reaches a smaller maximum size and age compared to *S. s. solidissima*.

Management: The MAFMC developed the Surfclam and Ocean Quahog Fishery Management Plan in the mid-1970s and it was implemented in 1977. The FMP established the management unit as all Atlantic surfclams in the Atlantic Exclusive Economic Zone (EEZ). The FMP is managed by the MAFMC, in conjunction with NMFS as the Federal implementation and enforcement entity. The primary management tool is the specification of an annual quota, which is allocated to the holders of allocation shares (Individual Transferable Quotas - ITQs) at the beginning of each calendar year as specified in Amendment 8 to the FMP (1988). These fisheries were the first in the U.S. to adopt an ITQ system (the Maine mahogany quahog fishery is not managed under ITQs). Quota shareholders may purchase, sell, or lease quota to and from other shareholders. A framework adjustment in 2007 required the use of VMS for all vessels participating in the surfclam or ocean quahog fisheries. Additional information is available at: <http://www.mafmc.org>. In addition to the Federal fishery, there is a small fishery prosecuted in the state waters of New York, New Jersey, and Massachusetts.

Waters of the Gulf of Maine and Georges Bank are subject to intermittent harmful algal blooms, or “red tide,” caused by the dinoflagellate *Alexandrium fundyense*, which produces a toxin known to cause paralytic shellfish poisoning (PSP) in people consuming contaminated clams. Because of a history of harmful algal blooms and limited testing in the area, eastern GB was closed to the harvest of clams starting in 1990 (green area on Map 13). In 2013, a portion of GB was opened for the harvest of surfclams and ocean quahog by vessels using a new PSP testing protocol. This area was accessible to vessels developing the PSP testing protocol during 2007-2012 (blue overlay on Map 13); and remains open to the fishery today provided that testing

protocols are followed during each trip. Other smaller environmental degradation closures are also shown on the chart below.

Map 13 – Environmental Degradation Closures. Source: GARFO.



5.4.1.2 Blue Mussels

Distribution and life history: In the Northwest Atlantic, two mussel species are commonly found offshore in deeper water, the blue mussel, *Mytilus edulis* and the horse mussel, *Modiolus modiolus*. Blue mussels occur as far south as South Carolina and are common in shallow, nearshore waters. They attach with byssal threads to any firm substrate and often form shoals or

“beds,” even on muddy tidal flats. They also occur on the continental shelf to depths of several hundred feet (Gosner 1978). In prime habitats, blue mussels can reach full growth within a year; elsewhere 2-5 years are needed (Gosner 1978). Mussels provide a settlement substrate for other epifauna including hydroids, bryozoans, and sponges (see section 5.2).

The horse mussel is a boreal species that is reported to occur as far south as Cape Hatteras (Coen and Grizzle 2007) but may be scarce south of Cape Cod (Gosner 1978). It mainly lives in deeper waters (to 70 meters) and most occurs partly buried in soft sediments or attached by byssal threads to hard substrates where it forms clumps or extensive beds that vary in size, density, thickness, and form (ASMFC 2007). Horse mussels may not occur in great abundance within the HMA (Powell et al. 2018). *M. modiolus* is a long-lived species, with some individuals living for 25 years or more (Coen and Grizzle 2007). Here we focus on blue mussels, as they are important commercially.

At present, little is known about blue mussel distribution within the GSC HMA. Sources of information include observations in the SMAST drop camera survey, the federal surfclam/ocean quahog survey (Powell et al. 2016), catch in the industry-based clam dredge survey (Powell et al. 2018), and industry-provided mussel bed locations that were fished in the 1980s and 1990s, as well as some that were fished more recently with mussel dredge, clam dredge, or gillnet gear (see Map 14 for locations). These locations are unlikely to be a comprehensive accounting of all mussel beds, and the spatial extent of mussel biomass associated with the beds that exist on the Shoals is unknown. Based on the industry-based clam dredge survey, there is at least some correspondence between mussel and surfclam distributions in mid-depths in the HMA at the scale of a survey tow.

Population status: Unknown

Essential Fish Habitat: None designated, no federal fishery management plan.

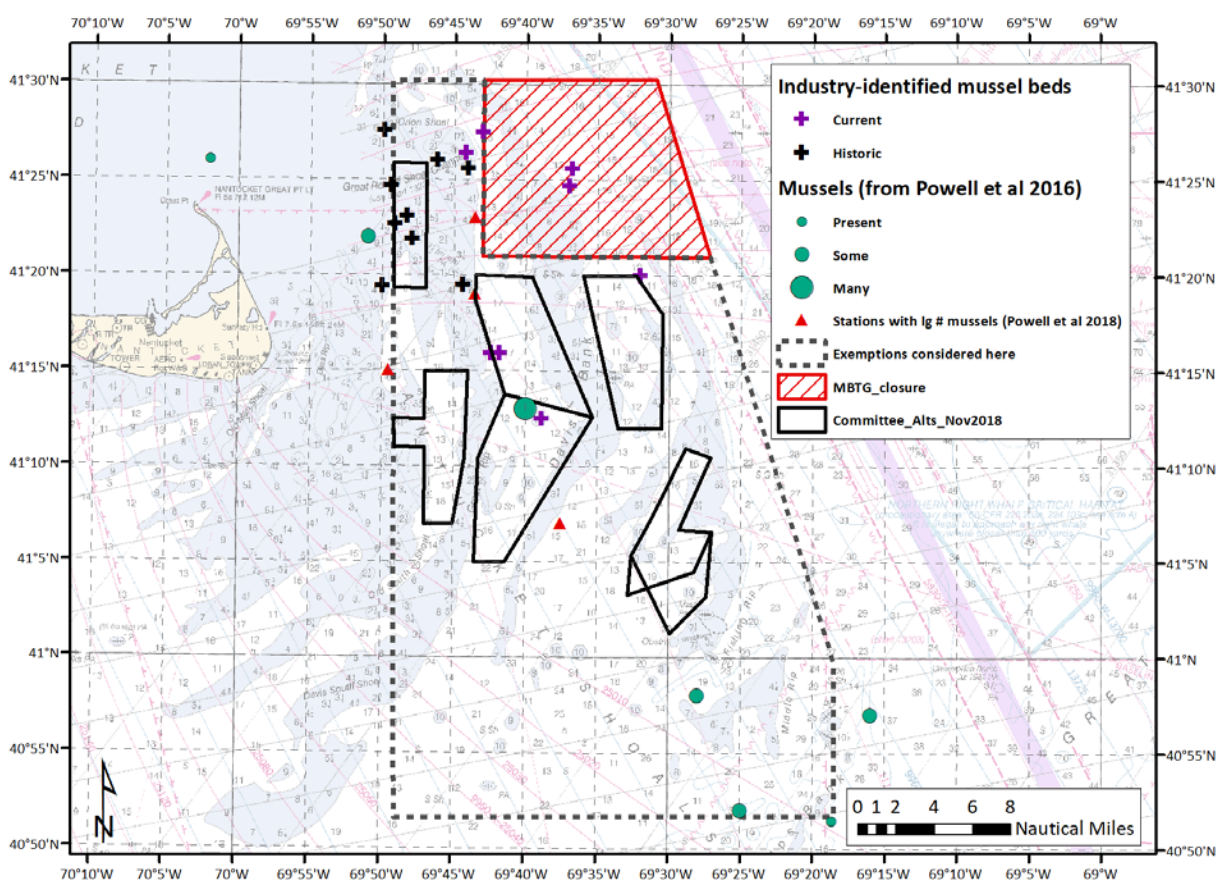
Management: Blue mussels are the target of commercial fishing. Fishing for mussels in federal waters is not managed as a stock in a federal fishery management plan. Historically, there had been a mussel fishery on Nantucket Shoals in the 1980s, and was likely the basis for the Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area (50 CFR 648.80(a)(12)) created in 1997 by Framework Adjustment 20 to the Northeast Multispecies Fishery Management Plan (Map 21). Unless otherwise prohibited in CFR §648.81, §648.370, or §648.371, a vessel may fish with a dredge in the exemption area, provided that any dredge on board the vessel does not exceed 8 ft (2.4 m), measured at the widest point in the bail of the dredge, and the vessel does not fish for, harvest, possess, or land any species of fish other than mussels and sea urchins.

Under OHA2, implemented April 9, 2018, the Great South Channel HMA is closed to all mobile bottom-tending gear. Atlantic surfclam and ocean quahog permitted vessels fishing with hydraulic clam dredge gear were exempt from a portion of this closure until April 9, 2019 (see § 648.370(h)). Mussel dredges are prohibited in the HMA, but the gear can be used in portions of the Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area that lie outside of the Great South Channel HMA.

A permit is required to land mussels in Massachusetts, and the state collects data on fishing location associated with mussel landings. Since the fishery is not federally managed, mussel dredge vessels are not required to submit a VTR unless they have another federal permit that requires such. There are no recent VTR records from the mussel dredge fishery.

Mussel dredges are not observed at sea under the Standardized Bycatch Reporting Methodology. However, observer requirements could apply to mussel dredge vessels if they held a federal permit for Atlantic sea scallops, Northeast multispecies, Monkfish, Skates, Atlantic mackerel, Squid, Butterfish, Scup, Black seabass, Bluefish, Spiny dogfish, Atlantic herring, Tilefish, Atlantic deep-sea red crab, Summer flounder (moratorium permit), American lobster, Atlantic surfclam, and/or Ocean quahog.

Map 14 – Mussel bed locations within the GSC HMA based on various data sources.



5.4.2 Other Managed Resources

The other managed resources described here are those that have Essential Fish Habitat designations that occur within the Great South Channel, and thus may be impacted by the alternatives under consideration.

Table 4 – NEFMC-managed species found in the Great South Channel HMA

Species and life-stage	Degree of overlap between EFH and HMA	Species assoc. with complex substrate ¹	One or more stocks overfished	Substrate features of EFH
Atlantic cod juvenile	High	X	X	YOY: inshore, prefer gravel and cobble habitats and eelgrass beds after settlement, but also use adjacent unvegetated sandy habitats for feeding; also settle on sand and gravel on Georges Bank. Older juveniles: structurally complex habitats, including eelgrass, mixed sand and gravel, and rocky habitats (gravel pavements, cobble, and boulder) with and without attached macroalgae and emergent epifauna
Atlantic cod adult	Moderate	X	X	Structurally complex hard bottom habitats of gravel, cobble, and boulder substrates with and without emergent epifauna and macroalgae
Windowpane flounder juvenile	Moderate		X	Mud and sand substrates
Windowpane flounder adult	High		X	Mud and sand substrates
Winter flounder egg	Moderate	X	X	Eggs are adhesive and deposited in clusters on mud, sand, muddy sand, gravel, and submerged aquatic vegetation, especially in areas with reduced bottom current with little suspended sediment to bury them when settling
Winter flounder juvenile	High		X	Various bottom types: mud, sand, rocky substrates with attached macro algae, tidal wetlands, and eelgrass
Winter flounder adult	High	X	X	Muddy and sandy substrates, and on hard bottom on offshore banks, for spawning
Yellowtail flounder juvenile	Moderate		X	Sand and muddy sand
Yellowtail flounder adult	Moderate		X	Sand, shell hash, muddy sand, and sand with gravel
Little skate juvenile	High	X		Sand and gravel, also found on mud
Little skate adult	Moderate	X		Sand and gravel, also found on mud
Winter skate juvenile	High	X		Sand and gravel, also found on mud
Winter skate adult	High	X		Sand and gravel, also found on mud
Atlantic sea scallop - all	Moderate	X		Pelagic larvae settle on any hard surface, including shells, pebbles, and gravel; they also attach to macroalgae and other benthic organisms such as hydroids, but do not survive on shifting sand.
Atlantic herring egg	High	X		Deposited on the bottom in beds, stick to coarse sand, pebbles, cobbles, and boulders and/or on macroalgae

5.4.2.1 Large mesh multispecies

There are 13 species managed under the Northeast Multispecies Fishery Management Plan (FMP) as large mesh (groundfish) species, based on the type of gear used to harvest the fish: American plaice, Atlantic cod, Atlantic halibut, Atlantic wolffish, haddock, pollock, redfish, ocean pout, yellowtail flounder, white hake, windowpane flounder, winter flounder, and witch flounder. Several of these species are managed as two or more stocks based on geographic region. The commercial fishery catches all of these species, although some are considered non-target, but the recreational fishery focuses on GOM cod and GOM haddock (NEFMC 2017).

Life history, distribution, and essential fish habitat: Volume 1 section 4.3.1.1 of OHA2 describes the life history and distribution for each species in the large mesh multispecies FMP. Volume 2 section 2.2 contains the updated EFH text descriptions and maps, which are by individual life stage (egg, larvae, juvenile, adult). The exemption area alternatives under consideration comprise areas of essential fish habitat for Atlantic cod, winter flounder, windowpane flounder, and yellowtail flounder. All four species occur throughout the New England region, in the Gulf of Maine, on Georges Bank, and in Southern New England, from the coastline out to moderate depths. Cod have the deepest distribution of the four species, and for all species the adult EFH designations extend into slightly deeper waters relative to those for juveniles (Map 15).

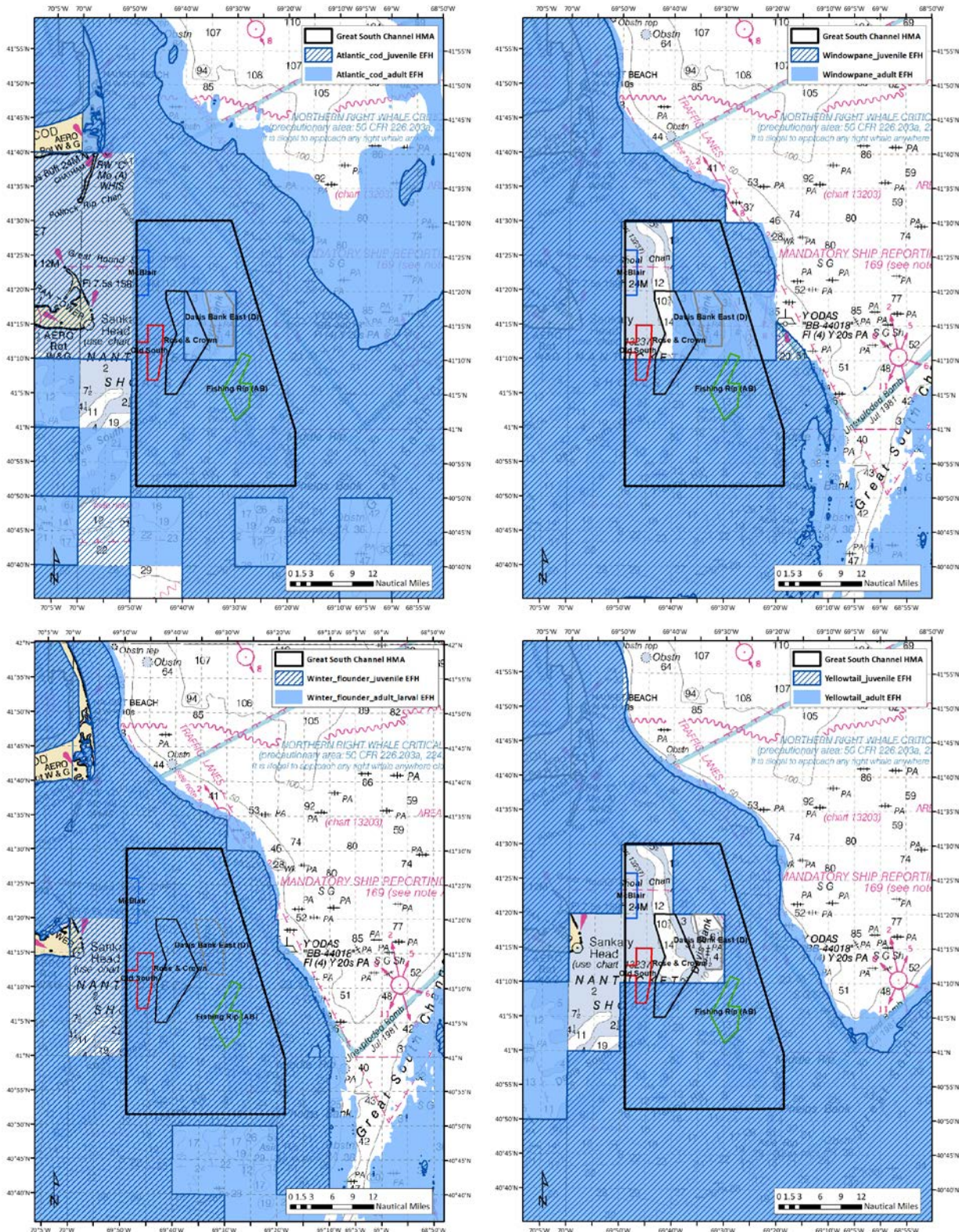
Many marine species exhibit changes in habitat use by age. Cod eggs and larvae are planktonic. The juveniles settle to the seabed shortly after transformation from the larval stage, when they are between 2.5-6 cm (Fahay 1983, Lough et al. 1989) or less than 7 cm (Bailey 1975). Atlantic cod tend to associate with gravel sediments (see section 5.2 of this document and Vol. 1, section 4.3.1.1.3 of the OHA2 FEIS for details). With respect to juvenile cod, this association is expected to provide shelter from predation and flow as well as access to prey items. Both windowpane and yellowtail are typically associated with finer sediments. Juvenile and adult winter flounder occur in a range of substrate types.

In addition to age-related changes, often fishes shift their distributions spatially during the year, in response to changes in water temperature. Adult winter flounder exhibit pronounced seasonal shifts in their distribution in relation to spawning activities, moving inshore in late winter and early spring. Spawning females deposit their benthic eggs in shallow waters, and after hatching the juveniles stay in these coastal areas until water temperatures decline, at which point they move into deeper areas offshore.

Atlantic cod spawn in specific areas, and cod spawning grounds identified by fishermen occur in and around the HMA. A recent report (DeCelles et al. 2017a) and related primary publication (DeCelles et al. 2017b) summarize the state of knowledge on cod spawning on the Shoals. Overlaps between identified cod spawning areas and potential exemption areas are shown on Map 14. Based on this report and the references therein (summarized in Table 5), November through April seems an appropriate closure period for East Door/Old South (an element of Alternatives 2, 4, and 5) to protect cod while they are spawning.

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Map 15 – Juvenile and adult EFH designations for Atlantic cod, windowpane, winter flounder, and yellowtail flounder relative to the HMA and Alternative 5 exemption and research areas.



Map 16 – Overlap between potential exemption areas and cod spawning grounds identified by fishermen (DeCelles et al. 2017a, b).

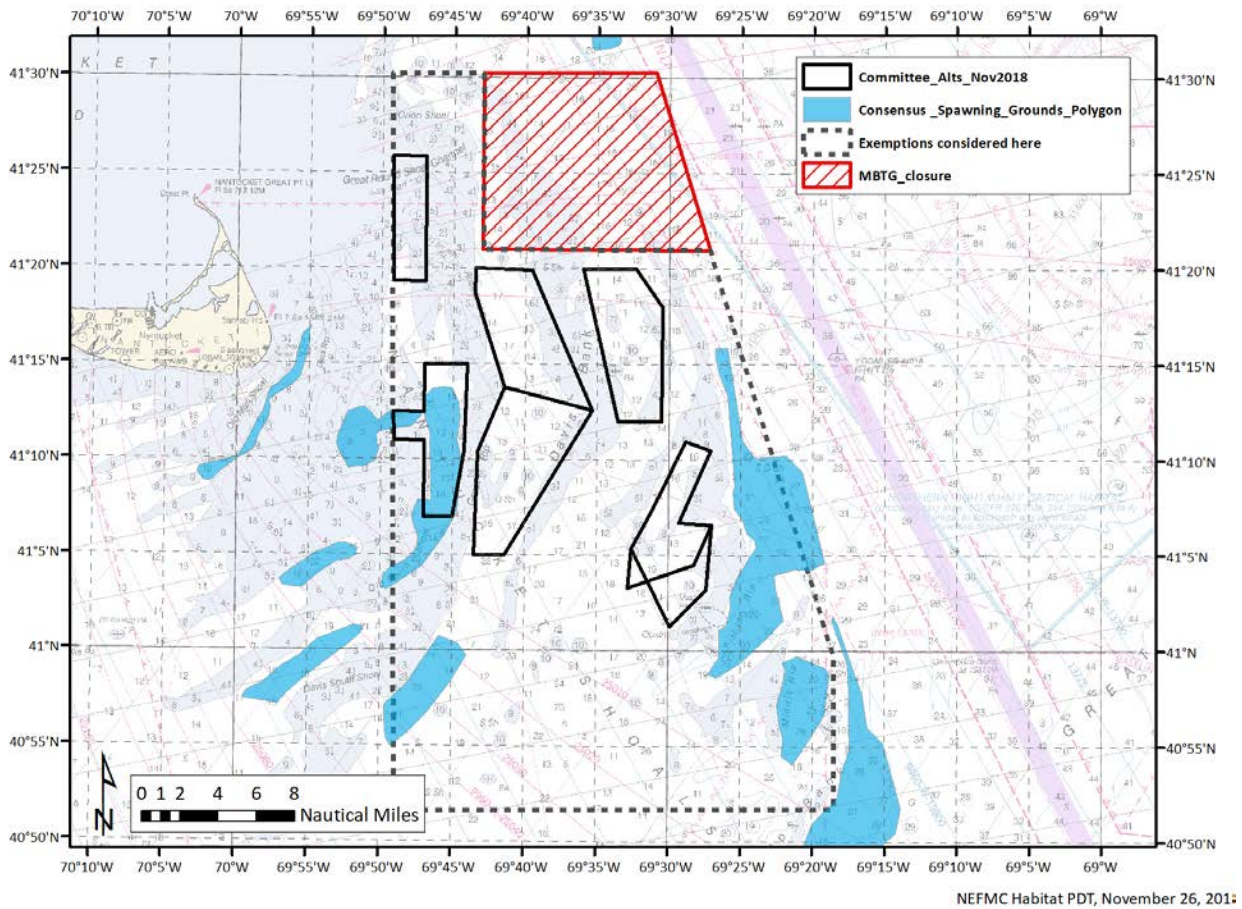


Table 5 – Evidence for the timing of cod spawning on Nantucket Shoals (DeCelles et al. (2017a).

Timing	Criteria	Reference
November – April	Direct observation	Schroeder, 1930
November – January	Holding study	Smith, 1902
Late autumn and early winter	Unknown	Bigelow and Schroeder, 1953
November	Direct observation	Kovach et al. 2010
November	Direct observation	Wirgin et al. 2007
November – March	Eggs present, all stages	Berrien and Sibunka, 1999

Population status: Status varies for stocks of the four species for which the areas under consideration are essential fish habitat (Table 6; NEFSC 2017b). The table provides information for two or three stocks depending on the species because the Great South Channel/Nantucket Shoals region is generally located at the edge of the stock boundaries. For winter flounder, both stocks are not subject to overfishing. The Georges Bank stock is not overfished, but it is unknown whether the Gulf of Maine stock is as well. For cod, both stocks are overfished, with

overfishing occurring. The northern Gulf of Maine/Georges Bank windowpane flounder stock is overfished, but the southern stock is not, and neither stock is experiencing overfishing. All three stocks of yellowtail are overfished and experiencing overfishing.

Table 6 – Status of selected Northeast groundfish stocks, FY2017

Stock	2017 Assessments	
	Overfishing?	Overfished?
Georges Bank cod	Yes	Yes
Gulf of Maine cod	Yes	Yes
Georges Bank winter flounder	No	No
Gulf of Maine winter flounder	No	Unknown
Cape Cod/Gulf of Maine yellowtail flounder	Yes	Yes
Southern New England/Mid-Atlantic yellowtail flounder	Yes	Yes
Georges Bank yellowtail flounder	Yes	Yes
Gulf of Maine/Georges Bank windowpane flounder	No	Yes
Southern windowpane flounder	No	No
Source: NEFSC 2017b.		

Management: A groundfish management plan for cod, haddock, and yellowtail flounder was adopted in 1977. This plan initially relied on hard quotas, but the quota system ended in 1982 with the adoption of the Interim Groundfish Plan, which controlled fishing mortality with minimum fish sizes and codend mesh regulations. The Northeast Multispecies FMP replaced this plan in 1986, initially continuing to control fishing mortality with gear restrictions and minimum mesh size, using biological targets based on a percentage of maximum spawning potential. The FMP has had many revisions. Since 2010, most of the fishery has been managed with a catch share program, in which self-selected groups of commercial fishermen (i.e., sectors) are allocated a portion of the available catch. These annual catch limits are combined with gear restrictions, year-round and seasonal spatial management, and minimum fish sizes, among other measures, to minimize the risk of overfishing and optimize yield in the fishery.

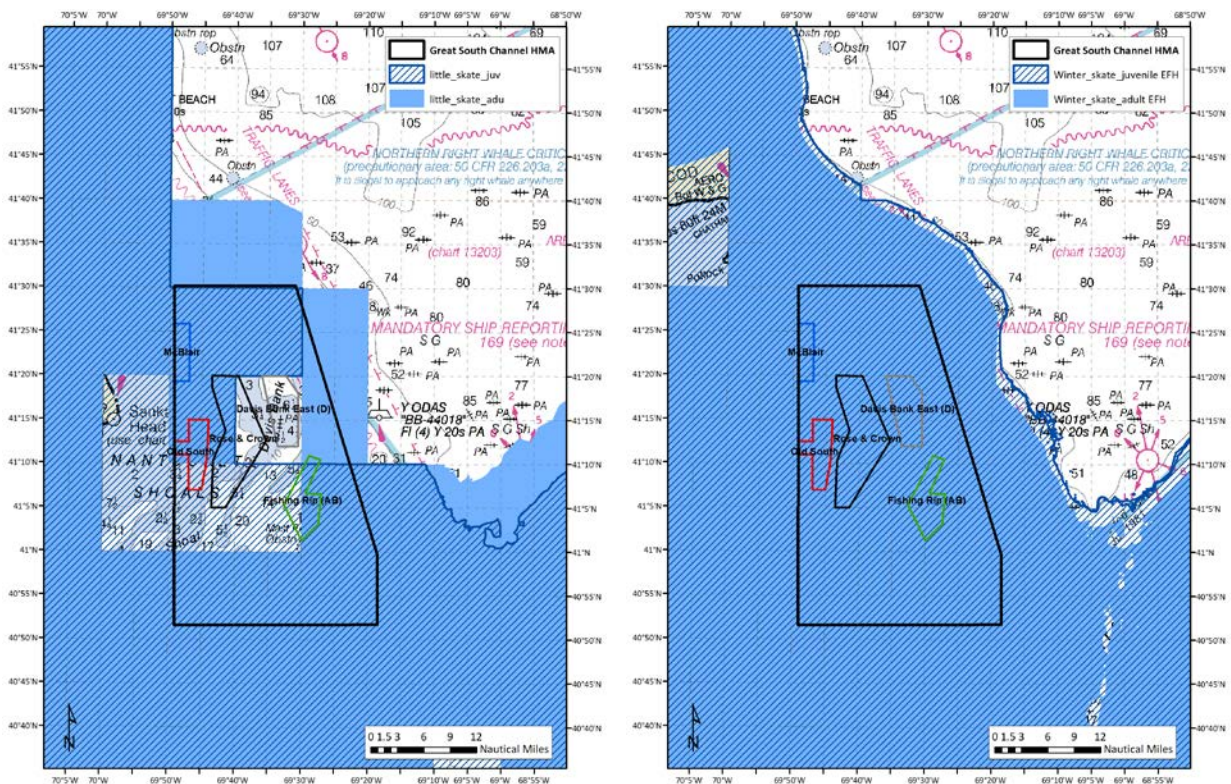
5.4.2.2 Northeast skate complex

Life history, distribution, and essential fish habitat: There are seven species in the Northeast Region skate complex: little skate, winter skate, barndoor skate, thorny skate, smooth skate, clearnose skate, and rosette skate. Barndoor skate is the most common skate in the Gulf of Maine, on Georges Bank, and in southern New England. Thorny and smooth skates typically occur in the Gulf of Maine. Clearnose and rosette skates have a more southern distribution and occur primarily in southern New England and the Chesapeake Bight. Georges Bank/Southern New England is the center of distribution for little and winter skates in the northeast, and these two species have the greatest degree of overlap with the HMA. Skates are not known to undertake large-scale migrations but they do move seasonally with changing water temperature; going offshore in summer and early autumn and then returning inshore during winter and spring. They lay eggs enclosed in a hard, leathery case commonly called a mermaid's purse. Incubation time is 6-12 months, with the young having the adult form at the time of hatching. Catches of

these species are largely interrelated with the NE multispecies, monkfish, and scallop fisheries (NEFMC 2018c).

EFH for both species is similar and is designated within the HMA (Map 17). Little skate EFH extends to 80 m for juveniles and 100 m for adults, on sand and gravel substrates as well as on mud. Winter skate EFH extends to 90 m for juveniles and 80 m for adults, on sand and gravel substrates as well as on mud.

Map 17 – Juvenile and adult EFH designations for little skate and winter skate relative to the HMA and Alternative 5 exemption and research areas.



Population status: Of the seven species within the Northeast skate complex, thorny skate is overfished, but overfishing is not occurring. All other skate species are not overfished and overfishing is not occurring.

Management: NMFS implemented the Northeast Skate Complex Fishery Management Plan in September 2003. The FMP requires dealers and vessels to report skate landings by species. Framework Adjustment 2 modified the VTR and dealer reporting codes to further improve species specific landing reports. Possession prohibitions of barndoor, thorny, and smooth skates in the Gulf of Maine were also provisions of the FMP. The FMP implemented a trip limit of 10,000 lbs (4,536 kg) for winter skate and required fishermen to obtain a Letter of Authorization to exceed trip limits for the little skate bait fishery. In 2010, Amendment 3 to the Skate FMP implemented a rebuilding plan for smooth skate and established an ACL and annual catch target

for the skate complex, total allowable landings for the skate wing and bait fisheries, and seasonal quotas for the bait fishery. Possession limits were reduced, in-season possession limit triggers were implemented, and other measures were taken to improve management of the skate fisheries.

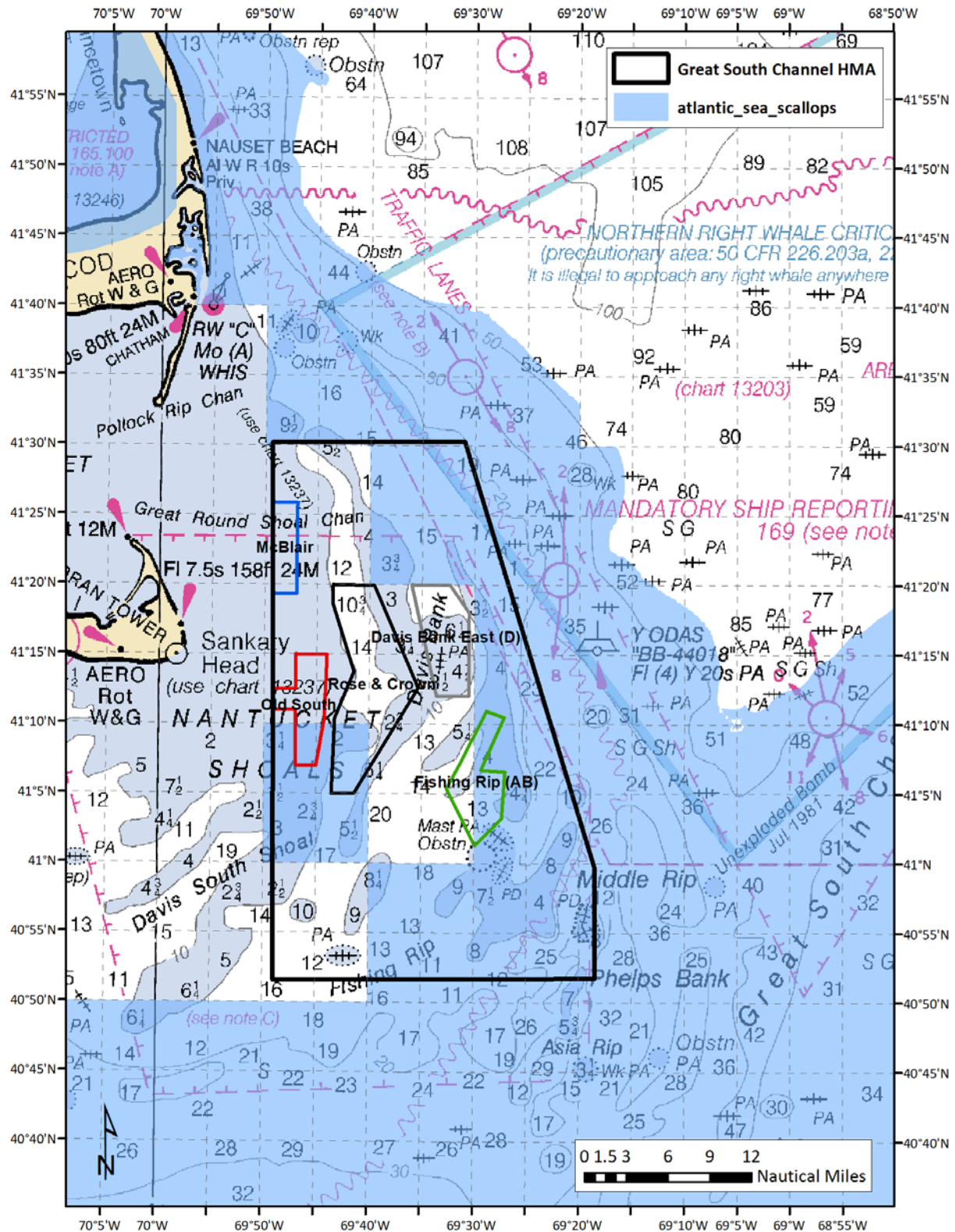
Skates are harvested in two different fisheries, one for lobster bait and one for wings for food. Fishery specific Total Allowable Landings (TALs) and possession limits are set as part of specifications. Both fisheries have independent seasonal management structures and are subject to effort controls and accountability measures.

5.4.2.3 Atlantic sea scallop

Life history, distribution, and essential fish habitat: Sea scallops are filter feeders, primarily on phytoplankton, but also on microzooplankton and detritus (Hart and Chute 2004). Sea scallops grow rapidly during the first several years of life. Between ages 3 and 5, they commonly increase 50-80% in shell height and quadruple their meat weight. Sea scallops have been known to live more than 20 years. They usually become sexually mature at age 2, but individuals younger than age 4 probably contribute little to total egg production. Sexes are separate, and fertilization is external. Spawning usually occurs in late summer and early autumn; spring spawning may also occur, especially in the Mid-Atlantic Bight. Sea scallops are highly fecund; a single large female can release hundreds of millions of eggs annually. Larvae remain in the water column for four to seven weeks before settling to the bottom. Sea scallops attain commercial size at about four to five years old and have a somewhat uncommon combination of life-history attributes: low mobility, rapid growth, and low natural mortality (Hart & Chute 2004).

Sea scallops are distributed in the northwest Atlantic Ocean from Newfoundland to North Carolina, mainly on sand and gravel sediments where bottom temperatures remain below 20° C (68° F), with optimal adult growth between 10-15° C (50-59° F). North of Cape Cod, concentrations generally occur in shallow water <40 m (22 fathoms) deep. South of Cape Cod and on Georges Bank, sea scallops typically occur at depths 25- 200 m (14-110 fathoms), with commercial concentrations generally 35-100 m (19-55 fathoms). EFH is designated between 18-110 m (10-60 fathoms, Map 18), generally on the eastern and deeper side of the HMA.

Map 18 – Atlantic sea scallop EFH designation relative to the HMA and Alternative 5 exemption and research areas.



Population status: The scallop resource was assessed in 2018, and it was not overfished, and overfishing was not occurring (NEFSC 2018).

Management: Sea scallops are managed by the New England Fishery Management Council, which established the Scallop FMP in 1982. The commercial fishery is conducted year-round, primarily using offshore New Bedford style scallop dredges. A small percentage of the fishery employs otter trawls, mostly in the Mid-Atlantic. The principal U.S. commercial fisheries are in the Mid-Atlantic (from Virginia to Long Island, New York) and on Georges Bank and neighboring areas, such as the Great South Channel and Nantucket Shoals. There is also a small, primarily inshore fishery for sea scallops in the Gulf of Maine. The fishery consists of two primary fleets, the Limited Access (LA) fleet, and the Limited Access General Category (LAGC) fleet. The LA fleet is managed with days-at-sea and an area rotational access program. The primary component of the LAGC fleet is vessels with Individual Fishing Quotas (IFQ). These vessels are allocated a yearly IFQ allocation which may be leased or permanently transferred within the IFQ fleet and may be fished throughout the fishing year.

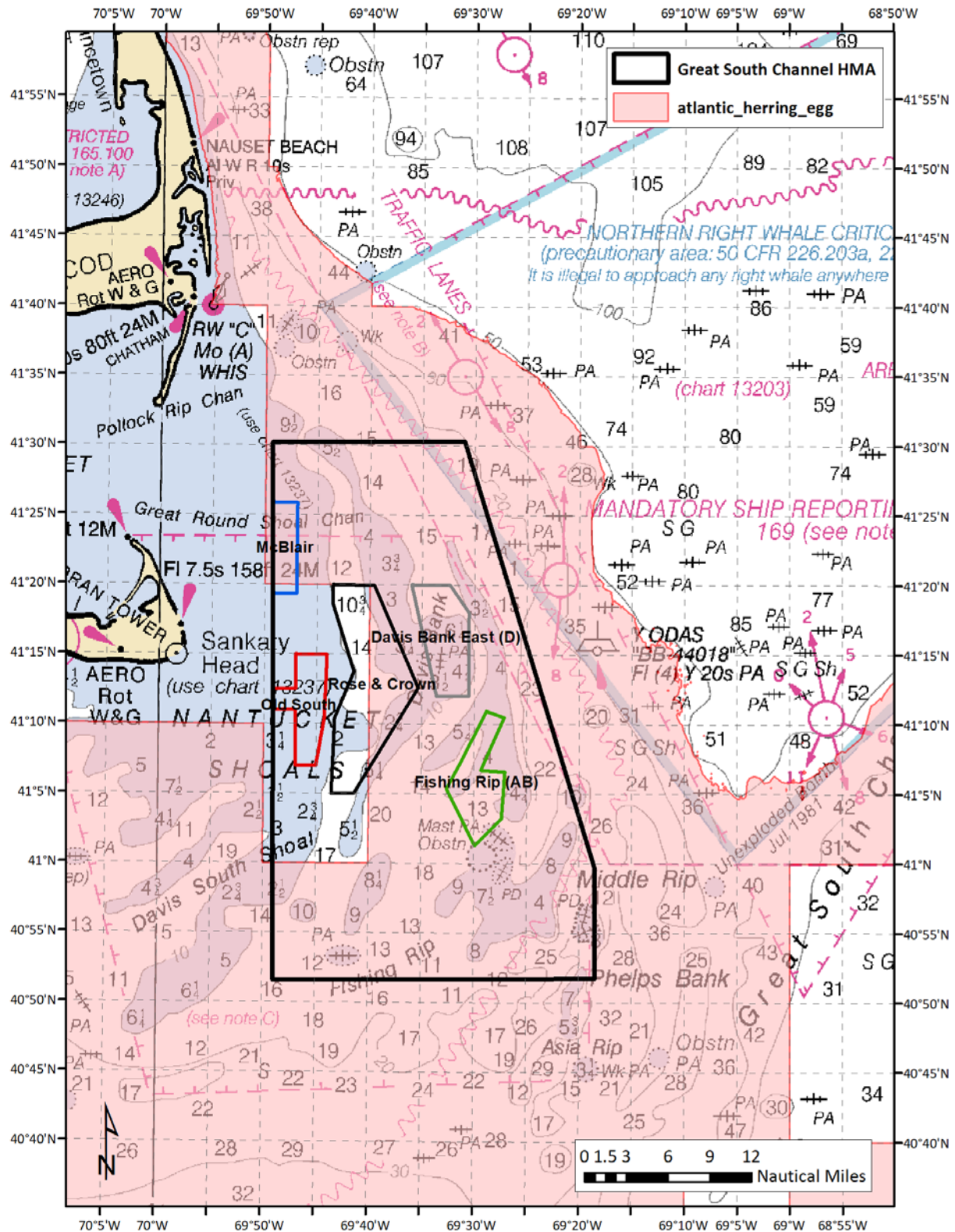
5.4.2.4 Atlantic herring

Life history, distribution, and essential fish habitat: Atlantic herring play an important role as forage in the Northeast U.S. shelf ecosystem. They are eaten by a wide variety of fish, marine mammals, birds, and (historically) by humans in the region.

Atlantic herring are widely distributed in continental shelf waters of the Northeast Atlantic, from Labrador to Cape Hatteras. They occur in every major estuary from the northern Gulf of Maine to the Chesapeake Bay. They are most abundant north of Cape Cod and become increasingly scarce south of New Jersey (Kelly and Moring 1986). Spawning occurs in the summer and autumn, starting earlier along the eastern Maine coast and southwest Nova Scotia (August-September) than in the southwestern Gulf of Maine (early to mid-October in the Jeffreys Ledge area) and Georges Bank (as late as November-December; Reid et al. 1999). In general, Gulf of Maine herring migrate from summer feeding grounds along the Maine coast and on Georges Bank to southern New England and the Mid-Atlantic areas during winter, with larger individuals tending to migrate farther distances. Eggs adhere to the bottom, often in areas with strong bottom currents, forming egg “beds” that may be many layers deep. As the only demersal life stage of the species, eggs are the only stage likely affected by mobile bottom-tending gears. Egg EFH includes inshore and offshore benthic habitats in the Gulf of Maine and on Georges Bank and Nantucket Shoals in depths of 5-90 m on coarse sand, pebbles, cobbles, and boulders and/or macroalgae (Map 19). The distribution of egg EFH is based on locations where egg beds have been known to occur, combined with the distribution of newly hatched larvae (see OHA2 Volume 2 for details).

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Map 19 – Atlantic herring egg EFH designation relative to the HMA and Alternative 5 exemption and research areas.



Population status: Herring from the GOM (inshore) and GB (offshore) stock components are combined for assessment purposes into a single coastal stock complex. As of the 2018 assessment, Atlantic herring was not overfished and overfishing was not occurring. The retrospective adjusted spawning stock biomass in 2017 was estimated to be 141,473 mt, relative to a reference point $SSB_{MSY\ proxy} = 189,000$ mt (NEFSC 2018). Average fishing mortality over ages 7-8 was estimated to be 0.45.

Management: The Atlantic herring fishery is managed by the NEFMC. Due to the spatial structure of the Atlantic herring stock complex (multiple stock components that separate to spawn and mix during other times of the year), the total annual catch limit for Atlantic herring (stock-wide ACL/OY) is divided and assigned as sub-ACLs to four management areas. The best available information is used about the proportion of each spawning component of the Atlantic herring stock complex in each area/season and minimizing the risk of overfishing an individual spawning component to the extent practicable. The fishery, prosecuted primarily by midwater trawls (single and paired) and purse seines, has quotas by area and season. Management measures include bycatch caps for haddock and river herring/shad.

5.4.2.5 American lobster

Life history, distribution, and essential fish habitat: American lobsters are benthic crustaceans found in U.S. waters from Maine to New Jersey inshore and Maine to North Carolina offshore. Lobsters tend to be solitary, territorial, and have a relatively small home range of 5-10 km², although large mature lobsters living in offshore areas may migrate inshore seasonally to reproduce, and southern inshore lobsters may move to deeper areas to seek cooler temperatures on a seasonal or permanent basis. There is no federal EFH designation, but components of habitat are identified in the FMP (see ASMFC 2014).

Population status: The 2009 lobster stock assessment assumed three distinct stocks: Gulf of Maine, Georges Bank, and Southern New England. However, the 2015 stock assessment combined the Gulf of Maine and GB stocks to more effectively model recruitment size compositions and seasonal variations in the location of large females. The 2015 assessment concluded that the SNE stock is depleted (record low levels), while the GOM/GB stock not overfished (record abundance). However, overfishing is not occurring for either stock. However, the overfishing determination for SNE may be misleading and unreliable, because the methods used to estimate fishing mortality are not designed for such low biomass situations (ASMFC 2015).

Management: Lobster is managed by the Atlantic States Marine Fisheries Commission in state waters (0-3 nm from shore) and by NMFS in federal waters (3-200 mi from shore). Between 1981 and 2013, 96% of all lobster was harvested using traps (ASMFC 2015). The fishery occurs within the three stock units: Gulf of Maine, Georges Bank, and Southern New England, each with an inshore and offshore component. The fishery is managed using minimum and maximum lobster sizes; limits on the number and configuration of traps; possession prohibitions on egg-bearing females and v-notched lobsters, lobster meat, or lobster parts; prohibitions on spearing lobsters; and limits on non-trap landings. Measures vary by management area (the GSC HMA overlaps Area 3, i.e. offshore Gulf of Maine, Georges Bank, and Mid-Atlantic Bight to the EEZ).

5.5 Human Communities

This framework evaluates the effect the management alternatives may have on the human environment: the economy, ways of life, traditions, and communities. These social and economic impacts may be driven by changes in fishery flexibility, opportunity, stability, certainty, safety, and/or other factors. While it is possible that social and economic impacts could be solely experienced by individuals, it is more likely that impacts would be experienced across communities, gear types, and/or vessel size classes. Summarized here are the fisheries and human communities most likely to be impacted by the alternatives under consideration. Social, economic and fishery information presented herein is useful in describing the response of the fishery to past management actions and predicting how the alternatives may affect human communities. Also, this section establishes a descriptive baseline for the fishery with which to compare actual and predicted future changes that result from management actions.

A “fishing community” is defined in the MSA, as amended in 1996, as “a community which is substantially dependent on or substantially engaged in the harvesting or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community” (16 U.S.C. § 1802(17)). Determining which fishing communities are “substantially dependent” on and “substantially engaged” in the surfclam fishery can be difficult.

For additional information on the fishing communities described in this section, refer to:

- ***Snapshots of Human Communities and Fisheries in the Northeast*** are brief summaries with the most recent data for key indicators of dependence on fisheries and other economic and demographic characteristics:
<http://www.nefsc.noaa.gov/read/socialsci/communitySnapshots.php>.
- ***Community Profiles for the Northeast U.S. Fisheries*** are in-depth information on the historic, demographic, cultural, and economic context for understanding the involvement of a community in fishing (Clay *et al.* 2007, also at snapshots link).

5.5.1 Method to Identify Communities of Interest

There are several fisheries potentially impacted by this action that are active in fishing communities throughout the Greater Atlantic Region. The approach to identifying the communities of interest here is, where possible, consistent with how the lead management entity for each fishery (e.g., NEFMC, MAFMC, ASMFC) has identified important communities. In cases where the lead management entity has not previously identified important communities, a method developed through a prior NEFMC action was used or a method was developed here. Several of the specific methods include use of the NMFS Community Vulnerability Indicators, which provide a broader view of the degree of involvement of communities in fisheries than simply using pounds or revenue of landed fish. The indicators portray the importance or level of dependence of commercial or recreational fishing to coastal communities.

- ***The engagement index*** incorporates the pounds and value of landed fish, the number of commercial fishing permits with that community as the permit holder’s homeport, and the number of dealers buying fish in that community (all using NMFS dealer data).

- ***The reliance index*** is a per capita measure using data for the engagement index divided by the total population of the community based on U.S. Census data.

Using a principal component and single solution factor analysis, each community receives a factor score. A score of 1.0 or more places the community at 1 standard deviation above the mean (or average) and is considered highly engaged or reliant. Communities with scores below 0.0 have low engagement/reliance (Jepson & Colburn 2013). These indicators have been developed community-wide for commercial and recreational fishing for over 3,800 communities nationally (<http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/index>). There is ongoing work to develop fishery-specific indicators. Where available, the specific indicators are included in this action.

5.5.2 Surfclam Fishery

The following sections describe the surfclam fishery, with a focus on the Nantucket Shoals fleet.

5.5.2.1 Overview

Surfclam harvests were concentrated off the New York coast until the discovery of extensive clam beds off New Jersey around 1950. Waters near Delaware and Maryland were also important during this time. In the early 1970s, diminished surfclam beds off New Jersey led to shifting effort to waters off Virginia (Ritchie 1977). Since 2010, landings from Southern New England and Georges Bank have increased. Almost all landings of surfclams are from vessels using hydraulic clam dredges. The relatively small Maine mahogany quahog fishery uses a non-hydraulic dredge. In addition to the Federal fishery, there is a small surfclam fishery prosecuted in the state waters of New York, New Jersey, and Massachusetts. There is no recreational fishery for the species.

Traditionally, the primary use of surfclams has been in the "strip market" to produce fried clams. In the last few decades, they have been used in chopped or ground form for other products, such as high-quality soups and chowders (MAFMC 2003, p. 97; and personal communications with industry). The Nantucket Shoals fishery largely supplies the tongue market. It is a high-value market, not replicated elsewhere.

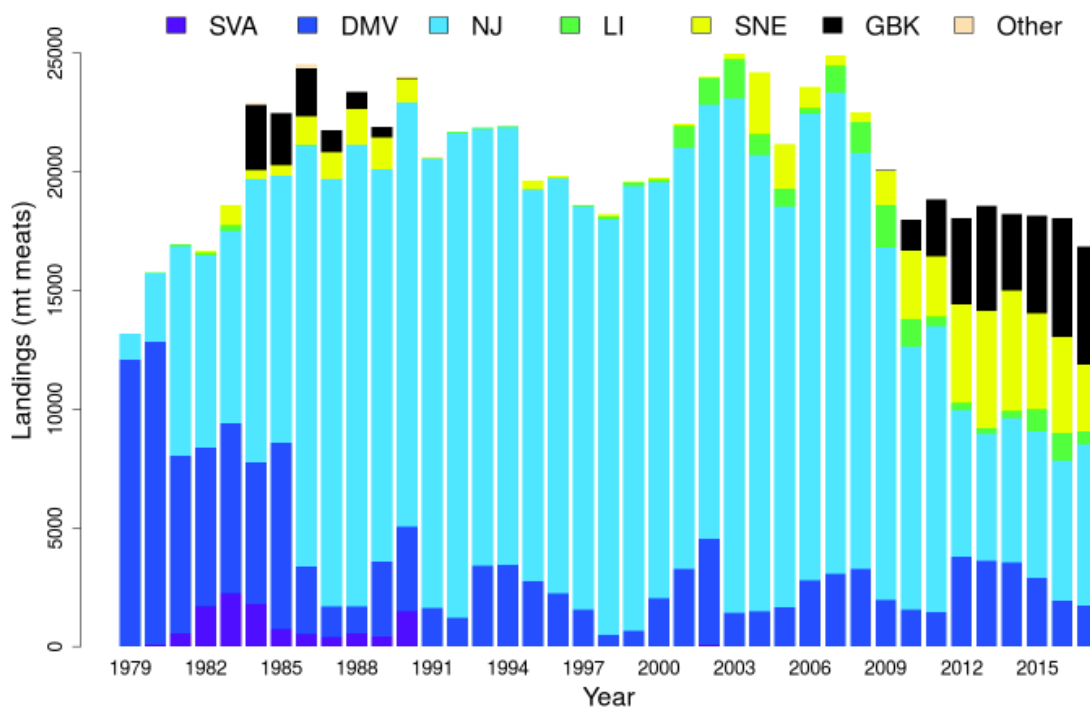
5.5.2.2 Current Specifications and Catch

Since Annual Catch Limits (ACLs) were first specified for Atlantic surfclams in 2010, ACLs have declined from 97K mt in 2010-2013 to 29K mt in 2018-2020 (Table 7). However, both the quota available to the federal fishery, 26K mt or 3.4M bushels, and quota use has remained constant since 2010 and at about 70% of the available quota. Industry has indicated that this is their preferred level due to economic factors (e.g., market and processor demand, quota lease prices, financial equity; MAFMC 2017; Table 7).

The surfclam fishery primarily occurs in waters off New York to Maryland, southeast of Cape Cod on Nantucket Shoals, and on Georges Bank. The distribution of catches has changed over time, with a shift to increased landings in Southern New England and GB Areas (Figure 2, Map 20). The Great South Channel Habitat Management Area, the focus of this framework, occurs

within the Southern New England Area. Thus, this action is focusing on a region that has become increasingly important for the fishery.

Figure 2 – Surfclam landings from the U.S. EEZ during 1979-2016, and preliminary 2017



Source: Dan Hennen Pers. Comm., NEFSC 2018, as cited in MAFMC (2018a).

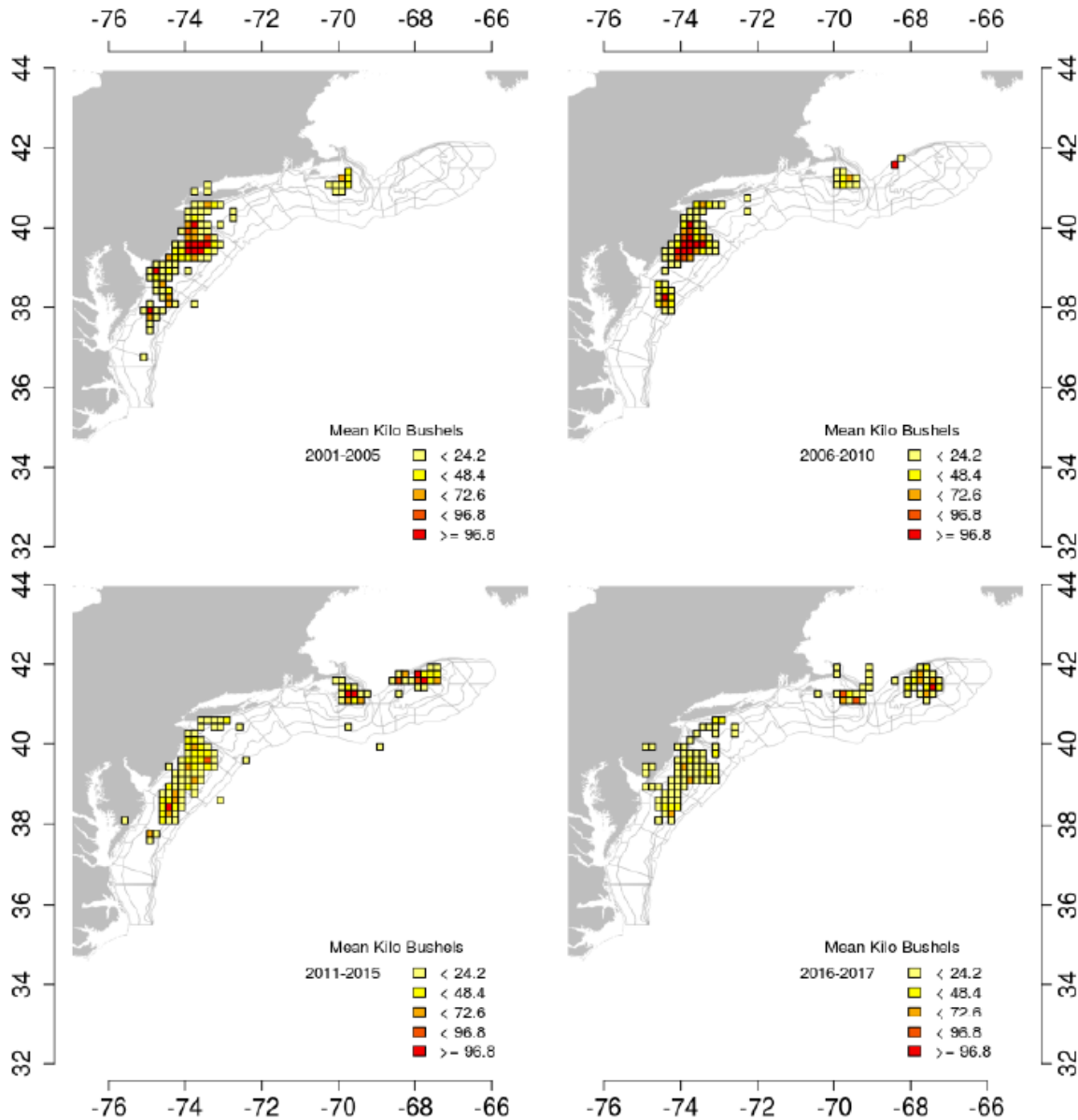
Clam Dredge Framework

Table 7 – Federal surfclam quotas and landings, 1998-2020

Year	OFL (mt)	ABC/ACL (mt)	Total Landings (mt meats; incl. state waters)	EEZ Landings (mt meats)	EEZ Landings ^a ('000 bu)	EEZ Quota ('000 bu)	% Harvested
1998	NA	NA	24,506	18,234	2,365	2,565	92%
1999	NA	NA	26,677	19,577	2,539	2,565	99%
2000	NA	NA	31,093	19,788	2,566	2,565	100%
2001	NA	NA	31,237	22,017	2,855	2,850	100%
2002	NA	NA	32,645	24,006	3,113	3,135	99%
2003	NA	NA	31,526	24,994	3,241	3,250	100%
2004	NA	NA	26,463	24,197	3,138	3,400	92%
2005	NA	NA	22,734	21,163	2,744	3,400	81%
2006	NA	NA	25,779	23,573	3,057	3,400	90%
2007	NA	NA	27,091	24,915	3,231	3,400	95%
2008	NA	NA	25,223	22,510	2,919	3,400	86%
2009	NA	NA	22,396	20,065	2,602	3,400	77%
2010	129,300	96,600	19,941	17,984	2,332	3,400	69%
2011	114,000	96,600	20,044	18,839	2,443	3,400	72%
2012	102,300	96,600	18,393	18,054	2,341	3,400	69%
2013	93,400	96,600	18,924	18,551	2,406	3,400	71%
2014	81,150	60,313	18,834	18,227	2,364	3,400	70%
2015	75,178	51,804	18,517	18,154	2,354	3,400	69%
2016	71,512	48,197	18,202	18,039	2,339	3,400	69%
2017	69,925	44,469	17,696 ^c	16,853 ^c	2,186 ^c	3,400	64% ^c
2018 ^b	Not specified	29,363	NA	NA	NA	3,400	NA
2019	Not specified	29,363	NA	NA	NA	3,400	NA
2020	Not specified	29,363	NA	NA	NA	3,400	NA

Notes: Landings for state waters are approximated as total landings - EEZ landings and may not accurately reflect state landings. SSC determined OFLs and ABCs included for years specified.
^a 1 surfclam bushel is about 17 lb.
^b Revised previous 2018 values due to receipt of a new stock assessment.
^c Preliminary, incomplete 2017 data.
Source: NMFS clam vessel logbook reports. Dan Hennen Pers. Comm., NEFSC 2018.

Map 20 – Average surfclam landings by ten-minute squares over time, 2001-2016, and preliminary 2017



Note: Only squares where more the 5 kilo bushels were caught are shown.

Source: Dan Hennen Pers. Comm., NEFSC 2018, as cited in MAFMC (2018a)

5.5.2.3 Spatial Management

Paralytic Shellfish Poisoning Closures. Fishing areas can also be closed for public health related issues due to environmental degradation or the toxins that cause paralytic shellfish poisoning (PSP). PSP is a public health concern, caused by saxitoxins, produced by the alga

Alexandrium fundyense (red tide). Surfclams on Georges Bank were not fished from 1990-2008 due to the risk of PSP. There was light fishing on GB in years 2009-2011 under an exempted fishing permit and LPUE in that area was substantially higher (5-7 times higher) than in other traditional fishing grounds. Beginning January 1, 2013, a portion of GB has been open to the harvest of surfclams (77 FR 75057, December 19, 2012, under its authority in 50 CFR 648.76). Harvesting vessels must adhere to the adopted testing protocol from the National Shellfish Sanitation Program (MAFMC 2018a). The industry has invested heavily in PSC protocols and testing (Section 5.5.2.8).

Other spatial management: There are no regulatory area closures for the surfclam fishery, other than for public health issues or in areas encompassing unexploded ordinances. Areas can be closed to surfclam fishing if the abundance of small clams in an area meets certain threshold criteria. During the 1980s, there were three such area closures (off Atlantic City, NJ; Ocean City, MD; and Chincoteague, VA), with the last of the three areas reopening in 1991.

5.5.2.4 Permits, Vessels, and Effort

The surfclam fishery in the EEZ occurs with open access, individual fishing quota (IFQ) or individual transferable quota (ITQ) permits. In fisheries in which quota may be traded, individuals have the flexibility to harvest their annual share of the quota themselves, or to "lease" a portion or all their allocation to others. To fish, permit holders must have a quota allocation, or they must obtain allocation through quota transfer. In 2017, 617 vessels were issued a Federal surfclam permit, down from 847 in 2008 (Table 8). While the surfclam and ocean quahog fishery is open access, only about 4-6% of permitted vessels, 32-42 vessels annually, have been active recently (Table 9). Inactive entities likely do not hold quota or have marketing relationships with surfclam processors, or own gear for harvesting surfclam and ocean quahog. Some active participants may not hold allocation but lease it from others. Some vessels may be part of the same firm, having the same owners. In 2016, 349 fishing firms held at least one surfclam or ocean quahog permit and 24 firms were active (MAFMC 2017). Over time, participants have merged harvesting operations and/or have leased quota, reducing the number of active vessels (Brandt 2005; Olson 2011).

Table 8 – Vessels issued Federal surfclam and ocean quahog permits, 2008-2017

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Has a Federal ocean quahog permit	873	838	781	730	701	674	663	656	658	629
Has a Federal surfclam permit	847	811	753	706	679	654	648	643	647	617
Has both a Federal ocean quahog and surfclam permit	799	776	720	677	651	627	619	621	623	595
Source: GARFO (2018)										

Table 9 – Active vessels in the Federal surfclam fishery, 2008-2017

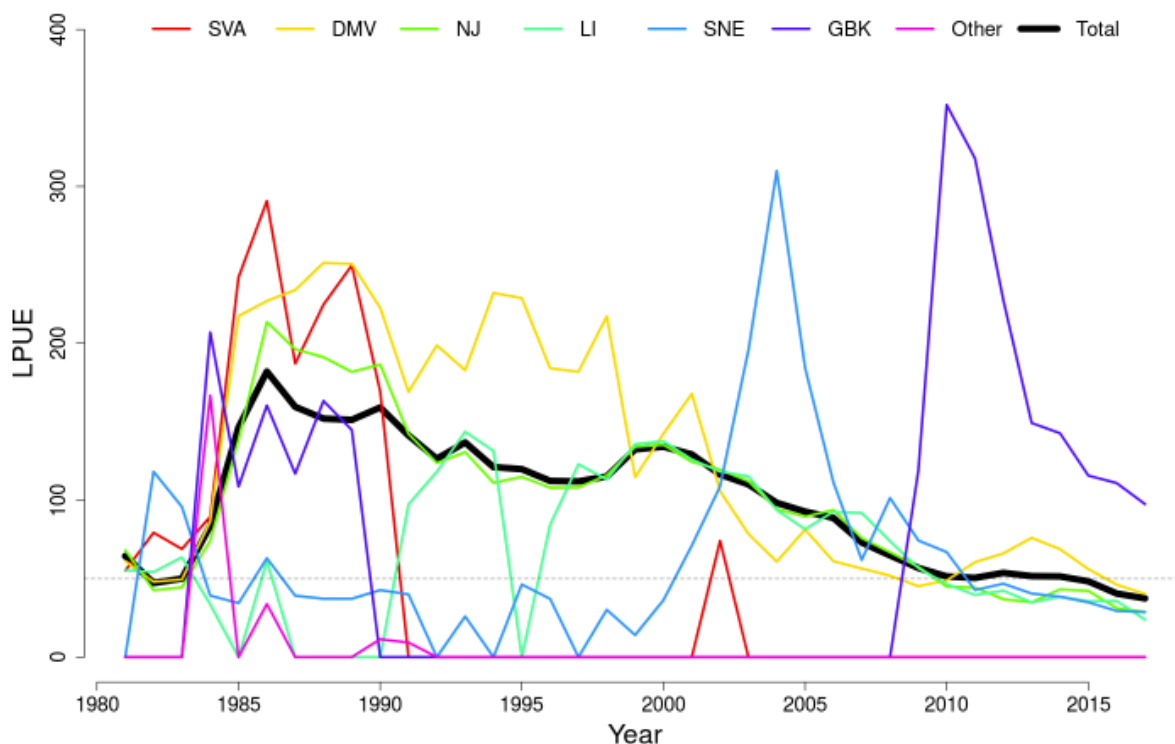
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Harvesting both surfclams & ocean quahogs	8	8	12	12	13	7	7	6	8	14
Harvesting only surfclams	24	28	22	24	29	33	31	31	30	26
Total active surfclam vessels	32	36	34	36	42	40	38	37	38	40
Source: vessel activity from NMFS clam vessel logbooks; from MAFMC (2018a).										

Table 10 – Vessels in the Federal surfclam fishery, 2017

Vessel Length	# vessels	
	All	Active
< 60'	169 (27%)	2 (5%)
60-80'	229 (37%)	19 (48%)
> 80'	219 (35%)	19 (48%)
Total	617 (100%)	40 (100%)
Range	9-158'	55-139'
Source: GARFO (2018).		

With the implementation of the ITQ system, the fleet shifted towards larger vessels (McCay & Creed 1990). The 40 active surfclam vessels in 2017 ranged in length from 55-139' (Table 10). Vessels in the 80-90' range are considered medium-sized and do not have the capacity to fish far offshore on Georges Bank or have enough revenue to afford PSP testing required to do so. Within New England, vessels of this size have been dependent on the Nantucket Shoals area, some for several decades (personal communications with industry, 2018). Trips harvesting surfclams have increased in length as catch rates have declined (Figure 3).

Figure 3 – Nominal landings per unit effort (LPUE in bushels landed per hour fished) for surfclam, by region, during 1981-2016, and preliminary 2017



Notes: LPUE is total landings in bushels divided by total fishing effort.

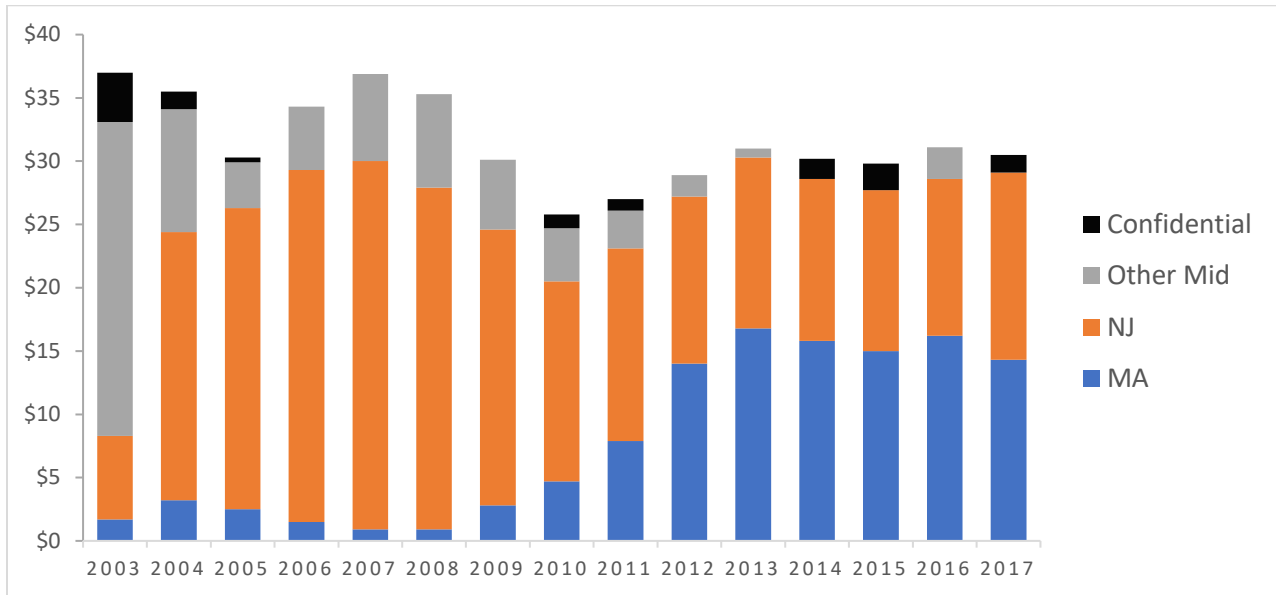
Source: Dan Hennen Pers. Comm., NEFSC 2018, as cited in MAFMC (2018a).

5.5.2.5 Fishery Economics

Price of surfclams. The average ex-vessel price of surfclams reported by processors was \$13.90 per bushel in 2017, higher than the prices in 2016 and 2015 at \$13.25 and \$12.61 per bushel respectively. Ex-vessel prices for surfclams can vary considerably depending on the meat quality and yield. Surfclam beds in New York State waters and off the Delmarva Peninsula tend to have lower meat weights and command lower prices. Prices also depend on individual contracts with processors. Increasingly, the harvesting and processing sectors are becoming more vertically integrated (MAFMC 2003, p. 97).

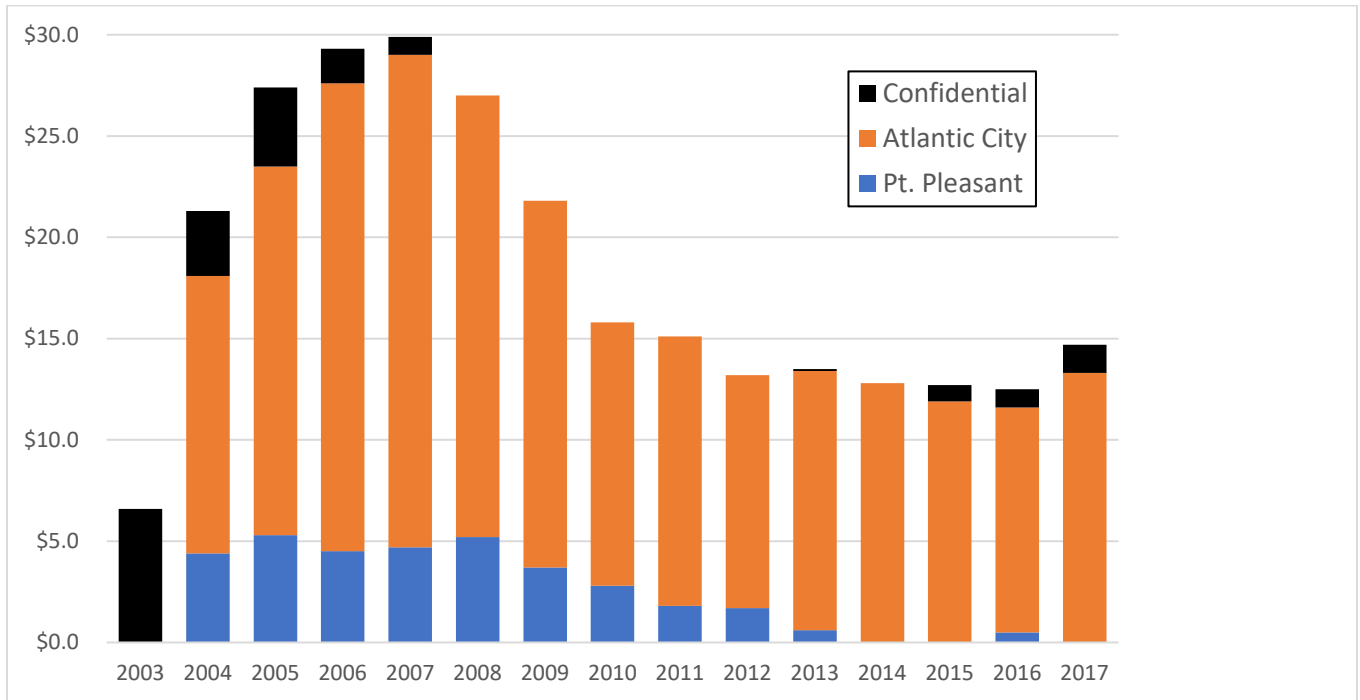
Fishery revenue. Ex-vessel revenue from the Federal surfclam harvest has fluctuated between \$26-37M (nominal value) since 2003, hovering at about \$30M since 2012 (Figure 4). Fishery revenue was primarily from landings in New Jersey and other Mid-Atlantic states from 2003 until 2011. Since that time, landings in Mid-Atlantic states have declined and landings in Massachusetts have increased and become equivalent to Mid-Atlantic landings. In New Jersey, landings revenue has largely been from Atlantic City; landings have also occurred in Point Pleasant, but have been minimal since 2013 (Figure 5). In Massachusetts, landings revenue has largely been from Bristol County (e.g., New Bedford, Fairhaven), though landings have also occurred in Barnstable County (e.g., Hyannis) since at least 2012 (Figure 6).

Figure 4 – Atlantic surfclam nominal revenue (\$M) by state, 2003-2017



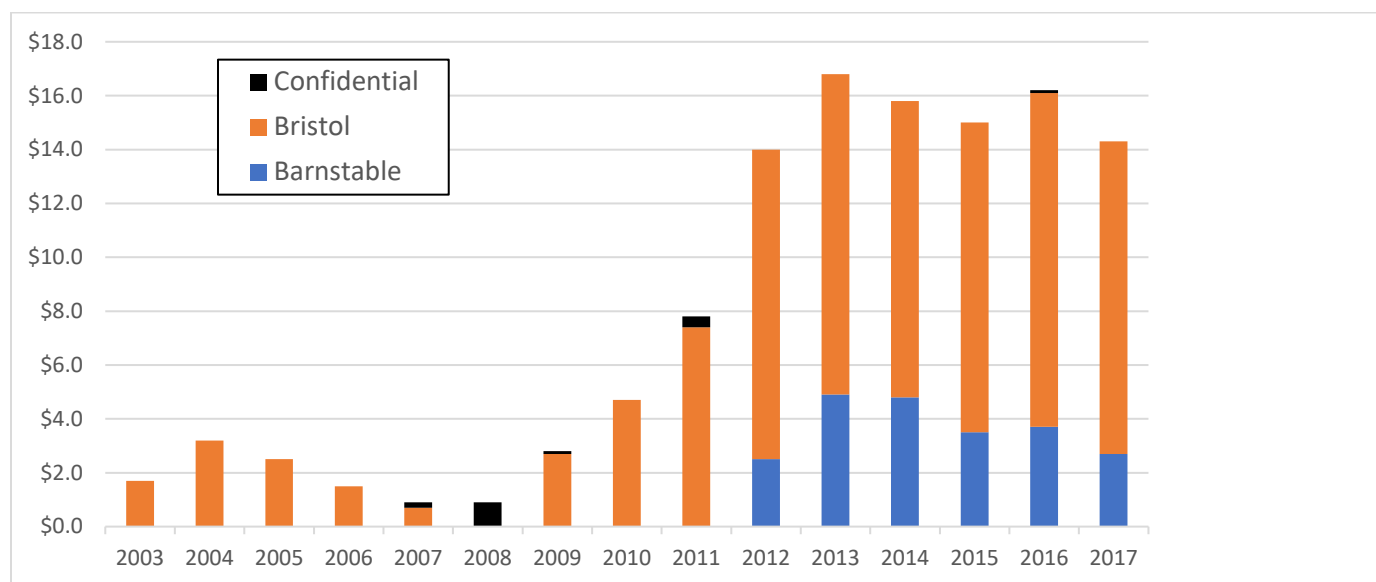
Note: "Other Mid" includes New York, Delaware, Maryland, Pennsylvania, and Virginia. Source: SCOQ processor reports.

Figure 5 – New Jersey landings nominal revenue (\$M) of Atlantic surfclam by landing port, 2003-2017



Source: SCOQ processor reports.

Figure 6 – Massachusetts landings nominal revenue (\$M) of Atlantic surfclam by county, 2003-2017



Source: SCOQ processor reports.

Factors influencing economics. Industry has described several factors that have affected their economic situation. Food manufacturing companies that use clam meats in their products have reduced their purchases of clams and have stopped advertising products like clam chowder in the traditional media. Industry members reported that increases in imported clam meat from Canada and Vietnam has placed downward pressure on clam meat price in the marketplace. The costs to vessels harvesting clams have increased due to the rising costs of insurance. Industry has also indicated that the price of diesel fuel in conjunction with distance traveled to fish is a big factor determining trip cost (MAFMC 2017; 2018a). Within a quota managed fishery such as the surfclam fishery, decreasing output prices and increasing input costs would be expected to decrease the total effort/landings. This interpretation is consistent with the decrease in landings, as detailed in Table 7.

Dependence on surfclams: The active surfclam and ocean quahog fishery participants derive a large share of gross receipts from the surfclam and ocean quahog fishery (MAFMC 2017).

5.5.2.6 State Waters Fishery in Massachusetts

The Massachusetts state waters fishery is very limited and does not provide a significant alternative to fishing in the GSC HMA for the vessels affected by this action. In Massachusetts state waters, dredging for surfclams is prohibited during the following seasons and in the following areas with hydraulic and toothed dredges.

- November 1-April 30, shoreward of the 12 ft depth contour from Hull to the MA/RI border, including Cape Cod and the Islands
- May 1-October 31, shoreward of the 20 ft depth contour, from Hull to the MA/RI border, including Cape Cod and the Islands

- c) Shoreward of a line drawn from Long Point, Provincetown, to the “Hopper” in North Truro
- d) Shoreward of a line drawn from Jeremy Point, Wellfleet, to the “Spire” in Brewster
- e) Shoreward of Seal Rocks off Scraggy Neck, Bourne, to the southernmost tip of Sandy Point Dike, Wareham
- f) May 1-October 31 within an area one mile seaward of mean low water from Great Point Light to Sankaty Light, Nantucket

There are provisions for the administrative requirements for setting additional closures, for openings/closures need for shellfish sanitation purposes, and for various specific exemptions to the above list.

In Massachusetts state waters, vessels cannot use a hydraulic dredge greater than 48 in. wide or use more than one dredge. There are specific requirements off Chatham. The surfclams harvested must be at least 5 in. long, with clams smaller than this accounting for no more than 5% of the catch, although federal permit holders fishing in federal waters are exempt, as are aquaculture-reared clams. The trip limit is 200 bushels of surfclams per 24-hr day, up to 400 bushels per trip. Again, federally permitted vessels are exempt from this limit, but cannot fish in state waters during the trip if they exceed these limits. Vessels using hydraulic dredges cannot possess or land bay scallops (*Argopecten irradians*) or quahogs (*Mercenaria mercenaria*).

5.5.2.7 Surfclam Dealers, Processors, and Shoreside Support

Although this document focuses on the surfclam fishery, the information in this section on the processing sector is for both surfclams and ocean quahogs as some facilities purchase/process both species. These fisheries have always been strongly connected to processing facilities, ties which have strengthened over time with fishery consolidation. At present, processors have direct or indirect control over most of the fishing quota (McCay 2004). In 2017, there were nine companies reporting purchases of surfclams and/or ocean quahogs from the industrial fisheries outside of Maine, seven of which are located in Massachusetts. In 2017, these companies bought \$31M of surfclam and \$23M of ocean quahogs (MAFMC 2018a).

The dealers/processors summarized here provide a snapshot of typical business involved in dealing and/or processing surfclams. This information has been volunteered by the businesses and has not been verified through any independent sources of information.

Atlantic Capes Fisheries, Inc. (Fall River, MA; Bristol, RI; and Cape May, NJ). Atlantic Capes Fisheries, Inc., based in Cape May, NJ, is fully integrated, from harvesting and processing through marketing and distribution. It participates in several fisheries including scallops, surfclams, groundfish, and squid. Its surfclam vessels, eight in all, fish year-round, primarily on Nantucket Shoals and land in Fairhaven and Hyannis, MA. Product is then trucked to a processing facility in Bristol, RI. It is a hand-shucking operation, in which the clam foot, a tender piece of meat called the “tongue,” is cut down into strips and sold throughout New England to clam shacks, restaurants and home consumers. The “salvage” – the chopped adductor mussel, mantel, syphon, and strap, is sold to clam chowder manufacturers like Blount Soups in Warren, RI, and Kettle Cuisine in Lynn, MA. Atlantic Capes distributes a minor amount of surfclams to

New York, but most of the product stays within New England. Atlantic Capes employs over 500 people, including seasonal workers, with about 200 directly involved in its surfclam operations. There are about 80 people in harvesting and hauling (four-man crews on eight vessels, dockside workers, truckers) and about 120 in the processing facility.

Over the 40-year history of the company, it has always participated in the surfclam fishery. Originally, surfclam harvesting and processing (also hand-shucking) were based in Pt. Pleasant, NJ. About ten years ago, the company migrated its surfclam operations to New England due to climate change and the pursuit of a surfclam resource that was diminishing down south. Also, surfclam processing facilities need to be near landing docks to preserve meat quality. The Bristol facility has been processing surfclams for almost four decades. It has changed hands more than once, but Atlantic Capes was able to maintain the workforce when it took over. Many employees have processed surfclams there for 35 years and are just shy of retirement age. Atlantic Capes aims to remain competitive in the protein market and has worked to retain good labor by increasing salaries. It is one of the companies approved to participate in using the fishery's Marine Stewardship Council certification that became effective in December 2016 (<http://www.atlanticcap.es.com/>; C. Shriver and P. Hughes, personal communication, 2018).

Nantucket Sound Seafood, LLC. (New Bedford, MA). Nantucket Sound Seafood, LLC., based in New Bedford, MA, is fully integrated, from harvesting and processing through marketing and distribution. It participates in several fisheries including hardshell quahogs, conch, softshell clams, and bay scallops, but 90% of its revenue comes from surfclams. The owner has been a fisherman for over 30 years, first as a deck hand, then running a vessel, then co-owning a vessel, eventually owning two vessels. He had been selling surfclams to other processors, but needed more independence, so started Nantucket Sound Seafood about five years ago. The company owns *F/V Seafox* and *F/V Miss Kara*, which fish year-round on Nantucket Shoals but in winter also fish in state waters. The vessels land in Hyannis, MA. Nantucket Sound Seafood processes 60,000-80,000 bushels of surfclams annually, primarily harvested by its two vessels, but occasionally buying from other vessels. Like Atlantic Capes, it is a hand-shucking operation, in which the clam foot is cut into strips and the salvage is sold for chowder. Both the fishing and the demand for surfclams occur year-round, though more so in summer. Clams have a longer shelf-life in the winter, so the winter fishery focuses on live clams for markets in Boston and New York. There is year-round demand for chopped meat and strips, and summer fishery caters to tourist markets within Massachusetts (e.g., clam shacks). Also, quahog shells are sold to stuffed clam manufacturers.

Nantucket Sound Seafood employs about 45 people year-round, with about 35 in the processing facility and trucking and eight in harvesting (four-man crews on two vessels). The vessels participate in surfclam and ocean quahog surveys for the State of Massachusetts, working closely with Division of Marine Fisheries Assistant Director for shellfish Michael Hickey. The owner has served on the Massachusetts Shellfish Advisory Board for the past five years. (<https://www.nantucketssoundseafood.com/>; A. Rencurrel, personal communication, 2018).

5.5.2.8 Surfclam Fishing Communities

Since 2008, there are over 20 communities that have been a homeport or landing port to one or more vessels participating in the surfclam fishery. These ports occur in Massachusetts and throughout the Mid-Atlantic. The level of activity in the surfclam fishery has varied across time. This section identifies the communities for which the Atlantic surfclam is particularly important. While the involvement of communities in the surfclam fishery is described, individual vessel participation may vary.

The surfclam fishing communities likely to be most impacted by this action are those in which landings have been derived from the Great South Channel HMA in recent years. However, area closures have the potential to either preclude fishing or shift effort to areas that remain open, either by shifting the areas that active vessels fish or by shifting effort to other vessels that can access areas that remain open. In either case, the landing ports potentially impacted are likely broader than those important to the vessels fishing in the GSC in the past. Thus, it is appropriate to identify here the fishing communities that are important to the entire surfclam fishery.

Primary ports. The surfclam fishery primary ports are those that are substantially engaged in the fishery, and which are likely to be the most impacted by the proposed action. The primary ports meet at least one of the following criteria:

- Identified by the MAFMC SCOQ Advisory Panel as important for the fishery (MAFMC 2018b).
- Revenue in 2012 derived from the Great South Channel, as identified through the Omnibus Habitat Amendment 2 (Volume 4, Table 73).
- A ranking of “medium-high” or “high” for engagement in or reliance on the surfclam fishery (defined in Section 5.5.1), according to the NMFS Community Vulnerability Indicators averaged over the five-year period of 2012-2016. This is a subset of the 15 communities that have a surfclam fishery engagement index in the range of low to high (Table 11).

Secondary ports. The surfclams harvested from Nantucket Shoals comprise approximately 20% of landings coast-wide. Thus, a decrease in harvests from the area being managed via this action would affect other port communities with some reliance on surfclams, assuming that overall surfclam harvests remain relatively stable. The surfclam fishery secondary ports are those that may not be as dependent or engaged in the fishery as the primary ports but are involved to a lesser extent. Because of the size and diversity of the surfclam fishery, it is impractical to examine each secondary port individually. However, they are listed here to provide a broader scope of potential communities impacted by surfclam management measures. The secondary ports meet the following criterion:

- A ranking of “low” or “medium-low” surfclam fishery engagement or reliance index averaged over 2012-2016 that do not meet the criteria for being a primary port.

Table 11 – Surfclam fishing community engagement index for individual years 1990-2010 and engagement and reliance indices for 2012-2016 average

State	Community	1990	1995	2000	2005	2010	2012-2016 Average	
		Engagement					Engage.	Reliance
ME	Jonesport	-	-	-	-	-	L	M
NH	Portsmouth	-	-	-	-	-	L	L
MA	Gloucester	-	-	-	-	-	L	L
	Hingham	-	-	-	-	-	L	L
	Provincetown	-	-	-	-	-	L	M-H
	Harwichport	-	-	-	-	-	L	H
	Barnstable/Hyannis/ Hyannisport	L	L	L	L	L	H	M
	Fairhaven	-	-	-	-	-	H	H
	New Bedford	M-H	H	H	H	H	H	H
RI	Warren	H	H	M-H	L	M	-	-
	Bristol	M	H	H	L	L	-	-
NY	Islip	-	-	-	-	-	L	L
NJ	Point Pleasant	L	L	H	H	H	M-H	M-H
	Atlantic City	L	L	L	H	H	H	H
	Middle/Burleigh	H	L	L	L	L	-	-
	Wildwood	L	L	L	M	L	L	M
	Cape May	H	H	H	L	L	L	H
	Point Norris, Bivalve	H	M	H	L	L	-	-
DE	Milford	L	L	L	L	L	-	-
MD	Ocean City	L	H	L	M-H	M-H	M-H	H
VA	Accomack/Atlantic/ Mappsville/Sanford	L	L	L	L	L	-	-
	Northampton/Willis Wharf	H	M-H	L	L	L	-	-
	Northampton/ Oyster	H	L	L	L	L	-	-
	Norfolk	H	H	H	L	L	-	-

Source: Colburn *et al.* (2017).
Index scores: “L” = low (<0.0); “M” = medium (0.0-0.49); “M-H” = medium-high (0.5-0.99); “H” = high (≥ 1)

Communities identified. Based on these criteria, there are nine primary ports and six secondary ports in the surfclam fishery (Table 12). Ports in New Jersey and Massachusetts handle the most volume and value. Since 1990, there has been a northward shift in the ports engaged in the surfclam fishery (Table 11), though Ocean City, MD and Atlantic City and Point Pleasant, NJ remain important ports. Within Massachusetts, New Bedford and

Barnstable/Hyannis/Hyannisport have been engaged in the fishery since at least 1990 (New Bedford to a higher degree). In recent years, Fairhaven has been highly engaged and six ports north of Barnstable have become engaged in the fishery, but at a low level, including ports in New Hampshire and Maine. Should the northward trend continue, these ports may become more important in the future.

Table 12 – Communities of Interest (primary ports and secondary ports) in the surfclam fishery

State	Community	AP input	GSC revenue in 2012	Med-high or high engagement or reliance	Primary/ Secondary ports
ME	Jonesport				Secondary
NH	Portsmouth				Secondary
MA	Gloucester				Secondary
	Hingham				Secondary
	Provincetown			√	Primary
	Harwichport			√	Primary
	Hyannis/Hyannisport/Barnstable	√	√	√	Primary
	New Bedford	√	√	√	Primary
	Fairhaven		√	√	Primary
NY	Oceanside	√			Primary
	Islip				Secondary
NJ	Point Pleasant	√		√	Primary
	Atlantic City	√		√	Primary
	Wildwood				Secondary
	Cape May			√	Primary
MD	Ocean City			√	Primary
AP input = most of the vessels are fishing out of these ports today (MAFMC 2018b).					
GSC revenue = 2012 (non-confidential) revenue as identified in OHA2 (Volume 4, Table 73).					

5.5.3 Mussel Fishery

As noted in Section 5.4.1.2, mussels can be targeted within the Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area (Map 21). The Nantucket Shoals mussel fishery was active in the 1980s but waned during the 1990s due to storm-related effects on the beds and a large volume of imports (American Mussel Harvesters, Inc. and Chatham Light Seafood, personal communication, 2018). The lack of data for this fishery makes it difficult to say precisely when it ended or how large the fishery had been. During the development of OHA2, it was not anticipated that this lapsed fishery would reemerge, however, during the development of this framework, the industry indicated that there is renewed interest in harvesting mussels on Nantucket Shoals. Mussel dredging in the GSC HMA has been prohibited since April 9, 2018, because mussel dredges are considered a mobile bottom-tending gear.

Fishery overview: It is unknown how many vessels might participate in a mussel dredge fishery in the GSC HMA, but the present fishery in Cape Cod Bay provides a sense of scale in terms of

number of vessels and total landings. Table 13 shows Massachusetts mussel landings for the most recent five-year period. The mussel dredge fishery is growing in Massachusetts, with ex-vessel landings of 5.9 million, 10.3 million, and 11.6 million pounds harvested from state waters for fishing years 2013-2015 (M. Griffin and A. Webb, MADMF, personal communication). Massachusetts requires vessels to have a permit to land mussels in the state, and landings are summarized by area, including whether mussels were harvested in state or federal waters. Based on Massachusetts data, none of the landings in recent years were attributed to federal waters, and well over 95% of landings came from Cape Cod Bay. No landings of mussels from the GSC HMA were identified in the federal vessel trip report database between 2011 and 2016. Correspondence from industry members indicates that Nantucket Shoals was fished for mussels in the 1980s and into the early 1990s (see NEFMC Habitat Committee meeting materials from August 28, 2018).

Table 13 – Massachusetts mussel landings, 2013-2017.

	Total MA landings		Total MA landings	D. Santoro landings only
Source	MATL Reports, NMFS VTRs		dealer/ACCSP data warehouse	MATL Reports, NMFS VTRs
Year	Live pounds	Vessel count	Live pounds	Live pounds, SRA 7
2013	5,920,892	6	7,051,045	416,470
2014	10,274,760	6	10,914,657	4,881,175
2015	11,559,448	10	15,337,133	5,937,118
2016	10,547,611	11	11,578,741	6,255,316
2017	9,930,356	11	12,140,181	7,178,969
Note: Data in the last column were provided by Domenic Santoro, a fishermen interested in harvesting mussels within the GSC HMA.				

Fishing Communities of Interest. The current state-waters fishery for mussels occurs largely out of Chatham, Massachusetts. American Mussel Harvesters, Inc. is based in North Kingston, RI and is one of the largest mussel processing and distribution companies in the Northeast (www.americanmussel.com). Given current activity in the fishery, Chatham and North Kingston are considered the mussel fishery communities of interest for this action. Should exemptions proposed in this framework allow for significant mussel harvest on Nantucket Shoals, there is potential for the fishery to expand, and perhaps other ports may become important in the future.

Clam Dredge Framework

Map 21 – Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area.

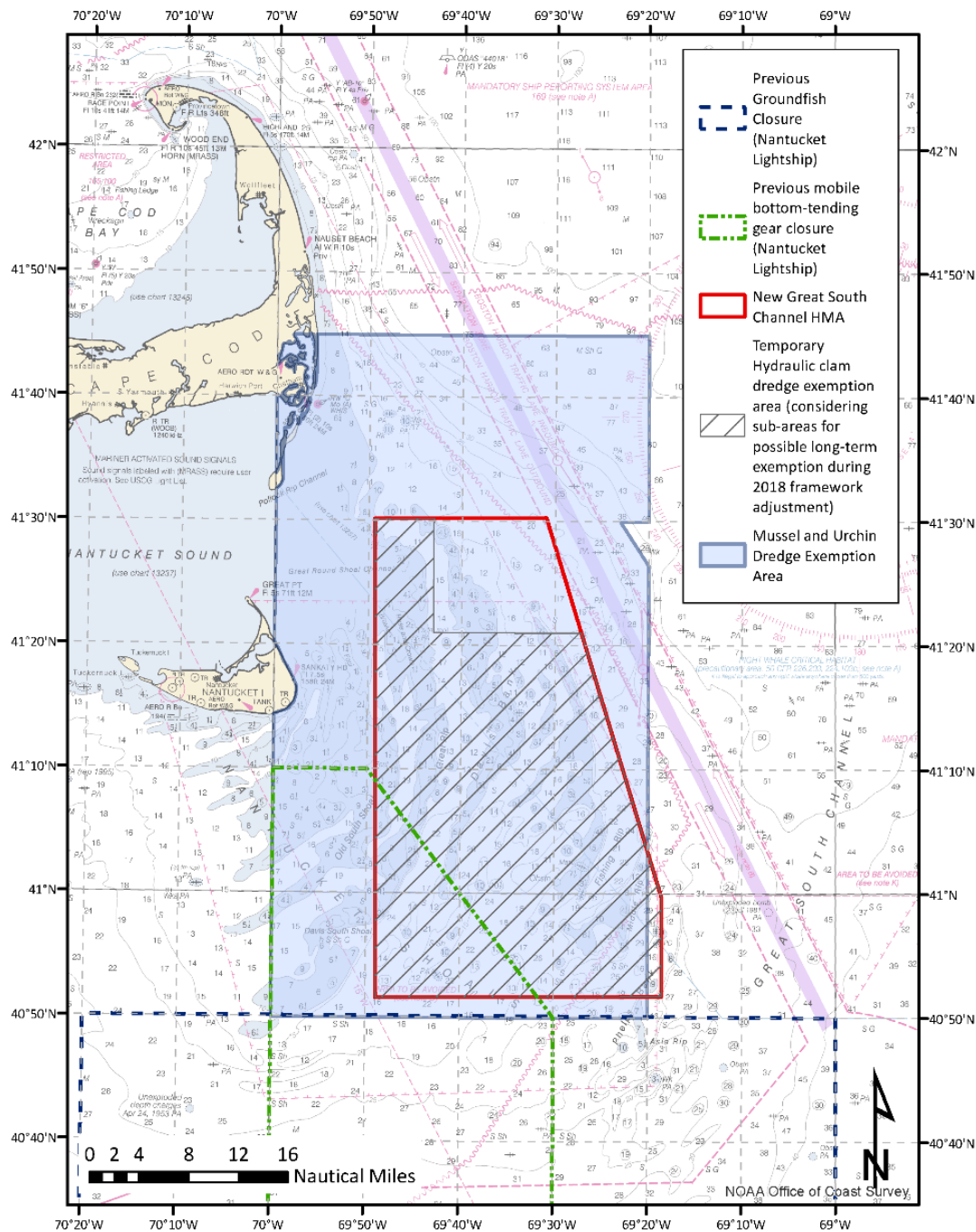


Chart created by NEFMC, January 25, 2018

5.5.4 Other Managed Fisheries

In addition to Atlantic surfclams, many other fisheries could be indirectly impacted by the alternatives under consideration via habitat protection measures intended to enhance conservation of species with essential fish habitats overlapping the Great South Channel HMA (Table 4). VTR and VMS data indicate that the Northeast multispecies fishery, the skate fishery

and lobster fishery are all active in this area. Described here are the key fisheries and their respective fishing communities. Identifying specific communities that may be impacted by alternatives that provide EFH protection is difficult and uncertain. Communities that are far removed from the GSC would likely only have minor or indirect impacts. For example, fishing ports in eastern Maine are very important for the lobster fishery, but the fishery there is primarily active in waters within 12 nm of the coast of Maine; it is likely that any impacts from habitat protections in the GSC would be minimal.

5.5.4.1 *Large Mesh Multispecies Fishery*

Fishery overview: The overall trend since the start of sector management through 2014 has been a decline in groundfish landings and revenue (\$55M in FY2014) and the number of vessels with revenue from at least one groundfish trip (273 in FY2014). The groundfish fishery has had a diverse fleet of vessels sizes and gear types. Over the years, as vessels entered and exited the fishery, the typical characteristics defining the fleet changed as well. The decline in active vessels has occurred across all vessel size categories. Since FY2009, the 30' to < 50' vessel size category, which has the largest number of active groundfish vessels, experienced a decline from 305 to 145 active vessels. The <30' vessel size category, containing the least number of active groundfish vessels, experienced the largest reduction since FY2009 (34 to 14 vessels; Murphy et al. 2015; NEFMC 2017).

Fishing communities of interest – commercial: There have been over 400 communities that have been the homeport or landing port to one or more commercial Northeast groundfish fishing vessels since 2008. Of these, 10 ports are considered primary commercial groundfish port communities. During FY 2009-FY 2013, primary ports had at least \$100,000 average annual revenue (for all species, not just groundfish) and are in the top ten ranking in regional quotient or local quotient (confidential ports excluded). Secondary ports are in the top 11-30 ranking in regional or local quotient (same revenue threshold; NEFMC 2018d). The commercial groundfish fishery communities of interest for this action are:

1. Identified as a primary or secondary commercial groundfish port in the Northeast Multispecies FMP (NEFMC 2018d); and
2. Have revenue derived from mobile bottom-tending gear in the Great South Channel, as identified through the Omnibus Habitat Amendment 2 (2012 only; OHA2 Volume 4, Table 73).

Under these criteria, there are 13 commercial groundfish fishery communities of interest for this action, from Maine to New York (Table 14).

Fishing communities of interest – recreational: In the Northeast Multispecies FMP, criteria for identifying key recreational fishing communities have not been identified, but recreational fishing (party/charter and private angler) occurs throughout the Northeast region. The recreational groundfish fishery communities of interest for this action are:

1. Located on or near the coast in a coastal state from Chatham, Massachusetts to Long Island, New York; it is unlikely that substantial recreational fishing in proximity to the GSC would occur out of ports beyond that range to the north or south; and

2. Has a high level of engagement or reliance in recreational fishing using the NMFS Community Vulnerability Indicators, which portray the importance or level of dependence on recreational fishing by coastal communities (Jepson & Colburn 2013). The engagement index incorporates the number of recreational fishing trips in 2011-2015 by fishing mode (private boat, charter boat, shore fishing) originating in the community (using MRIP data). The reliance index is a per capita measure using the same data as the engagement index, but divided by total population in the community; or
3. Have revenue derived from party-charter recreational fishing revenue in the Great South Channel, as identified through the Omnibus Habitat Amendment 2 (2012 only).

Under these criteria, there are 35 recreational groundfish fishery communities of interest for this action (Table 14). Ports with over 10 party/charters permits are considered primary ports. Completed earlier in 2019, Amendment 8 to the Atlantic Herring FMP details the community vulnerability indicators for these ports (NEFMC 2018a). Only Point Judith, RI and Montauk, NY had 2012 party/charters revenue associated with the GSC HMA (OHA2 Volume 4, Table 75).

5.5.4.2 Northeast Skate Fishery

Fishery overview: Skates are harvested in two different fisheries, one for lobster bait and one for wings for food. The bait fishery is a more historical and directed skate fishery, involving vessels primarily from Southern New England ports that target a combination of little skates (>90%) and, to a much lesser extent, juvenile winter skates (<10%). The fishery for skate wings evolved in the 1990s as skates were promoted as “underutilized species,” and fishermen shifted effort from groundfish and other troubled fisheries to skates and dogfish. The wing fishery is largely an incidental fishery that includes a larger number of vessels located throughout the region, with a smaller portion of fishery targeting skate wings. Vessels often catch skates when targeting other species like groundfish, monkfish, and scallops and land them if the price is high enough. However, a smaller component of the fishery targets skates and accounts for a large portion of landings. In 2016, there were 415 active skate permits and the fishery had a total revenue of \$5.4M (NEFMC 2018c).

Fishing communities of interest: There were 78 communities where skate was landed for food, and 16 where skate was landed for bait, during 2015-2016, from all states Maine to North Carolina. The skate fishery communities of interest for this action are:

1. Identified as a primary or secondary port in the Northeast skate FMP (Skate Framework 5); and
2. Have revenue derived from mobile bottom-tending gear in the Great South Channel, as identified through the Omnibus Habitat Amendment 2 (2012 only; OHA2 Volume 4, Table 73).

Under these criteria, there are five Northeast skate fishery communities of interest for this action, from Massachusetts to Connecticut (Table 14).

5.5.4.3 Sea Scallop Fishery

Fishery overview: During the period from fishing year 2009 to 2016, the scallop landings ranged from about 32 to 56 million pounds. Scallop revenue peaked in 2011 at \$591M (in inflation adjusted 2016 dollars) and declined to \$485M in 2016. The scallop fishery uses predominantly paired or single scallop dredges throughout the entire range of the fishery. To a much smaller extent, and mainly in the Mid-Atlantic, the scallop fishery uses trawl gear. Most vessels land Atlantic sea scallops as shucked meats (the adductor muscle) but some vessels also land whole (in-shell) scallops. In 2016, there were 350 active scallop vessels, respectively (NEFMC 2018b).

Fishing communities of interest: There are over 200 communities that have been a homeport or landing port to one or more active sea scallop vessels since 2010, primarily from Massachusetts to Virginia. The scallop fishery communities of interest for this action are:

1. Identified as a primary or secondary port in the sea scallop FMP (NEFMC 2019); and
2. Have revenue derived from mobile bottom-tending gear in the Great South Channel, as identified through the Omnibus Habitat Amendment 2 (2012 only; OHA2 Volume 4, Table 73).

Under these criteria, there are 15 sea scallop fishery communities of interest for this action, from Massachusetts to Virginia (Table 14). New Bedford is a primary landing port; about 60% of the scallop revenue during 2010-2017 was landed in New Bedford.

5.5.4.4 Atlantic Herring Fishery

Fishery overview: The Atlantic herring fishery occurs over the Northwest Atlantic shelf region from Cape Hatteras to Maine, including an active fishery in the inshore Gulf of Maine and seasonally on Georges Bank. The fishery generally occurs south of New England during the winter, and oftentimes as part of the directed mackerel fishery. The herring summer fishery generally occurs throughout the GOM and on GB as fish are available. In 2016, there were about 34 active limited access vessels, and about 70% of recent landings have been by midwater trawl vessels. Fishery revenue peaked in 2013 at about \$30M, and has been above \$20M per year since 2011 (NEFMC 2018a).

Fishing communities of interest: There have been over 150 communities that have been a homeport or landing port to one or more active Atlantic herring fishing vessels since 1997. These ports primarily occur from Maine to Virginia. Of these, 18 are considered the primary Atlantic herring port communities, as they have relatively high recent herring landings, medium-high or high engagement in or reliance on the fishery, or other factors (NEFMC 2018a). Due to the migratory nature of herring throughout the Greater Atlantic, all the primary herring ports are *Communities of Interest* for this action (Table 14).

5.5.4.5 Lobster Fishery

The American lobster fishery has seen incredible expansion in effort and landings over the last 40 years and is now one of the top fisheries on the U.S. Atlantic coast. In the 1920s, lobster landings were about 11M lbs. Landings were stable between 1950 and 1975, around 30M pounds; however, from 1976 – 2008, landings tripled, reaching 92M pounds in 2006. Landings

continued to increase and peaked in 2013 at over 150M pounds. Landings leveled off but remained high at 147M pounds in both 2014 and 2015, but again jumped to over 158M pounds (over \$660M) in 2016. The largest contributors to the fishery are Maine and Massachusetts, with 83% and 11% of the recent landings, respectively. Landings, in descending order, also occurred in New Hampshire, Rhode Island, New Jersey, Connecticut, New York, Maryland, Delaware, and Virginia (ASMFC 2017).

Lobsters are typically harvested from inshore areas. Lobsters are most abundant inshore from Maine through New Jersey, with abundance declining from north to south. Offshore, lobsters occur from Maine through North Carolina. Area 1 (inshore Gulf of Maine) has the highest landings, 80% of total harvest between 1981 and 2012. This is followed by LCMA 3 (offshore), 9% of total landings. Dramatic declines in the catch from inshore SNE since 1999 have been attributed to waters increasingly exceeding the lobster thermal stress threshold of 20°C (ASMFC 2015).

There was an average of 8,315 vessels issued commercial lobster permits for the fishery in state waters each year between 2009 and 2013, and 3,080 vessels were issued federal permits, though in most cases, a vessel holding a federal permit also holds a state permit. Thus, there are about 8,300 vessels in the lobster fishery. The State of Maine has issued the largest number of state permits, recently averaging 5,163 (62%). For Maine, about 85% of the permits are active (~4,400). For New Hampshire, about 70% of the permits issued were active during 2009-2013.

Fishing communities of interest: The ASMFC has not identified key ports in the American lobster fishery, but lobster is landed in many port communities on the Atlantic coast. The lobster fishery communities of interest for this action are:

1. Located on or near the coast in a coastal state from Chatham, Massachusetts to Long Island, New York; it is unlikely that substantial lobster fishing in proximity to the GSC would occur out of ports beyond that range to the north or south; and
2. Was within the top 20 ports for lobster landed value in 2015; or
3. Has the homeport or primary landing port to at least 10 federal lobster vessels.

Under these criteria, there are eight lobster fishery communities of interest for this action (Table 14). In 2015, 18 of the top 20 ports for lobster landed value were in Maine (primarily Midcoast to eastern Maine), and two were in Massachusetts. As identified for Amendment 8 to the Atlantic Herring FMP (NEFMC 2018a), these 20 top ports are considered the primary lobster ports. In 2015, there were 2,297 federal lobster licenses issued to vessels from 279 home ports (15 states) and 273 primary landing ports (12 states). Of these, there were 63 ports that were either the home port or primary landing port to at least 10 federal lobster vessels, and these are considered secondary ports.

5.5.5 Co-occurrence of Fisheries Within Communities

In all, about 60 communities have been identified as potentially impacted by this action from Maine to Virginia (Table 14). The fisheries potentially impacted co-occur within many of these ports.

Clam Dredge Framework

Table 14 – Communities of interest for the fisheries potentially impacted by this action

State	Port	Surfclam/ Mussel	Groundfish		Skate	Sea scallop	Atlantic herring	Lobster
			Comm.	Rec.				
ME	Jonesport	Su					H*	
	Gouldsboro						H*	
	Stonington						H*	
	Rockland						H*	
	Vinalhaven						H*	
	Matinicus						H*	
	South Bristol						H*	
	Sebasco						H*	
	Portland		G*				H*	
NH	Portsmouth	Su						
MA	Gloucester	Su	G*	R*		Sc	H*	
	Boston		G*					
	Hingham	Su						
	Marshfield (Green Harbor, Cedar Crest)			R*				
	Provincetown	Su*				Sc*		
	Chatham	M*	G*	R	Sk*	Sc		L
	Harwich (Harwich Port)	Su*	G	R		Sc		
	Hyannis/Barnstable/Hyannisport	Su*				Sc		
	Falmouth			R				
	Woods Hole		G					
	Bourne			R				
	Wareham (W. Wareham, Onset)			R				
	Nantucket		G	R				
	Menemsha							L
	New Bedford/Fairhaven	Su*	G*		Sk*	Sc*	H*	L*
	Westport			R				L
RI	Tiverton			R				
	Bristol			R				
	Newport		G		Sk*		H*	L
	Jamestown			R				
	Warwick			R				
	Narragansett (Pt. Judith)		G*	R*	Sk*	Sc*	H*	L
	Kingstown (N. and S. Kingston, Wakefield-Peacedale)	M*		R			H*	
	Charlestown (Carolina)			R				
CT	Stonington (Mystic, Pawcatuck)		G	R		Sc*		L
	Groton (Noank)			R				
	New London				Sk*	Sc		
	Waterford			R				
	East Lyme (Niantic)			R				

Clam Dredge Framework

State	Port	Surfclam/ Mussel	Groundfish		Skate	Sea scallop	Atlantic herring	Lobster
			Comm.	Rec.				
	Old Lyme			R				
	Old Saybrook			R				
	Milford			R				
NY	Northport			R				
	Brookhaven (Port Jefferson, Mt. Sinai, Moriches, Shirley, Mastic Beach)			R				
	Orient			R				
	Montauk		G	R*		Sc	H*	L
	Hampton Bays/Shinnecock			R			H*	
	Islip	Su						
	Babylon (Oak Beach-Captree)			R				
	Hempstead (Freeport, Wantagh, Pt. Lookout, Oceanside)	Su*		R				
	Long Beach			R				
NJ	Point Pleasant	Su*				Sc*		
	Barnegat Light/Long Beach					Sc*	H*	
	Atlantic City	Su*						
	Wildwood/Avalon	Su						
	Cape May	Su*				Sc*	H*	
MD	Ocean City	Su*						
VA	Hampton/Seaford					Sc*		
	Newport News					Sc*		
Note: The fisheries and ports identified are those more likely to be impacted by this action. * Primary port								

5.5.6 Port Descriptions

Described here are several of the primary ports for the surfclam fishery. Information in this section is largely based on demographic data collected by the U.S. Census and fishery data collected by NMFS, much of which are available on the NEFSC website (NEFSC 2017c).

5.5.6.1 Hyannis/Barnstable, MA

General: Hyannis is a fishing community, a village within the town of Barnstable within Barnstable County, Massachusetts. In 2016, the town of Barnstable had a population of 44,498, a 2% decrease from the year 2010 (45,193). In 2012-2016, 0.7% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Barnstable; the poverty rate was 10.7%; and the population was 97% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for the town of Barnstable are medium-high and medium, respectively (Jepson & Colburn 2013).

In 2016, total landings in Barnstable County were valued at \$70M (dealer data), and the top five species by value were American lobsters, oysters, sea scallops, spiny dogfish, and Atlantic

surfclams (Table 15), comprising about 61% of that total. American lobsters were valued at \$16M, or 24% of total landings, landed by over 105 vessels and sold to over 42 dealers. The town of Barnstable (including Hyannis, Hyannisport, and Osterville), in 2016, was the registered homeport or primary landing port for 12 and 19 federal fishing permits (i.e., vessels), respectively (GARFO 2018) and total landings was valued at \$9.4M, 13% of the Barnstable County total and 2% of the state-wide total (\$551M; dealer data).

Surfclam fishery: In 2016, Atlantic surfclams was the fifth most valuable species landed in Barnstable County with a revenue of \$2.9M. These landings are attributed to seven Atlantic surfclam vessels, sold to seven dealers (Table 15; logbook data). The MAFMC Advisory Panel has indicated that Hyannis is one of five ports where “most of the fleet is fishing out of” (MAFMC 2018b, p. 2). The commercial surfclam fishing engagement index for the town of Barnstable (incl. Hyannis and Hyannisport) was generally low from 1990 to 2010 but was medium in 2011 and high in 2012 and 2013 (Table 11) (Colburn et al. 2017).

Other fisheries: Barnstable County contains several ports important to the fisheries potentially impacted by this action other than surfclams (Table 14). The mussel fishery is based primarily out of Chatham. For the commercial groundfish fishery, Chatham is a primary port and Harwich and Woods Hole are secondary ports. Chatham, Harwich and Falmouth are important for the recreational groundfish fishery. Chatham is a primary port for the skate fishery. Chatham, Harwich, and Barnstable are important for the scallop fishery, and Chatham is important for the lobster fishery.

Table 15 – Top five species landed by value in Barnstable County MA, 2016

Species	Nominal revenue (\$)	Vessels	Dealers
American lobster	\$16M	106	41
Oyster	\$12M	7	17
Sea scallops	\$8.5M	50	20
Spiny dogfish	\$3.1M	49	6
Atlantic surfclam	\$2.9M	7	7
Source: Surfclam data from logbooks. All other species from dealer data, as of June 8, 2018.			

5.5.6.2 Fairhaven, MA

General: Fairhaven is a fishing community in Bristol County, Massachusetts. In 2016, Fairhaven had a population of 16,078, a 1% increase from the year 2010 (15,873). In 2012-2016, 0.9% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Fairhaven; the poverty rate was 9.4%; and the population was 91% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Fairhaven are high and low, respectively (Jepson & Colburn 2013).

In 2016, total landings in Fairhaven were valued at \$22M, 4% of the state-wide total (\$551M; dealer data). The top five species by value included sea scallops, Atlantic surfclams, and whelk (Table 16), comprising 87% of that total. Sea scallops were valued at \$17M, or 77% of total landings, landed by 26 vessels and sold to eight dealers. In 2016, Fairhaven was the registered

homeport or primary landing port for 24 and 29 federal fishing permits (i.e., vessels), respectively (GARFO 2018).

Surfclam fishery: In 2016, Atlantic surfclams was one of the top five species by value in Fairhaven, with a revenue of \$1.7M. These landings are attributed to four Atlantic surfclam vessels, sold to seven dealers.

Other fisheries: Fairhaven, by itself and in combination with neighboring New Bedford, is a port important to the fisheries potentially impacted by this action other than surfclams (Table 14). New Bedford and Fairhaven combined is a primary port for the commercial groundfish fishery and for the skate, scallop, herring, and lobster fisheries.

Table 16 – Top five species landed by value in Fairhaven MA, 2016

Species	Nominal revenue (\$)	Vessels	Dealers
Sea scallop	\$17M	26	6
Atlantic surfclam	\$1.7M	4	7
Whelk	\$0.49M	11	3
<i>Note:</i> Data for one of the five top species landed are confidential.			
<i>Source:</i> Surfclam data from logbooks. All other species from dealer data, as of June 8, 2018.			

5.5.6.3 New Bedford, MA

General: New Bedford is a fishing community in Bristol County, Massachusetts. In 2016, New Bedford had a population of 94,988, a 0.1% decrease from the year 2010 (95,072). In 2012-2016, 2% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in New Bedford; the poverty rate was 23.5%; and the population was 65% white, non-Hispanic, 19% Hispanic or Latino, and 6% Black or African American alone (U.S. Census 2018). The commercial fishing engagement and reliance indices for New Bedford are high and medium, respectively (Jepson & Colburn 2013).

In 2016, total landings in New Bedford were valued at \$343M, 64% of the state-wide total (\$608M; dealer data). The top five species landed by value included sea scallops, Atlantic surfclams, American lobster, and winter flounder (Table 17), comprising 82% of that total. Sea scallops were valued at \$252M, or 73% of total landings, landed by 269 vessels and sold to 28 dealers. In 2016, New Bedford was the registered homeport or primary landing port for 223 and 245 federal fishing permits (i.e., vessels), respectively (GARFO 2018).

Surfclam fishery: In 2016, Atlantic surfclams was one of the top five species by value in New Bedford, with a revenue of \$13M. These landings are attributed to 14 Atlantic surfclam vessels, sold to 10 dealers (Table 17). The MAFMC Advisory Panel has indicated that New Bedford is one of five ports where “most of the fleet is fishing out of” (MAFMC 2018b, p. 2). The commercial surfclam fishing engagement index for New Bedford was generally medium high to high 1990 to 2010 and was high from 2011 to 2013 (Table 11, Colburn et al. 2017).

Other fisheries: New Bedford, by itself and in combination with neighboring Fairhaven, is a port important to the fisheries potentially impacted by this action other than surfclams (Table 14).

New Bedford and Fairhaven combined is a primary port for the commercial groundfish fishery and for the skate, scallop, herring, and lobster fisheries.

Table 17 – Top five species landed by value in New Bedford MA, 2016

Species	Nominal revenue (\$)	Vessels	Dealers
Sea scallop	\$252M	269	28
Atlantic surfclam	\$13M	14	10
American lobster	\$9.4M	86	19
Winter flounder	\$5.5M	59	6
<i>Note:</i> Data for one of the five top species landed are confidential.			
<i>Source:</i> Surfclam data from logbooks. All other species from dealer data, as of June 8, 2018.			

5.5.6.4 Oceanside, NY

General: Oceanside is a fishing community, a hamlet within the town of Hempstead within Nassau County, New York (Hempstead also includes the communities of Freeport, Wantagh, and Pt. Lookout). In 2016, Oceanside had a population of 30,813, a 4% decrease from the year 2010 (32,109). In 2012-2016, 0.2% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Oceanside; the poverty rate was 5.2%; and the population was 85% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Oceanside are low and medium, respectively (Jepson & Colburn 2013). In 2016, Oceanside was the registered homeport or primary landing port for two and seven federal fishing permits (i.e., vessels), respectively (GARFO 2018). In 2016 (and 2017), landings in Oceanside were confidential, so port data are not reported here further.

Surfclam fishery: Although fishing activity in Oceanside is confidential, the MAFMC Advisory Panel has indicated that it is one of five ports where “most of the fleet is fishing out of” (MAFMC 2018b, p. 2).

Other fisheries: Oceanside is a port important to the fisheries potentially impacted by this action other than surfclams, particularly the recreational groundfish fishery (Table 14).

5.5.6.5 Point Pleasant, NJ

General: Point Pleasant is a fishing community in Ocean County, NJ. In 2016, Point Pleasant had a population of 18,464, a 0.4% increase from the year 2010 (18,392). In 2012-2016, 0.6% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Point Pleasant; the poverty rate was 6.3%; and the population was 95% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Point Pleasant are high and medium, respectively (Jepson & Colburn 2013).

In 2016, total landings in Point Pleasant were valued at \$31M, 16% of the state-wide total (\$189M; dealer data). The top five species landed by value included sea scallops, summer flounder, and scup (Table 18), comprising 59% of that total. Sea scallops were valued at \$15M, or 48% of total landings, landed by 69 vessels and sold to 16 dealers. In 2016, Point Pleasant was

the homeport or primary landing port for 52 and 55 federal fishing permits (i.e., vessels), respectively (GARFO 2018).

Surfclam fishery: In 2016, Atlantic surfclams landed in Point Pleasant were valued at \$335K. These landings are attributed to seven Atlantic surfclam vessels, sold to four dealers (logbook data). The MAFMC Advisory Panel has indicated that it is one of five ports where “most of the fleet is fishing out of” (MAFMC 2018b, p. 2). The commercial surfclam fishing engagement index for Point Pleasant was generally low from 1990 to 1999 but has fluctuated between low and high since 2000 and was medium-high to high in 2011 to 2013 (Table 11) (Colburn et al. 2017).

Other fisheries: Point Pleasant is a port important to the fisheries potentially impacted by this action other than surfclams, particularly the sea scallop fishery (Table 14).

Table 18 – Top five species landed by value in Point Pleasant, 2016

Species	Nominal revenue (\$)	Vessels	Dealers
Sea scallop	\$15M	69	16
Summer flounder	\$2.1M	49	15
Scup	\$1.2M	31	12
<i>Note:</i> Data for two of the five top species landed are confidential.			
<i>Source:</i> Surfclam data from logbooks. All other species from dealer data, as of June 8, 2018.			

5.5.6.6 Atlantic City, NJ

General: Atlantic City is a fishing community within Atlantic County, New Jersey. In 2016, Oceanside had a population of 39,306, a 0.6% decrease from the year 2010 (39,558). In 2012-2016, 0.1% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Atlantic City; the poverty rate was 37%; and the population was 36% Black or African American alone, 28% Hispanic or Latino, 18% white, non-Hispanic, and 16% Asian alone (U.S. Census 2018). The commercial fishing engagement and reliance indices for Atlantic City are high and low, respectively (Jepson & Colburn 2013).

In 2016, total landings in Atlantic City were valued at \$20M, 11% of the state-wide total (\$189M; dealer data). The top five species landed by value included Atlantic surfclams, sea scallops, and American lobster (Table 19), comprising 71% of that total. In 2016, Atlantic City was the registered homeport or primary landing port for 32 and 37 federal fishing permits (i.e., vessels), respectively (GARFO 2018).

Surfclam fishery: In 2016, Atlantic surfclams was one of the top five species by value in Atlantic City, with a revenue of \$8.8M. These landings are attributed to 16 Atlantic surfclam vessels, sold to 4 dealers (Table 19). The MAFMC Advisory Panel has indicated that it is one of five ports where “most of the fleet is fishing out of” (MAFMC 2018b, p. 2). The commercial surfclam fishing engagement index for Atlantic City was low from 1990 to 2003 but was high from 2004 to 2013 (Table 11) (Colburn et al. 2017).

Other fisheries: Atlantic City is a port involved in the fisheries potentially impacted by this action other than surfclams, particularly the sea scallop and American lobster fisheries. However, Atlantic City is not considered a primary port for those fisheries (Table 14).

Table 19 – Top five species landed by value in Atlantic City, 2016

Species	Nominal revenue (\$)	Vessels	Dealers
Atlantic surfclam	\$8.8M	7	3
Sea scallop	\$2.7M	9	4
American lobster	\$0.0M	3	3
<i>Note:</i> Data for two of the five top species landed are confidential.			
<i>Source:</i> Surfclam data from logbooks. All other species from dealer data, as of June 8, 2018.			

5.6 Protected Resources

There are many species living in the affected environment for this action that are afforded protection under the Endangered Species Act of 1973 (ESA) and/or the Marine Mammal Protection Act of 1972 (MMPA). Table 20 lists protected species of marine mammals, sea turtles, and fish that occur within the management units for surfclam and ocean quahog. ‘Endangered’ or ‘threatened’ refers to status under ESA, while ‘protected’ indicates that the species is subject to MMPA provisions only. Detailed descriptions of the species listed in Table 20, including their environment, ecological relationships, and life history information including recent stock status, are available at: <http://www.greateratlantic.fisheries.noaa.gov/Protected/>.

The commercial fisheries for surfclam and ocean quahogs are mostly prosecuted with hydraulic clam dredges. An exception is the eastern Maine mahogany quahog fishery, which uses a toothed dredge but is not pertinent to this action. All dredges are considered bottom-tending mobile gears. There have been no observed or documented interactions of any protected species of marine mammals, sea turtles, or fish with hydraulic clam dredges and therefore, operation of surfclam and ocean quahog fisheries are not expected to pose an interaction risk to the species listed in (Table 20; NMFS NEFSC FSB 2018; <https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries>).

The mussel fishery is also prosecuted with dredges. Mussel dredges are not hydraulic, and are more like scallop dredges, but generally smaller, and towed more slowly. There is no fishery observer data on which to base an evaluation of mussel dredge interaction rates with protected resources. Scallop and mussel dredge gears might have similar interactions with protected species given their similar construction. Scallop dredge trips are observed at sea by scientific personnel, so we have a better understanding of the rate of interactions with specific protected species and scallop dredge gear. Interactions between scallop dredges and large whales, small cetaceans, pinnipeds, leatherback sea turtles, hawksbill sea turtles, or Atlantic salmon have never been observed or documented (NMFS NEFSC FSB 2018). Based on this, and the similarity between mussel dredges and scallop dredges, mussel dredge interactions with these species are not expected. However, scallop dredge interactions with species of hard-shelled sea turtles (i.e., loggerhead, Kemp’s ridley, and green) and Atlantic sturgeon have been observed (NMFS NEFSC FSB 2018). Based on the similarity of mussel dredges to scallop dredges, we expect

there is some potential for mussel dredges to interact with hard-shelled sea turtles and Atlantic sturgeon.

As provided in Table 20 and Map 22, North Atlantic right whale critical habitat occurs in the affected environment for this action. Critical habitat is that habitat identified as containing physical and biological features essential to the conservation of the species. For right whales, it contains the features essential for successful foraging, calving, and calf survival (NMFS 2015a). Although comprised of two areas, only the area in the Gulf of Maine and Georges Bank region (Unit 1) overlaps with the affected environment of the proposed action. Specifically, approximately half (372 nm²) of the GSC HMA overlaps with Unit 1 of critical habitat (21,334 nm²). This is 1.7% of the total right whale critical habitat. The action alternatives that propose exemption areas for the fishery have an overlap of less than 1.7% since they represent a subset of the HMA.

The boundaries of Unit 1 were defined by the distribution, aggregation and retention of *Calanus finmarchicus*, the primary and preferred prey of North Atlantic right whales, (NMFS 2015a,b). The essential physical features include prevailing currents, bathymetric features (such as basins, banks, and channels), oceanic fronts, density gradients, and flow velocities. The essential biological features include aggregations of copepods, preferably late stage *C. finmarchicus*, in the Gulf of Maine and Georges Bank region, as well as aggregations of diapausing (overwintering) populations in the deep basins of the region. NMFS (2015a,b) identified activities that may destroy or adversely modify these essential features. Navigational dredging (termed “dredging”) and commercial fisheries were amongst the activities analyzed and determined to not likely impact the identified physical or biological features of the foraging area.

“Dredging” as defined in NMFS’s critical habitat assessment (NMFS 2015a; 81 FR 4838, January 27, 2016) should not be confused with use of commercial fishing dredges, such as those used in the surfclam/ocean quahog FMP. In the assessment, dredging is in reference to the removal of material from the bottom of water bodies to deepen, widen or maintain navigation corridors, anchorages, or berthing areas, as well as for sand mining (NMFS 2015a). Dredges typically used for navigational deepening or sand mining operations include hopper and cutterhead dredges. Although dredge size varies by location, hydraulic hopper dredges have draghead widths from a few feet to 12 feet; cutterhead diameters typically range from 16-20 inches (maximum 36 inches). These dredges disturb the sediment surface down to 12 or more inches creating turbidity plumes that last up to a few hours. In contrast, the surfclam/ocean quahog fishery uses hydraulic dredges to capture shellfish by injecting pressurized water into the sediment to a depth of 8-10 inches, creating a trench up to 30 cm deep and as wide as the dredge (approximately 12 feet) (Northeast Region Essential Fish Habitat Steering Committee 2002; see Section 5.2.1 and Appendix B). The clam fishery primarily operates in sediments comprised of sand (large and fine grained), granule-pebble, and small gravel. The fine sediments are those that are principally re-suspended in the water column, creating a turbidity cloud that dissipates quickly (Northeast Region Essential Fish Habitat Steering Committee 2002; see Sections 5.3.1, 5.3.2, and Appendix B). Mussel dredges (approximately 1.8 m wide) create furrows approximately 2-5 cm deep (see Section 5.3.2).

Navigational/sand mine dredging has not been found to limit the recovery of North Atlantic right whales (NMFS 2017) or their critical habitat (NMFS 2015a). There is no evidence to suggest that this conclusion does not also hold true for dredging associated with commercial fishing operations. In terms of the surfclam/ocean quahog fishery, the scale and scope of hydraulic clam or mussel dredges is smaller than that associated with navigational/sand mining dredges. Turbidity created from such fishing dredges will be temporary in nature and will not impact the long-term viability of copepod aggregations. Fishing dredges, such as hydraulic clam or mussel dredges, may also temporarily disturb localized copepod concentrations; however, these localized patches are continually replaced and/or shifting due to the dynamic oceanographic features of the Gulf of Maine (e.g., strong current, sharp frontal gradients, high mixing rates) that have a large effect on the distribution, abundance, and concentration of zooplankton populations in within the Gulf of Maine (NMFS 2015b).

As provided above, one of the essential biological features of Unit 1 include aggregations of diapausing (overwintering) *C. finmarchicus* populations in the deep basins (i.e., Jordan, Wilkinson and Georges Basins) of the Gulf of Maine/Georges Bank Region. These basins provide refugia for diapausing populations of *C. finmarchicus* and serve as source populations for the annual recruitment of copepods into the Gulf of Maine population (Davis 1987; Meise & O'Reiley 1996; Lynch et al. 1998; Johnson et al. 2006). In late winter, diapausing *C. finmarchicus* emerge from their dormant state and migrate to the surface layer where they are advected to other areas within the Gulf of Maine by prevailing circulation patterns (Davis 1987; Baumgartner et al. 2007; Lynch et al. 1998; Johnson et al. 2006). Depending on where copepods are transported, concentrated patches of copepods within the Gulf of Maine and Georges Bank region will be variable, both spatially and seasonally. Due to the dynamic physical oceanographic features of the Gulf of Maine and Georges Bank, copepods will continuously be advected from the deep ocean basins to areas throughout the Gulf of Maine and Georges Bank region. As hydraulic clam dredges and mussel dredges do not operate in the deep basins of the Gulf of Maine, these fishing gears will not affect or disrupt diapausing *C. finmarchicus* populations that are essential for populating the region with right whales' preferred prey source. Based on this, although operation of these dredge fisheries has the potential to cause temporary and localized disturbances of aggregations of copepods, it will not result in the permanent removal of the forage base necessary for right whale recovery. In addition, operation of hydraulic clam and mussel dredges will not have any potential to affect the essential physical oceanographic features (i.e., currents, temperature, bathymetry) of critical habitat Unit 1.

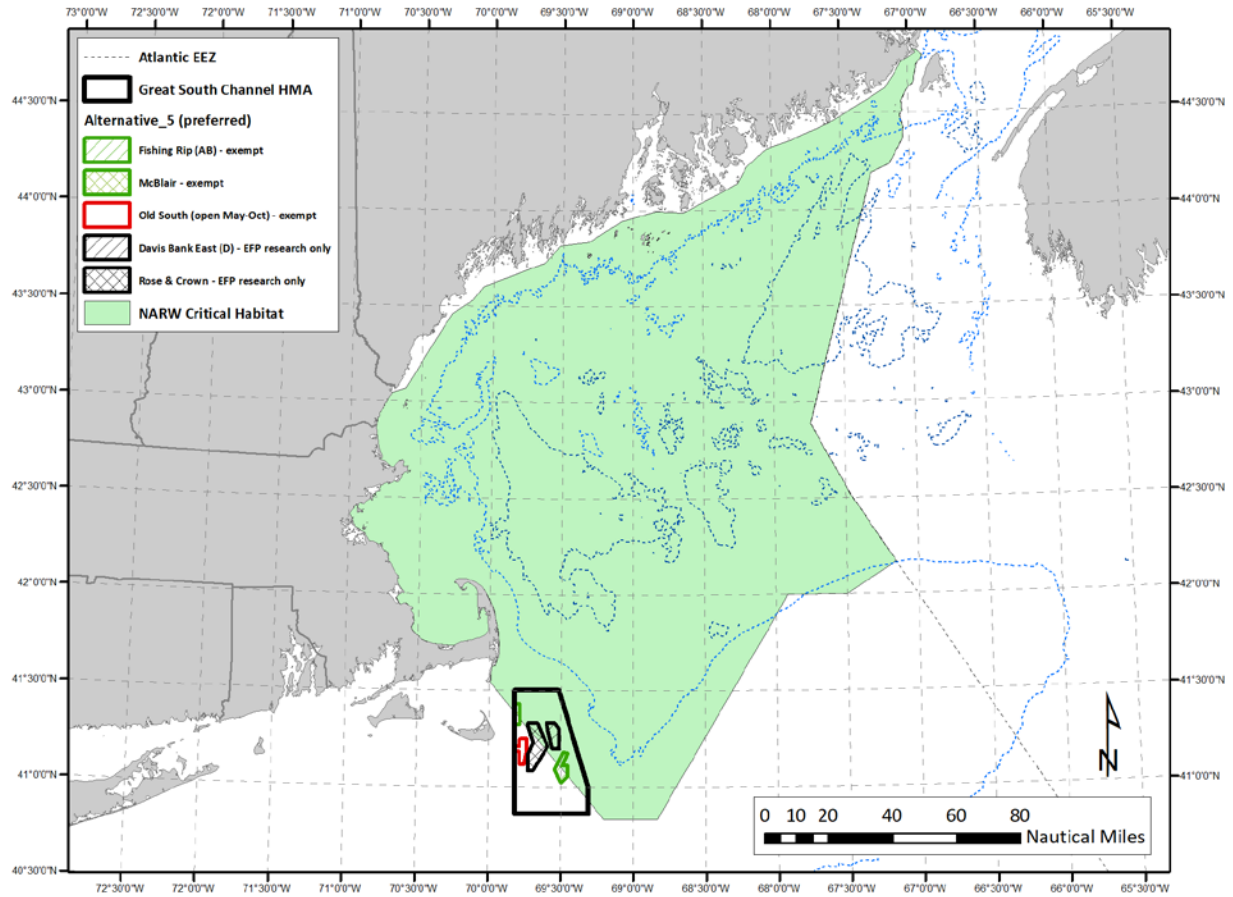
Given that (1) the impacts are temporary and localized, (2) the overlap of critical habitat and the alternatives is less than 1.7%, and (3) the activity is limited in scale and scope, the operation of the surfclam/ocean quahog fisheries will not affect the essential physical and biological features of North Atlantic right whale critical habitat and, therefore, will not result in the destruction or adverse modification of this species critical habitat (NMFS 2015a,b). The GSC HMA and proposed exemptions areas in the Great South Channel do not meet the adverse modification threshold and are not expected to impact right whale recovery.

Table 20 – Species protected under the ESA and/or MMPA that may occur in the affected environment

Species	Status	Potentially affected by this action?
Cetaceans		
North Atlantic right whale (<i>Eubalaena glacialis</i>)	Endangered	No
Humpback whale (<i>Megaptera novaeangliae</i>)	Endangered	No
Fin whale (<i>Balaenoptera physalus</i>)	Endangered	No
Sei whale (<i>Balaenoptera borealis</i>)	Endangered	No
Blue whale (<i>Balaenoptera musculus</i>)	Endangered	No
Sperm whale (<i>Physeter macrocephalus</i>)	Endangered	No
Minke whale (<i>Balaenoptera acutorostrata</i>)	Protected	No
Pilot whale (<i>Globicephala spp.</i>) ¹	Protected	No
Risso's dolphin (<i>Grampus griseus</i>)	Protected	No
Atlantic white-sided dolphin (<i>Lagenorhynchus acutus</i>)	Protected	No
Short Beaked Common dolphin (<i>Delphinus delphis</i>) ²	Protected	No
Bottlenose dolphin (<i>Tursiops truncatus</i>) ³	Protected	No
Harbor porpoise (<i>Phocoena phocoena</i>)	Protected	No
Sea Turtles		
Leatherback sea turtle (<i>Dermochelys coriacea</i>)	Endangered	No
Kemp's ridley sea turtle (<i>Lepidochelys kempii</i>)	Endangered	Yes
Green sea turtle (<i>Chelonia mydas</i>), North Atlantic DPS	Threatened	Yes
Loggerhead sea turtle (<i>Caretta caretta</i>), Northwest Atlantic Ocean DPS	Threatened	Yes
Hawksbill sea turtle (<i>Eretmochelys imbricate</i>)	Endangered	No
Fish		
Shortnose sturgeon (<i>Acipenser brevirostrum</i>)	Endangered	No
Atlantic salmon (<i>Salmo salar</i>)	Endangered	No
Atlantic sturgeon (<i>Acipenser oxyrinchus</i>)		
<i>Gulf of Maine DPS</i>	Threatened	Yes
<i>New York Bight DPS, Chesapeake Bay DPS, Carolina DPS & South Atlantic DPS</i>	Endangered	Yes
Cusk (<i>Brosme brosme</i>)	Candidate	No
Pinnipeds		
Harbor seal (<i>Phoca vitulina</i>)	Protected	No
Gray seal (<i>Halichoerus grypus</i>)	Protected	No
Harp seal (<i>Phoca groenlandicus</i>)	Protected	No
Hooded seal (<i>Cystophora cristata</i>)	Protected	No
Critical Habitat		
North Atlantic Right Whale	Protected (ESA)	No
¹ Due to the difficulties in discriminating short finned (<i>G. melas melas</i>) and long finned (<i>G. macrorhynchus</i>) pilot whales at sea, they are often just referred to as <i>Globicephala spp.</i> ² Called "common dolphin" before 2008 ³ Includes the Western N. Atlantic Offshore, Northern Migratory Coastal, and Southern Migratory Coastal Stocks.		

Clam Dredge Framework

Map 22 – North Atlantic Right Whale Critical Habitat in the Gulf of Maine, GSC HMA, and proposed action exemption areas and research areas. Additional areas of critical habitat are designated along the coasts of South Carolina, Georgia, and Florida, but are not shown here.



6 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

This section describes the potential positive and negative impacts associated with the management alternatives under consideration. These analyses are organized by valued ecosystem component (VEC) then by alternative to facilitate comparisons of costs and benefits across alternatives with respect to each VEC. While the GSC HMA is part of a regional portfolio of adverse impact minimization strategies, the analyses focus on similarities and differences in habitat features and fishing activity between different exemption areas within the HMA.

6.1 Introduction

The beginning of the section for each VEC summarizes the analytical approach specific to that ecosystem component, however the potential for effort redistribution and the terminology used to characterize impacts are relevant to analysis across all VECs and are therefore provided in this introductory section.

6.1.1 Potential for Effort Redistribution

One question relevant to the estimation of impacts across all VECs is how fishing effort is likely to redistribute should part or all the GSC HMA close to fishing with hydraulic clam dredges and what the costs of such shifts would be.⁴ Effort redistribution in response to management changes is generally difficult to predict, as effort depends on many factors, particularly the spatial distribution and relative density of the target stock. Commercial concentrations of surfclams are found primarily off New Jersey and the Delmarva Peninsula, on Nantucket Shoals and Georges Bank, and in Massachusetts state waters (Section 5.4.1.1). The Georges Bank grounds run along the northern edge of the bank between Cultivator Shoal and the western edge of Closed Area II.

The recent opening of the Nantucket Lightship (April 9, 2018) and lifting of the PSP closures on Georges Bank (2013) means there are some opportunities for effort to redistribute within New England. However, access to the Georges Bank fishing grounds is likely to require investment in new vessels, given the current fleet fishing in the GSC HMA is ill-equipped to make fishing trips that far offshore. The Georges Bank fishing grounds are the closest alternate fishing location to Nantucket Shoals. Surfclams are a quota-managed species and there is flexibility in which vessels harvest the quota, but certain factors may preclude significant short-term effort shifts onto Georges Bank. On Nantucket Shoals, depth, terrain, and current-related factors make fishing more challenging, and restrict effort to relatively small vessels, which have smaller hold capacities (number of cages). Vessels that fish on Georges Bank tend to be larger and can carry many more cages. Because clams must be landed quickly after harvest for food safety reasons, it is only economically practical to steam further offshore to catch clams if the per trip volumes are higher. Fishing on Georges Bank incurs a fixed, per-trip cost of testing the catch for paralytic shellfish poisoning (PSP) toxins, which is more economical when distributed across a greater number of cages. On-board refrigeration facilitates trips further offshore as well. Combined, these factors have led to distinct harvesting sectors for Georges Bank vs. Nantucket Shoals.

⁴ This question is not relevant for mussel dredges as there is not a fishery on Nantucket Shoals. As noted above, for the mussel fishery, exemption areas will increase access and fishing opportunities over those now available.

Shifting effort from Nantucket Shoals to Georges Bank will likely require some vessel reconfiguration.

Since the Nantucket Lightship area had been closed to clam dredges from 2004 through April 2018, the expected quality of these fishing grounds is uncertain. Surfclam fishermen have reported taking trips to the former Nantucket Lightship Habitat Closure Area during the 2018 fishing year but have indicated that the area is not particularly productive for surfclams at present, although it was fished in the past. Despite effort to do so, the Council was not able to identify 2018 trips to the Nantucket Lightship HCA in the fishery dependent clam logbook data to corroborate industry observations about catch rates.

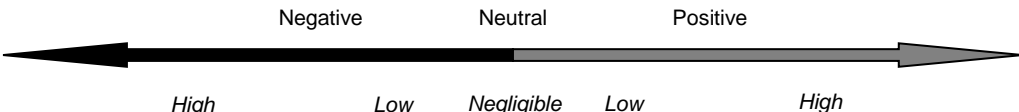
Fishing has historically occurred inshore (northwest) of the GSC HMA including within the past ten years over which VMS data were evaluated, meaning that some effort is likely to redistribute in that direction. However, the areas inshore of the HMA are open to fishing at present and have been continuously open for many years. Given that there has been relatively little effort inshore, it is likely an inferior fishing ground. Further inshore, fishing in Massachusetts state waters is subject to a variety of restrictions (see Section 5.5.2.7) and is therefore assumed to be an inferior alternative to fishing in federal waters on Nantucket Shoals.

6.1.2 Impact Analysis Approach

In discussing environmental impacts, it is important to use clear and consistent terminology within and across VECs. Table 21 explains the terms used to qualify the direction (positive, negative, or neutral) and magnitude (negligible, low, high) of impacts. The term ‘likely’ is used to suggest that impacts are possible but not certain to occur.

The impact to the resource condition is derived from the following steps: (1) a determination of the alternative’s impact direction on the resource condition and (2) the magnitude and intensity of those impacts provided by the impact qualifiers. Additional context of impacts is then provided by (3) comparing the impacts between alternatives and (4) discussing the magnitude and intensity of those impacts. Steps 1 and 2 describe the resource condition as it currently exists in the environment and steps 3 and 4 provide context and help describe the differences between alternatives. The magnitude and intensity of impacts between alternatives can be different from their magnitude compared to the baseline condition of the VEC. For example, an alternative could have a negative impact on the VEC but be highly negative compared to another alternative.

Table 21 - Terms used to summarize impacts on VECs

Impact Definition			
VEC	Direction		
	Positive (+)	Negative (-)	Neutral
Benthic habitats and EFH	Actions that improve the quality or reduce disturbance of habitat	Actions that degrade the quality or increase disturbance of habitat	Actions that have no positive or negative impact on habitat quality
Human Communities	Actions that increase revenue and social well-being of fishermen and/or associated businesses	Actions that decrease revenue and social well-being of fishermen and/or associated businesses	Actions that have no positive or negative impact on revenue and social well-being of fishermen and/or associated businesses
Managed species and protected resources	Actions that increase stock/population size	Actions that decrease stock/population size	Actions that have little or no positive or negative impacts to stocks/populations
Impact Qualifiers:			
Negligible	To a very slight degree		
Low	To a lesser degree		
High	To a substantial degree (not significant unless indicated as such)		
Likely	Some degree of uncertainty associated with the impact		
			

6.2 Benthic Habitats, EFH, and Managed Species

The habitats and managed species analysis in this action estimates the effects of closing or opening areas on benthic habitats and the managed species that use those habitats. The focus of the analysis is on comparisons among exemption areas, within the HMA, and not on comparisons between the HMA and other parts of the region. While managed species are dependent on a diversity of habitat types, complex habitats are emphasized in the analytical metrics described below because they have been found to be more vulnerable to the impacts of fishing (Section 5.2).

6.2.1 Introduction

This introduction describes data sources, methods, and overarching assumptions applied to the analysis of habitat impacts. Information and conclusions specific to each alternative follow.

6.2.1.1 Complex Habitat Metrics:

Three complex habitat-related metrics were calculated for each alternative. These data sources are described in Section 5.1. Data were not available to generate all three metrics for each exemption area. Exemption areas with low sample size are noted in the tables.

- Area covered by cobble or boulder-dominated habitat according to the SASI model base grid (combination of drop camera and grab sample sediment data)
- Percentage of drop camera survey stations characterized as complex (drop camera)
- Proportion of stable vs. unstable sediment from the Harris et al. (2012) analysis that combined modeled water flow with sediment characteristics to estimate areas of stable and unstable sediments

6.2.1.2 Hydraulic Dredging Effort as Area Swept

Annual estimates of clam dredge area swept for 2010 through 2017 are provided for each candidate exemption area. These values are intended to approximate bottom contact of the fishery within sub-areas of the HMA. This analysis was only done for clam dredges since mussel dredging was exploratory over the time period evaluated and no VTR data were available to quantify effort and understand its spatial distribution. The clam dredge swept area data sets were developed for use in Council's SASI model and recently updated Fishing Effects model. The conceptual model for hydraulic clam dredge area swept for an individual tow simply multiplies the width of the dredge times the distance covered by the tow (equation below). SASI and Fishing Effects utilize contact indices to reduce raw swept area values for gears that do not come fully in contact with the seabed. The contact index used for hydraulic dredges is 1, or 100% contact.

$$A_{hydraulic}(km^2) = d_t(w \cdot c),$$

where:

- d_t = distance towed in one tow (km)
- w = effective width of widest dredge component (km)
- c = contact index, all dredge components

While this conceptual model is at the level of a single fishing event or tow, all area swept estimates for SASI/Fishing Effects are done at the trip level. This is because the clam logbooks (as well as the vessel trip reports, which are similar, and used in all other Northeast fisheries as the record of catch), estimate effort at the trip level. The clam logbooks include a "time in fishing" value, which is intended to represent the total time that the dredge is pulled across the bottom during the trip. To estimate distance towed, a towing speed of 2 knots (2 nm/hr), was multiplied by time in fishing, in hours. These distances were then converted to kilometers.

Dredge width for trips taken during 2008 or later was set at a fixed value of 2.85 m (0.00285 km) across all vessels and trips. This width was multiplied by the distance towed per trip to obtain swept area estimates in km², as shown below.

$$\text{Area swept (km}^2 \text{ per trip)} = \frac{2 \text{ nm}}{\text{hr}} \times \text{time fishing (hr)} \times \frac{1.852 \text{ km}}{\text{nm}} \times 0.00285 \text{ km}$$

The accuracy of these estimates at the trip level is thus dependent on how closely the trips taken in the HMA adhere to the assumed towing speed and gear width, and how accurately time in fishing was reported in the logbook records. At-sea observer information would allow for independent validation of these estimates, but no trips have been observed on Nantucket Shoals.

Next, the swept area for each trip was assigned spatially using a modeling approach (DePiper 2014, Benjamin et al 2018), with the center point of each trip taken from the latitude and longitude coordinates provided in the clam logbook data. Briefly, this approach assumes most of the swept area for the trip occurred close to the reported point, but that some swept area occurs beyond the point location. See section 6.3.1.2 for more information. The estimated footprint for each trip is overlaid with the footprints from other clam dredge trips to obtain combined annual maps that estimate the distribution of swept area associated with the clam dredge fishery. See Map 23 for an example of these footprints, although with revenue distributed over the footprint instead of area swept. The last step in estimating annual swept area by exemption area was to sum swept area within each exemption area polygon using R statistical software, specifically the cellStats function from the raster package.

Note that the area swept calculations used here are additive across fishing events and make no assumptions about whether the same tow tracks are fished repeatedly. Thus, the intent is to present the total amount of bottom contact in km². If tow paths overlap, the area of seafloor contacted by the gear in any given year would be less than the area swept values presented. While industry members have indicated that fishing activity during a trip tends to be concentrated spatially, it is unknown whether tows overlap directly, or are merely adjacent or nearby to one another. Maps of speed-filtered VMS data from a series of fall 2018 ‘study fleet’ trips where positions were taken at 5-minute intervals suggests that effort is concentrated in small areas during individual fishing trips, but overlap between tow paths cannot be confirmed (William Semrau, NOAA, personal communication).

6.2.1.3 Vessel Behavior Relative to Complex Habitat

The alternatives under consideration could result in several changes to surfclam fishery effort, from shifting areas and/or seasons to potentially precluding fishing altogether. Effort shifts have follow-on impacts across all the VECs. The impacts analysis was informed by fishery data and the Council’s understanding of the general impacts of area closures and its working knowledge of the surfclam fishery. To supplement this knowledge, the PDT has had detailed discussions with clam industry members about their practices (e.g., September 18, 2018, PDT meeting summary). The input is summarized below. Statements have not necessarily been confirmed independently by the PDT.

Industry members have indicated that, while dredging, they actively try to avoid complex habitat features within the HMA. In the absence of fine scale spatial overlays between tows and habitat maps, the evidence that clam dredging activity avoids complex habitat can only come from industry accounts of their fishing practices. Captains indicate that they are continuously seeking to optimize clam catch rates during each trip, typically measured in cages filled per hour. Given product safety guidelines (i.e., time/temperature controls), time at sea is somewhat limited before the clams must be landed and processed, particularly during the warmer months. Industry members suggested that fishing in the eastern parts of the HMA (further from port) is more likely when air temperatures are cooler. During a trip, captains tend to make repeated tows in the same general location within the HMA, shifting to a different area if catch rates fall. Often captains will leave an area only to return to it later and find that catch rates have come back to previous high levels. Captains actively monitor their acoustic displays and avoid what they consider to be hard bottom. If large amounts of cobbles or rocks are encountered, they move to another nearby location to avoid damaging their gear and having to deal with lots of rocks on the deck. Avoiding coarse sediments in the first place appears to be a matter of experience and skill at interpreting sonar displays.

The analysis of fishing impacts to habitat presented here assumes that any habitats occurring within a given exemption area could be vulnerable to impact. Based on the above descriptions, it is possible that complex habitat features are avoided, thereby reducing impacts on these features at fine spatial scales. However, it is not possible to demonstrate that this avoidance is occurring. Clam vessel operators have indicated that they attempt to avoid fishing within mussel beds because any mussels captured tend to be broken and of poor product quality, such that they must be sorted from the catch. Given our knowledge of clam effort and mussel bed distributions, it is not possible to demonstrate empirically that such avoidance occurs. Thus, it should be assumed that if mussel beds do occur in a given exemption area they may be impacted by clam dredge gear, at least to some extent. In relation to the distribution of complex habitat more generally (of which mussel beds are a subset), considering the available habitat and fishery effort data within the GSC HMA, the two can only be related at scales of kilometers. At this scale, there is a clearly general correspondence between complex habitat features and clam dredging activity. Finer overlays between individual fishing events and benthic features would require fine scale habitat maps, at the scale of tens of meters, combined with start and end positions of vessel tows. This sort of habitat mapping would ideally be done with acoustic technology and groundtruthed using video or still imagery.

6.2.1.4 Caveats and assumptions

The following caveats and assumptions are important to bear in mind when considering these analyses.

- The HMA designations developed in OHA2 were based on the understanding that structured habitats enhance groundfish resource productivity by increasing the survival and growth of juveniles (see OHA2 FEIS, Volume 1 section 4.1.1, and section 5.2 of this document).

- Attached epifauna occurs throughout the HMA (see section 5.1). Some of these species live for multiple years, such that if removed, impacts could not be defined as temporary (i.e., less than one year). These species provide important habitat functions beyond those provided by the presence of gravel and rocky substrates alone.
- McBlair and Old South have no data from the drop camera survey and the habitat characteristics of these areas are therefore uncertain. Old South encompasses deeper seabed depressions between sand shoals. These depressions are assumed to have similar complex habitat features as Rose and Crown and Davis Bank East, but this assessment is uncertain. East Door (the westernmost part of the Old South exemption area) is located on a sand shoal.
- The stability of mixed beds is not straightforward (see section 5.1 for discussion). However, even if the sand fraction of the sediment in the GSC HMA is highly mobile and frequently shifting, larger grain sizes provide stable attachment sites for organisms and thus stable habitat for fish.
- Clam dredging and vulnerable habitat co-occur in space at the scale of kilometers. A higher resolution assessment that clam dredges avoid or interact with specific habitat features is impossible with available data (see section 6.2.1.3 above). Cobbles and boulders are caught in clam dredge gear, as shown by the industry-based and federal dredge surveys (see section 5.1). However, clam fishermen have indicated that the fishery avoids complex habitats to a large extent at fine spatial scales.
- In recent years, as shown in the swept area summary tables in this section, there has been interannual variability in the total amount of effort across all potential exemption areas. Furthermore, different exemption areas have waxed and waned in terms of their relative importance. Under the four action alternatives, different sections of the HMA would be open to fishing. In all cases, flexibility to choose where to harvest clams would be reduced. If area closures lead to lower catch rates, area swept estimates at the trip level could increase. This assumes that vessels would continue to harvest the same number of cages of clams per trip as they did prior to implementation of the framework. Thus, while these past estimates may serve as a general guide in terms of what swept area might look like under different alternative scenarios, patterns of effort are certain to change following implementation of the framework.

Impacts of fishing gear on benthic habitats in the HMA: Habitat feature susceptibility and recovery rates from the effects of hydraulic dredges are summarized in Section 5.3.1. Additional details are in the vulnerability assessment section of the Swept Area Seabed Impact model document (NEFMC 2011) and in Appendix B to this framework. Based on the scientific literature, hydraulic clam dredges are known to have significant adverse effects on sand- and gravel-dominated habitat. It can be inferred that they have similar impacts on mixed sand, gravel, cobble, and boulder habitats and the attached epifauna found therein. Effects of mussel dredge gear are summarized in section 5.3.2. These dredges remove mussels and other epifauna from the habitat, and it appears that some of these effects are lasting when sites are re-assessed at intervals following impact.

As noted in section 5.3.2, the effects of these gears have not been evaluated within the GSC HMA specifically, and recovery rates of cobble- and boulder-associated species in this HMA may be more rapid than assumed in the SASI vulnerability assessment and updates thereto, because Nantucket Shoals is highly dynamic relative to other locations in the Gulf of Maine and on Georges Bank. Specifically, natural disturbance and sand movement may be a more important determinant of habitat condition in the HMA than assumed in the SASI model. It is possible that these dynamics may render the impacts of fishing-related disturbance difficult to detect.

Cod spawning in the GSC HMA: The alternatives include seasonal access to the Old South area to minimize fishery impacts on cod spawning. The Council assumes that the primary conservation benefit of seasonal closures would be to eliminate the use of clam and mussel dredge gear from times and areas where cod spawning might occur. A similar rationale for seasonal cod spawning closures was in OHA2 for the new Massachusetts Bay Cod Spawning Protection Area. Finfish, including cod, are infrequently captured in clam dredges. There is no recent observer data on the capture of finfish in mussel dredges, but the Council considered finfish bycatch data when it created the Mussel and Urchin Dredge Exemption Area which overlaps the HMA, and there were no bycatch concerns at the time. Even assuming low rates of finfish bycatch in both gear types, it is reasonable to assume that spawning activity would be disturbed both by clam and mussel dredging due to noise and movement of the gear in the water alone.

Habitat benefits of seasonal closures: Seasonal exemption areas are assumed to have limited habitat benefits relative to year-round exemption areas because any benthic organisms that are impacted by dredging during the open period would only have six months to recover (re-colonize and grow) before the area opens again. Larger structure-forming epifauna typically have life spans measured in years, not months.

Mussel beds within the GSC HMA: Mussels are themselves a structure-forming epifauna species, such that their removal via fishing has a negative effect on habitat structure. Whether or not this constitutes an adverse effect to EFH arguably depends on the magnitude of removals relative to the biomass of the individual mussel bed, as well as the magnitude of mussel dredging relative to the amount of mussel beds occurring throughout the HMA overall, and the recovery rate following impact. As noted in section 5.4.1.2, the distribution of mussels in the HMA is not well understood. Since blue mussels are a relatively fast-growing species, it is likely that beds could recover from impact relatively quickly, depending on what proportion of the mussels in the bed is removed by dredging, and the interval between fishing events within the bed. Mussel industry members have suggested that a de-clumper be required of any vessel that fishes in the HMA, so that smaller mussels can be returned to the seafloor, thereby reducing impacts to the population. The survival rate of small mussels returned to the seabed is not known. The Council did not make use of a de-clumpers a requirement of their preferred exemption area alternative, but the one vessel captain who has expressed strong interest in the fishery noted that he already uses a de-clumpers when harvesting mussels from Cape Cod Bay, and presumably would do so in the GSC HMA as well.

Although the clam industry is not prohibited from fishing for mussels, industry members have explained that when they are fishing for clams, they are attempting to supply processing demands, such that there is no incentive to catch mussels. In addition, mussels are difficult to sort/process on the deck of a clam dredge vessel, and perhaps more importantly, the quality of mussels captured in hydraulic dredges is typically poor. Overall, vessels targeting surfclams avoid mussel beds whenever possible, and it seems possible to catch clams without catching large numbers of mussels. Clam dredge tows are typically less than a kilometer long, and mussel dredge tows can be even shorter. This suggests that if both mussel dredges and clam dredges were authorized to fish in an area, that the effort by the two gears may only overlap minimally, such that impacts of the two gears would be additive to one another.

6.2.2 Alternative 1/No Action

Under Alternative 1/No Action, the entire HMA will continue to be closed to all types of mobile bottom-tending gear (the one-year exemption for clam dredges expired April 9, 2019).

Volume 4, Section 3.2.5.4 of the OHA2 FEIS describes the habitat impacts associated with designation of the GSC HMA as a mobile bottom-tending gear closure with one-year exemption for clam dredges throughout most of the area.⁵ Overall, the alternative that included the GSC HMA was expected to have “slightly to moderately positive impacts on habitat, depending on clam dredge restrictions enacted over the longer term.” With an exemption for clam dredges (gear restriction Option 2 in OHA2), the alternative that included the GSC HMA was expected to have “slightly positive impacts on habitat.”

The northeastern part of the GSC HMA is already closed to mobile bottom-tending gears, regardless of which alternative is being considered (this area is identified as ‘MBTG closure’ in the habitat metrics tables). The MBTG closure has a greater percentage of cobble- or boulder-dominated habitat, a greater percentage of stations with complex habitat, and a greater percentage of observations indicating stable sediment relative to the portion of the HMA where exemptions are under consideration (Table 22). However, because the area where exemptions are being considered (total possible exemption area) is a large fraction of the HMA (87% by area), most of the cobble- or boulder-dominated habitat, observations of complex habitat, and observations of stable sediment are in the potential exemption area (Table 22). Therefore, closure of the remaining area of the HMA to clam dredges will protect these habitat types from the impacts of fishing and would have positive impacts on benthic habitat condition within the HMA, and on the species that rely on those habitats.

There was extensive discussion during development of OHA2 and this framework action as to whether complex habitat types may be ‘self-protecting’ because they are avoided by fishermen. As discussed in section 6.2.1.3, it is not possible to objectively evaluate whether or not such avoidance is occurring, and if it is, whether this mitigates the negative effects of fishing on habitat function. Clam fishermen have stated that they work to avoid habitats with large numbers

⁵ Great South Channel/Southern New England Alternative 4 from OHA2 also included designation of the Cox Ledge HMA as a closure to dredges and area where trawls would be prohibited from using ground cables, although the Cox Ledge HMA was ultimately not approved by NMFS.

of cobbles and boulders, which are of a size to be retained in the gear, because it is time consuming and therefore costly to sort these sediments from the surfclams. Nonetheless, it is presumed that any habitat features occurring in the HMA would be potentially vulnerable to the impacts of dredging.

The distribution and abundance of blue mussels within the HMA is not well understood, although the species appears to occur in various locations and at a range of depths (Map 14). Alternative 1/No Action would maintain the current prohibition on mussel dredge gears within the HMA. This will prevent the removal of mussels, a structure-forming species, and have positive impacts on benthic habitats and the managed species that use those habitats.

Managed species with distributions overlapping the HMA are described in section 5.4, and include Atlantic surfclams, Atlantic cod, winter flounder, windowpane flounder, yellowtail flounder, winter skate, little skate, Atlantic sea scallop, Atlantic herring, and American lobster. This alternative would protect the structure and function of benthic habitats used by certain life stages of these species and thereby have indirect, positive impacts on these managed resources, regardless of where they occur within the HMA. As noted in Volume 5, Section 2.2.5 of OHA2, the HMAs considered in the Great South Channel/Southern New England sub-region did not have a very strong overlap with distributional hotspots for groundfish species as compared to some of the HMAs considered and designated in other sub-regions. This analysis led to the conclusion in OHA2 that the benefits of the GSC HMA on managed groundfish would be slightly positive. However, conclusions regarding the magnitude of positive benefits of the GSC HMA on managed species, including groundfish, are somewhat uncertain, since much of Nantucket Shoals is poorly sampled in the federal trawl survey (see discussion in OHA2 Volume 1, Section 4.4).

In addition to benefits associated with protection of habitat structures, Alternative 1/No Action would prohibit all fishing with mobile bottom-tending gears in the portions of the HMA identified as cod spawning grounds. To the extent that clam dredging activity occurring at present might be disrupting cod spawning activity, this prohibition would have a positive effect on the function of the HMA as spawning habitat for the species. The current usage of these spawning grounds by Atlantic cod is not well understood. Because identified spawning grounds and seasons were excluded from other exemption area alternatives, the impacts of Alternative 1/No Action on cod spawning are likely similar to the impacts of the other four alternatives developed.

Overall, Alternative 1/No Action will have moderately positive impacts as identified in OHA2, and this action would continue to minimize the adverse impacts of fishing on EFH within the GSC HMA. No Action would have a greater magnitude of positive benefits for habitats and managed species as compared to any of the other alternatives considered, because it is the only alternative that prohibits all types of mobile bottom-tending gear throughout the HMA. However, No Action is expected to cause the largest amount of effort displacement of any of the alternatives. Therefore, the impacts of No Action on habitats outside the HMA could be negative, provided that the habitats onto which fishing is displaced are also vulnerable to impact and important to managed species.

Table 22 – Habitat metrics for Alternative 1/No Action.

Area name	Size, km ²	Area (km ²) and % where sediment is cobble- or boulder-dominated	% drop camera stations complex (sample size)	% obs indicating stable sediment
MBTG closure	332	98; 30%	86% (123)	81%
Total possible exemption area	2,234	338; 15%	59% (338)	37%
Great South Channel HMA	2,566	434; 17%	67% (461)	44%

6.2.3 Alternative 2

Under Alternative 2, clam and mussel dredging would be allowed in Rose and Crown, McBlair, Fishing Rip, Davis Bank East, and Old South. The southern portion of the Rose and Crown area as well as the Old South area would be open half the year each, in opposite seasons. The areas would be in place for five years, starting from the effective date of the final rule for the framework.

Cobble- and boulder-dominated habitats: Under Alternative 2, a total of 112 km² of cobble- and boulder-dominated habitat would be exposed to fishing, out of a total of 434 km² of this habitat type in the HMA (Table 23). This means 25% of the cobble- and boulder-dominated habitat in the HMA could be fished under this alternative, but that 75% of this habitat type would remain closed to fishing. This suggests that on average the areas included in Alternative 2 have a greater percentage of cobble- and boulder-dominated habitat than the HMA overall, which is 17% cobble- or boulder-dominated, but that by area, most of the cobble- and boulder-dominated habitats in the HMA are outside the alternative. The SASI base grid is likely to be underestimating these habitat types in the western portion of the HMA because the sampling gears used in this location to assess sediment grain size have limited ability to detect the presence of cobbles and boulders. This data limitation affects the assessment of the McBlair and Old South areas. If those two areas are removed from the calculation, cobble-and-boulder-dominated habitat accounts for 32% of the total area of Rose and Crown, Fishing Rip, and Davis Bank East, which is over twice as high as the proportion of these two habitat types in the total exemption area that is being considered within the HMA.

Complex habitats: Considering all the Alternative 2 exemption areas in combination, 87% of 103 stations examined had complex habitat as defined by the PDT for the drop camera image analysis (Table 23). Most of the stations were in the Rose and Crown area. This is a higher percentage of complex stations relative to the total exemption area (59%) and the HMA overall (67%) and is roughly comparable to the percentage observed in the MBTG closure portion (86%). However, of the 308 complex stations observed throughout the entire HMA, only 29% overlap the Alternative 2 areas. While the station locations are not distributed evenly across the HMA, and the Rose and Crown area was heavily sampled, this suggests that much of the complex habitat in the HMA lies outside the exemption areas. However, the two western areas, McBlair and East Door-Old South, cannot be evaluated using these data.

Sediment stability: Considering all of the Alternative 2 exemption areas in combination, 65% of the sediment stability observations indicate the presence of stable vs. unstable sediments (Table 23). This suggests that on average the three areas included in Alternative 2 that overlap with the stability data are more stable than the potential exemption area and the HMA overall (37% and 44% of observations, respectively), but less stable than just the MBTG closure section of the HMA (81% of observations). The two western areas, McBlair and East Door-Old South cannot be evaluated for sediment stability. There are areas of stable sediments located outside the Alternative 2 exemption areas.

Fishing effort area swept: As noted above, the exemption areas in this alternative comprise 453 km² in total (Table 23). Over the period 2010-2017, 36-58% of the total hydraulic dredge area swept in the HMA was attributed to the Alternative 2 exemption areas (Table 24). Since the exemption areas comprise less than 18% of the HMA by area, this suggests that they are disproportionately fished relative to other sections of the HMA. However, this result was expected, as the exemption areas were designed by industry members to encompass areas of the HMA most important to the fishery. Swept Area Ratio (SAR) values for the Alternative 2 areas combined range from 4-20%, depending on the year, with percentages varying between exemption areas. This indicates that in any given year, most of the seabed in each exemption area was not contacted by hydraulic dredges. Because Alternative 2 would constrain the area available to fishery, these SAR values would likely increase going forward, as harvest is concentrated into a subset of the HMA.

Blue mussel habitats: As noted previously, the distribution and abundance of blue mussels within the HMA is not well understood. Any mussel beds occurring outside the exemption areas would not be fished under Alternative 2. Known mussel beds in the Rose and Crown area, and any beds elsewhere in the potential exemption areas, could be fished. The McBlair area, which would be fishable under Alternative 2, was historically important to the mussel fishery but the present status of the resource in that area is not known.

Cod spawning areas: The only exemption area that overlaps cod spawning grounds identified by fishermen is Old South, and this exemption area would be closed between November 1 and April 30 when spawning is likely to occur. Other cod spawning grounds are found within what would be the closed portion of the HMA.

Conclusions: The habitat data available for Alternative 2 are almost totally limited to three areas that make up 77% of the total Alternative 2 area. In these three areas, the proportions of cobble and boulder-dominated, complex, and stable habitats are considerably higher than both the HMA overall and the total area that the Council considered for a continued clam dredge exemption. These are habitats that are vulnerable to the adverse effects of clam and mussel dredging. These data indicate that the Alternative 2 exemptions will have negative effects on vulnerable bottom habitats within the HMA relative to Alternative 1/No Action, reducing the benefits that these habitats provide to managed species. The seasonal closures of southern Rose and Crown and Old South are not expected to confer substantial positive habitat benefits.

However, there are additional areas of vulnerable habitat within the rest of the HMA that would remain closed to all mobile, bottom-tending gear. Further, within the Alternative 2 exemption areas, area swept data indicate that 4-20% of the area included in this alternative was fished annually between 2010 and 2017 (Table 25). While these estimates are based on logbook fishing locations and therefore somewhat uncertain, they suggest that most of the seabed in the exemption areas is not contacted on an annual basis. On the other hand, cumulatively, assuming effort shifts spatially over the longer time horizon required for habitat recovery of longer-lived epifauna, it is likely that a larger percentage of the exemption areas would be contacted by fishing gear within the time frame required for complete habitat recovery. In addition, with less area accessible to the fishery under Alternative 2 as compared to the 2010-2017 period, effort is likely to become more concentrated within the exemption areas. Overall, considering the habitat composition of the exemption areas in the context of the area swept data, this set of exemption areas will likely have a negative impact on seafloor habitats compared to Alternative 1/No Action. Alternative 2 is expected to have more negative impacts on seafloor habitats than Alternatives 3, 4, and 5 because it includes a larger portion of the seafloor and is composed of a higher proportion of vulnerable habitat. However, the effects of concentrating fishing effort within the areas that would remain open will be reduced under Alternative 2 as compared to other alternatives because the total access area is larger, 453 km² or 17.6% of the HMA.

The occurrence of mussel beds in the Rose and Crown area suggests that there would be some negative impacts of Alternative 2 on mussel beds, although the magnitude of this impact is uncertain, given that the total extent of the beds is unknown. If fishing is limited to just a few beds, and considering that blue mussels grow rapidly, impacts to mussel beds could be only slightly negative. On the other hand, if there are not many beds in the exemption areas and there is a significant increase in mussel harvesting within these beds, the negative impacts would be more severe. Although clam fishermen have stated that they avoid fishing in mussel beds when possible, clam dredges are likely to negatively impact mussel beds occurring in the Alternative 2 exemption areas, at least to some extent.

Managed species with distributions overlapping the HMA are described in section 5.4, and include Atlantic surfclams, Atlantic cod, winter flounder, windowpane flounder, yellowtail flounder, winter skate, little skate, Atlantic sea scallop, Atlantic herring, and American lobster. Under Alternative 2, the structure and function of benthic habitats used by certain lifestages of these species would be negatively affected. Therefore, this alternative would have indirect, negative impacts on these managed resources. Conclusions regarding the magnitude of negative impacts are somewhat uncertain, since much of Nantucket Shoals is poorly sampled in the federal trawl survey (see discussion in OHA2 Volume 1, Section 4.4).

While cod spawning grounds occur within these exemption areas, locations overlapping spawning grounds would be closed during the spawning season, thereby mitigating the impacts of dredging on cod spawning activities. Thus, Alternative 2 likely has similar positive impacts on cod spawning activity and cod spawning habitat as would a complete closure under Alternative 1/No Action.

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Table 23 – Habitat metrics for Alternative 2. Note that some parts of the HMA cannot be evaluated for habitat complexity or stability.

Area name	Size, km ²	Area km ² (% area) where sediment is cobble- or boulder-dominated	% of drop camera stations complex (sample size)	% obs indicating stable sediment
McBlair	38	0; 0%*	n/a	n/a
Old South	64	3; 5%*	n/a	n/a
Rose and Crown	192	75; 39%	89% (n=82)	76%
Davis Bank East	84	29; 35%	79% (n=14)	79%
Fishing Rip	75	8; 11%	86% (n=7)	24%
<i>Total Alternative 2</i>	<i>453</i>	<i>112; 25%</i>	<i>87% (n=103)</i>	<i>65%</i>
MBTG closure	332	98; 30%	86% (n=123)	81%
Total possible exemption area	2,234	338; 15%	59% (n=338)	37%
Total Great South Channel HMA	2,566	434; 17%	67% (n=461)	44%

* These areas are not well sampled with gears capable of detecting cobble and boulder substrates

Table 24 – Annual fishing effort as area swept (km²) in the Alternative 2 exemption areas. Although two of the areas would be seasonal under this alternative, these are annual totals. The exemption areas combined cover 453 km². The Swept Area Ratio section of the table shows the relationship between swept area and area size.

Swept Area	2010	2011	2012	2013	2014	2015	2016	2017
McBlair	1.21	1.42	1.16	1.35	1.13	2.58	1.27	0.38
Old South	3.79	6.75	4.69	8.11	23.19	18.20	24.37	6.99
Rose and Crown	8.31	10.74	37.4	36.42	46.95	37.77	27.47	13.48
Davis Bank East	6.77	0.69	4.73	12.05	8.35	9.36	12.71	6.27
Fishing Rip	1.17	0.30	1.25	9.72	11.69	6.94	7.59	8.77
<i>Total Alternative 2</i>	<i>21.25</i>	<i>19.91</i>	<i>49.24</i>	<i>67.64</i>	<i>91.30</i>	<i>74.84</i>	<i>73.42</i>	<i>35.88</i>
Total Great South Channel HMA	39.22	40.17	85.56	135.69	160.52	134.59	157.02	99.42
<i>Percent of total area swept attributed to Alternative 2</i>	<i>54%</i>	<i>50%</i>	<i>58%</i>	<i>50%</i>	<i>57%</i>	<i>56%</i>	<i>47%</i>	<i>36%</i>
Swept Area Ratio	2010	2011	2012	2013	2014	2015	2016	2017
McBlair	3%	4%	3%	4%	3%	7%	3%	1%
Old South	6%	11%	7%	13%	36%	28%	38%	11%
Rose and Crown	4%	6%	19%	19%	24%	20%	14%	7%
Davis Bank East	8%	1%	6%	14%	10%	11%	15%	7%
Fishing Rip	2%	0%	2%	13%	16%	9%	10%	12%
Overall SAR Alternative 2	5%	4%	11%	15%	20%	17%	16%	8%
Overall SAR GSC HMA	2%	2%	3%	5%	6%	5%	6%	4%

6.2.4 Alternative 3

Under Alternative 3, clam dredging would be allowed in Rose and Crown. Mussel dredging would be allowed under Sub-option 1 but prohibited under Sub-option 2.

Cobble- and boulder-dominated habitats: Under Alternative 3 (Rose and Crown), a total of 75 km² of cobble- and boulder-dominated habitat is exposed to fishing. There is a total of 434 km² of this habitat type in the HMA (Table 25). This means 17% of the cobble- and boulder-dominated habitat in the HMA could be fished under this alternative, but that 83% of this habitat type would remain closed to fishing. On average the Rose and Crown area has a greater percentage of cobble- and boulder-dominated habitat (39% of the 192 km² area) than the HMA overall, which is 17% cobble- or boulder-dominated (Table 25).

Complex habitats: Within the Rose and Crown area that comprises Alternative 3, 89% of 82 stations examined had complex habitat as defined by the PDT for the drop camera image analysis (Table 25). This is a higher percentage of complex stations than in the HMA overall (67%) or in the total possible exemption area (59%) and slightly higher than the percentage observed in the MBTG closure portion. However, of the 308 complex stations observed throughout the entire HMA, only 24% overlap the Rose and Crown Area (29% overlap Alt 2). This indicates that many areas of complex habitat lie outside the exemption area and therefore would remain protected from gear impacts under Alternative 3.

Sediment stability: Within the Rose and Crown area that comprises Alternative 3, 76% of the sediment stability observations indicate the presence of stable vs. unstable sediments. For comparison, 65% of the Alternative 2 observations and 81% of the MBTG closure observations indicate stable sediments. This suggests that on average Rose and Crown area is more stable than the HMA overall, and more stable than the Alternative 2 areas in combination, but slightly less stable than just the MBTG closure section of the HMA. As for the other action alternatives, there are areas of stable sediments located outside the Alternative 3 exemption areas.

Fishing effort area swept: The Rose and Crown exemption area covers 192 km² or 8% of the HMA (Table 25). Over the period 2010-2017, 14-44% of the total hydraulic dredge area swept in the HMA was attributed to the Rose and Crown exemption area, which indicates that Rose and Crown was disproportionately fished relative to other sections of the HMA (Table 26). This result was expected, as the exemption areas were designed by industry members to encompass areas of the HMA most important to the fishery. Swept Area Ratio (SAR) values for the Rose and Crown area ranges from 4-24%, depending on the year. This indicates that in any given year, most of the seabed in the Rose and Crown area was not contacted by hydraulic dredges. These SAR values would likely increase going forward, as clam harvest under Alternative 3 would be allowed in the Rose and Crown area only. This concentration would be more pronounced as compared to Alternative 2, which provides access to a larger subset of the HMA.

Blue mussel habitats: As noted previously, the distribution and abundance of blue mussels within the HMA is not well understood. Mussel beds are known to occur in the Rose and Crown area, and these could be fished under Sub-option 1. However, any mussel beds occurring outside Rose and Crown would not be fishable under Sub-Option 1. Mussel dredges would be prohibited from the HMA under Sub-option 2.

Cod spawning areas: The Rose and Crown exemption area does not overlap cod spawning grounds identified by fishermen. All identified cod spawning grounds are within what would be the closed portion of the HMA.

Conclusions: The Rose and Crown exemption area considered under Alternative 3 encompasses complex, cobble- and boulder-dominated habitats estimated to be stable under typical water flows, which are habitat types which are adversely affected by clam and mussel dredging. This indicates that clam and mussel dredging in the Alternative 3 exemption area would have negative effects on habitats within the HMA, reducing the benefits that these habitats provide to managed species.

Swept Area Ratios indicate that 4-24% of the Rose and Crown area was fished annually between 2010 and 2017 (Table 26). During that time, 14-44% of the total area swept by the gear in the HMA was attributed to the Rose and Crown exemption area. While these estimates are based on logbook fishing locations and therefore somewhat uncertain, they suggest that most of the seabed in the HMA is not contacted on an annual basis. However, cumulatively, assuming effort shifts spatially over the longer time horizon required for habitat recovery, it is likely that gear impacts extend over a larger percentage of the HMA than is indicated by the annual area swept estimates. In addition, with less area accessible to the fishery under Alternative 3 as compared to the 2010-2017 period, effort is likely to become more concentrated within the Rose and Crown area if it is the only portion of the HMA that remains open. Overall, relative to No Action, allowing access to the Rose and Crown area is expected to have a negative to low negative impact on seafloor habitats. The impacts of Alternative 3 are expected to be less negative than Alternative 2, similar to Alternative 4, and more negative than Alternative 5, based on the amount of complex habitat vulnerable to fishing included within each alternative.

The occurrence of mussel beds in the Rose and Crown area suggests that there would be some negative impacts of Alternative 3 on mussel beds, although the magnitude of this impact is uncertain, given that the total extent of the beds is unknown. **Sub-Option 1** would allow mussel dredging. If mussel dredging is limited to just a few beds, and considering that blue mussels grow rapidly, impacts to mussel beds could be only slightly negative. On the other hand, if there are not many beds in the exemption area and there is a significant increase in mussel harvesting within these beds, the negative impacts would be more severe. Although clam fishermen have stated that they avoid fishing in mussel beds when possible, clam dredges are likely to negatively impact mussel beds occurring in the Alternative 3 exemption area, at least to some extent. **Sub-Option 2** would not allow mussel dredging within the Rose and Crown area, mitigating to some extent the negative impacts on mussel habitats.

Managed species with distributions overlapping the HMA are described in section 5.4, and include Atlantic surfclams, Atlantic cod, winter flounder, windowpane flounder, yellowtail flounder, winter skate, little skate, Atlantic sea scallop, Atlantic herring, and American lobster. Under Alternative 3, the structure and function of benthic habitats used by certain lifestages of these species would be negatively affected. Therefore, this alternative would have indirect, slightly negative to negative impacts on these managed resources. Conclusions regarding the

magnitude of negative impacts are somewhat uncertain, since much of Nantucket Shoals is poorly sampled in the federal trawl survey (see discussion in OHA2 Volume 1, Section 4.4).

Cod spawning grounds are not known to occur in the Rose and Crown Area. Thus, Alternative 3 likely has similar positive impacts to cod spawning activity and cod spawning habitat as would a complete closure under Alternative 1/No Action.

Table 25 – Habitat metrics for Alternative 3. Note that some parts of the HMA cannot be evaluated for habitat complexity or stability.

Area name	Size, km ²	Area (km ²) and % where sediment is cobble- or boulder-dominated	% drop camera stations complex (sample size)	% obs indicating stable sediment
Rose and Crown	192	105; 39%	89% (82)	76%
MBTG closure	332	98; 30%	86% (123)	81%
Total possible exemption area	2,234	338; 15%	59% (338)	37%
Great South Channel HMA	2,566	434; 17%	67% (461)	44%

Table 26 – Annual fishing effort as area swept (km²) in the Alternative 3 exemption area. The Swept Area Ratio section of the table shows the relationship between swept area and area size.

	2010	2011	2012	2013	2014	2015	2016	2017
Rose and Crown	8.31	10.75	37.40	36.43	46.95	37.76	27.48	13.48
Total Great South Channel HMA	39.22	40.17	85.56	135.69	160.52	134.59	157.02	99.42
Percent of area swept attributed to Rose and Crown	21%	27%	44%	27%	29%	28%	18%	14%
Swept Area Ratio	2010	2011	2012	2013	2014	2015	2016	2017
Rose and Crown	4%	6%	19%	19%	24%	20%	14%	7%
Overall SAR GSC HMA	2%	2%	3%	5%	6%	5%	6%	4%

6.2.5 Alternative 4

Under Alternative 4, clam dredging would be allowed in McBlair, Area A, Davis Bank East, and Old South. Old South would be open only half the year. Mussel dredging would be allowed under Sub-option 1 but prohibited under Sub-option 2.

Cobble- and boulder-dominated habitats: Data available for the McBlair and Old South areas are not very reliable because the sampling gears used in this location to assess sediment grain size have limited ability to detect the presence of cobbles and boulders. Assuming that cobble- and boulder-dominated habitats may be underrepresented within these two areas, under Alternative 4, at least 40 km² (9%) of cobble- and boulder-dominated habitat would be exposed to fishing, out of a total of at least 434 km² of this habitat type in the HMA (Table 27). The fraction of the alternative that is cobble- or boulder-dominated is 17%, which indicates that on average the areas included in Alternative 4 have about the same percentage of cobble- and boulder-dominated habitat relative to the HMA overall. Again, this may be an underestimate

given data quality in McBlair and Old South and their immediate surrounds as compared to the remainder of the HMA.

Complex habitats: Data for this metric are limited to 19 stations in two of the four areas included in this alternative, 16 of which were complex (Table 28). Although a low sample size, this is a higher percentage (84%) of complex stations relative to the HMA overall (67%) and roughly comparable to the percentage observed in the MBTG closure portion. The two western areas, McBlair and Old South cannot be evaluated using these data because they were not surveyed. Of the 308 complex stations observed throughout the entire HMA, only 5% overlap the areas included in Alternative 4.

Sediment stability: 68% of the sediment stability observations indicate the presence of stable vs. unstable sediments in the two areas that were surveyed (Table 27). This suggests that on average the areas included in Alternative 4 that overlap with the stability data are more stable than the HMA overall, but less stable than just the MBTG closure section of the HMA. A caveat here is that the two western areas, McBlair and Old South cannot be evaluated for sediment stability. As for the other action alternatives, there are areas of stable sediments located outside the Alternative 4 exemption areas.

Fishing effort area swept: As noted above, the exemption areas in this alternative comprise 242 km² in total (Table 27). Over the period 2010-2017, 13-33% of the total hydraulic dredge area swept in the HMA was attributed to the Alternative 4 exemption areas (Table 28). Since the exemption areas comprise less than 10% of the HMA, this suggests that they are disproportionately fished relative to other sections of the HMA. However, this result was expected, as the exemption areas were designed by industry members to encompass areas of the HMA most important to the fishery. Swept Area Ratio (SAR) values for the Alternative 4 areas combined range from 4-18%, depending on the year, with percentages varying between exemption areas. This indicates that in any given year, most of the seabed in each exemption area was not contacted by hydraulic dredges. Because Alternative 4 would constrain the area available to fishery, these SAR values would likely increase going forward, as harvest is concentrated into a subset of the HMA.

Blue mussel habitats: As noted previously, the distribution and abundance of blue mussels within the HMA is not well understood. Any mussel beds occurring outside the exemption areas, including the beds in and around the Rose and Crown area, would not be fished under Alternative 4. The McBlair area which would be fishable under Alternative 4 was historically important to the mussel fishery but the present status of the mussel resource in that area is not known. Mussel dredges would be allowed in the exemption areas under Sub-Option 1 but prohibited from the HMA under Sub-option 2.

Cod spawning areas: The only exemption area that overlaps cod spawning grounds identified by fishermen is Old South, and this exemption area would be closed between November 1 and April 30 when spawning is likely to occur. Other cod spawning grounds are found within what would be the closed portion of the HMA.

Conclusions: The exemption areas considered under Alternative 4 encompass complex, cobble- and boulder-dominated habitats estimated to be stable under typical water flows, which are habitat types which would be adversely affected by clam and mussel dredging. This indicates that the Alternative 4 exemptions would have negative effects on vulnerable habitats within the HMA relative to Alternative 1/No Action, reducing the benefits that these habitats provide to managed species. The seasonal closure of Old South is not expected to confer substantial positive habitat benefits.

However, there are additional areas of vulnerable habitat within the rest of the HMA that would remain closed to all mobile, bottom-tending gear. Further, area swept data indicate that 4-18% of the exemption areas in this alternative were fished annually during 2010-2017 (Table 29). While these estimates are based on logbook fishing locations and therefore somewhat uncertain, they suggest that most of the seabed in the HMA is not contacted on an annual basis. On the other hand, cumulatively, assuming effort shifts spatially over the longer time horizon required for habitat recovery of longer-lived epifauna, it is likely that a larger percentage of the HMA is contacted by fishing gear. In addition, with less area accessible to the fishery under Alternative 4 as compared to the 2010-2017 period, effort is likely to become more concentrated within the exemption areas. This concentration will be more pronounced than under Alternative 2, which affords access to additional sections of the HMA. Overall, considering the habitat composition of the exemption areas in the context of the area swept data, these exemptions are expected to have a negative to low negative impact on seafloor habitats compared to Alternative 1/No Action. The impacts of Alternative 4 are expected to be less negative than Alternative 2, similar to Alternative 3, and more negative than Alternative 5, based on the amount of complex habitat vulnerable to fishing included within each alternative.

The past occurrence of mussel beds in the McBlair area suggests that there could be some negative impacts of Alternative 4 on mussel beds, although the magnitude of this impact is uncertain, given that the current occurrence and extent of mussel beds in this area is unknown.

Sub-Option 1 would allow mussel dredging. If mussel dredging is limited to just a few beds, and considering that blue mussels grow rapidly, impacts to mussel beds could be only slightly negative. On the other hand, if there are not many beds in the exemption area and there is a significant increase in mussel harvesting within these beds, the negative impacts would be more severe. Although clam fishermen have stated that they avoid fishing in mussel beds when possible, clam dredges are likely to negatively impact mussel beds occurring in the Alternative 4 exemption areas, at least to some extent. **Sub-Option 2** would not allow mussel dredging within the exemption areas, mitigating to some extent the negative impacts on mussel habitats.

Managed species with distributions overlapping the HMA are described in section 5.4, and include Atlantic surfclams, Atlantic cod, winter flounder, windowpane flounder, yellowtail flounder, winter skate, little skate, Atlantic sea scallop, Atlantic herring, and American lobster. Under Alternative 4, the structure and function of benthic habitats used by certain lifestages of these species would be negatively affected. Therefore, this alternative would have indirect, slightly negative to negative impacts on these managed resources. Conclusions regarding the

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magnitude of negative impacts are somewhat uncertain, since much of Nantucket Shoals is poorly sampled in the federal trawl survey (see discussion in OHA2 Volume 1, Section 4.4).

Cod spawning grounds overlap the Old South exemption area, although this area would be closed during the spawning season, mitigating any impacts of fishing on cod spawning activities. Thus, Alternative 4 likely has similar positive impacts to cod spawning activity and cod spawning habitat as would a complete closure under Alternative 1/No Action.

Table 27 – Habitat metrics for Alternative 4. Note that some parts of the HMA cannot be evaluated for habitat complexity or stability.

Area name	Size, km ²	Area (km ²) and % where sediment is cobble- or boulder-dominated	% drop camera stations complex (sample size)	% obs indicating stable sediment
McBlair	38	0; 0%*	n/a	n/a
Old South	64	6; 5%*	n/a	n/a
Davis Bank East	84	40; 35%	79% (14)	79%
Area A	56	12; 13%	100% (5)	22%
<i>Total Alternative 4</i>	<i>242</i>	<i>58; 24%</i>	<i>84% (19)</i>	<i>68%</i>
MBTG closure	332	98; 30%	86% (123)	81%
Total possible exemption area	2,234	338; 15%	59% (338)	37%
Great South Channel HMA	2,566	434; 17%	67% (461)	44%

* These areas are not well sampled with gears capable of detecting cobble and boulder substrates

Table 28 – Annual fishing effort as area swept (km²) in the Alternative 4 exemption areas. Although East Door/Old South would be seasonal under this alternative, these are annual totals. The Alternative 4 exemption areas combined cover 242 km². The Swept Area Ratio section of the table shows the relationship between swept area and area size.

Area	2010	2011	2012	2013	2014	2015	2016	2017
McBlair	1.21	1.42	1.16	1.35	1.13	2.58	1.27	0.38
Old South	3.79	6.75	4.69	8.11	23.19	18.20	24.37	6.99
Davis Bank East	6.77	0.69	4.73	12.05	8.35	9.36	12.71	6.27
Area A	1.13	0.30	0.81	7.01	10.38	5.66	5.71	7.54
<i>Total Alternative 4</i>	<i>12.89</i>	<i>9.16</i>	<i>11.39</i>	<i>28.51</i>	<i>43.04</i>	<i>35.79</i>	<i>44.07</i>	<i>21.17</i>
Total Great South Channel HMA	39.22	40.17	85.56	135.69	160.52	134.59	157.02	99.42
<i>Percent of area swept attributed to Alternative 4</i>	<i>33%</i>	<i>23%</i>	<i>13%</i>	<i>21%</i>	<i>27%</i>	<i>27%</i>	<i>28%</i>	<i>21%</i>
Swept Area Ratio	2010	2011	2012	2013	2014	2015	2016	2017
McBlair	3%	4%	3%	4%	3%	7%	3%	1%
Old South	6%	11%	7%	13%	36%	28%	38%	11%
Davis Bank East	8%	1%	6%	14%	10%	11%	15%	7%
Area A	2%	1%	1%	13%	19%	10%	10%	13%
Overall SAR Alternative 4	5%	4%	5%	12%	18%	15%	18%	9%
Overall SAR GSC HMA	2%	2%	3%	5%	6%	5%	6%	4%

6.2.6 Alternative 5 (Preferred)

Under Alternative 5, both clam and mussel dredging would be allowed in McBlair, Fishing Rip, and Old South. Old South would be open half the year.

Cobble- and boulder-dominated habitats: Data available for the McBlair and Old South areas are not very reliable because the sampling gears used in this location to assess sediment grain size have limited ability to detect the presence of cobbles and boulders. Assuming that cobble- and boulder-dominated habitats may be underrepresented within these two areas, under Alternative 4, at least 11 km² of cobble- and boulder-dominated habitat would be exposed to fishing, out of a total of at least 434 km² of this habitat type in the HMA (2.5%; Table 29). The fraction of the alternative that is cobble- or boulder-dominated is 6%, indicating that the areas in Alternative 4 have a lower percentage of cobble- and boulder-dominated habitat on average relative to the HMA overall. Again, this may be an underestimate given data quality in McBlair and Old South and their immediate surrounds relative to the remainder of the HMA.

Complex habitats: The two western areas, McBlair and East Door-Old South, cannot be evaluated using these drop camera survey data. Within the Fishing Rip area, habitat complexity was assessed at only 7 stations. Six of them met the criteria for complex habitat as defined by the PDT. Although a low sample size, this is a higher percentage (86%) of complex stations relative to the HMA overall (67%) and is the same as the percentage observed in the MBTG closure portion. Due to the absence of any data from two of the three areas included in this alternative and the low survey coverage in the Fishing Rip area, only six of the 308 complex stations observed throughout the entire HMA were in the Alternative 5 areas. Given that two of the three exemption areas cannot be evaluated using this metric, and the sample size is small within the Fishing Rip area, the complexity estimate for this alternative is not very informative.

Sediment stability: The two western areas, McBlair and Old South cannot be evaluated for sediment stability. Within the Fishing Rip area, 24% of the sediment stability observations indicate the presence of stable vs. unstable sediments. As for the other action alternatives, there are areas of stable sediments located outside the Alternative 5 exemption areas.

Fishing effort area swept: The exemption areas in this alternative comprise 177 km² in total. Over the period 2010-2017, 8-22% of the total hydraulic dredge area swept in the HMA was attributed to the Alternative 5 exemption areas (Table 30). Since the exemption areas comprise less than 7% of the HMA, this suggests that they are disproportionately fished relative to other sections of the HMA. However, this result was expected, as the exemption areas were designed by industry members to encompass areas of the HMA most important to the fishery. Swept Area Ratio (SAR) values for the Alternative 5 areas combined range from 3-20%, depending on the year, with percentages varying between exemption areas. This indicates that in any given year, most of the seabed in each exemption area was not contacted by hydraulic dredges. Because Alternative 5 would constrain the area available to fishery, these SAR values would likely increase going forward, as harvest is concentrated into a subset of the HMA.

Blue mussel habitats: As noted previously, the distribution and abundance of blue mussels within the HMA is not well understood. Any mussel beds occurring outside the exemption areas,

including the beds in and around the Rose and Crown area, would not be fished under Alternative 4. The McBlair area which would be fishable under Alternative 4 was historically important to the mussel fishery but the present status of the mussel resource in that area is not known.

Cod spawning areas: The only exemption area that overlaps cod spawning grounds identified by fishermen is Old South, and this exemption area would be closed between November 1 and April 30 when spawning is likely to occur. Other cod spawning grounds are found within what would be the closed portion of the HMA.

Conclusions: The exemption areas considered under Alternative 5 encompass complex, cobble- and boulder-dominated habitats estimated to be stable under typical water flows, which are habitat types that are adversely affected by clam and mussel dredging. This suggests that the Alternative 5 exemptions will have negative effects on habitats within the HMA, reducing the benefits that these habitats provide to managed species. This conclusion is, however, more uncertain than the impact conclusions reached for the other action alternatives because the two data-poor areas (McBlair and Old South) account for a larger proportion (58%) of the total exemption area being considered. Despite this uncertainty, because this alternative would limit the access areas to a smaller proportion of the HMA than the other three action alternatives, the negative impacts of this alternative are expected to be less pronounced. The seasonal closure of Old South is not expected to confer substantial positive habitat benefits.

Swept area ratios suggest bottom contact with hydraulic dredges is approximately 3-20% annually within the exemption areas (Table 30). While these estimates are based on logbook fishing locations and therefore somewhat uncertain, they suggest that most of the seabed in the exemption areas is not contacted on an annual basis. Over the same timeframe, swept area ratios ranged from 2-6% for the GSC HMA overall. However, considering a longer, multi-year time horizon, and considering that effort appears to shift spatially between years, a larger percentage of seafloor is impacted over the period that would be required for recovery of longer-lived structure-forming organisms. Over this period, only 8-22% of the swept area within the HMA was attributed to the McBlair, Old South, and Fishing Rip locations. With less area accessible to the fishery under Alternative 5 relative to the 2010-2017, effort is likely to become more concentrated within the exemption areas, leading to higher swept area ratios and more substantial negative impacts within these locations.

The past occurrence of mussel beds in the McBlair area suggests that there could be some negative impacts of Alternative 5 on mussel beds, although the magnitude of this impact is uncertain, given that the current occurrence and extent of mussel beds in this area is unknown. If mussel dredging is limited to just a few beds, and considering that blue mussels grow rapidly, impacts to mussel beds could be only slightly negative. On the other hand, if there are not many beds in the exemption area and there is a significant increase in mussel harvesting within these beds, the negative impacts would be more severe. Although clam fishermen have stated that they avoid fishing in mussel beds when possible, clam dredges are likely to negatively impact mussel beds occurring in the Alternative 5 exemption areas, at least to some extent.

Managed species with distributions overlapping the HMA are described in section 5.4, and include Atlantic surfclams, Atlantic cod, winter flounder, windowpane flounder, yellowtail flounder, winter skate, little skate, Atlantic sea scallop, Atlantic herring, and American lobster. Under Alternative 5, the structure and function of benthic habitats used by certain lifestages of these species would be negatively affected. Therefore, this alternative would have indirect, slightly negative impacts on these managed resources. Conclusions regarding the magnitude of negative impacts are somewhat uncertain, since much of Nantucket Shoals is poorly sampled in the federal trawl survey (see discussion in OHA2 Volume 1, Section 4.4).

Cod spawning grounds also occur within these exemption areas, although locations overlapping cod spawning grounds would be closed during the spawning season, mitigating any impacts of fishing on cod spawning activities. Thus, Alternative 5 likely has similar positive impacts to cod spawning activity and cod spawning habitat as would a complete closure under Alternative 1/No Action.

As with all the approaches under consideration, there are tradeoffs associated with redirection of fishing activity under Alternative 5. It may not be possible to maintain previous catch levels within the three exemption areas identified in this alternative, and if this occurs, surfclams will be harvested from other grounds instead. It is not possible to know where fishing effort will be redirected under this alternative, but if dredging is redirected into other vulnerable habitats, the net effects of Alternative 5 could be negative in areas outside the HMA. Possible scenarios could include fishing surfclam beds in the Mid-Atlantic Bight, where habitat impacts are generally of less concern. Alternatively, with reinvestment in larger vessels, surfclams could be taken from Georges Bank. Finally, some surfclams could be harvested inshore of the GSC HMA. It is possible that all three of these areas could be fished, or that other locations might be targeted as well.

Under Alternative 5, clam and mussel dredging will only be allowed in 7% of the HMA. Considering what is known about habitat composition of the exemption areas in the context of the area swept data, these exemptions will likely have a low negative impact on seafloor habitats compared to Alternative 1/No Action, i.e. negative to slightly negative impacts. Alternative 5 is expected to have positive impacts relative to Alternatives 2, 3, and 4, which would allow fishing within a greater proportion of the HMA. Except for No Action, Alternative will have the largest effects on effort redistribution of any of the alternatives.

Table 29 – Habitat metrics for Alternative 5. Note that two of the exemption areas under consideration cannot be evaluated for habitat complexity or stability.

Area	Size, km ²	Area (km ²) and % where sediment is cobble- or boulder-dominated	% drop camera stations complex (sample size)	% obs indicating stable sediment
McBlair	38	0; 0%*	n/a	n/a
Fishing Rip	75	8; 11%	86% (7)	24%
Old South	64	3; 5%*	n/a	n/a
Total Alternative 5	177	11; 6%	86% (7)	24%
MBTG closure	332	98; 30%	86% (123)	81%
Total possible exemption area	2,234	338; 15%	59% (338)	37%
Total Great South Channel HMA	2,566	434; 17%	67% (461)	44%

* These areas are not well sampled with gears capable of detecting cobble and boulder substrates

Table 30 – Annual fishing effort as area swept (km²) in the Alternative 5 exemption areas. Although one of the areas would be seasonal under this alternative, these are annual totals.

Area	2010	2011	2012	2013	2014	2015	2016	2017
Fishing Rip	1.17	0.30	1.25	9.72	11.69	6.94	7.59	8.77
McBlair	1.21	1.42	1.16	1.35	1.13	2.58	1.27	0.38
Old South	3.79	6.75	4.69	8.11	23.19	18.20	24.37	6.99
Total Alternative 5	6.17	8.47	7.1	19.18	36.01	27.72	33.23	16.14
Total Great South Channel HMA	39.22	40.17	85.56	135.69	160.52	134.59	157.02	99.42
Percent of area swept attributed to Alternative 5	16%	21%	8%	14%	22%	21%	21%	16%

Swept Area Ratio	2010	2011	2012	2013	2014	2015	2016	2017
McBlair	3%	4%	3%	4%	3%	7%	3%	1%
Old South	6%	11%	7%	13%	36%	28%	38%	11%
Fishing Rip	2%	0%	2%	13%	16%	9%	10%	12%
Overall SAR Alternative 5	3%	5%	4%	11%	20%	16%	19%	9%
Overall SAR GSC HMA	2%	2%	3%	5%	6%	5%	6%	4%

6.2.7 Summary of impacts to EFH

The following table compares habitat analysis metrics and impacts determinations across alternatives. The No Action alternative is expected to have positive impacts on EFH and managed species that occupy the benthic habitats of the GSC HMA. Alternatives 2-5 will have negative to slightly negative impacts on EFH and managed species. Alternative 2 is expected to be the most negative, Alternatives 3 and 4 are similar, and Alternative 5, which is preferred, the least negative. While there is uncertainty associated with the habitat metrics for some of these alternatives, this is not expected to affect the ranking amongst the action alternatives. While the preferred Alternative 5 has the greatest amount of uncertainty in terms of the complex habitat metrics, it encompasses the least number of candidate exemption areas and therefore the largest amount of the HMA would be closed to fishing compared to the other action alternatives. The

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preferred alternative affords less protection for the habitats of the HMA than Alternative 1/No Action.

Table 31 – Habitat analysis metrics and impacts determinations. For Alternatives 1-5, habitat metrics are in relation to exemption areas that would be open to clam and/or mussel dredging (under Alternative 1, the entire HMA would be closed). Information for the entire GSC HMA is provided for comparison purposes.

		Entire HMA	Alt. 1 No Action	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Description of alternative	Exemption areas	N/A	None	McBlair, Old South Rose & Crown, Davis Bank East, Fishing Rip	Rose & Crown	McBlair, Old South, Davis Bank East, Zone A	McBlair, Old South, Fishing Rip
	Mussel dredges allowed in exemption areas?	N/A	N/A	Yes	Yes, under Sub-Option 1	Yes, under Sub-Option 1	Yes
	Seasonal closures	N/A	N/A	Old South closed Nov-Apr, Rose & Crown S. closed May-Oct	No	Old South closed Nov-Apr	Old South closed Nov-Apr
Habitat metrics for exemption areas open to fishing*	Area (km ²) that is cobble- or boulder-dominated	434 km ² *	N/A	112 km ²	105 km ²	58 km ²	11 km ² **
	Percent of drop camera stations that indicate complex habitat	67% *	N/A	87%	89%	84%	86%**
	Percent of observations indicating stable sediment	44% *	N/A	65%	76%	68%	24%**
	Occurrence of mussel beds (distribution of mussels is generally uncertain)	Yes, known in Rose & Crown region, historically in McBlair region	N/A	Yes, known in Rose & Crown region, historically in McBlair region	Yes, known in Rose & Crown region	Historically in McBlair region	Historically in McBlair region
	Occurrence of cod spawning habitat	Yes, along western and eastern edges of HMA	N/A	Yes, in Old South	No	Yes, in Old South	Yes, in Old South
	Clam dredge swept area (annual average 2010-2017)	107 km ²	N/A	54 km ²	27 km ²	26 km ²	19 km ²
	Clam dredge swept area ratio	4%	N/A	12%	14%	11%	11%

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	Entire HMA	Alt. 1 No Action	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Conclusions	N/A	Positive impacts on EFH and managed species	Negative impacts on EFH and managed species	Low negative to negative impacts on EFH and managed species; more negative if mussel dredges are exempted (Sub-Option 1)	Low negative to negative impacts on EFH and managed species; more negative if mussel dredges are exempted (Sub-Option 1)	Low negative impacts on EFH and managed species

* For reference, these are the values for the entire HMA, including the northeastern corner which was closed under OHA2

** Low sample size; uncertainty associated with these metrics

6.3 Human Communities

The human community analysis in this action estimates the economic and social effects of closing or opening areas on fishing communities.

6.3.1 Introduction

An important general point in terms of evaluating the impacts of the alternatives under consideration in this framework is to remember that Alternative 1/No Action represents a change from recent management for the surfclam fishery. Clam dredge vessels had been able to operate continuously on Nantucket Shoals, even following implementation of OHA2 on April 9, 2018 because they were granted a one-year exemption from the GSC HMA mobile bottom-tending gear closure. This exemption expired April 9, 2019. Under Alternative 1/No Action, the area would remain completely closed. Thus, Alternatives 2-5 represent an increase in clam dredge access relative to Alternative 1/No Action, but a decrease in access as relative to recent fishery conditions. The magnitude of impact associated with each alternative will depend on how vessel operators respond to area closures by redirecting fishing effort elsewhere (see section 6.1.1 for a discussion of effort redistribution). For the mussel fishery, the GSC HMA closed on April 9, 2018, and this closure would continue under Alternative 1/No Action. The other alternatives (provided the mussel sub-option is chosen for Alternatives 3 and 4) provide increased access for that fishery relative to the No Action alternative and relative to current conditions.

6.3.1.1 General Approach to Assessing Economic and Social Impacts

When examining potential economic and social impacts of management measures, it is important to consider impacts on the fishing fleet (vessels grouped by fishery, primary gear type, and/or size); vessel owners and employees (captains and crew); dealers and processors; final users of seafood products; community cooperatives; fishing industry associations; cultural components of the community; and fishing families. While some management measures may have a short-term negative impact on some communities, this should be weighed against potential long-term benefits to all communities.

Economic impacts: In general, the economic effects of regulations can be categorized into regulations that change costs (including transactions costs such as search, information, bargaining, and enforcement costs) or change revenues (by changing market prices or by changing the quantities supplied). These economic effects are usually felt by the directly regulated entities (e.g., surfclam and mussel fisheries). They may also be felt by downstream industries that use outputs of these entities (e.g., processors), upstream industries that supply the regulated entities (e.g., shoreside support), and competing industries that use the same inputs or outputs as the regulated entities (e.g., other fisheries) and consumers.

Social impacts: Social impacts include those at the fishery and fishing community levels, but also impacts felt by the broader public. The social impact factors outlined below can be used to describe the potentially impacted fisheries, their sociocultural and community context and their participants. These factors or variables are considered relative to the management alternatives and used as a basis for comparison among alternatives. Use of these kinds of factors in social impact assessment is based on NMFS guidance (NMFS 2007) and other texts (e.g., Burdge 1998), though use of such lists should not be considered “exhaustive” or “a checklist” (e.g., IOCGP 2003; Burdge 2004). Longitudinal data describing these social factors region-wide and in comparable terms is limited. While this analysis does not quantify the impacts of the management alternatives relative to the social impact factors, qualitative discussion of the potential changes to the factors characterizes the likely direction and magnitude of the impacts. The factors fit into five categories:

- *Size and Demographic Characteristics* of the fishery-related work force residing in the area; these determine demographic, income, and employment effects in relation to the work force as a whole, by community and region.
- *Attitudes, Beliefs, and Values* of fishermen, fishery-related workers, other stakeholders and their communities; these are central to understanding behavior of fishermen on the fishing grounds and in their communities.
- Effects of proposed actions on *Social Structure and Organization*; that is, changes in the fishery’s ability to provide necessary social support and services to families and communities.
- *Non-Economic Social Aspects* of the proposed action or policy; these include life-style issues, health and safety issues, and the non-consumptive and recreational uses of living marine resources and their habitats.
- *Historical Dependence on and Participation* in the fishery by fishermen and communities, reflected in the structure of fishing practices, income distribution and rights (NMFS 2007).

6.3.1.2 Methods to Assess Impacts on Surfclam Fishery

A few different data sources have been used to estimate the magnitude of impacts on the surfclam fishery. Each data set has its own caveats and limitations, but together, they provide a general sense of recent fishing activity and indicate the importance of specific areas within the HMA to the fishery in the recent past. Importantly, other than looking for data from mussel dredges or catches of mussels as a species (which did not generate any results) only data from clam dredges were evaluated for this action. However, the use of other gear types in the GSC

HMA was considered during OHA2 and revenues from all bottom-tending gear types are summarized in the OHA2 FEIS for the period January 2005 through December 2014.

Data sources: Surfclam fishing effort and revenue was estimated using:

- *Clam logbooks:* Fishing coordinates in the clam logbooks (akin to vessel trip reports) were interpreted spatially using a confidence interval approach (DePiper 2014). Like vessel trip reports, the logbooks include a single set of coordinates to represent the average location fished. This approach, also used in OHA2 and the Council's Coral Amendment, spreads catch, revenue, and swept area from a trip over an estimated total footprint for each trip, and then trips are summed by year (or part of the year, in the case of seasonal areas). Then, the resulting datasets are used to estimate fishery revenue, catch, or swept area by exemption area or alternative. Caveats about the logbook data and confidence interval mapping method are summarized in the OHA2 FEIS Volume 4. An advantage of logbook data is that fishing locations are directly associated with catches and price paid per bushel. Also, logbook records are specific to a vessel.
- *Vessel monitoring system (VMS):* VMS data are available for all surfclam vessels. VMS provides hourly vessel positions (points) from which fishing vs. transiting or other activities must be inferred using speed, heading, or other information. For this action, GARFO Analysis and Program Support Division (APSD) staff filtered VMS data from 20 vessels active in the Nantucket Shoals fishery to remove polls where speed was estimated to be above 2.5 knots and likely to represent transiting, and then the time elapsed since the previous poll was used to indicate hours spent fishing at that location.⁶ Individual polls (points) were then gridded on a fine scale (0.0003 degrees, about 0.25 km x 0.33 km rectangles) to generate heat maps of hours of fishing time. These heatmaps were used by the clam industry to suggest nine candidate exemption areas and were then used by the Council to estimate hours fished in each potential exemption area. In addition, APSD staff summarized the number of vessels/permits fishing in the candidate exemption areas over time.

Metrics: The following metrics were calculated for different areas and combinations of areas (alternatives) using these datasets. Data are in calendar years, the same as the clam fishing year.

1. *Revenue by species (logbook):* Because some fishing gears are used to catch multiple species, revenue at the species level was estimated for each alternative to characterize fishery impacts. Data are provided for up to ten species caught with hydraulic dredges, however surfclams comprise almost all landings by species across all sections of the GSC HMA.
2. *Number of permits (VMS):* To estimate the number of vessels fishing in each exemption area, the database of VMS polls was used to identify the number of permits with polls in each of the candidate exemption areas. These data were summarized across the entire time series (2010-June 2018).

⁶ Where VMS can be matched with more detailed observer data, more nuanced models can convert VMS polls to estimated fishing hours (e.g., Muench et al. 2018), but this has not been done for the surfclam dredge fishery.

3. *Hours fished (VMS)*: To estimate fishing effort in each area or combination of areas, hours fished across the 20 vessels for which VMS data were assembled was estimated using a spatial analysis of annual heatmaps (gridded at 0.0003 degrees).
4. *Percent permit revenue (logbook)*: To help determine the importance of the areas under consideration at the permit (vessel) level, the contribution of the fishing attributed to the exemption areas to the annual revenue associated with each permit was calculated. The universe of permit revenue data considered includes only the permits with some degree of revenue from a given area, and the analysis compares their revenue derived from the area to their total revenue. Thus, the percent permit revenue data indicate the importance of an area to potentially affected vessels. Boxplots indicate the range of the percentages across all potentially affected vessels. In general, these percentages are moderate, but there are outliers suggesting that certain areas may be very important for some vessels.
5. *Percent owner revenue (logbook)*: To help determine the importance of the areas under consideration at the vessel owner level, the contribution of the fishing attributed to the exemption areas to the annual revenue associated with each owner was calculated. The universe of owner revenue data includes only the owners with some degree of revenue from a given area, and the analysis compares their revenue derived from that area or group of areas to their total revenue (all fishing areas and species). Thus, the percent owner revenue data indicate the importance of an area to potentially affected owners. These percentages were pooled across all species and were calculated for the most recent three years, 2015-2017. Boxplots indicate the range of the percentages. In general, these percentages are low to moderate, but there are outliers suggesting that for some owners, revenue from these areas comprise a large fraction of their overall surfclam revenues.⁷
6. *Revenue by port (logbook)*: To indicate the communities potentially impacted by an exemption area or group of areas, revenue at the port level was calculated. Data are summarized regionally as needed to ensure that at least three vessels selling to three dealers are represented by each value.

The years 2011-2017 were analyzed for this action. Clam dredge revenues approximate those identified through the analysis in the OHA2 FEIS (data from 2005-2014), so the magnitude of impacts on the fishery being considered is likely unchanged since the HMA was designated. However, relative to the analysis in OHA2, there is now a clearer sense of how catches in the Nantucket Shoals fishery are distributed across fishermen based on analysis of permit and owner-level dependence on the HMA (items 4 and 5 above). The OHA2 analysis did not include this level of detail.

Importantly, permit numbers and vessels are linked in the clam fishery, as with any other fishery, but fishing privileges are not directly attached to specific permits or vessels and are instead held as individual transferable quota (i.e., vessel and quota owners may be different). This action presents effort and revenue data in relation to permit (vessel) and owner (vessel owner) but does

⁷ During the years 2015-2017, the owners of clam vessels involved in the Nantucket Shoals fishery obtain almost all their revenues from a combination of surfclams and quahogs. Scallops are an additional source of revenue for some owners. Breaking out revenues from ocean quahogs vs. surfclams, the median owner obtains nearly 100% of their revenues from surfclams, but some owners generate a substantial fraction of their annual revenues from quahogs.

not summarize data based on quota owner. The Mid-Atlantic Fishery Management Council is developing an Excessive Shares Amendment which tracks quota holdings in the fishery.

Caveats: Spatial distribution of effort associated with both logbook and VMS data is somewhat uncertain. Because logbooks have only one set of coordinates specified per trip, while VMS data includes a position every hour (every 30 minutes for vessels with scallop permits), the VMS data are likely to be more spatially precise. Given these differences in resolution, the logbook-based and VMS-based estimates of revenue and activity should generally track with one another across alternatives but will not correspond exactly. In addition, some of the potential exemption areas are small relative to the spatial uncertainty in the effort data. This would likely affect the logbook revenue estimates particularly.

The percent revenue to permit and owner metrics, and the revenue by port, describe revenue concentration, but these analyses only reflect a portion of the impacts of this action related to ex-vessel revenues. The full impacts of this action would ripple through the economy and have effects on other businesses directly related to fishing (e.g., clam processors, fuel companies, ice companies). After the first point of sale, a host of other related industries, including seafood retailers, restaurants, transportation firms, all their suppliers, and ultimately the consumers who frequent these establishments are also impacted by area management decisions. Because the primary focus in this document is on ex-vessel revenues, the information provided should be considered a partial analysis; optimally, broader societal impacts would be determined.

As noted in the introduction to Section 6, alternative fishing choices associated with redistribution of effort into other locations are difficult to predict. This is particularly true given the high rates of dependence many vessels have on Great South Channel HMA. While a minority (20%) of coast-wide surfclam revenues are generated in the Great South Channel HMA, these revenues are concentrated among a relatively small number of permits, owners, and communities. Assuming effort can be redistributed, net losses to displaced fishermen will depend on changes in efficiency and any increased costs of fishing in alternate fishing grounds. The impacts analysis explores, qualitatively, possible alternative fishing location choices, based on current effort distribution.

Identifying affected surfclam communities: For each area, the data include landings revenue by state and port and the number of fishing permits those landings are attributed. Because a single vessel can land in multiple ports, each vessel may be included in more than one community at the port level. There are, however, data limitations and data confidentiality standards that constrain the extent of the analysis in this document. The fishing communities most likely to be impacted, at least in the near-term, include those that have been the homeport or landing port to fishing vessels active in the areas included in the management alternatives.

The port of landing could be directly impacted by the alternatives under consideration due to a loss of landings and revenue that can affect the fisheries infrastructure in the community. In addition to the ports explicitly identified, other ports may be impacted but cannot be detailed due to data confidentiality. Background information on several communities is in Section 5.5.6 and is also available at: <http://nefsc.noaa.gov/read/socialsci/communitySnapshots.php>.

This action would likely not affect all identified communities to the same extent. The communities that are more dependent on fishing with the affected gear types would likely have more impacts than those that participate in a range of fisheries and gear types. Even among communities with similar dependence, there are likely to be different impacts, since some alternatives have localized impacts. Also, the general level of vulnerability and resilience of a community will determine the magnitude of the impact. Social Vulnerability Indicators of each community are listed in the Affected Environment.

6.3.1.3 Impacts of Increased VMS Monitoring

At present, while all four of the type-approved VMS units in the Greater Atlantic Region can collect data at the 5-minute frequency required by Alternatives 2-5, only three of the four (“Thorium Triton” of Woods Hole Group, “I1500” of SkyMate, and “Sailor Platinum” of Network Innovation) can be triggered to do so remotely by NOAA OLE. This remote activation of the increased polling rate is important to the integrity of the enforcement system, and therefore a vessel would need to have one of these three VMS types if they wished to fish under this program. For vessels without these units, acquisition of a new unit would be a cost associated with fishing in the exemption areas. This capability could be added by other vendors in the future, so this specific list of VMS units is not intended to prevent the use of other suitable units should they become available.

In addition to the direct impacts of the exemption areas on fishing activity, there is a marginal increase in costs associated with increased frequency of VMS polling rates required under Alternatives 2-5. Given the discussion of these additional costs is consistent across these alternatives, it is presented here for the sake of brevity. Although it can be triggered automatically and remotely by NOAA Fisheries, increased VMS polling comes with a realized cost, realistically assumed here to be \$0.07/poll (NEFMC 2018e). Given the 5-minute frequency required for access under these alternatives, this translates into a cost of \$0.84/hour while a vessel is within 3 nm of the Great South Channel HMA. The number and duration of trips within each of the alternative areas considered within the Clam Dredge Framework is difficult to assess, given that historical effort within each area might not be representative of future fishing as a direct result of this action.

Nevertheless, a rough estimate of the additional cost associated with this VMS coverage can be developed based on the effort estimates derived from historical VMS effort estimates. Between 2010 and 2017, an average of 10,284 hours of fishing effort occurred within the full Great South Channel HMA (Table 35). This would translate into an average annual cost of \$8,639, spread across all vessels active in the Great South Channel HMA. It is unclear how precise this cost estimate is, in part because VMS polls were filtered by vessel speed to highlight fishing effort but not transiting time. This suggests that the cost estimate is low. However, several alternatives are likely to shift fishing effort substantially. Some of this effort is likely to relocate into exempted areas inside the Great South Channel HMA itself. Some of the effort could be relocated inshore of the Great South Channel HMA, and areas within 3 nautical miles of the HMA boundary would be subject to enhanced polling. Other effort could relocate, at substantial additional cost, to either Georges Bank or the Mid-Atlantic, where enhanced polling would not

be required. At least some of the potential scenarios would indicate the additional VMS cost is an overestimate. This reality precludes a clearer understanding of the potential cost. However, one-minute VMS polling frequency was originally proposed by the Massachusetts Mobile Gear Fishermen's Alliance to allow more precise location information regarding fishing within the Great South Channel HMA. This recommendation coming from the fishing industry suggests that the benefit to the industry of access to the Great South Channel HMA generally outweighs the higher cost of increasing VMS polling frequency. The exploratory nature of the mussel dredge fishery precludes an analysis of expected costs to that fishery due to increased VMS polls around the Great South Channel HMA. However, mussel fishermen would incur the expense of VMS if the expected benefits of doing so outweighed the costs.

6.3.1.4 Methods to Assess Impacts on Mussel Fishery

Effects on the mussel dredge fishery can only be estimated qualitatively based on descriptions of a previous fishery in the area during the 1980s-1990s and some information on where mussel beds occur within the HMA. Recent mussel dredge effort in the HMA has been limited to only a handful of trips during 2017 (Domenic Santoro, personal communication) and there is no recent VTR data showing mussel landings. The mussel fishery could be positively impacted by Alternatives 2-5 relative to Alternative 1/No Action, if exemptions for mussel dredge gear are created, since the GSC HMA is now closed to all gear types except hydraulic dredges. The magnitude of effort that might occur under each of Alternatives 2-5 is uncertain given limited data on the spatial distribution of mussel beds in the HMA, and the density/productivity of those beds.

6.3.1.5 Social Impacts

The social impacts of the alternatives under consideration are likely mixed. Since Alternatives 2-5 afford opportunities for surfclam fishery access relative to Alternative 1/No Action, these action alternatives will likely have positive social impacts on the surfclam fishery relative to No Action. The differences among action alternatives are uncertain but likely minor. However, every alternative affords less access for the surfclam fishery relative to pre-OHA2 management and the recent one-year exemption. The communities that would likely be most impacted are New Bedford, Fairhaven and Barnstable County, Massachusetts. All three are primary ports for the surfclam fishery (Table 12). From 1990 through 2010, New Bedford had medium-high to high engagement, Barnstable County had low engagement, and Fairhaven had no measurable engagement in the fishery. However, all three communities were highly engaged in the fishery from 2012 through 2016 (Table 11). During this recent time period, New Bedford and Fairhaven were highly reliant and Barnstable County had medium reliance.

With each alternative, employment and the size of the fishery-related workforce is likely to decrease for the surfclam fishery relative to the recent past, regardless of the alternative adopted. There is shoreside infrastructure that is particularly dependent on the Nantucket Shoals fishery (section 5.5.2.8), so these businesses would need to adapt to maintain viability, despite access afforded under the proposed exemptions. The historical dependence on and participation in the fishery (e.g., structure of fishing practices, income distribution, rights) would likely change, though it is difficult to predict specifically how. If effort shifts to outside the GSC HMA, there

could be increased conflicts within or between fisheries and negative impacts on vessel safety, particularly if the small vessels active in the GSC HMA attempt to fish further offshore. The social structure and organization of communities may be impacted should fishermen and shoreside support be unable to recoup revenue losses.

6.3.1.6 General impacts of area closures on human communities

This action considers a range of spatial closures for the Atlantic surfclam and mussel fisheries. Area closure alternatives can have many social impacts across various fisheries and communities. The most direct impacts would be on vessels fishing in these areas that would no longer have access to those areas. The addition of new closures would force the fishing operations to modify where and how they fish. This could have a negative impact on the historical dependence on and participation in the affected fisheries (e.g., structure of fishing practices, income distribution, rights). There would also be negative impacts on the size of the affected fisheries, because of a probable reduction in fishing opportunity, revenue, and employment. Negative impacts are likely in the non-economic social aspects of the fishery (e.g., lifestyle, health, safety), as there would be have less flexibility in choosing where to fish.

There are many caveats associated with landings/revenue estimates. Redistribution of effort into other locations may mitigate negative effects, but alternative fishing choices are difficult to predict. Relocation may be challenging if other locations are already crowded with gear or if it is difficult to catch the target species outside the closed area. If effort can be redistributed outside closed areas, net losses to displaced fishermen will be dependent on changes in efficiency and costs of fishing in alternate fishing grounds. The impacts analysis explores, qualitatively, possible alternate fishing location choices, based on current distributions of effort. While a relatively small fraction of revenue in a specific fishery may come from a specific area/season, the revenue may be concentrated among a small number of people and/or communities. Revenue estimates at the permit and owner level are provided in the sections below, by alternative.

In response to area closures, some vessels may have to change the times and areas within which they operate, moving to less desirable fishing grounds. Fishermen have developed agreements over time about sharing fishing grounds, so it may be difficult to adjust to new area closures. When deploying and fishing their gear, fishermen account for bathymetry, current, wind, and area restrictions. These factors may prevent them from fishing efficiently outside a specific area. The impact on these operations may be some combination of increased costs and/or decreased revenues. Increased costs may occur if vessels must travel further to reach alternative fishing grounds, or if they must fish in areas with lower catch-per-unit of effort (and thus, incur increased costly fishing effort to catch the same amount of fish). Decreased revenues may occur if fishermen find that they are unable to catch the same amount of fish in the time available due to increased travel or fishing time. Decreased revenues may also occur if shifts in fishing activity also make it harder to deliver a quality product.

The ability to adapt to a new closure is highly variable. Less mobile fishermen may bear a larger impact as they are less able to easily switch harvest areas. Smaller vessels would be less adaptable to near shore closures, as their range is limited, and they cannot easily prosecute the fishery in offshore areas. Any change in fishing behavior by less mobile fishing businesses that

attempt to employ more mobile fishing strategies would likely have additional social costs, such as disruptions to family and community life, and increase the likelihood of safety risks. Increased risk can result when fishermen spend longer periods at-sea to access offshore areas that would not be affected by the closures. Fishermen severely impacted by the new closed areas may leave fishing entirely or at least seek temporary opportunities in another fishery or gear type that is less affected by the management alternatives. Both possibilities would cause a change in employment and the size of the fishery-related workforce.

There are many instances in which fishermen have differing views than those of ocean and fisheries scientists. Fishermen's views are based largely on personal experience and their own proximal environment, which can be at odds with the larger environment described by fisheries scientists. A lack of faith in the science used to inform management decisions could undermine the perceived legitimacy of future management actions and have a negative social impact on the formation of attitudes and beliefs of fishermen towards management. The impact of new closures on the attitudes and beliefs of fishermen is uncertain but related to the level of acceptance and belief in the efficacy of the new closures to adequately protect essential fish habitat.

There is the potential for positive social impacts from new closures, generally associated with the potential future and long-term benefits that the closures would have on the improvement of fish stocks. These benefits are difficult to analyze, because of the uncertainty associated with the magnitude of the benefit, how these benefits would distribute among fishing communities, and the timing of these impacts. For example, vessels that are unable to adapt to new restrictions in the short term may not be able to benefit from the potential stock increases in the long term. Also, the short-term impacts on markets, processing capability, and other infrastructure during the period of adjustment to the new closures may be such that these shoreside resources are lost and unable to recover in the future when potential stock increases occur.

Those communities that are more dependent on the Atlantic surfclam and mussel fisheries and are in proximity to the potential closures would have larger social impacts than those that participate in a range of fisheries. The full impacts of this action would ripple through the economy (e.g., fuel, bait, ice suppliers). After the first point of sale, a host of other related industries, including seafood retailers, restaurants, transportation firms, all their suppliers, and ultimately the consumers that frequent these establishments are also impacted by area management decisions. Because the primary focus in this document is on ex-vessel revenues, the information here is a partial analysis. Optimally, broader societal impacts would be determined.

6.3.2 Alternative 1/No Action

Under Alternative 1/No Action, no exemption areas would be designated. The entire GSC HMA was closed year-round to hydraulic clam dredges on April 9, 2019. Mussel dredges and other mobile bottom tending gears were excluded on April 9, 2018 (background in Section 3.2).

Volume 4, Section 4.2.5.4 of the OHA2 FEIS (p. 298-301) describes the impacts on human communities associated with designation of the GSC HMA as a mobile bottom-tending gear closure with one-year exemption for clam dredges throughout most of the area. In that action, the long-term impacts were determined to be “highly negative” for the clam fishery, but “moderately

positive” in the short term due to the one-year exemption. Due to the expected (indirect) benefits for other fisheries of habitat protection, overall impacts on human communities are likely uncertain but neutral to moderately positive.

Impacts on the surfclam fishery: Nantucket Shoals is important to the surfclam fishery, and the impacts of Alternative 1/No Action on the surfclam fishery are likely negative relative to the access afforded prior to implementation of OHA2. Starting April 9, 2019, the entire GSC HMA was closed to the fishery. In 2011-2017, \$6.3M of surfclams were harvested from the No Action Area annually or 10-28% of total surfclam fishery revenue (Table 32). Given the intensity of fishing within the GSC HMA, the loss of these fishing grounds is likely to generate substantial losses to the surfclam fishery. Some revenue loss may be mitigated if effort shifts to areas outside the GSC HMA, and/or by leasing out quota, though there are logistical and financial constraints to doing so (Section 6.1.1). Incentives to shift effort would be highest under No Action, given that it would result in the largest amount of area being closed.

Revenue by gear and species: Between 2011 and 2017, clam dredge revenue from the full Great South Channel HMA, the area that would be closed under No Action, was about \$3-8M annually or \$6.0M on average and dominated by surfclam landings (Figure 7, Table 33). This revenue was 10-28% of total surfclam fishery revenue over that period (Table 32).

Permits and owners: The hydraulic clam dredge revenue attributed to the GSC HMA has been generated by 10-19 permits a year from 2011-2017 (Table 32), 37 permits in all (Table 33). There were seven permits that had revenue each year in this area. Most fishermen fishing within the Great South Channel HMA were doing so intensively, with the median permit generating 15-85% of their total annual revenue from the area depending on the year (Figure 8). Dependence at the owner group level is somewhat lower (Figure 9), with a median of 15-45% of total revenue generated from the area in 2015-2017. A small number of owner groups generate up to 80% of their revenue from the Great South Channel HMA.

Trips: During 2011-2017, the entire HMA was fished on 423-985 trips per year (Table 32). Regardless of how it is processed, logbook data are imprecise when assessing areas as small as those being considered in this action. This is because operators are only required to submit a single set of coordinates (latitude/longitude) to represent the entirety of a trip’s fishing location, and these points are unlikely to adequately represent the actual footprint of fishing at this granular of spatial scale. Thus, the number of trips is only reported for the entire HMA (i.e., just for No Action).

Table 32 – For each alternative, revenue as a percent of total annual surfclam revenue and number of active surfclam permits, 2011-2017.

Year	% of all surfclam revenue					Number of active vessel permits					Trips
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 1	Alt.2	Alt. 3	Alt. 4	Alt. 5	Alt. 1
2011	10%	4%	3%	2%	2%	10	10	9	10	10	423
2012	21%	9%	9%	2%	1%	18	17	13	17	17	677
2013	27%	11%	7%	5%	3%	19	17	15	17	17	954
2014	28%	11%	8%	6%	5%	19	18	18	18	18	985

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Year	% of all surfclam revenue					Number of active vessel permits					Trips
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 1
2015	24%	10%	7%	5%	3%	15	15	14	15	15	824
2016	24%	9%	5%	5%	4%	17	17	17	17	16	859
2017	16%	5%	3%	3%	2%	18	17	18	17	16	560
<i>Note: Data for Alternative 1 is for the area that would be closed. Data for Alternatives 2-5 is for the areas that would be open; some seasonally under Alternatives 2, 4 and 5.</i> <i>Source: Surfclam logbook analysis.</i>											

Impacts on the mussel fishery: The impacts on the mussel fishery of No Action are likely low negative. In recent years, the mussel fishery has occurred primarily in state waters and has been precluded from fishing within the GSC HMA since April 9, 2018. A mussel fishery occurred in this area in the past, and industry members have indicated an interest in reestablishing a fishery in this area. However, No Action would prohibit that possibility.

Impacts on other fisheries: The impacts on other fisheries (i.e., groundfish, skate, scallop, herring, lobster) of No Action are likely low positive. The GSC HMA provides habitat protection for other managed species, so their respective fisheries would likely fare better with reduced fishing activity for surfclams and no development of a fishery for mussels in the GSC HMA. Benefits to other fisheries would be indirect and accrue over time as habitats that have been impacted by mobile bottom tending gear recover to more productive states.

Impacts on communities: The impacts on fishing communities of Alternative 1/No Action are likely negative to low positive. While the surfclam and mussel fisheries may have negative to low negative impacts, impacts on other fisheries may be low positive. The communities that may be negatively impacted by hydraulic dredge restrictions in the GSC HMA are primarily located in Massachusetts, with lesser activity attributed to a few confidential states (Table 33). Revenue from hydraulic dredge fishing in 2011-2017 in the entire HMA, \$6.3M average, is attributed to 13 ports and 37 permits, and 99.9% of this revenue to ports in Massachusetts. New Bedford (29 permits), Barnstable County (17 permits) and Fairhaven (11 permits) are the top non-confidential landing ports, comprising 99.9% of the revenue, indicating that the GSC is particularly important for those three communities, which are some of the more proximal ports to the GSC HMA. In 2016 alone, the surfclam dredge revenue from the area that would be closed under No Action (the GSC HMA) that was landed in New Bedford, Barnstable County and Fairhaven was 28%, 82% and 79% of the total surfclam revenue to those ports, respectively (Table 34).

The communities that may benefit from No Action are those more active in the fisheries for species that could benefit from habitat protections afforded by the hydraulic dredge restrictions. These fisheries include groundfish, skate, sea scallop, Atlantic herring and lobster (Table 14) and are based in communities such as Gloucester, Chatham, New Bedford, Fairhaven, Narragansett and Montauk. Some of these ports are also important to the surfclam fishery (e.g., New Bedford), so, both positive and negative impacts within a given port may occur.

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Table 33 – Annualized revenue to states and ports and total permits and ports attributed to hydraulic dredge fishing within the alternatives under consideration, 2011-2017.

State/Port	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
	Avg. Revenue	Total Permits ^a	Avg. Revenue	Total Permits ^a	Avg. Revenue	Total Permits ^a	Avg. Revenue	Total Permits
Massachusetts	\$6.2M	37	\$2.5M	34	\$1.7M	31	\$1.1M	34
Barnstable Co.	\$1.9M	17	\$0.7M	16	\$0.5M	13	\$0.3M	15
Fairhaven	\$1.3M	11	\$0.5M	11	\$0.4M	10	\$0.2M	11
New Bedford	\$2.9M	29	\$1.3M	27	\$0.9M	26	\$0.6M	27
Other ^b	\$0.0M	5	\$0.0M	4	\$0.0M	5	\$0.0M	3
Total	\$6.3M	37	\$2.5M	34	\$1.7M	34	\$1.1M	34
Number of ports	13		11		9		11	

	Alternative 5		Alt. 5 Research		
Massachusetts	\$0.8M	33	\$2.1M	31	
Barnstable Co.	\$0.2M	15	\$0.6M	13	
Fairhaven	\$0.1M	11	\$0.5M	10	
New Bedford	\$0.4M	26	\$1.0M	26	
Other ^b	\$0.0M	3	\$0.0M	5	
Total	\$0.8M	33	\$2.1M	32	
Number of ports	11		11		

^a Totals may not equal the sum of the parts, because permits can land in multiple ports/states.

^b Includes confidential state(s).

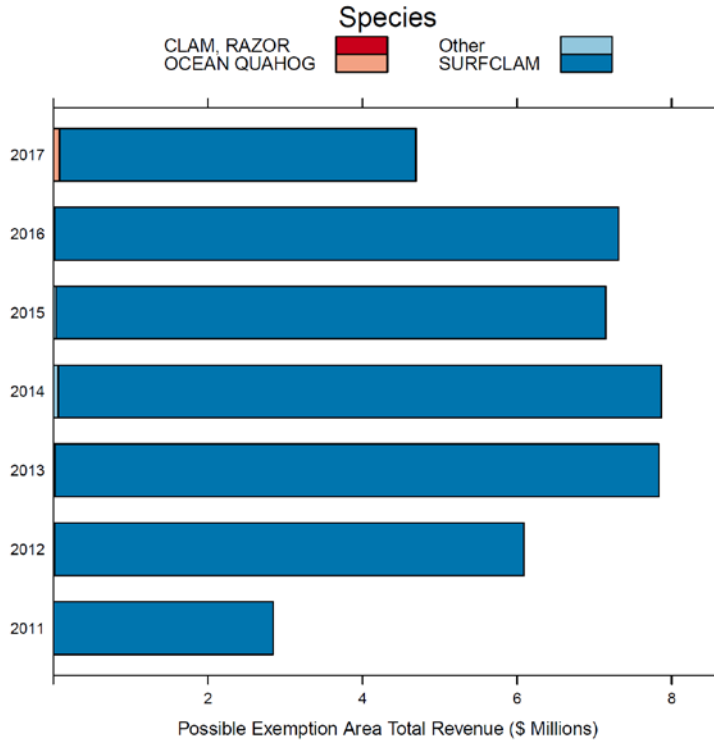
Note: Data for Alternative 1 is for the area that would be closed. Data for Alternatives 2-5 is for the areas that would be open; some seasonally under Alternatives 2, 4 and 5.

Source: Surfclam logbook analysis.

Table 34 – 2016 surfclam revenue to ports relative to the revenue from the area that would be closed under each alternative

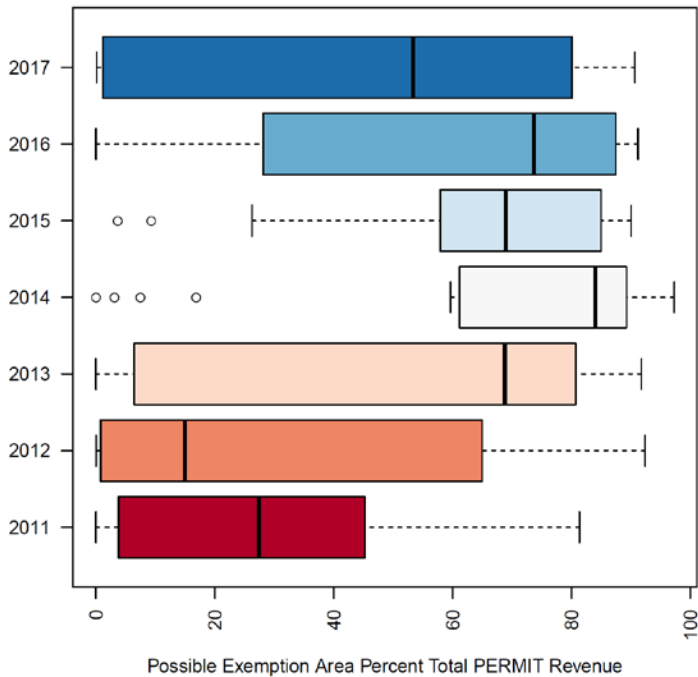
	Barnstable County	Fairhaven	New Bedford
Total	\$2.9M (100%)	\$1.7M (100%)	\$13M (100%)
Alt. 1	\$2.3M (79%)	\$1.4M (82%)	\$3.6M (28%)
Alt. 2	\$1.7M (59%)	\$0.9M (51%)	\$2.1M (16%)
Alt. 3	\$2.1M (72%)	\$1.0M (59%)	\$2.7M (21%)
Alt. 4	\$1.8M (62%)	\$1.2M (71%)	\$2.7M (21%)
Alt. 5	\$2.0M (69%)	\$1.2M (71%)	\$2.8M (22%)
<i>Source: Total from logbooks. Alternatives from surfclam logbook analysis.</i> <i>Note: Data for Alternative 1 is for the area that would be closed. Data for Alternatives 2-5 is for the areas that would be open; some seasonally under Alternatives 2, 4 and 5.</i>			

Figure 7 – Hydraulic clam dredge revenue by species from the GSC HMA, 2011-2017.



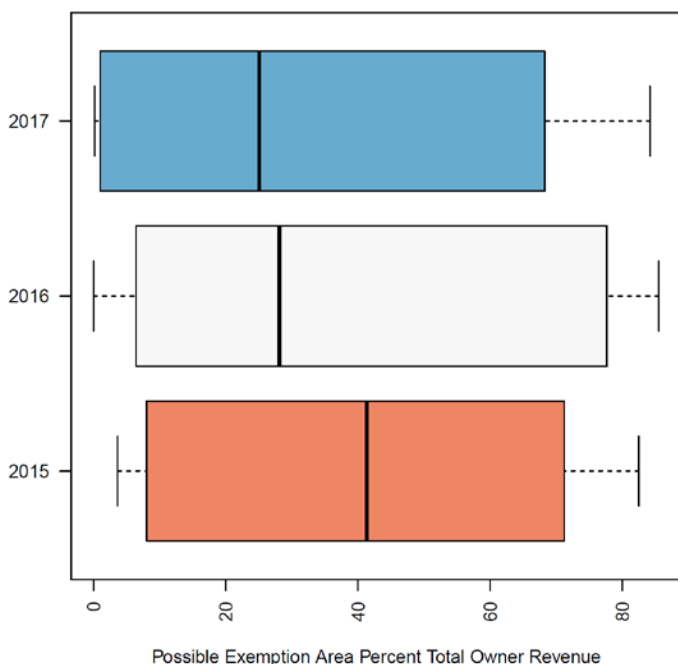
Source: Surfclam logbook analysis.

Figure 8 – Percent of total permit hydraulic clam dredge revenue from the GSC HMA, 2011-2017.



Source: Surfclam logbook analysis.

Figure 9 – Percent of total owner entity revenue from hydraulic clam dredges in the GSC HMA, 2015-2017



Source: Surfclam logbook analysis.

6.3.3 Alternative 2

Under Alternative 2 (Map 2), five exemption areas would be designated for both surfclam and mussel dredges: (1) McBlair, (2) Old South, (3) Rose and Crown, (4) Davis Bank East, and (5) Fishing Rip. Old South would be closed for six months from November 1-April 30. The southern part of Rose and Crown, which is near Old South, would be closed from May 1-October 31. The areas would be in place for five years, starting from the effective date of the final rule for the framework (Section 4.2). Besides the impacts described below, there are increased costs associated with increased VMS polling that would be borne by vessels fishing in the exemption areas (Section 6.3.1.3).

Impacts on the surfclam fishery: The impacts on the surfclam fishery of Alternative 2 would be positive relative to No Action. Impacts are likely low negative relative to recent management (up to April 9, 2019), as only a portion of the GSC HMA would remain open to fishing. In 2011-2017, there was substantially more surfclam fishing activity in the Alternative 2 areas than in the Alternative 3-5 areas. The activity represents between 41% - 65% of all clam dredge revenue generated from the HMA. Thus, Alternative 2 would likely provide more benefits to the surfclam fishery over the long-term relative to all other action alternatives. Given the intensity of fishing within the GSC HMA, loss of fishing grounds outside of the Alternative 2 exemption areas is likely to generate substantial losses to the surfclam fishery. Some revenue loss may be mitigated through shifting effort to open areas within Alternative 2, to areas outside the GSC HMA, and/or by leasing out quota, though there are logistical and financial constraints to doing so (Section

6.1.1). Incentives to shift effort would be lowest under Alternative 2 relative to the other alternatives, given that it would result in the smallest amount of area being closed.

Revenue by gear and species: Between 2011 and 2017, clam dredge revenue from the area that would be open under Alternative 2 (seasonally in some areas) was \$1-3.5M annually or \$2.5M on average and dominated by surfclam landings (Figure 10, Table 33). Recent revenue from the GSC HMA areas that would remain closed under Alternative 2 has been about \$3.5M annually.

Based on the logbook analysis, this revenue was between 32-44% of total surfclam revenue generated from the HMA between 2011 and 2017⁸. Note that fishing effort percentages outside the exemption areas are lower, with more effort inferred to the exemption areas vs. non-exempt areas. Table 35 compares annual (open and closed season) logbook and VMS estimates for the Alternative 2 areas and the HMA overall.

Permits and owners: The hydraulic clam dredge revenue attributed to the Alternative 2 areas was generated by 10-18 permits a year (Table 32) and 34 in all over 2011-2017 (Table 33). There were seven permits that had revenue each year in this area. Most fishermen fishing within this area were doing so intensively, with the median permit generating 15-85% of their total annual revenue from the area (Figure 11). Dependence at the owner group level is lower (Figure 12), with a median of 8-14% of total revenue generated from the area in 2015-2017. Both the permit and ownership analyses indicate a decreasing dependence on the Alternative 2 areas between 2015 and 2017, though the magnitude is quite different between the two, with higher percent dependence at the permit level. Nevertheless, Alternative 2 areas generated up to 50% of a permit's and up to 40% of an ownership group's total revenue in certain years.

Hours fished: The VMS data suggest that from January 2010-June 2018, 15-27 permits were used to fish within the Alternative 2 areas combined. Estimated fishing hours varied by area, with the largest number of hours in Rose and Crown North, moderate amounts of hours in East Door/Old South, Rose and Crown South, and Davis Bank East, and relatively few hours in McBlair and Fishing Rip (Table 35, Map 23, Map 24).

Impacts on the mussel fishery: A mussel fishery has occurred on Nantucket Shoals in the past, and industry members have indicated an interest in reestablishing a fishery in this area. In recent years, the mussel fishery has occurred primarily in state waters, and the mussel fishery has been precluded from fishing within the GSC HMA since April 9, 2018. As previously stated, there is no federal record of mussel dredge fishing within the Great South Channel HMA between 2011 and 2017 and the distribution of mussel beds is poorly understood at present.

The impacts on the mussel fishery of Alternative 2 are likely low positive relative to No Action, as a portion of the GSC HMA would become fishable, but the magnitude is somewhat uncertain given the general lack of data available. Impacts could be low positive relative to Alternatives 3-5 (assuming mussel dredges are exempted under Alternatives 3 and 4).

⁸ Note that Table 35 which is also based on logbook data shows year-round revenue estimates, so the percentages of total HMA revenue are higher.

Since Alternative 2 includes a larger number of exemption areas for mussel dredges than Alternatives 3-5, there is a greater likelihood that fishing would encounter concentrations of blue mussels dense enough to fish profitably. Mussel fishermen will only fish within the areas designated within Alternative 2 if they expect to benefit from doing so. Exploratory fishing within the areas would be expected in the short term, with long term fishing effort dependent on the success of those exploratory trips. The expected benefits of access for the mussel fishery are thus non-negative, but highly uncertain.

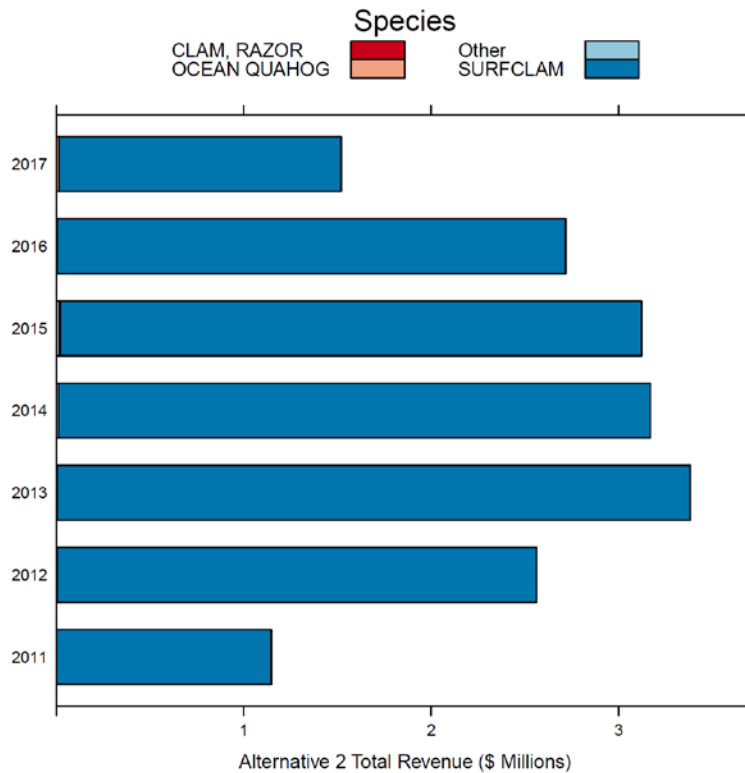
Impacts on other fisheries: The impacts on other fisheries (i.e., groundfish, skate, scallop, herring, lobster) of Alternative 2 are likely low positive. The GSC HMA provides habitat protection for other managed species, so their respective fisheries would likely fare better with reduced fishing activity for surfclams and mussels in the GSC HMA. Impacts are likely low negative relative to No Action and Alternatives 3-5, as Alternative 2 would provide the least habitat protection from bottom tending mobile gear. Benefits to other fisheries would be indirect and accrue over time as habitats that have been impacted by mobile bottom tending gear recover to more productive states.

Impacts on communities: The impacts on fishing communities of Alternative 2 are likely low negative to low positive. While the surfclam and mussel fisheries may have low negative and low positive impacts, respectively, impacts on other fisheries may be low positive.

The communities that may be negatively impacted by hydraulic dredge restrictions in the GSC HMA are primarily located in Massachusetts, with lesser activity attributed to a few confidential states (Table 33). Revenue from hydraulic dredge fishing in 2011-2017 in the Alternative 2 area is attributed to 11 ports and 34 permits, and 99.9% of this revenue to ports in Massachusetts. New Bedford (27 permits), Barnstable County (16 permits) and Fairhaven (11 permits) are the top non-confidential landing ports, comprising 99.9% of the revenue, indicating that this area is particularly important for those three communities, which are some of the more proximal ports to the GSC. The annual average revenue attributed to the Alternative 2 areas is \$2.5M, areas that would be open; areas that would remain closed account for \$3.5M annually. In 2016 alone, the surfclam dredge revenue from area that would be closed under Alternative 2 that was landed in New Bedford, Barnstable County and Fairhaven was 16%, 59% and 51% of the total surfclam revenue to those ports, respectively (Table 34). It is difficult, however, to determine if effort would shift to areas that would remain open (inside and outside the GSC HMA).

The communities that may benefit from Alternative 2 are those more active in the fisheries for species that could benefit from habitat protections afforded by the hydraulic dredge restrictions. These fisheries include groundfish, skate, sea scallop, Atlantic herring and lobster (Table 14). Based in communities such as Gloucester, Chatham, New Bedford, Fairhaven, Narragansett and Montauk, some of which are also important to the surfclam fishery (e.g., New Bedford). Thus, there may be both positive and negative impacts within a given port.

Figure 10 – Hydraulic clam dredge revenue by species from the Alternative 2 area, 2011-2017.



Source: Surfclam logbook analysis.

Note: Data is for the areas that would be open under Alternative 2; some seasonally.

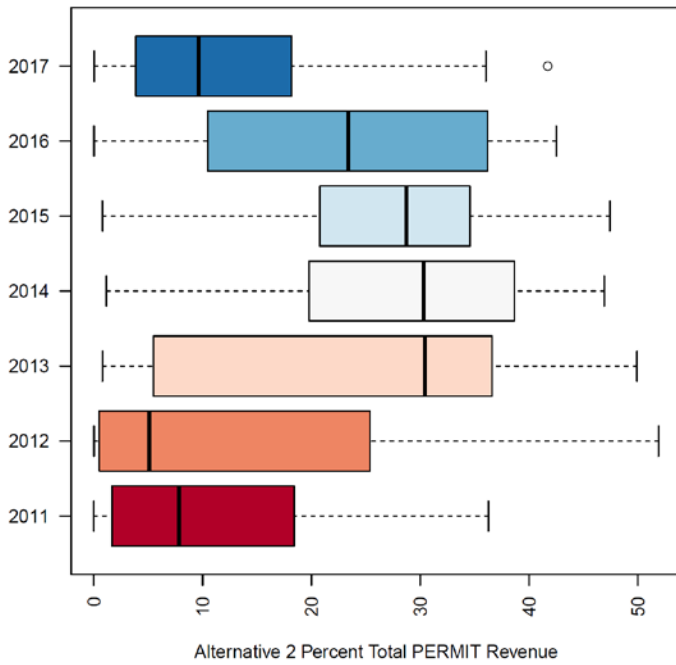
Clam Dredge Framework

Table 35 – Revenue (to nearest \$100K) and fishing effort (hours) within the Alternative 2 areas (note that these are year-round estimates for Old South and Rose and Crown South) for January 2011-December 2017.

Metric	Area	2011	2012	2013	2014	2015	2016	2017	Average
Revenue (logbook)	Fishing Rip	\$ -	\$ 100,000	\$ 700,000	\$ 600,000	\$ 300,000	\$ 300,000	\$ 300,000	\$ 300,000
	Davis Bank East	\$ -	\$ 300,000	\$ 700,000	\$ 400,000	\$ 600,000	\$ 500,000	\$ 300,000	\$ 400,000
	McBlair	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ -	\$ -	\$ 100,000
	Old South	\$ 500,000	\$ 300,000	\$ 300,000	\$ 1,200,000	\$ 1,000,000	\$ 1,300,000	\$ 400,000	\$ 700,000
	Rose and Crown N	\$ 500,000	\$ 1,300,000	\$ 1,300,000	\$ 1,000,000	\$ 1,200,000	\$ 600,000	\$ 500,000	\$ 900,000
	Rose and Crown S	\$ 300,000	\$ 1,200,000	\$ 600,000	\$ 1,100,000	\$ 800,000	\$ 900,000	\$ 400,000	\$ 800,000
	Total Alt 2	\$ 1,500,000	\$ 3,400,000	\$ 3,700,000	\$ 4,300,000	\$ 4,000,000	\$ 3,600,000	\$ 1,900,000	\$ 3,200,000
	Total HMA	\$ 2,800,000	\$ 6,100,000	\$ 7,800,000	\$ 7,800,000	\$ 7,100,000	\$ 7,300,000	\$ 4,700,000	\$ 6,200,000
Fishing Effort (hrs, VMS)	% of HMA revenue	52%	56%	48%	55%	56%	50%	41%	52%
	Fishing Rip	17	208	1,843	2,070	1,254	222	97	816
	Davis Bank East	45	248	1,956	532	1,375	2,974	2,077	1,315
	McBlair	795	10	106	178	564	300	34	284
	Old South	855	469	1,111	2,788	2,204	5,220	2,171	2,117
	Rose and Crown N	911	3,182	2,877	3,036	3,962	5,821	1,715	3,072
	Rose and Crown S	111	2,151	1,250	1,684	1,356	3,214	1,645	1,630
	Total	2,734	6,268	9,143	10,288	10,714	17,752	7,738	9,234
	Total in HMA	3,887	7,562	11,262	12,364	13,100	21,567	9,645	11,341
	% of HMA hours	70%	83%	81%	83%	82%	82%	80%	81%

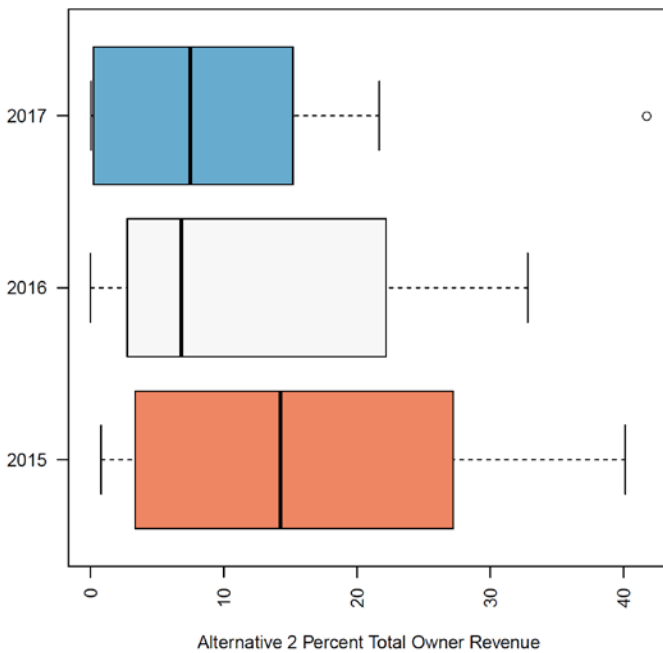
Source: Revenue from surfclam logbook analysis, fishing effort from VMS.

Figure 11 – Percent of total permit hydraulic clam dredge revenue from the Alternative 2 areas during periods in which they would be designated as open, 2011-2017.



Source: Surfclam logbook analysis.

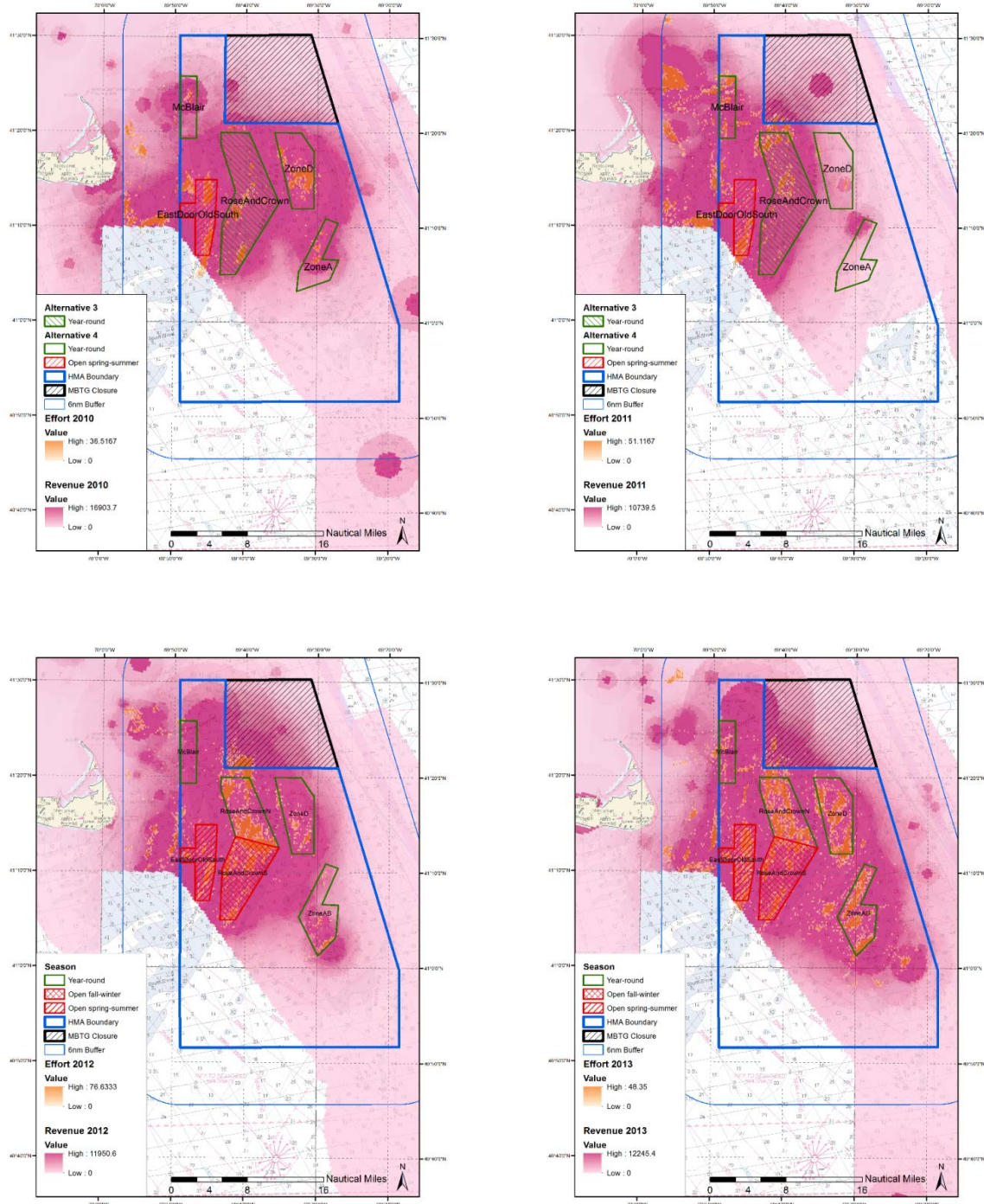
Figure 12 – Percent of total owner revenue from generated by hydraulic clam dredges in Alternative 2 areas during periods in which they would be designated as open, 2015-2017.



Source: Surfclam logbook analysis.

Clam Dredge Framework

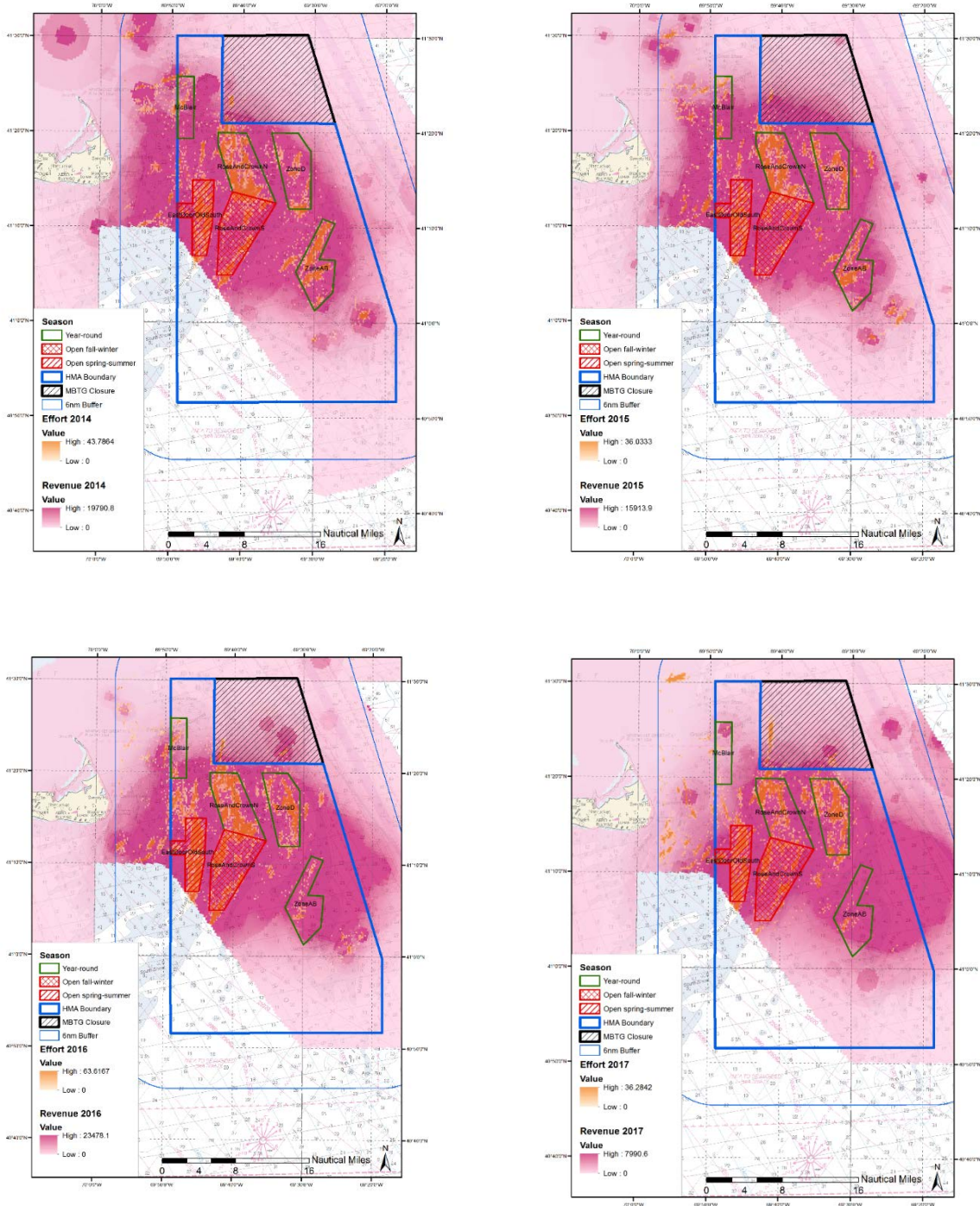
Map 23 – Surfclam vessel effort (hours fished) and revenue relative to the Alternative 2 boundaries, 2010-2013 (clockwise from upper left).



Source: Surfclam logbook analysis (revenue) and VMS data (hours fished).

Clam Dredge Framework

Map 24 - Surfclam vessel effort and revenue relative to the Alternative 2 boundaries, 2014-2017 (clockwise from upper left).



Source: Surfclam logbook analysis (revenue) and VMS data (hours fished).

6.3.4 Alternative 3

Under Alternative 3, a single exemption area would be designated for surfclam dredges, the Rose and Crown area. A sub-option would allow mussel dredges into the area. Besides the impacts below, there are increased costs associated with increased VMS polling (Section 6.3.1.3).

Impacts on the surfclam fishery: The impacts on the surfclam fishery of Alternative 3 are likely positive relative to No Action and Alternative 5, roughly neutral relative to Alternative 4, and low negative relative to Alternative 2. Impacts are likely low negative relative to recent management (up to April 8, 2019), as only a portion of the GSC HMA would remain fishable. Given the intensity of fishing within the GSCHMA, loss of fishing grounds outside of the Alternative 3 exemption area is likely to generate substantial losses to the surfclam fishery. Some revenue loss may be mitigated through shifting effort to open areas within Alternative 3, to areas outside the GSC HMA, and/or by leasing out quota, though there are logistical and financial constraints to doing so (Section 6.1.1). Effort shifts are likely under all alternatives, but effort shifts under Alternative 3 are more likely than under Alternative 2 and less likely than under Alternatives 1, 4 and 5.

Revenue by gear and species: Between 2011 and 2017, clam dredge revenue from the area that would be open under Alternative 3 was about \$0.8-2.6M annually or \$1.7M on average and dominated by surfclam landings (Figure 13, Table 33). Recent revenue from the GSC HMA areas that would remain closed under Alternative 3 has been about \$4.3M annually.

This revenue was between 18-49% of total surfclam revenue generated from the HMA between 2011 and 2017. Note that VMS effort percentages outside the exemption areas are lower, with more effort inferred to the exemption areas vs. non-exempt areas. Table 36 compares annual (open and closed season) logbook and VMS estimates for the Rose and Crown area and the HMA overall.

Permits and owners: The hydraulic clam dredge revenue attributed to the Alternative 3 area has been generated by 9-18 permits a year (Table 32) and 34 in all over 2011-2017 (Table 33). There were seven permits that had revenue each year in this area. The median permit generated 2-20% of their total annual revenue from the area depending on the year (Figure 14). Dependence at the owner group level is lower, with a median of 2-10% of total revenue generated from the area in 2015-2017 (Figure 15). Both the permit and ownership analyses indicate a decreasing dependence on the Alternative 3 areas between 2015 and 2017, with higher percent dependence at the permit level. Not all permitted vessels intensively fishing within the Great South Channel HMA are fishing the Rose and Crown area of Alternative 3 (Figure 14, Figure 8). Nevertheless, a subset of permitted vessels generates up to 60% of their revenue from Alternative 3.

The surfclam fishing in the Alternative 3 areas has been less intensive than in the Alternative 2 areas, but slightly more intensive than in the Alternative 4 areas. However, fishing intensity has decreased in the Rose and Crown area in recent past that has not occurred in the Alternative 4 areas. Because Alternative 3 allows fishing in just one area, versus Alternative 4 and 5 that allow fishing in four and three areas, respectively, Alternative 3 may provide slightly lower benefits

to the surfclam fishery over the long term, as there would be less flexibility to shift effort to other areas if there is a surfclam distribution shift and/or localized depletion. However, there is high uncertainty in this conclusion. The benefits of Alternative 3 are likely substantially lower than for Alternative 2, given the use of the areas, but higher than Alternative 1 given the access provided to important fishing grounds.

Hours fished: Between January 2010 and June 2018, an estimated 23 permits (vessels) fished in Rose and Crown North, and 25 vessels fished in Rose and Crown South. The average annual estimate of hours fished for Rose and Crown was 41% of the total for the HMA (Table 36, Map 25, Map 26).

Impacts on the mussel fishery with the mussel dredge exemption (Sub-option 1): If Sub-option 1 is selected, there would be a mussel dredge exemption within the Alternative 3 area. The impacts on the mussel fishery of Alternative 3 with the mussel dredge exemption are likely low positive relative to Sub-option 2. Impacts are likely low positive relative to Alternative 1/No Action, low negative relative to Alternatives 2 and 5, and low negative to low positive relative to Alternative 4 (depending on the Alternative 4 option).

As previously stated, there is no federal record of mussel dredge fishing within the Great South Channel HMA between 2011 and 2017. The industry has indicated that a vibrant mussel fishery was active within the general area of the Great South Channel HMA during the 1980s, and there is interest in fishing this area again. The proactive participation of the mussel fishery during development of the Clam Dredge Framework indicates that at least some fishermen expect a significant benefit from access to the Great South Channel HMA. Although what evidence exists suggests little overlap of mussel and clam distribution within the HMA, this analysis has substantial uncertainty and existing data do not allow the assessment of benefits expected to accrue to mussel fishery from access to the Rose and Crown area of Alternative 3. Ultimately, fishermen will only fish within the area designated within Alternative 3 if they expect a benefit from doing so. Exploratory fishing within the area would be expected in the short term, with long term fishing effort dependent on the success of those exploratory trips. The expected benefit to access for the mussel fishery is thus non-negative, but highly uncertain. It is difficult to say how an exemption in the Rose and Crown area would compare to exemptions in the Alternative 4 and 5 areas given limited information on mussel distributions.

Impacts on the mussel fishery without the mussel dredge exemption (Sub-option 2): If Sub-option 2 is selected, there would be no mussel dredge exemption within the Alternative 3 area. A mussel fishery has occurred in this area in the past, and industry members have indicated an interest in reestablishing a fishery in this area. In recent years, the mussel fishery has occurred primarily in state waters, and the mussel fishery has been precluded from fishing within the GSC HMA since April 9, 2018. The impacts on the mussel fishery of Alternative 3 without the mussel dredge exemption are likely low negative relative to Sub-option 1. Impacts are likely neutral relative to Alternative 1/No Action, low negative relative to Alternatives 2 and 5, and low negative to low positive relative to Alternative 4 (depending on the Alternative 4 option).

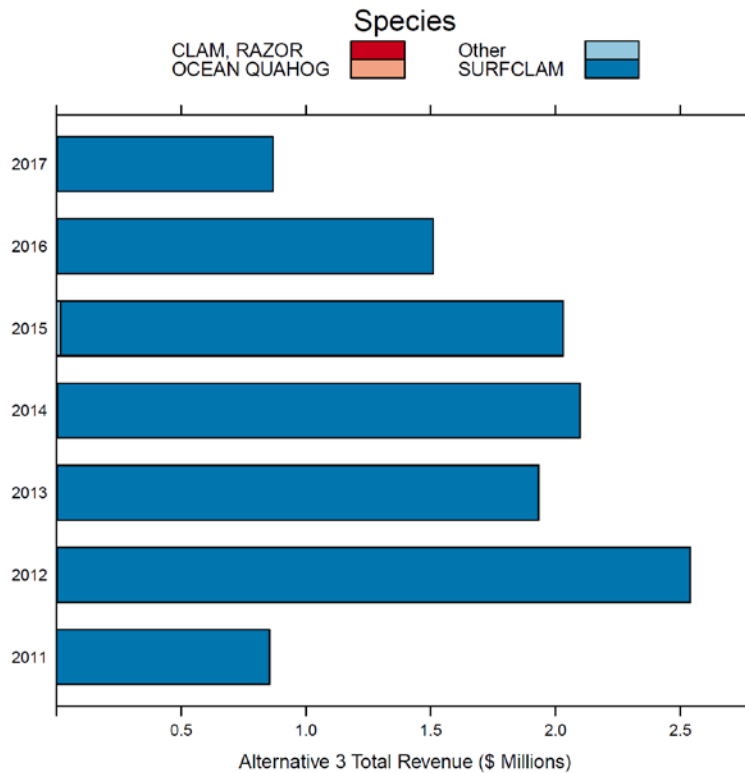
Impacts on other fisheries: The impacts on other fisheries (i.e., groundfish, skate, scallop, herring, lobster) of Alternative 3 are likely low positive. The GSC HMA provides habitat protection for other managed species, so their respective fisheries are expected to fare better with reduced fishing activity for surfclams and mussels in the GSC HMA. Impacts are likely low negative relative to Alternative 1 (No Action) and low positive relative to Alternatives 2, 4, and 5. Impacts are likely low negative relative to No Action and Alternatives 4 and 5 and low positive relative to Alternative 2, as Alternative 3 would provide less and more habitat protection from bottom tending mobile gear, respectively. Benefits to other fisheries would be indirect and accrue over time as habitats that have been impacted by mobile bottom tending gear recover to more productive states.

Impacts on communities: The impacts on fishing communities of Alternative 3 are likely low negative to low positive. While the surfclam and mussel fisheries may have low negative impacts (low positive for mussel fishery if sub-option 1 is selected), impacts on other fisheries may be low positive.

Although the logbook analysis has some degree of error, it suggests that the fishing communities impacted by hydraulic dredge restrictions in the GSC HMA are primarily located in Massachusetts, with lesser activity attributed to a few confidential states (Table 33). Revenue from hydraulic dredge fishing in 2011-2017 in the Alternative 3 area is attributed to 9 ports and 34 permits, and 99.9% of this revenue to ports in Massachusetts. New Bedford (26 permits), Barnstable County (13 permits) and Fairhaven (10 permits) are the top non-confidential landing ports, comprising 99.9% of the revenue, indicating that this area is particularly important for those three communities, which are some of the more proximal ports to the GSC HMA. The annual average revenue attributed to the Alternative 3 area is \$1.7M, an area that would be open; areas that would remain closed account for \$4.3M annually. In 2016 alone, the surfclam dredge revenue from area that would be closed under Alternative 3 that was landed in New Bedford, Barnstable County and Fairhaven was 21%, 72% and 59% of the total surfclam revenue to those ports, respectively (Table 34). It is difficult, however, to determine if effort would shift to areas that would remain open (inside and outside the GSC HMA).

The communities that may benefit from Alternative 3 are those more active in the fisheries for species that could benefit from habitat protections afforded by the hydraulic dredge restrictions. These fisheries include groundfish, skate, sea scallop, Atlantic herring and lobster (Table 14, p. 78). Based in communities such as Gloucester, Chatham, New Bedford, Fairhaven, Narragansett and Montauk, some of which are also important to the surfclam fishery (e.g., New Bedford). Thus, there may be both positive and negative impacts within a given port.

Figure 13 – Hydraulic clam dredge revenue by species from the Alternative 3 area, 2011-2017.



Source: Surfclam logbook analysis.

Note: Data is for the areas that would be open under Alternative 3.

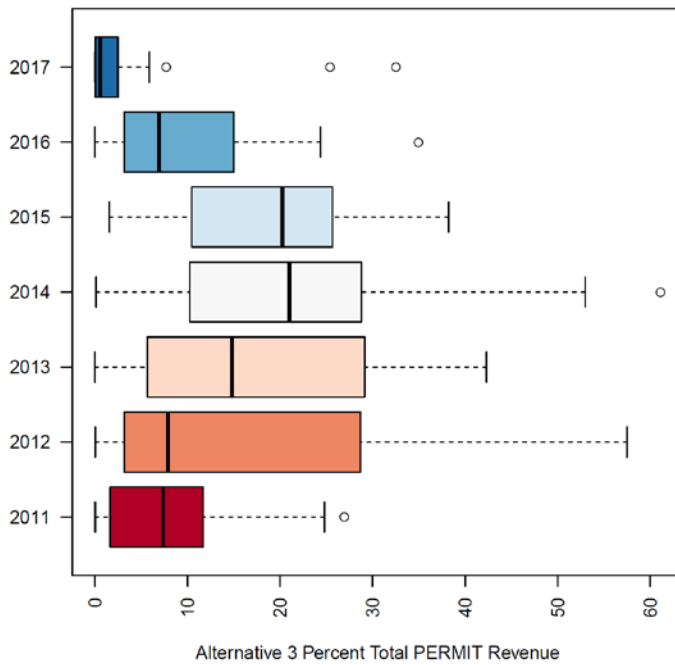
Clam Dredge Framework

Table 36 – Revenue (to nearest \$100K) and fishing effort (hours) within the Alternative 3 area for January 2011-December 2017.

Metric	Area	2011	2012	2013	2014	2015	2016	2017	Average
Revenue (logbook)	Rose and Crown	\$ 800,000	\$ 2,600,000	\$ 1,900,000	\$ 2,100,000	\$ 2,000,000	\$ 1,500,000	\$ 900,000	\$ 1,700,000
	Total in HMA	\$ 2,800,000	\$ 6,100,000	\$ 7,800,000	\$ 7,800,000	\$ 7,100,000	\$ 7,300,000	\$ 4,700,000	\$ 6,200,000
	% of HMA revenue	30%	42%	25%	27%	28%	20%	18%	27%
Fishing Effort (hrs, VMS)	Rose and Crown	1,022	5,334	4,126	4,720	5,318	9,036	3,360	4,702
	Total in HMA	3,887	7,562	11,262	12,364	13,100	21,567	9,645	11,341
	% of HMA hours	26%	71%	37%	38%	41%	42%	35%	41%

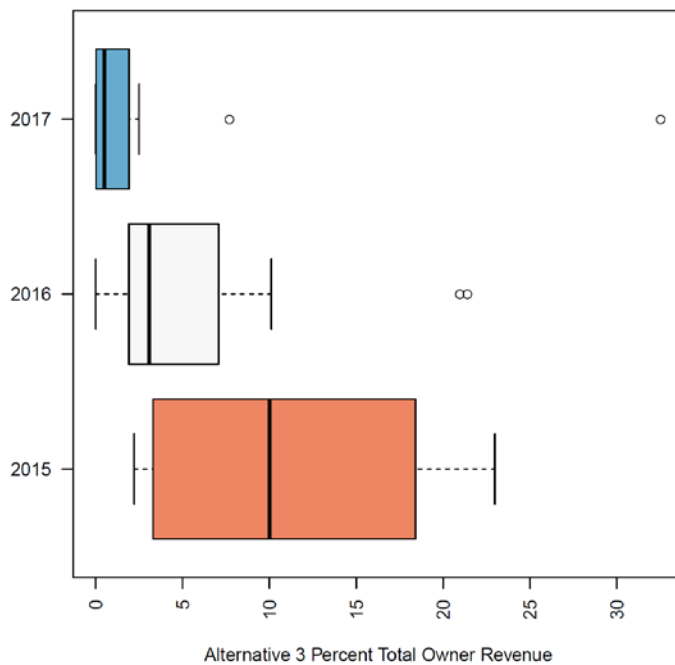
Source: Revenue from surfclam logbook analysis, fishing effort from VMS.

Figure 14 – Percent of total permit hydraulic clam dredge revenue from the Alternative 3 area, 2011-2017.



Source: Surfclam logbook analysis.

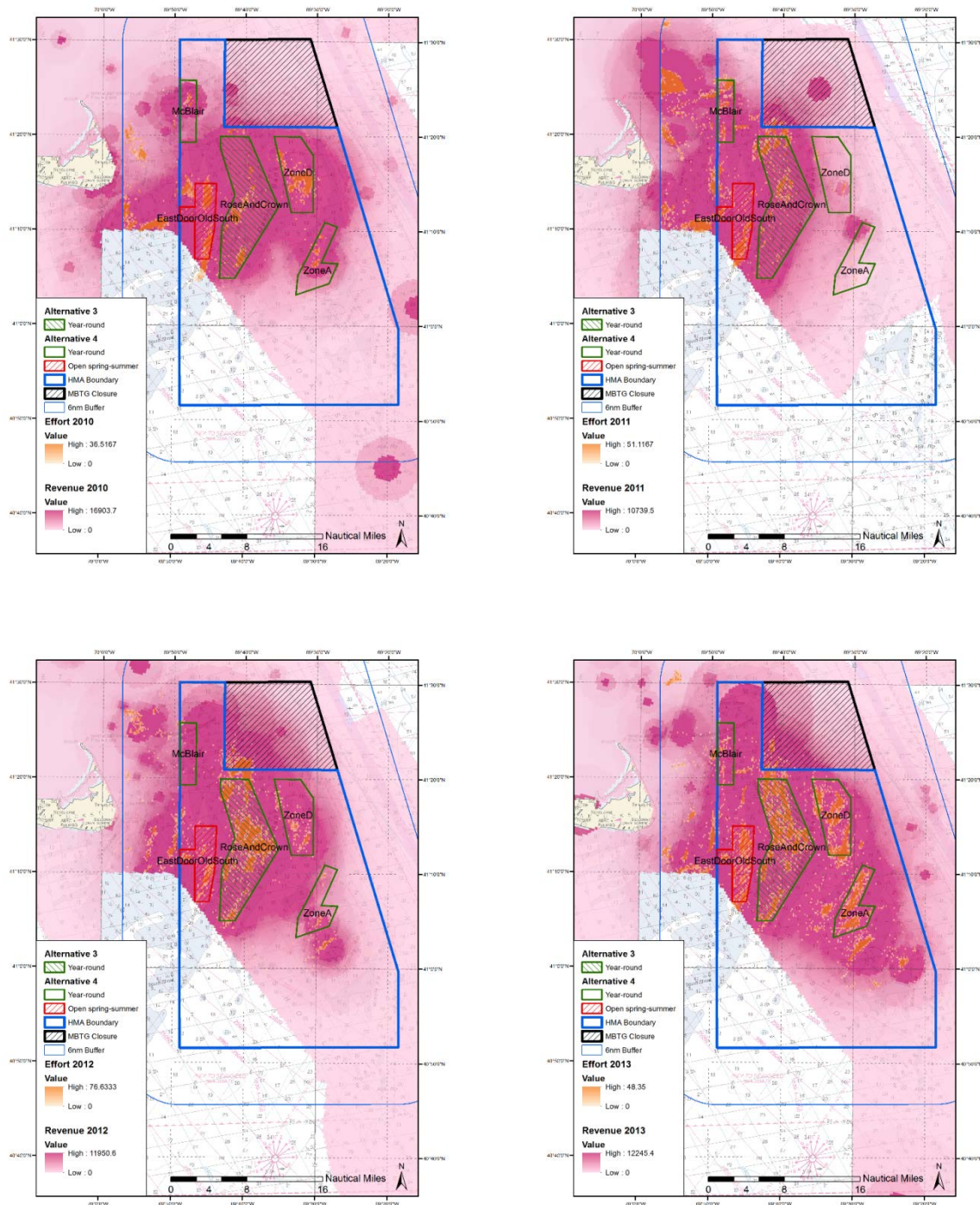
Figure 15 – Percent of total owner entity revenue generated from hydraulic clam dredges in the Alternative 3 area, 2015-2017.



Source: Surfclam logbook analysis.

Clam Dredge Framework

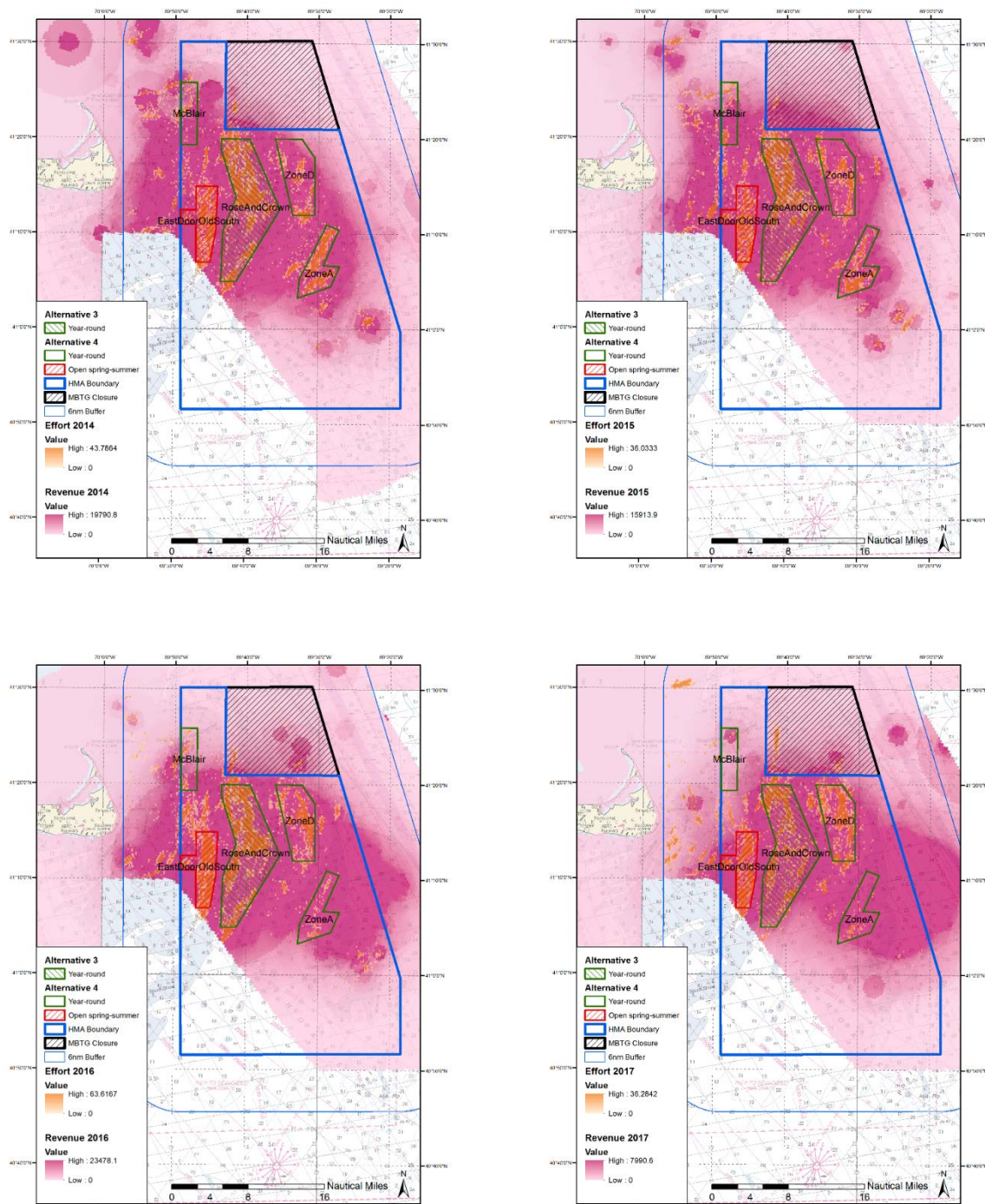
Map 25 – Surfclam vessel effort (hours fished) and revenue relative to the Alternative 3 and 4 boundaries, 2010-2013 (clockwise from upper left).



Source: Surfclam logbook analysis (revenue) and VMS data (hours fished).

Clam Dredge Framework

Map 26 – Surfclam vessel effort (hours fished) and revenue relative to the Alternative 3 and 4 boundaries, 2014-2017 (clockwise from upper left).



Source: Surfclam logbook analysis (revenue) and VMS data (hours fished).

6.3.5 Alternative 4

Under Alternative 4, four exemption areas (Old South, McBlair, Zone A, and Davis Bank East [Zone D]) would be designated for surfclam dredges, with seasonal access to Old South. A sub-option would allow mussel dredges into all these areas. Besides the impacts below, there are increased costs associated with increased VMS polling (Section 6.3.1.3).

Impacts on the surfclam fishery: The impacts on the surfclam fishery of Alternative 4 would be positive relative to No Action, low negative relative to Alternative 2, neutral to Alternative 3 and low positive relative to Alternative 5. Impacts are likely low negative relative to recent management (up to April 8, 2019), as only a portion of the GSC HMA would remain fishable. Given the intensity of fishing within the GSC HMA, the loss of fishing grounds outside of the Alternative 4 exemption areas is likely to have a substantial economic impact on the surfclam fishery. Some revenue loss may be mitigated through shifting effort to open areas within Alternative 4, areas outside the GSC HMA, and/or by leasing out quota. though there are logistical and financial constraints to doing so (Section 6.1.1). Effort shifts are likely under all alternatives, but effort shifts under Alternative 4 are more likely than under Alternatives 2 and 3 and less likely than under Alternatives 1 and 5.

Revenue by gear and species: Between 2011 and 2017, clam dredge revenue from the area that would be open under Alternative 4 was about \$0.5-1.7M annually or \$1.1M on average and dominated by surfclam landings (Figure 16, Table 33). Recent revenue from the GSC HMA areas that would remain closed under Alternative 4 has been about \$4.9M annually.

This revenue is 15-41% of all surfclam revenue annually generated within the GSC HMA, and ranges from \$0.49M to \$1.6M (average of \$1.1M) annually. Most fishermen fishing within the Great South Channel HMA are estimated to be active within the Alternative 4 areas. A comparison of Figure 8 and Figure 17 indicates that no one is fishing exclusively within the Alternative 4 areas. Further, a comparison of Figure 8 with Figure 14 and Figure 11 indicates permitted vessels using Alternative 2 and 3 areas more intensively than Alternative 4 areas. Conversely, those same figures indicate that the usage intensity for Alternative 4 has not decreased as quickly as Alternative 3 in the near past. A comparison of Figure 18 with Figure 15 and Figure 12 indicates the same pattern of intensity for ownership revenue, with Alternative 2 most intensively used, followed in order by Alternative 3 and Alternative 4. Whereas Alternative 3 has seen a decreasing intensity of ownership usage, the ownership-usage of Alternative 4 has been relatively stable.

Given this reality, the benefits associated with Alternative 4 could be slightly higher than Alternative 3, stemming primarily from access areas spread more diffusely throughout the HMA, which could help guard against shifts in surfclam distribution and depletion due to intensive harvesting. However, this is a highly uncertain conclusion. These benefits are likely not as high as for Alternative 2, of which Alternative 4 is a subset, but higher than Alternative 1, which provides no access to the surfclam resource in this area. Note that compared to the logbook-based estimates, VMS effort percentages outside the exemption areas are lower, with more effort inferred to the exemption areas vs. non-exempt areas. Table 37 compares annual (open and

closed season) logbook revenue and VMS hours fished estimates for the areas included in Alternative 4 with those for the HMA overall.

Hours fished: The VMS data suggest that from January 2010-June 2018, between 7 and 27 permits fished within the Alternative 4 areas. Estimated fishing hours varies by area, with moderate amounts of hours in East Door/Old South and Davis Bank East, and relatively few hours in McBlair and Fishing Rip, accounting for 39% of the total hours fished in the HMA on average, across the time series (Table 37, Map 25, Map 26).

Impacts on the mussel fishery with the mussel dredge exemption (Sub-option 1): If Sub-option 1 is selected, there would be a mussel dredge exemption within the Alternative 4 areas. The impacts on the mussel fishery of Alternative 4 with the mussel dredge exemption are likely low positive relative to Sub-option 2. Impacts are likely low positive relative to Alternative 1/No Action, low negative relative to Alternatives 2 and 5, and low negative to low positive relative to Alternative 3 (depending on the Alternative 3 option).

As previously stated, there is no federal record of mussel dredge fishing within the Great South Channel HMA between 2011 and 2017. The more diffuse areas of Alternative 4 could provide some robustness to the spatial uncertainty of the distribution of mussel beds within the Great South Channel HMA, when compared to Alternative 3, but this is a highly uncertain proposition given the general lack of data available. Like Alternative 3, fishermen will only fish within the areas designated within Alternative 4 if they expect a benefit from doing so. Exploratory fishing within the areas would be expected in the short term, with long term fishing effort dependent on the success of those exploratory trips. The expected benefit to access for the mussel fishery is thus non-negative, but highly uncertain.

Impacts on the mussel fishery without the mussel dredge exemption (Sub-option 2): If Sub-option 2 is selected, there would be no mussel dredge exemption within the Alternative 4 areas. A mussel fishery has occurred in this area in the past, and industry members have indicated an interest in reestablishing a fishery in this area. In recent years, the mussel fishery has occurred primarily in state waters, and the mussel fishery has been precluded from fishing within the GSC HMA since April 9, 2018. The impacts on the mussel fishery of Alternative 4 without the mussel dredge exemption are likely low negative relative to Sub-option 1. Impacts are likely neutral relative to Alternative 1/No Action, low negative relative to Alternatives 2 and 5, and low negative to low positive relative to Alternative 3 (depending on the Alternative 3 option).

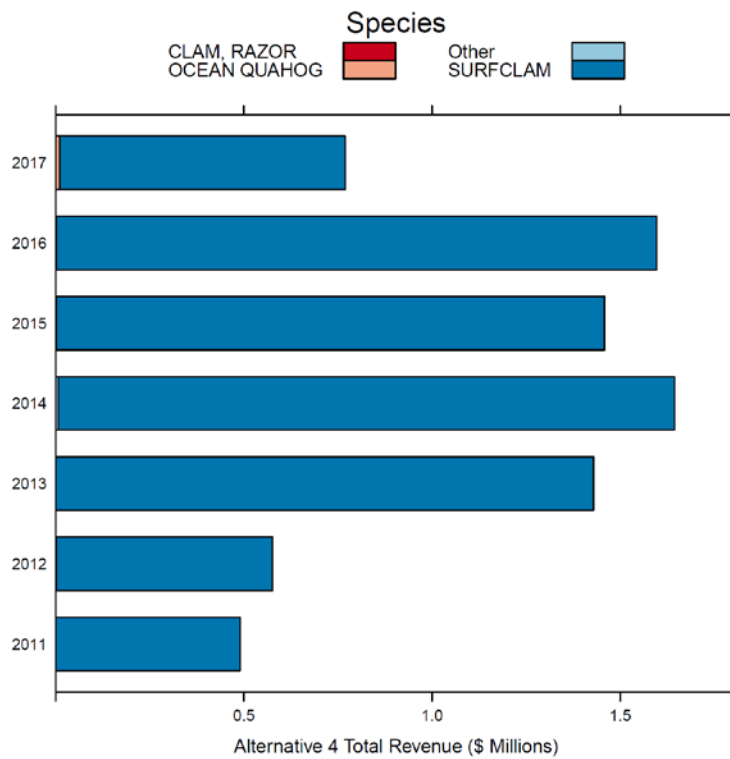
Impacts on other fisheries: The impacts on other fisheries (i.e., groundfish, skate, scallop, herring, lobster) of Alternative 4 are likely low positive. The GSC HMA provides habitat protection for other managed species, so their respective fisheries are expected to fare better with reduced fishing activity for surfclams and mussels in the GSC HMA. Impacts are likely low negative relative to No Action and Alternative 5, low positive relative to Alternatives 2 and 3, as Alternative 4 would provide less and more habitat protection from bottom tending mobile gear, respectively. Benefits to other fisheries would be indirect and accrue over time as habitats that have been impacted by mobile bottom tending gear recover to more productive states.

Impacts on communities: The impacts on fishing communities of Alternative 4 are likely low negative to low positive. While the surfclam and mussel fisheries may have low negative impacts (low positive for mussel fishery if sub-option 1 is selected), impacts on other fisheries may be low positive.

Although the logbook analysis has some degree of error, it suggests that the fishing communities impacted by hydraulic dredge restrictions in the GSC HMA are primarily located in Massachusetts, with lesser activity attributed to a few confidential states (Table 33). Revenue from hydraulic dredge fishing in 2011-2017 in the Alternative 4 areas is attributed to 11 ports and 34 permits, and 99.9% of this revenue to ports in Massachusetts. New Bedford (27 permits), Barnstable County (15 permits) and Fairhaven (11 permits) are the top non-confidential landing ports, comprising 99.9% of the revenue, indicating that this area is particularly important for those three communities, which are some of the more proximal ports to the GSC HMA. The annual average revenue attributed to the Alternative 4 areas is \$1.1M, areas that would be open; areas that would remain closed account for \$4.9M annually. In 2016 alone, the surfclam dredge revenue from area that would be closed under Alternative 4 that was landed in New Bedford, Barnstable County and Fairhaven was 21%, 62% and 71% of the total surfclam revenue to those ports, respectively (Table 34). It is difficult, however, to determine if effort would shift to areas that would remain open (inside and outside the GSC HMA).

The communities that may benefit from Alternative 4 are those more active in the fisheries for species that could benefit from habitat protections afforded by the hydraulic dredge restrictions. These fisheries include groundfish, skate, sea scallop, Atlantic herring and lobster (Table 14, p. 78) based in communities such as Gloucester, Chatham, New Bedford, Fairhaven, Narragansett and Montauk, some of which are also important to the surfclam fishery (e.g., New Bedford). Thus, there may be both positive and negative impacts within a given port.

Figure 16 – Hydraulic clam dredge revenue by species from the Alternative 4 areas, 2011-2017.



Source: Surfclam logbook analysis.

Note: Data is for the areas that would be open under Alternative 4; some seasonally.

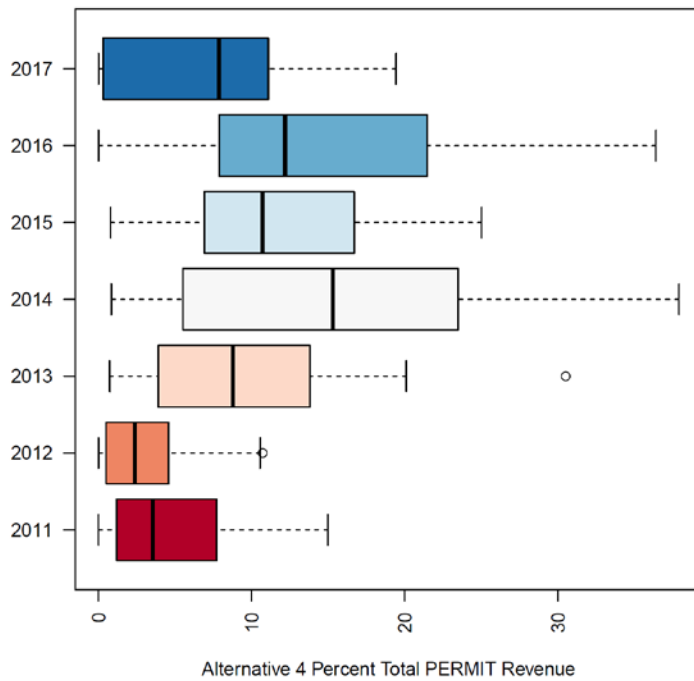
Clam Dredge Framework

Table 37 – Revenue (to nearest \$100K) and fishing effort (hours) within the Alternative 4 areas (note that these are year-round estimates for Old South) for January 2011-December 2017.

Metric	Area	2011	2012	2013	2014	2015	2016	2017	Average
Revenue	Zone A	\$ -	\$ 100,000	\$ 500,000	\$ 500,000	\$ 300,000	\$ 200,000	\$ 300,000	\$ 300,000
	Davis Bank East	\$ -	\$ 300,000	\$ 700,000	\$ 400,000	\$ 600,000	\$ 500,000	\$ 300,000	\$ 400,000
	McBlair	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ -	\$ -	\$ 100,000
	Old South	\$ 500,000	\$ 300,000	\$ 300,000	\$ 1,200,000	\$ 1,000,000	\$ 1,300,000	\$ 400,000	\$ 700,000
	Total	\$ 600,000	\$ 800,000	\$ 1,600,000	\$ 2,200,000	\$ 1,900,000	\$ 2,000,000	\$ 1,000,000	\$ 1,500,000
	Total in HMA	\$ 2,800,000	\$ 6,100,000	\$ 7,800,000	\$ 7,800,000	\$ 7,100,000	\$ 7,300,000	\$ 4,700,000	\$ 6,200,000
	% of HMA revenue	22%	13%	21%	28%	27%	28%	22%	23%
Fishing Effort (hrs)	Zone A	18	58	1,199	2,004	1,235	220	97	4,831
	Davis Bank East	45	248	1,956	532	1,375	2,974	2,077	9,206
	McBlair	795	10	106	178	564	300	34	1,988
	Old South	855	469	1,111	2,788	2,204	5,220	2,171	14,818
	Total	1,713	784	4,373	5,501	5,378	8,714	4,379	4,406
	Total in HMA	3,887	7,562	11,262	12,364	13,100	21,567	9,645	11,341
	% of HMA hours	44%	10%	39%	44%	41%	40%	45%	39%

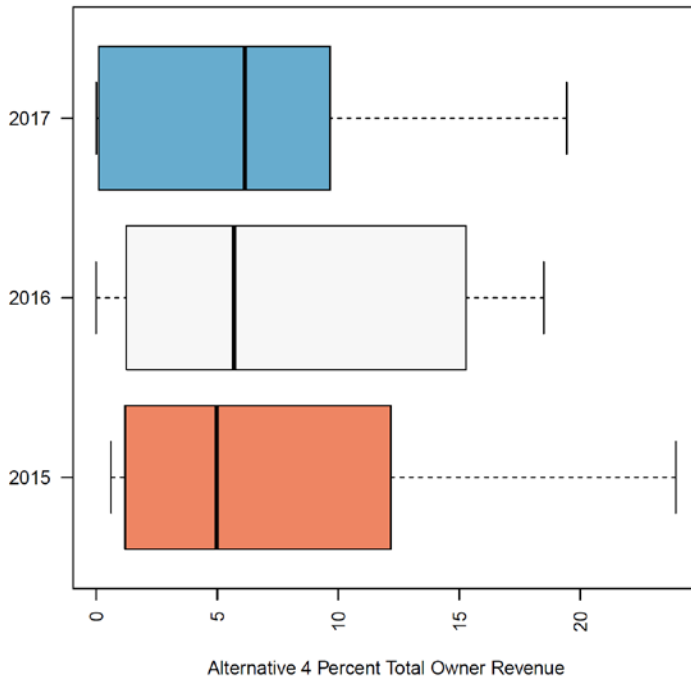
Source: Revenue from surfclam logbook analysis, fishing effort from VMS.

Figure 17 – Percent of total permit hydraulic clam dredge revenue from the Alternative 4 areas during periods in which they would be designated as open, 2011-2017.



Source: Surfclam logbook analysis.

Figure 18 – Percent of total owner entity revenue generated from hydraulic clam dredges in the Alternative 4 areas during periods in which they would be designated as open, 2015-2017.



Source: Surfclam logbook analysis.

6.3.6 Alternative 5 (Preferred)

Under Alternative 5 (Map 4), three exemption areas would be designated for both surfclam and mussel dredges: (1) McBlair, (2) Old South, and (3) Fishing Rip. Old South would be closed for six months from November 1-April 30 to reduce overlaps between clam dredging and cod spawning activities. Besides the impacts below, there are increased costs associated with increased VMS polling (Section 6.3.1.3).

Impacts on the surfclam fishery: The impacts on the surfclam fishery of Alternative 5 would be positive relative to No Action, which will close the entire HMA to hydraulic dredging, and low negative relative to Alternatives 2-4, because Alternative 5 affords less access to surfclam grounds relative to other action alternatives. Impacts are likely only slightly less positive than Alternatives 3 and 4. Impacts are likely low negative to negative relative to recent management (up to April 8, 2019), as a portion of the GSC HMA would remain fishable under Alternative 5. Given the intensity of fishing within the GSC HMA, loss of fishing grounds outside of the Alternative 5 exemption areas is likely to generate substantial losses to the surfclam fishery. Some revenue loss may be mitigated through shifting effort to open areas within Alternative 5, areas outside the GSC HMA, and/or by leasing out quota, though there are logistical and financial constraints to doing so (Section 6.1.1). Effort shifts are likely under all alternatives, but

effort shifts under Alternative 5 are more likely than under Alternatives 2, 3, and 4 and less likely than under Alternative 1.

Under Alternative 5, the Council would develop priorities for research in the Rose and Crown and Davis Bank East areas. Alternative 5 does not guarantee that research would take place though. Proposals would need to be approved by NMFS through the existing EFP process. The recent (2011-2017) annual average surfclam revenue attributed to the potential research areas is \$2.1M (Table 33). As research typically occurs in discrete times and locations, any revenue from participating in research is expected to be substantially lower, likely *de minimus* relative to the level of fishing activity in the Great South Channel HMA. Any revenue from research would accrue to just the participating vessels. Changes to management based on future research would be developed and analyzed in a future action.

Revenue by gear and species: Between 2011 and 2017, clam dredge revenue from the area that would be open under Alternative 5 was about \$0.3-1.4M annually or \$0.8M on average and dominated by surfclam landings (Figure 16, Table 33). Recent revenue from the GSC HMA areas that would remain closed under Alternative 5 has been about \$5.2M annually.

Clam dredge revenue from the Alternative 5 areas is dominated by surfclam landings (Figure 19). For 2010-2017, 10-27% of surfclam revenue generated from the GSC HMA was from the Alternative 5 areas (Table 38). The median permitted vessel fishing within Alternative 5 areas generated 3-10% of total revenue from these areas (Figure 20), with a substantial portion of the remaining revenue derived from other areas of the HMA (Figure 8). The owner-level dependence on these areas is somewhat lower (Figure 21), indicating that ownership entities fish across multiple areas concurrently, although again, a substantial portion of total ownership revenue is generated elsewhere within the HMA (Figure 9).

Hours fished: Estimated fishing hours varies by area, with moderate amounts of hours in East Door/Old South, and relatively few hours in McBlair and Fishing Rip (Table 38, Map 25, Map 26). On average Alternative 5 accounts for 29% of the total hours fished in the HMA (Table 38).

Impacts on the mussel fishery: A mussel fishery has occurred on Nantucket Shoals in the past, and industry members have indicated an interest in reestablishing a fishery in this area. In recent years, the mussel fishery has occurred primarily in state waters, and the mussel fishery has been precluded from fishing within the GSC HMA since April 9, 2018. As previously stated, there is no federal record of mussel dredge fishing within the Great South Channel HMA between 2011 and 2017 and the distribution of mussel beds is poorly understood at present.

The impacts on the mussel fishery of Alternative 5 are likely low positive relative to No Action, as a portion of the GSC HMA would become fishable, but the magnitude is somewhat uncertain given the general lack of data available. Impacts could be low negative relative to Alternatives 2-4, providing substantially less access than Alternative 2 and slightly less than Alternative 3 and 4.

There is no federal record of mussel dredge fishing within the Great South Channel HMA between 2011 and 2017. The more diffuse areas of Alternative 5 could provide some robustness

to the spatial uncertainty of the distribution of mussel beds within the Great South Channel HMA, when compared to Alternative 3, but this is a highly uncertain proposition given the general lack of data available. Fishermen will only fish within the areas designated within Alternative 5 if they expect a benefit from doing so. Exploratory fishing within the areas would be expected in the short term, with long term fishing effort dependent on the success of those exploratory trips. The expected benefit to access for the mussel fishery is thus non-negative, but highly uncertain.

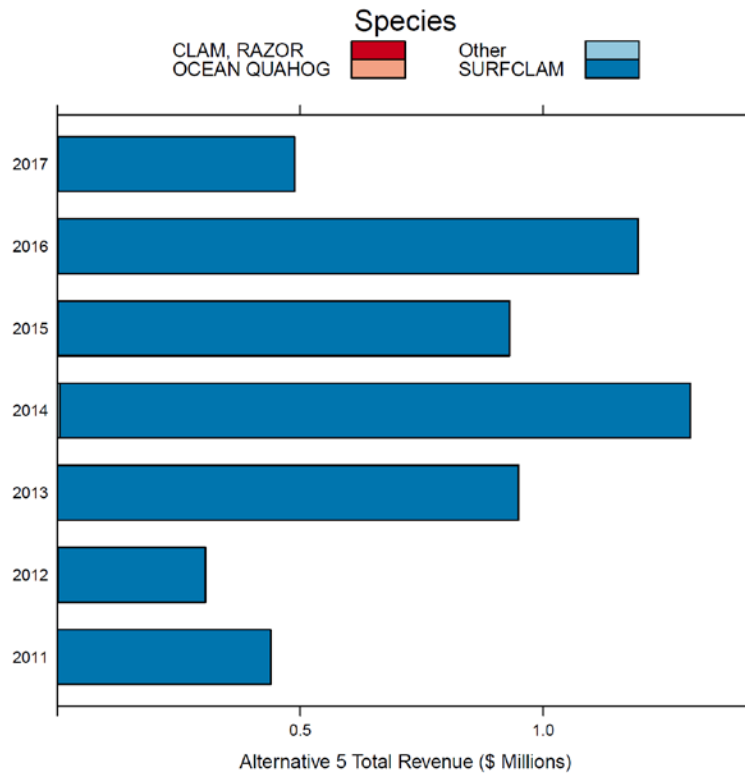
Impacts on other fisheries: The impacts on other fisheries (i.e., groundfish, skate, scallop, herring, lobster) of Alternative 5 are likely low positive. The GSC HMA provides habitat protection for other managed species, so their respective fisheries are expected to fare better with reduced fishing activity for surfclams and mussels in the GSC HMA. Impacts are likely low negative relative to No Action, but low positive relative to Alternatives 2-4 as Alternative 4 would provide less and more habitat protection from bottom tending mobile gear, respectively. Benefits to other fisheries would be indirect and accrue over time as habitats that have been impacted by mobile bottom tending gear recover to more productive states.

Impacts on communities: The impacts on fishing communities of Alternative 5 are likely low negative to low positive. While the surfclam and mussel fisheries may have low negative and low positive impacts, respectively, impacts on other fisheries may be low positive.

The communities that may be negatively impacted by hydraulic dredge restrictions in the GSC HMA are primarily located in Massachusetts, with lesser activity attributed to a few confidential states (Table 33). Revenue from hydraulic dredge fishing in 2011-2017 in the Alternative 5 area is attributed to 11 ports and 33 permits, and 99.9% of this revenue to ports in Massachusetts. New Bedford (26 permits), Barnstable County (15 permits) and Fairhaven (11 permits) are the top non-confidential landing ports, comprising 99.9% of the revenue, indicating that this area is particularly important for those three communities, which are some of the more proximal ports to the GSC. The annual average revenue attributed to the Alternative 5 areas is \$0.8M, areas that would be open; areas that would remain closed account for \$5.2M annually. In 2016 alone, the surfclam dredge revenue from area that would be closed under Alternative 5 that was landed in New Bedford, Barnstable County and Fairhaven was 22%, 69% and 71% of the total surfclam revenue to those ports, respectively (Table 34). It is difficult, however, to determine if effort would shift to areas that would remain open (inside and outside the GSC HMA).

The communities that may benefit from Alternative 5 are those more active in the fisheries for species that could benefit from habitat protections afforded by the hydraulic dredge restrictions. These fisheries include groundfish, skate, sea scallop, Atlantic herring and lobster (Table 14, p. 78). Based in communities such as Gloucester, Chatham, New Bedford, Fairhaven, Narragansett and Montauk, some of which are also important to the surfclam fishery (e.g., New Bedford). Thus, there may be both positive and negative impacts within a given port.

Figure 19 – Hydraulic clam dredge revenue by species from the Alternative 5 areas, 2011-2017.



Source: Surfclam logbook analysis.

Note: Data is for the areas that would be open under Alternative 4; some seasonally.

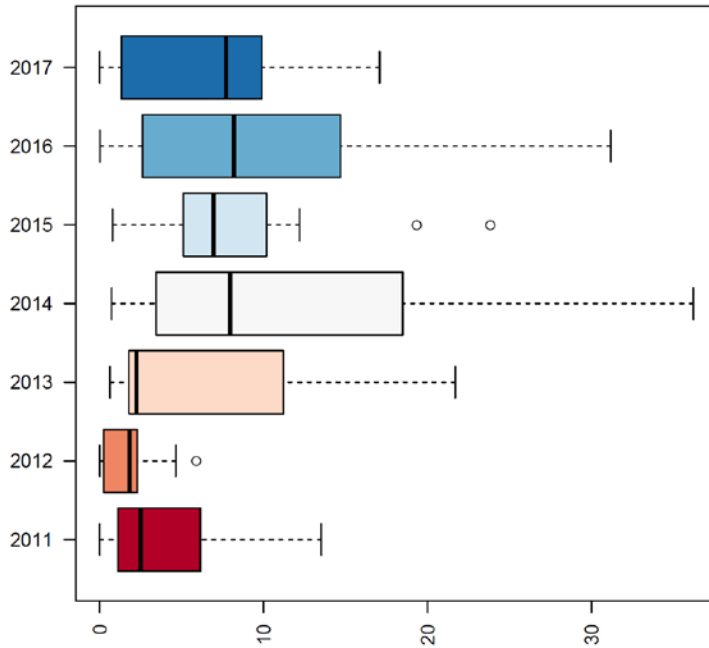
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Table 38 – Revenue (to nearest \$100K) and fishing effort (hours) within the Alternative 5 areas (note that these are year-round estimates for Old South) for January 2011-December 2017.

Metric	Area	2011	2012	2013	2014	2015	2016	2017	Average
Revenue	Fishing Rip	\$ -	\$ 100,000	\$ 700,000	\$ 600,000	\$ 300,000	\$ 300,000	\$ 300,000	\$ 300,000
	McBlair	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ -	\$ -	\$ 100,000
	Old South	\$ 500,000	\$ 300,000	\$ 300,000	\$ 1,200,000	\$ 1,000,000	\$ 1,300,000	\$ 400,000	\$ 700,000
	Total	\$ 600,000	\$ 500,000	\$ 1,100,000	\$ 1,900,000	\$ 1,400,000	\$ 1,700,000	\$ 800,000	\$ 1,100,000
	Total in HMA	\$ 2,800,000	\$ 6,100,000	\$ 7,800,000	\$ 7,800,000	\$ 7,100,000	\$ 7,300,000	\$ 4,700,000	\$ 6,200,000
	Pct Rev in HMA	20%	9%	14%	24%	20%	23%	16%	18%
Fishing Effort (hrs)	Fishing Rip	17	208	1,843	2,070	1,254	222	97	5,710
	McBlair	795	10	106	178	564	300	34	1,988
	Old South	855	469	1,111	2,788	2,204	5,220	2,171	14,818
	Total	1,667	687	3,060	5,036	4,022	5,742	2,302	3,216
	Total in HMA	3,887	7,562	11,262	12,364	13,100	21,567	9,645	11,341
	Percent in HMA	43%	9%	27%	41%	31%	27%	24%	29%

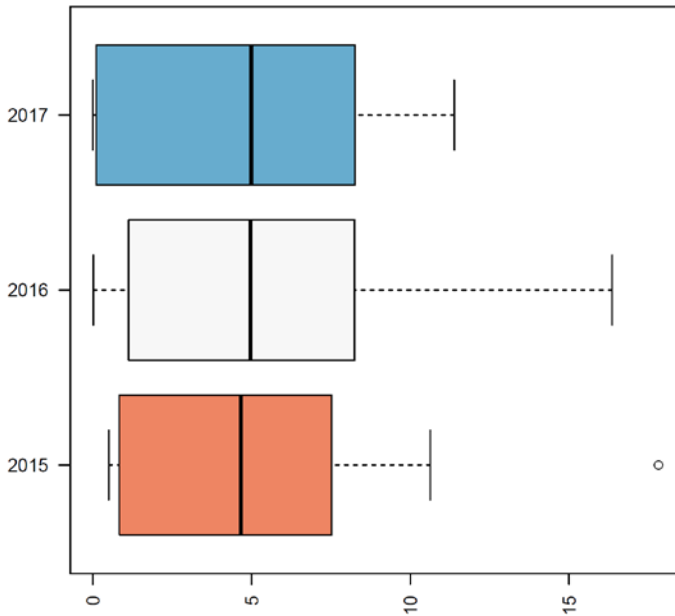
Source: Revenue from surfclam logbook analysis, fishing effort from VMS.

Figure 20 – Percent of total permit hydraulic clam dredge revenue from the Alternative 5 areas during periods in which they would be designated as open, 2011-2017.



Source: Surfclam logbook analysis.

Figure 21 – Percent of total owner entity revenue generated from hydraulic clam dredges in the Alternative 5 areas during periods in which they would be designated as open, 2015-2017.



Source: Surfclam logbook analysis.

6.4 Protected Resources

The alternatives under consideration in this action would change the spatial distribution and potentially the overall magnitude of clam and mussel dredging in the New England region, potentially indirectly affecting fishing effort for surfclams in the mid-Atlantic region as well. These changes in effort are not expected to significantly impact protected species for reasons described below.

Hydraulic dredges: Under Alternatives 2-5, use of hydraulic clam dredges would be allowed to continue in certain sections of the GSC HMA. Because the surfclam dredge fishery is active in the HMA, effort that cannot be absorbed by the exemption sub-areas identified under each of the alternatives would likely be displaced to areas outside the GSC HMA. Under Alternative 1/No Action, the fishery would be attempting to make up the entirety of the GSC HMA surfclam harvest in other areas, while under Alternatives 2-5, some effort will be redistributed. Although not all areas of the GSC HMA are equally valuable to the surfclam fishery, the exemption areas from largest to smallest are Alternative 2 (453 km²), Alternative 4 (242 km²), Alternative 3 (192 km²), Alternative 5 (177 km²). Alternative 2, which provides access to the largest amount of existing clam dredge fishing grounds, will have the fewest effects on the fishery, Alternatives 4, 3, and 5 will lead to larger changes on effort in the fishery, with the magnitude of effects likely increasing in that order.

Effort redistribution in response to spatial management is challenging to predict. However, regardless of how effort shifts, there have been no documented or observed interactions of any protected species of marine mammals, sea turtles, or fish with hydraulic clam dredges and therefore, operation of the fishery is not expected to pose any interaction risk to the species identified as potentially occurring within the affected environment for this action (Section 5.6). Therefore, changes in the spatial distribution or overall magnitude of clam dredging effort are not expected to have any impacts, positive or negative, on protected resources. Thus, Alternatives 1-5 are expected to have neutral impacts on all species of protected resources with respect to the surfclam fishery.

Mussel dredges: Under Alternatives 2 and 5, and under Alternatives 3 and 4 with the mussel dredge exemption sub-option, mussel dredges will be allowed in certain sections of the GSC HMA. Alternative 2 authorizes access to the largest combined area, Alternative 5 the smallest combined area, and Alternatives 3 and 4 are intermediate in terms of the amount of area that would be fishable. Because there has been only exploratory mussel harvest in the GSC HMA in recent years and the locations and sizes of mussel beds are not well known, it is difficult to project how much mussel dredging activity might occur within the GSC HMA under these alternatives. Under Alternative 1/No Action, the fishery will not expand onto Nantucket Shoals and there will be no change in the impacts of the mussel fishery on protected resources. Therefore Alternative 1/No Action is expected to have neutral impacts on all protected resources. Under Alternatives 2-5, mussel dredging effort may increase, which could change the fishery's effects on protected resources, specifically species of hard-shelled sea turtles and Atlantic sturgeon (Section 5.6).

As described in section 5.6, mussel dredges are like scallop dredges. Given the lack of observed or documented interactions between scallop dredges and large whales, small cetaceans, pinnipeds, leatherback sea turtles, hawksbill sea turtles, or Atlantic salmon, and the assumed similarity between these dredge types, Alternatives 2-5 are expected to have neutral impacts on these protected species. However, given the observed interactions between scallop dredge gear and species of hard-shelled sea turtles (i.e., loggerhead, Kemp's ridley, and green) and Atlantic sturgeon (NMFS NEFSC FSB 2018; Section 5.6), some interaction risk may exist between mussel dredges and these protected species. Because Alternatives 2 and 5 and Alternatives 3 and 4 with the mussel dredge exemption sub-option could increase effort in the mussel dredge fishery, these alternatives could lead to increased interaction risk between mussel dredges and listed species of hard-shelled sea turtles and/or Atlantic sturgeon. Thus, these alternatives could have a negative impact on these resources. The magnitude of this impact, while unknown, is likely low, because the exemption areas are small (a mile to a few miles across) and the scale of the fishery is not expected to be substantial (one or a few vessels).

6.5 Cumulative Effects Assessment

A cumulative effects assessment (CEA) is a required part of an EIS or EA according to the Council on Environmental Quality (CEQ) (40 CFR part 1508.7) and NOAA's agency policy and procedures for NEPA, found in NOAA Administrative Order 216-6A (Companion Manual, January 13, 2017). The purpose of the CEA is to integrate into the impact analyses the combined effects of many actions over time that would be missed if each action were evaluated separately. CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action from every conceivable perspective but rather, the intent is to focus on those effects that are truly meaningful. Predictions of potential synergistic effects from multiple actions, past, present and/or future will generally be qualitative in nature.

This section examines the potential direct and indirect effects of the alternatives in this framework together with past, present, and reasonably foreseeable future actions that affect the human environment. Specifically, this analysis describes past, present, and foreseeable future actions, the baseline status of all VECs, and the cumulative effects of No Action, the Council's preferred action, other alternatives considered, building upon the baseline status and considering other foreseeable future actions. The VECs identified as relevant to this action are identified in section 5 (Affected Environment), and include:

1. Benthic habitats, essential fish habitats, and managed species
2. Human Communities (includes economic and social effects on the fishery and fishing communities); and
3. Protected resources including endangered and threatened species.

The geographic scope of this analysis includes the New England region, as delimited by the New England/Mid-Atlantic inter-council boundary. The region includes U.S. waters in the Gulf of Maine, on Georges Bank, and in Southern New England, together with the continental shelf and slope off Georges Bank and Southern New England to the EEZ boundary. The temporal scope of this analysis extends backwards in time to the initiation of federal fisheries management but

focuses on the most recent major action in any given fishery management plan, and other relatively recent changes in non-fishing activities. The analysis goes forward in time ten years from the planned implementation date of 2019 (i.e., to 2029), although near-term actions are more reliably identified. Given the time it takes many species to recruit to the fishery, any benefits of habitat conservation are likely to be realized as productivity benefits at the stock level no earlier than around the five-year mark. Such benefits are difficult to measure. It will take even longer to translate any increases in resource productivity into increased landings and economic benefits. Therefore, evaluating cumulative effects up to ten years into the future is consistent with the anticipated conservation and fishery production outcomes of the alternatives in this action.

6.5.1 Past, Present, and Reasonably Foreseeable Future Actions

This section describes past, present, and future foreseeable actions that have effects on the valued ecosystem components evaluated in this amendment.

6.5.1.1 Fishery Management

Federal fishery management plans are developed to optimize yield in U.S. fisheries and to comply with the Magnuson-Stevens Act as reauthorized through 2007. The legislation promotes long-term positive impacts on the environment in the context of fisheries activities, stipulating that management plans must comply with a set of National Standards that collectively serve to optimize the conditions of the human environment. Specific goals of fishery management plans include improving or maintaining the stock structure and abundance of target species, improving economic and social outcomes, and minimizing incidental impacts, for example relative to protected resources and other non-target species. Under this regulatory regime, the cumulative impacts of past, present, and future Federal fishery management actions on the VECs should be expected to result in positive long-term outcomes, although these actions are often associated with offsetting impacts. For example, constraining fishing effort frequently results in negative short-term socio-economic impacts for fishery participants to bring about long-term sustainability of a given resource.

Annual catch limits and accountability measures, which are a major element of fishery management plans, are expected to have generally positive impacts of managed resources because these measures are designed to limit catches to biologically sustainable levels and to provide both proactive and reactive measures to ensure that these catch limits are not exceeded. Eliminating overfishing and reducing the number of overfished stocks is expected to generate long run benefits to the human community.

Table 39 below describes key fishery management actions by FMP for those fisheries directly or indirectly affected by the clam dredge framework. Note that there is no federal management of the blue mussel fishery, except to the extent that mussel dredges are permitted in the region in and around the Great South Channel HMA via a mussel and urchin dredge exemption to the regulated mesh areas in the Northeast Multispecies FMP. Additionally, reporting requirements apply to mussel dredge vessels that hold other federal permits. Depending on the permit, these

requirements could include the need to submit vessel trip reports or carry a vessel monitoring system.

In some cases, fishery management plan actions are developed in an omnibus fashion to update many plans at once. This approach was with the Council's recent Omnibus Habitat Amendment 2 (OHA2) and Deep-Sea Coral Amendment. As described previously in this document, OHA2 was implemented in April 2018. The Deep-Sea Coral Amendment is undergoing review and rulemaking and should go into effect during 2019. Spatially explicit gear restrictions developed in both of these actions are expected to have indirect, positive impacts on managed resources via habitat protection for those species that occur within each HMA and derive shelter and feeding benefits from the habitats therein.

Table 39 – Past, present, and future foreseeable actions within the fishery management plans in operation in the New England region that could be affected by this action

Fishery Management Plan	Past actions	Present actions	Future foreseeable actions
Northeast Multispecies FMP	FMP completed in 1986 by NEFMC to reduce fishing mortality and promote rebuilding. Past measures included input controls such as days-at-sea, mesh size, trip, and fish size, and permit limits, and seasonal and year-round management areas. EFH was designated in 1999. Amendment 18: caps accumulation limits at an average of 15.5% across all stocks and creates a 5% permit cap.	Current management includes annual catch limits by stock and accountability measures for overages. The most recent specifications were set via Framework 57 and Framework 58 is undergoing review. Most fishing conducted within the sector catch-share system. Limits on mesh-size, fish size, and permits are still used, along with area management. Trip limits and days-at-sea are infrequently relied upon.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. Possible changes to fisheries monitoring via Amendment 23.
Skate Complex FMP	FMP completed in 2003 by NEFMC to protect overfished skates and collect data about the fishery to improve management. Measures included federal permits, reporting requirements, possession limits for wing fishery, prohibitions on landings of depleted species, and EFH designations.	Current management includes annual catch limits and accountability measures for overages. Possession limits now include both wing and bait fisheries.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information.

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Fishery Management Plan	Past actions	Present actions	Future foreseeable actions
Atlantic Sea Scallop FMP	FMP completed in 1982 by NEFMC to rebuild stock and reduce interannual fluctuations in abundance. Measures included limits on permits, days-at-sea, crew size, gear restrictions, and meat count restrictions. EFH was designated in 1999 and Amendment 10 (implemented 2004) designated EFH closures, which were updated via Amendment 15 (implemented 2011) updated these areas to be consistent with those in Multispecies Amendment 13	Current management includes annual catch limits and accountability measures for overages. Rotational closure/access area system combined with open area days-at-sea. Seasonal closures and groundfish sub-ACLs to limit fish bycatch, gear restrictions to limit turtle bycatch. A 4-inch ring and rotational management used to optimize yield per recruit. Habitat closure areas.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. Considering adjustments to Northern Gulf of Maine and LAGC management programs through Amendment 21.
Atlantic Herring FMP	FMP completed in 1999 by NEFMC. Area-based quota/TAC system. EFH was also designated in 1999.	Current management includes annual catch limits and accountability measures for overages. Enhanced monitoring in groundfish management areas.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. Increased frequency of stock assessment updates and specifications actions in near term given condition of stock. Coordination with MAFMC and ASFMC on river herring/shad monitoring/bycatch. Amendment 8 which includes an ABC control rule and a localized depletion closure is under review.
Surfclam and Ocean Quahog FMP	FMP completed in 1977 by MAFMC. Initial approaches included limited entry, quarterly quotas, and fishing time restrictions. ITQ system established in 1990.	Fishery is currently managed as an ITQ system, with annual catch limits capping total catch and accountability measures for overages. Fishing is subject to food safety/PSP closures. Georges Bank fishery has expanded recently.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. MAMFC is developing an excessive shares amendment.

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Fishery Management Plan	Past actions	Present actions	Future foreseeable actions
American Lobster FMP	ASFMC plan in state waters, federally managed in Federal waters consistent with ASFMC approach. Area-based management system with trap limits, minimum-maximum size limits, and protections for egg-bearing females.	Area-based management system with trap limits, minimum-maximum size limits, and protections for egg-bearing females. Focus on fishing mortality reduction in Southern New England. Monitoring changes via Addendum XXVI (2018).	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. Potential gear changes in fishery in response to concerns about marine mammal impacts.

6.5.1.2 Protected Resources Management

Protected resource management (Table 40) focuses on evaluation of stock status, identification of fisheries and other activities that interact with protected resources, and development of measures to minimize interactions and the negative impacts associated with interactions that do occur. Management may also include designation of critical habitats. Protected resource conservation measures include among other measures restrictions on fishing in specific areas and during particular seasons. These restrictions are additive to fishing restrictions designed to ensure conservation of managed fish and shellfish stocks. Measures also include areas closed seasonally to specific gears, and gear requirements (e.g. pingers, turtle-compliant dredges, sinking groundlines, etc.). Recently there has been a specific focus on the conservation of Northern Atlantic right whales due to new information indicating that the North Atlantic right whale abundance has been in decline since 2010 and the relatively high number of right whale deaths in recent years, specifically 2017 (Pettis et al. 2018; Pace et al. 2017). Development of measures to protect right whales is expected to continue.

Table 40 – Past, present, and future foreseeable actions within the protected resource management plans in operation in the New England region

Plan	Past actions	Present actions	Future foreseeable actions
Harbor Porpoise Take Reduction Plan	Spatial and seasonal gear restrictions to minimize interaction, injuries, and mortalities between fishing gear and harbor porpoises, including requirements for pingers. Modifications to plan (effective September 30, 2013) eliminated consequence closure areas.	Continue previous actions	Continue previous actions
Atlantic Large Whale Take Reduction Plan	Spatial and seasonal gear restrictions to minimize serious injuries, and mortalities between vertical lines and	Continue previous actions. Focus on conservation actions for North Atlantic Right Whale.	Continue previous actions. Expect ongoing focus on conservation actions for

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Plan	Past actions	Present actions	Future foreseeable actions
	large whale species. Changes to plan were published June 2014 (79 FR 36586), December 2014 (79 FR 73848), and May 2015 (80 FR 30367).		North Atlantic Right Whale.
Ship strike reduction programs	Reporting systems and speed restrictions to minimize ship strike events; education/outreach activities	Ongoing development of temporary speed restricted areas as needed	Continued updates to measures to reduce ship strikes as technology improves
Sea turtle regulations	Annual fisheries observer coverage requirements for certain fisheries; requirements on handling and resuscitation. Biological opinions have led to gear requirements in sea scallop fishery, summer flounder fishery, NC/VA large mesh gillnet fishery, and VA pound net fishery.	Continue previous actions including coordination with stranding and disentanglement networks.	Continue previous actions
Shortnose Sturgeon Recovery Program	Fishing for, catching or keeping shortnose sturgeon illegal; federal agencies that conduct, fund or authorize activities that may adversely affect shortnose sturgeon must consult with NOAA; periodic status reviews; development and implementation of recovery plan (1998). A biological assessment was completed in 2010.	Continue previous actions	Continue previous actions
Atlantic Sturgeon Recovery Program	Fishing for, catching or keeping Atlantic sturgeon illegal; various restrictions by state. Intent to conduct 5-year review issued in 2018.	Continue previous actions	Continue previous actions.
Atlantic Salmon Recovery Program and General Conservation Plan	Species listings by distinct population segment; designation of critical habitats	General Conservation Plan to promote fish passage and dam removals. Revised recovery plan released February 2019.	Continue previous actions, compliance with updated plan.
Proactive Conservation Program for Species of Concern and Candidate Species	Grants to fund research activities, monitoring of status of species of concern/candidate species.	Continue previous actions	Continue previous actions

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Plan	Past actions	Present actions	Future foreseeable actions
Stranding and disentanglement program	Network of organizations that respond to dead, sick, injured, or entangled marine mammals and sea turtles. Response often includes rescue, rehabilitation, and release of mammal or sea turtle.	Continue previous actions	Continue previous actions

6.5.1.3 Other Industrial Uses of the Marine Environment

Non-fishing activities (Table 41) combine with fishery management efforts to affect the VECs considered in this action. Wherever these activities co-occur, they are likely to work additively or synergistically to decrease the quality of the physical and biological environment, and, as such, may indirectly constrain the sustainability of the managed resources, protected resources, and human communities associated with fishing. Offshore wind energy is a particularly active area at present and for the near future.

Table 41 – Past, present, and future foreseeable non-fishing activities within the New England region

Activity	Past actions	Present actions	Future foreseeable actions
Offshore renewable wind energy	Bureau of Ocean Energy Management (BOEM) oversees offshore wind leasing and development. First small-scale 5 turbine windfarm off RI operational 2016.	Leases have been sold along the entire Atlantic coast offshore MA south to NC. Other wind energy areas have been identified for future leasing. Many projects in the site assessment and construction/operations planning phase.	Construction of new facilities expected to begin in early 2020s. Additional leasing of new areas. Site assessment, permitting, and planning will continue. States are issuing requests for proposals for energy projects to meet 5 to 10-year targets for renewable energy production.
Oil and natural gas exploration and development	Seismic testing, drilling sediment cores and test wells. Leases sold and test wells drilled in late 1970s and early 1980s; given findings, no additional test well activity after that (see http://www.boem.gov/OCS-Report-MMS-2000-031/) for more information.	Bureau of Ocean Energy Management (BOEM) oversees these activities; currently we are within the 2017-2022 planning period, and there are no lease sales proposed in the North Atlantic. An updated 5-year program is under development, which will revise and replace the 2017-2022 program prior to its expiration. Geological and geophysical survey permits presently being issued in Mid-Atlantic region.	Depends on outcome of 5-year plan revisions; could potentially include additional resource assessment and possible leases in the North and Mid-Atlantic regions.

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Activity	Past actions	Present actions	Future foreseeable actions
Liquefied natural gas facilities	Three New England import facilities, one land-based just north of Boston, MA, and two offshore of Cape Ann, MA. See http://www.northeastgas.org/about_lng.php .	Existing facilities are not especially active and imports of LNG have been down in New England from 2006-2010 levels, although up from 2014 lows. See https://www.northeastgas.org/pdf/lng_annual0218.pdf .	The U.S. Department of Energy regulates import and export of natural gas and would approve new import facilities or import to export facility conversions. Given excess capacity at existing New England import terminals, new terminal construction does not appear likely, at least in the short term.
Wave and tidal energy	Regulations for the Outer Continental Shelf Renewable Energy Program published in 2009; these include offshore wind energy and wave and current (i.e. hydrokinetic) energy projects. BOEM oversees development of these types of projects.	Information about current projects can be found here: http://en.openei.org/wiki/Marine_and_Hydrokinetic_Technology_Database . Various projects in Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut are in the siting/planning, site development, and device testing phases. There are no deployed projects in the New England region.	Future projects could be developed pursuant to the 2009 regulations.
Aquaculture	Existing facilities in New England are in currently in state waters only. There are facilities oriented towards commercial production and restoration aquaculture (e.g. oyster reefs, hatcheries).	Currently there are facilities in all coastal New England states, with the largest number of operations in Maine. NH, MA, RI, and CT focus mainly on shellfish, although NH has a steelhead trout facility. Maine raises a diversity of finfish and shellfish species including Atlantic salmon. Salmon is the dominant finfish aquaculture species in New England. Algae and seaweeds are also currently grown.	Expansion of aquaculture appears likely and could include offshore waters in the future. Many factors influence the rate of growth in this sector such as permitting concerns, availability of suitable sites, and regulatory stability. The National Sustainable Offshore Aquaculture Act of 2011 establishes a permitting and programmatic review system for offshore aquaculture sites, although the extensive regulatory requirements of the law could discourage entry into the system (Lapointe, 2013).

Activity	Past actions	Present actions	Future foreseeable actions
Offshore mineral mining	BOEM oversees offshore mineral extraction. First marine minerals program lease executed in 1995.	BOEM has signed agreements with various states to evaluate sand resources for coastal resilience and restoration. Sand mining projects are ongoing in the northeast region. BOEM and USGS collaborating as of December 2017 to locate critical mineral resources on OCS.	Assessment, leasing, and extraction of marine minerals resource areas expected to continue.
Offshore vessel disposal		The Environmental Protection Agency approves requests for vessel disposal offshore; a handful of vessels have been disposed of in the past few years in the western Gulf of Maine	Continued disposal of vessels at sea through EPA process (see http://www.epa.gov/region2/water/oceans/wrecks.htm)

6.5.1.4 Climate Change

Globally, conditions in the oceans, atmosphere, and cryosphere (ice cover) are changing. These shifts will affect ecosystem components including fishery resources, their habitats, and the human communities that depend on them, as well as protected resources. Climate science is complex, and synthesis and vetting of models and their conclusions rely on an extensive body of experts working in many different scientific fields. The Intergovernmental Panel on Climate Change or IPCC published their fifth and most recent assessment report in November 2014. The sixth report is under development and due out in 2022. Although a detailed description of the underpinnings of climate science and a discussion of the results of climate projection models are beyond the scope of this document, a few conclusions from the fifth assessment synthesis report (IPCC 2014) are highlighted here.

- “Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.
- In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate.
- Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level to rise.”

The magnitude and direction of changes in sea surface and bottom temperature and salinity are predicted to vary by region. Saba et al. (2015) explore differences between lower and higher resolution climate models with regards to projections for the northwest Atlantic Ocean in particular. In the northwest Atlantic, colder, fresher waters have a generally southwestern flow via the Labrador Current, while warmer, saltier waters move northeast with the Gulf Stream. The Northeast Channel separates Georges Bank from the Scotian shelf and allows slope (Gulf Stream) and shelf (Labrador Current) waters to mix in the relatively enclosed Gulf of Maine. While acknowledging the increased implementation costs associated with high resolution models, Saba et al. note that NOAA's Geophysical Fluid Dynamics Laboratory's high-resolution global climate model CM2.6 can resolve important features of the northeast shelf, including the Northeast Channel, that lower resolution models do not resolve. This high-resolution model predicts temperature changes of +3°C in the upper 300 meters of the ocean in response to a doubling of carbon dioxide concentration in the atmosphere, which is a faster (2-3x) rate of increase compare to CM2.6's global average, and twice as fast as a coarser resolution climate model, CM2.1. Saba et al. suggest that the Atlantic Meridional Overturning Circulation, which appears to have a robust and inverse relationship with the position of the Gulf Stream, likely has a substantial influence on temperature patterns in the northwest Atlantic via its influence on the Gulf Stream. They surmise that models that can accurately capture the likely magnitude of weakening of the AMOC should better predict oceanographic changes in the region.

The fifth IPCC assessment estimated that the oceans have absorbed approximately 28% of human-generated carbon emissions since 1750 (IPCC 2014). While this absorption helps to sequester atmospheric carbon in the oceans, it does impact ocean chemistry. Specifically, when carbon dioxide chemically reacts with seawater, carbonic acid is produced, which decreases the pH of seawater. This ocean acidification can have biological effects because lower carbonate ion concentrations lead to lower calcium carbonate saturation levels, which in turn can negatively affect the ability of certain marine organisms to build and maintain bones and shells (Fabry et al. 2008, Feely et al. 2009). Calcium carbonate is present in multiple forms, including aragonite, calcite, high magnesium calcite, and amorphous calcium carbonate (Fabry et al. 2008). These different molecules vary in their chemistry and are used differently by various marine organisms. While the impacts of changes in ocean chemistry will be challenging to predict at the population or ecosystem level, they will certainly be negative, and more impactful more quickly for some organisms than others.

6.5.2 Baseline Status of Valued Ecosystem Components

This section summarizes the current status of all VECs, based on past and present actions but not including the proposed action.

6.5.2.1 Benthic Habitats, Essential Fish Habitats, and Managed Species

Fishery management actions have likely had a positive cumulative impact on benthic habitats and essential fish habitats. Fishery management plans are required to evaluate and minimize to the extent practicable adverse effects of fishing on essential fish habitats, and these actions are assumed to have made a positive contribution to habitat condition since the habitat requirements were added to the Magnuson-Stevens Act in 1996. The overall amount of fishing activity also

contributes to the condition of the physical and biological environment. In this region, the Swept Area Seabed Impact analysis indicates that bottom otter trawls are the primary source of fishery impacts on benthic habitats, and the use of this gear has been on the decline overall, due to declining activity in the large-mesh groundfish fishery. This trend likely contributes positively to the condition of the physical and biological environment.

This VEC also includes the following fishery resources (section 5.4 describes the biology, status, and distribution of these resources and the fisheries which prosecute them). Additional information is provided in Vol 1 section 4.3 of the OHA2 FEIS and in individual FMPs for the species. The focus here is the status (overfished/overfishing occurring) of the various species, including the status by stock if the species is not managed as a single unit. Surfclams and mussels are targets of the two gear types that would be exempted under this framework, while the other species listed occur within the HMA and could benefit incidentally from habitat protection measures.

- Atlantic surfclam
- Blue mussel
- Large mesh multispecies (specifically cod, winter flounder, yellowtail flounder, and windowpane flounder)
- Sea scallop
- Skate (specifically little and winter)
- Atlantic herring
- American lobster

In general, past fishery management actions have contributed positively to stock status, but additional action will be necessary to rebuild all stocks in the region. Some stocks that overlap the Great South Channel HMA are not overfished with overfishing not occurring, while others are overfished with overfishing occurring, and others are overfished but overfishing is not occurring (Table 42). Habitat protections such as those afforded via the gear restrictions proposed in this action are expected to contribute positively to stock condition.

Table 42 – Baseline status of stocks in the FMPs listed in the text above. The status of blue mussels is unknown as there is no federal FMP or assessment for the stock.

	<i>Fishing mortality below reference point</i>	<i>Fishing mortality above reference point</i>
<i>Stock size above status determination criteria</i>	<u>Not overfished, overfishing not occurring:</u> Atlantic surfclam, Southern windowpane flounder, GOM winter flounder*, GB winter flounder, Little skate, Winter skate, Atlantic sea scallop, Atlantic herring, GB/GOM lobster	<u>Not overfished, overfishing occurring:</u> None
<i>Stock size below status determination criteria</i>	<u>Overfished, overfishing not occurring:</u> Gulf of Maine/Georges Bank windowpane flounder, SNE/MA winter flounder; SNE lobster (depleted)	<u>Overfished, overfishing occurring:</u> Gulf of Maine Atlantic cod, Georges Bank Atlantic cod, Cape Cod-Gulf of Maine yellowtail flounder, Georges Bank yellowtail flounder, Southern New England/Mid-Atlantic yellowtail flounder

* Overfished status for GOM winter flounder is unknown.

Long term climate shifts combined with decadal oscillations and interannual variability produce the ocean conditions experienced by managed species. The effects of climate change on the physical environment, i.e. changes in temperature, salinity, pH, sea level, and currents, influence

habitat suitability. Species vary in terms of their sensitivity to these climate factors. Based on species-specific biological attributes, Hare et al. (2016) estimate the likely effects of climate factors on managed and unmanaged biological resources, combining effects across factors to generate an overall assessment of vulnerability to climate change for each species. Based on climate model results, all species living in the region were likely to experience either high or very high climate exposure, with no species expected to experience low or moderate climate exposure. However, species' sensitivity varied from low to very high. The vulnerability categories of greatest concern were those where sensitivity, exposure, or both were estimated to be very high. The matrix is reproduced below for the subset of species considered to be part of the affected environment in this action (Table 43). These species-level vulnerabilities influence the cumulative effects that this action and other ongoing present and future foreseeable actions will have on the status of managed resources.

Table 43 – Vulnerability of managed species to climate change, reproduced from Hare et al. 2016. Overall climate vulnerability is denoted by color: low (green), moderate (yellow), high (orange), and very high (red). Only for species included in the FMPs listed in the text above or identified as protected resources under consideration.

Biological sensitivity	Very high	--	Atlantic salmon
	High	Atlantic surfclam, Atlantic sea scallop	Winter flounder, blue mussel, Atlantic sturgeon
	Moderate	Atlantic cod, American lobster	--
	Low	Windowpane, Yellowtail flounder, Winter skate, Little skate, Atlantic herring	--
		High	Very high
		Climate exposure	

Climate-induced changes are already evident among northeast managed species. Nye et al. (2009) examined Northeast Fisheries Science Center trawl survey data through 2007 and found evidence for poleward movement, change in area occupied, change in maximum or minimum latitude, change in mean temperature of occurrence, and/or change in mean depth of occurrence for 24 of 36 stocks examined. All of these changes are not necessarily negative, for example, the ability of a stock to undergo range expansion may be a positive adaptation under a changing climate. However, some changes indicate vulnerability to climate shifts. Specifically, Georges Bank cod, southern winter and yellowtail flounders, and windowpane flounder showed a poleward shift in their distribution. While evidence of range expansion was present in some stocks, other stocks showed evidence of range contraction, including Georges Bank cod and southern yellowtail flounder. Movement into deeper waters could indicate that the fish are seeking refuge from warm summer temperatures. For example, Gulf of Maine cod showed shifts in their centers of biomass and moved into deeper waters.

6.5.2.2 Human Communities

The various fisheries that are likely to be affected are described in section 5.5. These include fisheries for surfclams, blue mussels, large mesh Northeast multispecies, skates, sea scallops,

Atlantic herring, and American lobster. The status of these fisheries is mixed, with some fisheries relatively stable or increasing, and others declining in terms of landings and value (Table 44). In the Northeast Multispecies large-mesh fishery and Atlantic herring fishery, declining fishery conditions may be linked to poor conditions for some stocks. Other fisheries have stable landings that are below allocations. Recent fishery management plan actions should be consulted for detailed assessments of fishery status and communities affected. Fisheries of the United States 2017 (NMFS 2018) summarizes overall fisheries economics of the United States during 2017.

A “fishing community” is defined in the Magnuson-Stevens Act, as amended in 1996, as “a community which is substantially dependent on or substantially engaged in the harvesting or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community” (16 U.S.C. §1802(17)). Fishing communities that are likely to be influenced by the alternatives in this amendment are listed in section 5.5.2.9 (Surfclam Fishing Communities). The specific communities of interest were identified through the economic analysis of vessel trips most likely to be impacted by the addition of new closed areas. Depending on the status of their dominant fisheries, the associated communities may be on a positive, stable, or negative trajectory. Many other factors contribute to community status besides fishery conditions; but the community indicators suggest which communities are most engaged in and reliant on commercial and/or recreational fisheries.

Fishery management actions and stock status are assumed to be the major contributors to fishery status and associated community impacts, with protected resources management and non-fishing uses of the marine environment contributing incidentally to fishery and community baseline status. Some protected resource conservation measures impact fishing operations, restricting the use of particular gear types during specific seasons and in specific areas.

Changes in the abundance and distribution of biological resources affect the communities that prosecute fisheries for these resources. For example, if the target species important to a port community declines in abundance or its distribution shifts north or south due to environmental factors, there may be negative economic impacts locally, although there could be positive impacts due to increases in abundance of other species. It is impossible to pinpoint the degree to which these types of environmental changes are influencing the baseline status of the VECs analyzed in this action, but certainly regional-scale changes in climate combine with fishing and non-fishing human activities combine together to shape the baseline status.

Table 44 – Baseline status of fisheries

Fishery	Status and trends
Atlantic surfclam	Landings of surfclams have been stable since around 2009, and increasingly are taken from New England (both Nantucket Shoals and Georges Bank). There are about 40 vessels that actively participate. Total value of landings has been around \$30 million since 2012, with the value of landings in MA increasing.

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Fishery	Status and trends
Blue mussel	The MA blue mussel fishery is prosecuted in Cape Cod Bay by between 6-11 vessels, with landings of around 10 million pounds between 2014-2017, an increase over 2013 landings. Fishing on Nantucket Shoals would represent an expansion of the grounds used by the fleet.
Northeast multispecies large mesh fishery	Murphy et al. 2018 provides a summary of the economic performance of the Northeast multispecies fishery through the end of fishing year 2015 (April 2016). Groundfish revenue decreased to a low of \$51.2 million in 2015, and non-groundfish revenues have become increasingly important to the fleet. This decline resulted from a combination of reduced landings and reduced or stable prices depending on the species. The size of the fleet and effort have also declined.
Northeast skate	Total skate landings have fluctuated between FY 2010 and 2016 (NEFMC 2018f). The fluctuations in landings are largely attributable to the wing fishery as landings in the bait fishery have remained relatively stable. Framework adjustment 6 (effective February 15, 2019) increases total allowable landings in the wing and bait fisheries by 20% for fishing years 2018 and 2019.
Sea scallop	Scallop landings and revenue peaked in 2011 at 58 million lbs. and \$532 million, respectively, although 2017 values were close to these levels (NEFMC 2019). The number of permits in the fishery has been stable since 2009 (348 limited access and 166 IFQ in 2018); NGOM permits have increased from 30-40 during the 2009-2012 period to 50-60 over the 2013-2017 period (NEFMC 2019).
Atlantic herring	The herring fishery has seen a decline in allowable landings and catch over the past fishing year, and this trend is expected to continue for the next few years based on the biomass indicated by the 2018 stock assessment.
American lobster	The lobster fishery is one of the top fisheries on the U.S. Atlantic coast (>\$461M total revenue in 2013). Most landings are in Maine (over 80%), although Georges Bank and the canyons are also important grounds. The fishery has declined in Southern New England. Commercial Jonah crab landings were 2-3M lbs. throughout the 1990s, but steadily rose to over 17M lbs. in 2014. A similar increase occurred in the value of fishery, as ex-vessel values grew from about \$1.5M in the 1990s to about \$12.7M in 2013. Landings in 2014 predominately came from Massachusetts (70%), followed by Rhode Island (24%).

6.5.2.3 Protected Resources

Various protected resources overlap the New England region. The distribution and status of those species potentially affected by this action are described in section 5.6. There are various large whales, sea turtles, Atlantic sturgeon and Atlantic salmon that overlap the region and are considered endangered or threatened under the Endangered Species Act. Various small cetaceans, large whales (i.e., minke and humpback) and pinniped species also present in the affected environment of the action are protected by the Marine Mammal Protection Act but are not listed under the ESA.

The population trends for protected resources are variable. Nest counts inform population trends for sea turtle species. In the affected environment (see section 5.6), four sea turtle species were identified as having the potential to be affected by the proposed action: Northwest Atlantic Ocean DPS of loggerhead, Kemp's ridley, North Atlantic DPS of green, and leatherback sea turtles. For the Northwest Atlantic Ocean DPS of loggerhead sea turtles, there are five unique recovery units that comprise the DPS. Nesting trends for each of these recovery units are variable; however, recent data from Florida index nesting beaches, which comprise most of the nesting in the DPS, indicate a 19% increase in nesting from 1989 to 2018

(<https://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/>). For Kemp's ridley sea turtles, from 1980 through 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15 percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival of immature and adult sea turtles, and updated population modeling, this rate is not expected to continue and the overall trend is unclear (NMFS and USFWS 2015; Caillouett et al. 2018). The North Atlantic DPS of green sea turtle is showing a positive trend in nesting (Seminoff et al. 2015). Leatherback turtle nesting in the Northwest Atlantic is showing an overall negative trend, with the most notable decrease occurring during the most recent time frame of 2008 to 2017 (NW Atlantic Leatherback Working Group 2018).

In terms of protected species of marine mammals, large whale assessments indicate that for some species there is an increasing (i.e., humpback whales) or decreasing (i.e., North Atlantic right whales) trend in the population, while for other species, as a trend analysis has not been conducted, it is unknown what the population trajectory is (<https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region>). For most small cetacean and pinniped populations, it is unknown what the population trajectory is as a trend analysis has not been conducted for these populations (<https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region>). However, in the most recent stock assessment report, population trends were provided for common bottlenose dolphin stocks and gray seals; the analysis indicated a declining trend in population size for all common bottlenose dolphin stocks and an increasing trend for the gray seal population (Hayes et al. 2018).

Population trends for Atlantic sturgeon are difficult to discern; however, the most recent stock assessment report concludes that Atlantic sturgeon, at both the coastwide and DPS level, are depleted relative to historical levels (ASSRT 2007; ASMFC 2017). There is no population growth rate available for Gulf of Maine DPS Atlantic salmon; however, the consensus is that the DPS exhibits a continuing declining trend (NOAA 2016; USFWS and NMFS 2018).

6.5.3 Cumulative Effects Summary

This framework includes five alternatives for fishing restrictions in the Great South Channel Habitat Management Area (GSC HMA) as summarized below and detailed in section 4.

- **Alternative 1/No Action:** The clam dredge exemption expires on April 9, 2019, and the GSC HMA is closed to all mobile bottom-tending gears.
- **Alternative 2:** Five exemption areas designated (McBlair, Old South, Rose and Crown, Davis Bank East, Area A). Old South open May 1-October 31 only; southern part of Rose and Crown open November 1-April 30 only. Clam and mussel dredges would be authorized in the areas for five years. Enhanced monitoring including 5-minute VMS required. Council to develop a research agenda to be funded by clam industry with results within 3 years.

- **Alternative 3:** One exemption area designated (Rose and Crown). Clam dredges would be authorized with no sunset date; mussel dredges could also be authorized by selecting a sub-option. Enhanced monitoring including 5-minute VMS required.
- **Alternative 4:** Four exemption areas designated (McBlair, Old South, Davis Bank East, Fishing Rip). Old South open May 1-October 31 only. Clam dredges would be authorized with no sunset date; mussel dredges could also be authorized by selecting a sub-option. Enhanced monitoring including 5-minute VMS required.
- **Alternative 5 (preferred):** Three exemption areas designated (McBlair, Old South, Fishing Rip). Old South open May 1-October 31 only. Both clam and mussel dredges would be authorized. Enhanced monitoring including 5-minute VMS required. Within two additional areas (Rose and Crown, Davis Bank East), research fishing only would be permitted through the exempted fishing permit process.

The potential direct impacts of these alternatives on the three VECs are described in section 6 and summarized below. Since these alternatives are mutually exclusive, there is no need to assess the combined impacts of multiple alternatives on each VEC as a precursor to estimating cumulative effects of the alternatives combined with other reasonably foreseeable future actions. As noted above, restrictions on mobile bottom-tending gears are expected to have positive impacts on essential fish habitats and the species dependent on those habitats. Exemption areas designated via Alternatives 2-5 reduce but do not eliminate the positive impacts of the GSC HMA on habitats and managed species. Fisheries for species using these habitats are expected to benefit indirectly over the long term as habitat protection improves production of target resources. Fisheries for Atlantic surfclams and blue mussels are expected to be negatively affected by closure of the HMA (Alternative 1) and will derive economic benefits from exemptions (Alternatives 2-5). Differential magnitudes of impacts among alternatives are related to the fraction of the HMA that would be open to fishing and the characteristics of areas selected for exemption.

Table 45 – Summary of impacts in the clam framework on valued ecosystem components

Valued ecosystem component	Sub-element of VEC	Alternative 1/No Action	Alternative 2	Alternative 3	Alternative 4	Alternative 5 (Preferred)
Benthic habitats, EFH, and managed species	Benthic habitats/EFH	Positive	Negative relative to No Action	Low negative to negative relative to No Action	Low negative to negative relative to No Action	Low negative relative to No Action
	Managed species	Positive	Negative relative to No Action	Low negative to negative relative to No Action	Low negative to negative relative to No Action	Low negative relative to No Action
Human communities	Surfclam fishery	Negative relative to current management; no access opportunities	Positive relative to No Action; low negative relative to	Positive relative to No Action; low negative to negative relative to	Positive relative to No Action; low negative to negative relative to	Positive relative to No Action; low negative to negative relative to

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Valued ecosystem component	Sub-element of VEC	Alternative 1/No Action	Alternative 2	Alternative 3	Alternative 4	Alternative 5 (Preferred)
		provided to GSC HMA	current management	current management	current management	current management
	Mussel fishery	Neutral relative to current management; no access opportunities provided to GSC HMA	Low positive relative to No Action; access to areas with known mussel beds	With exemption, low positive relative to No Action; access to areas with known mussel beds; without exemption, neutral to No Action	With exemption, slightly to low positive relative to No Action; status of mussel beds in exemption areas unknown; without exemption, neutral to No Action	Slightly to low positive relative to No Action; status of mussel beds in exemption areas unknown
	Other fisheries	Low positive via habitat-related enhancement of resource production	Low positive via habitat-related enhancement of resource production	Low positive via habitat-related enhancement of resource production	Low positive via habitat-related enhancement of resource production	Low positive via habitat-related enhancement of resource production
	Communities	Negative to low positive	Low negative to low positive	Low negative to low positive	Low negative to low positive	Low negative to low positive
Protected resources	Large cetaceans	Neutral	Neutral	Neutral	Neutral	Neutral
	Small cetaceans	Neutral	Neutral	Neutral	Neutral	Neutral
	Pinniped	Neutral	Neutral	Neutral	Neutral	Neutral
	Turtles	Neutral	Neutral (surfclam fishery); low negative (mussel dredge fishery)	Neutral (surfclam fishery); low negative (mussel dredge fishery with exemption); neutral (mussel dredge fishery without exemption)	Neutral (surfclam fishery); low negative (mussel dredge fishery with exemption); neutral (mussel dredge fishery without exemption)	Neutral (surfclam fishery); low negative (mussel dredge fishery)

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Valued ecosystem component	Sub-element of VEC	Alternative 1/No Action	Alternative 2	Alternative 3	Alternative 4	Alternative 5 (Preferred)
	Atlantic salmon	Neutral	Neutral	Neutral	Neutral	Neutral
	Atlantic sturgeon	Neutral	Neutral (surfclam fishery); low negative (mussel dredge fishery)	Neutral (surfclam fishery); low negative (mussel dredge fishery with exemption); neutral (mussel dredge fishery without exemption)	Neutral (surfclam fishery); low negative (mussel dredge fishery with exemption); neutral (mussel dredge fishery without exemption)	Neutral (surfclam fishery); low negative (mussel dredge fishery)

The remainder of this section describes how each alternative combined with reasonably foreseeable future actions is expected to influence the trajectory of each valued ecosystem component. Given the number and diversity of current and future foreseeable management actions, combined with uncertainties about direct effects of the alternatives considered in this action, these assessments are qualitative and uncertain.

Benthic habitats, essential fish habitats, and managed species: The GSC HMA is likely to continue to have positive impacts on benthic habitats, EFH, and managed species, regardless of the alternative adopted via this action. Alternative 1/No Action would likely have the greatest magnitude of positive impacts by eliminating the adverse impacts of mobile bottom-tending gears on habitats within the HMA, but Alternative 5 (preferred) will maintain many of the positive impacts associated with the HMA and will continue to minimize the adverse effects of regional fisheries on EFH. Alternatives 2, 3, and 4 are intermediate in impacts between Alternatives 1 and 5. Fishery management actions more generally are expected to contribute in a positive way to the condition of fish habitats and managed resources. Protected resource management actions are expected to have a neutral or positive impact on habitats and resources, as these measures contribute positively to the overall condition of the ecosystem by protecting species including whales, small cetaceans, turtles, and ESA-listed fishes. Certainly, the relationships between fishery targets and managed resources can be complicated (for example, seal predation on cod) and increases in protected species populations will not necessarily lead to a positive impact on fishery stocks.

Conversely, other industrial uses of the marine environment, in concert with climate change, are expected to have a negative influence on fish habitats and fishery resources. It may be possible to mitigate negative effects on development on fish habitats and fishery resources, but negative effects are likely, with the magnitude depending on the scale of coastal and offshore development. Fisheries management strategies will adapt to this changing environment and may

be able to reduce net impacts of development on managed fish stocks by reducing harvest limits or otherwise managing fishing strategies.

Human communities: Fisheries-related human communities that have a relationship to the GSC HMA are likely to experience a combination of positive and negative impacts associated with the measures proposed in this action. Fisheries that depend on stocks that derive conservation benefits from the GSC HMA should experience positive impacts, although of uncertain magnitude, regardless of the alternative adopted. Exemption areas designated via Alternatives 2-5 should have positive impacts on the surfclam and mussel fisheries and associated communities in comparison with closure of the HMA under Alternative 1/No Action. However, all alternatives in the framework reduce access for surfclam vessels relative to recent management, which will have negative impacts on the fishery. These effects will mainly be localized to specific fishery participants most dependent on the HMA but could have ripple effects throughout the fishery as effort and landings are redistributed to other locations. While protected resources management has limited impacts on clam fishery participants as gear-restrictions and other measures are not directed towards vessels using hydraulic dredge gears, both climate change and other industrial uses of the marine environment will negatively affect clam fishery participants. Surfclam habitat has a preferred temperature window, and changes in ocean temperature influence the distribution and availability of habitats for the species. Temperature and other oceanographic changes are affecting other species as well. While intended to mitigate the negative effects of climate change, offshore renewable energy development is poised to become a significant use of the continental shelf off Southern New England over the next ten years, and these installations will directly impact fishing operations. Strategic siting of wind turbines, designated transit corridors, and other mitigation approaches to limit impacts to navigation or compensate fishermen for lost access may help reduce these negative effects, but at the scale at which wind development is proposed, interactions with fishing operations are unavoidable. Many regional fisheries, not just the surfclam fishery, will be impacted by such development.

Protected resources: The direct effects associated with the alternatives in this framework are minor across all types of protected resources. Protected resources management actions are expected to have a greater influence on the trajectory of the various groups of protected species, because these management actions serve to mitigate negative outcomes that could be caused by non-fishing activities, and climate change. While some fisheries do have negative effects on some protected species, future fishery management actions that influence spatial patterns and magnitudes of fishing effort may have a range of effects on protected resources, from negative to positive. Conservation requirements issued under various biological opinions and other ESA/MSA regulations serve to mitigate some of the negative impacts of fisheries on protected resources. Across all protected resources, considering their current trends (see section 6.5.2.3) and the effects on all future actions, the trajectory could range from somewhat negative to positive. The management alternative adopted through this framework is not expected to influence this trajectory.

7 COMPLIANCE WITH APPLICABLE LAWS

The following sections describe compliance with the Magnuson Stevens Fishery Conservation and Management Act, the National Environmental Policy Act, and other applicable laws.

7.1 Compliance with the Magnuson Stevens Fishery Conservation and Management Act

The Magnuson Stevens Fishery Conservation and Management Act (MSA) is the primary legislation governing fisheries management in the United States.

7.1.1 Consistency with National Standards

Section 301 of the MSA requires that regulations implementing any fishery management plan or amendment be consistent with the ten national standards listed below.

1. *Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.*

Omnibus Habitat Amendment 2 (OHA2), which this framework adjustment modifies, does not directly manage overfished stocks, because the management of overfished stocks is part of the Council's individual FMP process. OHA2 aimed to enhance the role that area management plays in achieving optimum yield, by implementing management measures that consider social, economic, and ecological factors and that would likely increase species productivity and improve the overall health of fish stocks. OHA2 analyses, and those employed in this action, are based on the premise that species productivity would be enhanced by protecting habitats that are important to critical life stages of managed fish species and protecting habitat areas that are most susceptible to adverse impacts from fishing.

The New England Council's Fishery Management Plans, and other federal fishery management plans including the Atlantic Surfclam/Ocean Quahog FMP, address additional specific goals and regulations regarding achievement of optimum yield for managed species. Individual FMP management actions consider the sustainability of managed species, which is affected by fishing pressures, in addition to factors that affect natural mortality. For the reasons listed above, this framework complies with National Standard 1.

2. *Conservation and management measures shall be based on the best scientific information available.*

Again, this framework builds on OHA2, and therefore uses much of the same scientific information. Candidate exemption areas including the Council's preferred areas were identified and evaluated based on fishery-dependent vessel monitoring system data as well as benthic habitat data. These habitat data included depth and seabed form, sediment type, living and non-living substrate features (see Appendix A), benthic boundary shear stress, and estimated sediment stability. An understanding of the gear effects of clam and mussel dredges on the seabed was developing using the primary scientific literature. The gear effects evaluation for clam dredges builds upon the vulnerability assessment from the Council's Swept Area Seabed Impact approach (see NEFMC 2011 for the original approach, and Appendix B for updated

information). The analyses of impacts to the human community are based primarily on landings, revenue, and effort information collected through the NMFS data collection systems used for this fishery, as well as from interviews with fishery participants to better understand at-sea operations as well as the processing sector. Based on the scientific information listed above, this framework complies with National Standard 2.

3. *To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.*

Direct management of stocks is done through the appropriate FMP. This framework does not include any substantial changes or significant new information bearing on the unit management or stocks determinations made in those plans. For these reasons, this framework complies with National Standard 3.

4. *Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.*

OHA2 and this framework adjustment do not discriminate between residents of different states and do not allocate fishing privileges. The proposed measures are applied to all vessels regardless of the state of residence of the owner or operator of the vessels. All surfclam and mussel vessels may fish in the exempted areas that would be established under this action. Consequently, this action complies with National Standard 4.

5. *Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.*

The exemption areas identified in this framework adjustment have both administrative costs and costs to the fishing community that result primarily from effort displacement. The Council considered the practicability of measures when identifying preferred alternatives, i.e. balancing the needs of the fisheries in addition to the benefits of habitat protections for managed species. Impacts to the human community including economic information were provided to the Council in the draft framework document/Environmental Assessment, and voting members considered oral and written input from its oversight committees, advisory panels, and fishing industry members attending its meetings. The action does not make an economic allocation of fishing privileges and therefore does not have economic allocation as its sole purpose. For the reasons listed above, the framework complies with National Standard 5.

6. *Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.*

Fishing effort is subject to change based on market demand, weather variability, response to fishing regulations, and availability of fish. Potential fishing effort displacement as a result of the measures in this framework is evaluated in section 6.2.7. The framework does not propose changes to fishing limits; therefore, economic impacts are only considered with regard to shifts in effort among areas and differences between areas that may affect catch per unit effort. General trends in each fishery, as well as the potential for changes in the future, were considered when estimating impacts. In addition to changes in fishing behavior, the status of stocks can also change, which can lead to subsequent management action to remedy stock declines. For example, more stringent measures would be appropriate if a stock is in decline, overfished, or overfishing is occurring.

The underlying OHA2 includes methods to alter management actions to meet the goals of the amendment. Through OHA2, the Council implemented a management system that would allow changes in HMA designations and fishing restrictions to be modified through a framework action, such as this one. Also through OHA2, the Council proposed a 10-year review process for habitat and spawning protection measures and identified additional data and monitoring needs. This framework proposes two sub-areas of the Great South Channel Habitat Management Area as targets for research, to better understand the impacts of fishing on habitat

For the reasons listed above, this framework complies with National Standard 6, to allow for flexibility to react to changing circumstances in the Council-managed fisheries.

7. *Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.*

During the development of the exemption areas considered in this framework, the Council considered the costs to the fishing industry, managers, and the fishery resources it aims to protect. The Council is acting to address habitat protection in the federal waters within its jurisdiction, which eliminates duplicative efforts to develop and implement regulations outside of its management authority. Collaboration between NMFS and the Mid-Atlantic Fishery Management Council further prevents duplication of effort. Costs to implement regulations under this framework must be compared to the benefit to the resource. Cost analysis considered the following factors as outlined in Federal guidelines: Capital outlays; operating and maintenance costs; reporting costs; administrative, enforcement, and information costs; and prices to consumers. Benefit analysis includes consideration of gains from habitat protection. Long-term gains to the resource are expected to generate long-term gains to associated fisheries if increased catches result from improved biological production.

This framework proposes to increase the rate of VMS polling for vessels fishing in or near the Great South Channel HMA. The increased costs of complying with this provision are expected to be relatively small relative to the revenues generated from landing surfclams or mussels from the HMA. For the reasons listed above, this framework complies with National Standard 7.

8. *Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing*

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communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse impacts on such communities.

Impacts to fishing communities were considered throughout the decision-making process. In cases where adverse impacts to the fishing community were anticipated, a balance of the short-term and long-term costs and benefits to fishing communities were considered. Throughout the final deliberations, Council members heard from the public and fishing industry regarding the short- and long-term social and economic implications of the alternatives. In addition, social and economic analyses were provided to the Council to help inform their decision. For the reasons listed above, this framework complies with National Standard 8.

9. *Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.*

Mitigation measures to reduce bycatch and bycatch mortality are already included in each FMP to which this action applies, and this framework does affect existing measures to reduce bycatch. For these reasons, the framework complies with National Standard 9.

10. *Conservation and management measures shall, to the extent practicable, promote safety of human life at sea.*

The Council discussed potential changes to fishing operations within the Great South Channel HMA under various exemption area alternatives. One specific aspect of the preferred alternative that is intended to promote safe operation of fishing vessels is that when transiting between exemption areas within the HMA, clam vessels are required to have the dredge on deck, but the hydraulic hoses may remain in the water until they are retrieved at the conclusion of the trip. In addition, 5-minute VMS polling from test vessels was used to assess the ability of vessels to safely work within exemption areas of the sizes and shapes under consideration, and exemption areas boundaries were drawn to allow sufficient room for vessels to maneuver while fishing. For these reasons, the framework complies with National Standard 10.

7.1.2 Other MSA Requirements

Section 303 (a) of the MSA contains 14 required provisions for FMPs. These are discussed below. It should be emphasized that the requirement is imposed on the FMPs generally, and not to specific actions that update the FMPs. In many cases as noted below, these requirements are met by information in the underlying FMPs, as amended, and not through this action, which focuses on the essential fish habitat provisions for a specific portion of the New England region.

- *Any fishery management plan that is prepared by any Council, or by the Secretary, with respect to any fishery, shall—*

Contain the conservation and management measures, applicable to foreign fishing and fishing by vessels of the United States, which are-- (A) necessary and appropriate for the conservation and management of the fishery to prevent overfishing and rebuild overfished stocks, and to protect, restore, and promote the long-term health and stability

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of the fishery; (B) described in this subsection or subsection (b), or both; and (C) consistent with the National Standards, the other provisions of this Act, regulations implementing recommendations by international organizations in which the United States participates (including but not limited to closed areas, quotas, and size limits), and any other applicable law;

Measures proposed in this framework do not apply to foreign fishing vessels.

- *Contain a description of the fishery, including, but not limited to, the number of vessels involved, the type and quantity of fishing gear used, the species of fish involved and their location, the cost likely to be incurred in management, actual and potential revenues from the fishery, any recreational interest in the fishery, and the nature and extent of foreign fishing and Indian treaty fishing rights, if any;*

Fishery information, including these specific factors, is discussed throughout this document, especially for the Atlantic surfclam fishery (see section 5.5.2). This action does not affect any foreign fishing regulations or Indian Treaty rights.

- *Assess and specify the present and probable future condition of, and the maximum sustainable yield and optimum yield from, the fishery, and include a summary of the information utilized in making such specification;*

OHA2 and this framework adjustment to it do not specify maximum sustainable yield and optimum yield; rather, they propose regulations to modify areas available for fishing and areas for habitat protection. The Council's fishery management programs develop MSY and OY.

- *Assess and specify-- (A) the capacity and the extent to which fishing vessels of the United States, on an annual basis, will harvest the optimum yield specified under paragraph (3); (B) the portion of such optimum yield which, on an annual basis, will not be harvested by fishing vessels of the United States and can be made available for foreign fishing; and (C) the capacity and extent to which United States fish processors, on an annual basis, will process that portion of such optimum yield that will be harvested by fishing vessels of the United States;*

OHA2 and this framework adjustment to it do not propose management measures related to catch limits and fishery specifications; rather, they propose regulations to modify areas available for fishing and areas for habitat protection. The Council's fishery management programs develop fishery specifications and would consider the potential harvest and processing capabilities.

- *Specify the pertinent data which shall be submitted to the Secretary with respect to commercial, recreational, and charter fishing in the fishery, including, but not limited to, information regarding the type and quantity of fishing gear used, catch by species in numbers of fish or weight thereof, areas in which fishing was engaged in, time of fishing, number of hauls, and the estimated processing capacity of, and the actual processing capacity utilized by, United States fish processors;*

OHA2 and this framework adjustment do not intend to provide NMFS with information that would characterize items A and B related to the fisheries affected by these proposed regulations. The New England and Mid-Atlantic Council's FMPs describe this information and there is not a requirement to duplicate that effort. The information contained in this document addresses the types of fishing effort, magnitude of fishing effort, quantity of gear used (or other fishing effort measure such as swept area), and spatial distribution of fishing effort. Information regarding the magnitude of fishing effort and location of fishing effort was used to analyze the potential for displaced fishing effort, and to quantify potential loss and gains in revenue affected by the proposed management measures. This document describes fish processors who process species that are (surfclams) or could be (mussels) caught on Nantucket Shoals, but information on processing capacity relative to optimum yield is discussed in the underlying clam FMP. There is no federal FMP for mussels.

- *Consider and provide for temporary adjustments, after consultation with the Coast Guard and persons utilizing the fishery, regarding access to the fishery for vessels otherwise prevented from harvesting because of weather or other ocean conditions affecting the safe conduct of the fishery; except that the adjustment shall not adversely affect conservation efforts in other fisheries or discriminate among participants in the affected fishery;*

These types of provisions are implemented in the underlying FMPs and are not part of this habitat action.

- *Describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under section 305(b)(1)(A), minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat;*

EFH designations were most recently updated through Omnibus Habitat Amendment 2 (OHA2) for all NEFMC FMPs (NEFMC 2017). Descriptions and maps of the designations that overlap the Great South Channel Habitat Management Area (GSC HMA), which is the specific focus of this action, are provided in section 5.4.2.

The purpose of the GSC HMA, which was designated via OHA2, is to contribute to minimization of adverse effects across the Council's area of jurisdiction and considering fisheries managed by NEFMC and other authorities. The habitat impacts analysis for this action (section 6.2) as well as the EFH assessment (section 7.1.3) describe how the adverse effects of fishing will continue to be minimized after implementation of the Council's proposed action for this framework.

- *In the case of a fishery management plan that, after January 1, 1991, is submitted to the Secretary for review under section 304(a) (including any plan for which an amendment is submitted to the Secretary for such review) or is prepared by the Secretary, assess and specify the nature and extent of scientific data which is needed for effective implementation of the plan;*

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Scientific and research needs are not required for a framework adjustment. Current research needs are identified in underlying plan amendments for the Council's managed fisheries, and as part of the Council's 5-year process for identifying research needs across FMPs. The proposed action includes a recommendation that the Council work with the fishing industry to develop a research agenda specific to further understanding habitat characteristics and the results of fishing impacts on habitats within specific areas of the Great South Channel Habitat Management Area.

- *Include a fishery impact statement for the plan or amendment (in the case of a plan or amendment thereto submitted to or prepared by the Secretary after October 1, 1990) which shall assess, specify, and describe the likely effects, if any, of the conservation and management measures on-- (A) participants in the fisheries and fishing communities affected by the plan or amendment; and (B) participants in the fisheries conducted in adjacent areas under the authority of another Council, after consultation with such Council and representatives of those participants;*

Impacts of this framework on fishing communities directly affected by this action and adjacent areas can be found in section 6.2.6.

- *Specify objective and measurable criteria for identifying when the fishery to which the plan applies is overfished (with an analysis of how the criteria were determined and the relationship of the criteria to the reproductive potential of stocks of fish in that fishery) and, in the case of a fishery which the Council or the Secretary has determined is approaching an overfished condition or is overfished, contain conservation and management measures to prevent overfishing or end overfishing and rebuild the fishery;*

Objective and measurable Status Determination Criteria for all species in the management plan identified in the underlying FMPs.

- *Establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures that, to the extent practicable and in the following priority-- (A) minimize bycatch; and (B) minimize the mortality of bycatch which cannot be avoided;*

The final rule for the omnibus SBRM amendment, developed by both the New England and Mid-Atlantic Fishery Management Councils, was published on June 30, 2015. It is in place and applies to all federally-managed regional fisheries. The intended effect of the amendment was to implement the following: a new prioritization process for all allocation of observers if agency funding is insufficient to achieve target observer coverage levels, bycatch reporting and monitoring mechanisms, analytical techniques and allocation of at-sea fisheries observers, a precision-based performance standard for discard estimates, a review and reporting process, framework adjustment and annual specifications provisions, and provisions for industry-funded observers and observer set-aside programs.

- *Assess the type and amount of fish caught and released alive during recreational fishing under catch and release fishery management programs and the mortality of such fish,*

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and include conservation and management measures that, to the extent practicable, minimize mortality and ensure the extended survival of such fish;

None of the New England Council's FMPs include a catch and release recreational fishery management program and thus do not address this requirement.

- *Include a description of the commercial, recreational, and charter fishing sectors which participate in the fishery and, to the extent practicable, quantify trends in landings of the managed fishery resource by the commercial, recreational, and charter fishing sectors;*

A description of the commercial, recreational, and charter fishing sectors that participate in the fisheries prosecuted within and around the Great South Channel HMA is included in the underlying FMPs, and this framework is not specifically intended to meet this requirement. However, section 5.5 describes aspects of these sectors to the extent needed to inform Council decisions on exemption areas for the HMA.

- *To the extent that rebuilding plans or other conservation and management measures which reduce the overall harvest in a fishery are necessary, allocate any harvest restrictions or recovery benefits fairly and equitably among the commercial, recreational, and charter fishing sectors in the fishery.*

Rebuilding plans are specified in the Council's underlying FMPs, and not in OHA2 or this framework action.

- *Establish a mechanism for specifying annual catch limits in the plan (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, including measures to ensure accountability.*

Annual catch limits are specified in the Council's underlying FMPs, and not in OHA2 or this framework action.

7.1.3 EFH Assessment

This Essential Fish Habitat (EFH) assessment is provided pursuant to 50 CFR 600.920(e) of the EFH Final Rule to initiate EFH consultation with the National Marine Fisheries Service.

7.1.3.1 Description of Action

The Council developed this framework to evaluate and possibly designate areas where hydraulic clam dredging might continue in the Great South Channel Habitat Management Area (GSC HMA). The purpose of the GSC HMA is to minimize, to the extent practicable, the effects of regional fisheries on essential fish habitat (EFH). The GSC HMA was designated by the Council through Omnibus Essential Fish Habitat Amendment 2 and became effective on April 9, 2018. On this date the HMA closed to all mobile bottom-tending gears, but there was a one-year exemption from this closure for hydraulic clam dredges. This one-year delay allowed time for development of this action, the purpose of which is to identify areas where fishing for surfclams with hydraulic dredges would have only minimal and temporary impacts on the habitats in the HMA. This action is needed to comply with the Magnuson-Stevens Fishery Conservation and

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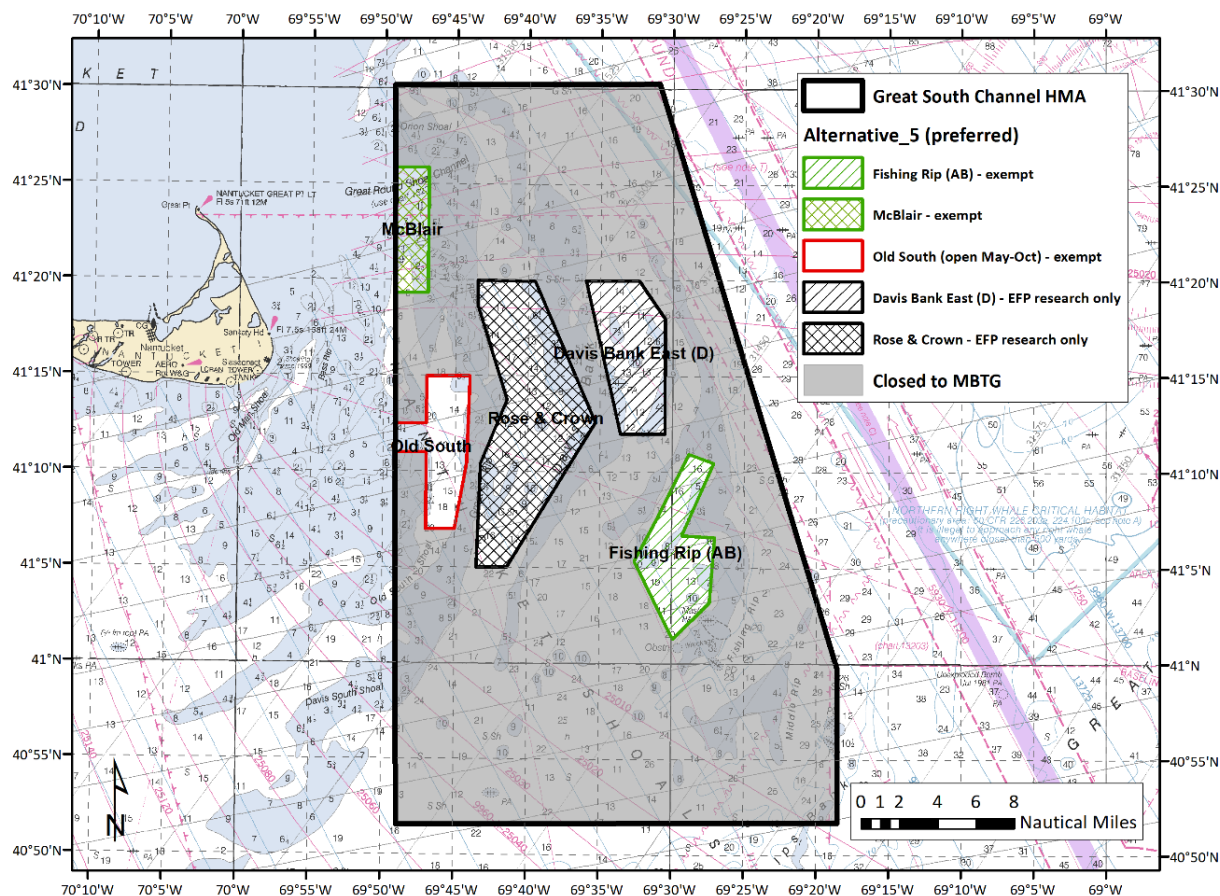
Management Act requirement to minimize the effects of fishing on EFH to the extent practicable.

The proposed action (designated as Alternative 5; see section 4.5 for details) would designate three areas within the GSC HMA where clam and mussel dredges can be used. Under the proposed action, the remainder of the HMA will be closed to all mobile bottom-tending gears. Vessels in the exemption program would be required to carry a vessel monitoring system that sends positions every five minutes. Vessel positions within three nautical miles of the HMA would trigger this polling rate. Vessels can transit this buffer zone as well as closed portions of the HMA between tows, but dredges must be on deck when doing so. The intent of these monitoring provisions is to help ensure that fishing occurs only within the designated exemption areas.

The three exemption areas are McBlair, in the northwestern part of the HMA, Old South, in the central western part, and Fishing Rip, in the central eastern part (Map 27). There would be no limits on fishing effort (i.e. number of trips, harvest per trip) within these three areas. McBlair and Fishing Rip would be open to fishing with clam and mussel dredges year-round, while the Old South area would only be open from May 1 through October 31 and would be closed November 1 through April 30 to protect spawning cod. Two additional areas, Rose and Crown and Davis Bank East, would be identified as sites where clam and mussel dredges could be used as part of a research program, provided that an exempted fishing permit is obtained for the project. Otherwise, these two research areas would not generally be open to dredging.

Under No Action (Alternative 1) the full HMA would have closed to all types of mobile bottom-tending gears, with no exemptions.

Map 27 – Alternative 5 (preferred). Year-round exemption areas are shown in green, and the seasonal exemption area is shown in red. Rose and Crown and Davis Bank East outlined in black would be open to research fishing only under an exempted fishing permit. The rest of the HMA (shaded grey) would be closed to all mobile bottom-tending gears.



7.1.3.2 Assessing the Potential Adverse Impacts

Environmental impacts of the proposed action, the no action alternative, and other alternatives are described in section 6, with impacts to EFH and managed species specifically evaluated in section 6.2. When making a determinization about the direction and magnitude of impacts associated with the proposed action, the analysis considers the habitat characteristics of the GSC HMA and candidate exemption areas, the scale of the exemption areas relative to the size of the HMA overall, and the amount of fishing that has historically occurred within the candidate exemption areas. The analysis also considers the linkages between habitat and fish production in order to assess the potential impacts of the alternatives on managed resources.

The conclusion of the analysis is that the proposed action would have negative impacts on EFH relative to taking no action and keeping the HMA closed to all mobile bottom-tending gears. The magnitude of this negative impact is uncertain due to data gaps and low survey coverage. Because this alternative would limit the access areas to a smaller proportion of the HMA than

Alternatives 2-4, the negative impacts of this alternative on EFH are expected to be less pronounced than those associated with the other action alternatives.

7.1.3.3 Minimizing or Mitigating Adverse Impacts

The proposed action is intended to limit the negative impacts of clam and mussel dredging on complex habitats within the GSC HMA, and thus contribute to the Council's regional strategy for minimizing adverse effects of fishing on EFH. While impacts of the proposed action are expected to be slightly negative relative to complete closure of the HMA under no action, no mitigation measures are required because the known extent of vulnerable habitat that will remain exposed to clam and mussel dredging is small (7%) compared to the HMA as a whole. Thus, the action will continue to minimize adverse impacts of fishing in the HMA to the extent practicable.

7.1.3.4 Conclusions

Based on these findings, and on the need to be consistent with the habitat protection objectives of the Council's Omnibus Habitat Amendment 2, an EFH consultation on the proposed action will be required.

7.2 Compliance with the National Environmental Policy Act

The following sections describe how this framework adjustment and environmental assessment document comply with the provisions of the National Environmental Policy Act.

7.2.1 Environmental Assessment

The required elements of an Environmental Assessment (EA) are specified in 40 CFR 1508.9(b) and NAO 216-6A §5.04b.1. They are included in this document as follows:

- The need for this action is described in section 3.1
- The alternatives that were considered are described in section 4
- The environmental impacts of alternatives are described in section 6
- The agencies and persons consulted on this action are listed in section 7.2.4

This document includes the following additional sections that are based on requirements for an Environmental Impact Statement (EIS).

- An Executive Summary and a summary of the document can be found in section 1
- A Table of Contents can be found in section 2
- Background and purpose are described in section 3
- A brief description of the affected environment is in section 5
- Cumulative impacts of the Preferred Alternatives are described in section 6.5
- A determination of significance is in section 7.2.2
- A list of preparers is in section 7.2.3

7.2.2 Finding of No Significant Impacts (FONSI)

The Council on Environmental Quality (CEQ) Regulations state that the determination of significance using an analysis of effects requires examination of both context and intensity and

lists ten criteria for intensity (40 CFR 1508.27). In addition, the Companion Manual for National Oceanic and Atmospheric Administration Administrative Order 216-6A provides sixteen criteria, the same ten as the CEQ Regulations and six additional, for determining whether the impacts of a proposed action are significant. Each criterion is discussed below with respect to the proposed action and considered individually as well as in combination with the others.

1. Can the proposed action reasonably be expected to cause both beneficial and adverse impacts that overall may result in a significant effect, even if the effect will be beneficial?

No. The proposed action is expected to have environmental impacts, but these impacts are not expected to be significant for the purposes of NEPA. These impacts are described in section 6 (section 6.2.6 Benthic habitats, managed species, and EFH; section 6.3.5 Human communities; section 6.4 Protected resources). Generally, restrictions on mobile bottom-tending gears are expected to have positive impacts on essential fish habitats and the species dependent on those habitats. Fisheries for species using these habitats are expected to benefit indirectly over the long term as habitat protection improves production of target resources. Impacts on protected resources are likely to be neutral to at worst low negative. Fisheries for target species, namely Atlantic surfclams and blue mussels, are expected to be negatively affected by closure of the HMA and will derive economic benefits from the proposed exemptions. The magnitude of this positive impact is uncertain, but likely less than the \$3-8 million value of the Nantucket Shoals clam fishery over the 2011-2017 period evaluated for this action.

2. Can the proposed action reasonably be expected to significantly affect public health or safety?

No. In terms of public health, the seafood safety aspects of harvest, processing, and distribution for sale of surfclams and blue mussels are subject to various federal and state restrictions. These regulations are outside of the scope of the Council's work and would not be affected in any way by the proposed action. Safety during processing is similarly regulated but outside the purview of the Council and this action. In terms of safety of workers at sea, no significant changes in fishing methods or operations are expected to result from the proposed action, except that the locations which can be dredged for either surfclams or mussels within the HMA will be limited to select areas and seasons. The Council has recommended that partial stowage of fishing gear is sufficient for compliance with closed areas when transiting between these exemption areas, and this measure prevents the need to retrieve hydraulic hoses during the fishing trip, which can cause safety concerns.

3. Can the proposed action reasonably be expected to result in significant impacts to unique characteristics of the geographic area, such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?

No. Many of these examples are not relevant to the marine environment. While the area encompassed by the Great South Channel Habitat Management Area is ecologically important, significant adverse impacts to this area are not expected to result from the proposed action, for reasons noted in criterion 1, above.

4. Are the proposed action's effects on the quality of the human environment likely to be highly controversial?

No. This action affects fishing privileges in the Great South Channel Habitat Management Area for vessels using hydraulic clam dredges to target Atlantic surfclams and for vessels using mussel dredges to target blue mussels. Relative to current management, the proposed action expands access for mussel dredges and reduces access for hydraulic dredges. Relative to the No Action alternative, the proposed action provides increased access for both gear types. In general harvesters in both fisheries may choose where to fish within state and federal waters. Although some surfclam harvesters are highly dependent on the Great South Channel Habitat Management Area, these vessels are a minority of vessels in the fishery and their landings from portions of the Great South Channel Habitat Management Area that will close are under 20% of coastwide of surfclam landings. The measures adopted in this framework are based on the management program adopted through the fishery management plans adopted by the New England and Mid-Atlantic Fishery Management Councils and are based on the best available scientific information.

5. Are the proposed action's effects on the human environment likely to be highly uncertain or involve unique or unknown risks?

No. The effects on the human environment are described under criterion 4, above. While there are some uncertainties as to how fishing effort will redistribute upon implementation of the proposed action relative to current patterns of activity (Section 6.1.1), the range of likely outcomes are able to be forecast with reasonable certainty. The risks of changing access to fishing grounds are not unique or unknown and are based on the best information available, including fishery-dependent data sources such as vessel logbooks and satellite vessel monitoring system data, as well as discussions with members of the fishing industry.

6. Can the proposed action reasonably be expected to establish a precedent for future actions with significant effects or represent a decision in principle about a future consideration?

No. The underlying Omnibus Habitat Amendment 2 from which this framework action derives had clear purposes to designate essential fish habitat (EFH) and minimize adverse effects on fishing on those habitats to the extent practicable. The basis for these actions lies in federal law, the Magnuson Stevens Fishery Conservation and Management Act, and in the regulations that expand upon the EFH provisions of the Act. The intent of this action is to comply with these provisions, and not to establish new precedent for how these provisions might be interpreted by the Council or NOAA Fisheries in the future. Revisions to these habitat conservation measures that are completed through future actions will fall under these same laws and regulations.

7. Is the proposed action related to other actions that when considered together will have individually insignificant but cumulatively significant impacts?

No. The underlying Omnibus Habitat Amendment 2 was acknowledged to have significant impacts. That action included an analysis of the impacts of surfclam fishery access to the Great South Channel Habitat Management Area. The impacts assessed for this action do not change the estimated magnitude of environmental impacts associated with the underlying amendment.

8. Can the proposed action reasonably be expected to adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources?

No. No such resources are known to occur within the Great South Channel Habitat Management Area. While there could be shipwrecks in the management area, fishermen working in the area avoid these features to the extent possible for safety reasons.

9. Can the proposed action reasonably be expected to have a significant impact on endangered or threatened species, or their critical habitat as defined under the Endangered Species Act of 1973?

No. Impacts to ESA listed species are described in section 6.4, and are not expected to be significant. Impacts on listed species are likely to be neutral to at worst low negative. There have been no observed interactions of any listed species of marine mammals, sea turtles, or fish with clam dredges and therefore, operation of surfclam and ocean quahog fisheries are not expected to pose an interaction risk to these organisms.

Due to mussel dredges similarity to scallop dredges, and observed interactions of hard-shelled sea turtles and Atlantic sturgeon with scallop gear, there is the potential for interactions between hard-shelled sea turtles or Atlantic sturgeon and mussel dredges (see section 5.6; NMFS NEFSC FSB 2018). However, because the magnitude of effort with mussel dredges is likely small, overall interaction risk to hard-shelled sea turtles or Atlantic sturgeon is probably low. Interactions between scallop dredges and large whales, small cetaceans, pinnipeds, leatherback sea turtles, hawksbill sea turtles, or Atlantic salmon have never been observed or documented (NMFS NEFSC FSB 2018; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; <https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region>; <https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries>). Based on this, and the similarity between mussel dredges and scallop dredges, mussel dredge interactions with these species are not expected.

As described in section 5.6, the proposed action is also not likely to adversely affect North Atlantic right whale critical habitat. Specifically, the proposed action will not affect the essential physical and biological features of North Atlantic right whales critical habitat and therefore, will not result in the destruction or adverse modification of this species critical habitat (NMFS 2015a,b).

10. Can the proposed action reasonably be expected to threaten a violation of Federal, state, or local law or requirements imposed for environmental protection?

No. The proposed action has been reviewed for compliance with various environmental laws, and no violations of such laws or requirements are threatened. The compliance of this action with those laws is discussed in section 7.1 (Magnuson Stevens Fishery Conservation and Management Act) and section 7.3 (other applicable laws).

11. Can the proposed action reasonably be expected to adversely affect stocks of marine mammals as defined in the Marine Mammal Protection Act?

No. Impacts to marine mammals are described in section 6.4 and stocks of marine mammals are not expected to be adversely affected. Relative to No Action, impacts to large cetaceans, small cetaceans, and pinnipeds are expected to be neutral. There have been no observed or documented interactions between clam or mussel dredges and large cetaceans, small cetaceans, or pinnipeds protected under MMPA.

12. Can the proposed action reasonably be expected to adversely affect managed fish species?

No. Impacts to managed fish species are described in section 6.2 (proposed action specifically in section 6.2.6) and are not expected to be adverse. Impacts are expected to be low negative relative to no action. As there are low bycatch rates of managed species in both clam and mussel dredges, these low negative impacts are indirect, and associated with the negative effects of fishing on benthic habitats that would be allowed to occur within the exemption areas of the Great South Channel HMA under the proposed action. However, this action will continue to minimize the adverse habitat impacts of fishing in the HMA to the extent practicable (see Question 13).

13. Can the proposed action reasonably be expected to adversely affect essential fish habitat as defined under the Magnuson-Stevens Fishery Conservation and Management Act?

Yes, the proposed action is expected to adversely affect essential fish habitat within the HMA, but as the majority of known complex habitat occurs outside the preferred exemption areas and 93% of the HMA will remain closed to all mobile, bottom-tending fishing gear, the adverse impacts will be no more than minimal. Impacts to essential fish habitats are described in section 6.2 (proposed action specifically in section 6.2.6). While these effects are estimated to be negative relative to the No Action alternative, the negative impacts of this alternative are expected to be less pronounced than they would be for the other alternatives, and this action will continue to minimize adverse impacts of fishing in the HMA to the extent practicable.

14. Can the proposed action reasonably be expected to adversely affect vulnerable marine or coastal ecosystems, including but not limited to, deep coral ecosystems?

No. As described under criterion 13, above, adverse impacts to vulnerable components of EFH will continue to be minimized under the proposed action. Deep-sea corals and sponges specifically are not known or likely to occur in the Great South Channel Habitat

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Management Area. The proposed action will have some effects on fishing effort within the New England region and perhaps into the Mid-Atlantic if surfclam vessels increase their efforts in other areas in response to displacement from the habitat management area. However, effort is unlikely to be displaced into areas that have not been previously fished and substantial changes in effort are not expected.

15. Can the proposed action reasonably be expected to adversely affect biodiversity or ecosystem functioning (e.g., benthic productivity, predator-prey relationships, etc.)?

No. As described under criterion 13, above this action will continue to minimize the adverse habitat impacts of fishing in the HMA to the extent practicable. Both benthic habitat structure as well as feeding opportunities provided by these habitats are considered when evaluating impacts to EFH. As noted above, large changes in fishing activity are not expected to result from this action.

16. Can the proposed action reasonably be expected to result in the introduction or spread of a non-indigenous species?

No. While it is possible that fishing activities could introduce or spread non-indigenous species, the proposed action does not authorize fishing in areas that were previously unfished, such that the risk of this action influencing the spread of a non-indigenous species is very low. Clam and mussel dredges are not known to have introduced non-indigenous species in the past.

DETERMINATION

In view of the information presented in this document and the analysis contained in the supporting Environmental Assessment prepared for the Clam Dredge Framework, it is hereby determined that the Clam Dredge Framework will not significantly impact the quality of the human environment as described above and in the supporting Environmental Assessment. In addition, all beneficial and adverse impacts of the proposed action have been addressed to reach the conclusion of no significant impacts. Accordingly, preparation of an environmental impact statement for this action is not necessary.

Decision Maker

Date

[Insert name of Office]

7.2.3 List of Preparers, Point of Contact

This environmental assessment was prepared by the New England Fishery Management Council in consultation with the National Marine Fisheries Service. Questions concerning this document may be addressed to:

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7.2.4 Agencies Consulted

The following agencies were consulted in the preparation of this document:

Mid-Atlantic Fishery Management Council
New England Fishery Management Council, which includes representatives from the following additional organizations:
Connecticut Department of Environmental Protection
Rhode Island Department of Environmental Management
Massachusetts Division of Marine Fisheries
New Hampshire Fish and Game
Maine Department of Marine Resources
National Marine Fisheries Service, NOAA, Department of Commerce
United States Coast Guard, Department of Homeland Security

7.2.5 Opportunities for Public Comment

This action was developed at a series of meetings held between autumn 2015 and autumn 2018. Opportunities for public comment were provided at each of these meetings. Additional technical (Plan Development Team) meetings were also held throughout this period and public comments were taken during most of these technical meetings as well.

Table 46 – NEFMC meetings (Council, Committee, or Advisory Panel) where the clam framework was discussed. Public comments were taken during all meetings.

Date	Meeting	Location
December 4-6, 2018	Council	Newport, RI
November 7, 2018	Habitat Committee	Warwick, RI
November 5, 2018	Habitat Advisory Panel	Boston, MA
November 1, 2018	Enforcement Committee/Advisory Panel	Boston, MA
September 24-27, 2018	Council	Plymouth, MA
August 28, 2018	Habitat Committee	Wakefield, MA
June 12-14, 2018	Council	Portland, ME

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May 22, 2018	Habitat Committee	Providence, RI
April 26, 2018	Habitat Committee	New Bedford, MA
April 17-19, 2018	Council	Mystic, CT
April 3, 2018	Habitat Advisory Panel	Mansfield, MA
January 9, 2018	Habitat Committee	Wakefield, MA
December 20, 2017	Habitat Advisory Panel/Plan Development Team	New Bedford, MA
December 5-7, 2017	Council	Newport, RI
October 4, 2017	Habitat Committee	New Bedford, MA
September 26-28, 2017	Council	Gloucester, MA
May 30, 2017	Habitat Committee	Wakefield, MA
April 18-20, 2017	Council	Mystic, CT
April 14, 2017	Habitat Committee	Boston, MA
February 24, 2017	Habitat Committee	Danvers, MA
January 30, 2017	Habitat Advisory Panel	Wakefield, MA
September 20-22, 2016	Council	Danvers, MA
August 18, 2016	Habitat Committee	Mansfield, MA
March 22, 2016	Habitat Committee	Warwick, RI
September 29-October 1, 2015	Council	Plymouth, MA
September 23, 2015	Habitat Committee	Danvers, MA

7.3 Relationship to Other Applicable Laws

This FMP adjustment complies with various other federal laws and executive orders as summarized below.

7.3.1 Endangered Species Act

Section 6.4 should be referenced for a description of impacts of the Preferred Alternatives on species and critical habitats listed under the ESA. The Preferred Alternative is expected to have neutral effects on ESA-listed large cetaceans, Atlantic salmon, and leatherback sea turtles, and may have slight negative impacts on hard-shelled sea turtles and Atlantic sturgeon. However, none of the alternatives in this framework including the Preferred Alternative are expected to impact the recovery of any protected species.

7.3.2 Marine Mammal Protection Act

The NEFMC has reviewed the impacts of the Preferred Alternatives on marine mammals and has concluded that the management actions proposed are consistent with the provisions of the MMPA. The proposed action alters fishing privileges, specifically fishery access to grounds on Nantucket Shoals, in the Atlantic surfclam and blue mussel fisheries. Interactions between hydraulic clam dredges and scallop dredges, which are like blue mussel dredges, and marine mammals have not been documented, so the changes in fishing that will result from implementation of this framework are not expected to impact marine mammals in any way,

positive or negative. Further, the measures will not alter the effectiveness of existing MMPA measures, such as take reduction plans, to protect those species based on overall reductions in fishing effort that have been implemented through regional FMPs. For further information on the potential impacts of the fishery and the proposed management action on marine mammals, see section 6.4 of this document.

7.3.3 Coastal Zone Management Act

Section 307(c)(1) of the Federal CZMA of 1972 requires that all Federal activities that directly affect the coastal zone be consistent with approved state coastal zone management programs to the maximum extent practicable. Pursuant to Section 930.36(c) of the regulations implementing the Coastal Zone Management Act, NMFS made a general consistency determination that the Greater Atlantic FMPs are consistent to the maximum extent practicable with the enforceable policies of the approved coastal management program of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina. This general consistency determination applies to the current versions of these FMPs and all subsequent routine federal actions carried out in accordance with the FMPs such as Framework Adjustments and specifications. A general consistency determination is warranted because Framework Adjustments to the FMP are repeated activities that adjust the use of management tools previously implemented in the FMP. A general consistency determination avoids the necessity of issuing separate consistency determinations for each incremental action. This determination was submitted to the above states on October 21, 2009. To date, the states of North Carolina, Rhode Island, Virginia, Connecticut, New Hampshire, and Pennsylvania have concurred with the General Consistency Determination. Consistency was inferred for those states that did not respond.

7.3.4 Administrative Procedures Act

This action was developed in compliance with the requirements of the Administrative Procedure Act, and these requirements will continue to be followed when the proposed regulation is published. Section 553 of the Administrative Procedure Act establishes procedural requirements applicable to informal rulemaking by federal agencies. The purpose of these requirements is to ensure public access to the federal rulemaking process, and to give the public adequate notice and opportunity for comment. The Council is not requesting any abridgement of the rulemaking process for this action.

7.3.5 Data Quality Act

Pursuant to NOAA guidelines implementing section 515 of Public Law 106-554 (the Data Quality Act), all information products released to the public must first undergo a Pre-Dissemination Review to ensure and maximize the quality, objectivity, utility, and integrity of the information (including statistical information) disseminated by or for Federal agencies. The following section addresses these requirements.

7.3.5.1 Utility of Information Product

The information presented in this document is helpful to the intended users (the affected public) by presenting a clear description of the purpose and need of the Preferred Alternatives on, the measures proposed, and the impacts of those measures. A discussion of the reasons for selecting the Preferred Alternatives is included so that intended users may have a full understanding of the Preferred Alternatives and its implications.

Until a proposed rule is prepared and published, this document is the principal means by which the information contained herein is available to the public. The information provided in this document is based on the most recent available information from the relevant data sources. The development of this document and the decisions made by the Council to propose this action are the result of a multi-stage public process. The information pertaining to management measures contained in this document takes into account comments from the public, the fishing industry, members of the Council, and NOAA Fisheries Service.

This document is available in several formats, including printed publication provided at public meetings and online through the Council's web page in PDF format. The Federal Register notices that announces the proposed rule and the final rule and implementing regulations will be made available in printed publication, on the website for the Greater Atlantic Regional Office, and through the Regulations.gov website.

7.3.5.2 Integrity of Information Product

Before dissemination, information associated with this action, independent of the specific intended distribution mechanism, is safeguarded from improper access, modification, or destruction, to a degree commensurate with the risk and magnitude of harm that could result from the loss, misuse, or unauthorized access to or modification of such information. All electronic information disseminated by NOAA Fisheries Service adheres to the standards set out in Appendix III, "Security of Automated Information Resources," of OMB Circular A-130; the Computer Security Act; and the Government Information Security Act. All confidential information (e.g., dealer purchase reports) is safeguarded pursuant to the Privacy Act; Titles 13, 15, and 22 of the U.S. Code (confidentiality of census, business, and financial information); the Confidentiality of Statistics provisions of the Magnuson-Stevens Act; and NOAA Administrative Order 216-100, Protection of Confidential Fisheries Statistics.

7.3.5.3 Objectivity of Information Product

For purposes of the Pre-Dissemination Review, this document is considered to be a "Natural Resource Plan." Accordingly, the document adheres to the published standards of the Magnuson-Stevens Act; the Operational Guidelines, Fishery Management Plan Process; the Essential Fish Habitat Guidelines; the National Standard Guidelines; and NOAA Administrative Order 216-6A, Environmental Review Procedures for Implementing the National Environmental Policy Act.

This information product uses information of known quality from sources acceptable to the relevant scientific and technical communities. Stock status (including estimates of biomass and fishing mortality) reported in this product are based on either assessments subject to peer-review through the Stock Assessment Review Committee or on updates of those assessments prepared

by scientists of the Northeast Fisheries Science Center. Landing and revenue information is based on information collected through the Vessel Trip Report, Clam Logbook, Vessel Monitoring System, and Commercial Dealer databases. In addition to these sources, additional information is presented that has been accepted and published in peer-reviewed journals or by scientific organizations. Original analyses in this document were prepared using data from accepted sources, and the analyses have been reviewed by members of the Habitat Plan Development Team.

Despite current data limitations, the conservation and management measures proposed for this action were selected based upon the best scientific information available. The analyses conducted in support of the Preferred Alternative were conducted using information from the most recent complete calendar years, through 2017, and in some cases includes information that was collected through the first six months of calendar year 2018. The data used in the analyses provide the best available information on the number of harvesters in the fishery, the catch by those harvesters including the spatial distribution of catches, and the sales and revenue of those landings to dealers. Specialists (including professional members of plan development teams, technical teams, committees, and Council staff) who worked with these data are familiar with the most current analytical techniques and with the available data and information relevant to the surfclam fishery.

The policy choices are clearly articulated, in section 4 of this document, as the management alternatives considered in this action. The supporting science and analyses, upon which the policy choices are based, are summarized and described in section 6 of this document. All supporting materials, information, data, and analyses within this document have been, to the maximum extent practicable, properly referenced according to commonly accepted standards for scientific literature to ensure transparency.

The review process used in preparation of this document involves the responsible Council, the Northeast Fisheries Science Center, the Greater Atlantic Regional Fisheries Office, and NOAA Fisheries Service Headquarters. The Council review process involves public meetings at which affected stakeholders have opportunity to provide comments on the document. The Center's technical review is conducted by senior level scientists with specialties in population dynamics, stock assessment methods, demersal resources, population biology, and the social sciences. Review by staff at the Regional Office is conducted by those with expertise in fisheries management and policy, habitat conservation, protected species, and compliance with the applicable law. Final approval of the action proposed in this document and clearance of any rules prepared to implement resulting regulations is conducted by staff at NOAA Fisheries Service Headquarters, the Department of Commerce, and the U.S. Office of Management and Budget.

7.3.6 Executive Order 13132 (Federalism)

This E.O. established nine fundamental federalism principles for federal agencies to follow when developing and implementing actions with federalism implications. The E.O. also lists a series of policy making criteria to which Federal agencies must adhere when formulating and implementing policies that have federalism implications. However, no federalism issues or

implications have been identified relative to the measures proposed in this framework. This action does not contain policies with federalism implications enough to warrant preparation of an assessment under E.O. 13132. The affected states have been closely involved in the development of the proposed management measures through their representation on the Council (all affected states are represented as voting members of at least one Regional Fishery Management Council). No comments were received from any state officials relative to any federalism implications that may be associated with this action.

7.3.7 Executive Order 13158 (Marine Protected Areas)

The Executive Order on Marine Protected Areas requires each federal agency whose actions affect the natural or cultural resources that are protected by an MPA to identify such actions, and, to the extent permitted by law and to the maximum extent practicable, in taking such actions, avoid harm to the natural and cultural resources that are protected by an MPA. The E.O. directs federal agencies to refer to the MPAs identified in a list of MPAs that meet the definition of MPA for the purposes of the Order. The E.O. requires that the Departments of Commerce and the Interior jointly publish and maintain such a list of MPAs. A list of MPA sites has been developed and is available at:

<http://marineprotectedareas.noaa.gov/nationalsystem/nationalsystemlist/>. No further guidance related to this Executive Order is available at this time.

7.3.8 Paperwork Reduction Act

The purpose of the PRA is to control and, to the extent possible, minimize the paperwork burden for people, small businesses, nonprofit institutions, and others resulting from the collection of information by or for the Federal Government. The authority to manage information and recordkeeping requirements is vested with the Director of the Office of Management and Budget (OMB). This authority encompasses establishment of guidelines and policies, approval of information collection requests, and reduction of paperwork burdens and duplications.

The proposed action includes some additional reporting requirements for the purpose of enforcing compliance with the exemption area program. Vessels fishing in the exemption program would be required to request a letter of authorization to participate on an annual basis, when they apply for their vessel permit. In addition, in order to fish in the exemption areas, vessels will need to have an operational vessel monitoring system unit capable of sending a position to NOAA Office of Law Enforcement every five minutes. Vessel monitoring systems are already required for vessels that hold surfclam permits, and therefore these systems would only be a new requirement for mussel dredge vessels that don't already hold a federal permit with a VMS requirement. Currently, federally-permitted fishing vessels are polled every 30 or 60 minutes, depending on whether the vessel holds a sea scallop permit or not. The 5-minute polling would represent an additional information collection, but this information collection is automated, and includes a relatively minor cost (estimated at \$0.84/hour while a vessel is within 3 nm of the Great South Channel HMA, see section 6.3.1.3).

Overall, the costs of compliance are expected to be relatively minimal, and the measures are needed for effective enforcement of the exemption area fishery.

7.3.9 Regulatory Flexibility Act

The purpose of the Regulatory Flexibility Act (RFA) is to reduce the impacts of burdensome regulations and recordkeeping requirements on small businesses. To achieve this goal, the RFA requires federal agencies to describe and analyze the effects of proposed regulations, and possible alternatives, on small entities. Ultimately, the goal of the RFA analysis is to understand to what extent the action induces significant economic impacts on small entities. To this end, this document contains an Initial Regulatory Flexibility Analysis (IRFA), found below, which includes an assessment of the effects that the proposed action and other alternatives are expected to have on small entities.

Under Section 603(b) of the RFA, an IRFA must describe the impact of the proposed rule on small entities and contain the following information:

1. A description of the reasons why the action by the agency is being considered.
2. A succinct statement of the objectives of, and legal basis for, the proposed rule.
3. A description—and, where feasible, an estimate of the number—of small entities to which the proposed rule will apply.
4. A description of the projected reporting, recordkeeping, and other compliance requirements of the proposed rule, including an estimate of the classes of small entities that will be subject to the requirement and the types of professional skills necessary for preparation of the report or record.
5. An identification, to the extent practicable, of all relevant federal rules that may duplicate, overlap, or conflict with the proposed rule.

7.3.9.1 Reasons for Considering the Action

The statement of the problem(s) that this document addresses, along with the goals and objectives of the Clam Dredge Framework, is in the Purpose and Need for the Action, Section 3.1, which should be referenced for additional information.

7.3.9.2 Objectives and Legal Basis for the Action

The Council developed this framework to evaluate and possibly designate areas where hydraulic clam dredging might continue in the Great South Channel Habitat Management Area (GSC HMA). The purpose of the HMA is to minimize, to the extent practicable, the effects of regional fisheries on essential fish habitat (EFH). The purpose of this action is to identify areas where fishing for surfclams with hydraulic dredges would have only minimal and temporary impacts on the habitats in the HMA. This action is needed to comply with the Magnuson-Stevens Fishery Conservation and Management Act requirement to minimize the effects of fishing on EFH to the extent practicable.

7.3.9.3 Description and Number of Small Entities to Which the Rule Applies

The RFA recognizes three kinds of small entities: small businesses, small organizations, and small governmental jurisdictions. Small organizations and small governmental jurisdictions are not directly regulated by this action. For RFA purposes only, NMFS has established a small business size standard for businesses, including their affiliates, whose primary industry is commercial fishing (see 50 CFR §200.2). A business primarily engaged in commercial fishing

(NAICS code 11411) is classified as a small business if it is independently owned and operated, is not dominant in its field of operation (including its affiliates) and has combined annual receipts not in excess of \$11 million for all its affiliated operations worldwide. Throughout this section, revenue is presented in 2015 dollars, for consistency with the rest of the document, although classification was made using 2011 dollars, consistent with SBA guidelines. Further, SBA rules of affiliation are used to define a business entity. Thus, the following analysis is conducted upon unique business interests when possible, which can represent multiple vessel-level permits.

The Clam Dredge Framework to the Omnibus Habitat Amendment regulates all fishermen with federal permits allowing the holder to fish in the federal waters off Southern New England, Georges Bank, and the Gulf of Maine, and permitted to fish for either mussels or surfclams. There are no federal permits for mussel fishing; all mussel fishing is regulated by relevant state agencies. As such, the description of entities is broken down by surfclam/ocean quahog permitted vessels and mussel permitted vessels due to differences in data availability.

Between 10 (2015) and 11 (2016, 2017) vessels were permitted and active in the mussel fishery in the most recent three-year period (Table 13). As noted in section 5.5.3, Massachusetts requires vessels to have a permit in order to land mussels in the state, and well over 95% of all landings in the state are generated from Cape Cod Bay, well away from the Great South Channel HMA. Although mussel fishermen in Rhode Island would also qualify as regulated entities, there is no federal data from which to assess their numbers, and no mussel fishing has occurred in the waters around the Great South Channel HMA in recent history. Also, section 6.3.2 through 6.3.5 make clear that the current status of the mussel fishery in Great South Channel environs is exploratory, and ownership data is not available from which to assess business size for state-permitted vessels. This situation precludes a more thorough investigation into the number and size of mussel businesses regulated under the Clam Dredge Framework.

In 2017, eight large commercial fishing businesses, and 377 small commercial fishing businesses held either a surfclam or ocean quahog category 6 permit. Category 7 ocean quahog permits apply only to the Maine Mahogany Quahog fishery, which exists solely in the Gulf of Maine and thus is not regulated by management areas within waters off Southern New England. Total revenue from estimates used in entity classification is in Table 47.

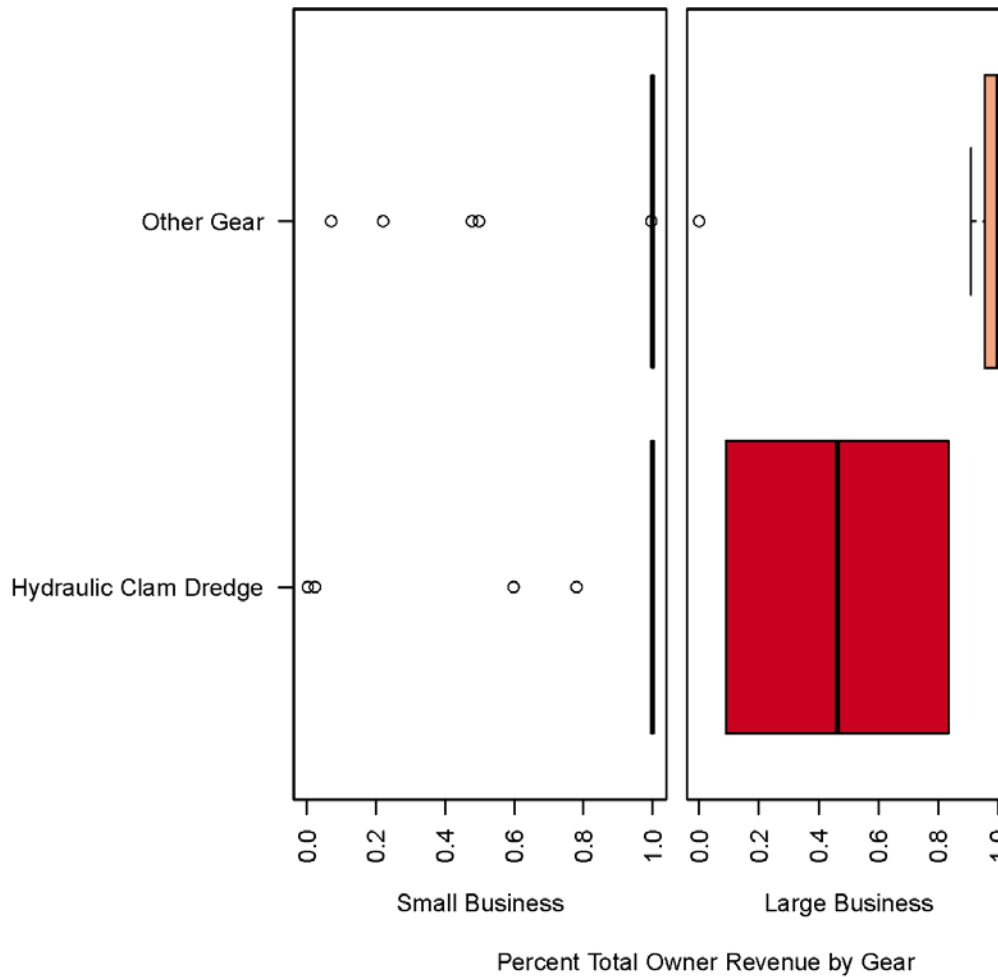
Clam Dredge Framework

Table 47 – Total revenue estimates used for entity classification for individuals holding either a surfclam or ocean quahog category 6 permit, in \$2011 per SBA Guidelines

Year	Size	Entity Type	Total Revenue	Commercial Revenue	For-Hire Revenue
2015	Large Business	Commercial Fishing	\$129,694,237	\$129,694,237	\$0
2016	Large Business	Commercial Fishing	\$131,456,225	\$131,456,225	\$0
2017	Large Business	Commercial Fishing	\$136,687,675	\$136,687,675	\$0
2015	Small Business	Commercial Fishing	\$420,978,577	\$420,972,945	\$5,632
2016	Small Business	Commercial Fishing	\$463,977,640	\$463,961,927	\$15,713
2017	Small Business	Commercial Fishing	\$475,443,498	\$475,441,919	\$1,579
2015	Small Business	No Revenue	\$6,940,516	\$6,940,516	\$0
2016	Small Business	No Revenue	\$4,945,630	\$4,945,630	\$0
2017	Small Business	No Revenue	\$0	\$0	\$0

The number of fishermen actively engaged in the surfclam and ocean quahog fishery is much smaller than the number of individuals permitted for those two fisheries. This is because there is an individual transferrable quota associated with both species, meaning only individuals holding or leasing quota can land surfclam and ocean quahog (except mahogany quahog, which as previously stated occur wholly outside the bounds of the Great South Channel HMA) and some permit holders only lease out quota and do not fish. Fishing for surfclam and ocean quahog is conducted primarily using hydraulic clam dredges, which, together with mussel dredge fishing, is the only gear exempted under the alternatives considered within this action. Figure 22 has the distribution of revenue generated by regulated gears vs. other gears, for entities that would be regulated under this framework adjustment, which highlights that small businesses that harvest fish tend to be less diversified in gear used compared to large businesses that harvest fish. Most fishermen using hydraulic dredges generate 100% of ownership revenue from that gear type.

Figure 22 – Distribution of the percent of total ownership group revenue generated by gears regulated under the Habitat Amendment Clam Dredge Framework, for regulated entities 2015-2017.



Given the spatial nature of the management alternatives, self-reported VTR data, modeled as outlined in DePiper (2014) and Benjamin et al. (2018), were used to assess impacts for this action. Historical fishing revenue generated within clam dredge exemption alternatives within the Great South Channel HMA are reviewed in section 6.2.6. This RFA analysis complements the above analysis by providing an estimate of the number and types of businesses potentially affected by the proposed action due to historical fishing patterns overlapping area alternatives. Small businesses have historically generated a higher percentage of their revenue within the Great South Channel HMA and are expected to benefit more from any exemption than large businesses, relatively speaking (Table 48).

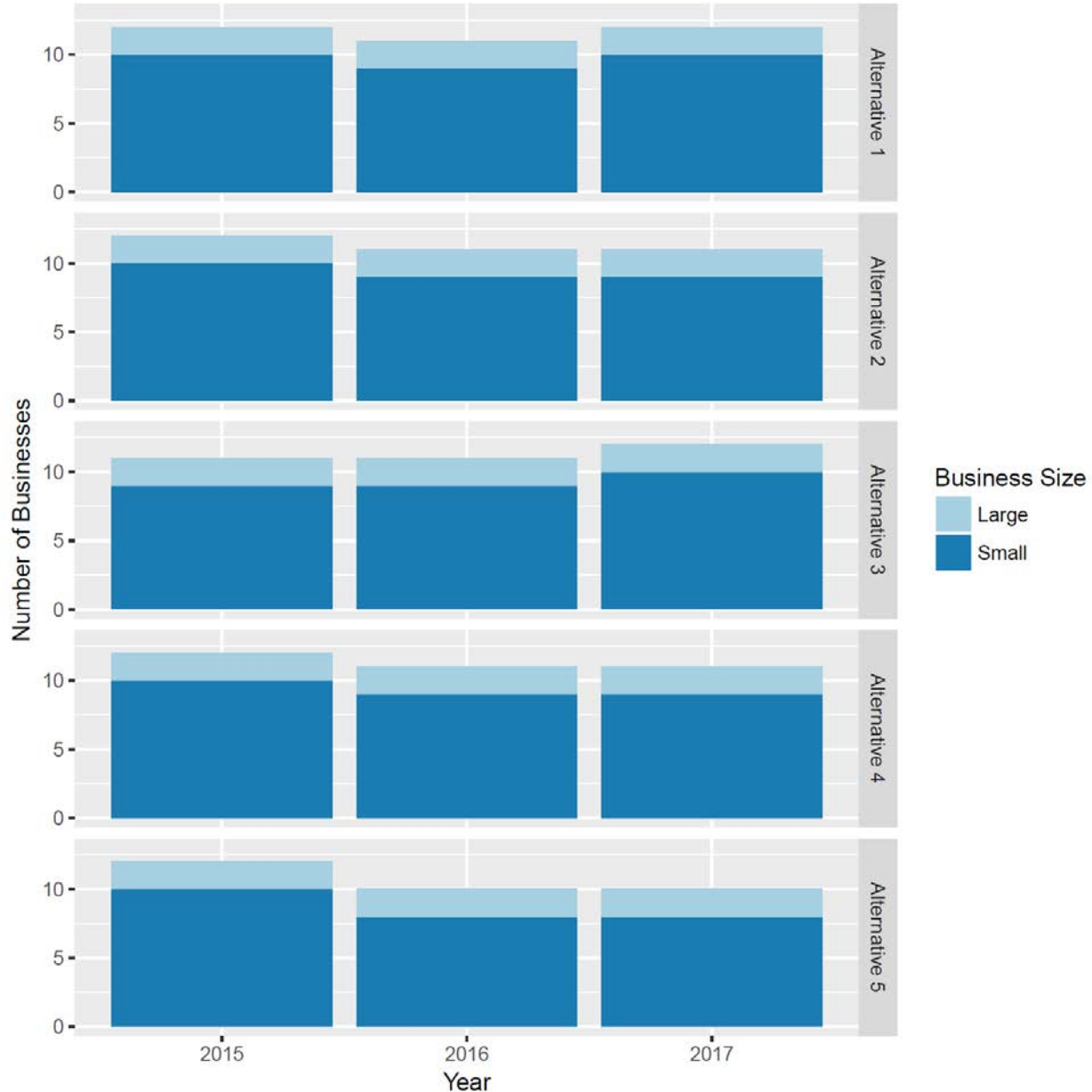
Table 48 – Median of the 3 year (2015, 2016, 2017) average percentage of owner revenue , total revenue, and number of ownership groups estimated within areas defined by each alternative, by business size.

Alternative	Business Size	Median of the 3 Year Mean Percentage Business Revenue	Median of the 3 Year Mean Business Revenue	Mean Number of Businesses per Year
Alternative 1*	Large	Suppressed due to confidentiality concerns		2.00
Alternative 1*	Small	62.2%	\$349,270	9.67
Alternative 2	Large	Suppressed due to confidentiality concerns		2.00
Alternative 2	Small	14.2%	\$86,755	9.33
Alternative 3	Large	Suppressed due to confidentiality concerns		2.00
Alternative 3	Small	3.7%	\$25,000	9.33
Alternative 4	Large	Suppressed due to confidentiality concerns		2.00
Alternative 4	Small	7.4%	\$61,310	9.33
Alternative 5	Large	Suppressed due to confidentiality concerns		2.00
Alternative 5	Small	5.5%	\$45,629	8.67

*Note: Alternative 1 highlights potentially displaced revenue, while the remaining alternatives highlight revenue generated from areas that would be kept open to fishing.

Figure 23 has the number of businesses historically fishing in areas defined by each alternative as defined in the Clam Exemption Framework. Although most businesses are active in all areas, the areas included in the Proposed Action (Alternative 5) have the lowest activity of all exemption area alternatives in two of the three years investigated. Small businesses drive all the variability in number of businesses fishing in areas defined by the alternatives.

Figure 23 – Number of businesses fishing within the boundaries of each Alternative, by business size.



Note: Alternative 1 indicates the number of businesses which would be excluded by the framework, while all other alternatives indicate the number of businesses historically active in areas that would continue to be open to fishing.

7.3.9.4 Record Keeping and Reporting Requirements

The Clam Dredge Framework requires additional Vessel Monitoring System (VMS) polling and an annual letter of authorization for fishermen accessing the Great South Channel HMA exemption areas, as described in section 4. The letter of authorization is a relatively minor inconvenience for fishermen and is an administrative step that is expected to generate only *de minimus* costs. Although it can be triggered automatically and remotely by NOAA Fisheries,

increased VMS polling comes with a cost, realistically assumed for the purpose of this framework to be \$0.06/poll (NPFMC, 2012). Section 6.2.6 has a discussion of the potential costs associated with increased VMS polling.

7.3.9.5 Duplication, Overlap, or Conflict with Other Federal Rules

The proposed Clam Dredge Framework does not duplicate, overlap, or conflict with any other Federal Rule, although it explicitly aims to alter the Great South Channel HMA as defined in the Habitat Omnibus Amendment (NMFS 2018b).

7.3.10 Executive Order 12866 (Planning and Coordination)

The purpose of Executive Order 12866 (E.O. 12866, 58 FR 51735, October 4, 1993) is to enhance planning and coordination with respect to new and existing regulations. This E.O. requires the Office of Management and Budget (OMB) to review regulatory programs that are considered to be “significant.” E.O. 12866 requires a review of proposed regulations to determine whether or not the expected effects would be significant, where a significant action is any regulatory action that may:

- Have an annual effect on the economy of \$100 million or more, or adversely affect in a material way the economy, a sector of the economy, productivity, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;
- Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
- Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or
- Raise novel legal or policy issues arising out of legal mandates, the President’s priorities, or the principles set for the Executive Order.

In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider.

7.3.10.1 Statement of the Problem, Goals and Objectives

The statement of the problem(s) that this document addresses, along with the goals and objectives of the Clam Dredge Framework, is in the Purpose and Need for the Action, section 3.1, which should be referenced for additional information.

7.3.10.2 Management Alternatives and Rationale

A description, including rationale, for development of the proposed action is in section 4.

7.3.10.3 Description of the Fishery

Information about fishery-related businesses and communities potentially affected by the Clam Dredge Framework is in section 5.5.

7.3.10.4 Summary of Impacts

An overview of the analytical approach, including caveats, is in section 6.2.6. Impacts of each alternative relative to No Action are in section 6.3.2- 6.3.5. The number of businesses regulated and expected to be impacted by the Clam Dredge Framework is in section 7.3.9.3.

In summary, the preferred alternative is not expected to have an annual impact on the economy more than \$100 million compared to No Action in the short- and the long-term. The proposed alternatives will not adversely affect in a material way the economy, productivity, competition, public health or safety, jobs or state, local, or tribal governments or communities in the long run and will not raise novel legal and policy issues, other than those that were already addressed and analyzed in the Omnibus Habitat Amendment 2 (OHA2). The preferred alternative also does not interfere with an action planned by another agency, since no other agency regulates the level of clam or mussel harvest in the EEZ. Also, it does not materially alter the budgetary impact of entitlements, grants, user fees, or loan programs, or the rights and obligations of recipients. As a result, this action is not considered to be “significant” for the purpose of E.O. 12866.

8 LITERATURE CITED

- ASMFC (2007). The importance of habitat created by molluscan shellfish to managed species along the Atlantic coast of the United States. Habitat Management Series #8.
- ASMFC (2014). Addendum XXIII to Amendment 3 to the Interstate Fishery Management Plan for American Lobster; Habitat Considerations. 42 p.
http://www.asmfc.org/uploads/file/53ebd78bamLobsterAddendumXXIII_Habitat_Aug2014.pdf.
- ASMFC (2015). American Lobster Stock Assessment for Peer Review Report. Alexandria, VA: Atlantic States Marine Fisheries Commission. 463 p.
http://www.asmfc.org/uploads/file/55d61d73AmLobsterStockAssmt_PeerReviewReport_Aug2015_red2.pdf.
- ASMFC (2017). 2017 Atlantic sturgeon benchmark stock assessment and peer review report. October 18, 2017. 456 p.
- ASMFC (2017). Memorandum from the American Lobster Technical Committee to the American Lobster Management Board. January 25, 2017. Arlington, VA: Atlantic States Marine Fisheries Commission. 26 p.
http://www.asmfc.org/uploads/file/55d61d73AmLobsterStockAssmt_PeerReviewReport_Aug2015_red2.pdf.
- Atlantic Sturgeon Status Review Team (ASSRT). 2007. Status review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 p.
- Auster PJ, Malatesta RJ & LaRosa SC (1995). Patterns of Microhabitat Utilization by Mobile Megafauna on the Southern New England (USA) Continental Shelf and Slope. Mar. Ecol. Prog. Ser. 127(77-85).
- Auster PJ, Michalopoulos PC, Valentine PC & Malatesta RJ (1998). Delineating and Monitoring Habitat Management Units in a Temperate Deep-water Marine Protected Area. In: Linking Protected Areas with Working Landscapes, Conserving Biodiversity. Wolfville, Nova Scotia: Science and Management of Protected Areas Association. p. 169-185.
- Baumgartner MF, Mayo CA & Kenney RD (2007). Enormous carnivores, microscopic food, and a restaurant that's hard to find. Pages 138-171 in "The Urban Whale: North Atlantic Right Whales at the Crossroads" (Kraus SD and Rolland RM, eds.). Harvard University Press, Cambridge, MA.
- Belkin, IM, Cornillon PC & Sherman K (2009). Fronts in Large Marine Ecosystems. Progress in Oceanography 81(1): 223-236.
- Benjamin S, Lee M-Y, DePiper G (2018). Visualizing fishing data as rasters. NEFSC Ref Doc 18-12; 24 p.
- Borg A, Pihl L & Wennhage H (1997). Habitat Choice by Juvenile Cod (*Gadus morhua* L.) on Sandy Soft Bottoms with Different Vegetation Types. Helgoländer Meeresuntersuchungen. 51(2): 197-212.
- Borthagaray, AI & Carranza A (2007). "Mussels as ecosystem engineers: Their contribution to species richness in a rocky littoral community." Acta Oecologica 31(3): 243-250.
- Brandt S (2005). The equity debate: Distributional impacts of individual transferable quotas. Ocean and Coastal Management. 48: 15-30.
- Burdge RJ (1998). A Conceptual Approach to Social Impact Assessment. Revised ed. Madison, WI: Social Ecology Press. 284 p.
- Caddy JF (2008). The Importance of Cover in the Life Histories of Demersal and Benthic Marine Resources: A Neglected Issue in Fisheries Assessment and Management. Bulletin of Marine Science. 83(1): 7-52.
- Caddy JF (2013). Why do Assessments of Demersal Stocks Largely Ignore Habitat? ICES Journal of Marine Science. doi:10.1093/icesjms/fss199. 13 p.
- Caillouet CW, Raborn SW, Shaver DJ, Putman NF, Gallaway BJ & Mansfield KL (2018). Did declining carrying capacity for the Kemp's ridley sea turtle population within the Gulf of Mexico contribute to the nesting setback in 2010-2017? Chelonian Conservation and Biology 17(1): 123-133.

Clam Dredge Framework

- Cargnelli L, Griesbach S, Packer D & Weissberger E (1999). Essential Fish Habitat Source Document: Atlantic Surfclam, *Spisula solidissima*, Life History and Habitat Characteristics. Vol. NOAA Tech. Memo. NMFS-NE-142.
- Clay PM, Colburn LL, Olson J, Pinto da Silva P, Smith SL, Westwood A & Ekstrom J (2007). Community Profiles for the Northeast U.S. Fisheries. Woods Hole, MA: U.S. Department of Commerce; <http://www.nefsc.noaa.gov/read/socialsci/communityProfiles.html>.
- Coen, LD & Grizzle RE (2007). The Importance of Habitat Created by Molluscan Shellfish to Managed Species along the Atlantic Coast of the United States; ASMFC Habitat Management Series #8. J. Thomas and J. Nygard, editors. Atlantic States Marine Fisheries Commission, Washington, D.C.
- Colburn LL, Jepson M, Himes-Cornell A, Kasperski S, Norman K, Weng C & Clay PM (2017). Community Participation in U.S. Catch Share Programs. Silver Spring, MD: U.S. Department of Commerce. NOAA Technical Memorandum NMFS-F/SPO-179. 136 p.
- Dalyander PS, Butman B, Sherwood CR, Signell RP & Wilkin JL (2013). Characterizing Wave- and Current-induced Bottom Shear Stress: U.S. Middle Atlantic Continental Shelf. Cont. Shelf Res. 52(0): 73-86.
- Davis, C.S (1987). Zooplankton life cycles. Pages. 254-267 in "Georges Bank" (Backus RH & Bourne DW, eds.). MIT Press, Cambridge, MA.
- DeCelles GR, Martins D, Zemeckis DR, Ames T & Cadrin SX (2017a). Mapping the distribution of Atlantic cod spawning on Georges Bank using fishermen's ecological knowledge and scientific data. Final Report. 129 p.
- DeCelles GR, Martins D, Zemeckis DR & Cadrin SX (2017b). Using fishermen's ecological knowledge to map Atlantic cod spawning grounds on Georges Bank. ICES J. Mar. Sci.: 74(6): 1587-1601.
- DePiper, GS (2014). Statistically assessing the precision of self-reported VTR fishing locations. NOAA Technical Memorandum NMFS-NE-229: 16 p.
- Deroba J (2015). Atlantic Herring Operational Assessment Report. Woods Hole, MA: U.S. Department of Commerce. NEFSC Reference Document 15-16. 30 p. <http://www.nefsc.noaa.gov/publications/crd/crd1516/>.
- Diaz RJ, Cutter GR & Able KW (2003). The Importance of Physical and Biogenic Structure to Juvenile Fishes on the Shallow Inner Continental Shelf. Estuaries. 26(1): 12-20.
- Dolmer P & Frandsen R (2002). "Evaluation of the Danish mussel fishery: suggestions for an ecosystem management approach." Helgoland Marine Research 56(1): 13-20.
- Dolmer P, Kristensen T, Christiansen ML, Peterson MF, Kristensen PS & Hoffmann E (2001). Short-term impact of blue mussel dredging (*Mytilus edulis* L.) on a benthic community. Hydrobiologia. Vol 465. 13 pp. Available at: <http://link.springer.com/article/10.1023%2FA%3A1014549026157>.
- Dolmer P (2002). Mussel dredging: impact on epifauna in Limfjorden, Denmark. J. Shellfish Res. 21: 529–537.
- Fahay, MP (1983). Guide to the Early Stages of Marine Fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf. J. Northw. Atl. Fish. Sci. 4: 3-423.
- GARFO Greater Atlantic Region Permit Data. Gloucester, MA: NMFS Greater Atlantic Regional Fisheries Office; <https://www.greateratlantic.fisheries.noaa.gov/aps/permits/data/index.html>.
- Gosner, KL (1978). A Field Guide to the Atlantic Seashore: Invertebrates and Seaweeds of the Atlantic Coast from the Bay of Fundy to Cape Hatteras. Boston, Houghton Mifflin Co.
- Gotceitas V, Fraser S & Brown JA (1995). Habitat Use by Juvenile Atlantic Cod (*Gadus morhua*) in the Presence of an Actively Foraging and Non-foraging Predator. Mar. Biol. 123(3): 421-430.
- Grabowski, JH, Bachman M, Demarest C, Eayrs S, Harris BP, Malkoski V, Packer D & Stevenson D (2014). Assessing the Vulnerability of Marine Benthos to Fishing Gear Impacts. Rev. Fish. Sci. Aquac.: 142-155.

Clam Dredge Framework

- Harris BP, Cowles GW & Stokesbury KDE (2012). Surficial Sediment Stability on Georges Bank in the Great South Channel and on eastern Nantucket Shoals. *Cont. Shelf Res.* 49: 65-72.
- Hart DR & Chute AS (2004). Essential Fish Habitat Source Document: Sea Scallop, *Placopecten magellanicus*, Life History and Habitat Characteristics 2nd ed. Woods Hole, MA: U.S. Department of Commerce. NEFSC Technical Memorandum NE-198.
- Hayes SA, Josephson E, Maze-Foley K & Rosel P (2018). US Atlantic and Gulf of Mexico Marine Mammal Stock Assessment 2017. NOAA Technical Memorandum NMFS-NE-245.
- Heppell SS, Crouse DT, Crowder LB, Epperly SP, Gabriel W, Henwood T, Marquez R, & Thompson NB (2005). A population model to estimate recovery time, population size, and management impacts on Kemp's ridley sea turtles. *Chelonian Conservation and Biology* 4(4): 767-773.
- Jepson M & Colburn LL (2013). Development of Social Indicators of Fishing Community Vulnerability and Resilience in the U.S. Southeast and Northeast Regions. Silver Spring, MD: U.S. Department of Commerce. NOAA Tech. Memo. NMFS-F/SPO-129. 64 p. <http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/index>.
- Johnson C, Pringle J & Chen C (2006). Transport and retention of dormant copepods in the Gulf of Maine. *Deep-Sea Res. II.* 53: 2520–2536.
- Kelly KH & Moring JR (1986). Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates - Atlantic Herring. U.S. Fish and Wildlife Service. Biological Report 82 (11.38) TR EL-82-4. 22 p.
- Langton RW, Auster PJ & Schneider DC (1995). A Spatial and Temporal Perspective on Research and Management of Groundfish in the Northwest Atlantic. *Rev. Fisheries Sci.* 3(3): 201-229.
- Lindholm JB, Auster PJ & Kaufman LS (1999). Habitat-mediated Survivorship of Juvenile (0-year) Atlantic Cod *Gadus morhua*. *Mar. Ecol. Prog. Ser.* 180: 247-255.
- Linehan JE, Gregory RS & Schneider DC (2001). Predation Risk of Age-0 Cod (*Gadus*) Relative to Depth and Substrate in Coastal Waters. *J. Exp. Mar. Biol. Ecol.* 263(1): 25-44.
- Lough, RG, Valentine PC, Potter DC, Auditore PJ, Bolz GR, Neilson JD & Perry RI (1989). Ecology and distribution of juvenile cod and haddock in relation to sediment type and bottom currents on eastern Georges Bank. *Mar. Ecol. Prog. Ser.* 56(1-2): 1-12.
- Lynch DR, Gentleman WC, McGillicuddy DJ & Davis CS (1998). Biological/ physical simulations of *Calanus finmarchicus* population dynamics in the Gulf of Maine. *Mar. Ecol. Prog. Ser.* 169: 189-210.
- MAFMC (1998). Amendment 12 to the Atlantic Surfclam and Ocean Quahog Fishery Management Plan. Dover, DE: Mid-Atlantic Fishery Management Council in cooperation with the Northeast Regional Office of the National Marine Fisheries Service. 340 p.
- MAFMC (2003). Amendment 13 to the Atlantic Surfclam and Ocean Quahog Fishery Management Plan. Vol. I. Dover, DE: Mid-Atlantic Fishery Management Council in cooperation with the Northeast Regional Office of the National Marine Fisheries Service. 472 p.
- MAFMC (2017). Atlantic Surfclam and Ocean Quahog 2018, 2019, and 2020 Specifications Supplemental Information Report (SIR) and Regulatory Flexibility Analysis (RFA). Dover, DE: Mid-Atlantic Fishery Management Council in cooperation with the National Marine Fisheries Service. 20 p.
- MAFMC (2018a). Mid-Atlantic Fishery Management Council Atlantic Surfclam Information Document. Dover, DE: Mid-Atlantic Fishery Management Council. 15 p.
- MAFMC (2018b). Surfclam and Ocean Quahog Advisory Panel Fishery Performance Report (FPR) April 2018. Dover, DE: Mid-Atlantic Fishery Management Council. 6 p. <http://www.mafmc.org/surfclams-quahogs/>.

Clam Dredge Framework

- McCay BJ (2004). ITQs and community: An essay on environmental governance. *Agricultural and Resource Economics Review*. 33(2): 162-170.
- McCay BJ & Creed CF (1990). Social structure and debates on fisheries management in the Atlantic surf clam fishery. *Ocean and Shoreline Management*. 13(3): 199-229.
- Meise CJ & O'Reilly JE (1996). Spatial and seasonal patterns in abundance and age composition of *Calanus finmarchicus* in the Gulf of Maine and on Georges Bank: 1977-1987. *Deep Sea Res. II*. 43(7-8):1473-1501.
- Miller, CB, Lynch DR, Carlotti F, Gentleman W & Lewis CVW (1998). Coupling of an individual-based population dynamic model of *Calanus finmarchicus* to a circulation model for the Georges Bank region. *Fisheries Oceanography* 7 (3-4): 219-234.
- Murphy T, Kitts A, Demarest C & Walden J (2015). 2013 Final Report on the Performance of the Northeast Multispecies (Groundfish) Fishery (May 2013 - April 2014). Woods Hole, MA: NOAA Fisheries Northeast Fisheries Science Center. 111 p.
- NEFMC (2011). The Swept Area Seabed Impact (SASI) approach: a tool for analyzing the effects of fishing on Essential Fish Habitat. 257 p.
- NEFMC (2017). Framework Adjustment 56 to the Northeast Multispecies Fishery Management Plan. Newburyport, MA: New England Fishery Management Council in consultation with the National Marine Fisheries Service. 309 p.
- NEFMC (2018a). Draft Amendment 8 to the Atlantic Herring Fishery Management Plan. Newburyport, MA: New England Fishery Management Council.
- NEFMC (2018b). Framework 29 to the Scallop Fishery Management Plan. Newburyport, MA: New England Fishery Management Council in cooperation with the National Marine Fisheries Service. 398 p.
- NEFMC (2018c). Framework Adjustment 5 to the Northeast Skate Complex Fishery Management Plan and 2018-2019 Specifications. Newburyport, MA: New England Fishery Management Council in cooperation with the National Marine Fisheries Service. 161 p.
- NEFMC (2018d). Framework Adjustment 57 to the Northeast Multispecies Fishery Management Plan. Newburyport, MA: New England Fishery Management Council in consultation with the National Marine Fisheries Service. 381 p.
- NEFMC (2018e). VMS/Enforcement Committee and Advisors Meeting Summary. November 1, 2018. Boston, MA. Retrieved from https://s3.amazonaws.com/nefmc.org/181101_ENF_Report_final.pdf
- NEFMC (2018f). Framework Adjustment 6 to the Northeast Skate Complex Fishery Management Plan and 2018-2019 Specifications. Newburyport, MA: New England Fishery Management Council in cooperation with the National Marine Fisheries Service. 150 p.
- NEFMC (2019). Draft Framework 30 to the Scallop Fishery Management Plan. Newburyport, MA: New England Fishery Management Council in cooperation with the National Marine Fisheries Service. 296 p.
- NEFSC (2014). 59th Northeast Regional Stock Assessment Workshop (59th SAW) Assessment Report. Woods Hole, MA: U.S. Department of Commerce. NEFSC Reference Document 14-09. 782 p.
- NEFSC (2017a). 61st Northeast Regional Stock Assessment Workshop (61st SAW) Assessment Report. Woods Hole, MA: U.S. Department of Commerce. NEFSC Reference Document 17-05. 466 p. <https://www.nefsc.noaa.gov/publications/crd/crd1705/>.
- NEFSC (2017b). Operational Assessment of 19 Northeast Groundfish Stocks, updated through 2016. Woods Hole, MA: U.S. Department of Commerce. NEFSC Reference Document 17-17. 259 p.
- NEFSC (2018). 65th Northeast Regional Stock Assessment Workshop (65th SAW) Assessment Summary Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 18-08; 38 p.

Clam Dredge Framework

- NEFSC Social Sciences Branch. Woods Hole, MA: NMFS Northeast Fisheries Science Center; <http://www.nefsc.noaa.gov/read/socialsci/index.html>.
- NMFS (2015a). Endangered Species Act Section 4(b)2 Report: Critical Habitat for the North Atlantic Right Whale (*Eubalaena glacialis*) <https://www.fisheries.noaa.gov/webdam/download/78140281>.
- NMFS (2015b). North Atlantic right whale (*Eubalaena glacialis*) source document for the critical habitat designation: A review of information pertaining to the definition of critical habitat. <https://repository.library.noaa.gov/view/noaa/18664/Share>.
- NMFS (2017). North Atlantic right whale 5 year review. Summary and evaluation. https://www.greateratlantic.fisheries.noaa.gov/protected/final_narw_5-year_review_2017.pdf
- NMFS Northeast Fisheries Science Center Fisheries Statistics Branch (2018). Northeast Fisheries Observer Program: Incidental Take Reports. Omnibus data request + supplemental data for 2017.
- NMFS & USFWS (2015). Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-year Review: Summary and Evaluation. National Marine Fisheries Service and United States Fish and Wildlife Service, Silver Spring, Maryland.
- NOAA (2016). Species in the Spotlight Priority Actions: 2016-2020 Atlantic Salmon (*Salmo salar*). Atlantic Salmon Five Year Action Plan.
- Norling, P. and N. Kautsky (2007). "Structural and functional effects of *Mytilus edulis* on diversity of associated species and ecosystem functioning." Mar. Ecol. Prog. Ser. 351: 163-175.
- Northwest Atlantic Leatherback Working Group (2018). Northwest Atlantic Leatherback Turtle (*Dermochelys coriacea*) Status Assessment (Bryan Wallace and Karen Eckert, Compilers and Editors). Conservation Science Partners and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). WIDECAST Technical Report No. 16. Godfrey, Illinois. 36 p.
- NPFMC. 2012. Overview of Vessel Monitoring System: Discussion Paper 312. Accessed December 14, 2018 from https://www.npfmc.org/wp-content/PDFdocuments/conservation_issues/VMSdiscussionPaper312.pdf.
- Olson J (2011). Understanding and contextualizing social impacts from the privatization of fisheries: An overview. Ocean Coast. Manag. 54: 353-363.
- Pace RM, Corkeron PJ & Kraus SD (2017). State–space mark–recapture estimates reveal a recent decline in abundance of North Atlantic right whales. Ecol. Evo. 1-12.
- Pettis HM, Pace RM & Hamilton PK (2018). North Atlantic Right Whale Consortium 2018 Annual Report Card. Report to the North Atlantic Right Whale Consortium. www.narwc.org.
- Powell, EN., Kuykendall K, and Moreno P (2016). Analysis of ancillary survey data and surfclam fishery tow data for the Georges Shoals Habitat Management Area on Georges Bank and the Great South Channel Habitat Management Area. Science Center for Marine Fisheries. 29 p.
- Powell, EN, Mann R, Kuykendall KM, Long MC, Timbs J (2018). The “East of Nantucket” Survey. Science Center for Marine Fisheries. 33 p plus appendices.
- Reid RN, Cargnelli LM, Griesbach SJ, Packer DB, Johnson DL, Zetlin CA, Morse WW & Berrien PL (1999). Essential Fish Habitat Source Document: Atlantic Herring, *Clupea harengus* L., Life History and Habitat Characteristics. Highlands, NJ: U.S. Department of Commerce.
- Ritchie TP (1977). A Comprehensive Review of the Commercial Clam Industries in the United States. Washington, DC: USDo Commerce. DEL-SG-26-76. 106 p. <https://ia802601.us.archive.org/5/items/comprehensiverev00ritc/comprehensiverev00ritc.pdf>.
- Seminoff JA, Allen CD, Balazs GH, Dutton PH, Eguchi T, Hass HL, Hargrove SA, Jensen M, Klemm DL, Lauritsen AM, MacPherson SL, Opay P, Possardt EE, Pultz S, Seney E, Van Houtan KS & Waples RS (2015). Status review of the green turtle (*Chelonia mydas*) under the Endangered Species Act. Southwest Fisheries Science

Clam Dredge Framework

Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-539, Miami, Florida.

Steves BP & Cowen RK (2000). Settlement, Growth, and Movement of Silver Hake *Merluccius bilinearis* in Nursery Habitat on the New York Bight Continental Shelf. Mar. Ecol. Prog. Ser. 196: 279-290.

Sullivan MC & Cowen RK (2006). Applying the Basin Model: Assessing Habitat Suitability of Young-of-the-Year Demersal Fishes on the New York Bight Continental Shelf. Cont. Shelf Res. 26(14): 1551-1570.

Tupper M & Boutilier RG (1995). Effects of Habitat on Settlement, Growth, and Postsettlement Survival of Atlantic Cod (*Gadus morhua*). Can. J. Fisheries Aq. Sci. 52(9): 1834-1841.

U.S. Census 2012-2016 American Community Survey;
<http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml>.

USFWS & NMFS (2018). Recovery plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*). 74 p.