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MEMORANDUM

DATE: May 16, 2018

TO: Habitat Committee

FROM: Habitat Plan Development Team

SUBJECT: **Preliminary assessment of alternatives for clam framework**

This memo addresses Committee tasking from April 26, 2018 on alternatives development in the clam dredge framework. The information presented here was discussed during a Plan Development Team (PDT) conference call on May 11, as well as at earlier meetings, including during the development of Omnibus Essential Fish Habitat Amendment 2 (OHA2). An April 24, 2018 memo from the PDT to the Committee provides context and background for the discussion below. The two documents should be reviewed together.

1. *Analysis of sections of the Great South Channel HMA based on habitat and fishery attributes*

Committee tasking

For each of the following tasks, the PDT is providing an analysis of the frequency of encountering complex habitat and the recent surfclam revenue generated from the areas.

Quadrants: For exploratory purposes, the PDT had divided the portion of the Great South Channel Habitat Management Area (HMA) outside the mobile bottom-tending gear (MBTG) closure into four equal area quadrants (northwest, northeast, southwest, and southeast; Map 1). The Committee requested an analysis of these quadrants.

Clam Industry/Habitat AP Members Proposal: On April 3, 2018 members of the Habitat Advisory Panel (AP; no meeting quorum) recommended a specific set of areas to be closed to hydraulic dredging (Map 2). The area along the southern boundary of the HMA is a rectangle that extends from the southeastern corner of the HMA north to 40° 56’ N and west to 69° 40’ W. The other section is bounded by the eastern edge of the HMA. The western boundary of this area begins at 41° 15’ N, 69° 27.5’ W, and runs southeast parallel to the HMA boundary until it reaches 41° N, 69° 21’ W, and then extends south to 40° 56’ N, 69° 21’ W. This alternative also includes the MBTG closure. The Committee requested an analysis of this proposal.

MFMGA proposal: The Committee requested that the PDT develop an alternative based on a map of cobble- and boulder-dominated habitats enclosed with a letter from Massachusetts Fishermen’s Mobile Gear Alliance (MFMGA; Map 3). John Verissimo of the MFMGA

communicated that the colored areas on the map were drawn by surfclam fishermen. The blue areas on the MFMGA map correspond closely with the black areas on Map 4, the four largest contiguous areas of cobble-boulder dominated substrate based on the SASI[1] Voronoi substrate mapping, generated by the PDT in 2013. These areas were drawn by taking the SASI base grid dominant sediment map, dissolving the cobble and boulder Voronoi polygons together to create a cobble-boulder polygon layer, then calculating the area of the cobble-boulder polygons, and finally ranking them by area. The four largest were selected from this and are highlighted on Map 4. The similar set of areas on Map 5 in yellow-gold coloration are clusters of gravel sediments identified by Harris and Stokesbury (2010), using the subset of the data collected with the SMAST drop camera survey. Responding to the Committee's tasking, the PDT drew regularly shaped boxes that approximate the black areas (Committee request), as well as the gold areas to create two alternative sets of areas for consideration and analysis. As with the Industry/AP member proposal, these alternatives also include the MBTG closure.

Habitat analysis

First, the PDT characterized the HMA and the various sub-areas using four habitat-related metrics. These included the total size of the area in square kilometers, the area covered by cobble or boulder-dominated habitat according to the SASI model base grid (Map 6), the area covered by depressions in the Nature Conservancy's Northwest Atlantic Marine Ecoregional Assessment layer (Map 7), and the 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 (Map 9).

Table 1 – Habitat metrics for Great South Channel HMA and various sub-areas. The seabed form/depression metric was not calculated for all areas.

Area name	Size, km^2	Area (km^2) and % area where sediment composition is cobble- or boulder-dominated	Area (km^2) and % area where the seabed form is "depression"	% obs indicating stable sediment
MBTG closure	332	98, 30%	-	81%
Possible exemption area	2,234	338, 15%	981, 44%	37%
Total Great South Channel HMA	*2,566*	*434, 17%*	-	*44%*
Northwest quad	564	97, 17%	218, 39%	42%
Northeast quad	559	123, 22%	233, 42%	46%
Southeast quad	555	69, 12%	272, 49%	30%
Southwest quad	556	41, 07%	258, 46%	32%
Total of quadrants = poss. ex. area	*2,234*	*338, 15%*	*981, 44%*	*37%*
Eastern edge	125	62, 49%	-	88%
Southeast corner	250	13, 05%	-	15%
Total Industry/AP	*375*	*74, 21%*	*212, 57%*	*40%*
Great Rip	260	73, 28%	-	50%
Fishing Rip	177	63, 35%	-	65%
Total Great and Fishing Rips	*437*	*135, 31%*	*234, 54%*	*57%*
Great Rip G*	362	99, 27%	-	56%
Fishing Rip G*	316	103, 33%	-	56%
*Total Great and Fishing Rips G**	*678*	*203, 30%*	*330, 44%*	*56%*

[1] SASI is the Swept Area Seabed Impact model, a tool developed by the PDT to evaluate the effects of fishing on EFH in space and time. Voronoi interpolation converts point data into a grid of polygons by drawing lines equidistant to each pair of points (see Map 4).

Next, for all three sets of areas (quadrants, industry/AP alternative, two sets of cobble-boulder habitat alternatives), the PDT analyzed the proportion of University of Massachusetts Dartmouth School for Marine Science and Technology drop camera survey stations meeting certain criteria. The MBTG closure was set aside for this analysis, i.e. the possible exemption area was taken as a baseline. Also, the analysis excluded stations sampled during a 2006 "Great South Channel North" fine scale survey, because this survey was directed at areas where complex habitats were likely to occur, only covering certain parts of the GSC HMA. Stations within the closed portions of a given alternative were pooled and compared to the stations within the potential exemption area but outside of the areas to be closed. Specifically, for the industry/AP alternative the eastern edge and southeastern corner areas were combined, and for the cobble-boulder alternatives the Great Rip and Fishing Rip and Great Rip G* and Fishing Rip G* areas were combined. All tests were two-tailed, and the quadrant analysis was corrected for multiple comparisons. One caveat with these analyses is that portions of the northwest and southwest quadrants are not sampled by the drop camera survey.

The first case examined was whether the proportion of stations with complex habitat (Map 10) was different between sets of areas. Complex was defined as at least one image from a station had greater than 10% gravel cover (complex) vs. none of the images having more than 10% gravel cover (not complex). Results are in Table 2. Correcting for multiple comparisons, the northeast and southwest quadrants have significantly different encounter rates for complex habitat. Other quadrants are not significantly different from one another at the $p=0.05$ level. The encounter rate of complex habitat at stations within the industry/AP alternative relative to the remainder of the potential exemption area is not significantly different. The cobble-boulder and cobble-boulder G* alternatives have a higher proportion of stations with complex habitat relative to the remainder of the potential exemption area.

Table 2 – Results of analysis of proportions, complex habitat metric. Results significant at p=0.05 level are starred and bolded.

	Areas	Stations complex	Stations not complex	Proportion complex	Results
Quadrant analysis	Northwest	19	12	0.61	NW to SE p=0.840 NW to SW p=0.840 NE to NW p=0.840 **NE to SW p=3.06e-05*** NE to SE p=0.073 SE to SW p=0.185
	Northeast	45	18	0.71	
	Southeast	25	26	0.49	
	Southwest	19	43	0.31	
Portion of HMA considered for exemptions (baseline for the following three comparisons)		*108*	*99*	*0.52*	*n/a*
Industry/AP alternative	Inside Eastern edge/SE corner	24	26	0.48	p=0.498
	Outside Eastern edge/SE corner	84	73	0.54	
Contiguous cobble-boulder dominated	Inside Fishing Rip/Great Rip	30	12	0.71	**p=0.00514***
	Outside Fishing Rip/Great Rip	78	87	0.47	
Contiguous cobble-boulder G* clusters	Inside Fishing Rip G*/Great Rip G*	41	16	0.72	**p=0.000452***
	Outside Fishing Rip G*/Great Rip G*	67	83	0.45	

The second case examined was whether the proportion of stations with long-lived epifauna was different between sets of areas (Map 10). Results are in Table 3. Correcting for multiple comparisons, the quadrants were not significantly different from one another at the p=0.05 level. The encounter rate of long-lived epifauna at stations within the industry/AP alternative as compared to the remainder of the potential exemption area is not significantly different. The cobble-boulder and cobble-boulder G* alternatives have a higher proportion of stations with long lived epifauna as compared to the remainder of the potential exemption area.

Table 3 – Results of analysis of proportions, long-lived epifauna metric. Results significant at p=0.05 level are starred and bolded.

	Areas	Stations with long-lived epifauna	Stations without long-lived epifauna	Proportion with long-lived epifauna	Results
Quadrant analysis	Northwest	18	13	0.58	NW to SE p=0.330 NW to SW p=0.129 NE to NW p=1 NE to SE p=0.330 NE to SW p=0.089 SE to SW p=1
	Northeast	35	28	0.56	
	Southeast	20	31	0.39	
	Southwest	21	41	0.34	
Portion of HMA considered for exemptions (baseline for the following three comparisons)		*94*	*113*	*0.45*	*n/a*
Industry/AP alternative	Inside Eastern edge/SE corner	21	29	0.42	p=0.578
	Outside Eastern edge/SE corner	73	84	0.46	
Contiguous cobble-boulder dominated	Inside Fishing Rip/Great Rip	26	16	0.62	**p=0.0162***
	Outside Fishing Rip/Great Rip	68	97	0.41	
Contiguous cobble-boulder G* clusters	Inside Fishing Rip G*/Great Rip G*	37	20	0.65	**p=0.000513***
	Outside Fishing Rip G*/Great Rip G*	57	93	0.38	

The third case examined whether the proportion of stations with cobble and/or boulder habitat present was different between sets of areas (Map 11). Results are in Table 4. Correcting for multiple comparisons, both the northeast and northwest quadrants are significantly different from the southwest quadrant at the p=0.05 level, and the northeast quadrant is also different from the southeast quadrant. The encounter rate of long-lived epifauna at stations within the industry/AP alternative as compared to the remainder of the potential exemption area is not significantly different. The cobble-boulder and cobble-boulder G* alternatives have a higher proportion of stations with long lived epifauna relative to the remainder of the potential exemption area.

Table 4 – Results of analysis of proportions, cobble-boulder metric. Results significant at p=0.05 level are starred and bolded.

	Areas	Stations with cobble or boulder present	Stations without cobble or boulder present	Proportion with cobble or boulder present	Results
Quadrant analysis	Northwest	15	16	0.48	NW to SE p=0.251 **NW to SW p=0.0182*** NE to NW p=0.611 **NE to SE p=0.0338*** **NE to SW p=0.000361*** SE to SW p=0.424
	Northeast	34	29	0.54	
	Southeast	15	36	0.29	
	Southwest	12	50	0.19	
Portion of HMA considered for exemptions (baseline for the following three comparisons)		*76*	*131*	*0.37*	*n/a*
Industry/AP alternative	Inside Eastern edge/SE corner	14	36	0.28	0.142
	Outside Eastern edge/SE corner	62	95	0.39	
Contiguous cobble-boulder dominated	Inside Fishing Rip/Great Rip	22	20	0.52	**0.0183***
	Outside Fishing Rip/Great Rip	54	111	0.33	
Contiguous cobble-boulder G* clusters	Inside Fishing Rip G*/Great Rip G*	33	24	0.58	**9.741e-05***
	Outside Fishing Rip G*/Great Rip G*	43	107	0.29	

Surfclam fishery analysis

To identify recent surfclam fishery activity by spatial management area, both in OHA2 and to support this framework, logbook data were interpreted spatially using a confidence interval approach (DePiper 2014). During the QA/QC process, it was noted that some Limited Access Scallop trips were self-reported into the Vessel Trip Reports (VTR) as having utilized clam dredges (GEARCODE = DRC). After consultation between MAFMC, NEFMC, GARFO, and NEFSC representatives on the PDT, a filter was applied to the data recategorizing the gear code of any trip landing greater than 600 lbs of scallops to scallop dredge (DRS). This rule was implemented after noting that a separate NEFMC assessment had identified the fact that several General Category scallop fishermen utilized clam dredges to land a portion of their quota, the specific language in regulations allowing General Category scallop fishing with alternate gear (50 CFR §648.52[2]), and the volume of vessels in the Surfclam and Ocean Quahog fishery

[2] (a) A vessel issued an IFQ scallop permit that is declared into the IFQ scallop fishery as specified in §648.10(b), or on a properly declared NE multispecies, surfclam, or ocean quahog trip (or other fishery requiring a VMS

holding incidental scallop permits. The filtered data indicate that between 2011 and 2016, $3-8 million dollars of hydraulic clam dredge revenue were generated annually within the portion of the Great South Channel HMA where exemptions are under consideration, with the clear majority from surfclams (Figure 1). Most of the areas under consideration do not have species revenue compositions (surfclams vs. other species) substantially different than the full Great South Channel HMA (Figure 1). Annually, revenue from the HMA amounts to between 10-28% of total surfclam revenue coastwide. Map 12 (all years combined) and Map 13 (each year individually) depict the distribution of revenue relative to the different sections of the HMA evaluated here.

Permits and owners by area: During 2011-2016, the entire HMA was fished by 11-21 vessels per year during 423-986 trips (Table 5). Note that the analysis assumes each trip has a circular footprint vs. attributing all landings to the point in space reported on the logbook. Thus, portions of any given trip may occur outside a particular management area. For this reason, the number of overlapping trips is only reported for the entire HMA.

Table 5 – Table identifying the number of unique permits and owner groups within each region. Note: Ownership groups are defined consistent with the Regulatory Flexibility Act guidelines.

Year	Zone	Permits	Owners	Year	Zone	Permits	Owners
2012	Fishery Proposed Alternative	5		2011	Great Rip G Star	9	
2013	Fishery Proposed Alternative	8		2012	Great Rip G Star	14	
2014	Fishery Proposed Alternative	8	7	2013	Great Rip G Star	15	
2015	Fishery Proposed Alternative	7	6	2014	Great Rip G Star	19	16
2016	Fishery Proposed Alternative	7	5	2015	Great Rip G Star	15	12
2011	Fishing Rip	5		2016	Great Rip G Star	17	13
2012	Fishing Rip	10		2011	Great South Channel HMA	10	
2013	Fishing Rip	13		2012	Great South Channel HMA	18	
2014	Fishing Rip	15	13	2013	Great South Channel HMA	19	
2015	Fishing Rip	11	9	2014	Great South Channel HMA	19	16
2016	Fishing Rip	16	12	2015	Great South Channel HMA	15	12
2011	Fishing Rip G Star	5		2016	Great South Channel HMA	17	13
2012	Fishing Rip G Star	11		2011	MBTG Closure	9	
2013	Fishing Rip G Star	13		2012	MBTG Closure	14	
2014	Fishing Rip G Star	15	13	2013	MBTG Closure	15	
2015	Fishing Rip G Star	11	9	2014	MBTG Closure	18	15
2016	Fishing Rip G Star	16	12	2015	MBTG Closure	15	12
2011	Great Rip	9		2016	MBTG Closure	16	13
2012	Great Rip	14		2011	Possible Exemption Area	10	
2013	Great Rip	15		2012	Possible Exemption Area	18	
2014	Great Rip	19	16	2013	Possible Exemption Area	19	
2015	Great Rip	15	12	2014	Possible Exemption Area	19	16
2016	Great Rip	17	13	2015	Possible Exemption Area	15	12
				2016	Possible Exemption Area	17	13

declaration) and not fishing in a scallop access area, unless as specified in paragraph (g) of this section or exempted under the state waters exemption program described in §648.54, may not possess or land, per trip, more than 600 lb (272.2 kg) of shucked scallops, or possess more than 75 bu (26.4 hL) of in-shell scallops shoreward of the VMS Demarcation Line. Such a vessel may land scallops only once in any calendar day. Such a vessel may possess up to 100 bu (35.2 hL) of in-shell scallops seaward of the VMS Demarcation Line on a properly declared IFQ scallop trip, or on a properly declared NE multispecies, surfclam, or ocean quahog trip, or other fishery requiring a VMS declaration, and not fishing in a scallop access area.

Revenue from quadrats: The northwest and northeast quadrants generated the most revenue by the fishery over 2011-2016 (Figure 2, Table 6). However, the southwestern corner (65% of the southwest quadrant and 5% of the southeast quadrant) was closed to clam dredging between 2004 and 2018 due to the Nantucket Lightship Habitat Closure Area (recently removed), so it is possible that additional revenue would have been generated in these quadrants had the habitat closure not been in place. This area can be fished as of April 9, 2018; however clam logbook data generated since implementation of OHA2 is incomplete and has not been evaluated.

Table 6 – Revenue by quadrant compared to the total possible exemption area revenue (total is excluding MBTG closure in northeast corner of GSC HMA). Upper panel in dollars, lower panel in percent.

	2011	2012	2013	2014	2015	2016
Northwest	2,045,788	4,183,629	3,890,568	4,729,522	4,310,324	2,917,869
Northeast	230,316	1,242,199	2,590,253	2,156,802	1,924,386	2,109,060
Southeast	18,728	262,554	799,211	324,840	272,543	318,326
Southwest	549,310	397,273	551,750	656,312	486,748	453,979
Possible Exemption Area	2,844,554	6,086,913	7,833,745	7,868,135	6,932,118	5,595,577
Northwest	72%	69%	50%	60%	62%	52%
Northeast	8%	20%	33%	27%	28%	38%
Southeast	1%	4%	10%	4%	4%	6%
Southwest	19%	7%	7%	8%	7%	8%
Possible Exemption Area	100%	100%	100%	100%	100%	100%

Revenue from clam industry/AP areas: Table 7 compares total revenue generated from clam dredges within the industry/AP areas against the total revenue generated from the possible exemption area. A very small percentage of the total clam dredge revenue from the possible exemption area is estimated to occur within the industry/AP proposed area, between 0.1% (2012) and 0.8% (2016). Note that for the industry/AP alternative, 2011 results were suppressed due to data confidentiality issues.

Revenue from cobble-boulder areas: Table 7 compares clam dredge revenue within the cobble-boulder areas against the total generated from the possible exemption area. The revenue estimates for the two sets of cobble-boulder areas (Great Rip + Fishing Rip) and (Great Rip G* + Fishing Rip G*) are similar, because the former areas are a subset of the G* areas. The differences between the areas are not a fixed proportion across years, which indicates spatial differences in fishing patterns across the two sets of areas over time. A substantial portion of the total revenue estimated from the possible exemption area falls within these alternatives. In both alternatives, most of the revenue is generated within the Great Rip area. Great Rip and Fishing Rip areas combined comprise between 35% (2013) and 51% (2012) of all the revenue generated within the possible exemption area. The combined G* Great Rip and Fishing Rip areas are estimated to generate a slightly higher proportions, between 44% (2013) and 58% (2012).

Table 7 – Revenue generated from the industry/AP and cobble-boulder areas compared to the total possible exemption area revenue (total is excluding MBTG closure).

Year			Industry/AP	Possible Exemption Area	Percent
2011			*Suppressed*	$2,844,554	-
2012			$18,487	$6,086,913	0%
2013			$63,781	$7,833,745	1%
2014			$34,969	$7,868,135	0%
2015			$24,980	$6,932,118	0%
2016			$7,226	$5,595,577	0%
Year	**Great Rip**	**Fishing Rip**	**Total**	**Possible Exemption Area**	**Percent**
2011	$1,146,656	$8,596	$1,155,252	$2,844,554	41%
2012	$3,035,040	$70,198	$3,105,238	$6,086,913	51%
2013	$2,465,168	$315,212	$2,780,380	$7,833,745	35%
2014	$2,923,249	$244,790	$3,168,039	$7,868,135	40%
2015	$2,842,041	$166,236	$3,008,277	$6,932,118	43%
2016	$1,708,585	$901,912	$2,610,497	$5,595,577	47%
Year	**Great Rip G***	**Fishing Rip G***	**Total**	**Possible Exemption Area**	**Percent**
2011	$1,485,679	$11,882	$1,497,561	$2,844,554	53%
2012	$3,428,051	$124,945	$3,552,996	$6,086,913	58%
2013	$2,883,282	$549,262	$3,432,544	$7,833,745	44%
2014	$3,522,762	$404,455	$3,927,218	$7,868,135	50%
2015	$3,275,009	$267,174	$3,542,183	$6,932,118	51%
2016	$2,068,006	$1,067,702	$3,135,708	$5,595,577	56%

Dependence on areas: Revenue at the permit (vessel) and owner level within potential closure areas was compared to all surfclam revenue attributed to that permit or owner to assess dependence on the management area. Median percent revenues to individual permits range from below 20% in 2011 to over 80% in 2014, with 2013, 2015, and 2016 values falling between 60-70% (upper left panel in Figure 3). Median percent revenue to owner was around 60% in 2014, and around 20% in 2015 and 2016 (upper left panel in Figure 4). Although interannual variation exists, there appears to be a high level of dependence on the HMA at both the owner and permit levels.

For permits fishing in the Great Rip, Fishing Rip, Great Rip G*, and Fishing Rip G*, a substantial portion of that permit's revenue is generated from the area of interest, while the dependence on the industry/AP alternative area is much lower (Figure 3). There is, however, substantial interannual variability with respect to that dependence. In addition, it seems that the fishery is moving eastward across time, with dependence on the Fishing Rip and Fishing Rip G* areas very low in 2011 and 2012, increasing moderately from 2013 to 2015, and spiking much higher in 2016. Although this shift is consistent with industry comments, additional data will be necessary to assess whether this is a true trend. There are similar dependence trends for ownership entities across areas, although the magnitude tends to be lower than at the permit level (Figure 4).

Fishing communities: Although the logbook analysis has some degree of error, it suggests that the fishing communities that may be impacted by hydraulic dredge restrictions in the GSC HMA are primarily located in Massachusetts, with lesser activity attributed to a few confidential states (Table 8). Revenue from hydraulic dredge fishing in 2011-2016 in the entire HMA is attributed to 12 ports and 40 permits, and 99.9% of this revenue to ports in Massachusetts. New Bedford (32 permits), Barnstable County (17 permits), and Fairhaven (8 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.

For the quadrants, the clam industry/Habitat AP members proposed areas, and the cobble-boulder dominated areas, revenue is attributed to each of these three ports in approximately the same proportions as the revenue from the entire GSC HMA.

Table 8 - Landings revenue to states and ports attributed to hydraulic dredge fishing within the GSC HMA, 2011-2016.

State/Port	Landings Revenue 2011-2016		Total Permits, 2011-2016[a]
	Total $	Average $	
Massachusetts	$39M	$6.5M	40
Barnstable County	$13.4M	$2.2M	17
Fairhaven	$6.7M	$1.1M	8
New Bedford	$19.0M	$3.2M	32
Other[b]	$30K	$6.5K	4
Total	**$39M**	**$6.5M**	**40**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: Surfclam logbook analysis.

Comparison of habitat and fishery revenue metrics

Table 9 summarizes the habitat and fishing revenue analyses for each area.

Table 9 – Summary of habitat and fishing revenue analyses

Area	Habitat characteristics	Fishery characterization
Northwest quadrant	Larger proportion of stations with complex or cobble-boulder habitat vs. SW quad.	Largest amount of clam dredge revenue estimated to come from this area.
Northeast quadrant	Larger proportion of complex habitat vs. SW quad. Larger proportion of stations with cobble-boulder habitat vs. SE and SW quads.	Second largest amount of clam dredge revenue estimated to come from this area.
Southeast quadrant	Smaller proportion of cobble-boulder habitat vs. NE quad.	Lesser amounts of clam dredge revenue estimated to come from this area.
Southwest quadrant	Smaller proportion of complex or cobble-boulder habitats vs. NW and NW/NE quads, respectively.	Lesser amounts of clam dredge revenue estimated to come from this area. Most of this quadrant closed as part of NLCA habitat area until recently.

Area	Habitat characteristics	Fishery characterization
Industry/AP closure area - eastern edge and southeast corner	Not significantly different from remainder of exemption area in terms of proportion of stations with complex habitat, long-lived epifauna, or cobble-boulder habitat. Eastern edge area has a high percentage of cobble-boulder and stable habitat.	Low amounts of clam dredge revenue estimated to come from this area (<?65K/year).
Fishing Rip and Great Rip cobble boulder areas	Significantly larger proportion of stations with complex habitat, long-lived epifauna, or cobble-boulder habitat as compared to remainder of exemption area.	35-51% of clam dredge revenues from potential exemption area from these two areas combined. Shift towards Fishing Rip Area over time.
Fishing Rip and Great Rip cobble boulder areas (G* versions)	Significantly larger proportion of stations with complex habitat, long-lived epifauna, or cobble-boulder habitat as compared to remainder of exemption area.	44-58% of clam dredge revenues from potential exemption area from these two areas combined. Shift towards Fishing Rip Area over time.

2. *Evaluation of a rotational management approach for the Great South Channel HMA*

Committee tasking

The PDT conducted an initial evaluation of a rotational management approach for Atlantic surfclam dredging in the Great South Channel HMA, as requested by the Habitat Committee at its April 26, 2018 meeting. At that time, the Committee discussed the possibility of using a rotational approach to reduce impacts to fish habitat while allowing the surfclam fishery access to the HMA.

Overview of sea scallop rotational management programs

The PDT first considered on other fisheries in the region that are managed under rotational management: the federal and state of Maine sea scallop fisheries.

Federal fishery: In the federal fishery, the area rotation system is a comprehensive management strategy designed to maximize sea scallop yield. Different areas are opened and closed to scallop fishing on a rotational basis to protect juvenile sea scallops and direct fishing effort to area where optimum harvest conditions occur. Three types of areas are used as part of the rotational management system:

- Open areas where scallop fishing can occur using Days at Sea (DAS) or Individual Fishing Quota (IFQ);
- Access areas that are open periodically to restricted levels of scallop fishing. When scallop vessels are fishing in these areas, they are limited in terms of total removal and sometimes season; and
- Temporary closed areas that are used to protect small scallops until a future date.

Although some access area fishing occurred within the Georges Bank groundfish closures as early as 1999, Amendment 10 to the Scallop Fishery Management Plan (2004) formally established the rotational program including criteria for opening and closing areas. Under the program, areas that contain beds of small scallops are closed before they are subjected to fishing mortality, and then re-opened when scallops are larger to produce a higher yield-per-recruit. In general, this takes approximately 3 years, however specific metrics that are observed in resource surveys are used to open and close areas. Generally, an area would close when large numbers of 2-year-old scallops are observed in surveys. The Scallop Area Management Simulator (SAMS) model is used to forecast yield and thus to help determine when areas should be reopened. While Amendment 10 established the criteria for management under this system, framework adjustments are used to implement the changes to these access areas (i.e., opening/closing areas, adjusting closed/access area boundaries, setting trip limits and numbers of trips).

Funded partly through the Research Set-Aside program, intensive survey work is generally done in access areas, often including dredge survey, drop camera survey, and a towed camera survey (HabCam). Despite multiple surveys, there remain cases where projected yields do not materialize. For example, the Elephant Trunk access area experienced slower than expected growth between 2016 and 2017.

Importantly, Amendment 10 also designated essential fish habitat (EFH) closed areas to minimize adverse effects on EFH due to scallop fishing activities. These EFH closures (i.e., habitat management areas) were updated via OHA2 (2018). No vessel may fish for or land scallops from these closed areas intended to protect habitat. While the Council recommended a HMA on the northern edge of Georges Bank where rotational scallop dredging would have been allowed, it was not approved by NMFS.

State fishery: The state of Maine sea scallop fishery rotational system is designed to maximize yield. Under the rotational program (2012), different areas are opened to scallop fishing cyclically. Closures and resource assessments to support the rotational program began in 2007/2008. There were six multi-year closures, the fishery was transitioned to limited entry, drag ring size was increased to 4”, possession limits were established, and season length was decreased.

Sea scallop management in Maine state waters is divided into three zones, two of which (Zones 1 and 3) are managed with limited access and targeted conservation closures. Zone 2 is under rotational management and has 7 areas that are rotated on a 3-year cycle. This management system has resulted in 2017 being the highest landed value and meat weights on record (since 1993 and 1997, respectively).

Other considerations: Rotational management is data-intensive. Sea scallop resource assessment surveys are conducted annually and in-season. Specifically, a spring survey occurs every April to assess biomass in Zone 2, a fall pre-season survey occurs every November in Zone 3, and in-season monitoring occurs annually, on a rotating schedule to determine pre-season density of selected rotational areas in Zone 2. In-season monitoring involves weekly harvester phone checks and 1-3 days of surveys that are conducted to estimate changes in biomass to determine resource extraction levels. A 30-40% biomass removal level is used as a soft target. The Commissioner has in-season closure authority and can enact emergency regulation to prevent depletion of the resource beyond this level. There is also daily monitoring of this fishery by the Marine Patrol, who provide updates to the fishery management staff.

In summary, the state and federal sea scallop rotational management programs are predicated on specific objectives related to scallop biomass targets (yields, changes in biomass, and/or removal rates). Neither the federal or state rotational systems were established to protect habitat, nor do these rotational fisheries occur in designated habitat protection/management areas.

Data limitations to support potential rotational access

The Northeast Fisheries Science Center annually conducts resource assessment surveys for clams (i.e., surfclam and ocean quahogs) and rotates its sampling each year throughout the region. However, the survey does not (and likely will not) cover portions of the northern and western part of Great South Channel HMA. This is because the survey vessel (F/V Pursuit) is not able to conduct NOAA survey operations in water shallower than specific depths (per NOAA Corps. depth/safety requirements). During August 2017, a special research survey was conducted by SCEMFIS, on a smaller hired vessel, which provided resource information for areas in the HMA that had not be previously sampled. That research was separate from the routine, annual monitoring conducted by the NEFSC clam survey, nor is it part of another annual resource assessment program for the HMA.

Therefore, if the intent is to manage a surfclam rotational management system using biomass/resource- based metrics, the current clam survey is not designed to provide information in the areas needed to support a rotational management system that is designed to maximize and monitor the surfclam population. In addition, in areas where the survey is conducted, large strata are used to which sample stations are randomly allocated. Thus, the survey is not designed to provide fine scale information on specific areas of interest, as would be needed under a rotational management system.

Both the federal and state of Maine sea scallop rotational management systems have resource assessment surveys that allow for specific criteria/metrics for opening and closing of areas to be monitored at the spatial scale of the closed/open areas, and the ability to relate that information to the condition of the entire sea scallop stock. The NEFSC clam survey does not collect the information needed to support a rotational management system.

Life history considerations

The life history of surfclams should also be considered. While surfclams recruit to the commercial gear around 5-7 years of age, most of the surfclams landed in the commercial fishery are about 8-12 years old.[3] This means potential rotation would need to occur on much longer time scales for surfclams (5+ years) relative to scallops (~3 years), if yield and biomass metrics are desired for a rotational management system.

Rotational management for surfclams or for habitat recovery?

Rotational management in the context of sea scallops is designed to optimize scallop yield. The PDT assumes that the Committee's intent for rotational surfclam management for the GSC HMA is to rotate habitat disturbance throughout the HMA, rather than to optimize fishery yields. The information needed to evaluate a rotational habitat disturbance management program is different from that needed for a yield-based rotational program. The PDT recommends that the following

[3] https://www.nefsc.noaa.gov/sos/spsyn/iv/surfclam/index.html and http://www.fishwatch.gov

issues be addressed if the Committee wishes to further develop a rotational management program for the GSC HMA surfclam fishery.

- EFH closures/HMAs have not previously been subject to rotational fishing with mobile bottom-tending gears. Any rotational program must not compromise the purpose of these areas, which is to minimize the adverse effects of fishing on habitats within the HMAs.
- Specific criteria to monitor and to maintain the functional value of the habitats within the HMA would need to be established.
- Considering both surfclam biology and habitat recovery rates from hydraulic dredge impacts, the closure intervals in a GSC HMA surfclam rotational program would be need to be relatively lengthy, with a minimum closure period of at least 5-10 years.
- Fishing effort shifts out of the rotational closures would need to be accounted for. The PDT concluded that if vulnerable habitats are fished sequentially, overall effort would need to be capped to ensure effort reductions in one area do not result in increased impacts in another area via effort displacement. Effort caps would require monitoring and enforcement for the portions of the HMA open to fishing.
- It is not straightforward to delineate closed and exemption areas within the GSC HMA in space. Defining areas in space and time will pose additional challenges.
- As with scallops, rotational management systems require extensive and routine (often in-season) monitoring systems and enforcement. A rotational habitat disturbance management system would likewise require extensive habitat monitoring to determine how the system is performing relative to baselines.

3. Evaluation of an exemption for mussel dredges in the northwestern quadrant of the HMA

Committee tasking

The PDT conducted an initial evaluation of mussel dredge exemptions in the northwest quadrant of the Great South Channel HMA, as requested by the Habitat Committee at its April 26, 2018 meeting.

Mussel species

In our region, two mussel species are commonly found offshore in deeper water, the blue mussel, *Mytilus edulis* and the horse mussel, *Modiolus modiolus*. Blue mussels are common in shallow, nearshore waters, but can also occur on the continental shelf to depths of several hundred feet (Gosner 1978). They attach by means of byssal threads to any type of firm substrate and often form shoals or “beds”. In prime habitats, blue mussels can reach full growth within a year; elsewhere 2-5 years are needed (Gosner 1978). 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 inhabits deeper waters (to 70 meters) and most commonly occur partially 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 (Coen and Grizzle 2007). *M. modiolus* is a long-lived species, with some individuals living for 25 years or more (Coen and Grizzle 2007). While mussels are solitary vs. colonial animals, they do have a contagious distribution. Mussels provide a settlement substrate for other epifauna including hydroids, bryozoans, and sponges.

Based on a combination of drop camera survey data and hydraulic dredge survey data, mussel beds occur throughout all areas of the HMA, including in the northwest quadrant (Map 14). The northwest quadrant has the largest number of observations across these two data sets, but the significance of this observation is unknown. The spatial extent of mussel beds sampled with these surveys is not understood. In general, mussel occurrence appears to correspond with depressions in the seabed.

Mussel fishery

Blue mussels and not horse mussels are understood to be 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. This fishery was active in the 1980s, but waned during the 1990s, apparently due to storm-related effects on the beds and a large volume of imports (mussel harvester Domenic Santoro, personal communication). The lack of data for this fishery makes it difficult to say precisely when it ended or how large the fishery had been. The scope of the analysis used in the development and assessment of the OHA2 alternatives did not anticipate this lapsed fishery would reemerge, however Capt. Santoro indicated that there is renewed interest in mussel harvest on Nantucket Shoals. At present, mussel dredging in federal waters in or around the GSC HMA should be considered exploratory.

The Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area (see 50 CFR 648.80(a)(12)) was created in 1997 by Framework Adjustment 20 to the Northeast Multispecies Fishery Management Plan . 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. At present, the gear can be used in other portions of the Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area.

A permit is required to land mussels in Massachusetts, and the state collects data on fishing location associated with mussel landings. The mussel dredge fishery is growing in Massachusetts, with ex-vessel landings valued at $5.9 million, $10.3 million, and $11.6 million harvested from state waters for fishing years 2013-2015 (Melanie Griffin and Anna 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. The current state-waters fishery for mussels occurs largely out of Chatham, Massachusetts.

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. No landings of mussels from the GSC HMA were identified in the federal vessel trip report database between 2011 and 2016.

Conclusions

With the above information in mind, the PDT recommends that the Committee consider the following points should they wish to consider mussel dredge exemptions as part of this framework.

- Mussels occur throughout the HMA and appear to be associated with depressions vs. shoals. The extent of mussel beds is not known (samples from drop camera or dredge surveys can be taken as point observations).
- Mussel beds provide a substrate for other epifaunal species. Mussels and other attached epifauna provide habitat for finfish. Removal of mussels by fishing constitutes a removal of habitat features. In terms of their ability to provide shelter to fishes, individual mussels are in the size range of small to medium cobbles.
- Mussel dredge gear is different from hydraulic clam dredge gear in terms of its interactions with the seabed. The PDT is not aware of gear effects studies specific to mussel dredge gear.
- At present, there is not a fishery inside the Great South Channel HMA, but there is industry interest in fishing for mussels within this area.

4. References

Coen, L.D. and R. E. Grizzle (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.

DePiper, G. S. (2014). Statistically assessing the precision of self-reported VTR fishing locations. NOAA Technical Memorandum NMFS-NE-229: 16.

Gosner, K. L. (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.

Harris, B. P. and K. D. E. Stokesbury (2010). "The spatial structure of local surficial sediment characteristics on Georges Bank, USA." Continental Shelf Research 30: 1840-1853.

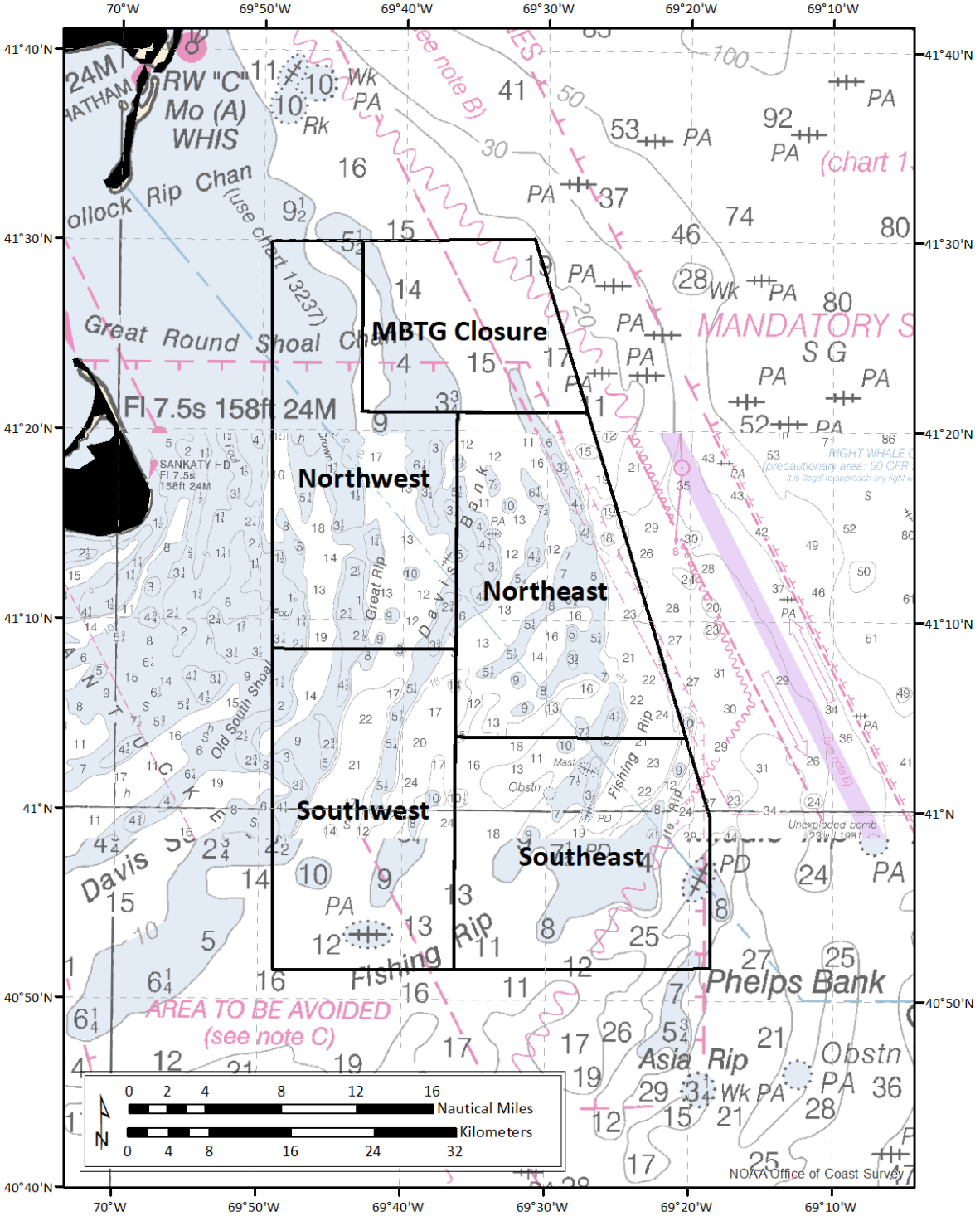
Harris, B. P., G. W. Cowles and K. D. E. Stokesbury (2012). "Surficial Sediment Stability on Georges Bank in the Great South Channel and on eastern Nantucket Shoals." Continental Shelf Research 49: 65-72.

5. Additional maps and figures

Maps

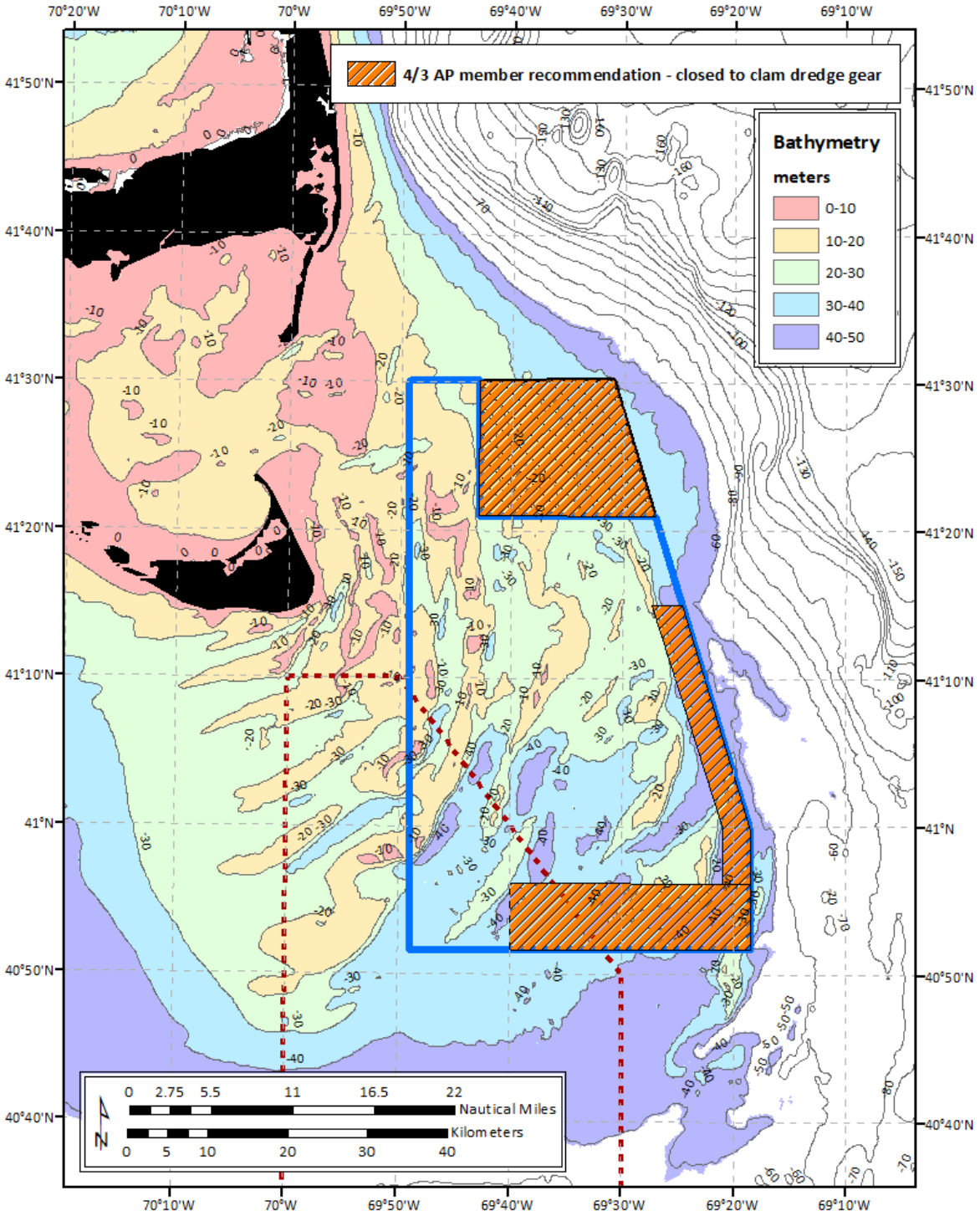
Figures

Map 1 - GSC HMA divided into quadrants for analysis.



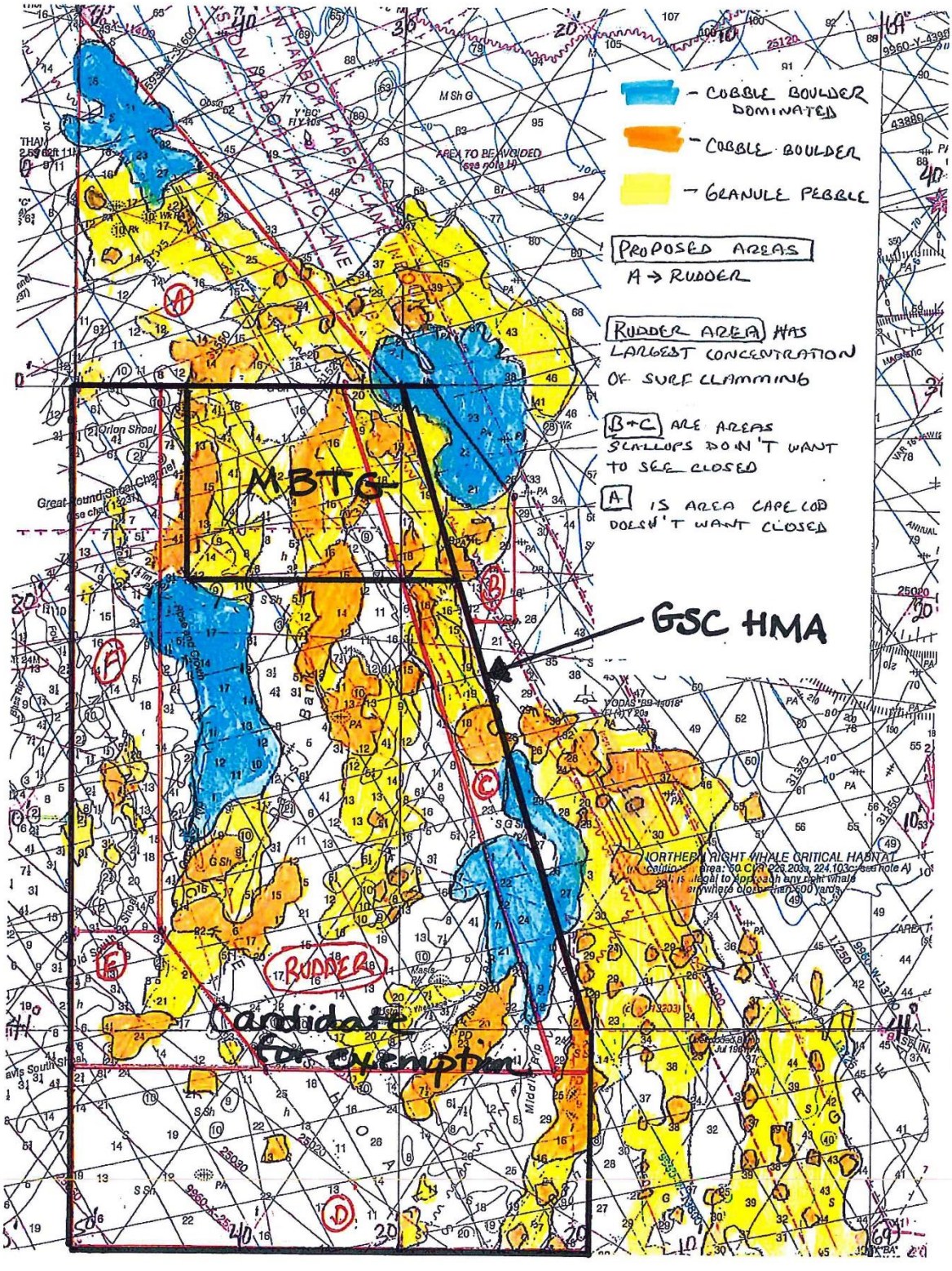
Clam Dredge Framework - Map credit: NEFMC - Date: April 2, 2018

Map 2 – Industry/Advisory Panel recommended alternative (orange hatching). Upper right area is mobile bottom tending gear closure.

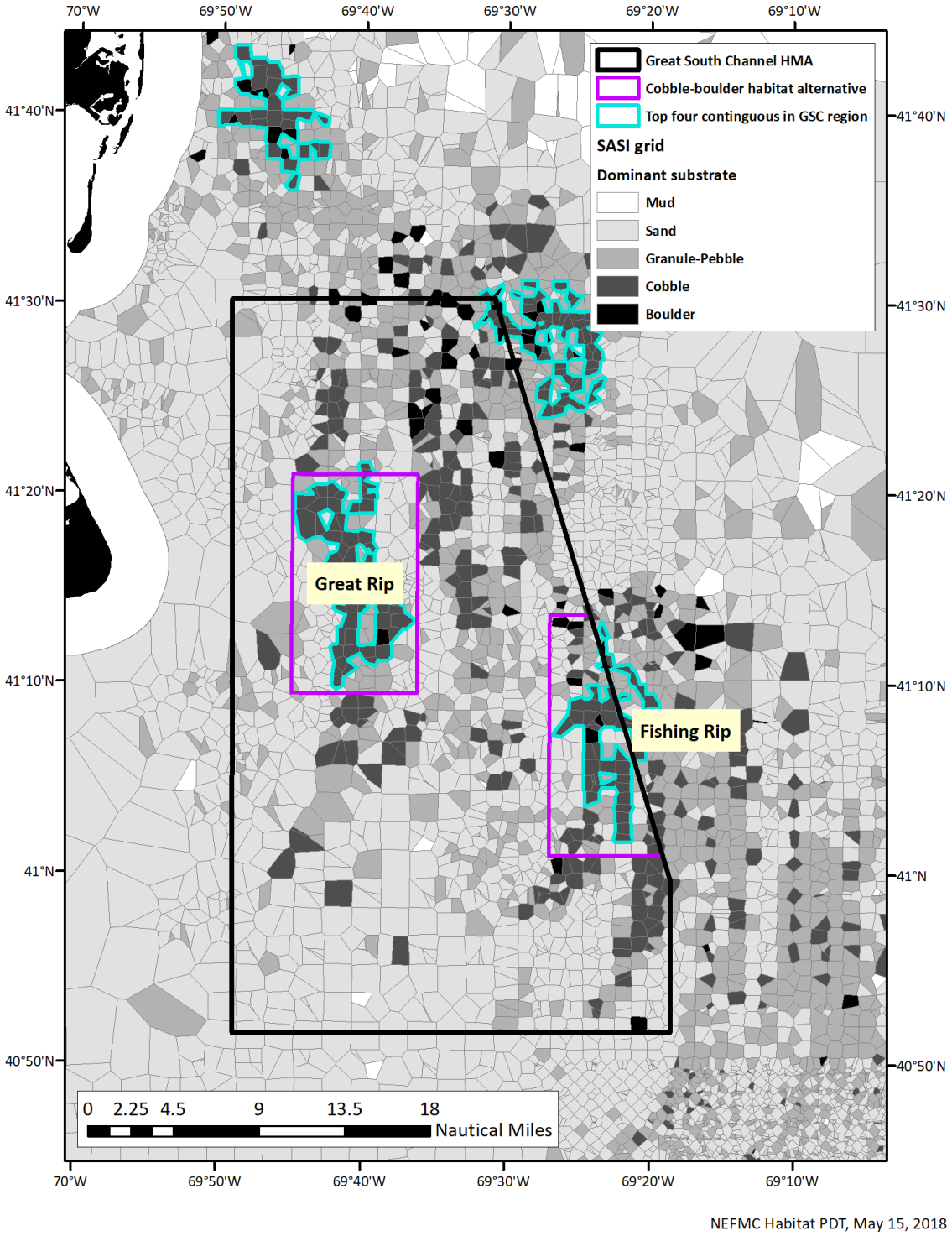


Clam Dredge Framework - Map credit: NEFMC - Date: April 6, 2018

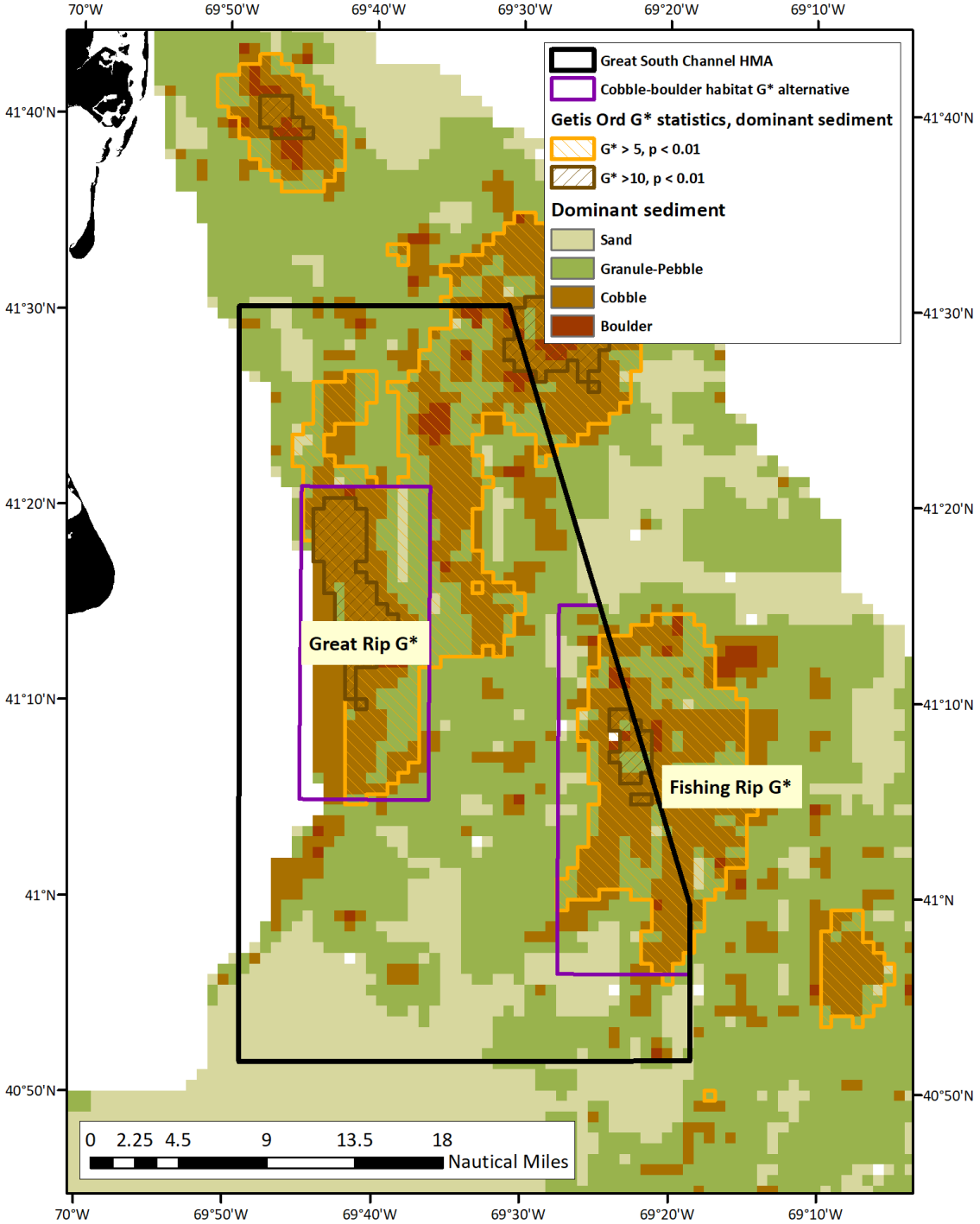
Map 3 – Figure submitted by Massachusetts Fishermen's Mobile Gear Alliance. GSC HMA including the MBTG closure section outlined in heavy black. Lettered areas were analyzed as part of the initial development of GSC HMA boundary. Areas encompassed by polygons A and B were evaluated as part of Alternative 3 (Great South Channel East) in OHA2 FEIS. MFMGA communicated that the colored polygons were identified by clam dredge fishermen.



Map 4 – Cobble-boulder alternative developed by PDT based on MFMGA chart and 2013 PDT analysis. The Great Rip and Fishing Rip areas are based on contiguous areas of cobble-boulder habitat.

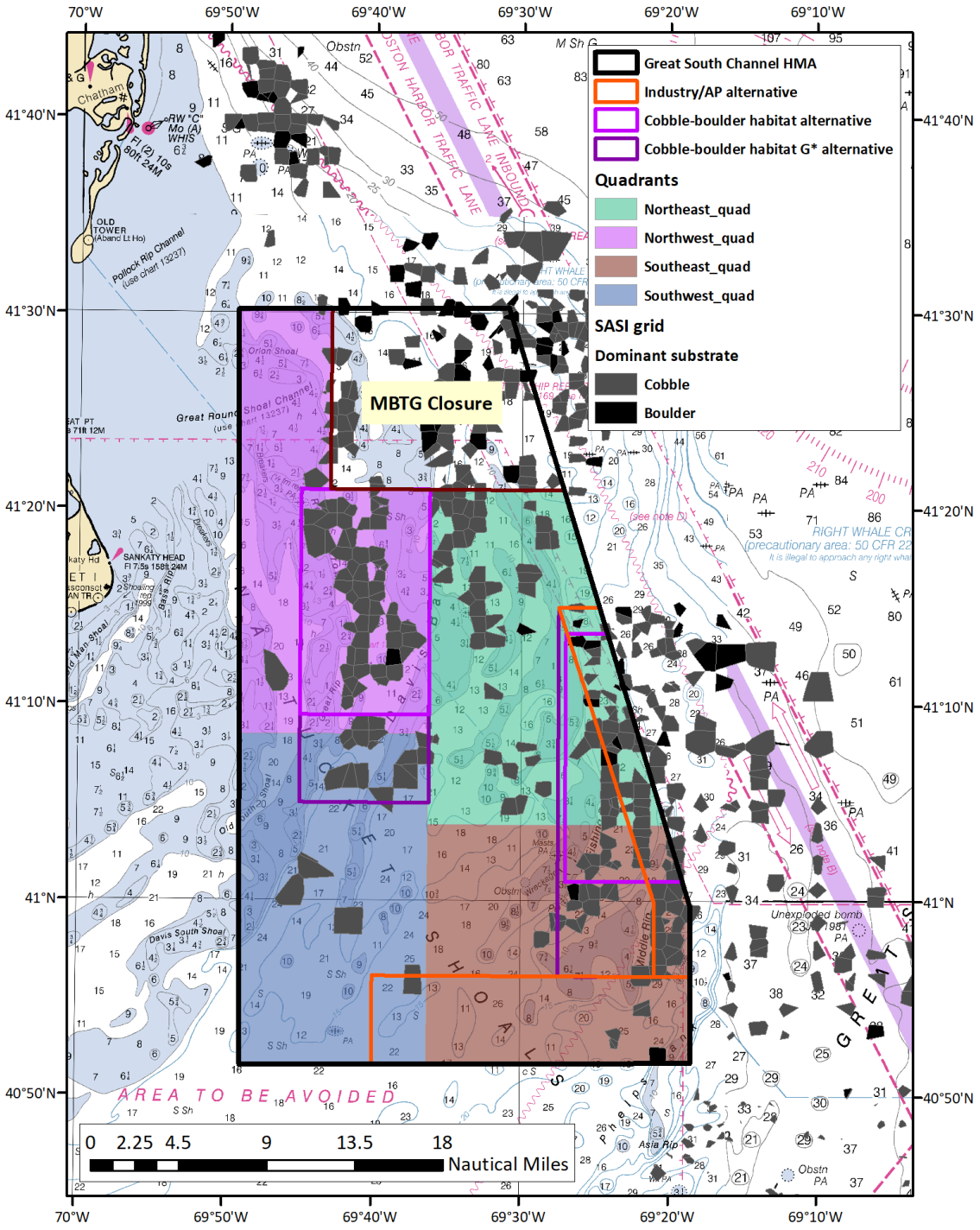


Map 5 – Cobble-boulder G* alternative based on the Harris and Stokesbury 2010 dominant sediment cluster analysis.



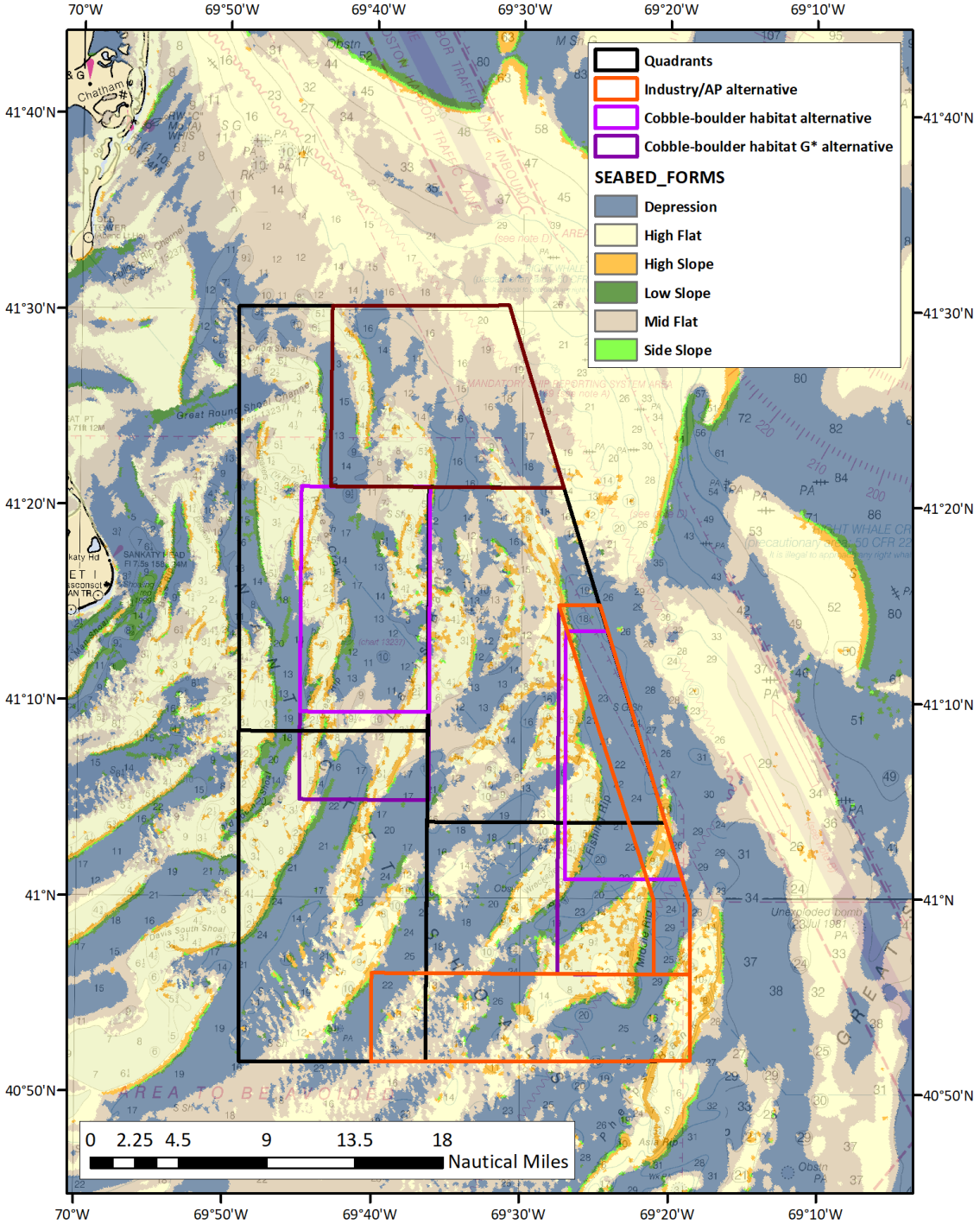
NEFMC Habitat PDT, May 15, 2018

Map 6 – Cobble- and boulder-dominated habitat polygons as defined in the SASI model base grid. MBTG closure, four quadrants, advisory panel alternative, and cobble-boulder alternatives overlaid.



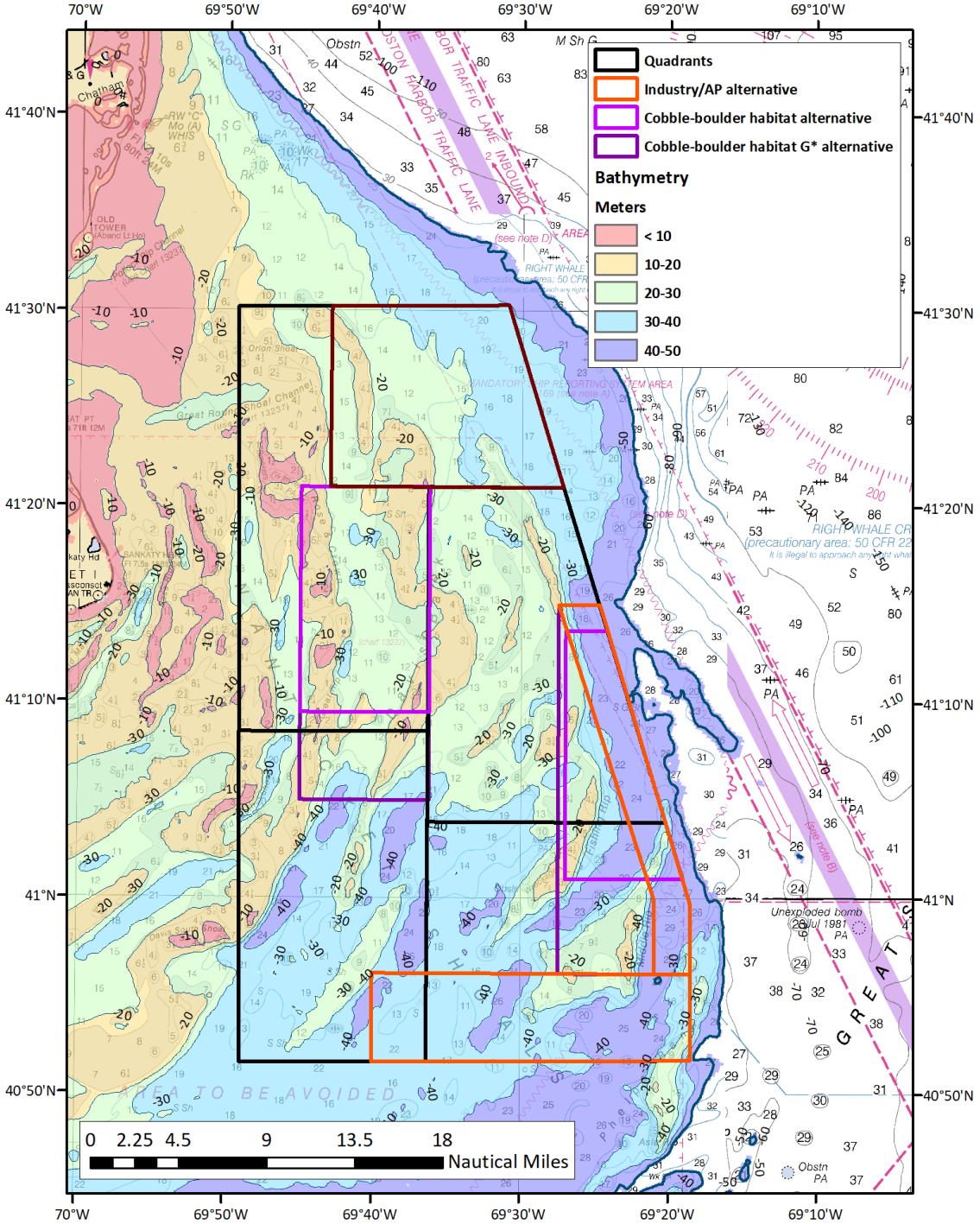
NEFMC Habitat PDT, May 15, 2018

Map 7 – Seabed forms. MBTG closure, four quadrants, advisory panel alternative, and cobble-boulder alternatives overlaid.



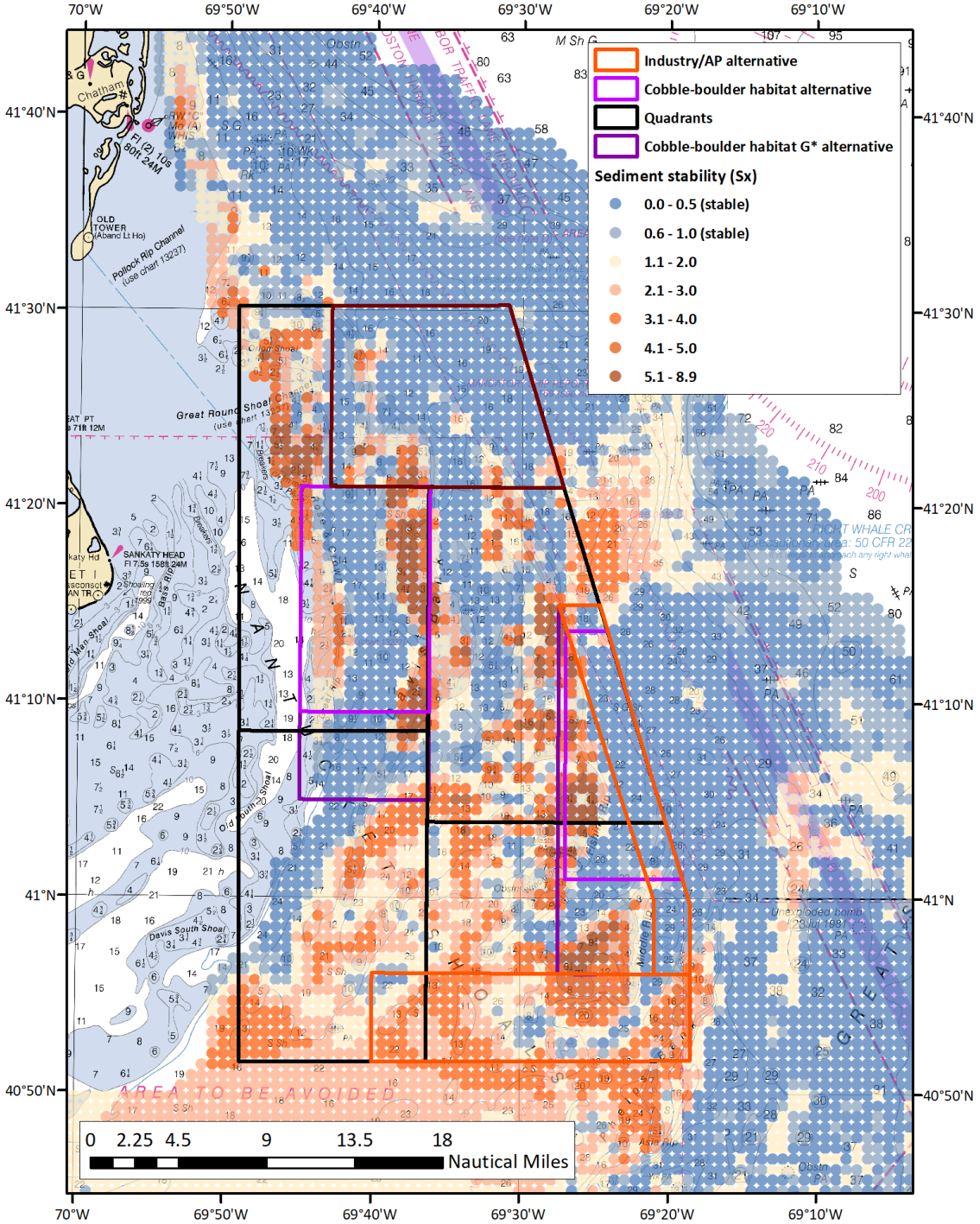
NEFMC Habitat PDT, May 15, 2018

Map 8 – Depth. MBTG closure, four quadrants, advisory panel alternative, and cobble-boulder alternatives overlaid.



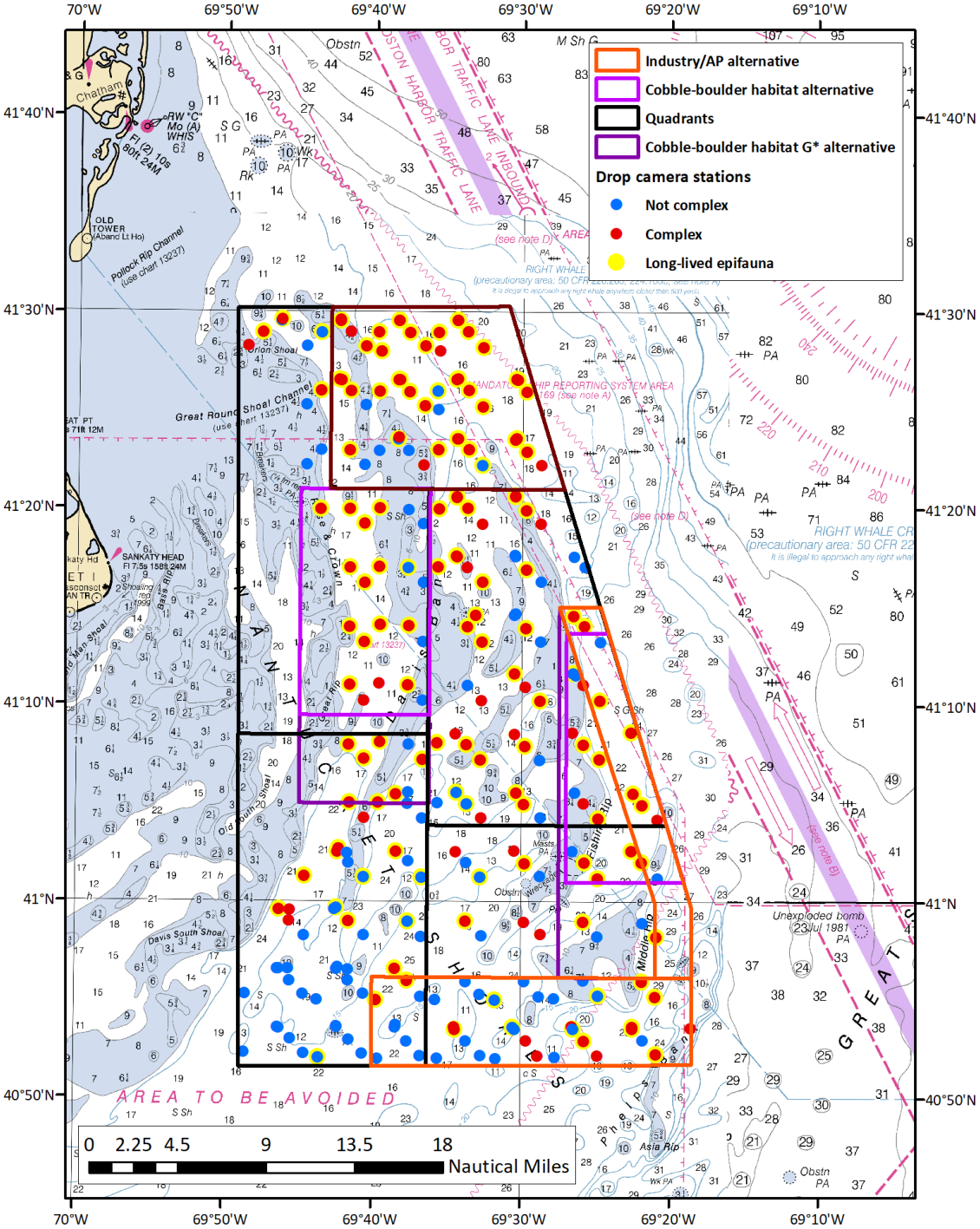
NEFMC Habitat PDT, May 15, 2018

Map 9 – Sediment stability. MBTG closure, four quadrants, advisory panel alternative, and cobble-boulder alternatives overlaid.



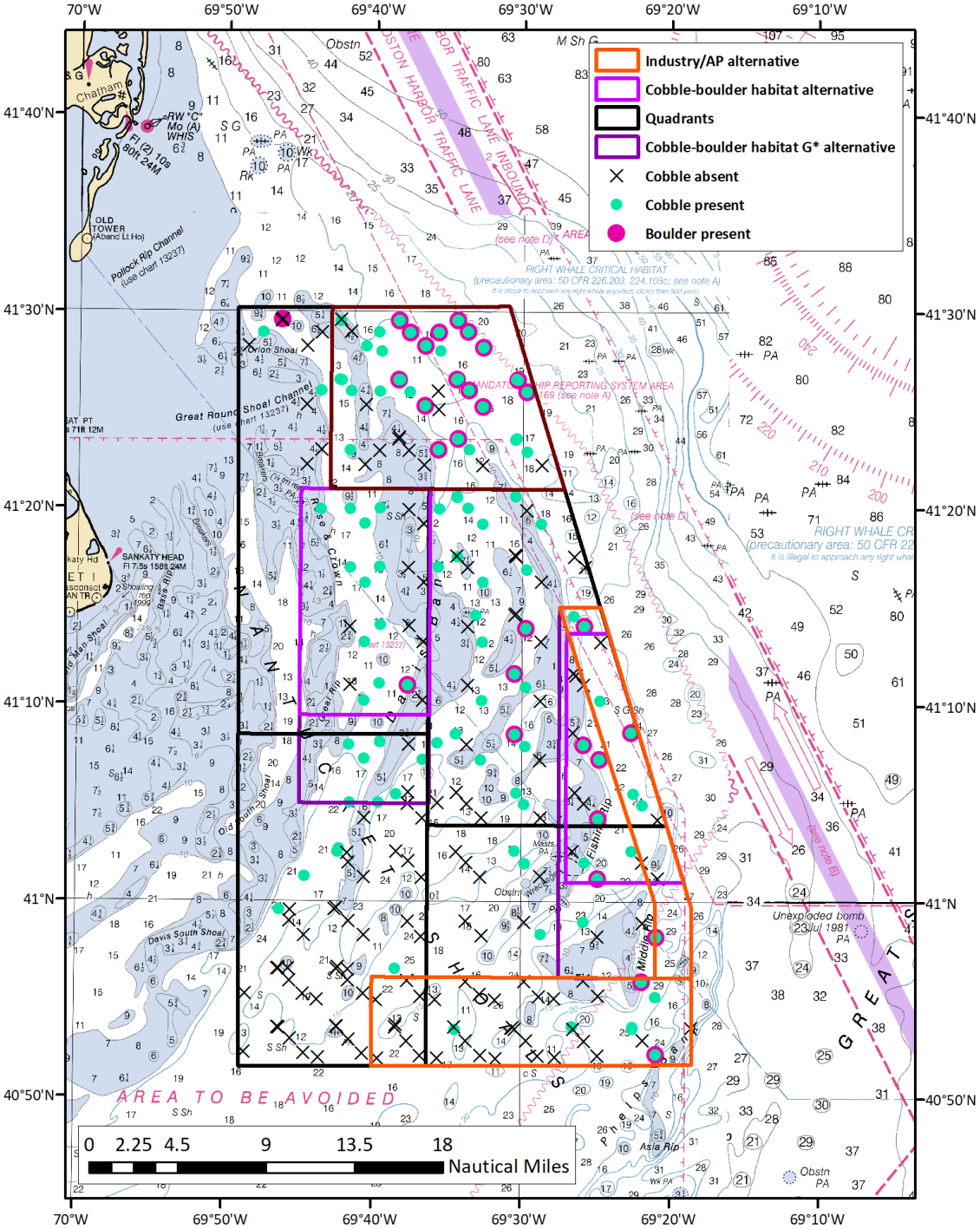
NEFMC Habitat PDT, May 15, 2018

Map 10 – Occurrence of complex habitat and long-lived epifauna. MBTG closure, four quadrants, advisory panel alternative, and cobble-boulder alternatives overlaid.



NEFMC Habitat PDT, May 15, 2018

Map 11 – Occurrence of cobble and boulder habitat. MBTG closure, four quadrants, advisory panel alternative, and cobble-boulder alternatives overlaid.



NEFMC Habitat PDT, May 15, 2018

Figure 1 – Revenue by species reported to have been harvested within the Great South Channel HMA between 2011-2016 using clam dredges.

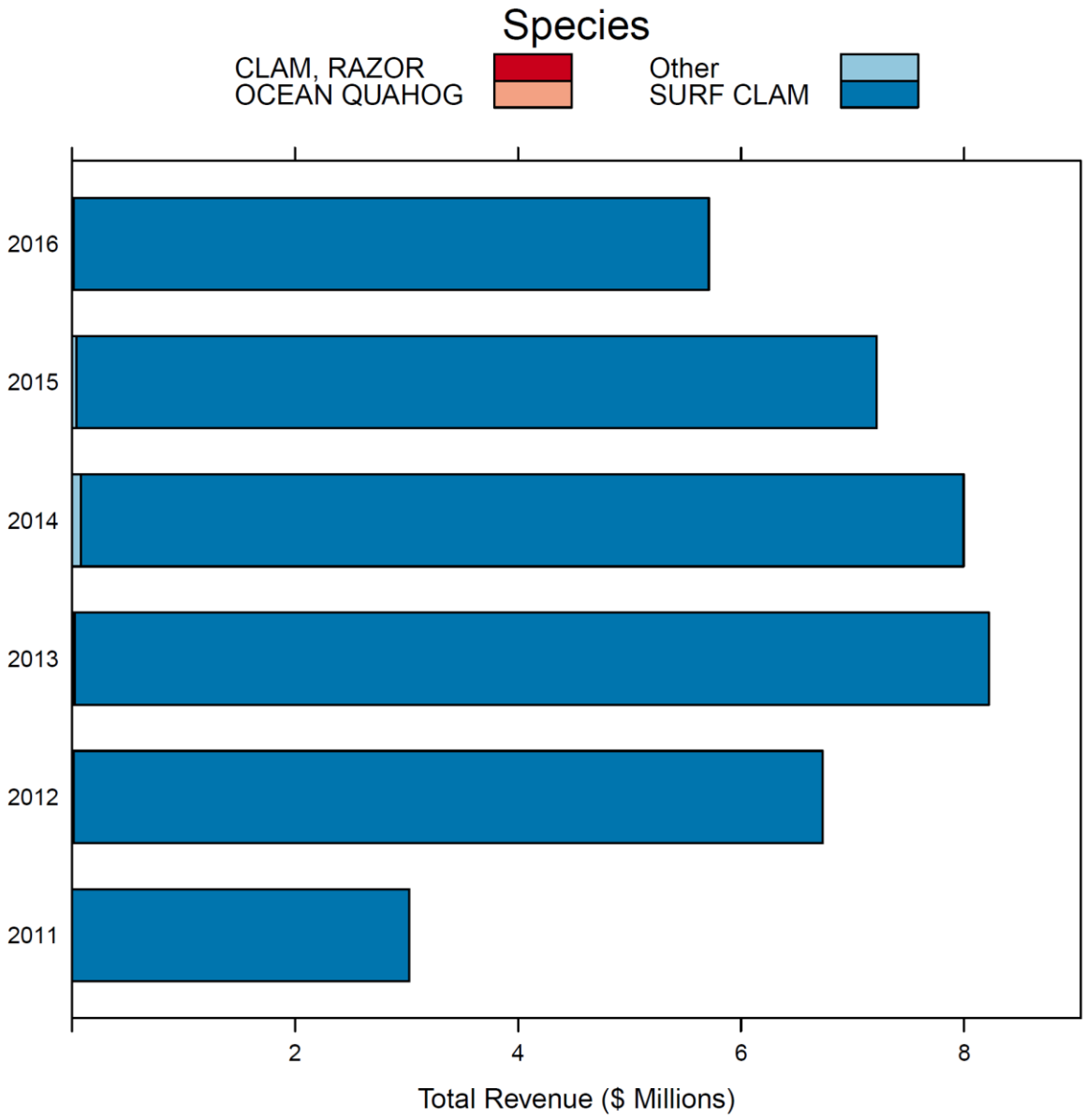
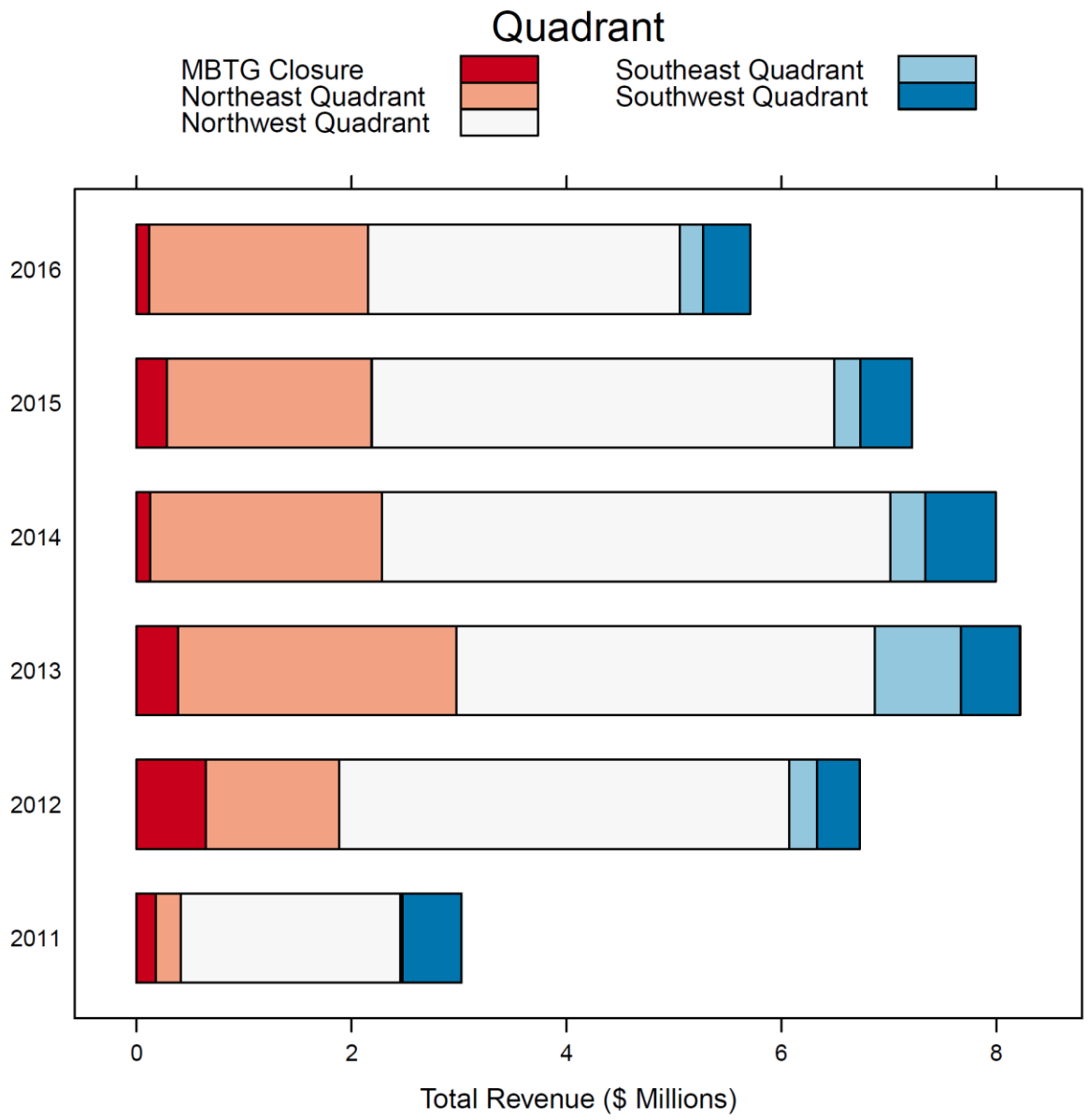
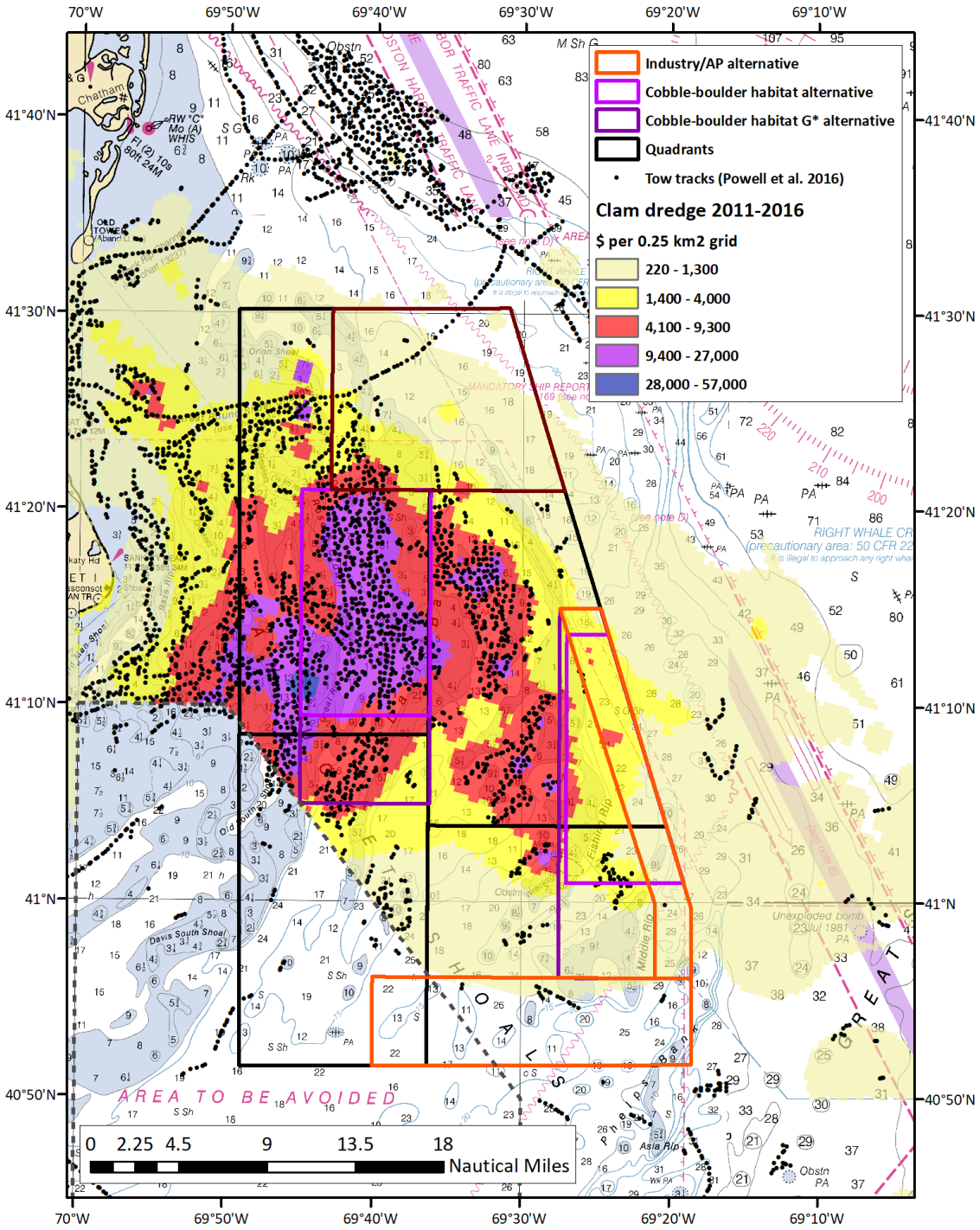


Figure 2 – Clam dredge revenue by quadrant within the Great South Channel HMA for calendar years 2011 – 2016.

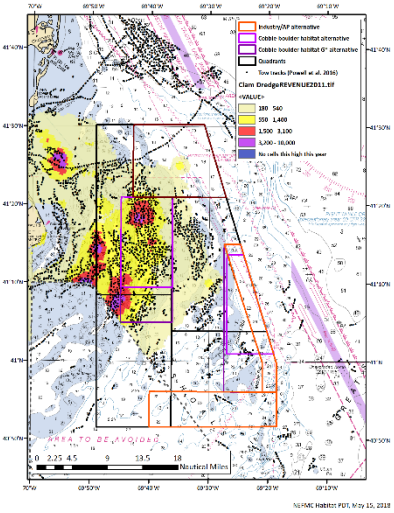


Map 12 – Fishing effort in GSC HMA 2011-2016, combined. Data from logbooks (DePiper 2014) and vessel tracks (Powell et al. 2016). MBTG closure, four quadrants, advisory panel alternative, and cobble-boulder alternatives overlaid.

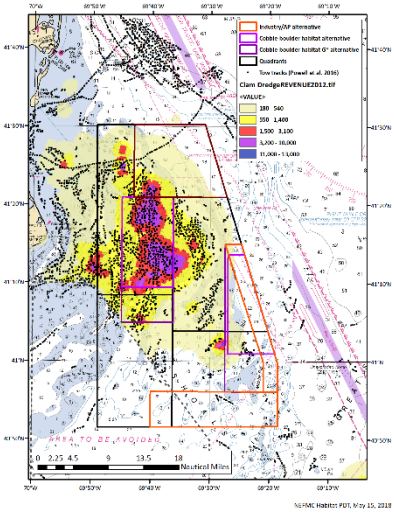


NEFMC Habitat PDT, May 15, 2018

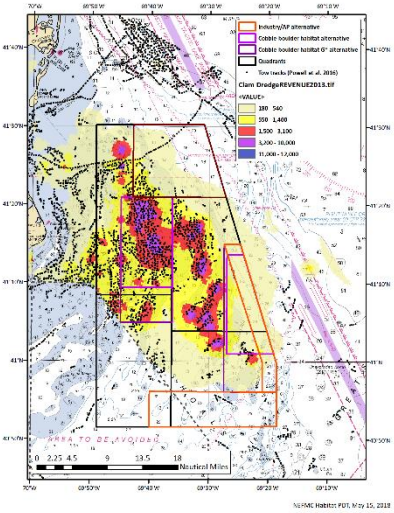
Map 13 – Fishing effort by year. Data from logbooks (DePiper 2014) and vessel tracks (Powell et al. 2016). MBTG closure, quadrants, AP alternative, and cobble-boulder alternatives overlaid.



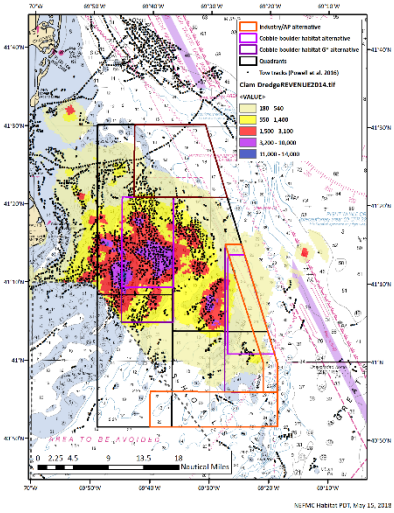
2011



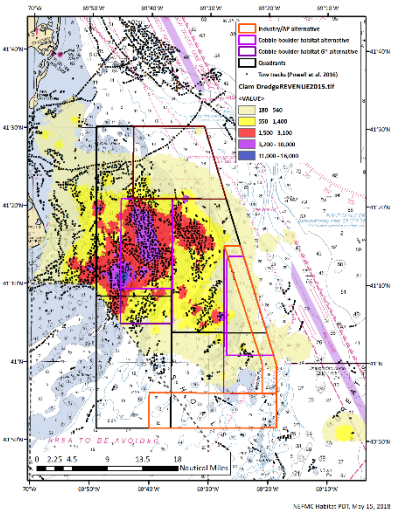
2012



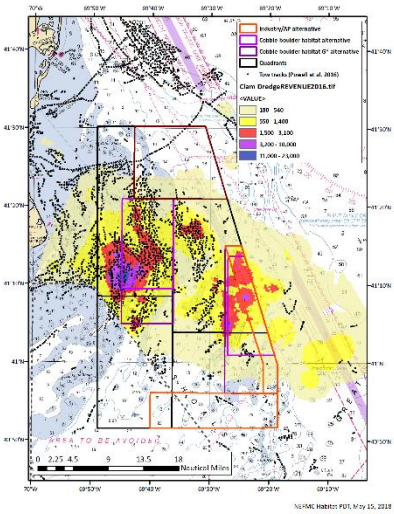
2013



2014



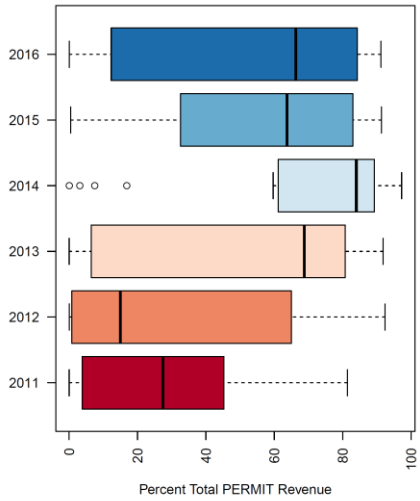
2015



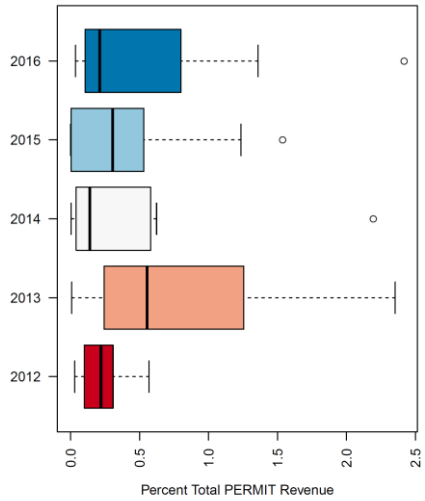
2016

Figure 3 – Percentage of a permit's total commercial revenue generated within each area or set of areas between 2014 and 2016. Note: Ownership groups defined consistent RFA guidelines.

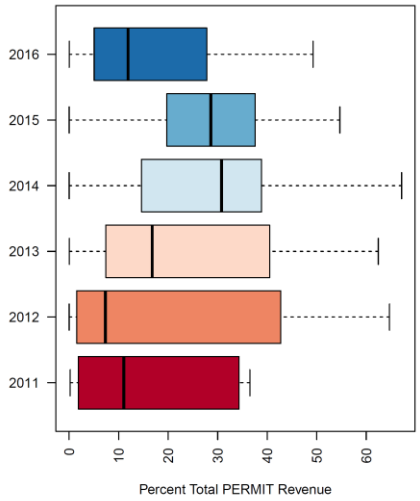
Full exemption area



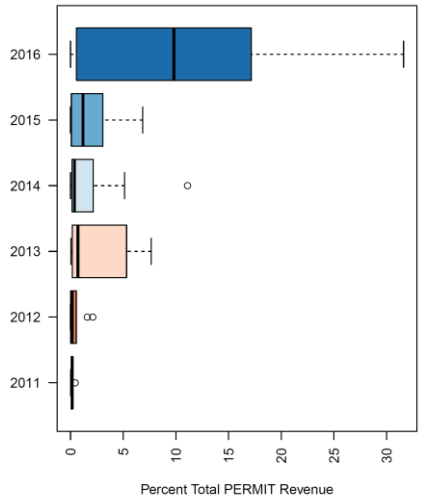
Industry/AP (two sub-areas combined)



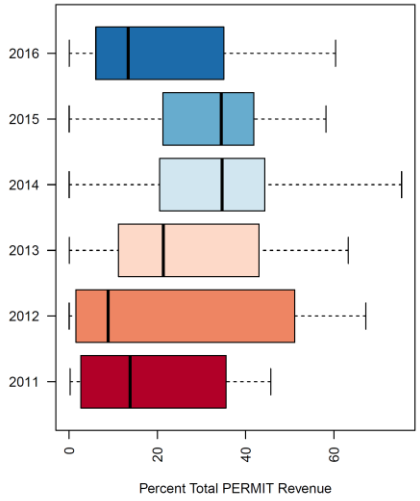
Great Rip



Fishing Rip



Great Rip G*



Fishing Rip G*

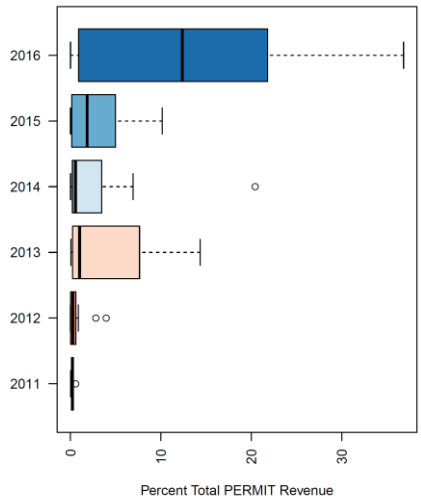
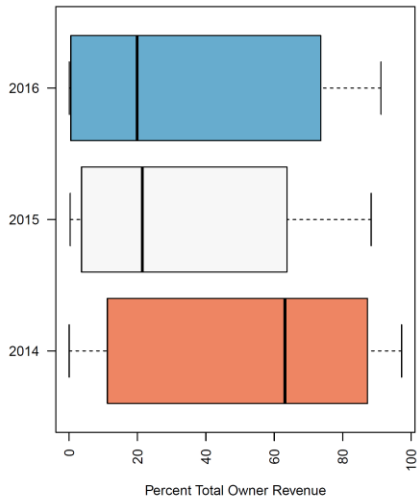
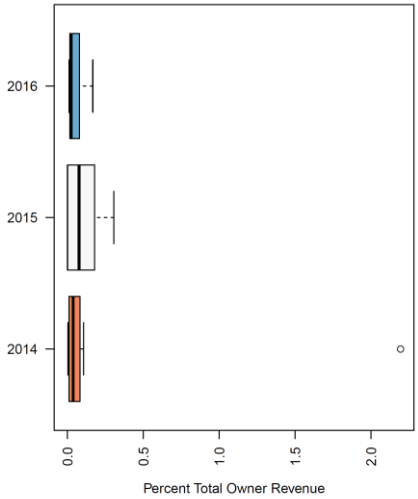


Figure 4 – Percentage of an owner's total commercial revenue generated within each area or set of areas between 2014 and 2016. Note: Ownership groups defined consistent RFA guidelines.

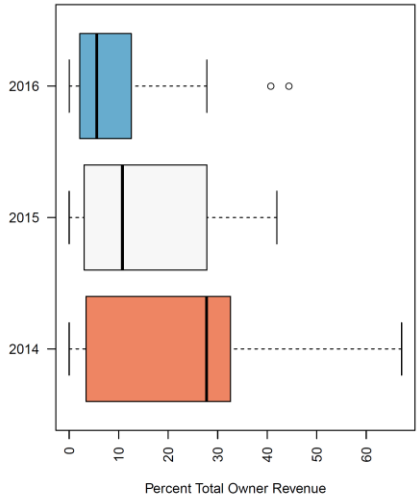
Full exemption area



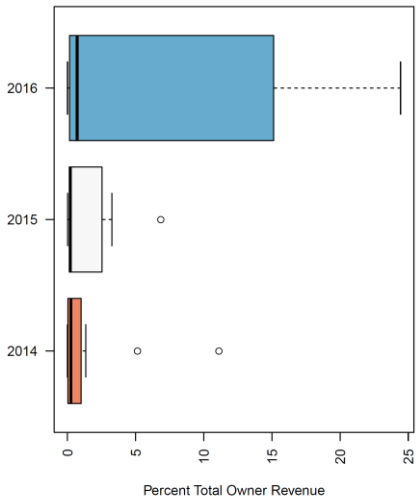
Industry/AP (two sub-areas combined)



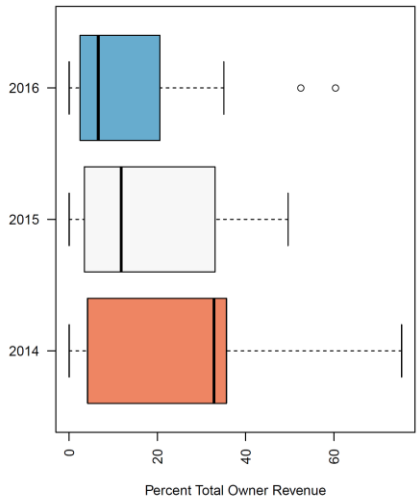
Great Rip



Fishing Rip



Great Rip G*



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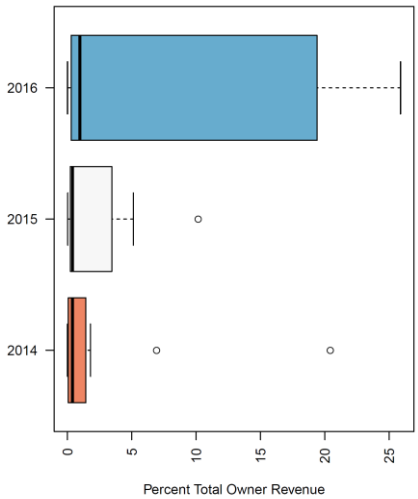
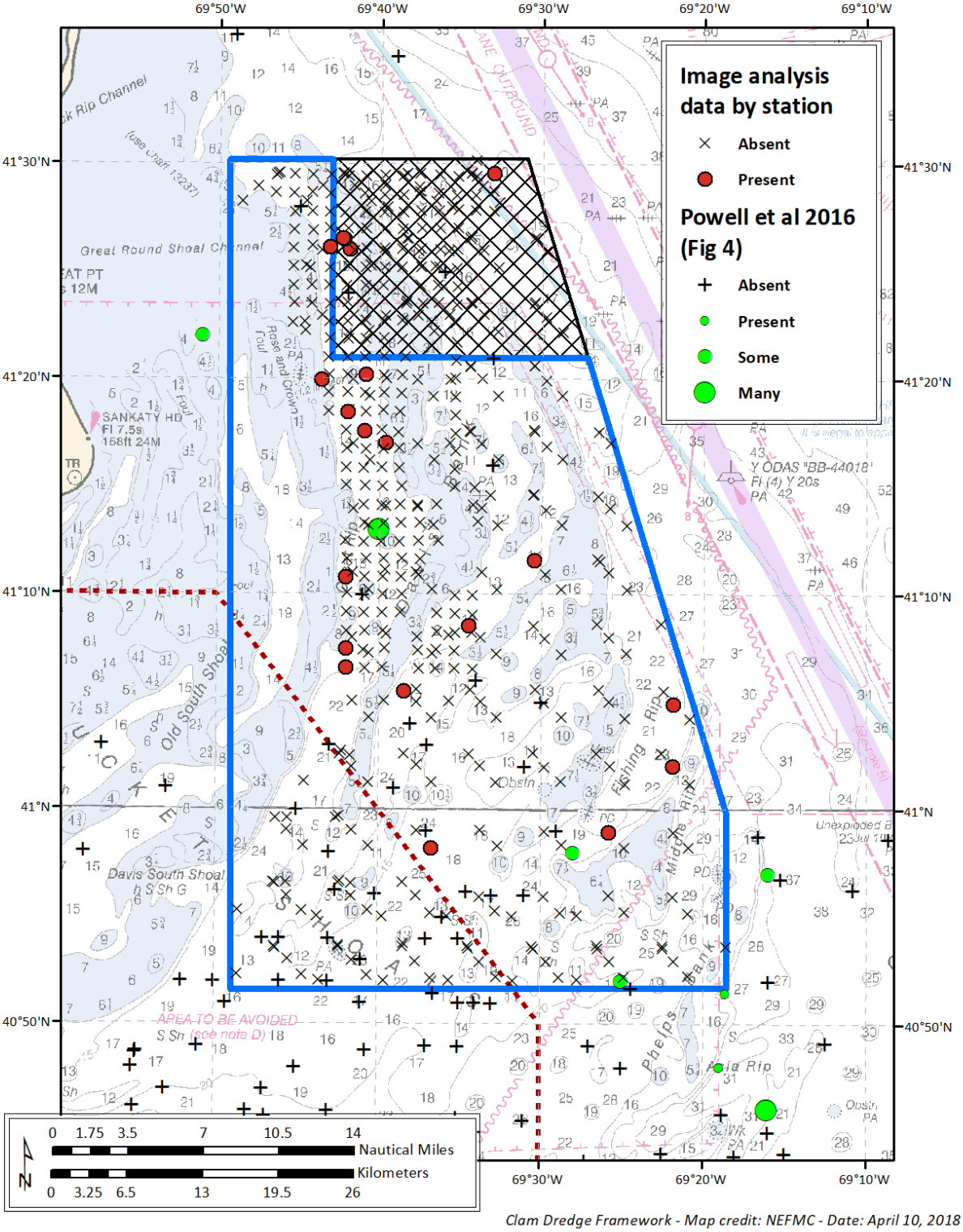


Map 14 – Mussel occurrence in GSC HMA



Clam Dredge Framework - Map credit: NEFMC - Date: April 10, 2018