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8. Appendix A: Habitat Classification

Table A1. Original depth descriptive value (left column) and reclassified descriptive value (right column).

Depth (Bathymetry)	
Original Descriptive Value	**Reclassified Descriptive Value**
very shallow water (0 - 23 m)	Shallow
shallow to moderate depths (0 – 44 m)	Shallow
very shallow to shallow water (0 - 23 m)	Shallow
very shallow to moderate depths (0 – 75 m)	Shallow
shallow water (23 - 44 m)	Shallow
shallow water (8-44 m)	Shallow
shallow depths (23 - 44 m)	Shallow
shallow water (8 - 31 m)	Shallow
shallow depths (8.4 to 44 meter)	Shallow
shallow water (23 - 31 m)	Shallow
very shallow to moderate depths (0 – 75 m)	Shallow
very shallow water (0 - 15 m)	Shallow
shallow water (15 and 22 m)	Shallow
shallow water (15 - 22 m)	Shallow
shallow (15 - 22 m)	Shallow
shallow to moderate depth (0 - 45 m)	Shallow
shallow water (25 - 45 m)	Shallow
shallow to moderate depth (0 - 45 m)	Shallow
shallow to moderate depths (22 - 45 m)	Shallow
shallow water (25 - 45 m)	Shallow
very shallow (0 - 22m),	Shallow
moderate depth (42 - 79 m)	Moderate
moderate depths (42 - 101 m)	Moderate
moderate depths (61 - 101 m)	Moderate
moderate depths (42 - 101 m)	Moderate
moderate depths (61 - 70 m)	Moderate
moderate depths (70 - 101 m)	Moderate
moderate depths (42 to 83 m)	Moderate
moderate depth (42 - 101 m)	Moderate
over 69 m	Moderate
moderate depths (70 - 101 m)	Moderate
moderately shallow water (42 - 70 m)	Moderate
moderate depth (70 - 233 m)	Moderate

moderate to deep water (101 - 233 m)	Moderate
moderate to deep depths (over 101 m)	Moderate
moderate depths (23 - 44 m)	Moderate
moderate depths (44 – 75 m)	Moderate
moderate depths (31 - 75 m)	Moderate
moderate depths (44 - 75 m)	Moderate
moderate depths (44 - 79 m)	Moderate
moderately deep water (44 – 139 m)	Moderate
moderately deep water (75 - 139 m)	Moderate
moderate to very deep depths (average 128 m, min 44 m)	Moderate
moderate to deep depths (44 - 139 m)	Moderate
moderate depths (15 - 82 m)	Moderate
moderate depth (45 - 82 m)	Moderate
medium depth (45 - 82 m)	Moderate
moderate depths (45 - 82 m)	Moderate
moderate depths (45 - 82 m)	Moderate
moderate depths (45 - 82)	Moderate
moderate depth (22 - 82 m)	Moderate
moderately deep water (82 - 95 m)	Moderate
moderate depths (45 - 82 m)	Moderate
deep water (143 - 233 m)	Deep
deep depths (143 - 233 m)	Deep
deep water (143 - 233 m)	Deep
deep water (101 - 233 m)	Deep
deep water (over 233 m)	Deep
deep water (75-139 m)	Deep
deep water (60 – 485 m	Deep
deep to very deep water (75 - 200 m)	Deep
very deep water (>139 m)	Deep
shallow to deep depths (22 - 592 m)	Deep
deep water (95 - 592 m)	Deep
deep water (95 - 592 m)	Deep
very deep water (>592 m)	Deep
moderate to deep depths (45 -592)	Deep

Table A2. Original substrate descriptive value (left column) and reclassified descriptive value (right column).

Substrate	
Original Descriptive Value	**Reclassified Descriptive Value**
fine to medium sand	Sand and pebbles
fine sand	Sand and pebbles

very fine sand	Sand and pebbles
fine to medium to coarse sand	Sand and pebbles
on medium to coarse sand but occasionally on silt	Sand and pebbles
very fine to medium sand	Sand and pebbles
fine to coarse sand	Sand and pebbles
medium to coarse sand	Sand and pebbles
very fine to fine sand	Sand and pebbles
coarse to fine sand	Sand and pebbles
fine to coarse sand	Sand and pebbles
silt to fine sand	Sand and pebbles
medium to coarse substrate	Sand and pebbles
medium sand	Sand and pebbles
medium to coarse sand	Sand and pebbles
mostly coarse to occasionally fine sand	Sand and pebbles
coarse to fine sand	Sand and pebbles
fine to coarse sand	Sand and pebbles
very coarse sand or pebbles	Sand and pebbles
silt and mud	Silt and mud
silt to fine sand	Silt and mud
silt and mud	Silt and mud
silt to fine sand	Silt and mud
mostly on silt and fine sand, but substrate is variable	Silt and mud
silt and mud	Silt and mud
silt, fine sand and sand	Silt and mud
any substrate	Any

Table A3. Original seabed form descriptive value (left column) and reclassified descriptive value (right column).

Seabed Form	
Original Descriptive Value	**Reclassified Descriptive Value**
Depressions	Depressions
Flat depressions	Depressions
High flats	Flats
All types of flats	Flats
Mid and low flats	Flats
High and mid-position flats	Flats
Mid and high position flats	Flats
High slopes	Sloped
High slopes	Sloped
Slopes and canyons	Sloped

High flats and depressions	Mixed
Depressions and mid-position flats	Mixed
Mid-position flats and depressions	Mixed
Depressions and high flats	Mixed
Mid position flats and depressions	Mixed
High flats and slopes	Mixed
Flats and slopes	Mixed
High slopes, canyons, flats	Mixed
High slopes and flats	Mixed
High slopes and flats	Mixed
Flats and slopes	Mixed
Flats and side slopes	Mixed
Depressions and high flats	Mixed
Depressions and high flats	Mixed
Steep slopes and flats	Mixed
Various seabed positions	Mixed
Depressions and mid-position flats	Mixed
Depressions and los slopes	Mixed

Habitat categories were then created with the combinations of the physical factors new classification schemes. This resulted in 10 categories covering all the combinations found within the project study area. Those categories with their descriptions are listed below. The original habitat classifications that fall within each category are listed below category headings.

Categories

Category #1 – characterized by shallow depth, sand/pebbles substrate, and depressions seabed forms.

Original classifications that were grouped in this category are:

- Habitat 109 (134 Samples): Depressions in very shallow water (0 - 23 m) mostly on medium to coarse sand but occasionally on silt.
- Habitat 200 (163 Samples): Depressions at very shallow to moderate depths (0 – 44 m) on very fine to medium sand.
- Habitat 390 (117 Samples): Depressions in shallow water (23 - 44 m) in very fine to fine sand.
- Habitat 230 (227 Samples): Depressions in shallow depths (23 - 44 m) on very fine sand.
- Habitat 229 (225 Samples): Depressions in shallow depths (8.4 to 44 meter) on very fine sand.
- Habitat 768 (22 Samples): Depressions in very shallow water (0 - 15 m) on silt to fine sand.
- Habitat 38 (95 Samples): Depressions in water shallow (15 - 22 m) on medium to coarse sand.

- Habitat 2 (58 Samples): Flat depressions at shallow to moderate depth (0 - 45 m) in medium sand.

Category #2 – characterized by shallow depth, sand/pebbles substrate, a flats seabed forms.
Original classifications that were grouped in this category are:

- Habitat 316 (301 Samples): Flats in shallow water (8-44 m) on very fine to medium sand.
- Habitat 32 (52 Samples): Mid-position flats at shallow to moderate depths (22 - 45 m) on medium sand.
- Habitat 4 (128 Samples): Mid-position flats in shallow water (25 - 45 m) on coarse to medium sand.

Category #3 – characterized by shallow depth, sand/pebbles substrate, and mixed seabed forms.
Original classifications that were grouped in this category are:

- Habitat 25 (492 Samples): Flats and side slopes in very shallow to shallow water (0 - 23 m) on fine to coarse sand.
- Habitat 36 (61 Samples): Depressions and high flats in very shallow to moderate depths (0 – 75 m) on medium to coarse sand.
- Habitat 873 (113 Samples): Flats and side slopes in shallow water (8 - 31 m) on very fine to medium sand.
- Habitat 2537 (37 Samples): Depressions and high flats in shallow water (23 - 31 m) on very fine to fine sand.
- Habitat 36 (61 Samples): Depressions and high flats in very shallow to moderate depths (0 – 75 m) on medium to coarse sand.
- Habitat 113 (314 Samples): Depressions and mid-position flats at moderate depths (23 - 44 m) on very fine sand.
- Habitat 64 (62 Samples): Depressions and mid-position flats in shallow water (15 and 22 m) on medium sand.
- Habitat 87 (20 Samples): Depressions and high flats in shallow water (15 - 22 m) on medium sand.
- Habitat 1(109 Samples): Depressions and mid-position flats, shallow to moderate depth (0 - 45 m) on coarse to fine sand.
- Habitat 7 (83 Samples): Mid-position flats and depressions in shallow water (25 - 45 m) on medium to coarse substrate.
- Habitat 44 (82 Samples): Depressions and mid-position flats mostly very shallow (0 - 22m), but occasionally very deep on fine to coarse sand.

Category #4 – characterized by moderate depth, sand/pebbles substrate, and depression seabed forms.
Original classifications that were grouped in this category are:

- Habitat 2367 (40 Samples): Depressions at moderate depths (61 - 70 m) on very fine sand.

- Habitat 25 (46 Samples): Depressions at moderate depths (15 - 82 m) on fine to coarse sand.
- Habitat 218 (96 Samples): Depressions at moderate depths (45 - 82 m) on medium to coarse sand.

Category #5 – characterized by moderate depth, sand/pebbles substrate, and flats seabed forms.
Original classifications that were grouped in this category are:

- Habitat 557 (125 Samples): Mid position flats at shallow to moderate depth (42 - 79 m) on fine to medium sand.
- Habitat 1451 (127 Samples): Mid-position flats at shallow to moderate depths (42 - 101 m) on fine sand.
- Habitat 1078 (305 Samples): Mid-position flats on at moderate depths (61 - 101 m) on fine sand.
- Habitat 1028 (67 Samples): Mid-position flats at moderate depths (61 - 101 m) on fine sand.
- Habitat 183 (136 Samples): Mid-position flats in shallow to moderate depths (42 - 101 m) on fine sand.
- Habitat 133 (61 Samples): Mid-position flats at moderate depths (70 - 101 m) on fine sand.
- Habitat 91 (307 Samples): Mid-position flats at moderate depths (42 to 83 m) on fine to medium sand.
- Habitat 9 (219 Samples): High and mid-postion flats at moderate depth (42 - 101 m) on fine to medium sand.
- Habitat 24 (139 Samples): Mid-position flats at moderate depths (70 - 101 m) on silt to fine sand.
- Habitat 317 (190 Samples): Mid-position flats at moderate depths (31 - 75 m) on fine to medium sand.
- Habitat 381 (99 Samples): Mid and high position flats in moderate depths (44 - 79 m) on fine to very fine sand.
- Habitat 949 (31 Samples): Mid and low flats in deep water (75-139 m) on medium to fine sand.
- Habitat 592 (50 Samples): Mid-position flats at moderate depth (45 - 82 m) on medium sand
- Habitat 306 (29 Samples): All types of flats at medium depth (45 - 82 m) on medium sand.
- Habitat 84 (104 Samples): All types of flats at moderate depth (22 - 82 m) on fine to medium sand.
- Habitat 1223 (35 Samples): High flats in moderately deep water (82 - 95 m) on medium sand.
- Habitat 219 (44 Samples): High flats at moderate depths (45 - 82 m) on coarse to fine sand.

Category #6 – characterized by moderate depth, sand/pebbles substrate, and mixed seabed forms.

Original classifications that were grouped in this category are:

- Habitat 12 (56 Samples): Steep slopes and flats at depths over 69 m, on fine to medium sand.
- Habitat 2 (116 Samples): Flats and slopes at moderate depth (70 - 233 m) on very coarse sand or pebbles.
- Habitat 372 (125 Samples): Depressions and los slopes at moderate depths (44 – 75 m) on very fine sand.
- Habitat 223 (98 Samples): Mid-position flats and depressions at moderate depths (44 - 75 m) on fine to medium sand.
- Habitat 66 (121 Samples): Hihg flats and slopes in moderately deep water (75 - 139 m) on very fine to fine sand.
- Habitat 6 (105 Samples): High slopes and flats at moderate to deep depths (44 - 139 m) on coarse to fine sand.
- Habitat 395 (78 Samples): Depressions and high flats at moderate depths (45 - 82 m) on fine to medium sand.
- 520 (31 Samples): Mid position flats and depressions at moderate depths (45 - 82) on mostly coarse to occsasionaly fine sand.
- *Habitat 3 (78 Samples): Flats and slopes at moderate to very deep depths (average 128 m, min 44 m) on fine to very fine sand.

Category #7 – characterized by deep depth, sand/pebbles substrate, and mixed seabed forms.
Original classifications that were grouped in this category are:

- Habitat 11 (78 Samples): High slopes, canyons, flats in deep water (60 – 485 m) on medium to fine sand.
- Habitat 229 (57 Samples): High flats and depressions at shallow to deep depths (22 - 592 m) on a fine to medium sand.
- Habitat 387 (29 Samples): High slopes and flats in very deep water (>139 m) on fine sand.
- Habitat 437 (34 Samples): High flats and slopes in deep to very deep water (75 - 200 m) on fine sand.

Category #8 – characterized by deep depth, silt/mud substrate, and mixed seabed forms.
Original classifications that were grouped in this category are:

- Habitat 18 (204 Samples): High flats at moderate to deep depths (over 101 m) on silt to fine sand.

Category #9 – characterized by deep depths, silt/mud substrate, and flat seabed forms.
Original classifications that were grouped in this category are:

- Habitat 247 (62 Samples): Depressions and high flats in moderate to deep water (101 - 233 m) on silt and mud.
- Habitat 7: (157 samples) Depressions, and high flats and slopes, in deep water (143 - 233 m) mostly on silt and fine sand, but substrate is variable.

- Habitat 72 (152 Samples): Depressions and high flats at deep depths (143 - 233 m) on silt and mud.
- Habitat 8 (266 Samples): Depressions and side slopes in deep water (143 - 233 m) on silt and mud.
- Habitat 5 (130 Samples): Depressions, high flats and slopes in deep water (101 - 233 m) on silt, fine sand and sand.
- Habitat 103 (42 Samples): High slopes, steep slopes and depressions in deep water (over 233 m) on silt and fine sand.
- Habitat 505 (51 Samples): Slopes and canyons in very deep water (>592 m) on silt and mud.

Category #10 – characterized by any depth, any substrate, and any seabed forms. Original classifications that were grouped in this category are:

- *Habitat 4 (791 Samples): Any seabed form at any depth and any substrate. Not a habitat type, but included in this list for completeness.
- Habitat 82 (92 Samples): All types of flats in moderately deep water (44 – 139 m)

9. Appendix B: Marine Management Areas

Site Name	Management Agency	Primary Conservation Focus
Bluff Point State Park/Natural Area Preserve	Connecticut Department of Environmental Protection	Natural Heritage
Silver Sands State Park/Charles Island Natural Area Preserve	Connecticut Department of Environmental Protection	Natural Heritage
Hammonasset Natural Area Preserve	Connecticut Department of Environmental Protection	Natural Heritage
Barn Island Wildlife Management Area	Connecticut Department of Environmental Protection	Natural Heritage
Bride Brook Wildlife Management Area	Connecticut Department of Environmental Protection	Sustainable Production
Charles E. Wheeler Wildlife Management Area	Connecticut Department of Environmental Protection	Natural Heritage
Duck Island Wildlife Management Area/Natural Area Preserve (Westbrook)	Connecticut Department of Environmental Protection	Natural Heritage
East Haven Marsh Wildlife Management Area	Connecticut Department of Environmental Protection	Sustainable Production
East River Marsh Wildlife Area/ East River Wildlife Area	Connecticut Department of Environmental Protection	Natural Heritage
Ferry Point Marsh Wildlife Area	Connecticut Department of Environmental Protection	Sustainable Production
Great Harbor Wildlife Area	Connecticut Department of Environmental Protection	Natural Heritage
Great Island Wildlife Area/Roger Tory Peterson Natural Area Preserve	Connecticut Department of Environmental Protection	Natural Heritage
Hager Creek Marsh Wildlife Area	Connecticut Department of Environmental Protection	Sustainable Production
Hammock River Marsh Wildlife Area	Connecticut Department of Environmental Protection	Natural Heritage
Lords Cove Wildlife Area/Natural Area Preserve	Connecticut Department of Environmental Protection	Natural Heritage
Nott Island Wildlife Area	Connecticut Department of Environmental Protection	Natural Heritage
Pattagansett River Marsh Wildlife Area	Connecticut Department of Environmental Protection	Sustainable Production
Pawcatuck River Wildlife Area	Connecticut Department of Environmental Protection	Sustainable Production
Pine Orchard Marsh Wildlife Area	Connecticut Department of Environmental Protection	Sustainable Production

Plum Bank Marsh Wildlife Area	Connecticut Department of Environmental Protection	Natural Heritage
Popes Island Wildlife Area	Connecticut Department of Environmental Protection	Natural Heritage
Quinnipiac River Marsh Wildlife Area	Connecticut Department of Environmental Protection	Natural Heritage
Ragged Rock Creek Marsh Wildlife Area	Connecticut Department of Environmental Protection	Natural Heritage
Six Penny Island Wildlife Area	Connecticut Department of Environmental Protection	Sustainable Production
South Cove Wildlife Area	Connecticut Department of Environmental Protection	Natural Heritage
Thatch Bed Marsh Wildlife Area	Connecticut Department of Environmental Protection	Sustainable Production
Hammonasset Beach State Park	Connecticut Department of Environmental Protection	Natural Heritage
West River Marsh Wildlife Area	Connecticut Department of Environmental Protection	Sustainable Production
Harkness Memorial State Park/William A Niering Natural Area Preserve	Connecticut Department of Environmental Protection	Natural Heritage
Selden Neck State Park/Natural Area Preserve	Connecticut Department of Environmental Protection	Natural Heritage
Cape Henlopen State Park	Delaware Department of Natural Resources and Environmental Control	Natural Heritage
Ted Harvey Conservation Area (Wildlife Area)	Delaware Department of Natural Resources and Environmental Control	Natural Heritage
Little Creek Wildlife Area	Delaware Department of Natural Resources and Environmental Control	Natural Heritage
Cheesequake State Park	New Jersey Department of Environmental Protection	Natural Heritage
Port Republic Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Swan Bay Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Great Bay Boulevard Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Sedge Islands Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production
Mad Horse Creek Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production

Nantuxent Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production
Egg Island Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production
Heislerville Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Dennis Creek Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Fortescue Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Cape May Wetlands Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Absecon Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production
Higbee Beach Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Barnegat Lighthouse State Park	New Jersey Department of Environmental Protection	Natural Heritage
Dix Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
New Sweden Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production
Pork Island Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production
Malibu Beach Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production
Tuckahoe Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Cape Island Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Salem River Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Navesink River Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production
Upper Barnegat Bay Wildlife Management Area	New Jersey Department of Environmental Protection	Sustainable Production
Cohansey River Wildlife Management Area	New Jersey Department of Environmental Protection	Natural Heritage
Island Beach State Park	New Jersey Department of Environmental Protection	Natural Heritage
Liberty State Park	New Jersey Department of Environmental Protection	Cultural Heritage
Swan Point State Natural Area	New Jersey Department of Environmental Protection	Natural Heritage

North Brigantine State Natural Area	New Jersey Department of Environmental Protection	Natural Heritage
Cape May Wetlands State Natural Area	New Jersey Department of Environmental Protection	Natural Heritage
Corson's Inlet State Park	New Jersey Department of Environmental Protection	Natural Heritage
Swimming River Natural Area	New Jersey Department of Environmental Protection	Natural Heritage
Carl N. Shuster, Jr. Horseshoe Crab Reserve	National Marine Fisheries Service	Sustainable Production
Mudhole Closure	National Marine Fisheries Service	Natural Heritage
Waters off New Jersey Closure	National Marine Fisheries Service	Natural Heritage
Seatuck National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Stewart B. McKinney National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Wertheim National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Target Rock National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Bombay Hook National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Cape May National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Conscience Point National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Edwin B. Forsythe National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Oyster Bay National Wildlife Refuge	U.S. Fish and Wildlife Service	Sustainable Production
Prime Hook National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Bayswater Point State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Heckscher State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Hither Hills State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Jones Beach State Park	New York State Office of	Natural Heritage

	Parks, Recreation and Historic Preservation	
Montauk Point State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Napeague State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Nissequogue River State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Orient Beach State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Camp Hero State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Robert Moses State Park - Long Island	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Shadmoor State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Wildwood State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Captree State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Caumsett State Historic Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Gilgo State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Governor Alfred E. Smith/Sunken Meadow State Park	New York State Office of Parks, Recreation and Historic Preservation	Natural Heritage
Neshaminy State Park - Tidal Marsh Natural Area	Pennsylvania Department of Conservation and Natural Resources	Natural Heritage
Little Tinicum Island Natural Area	Pennsylvania Department of Conservation and Natural Resources - Bureau of	Natural Heritage

	Forestry	
Albert Gallatin Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Alice M. Colburn Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Alice M. Lawrence Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Ardandhu Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Barge and Crane Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
California Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Charles S. Haight Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Chester A. Poling Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Chelsea Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
City of Salisbury Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Corvan Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Dixie Sword Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Edward Rich Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Henry Endicott Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Herbert Exempt Site	Massachusetts Board of	Cultural Heritage

	Underwater Archaeological Resources	
Herman Winter Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Hilda Garston Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
James S. Longstreet Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
John Dwight Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Kershaw Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Kiowa Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Lackawana Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Lunet Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Mars Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Pemberton Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Pendleton Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Pinthis Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Port Hunter Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Pottstown Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage

Romance Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Seaconnet Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Trojan Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
U.S.S. Grouse Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
U.S.S. New Hampshire Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
U.S.S. Triana Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
U.S.S. Yankee Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
U.S.S. YSD Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
H.M.C.S. Saint Francis Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
French Van Gilder Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Vineyard Sound Lightship Exempt Site	Massachusetts Board of Underwater Archaeological Resources	Cultural Heritage
Bourne Back River Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Sandy Neck/Barnstable Harbor Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Waquoit Bay Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Weir River Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Wellfleet Harbor Area of	Massachusetts Department of	Natural Heritage

Critical Environmental Concern	Conservation and Recreation	
Weymouth/Hingham Back River Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Cape and Islands Ocean Sanctuary	Massachusetts Department of Conservation and Recreation	Natural Heritage
Cape Cod Bay Ocean Sanctuary	Massachusetts Department of Conservation and Recreation	Natural Heritage
Cape Cod Ocean Sanctuary	Massachusetts Department of Conservation and Recreation	Natural Heritage
North Shore Ocean Sanctuary	Massachusetts Department of Conservation and Recreation	Natural Heritage
South Essex Ocean Sanctuary	Massachusetts Department of Conservation and Recreation	Natural Heritage
Ellisville Harbor Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Egg Rock (Henry Cabot Lodge) State Wildlife Sanctuary	Massachusetts Division of Fisheries and Wildlife	Natural Heritage
Horseneck Beach State Reservation	Massachusetts Department of Conservation and Recreation	Natural Heritage
Herring River Watershed Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Milk Island (Knight) State Wildlife Sanctuary	Massachusetts Division of Fisheries and Wildlife	Natural Heritage
Inner Cape Cod Bay Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Ram Island State Wildlife Sanctuary - Salisbury	Massachusetts Division of Fisheries and Wildlife	Natural Heritage
William Forward Wildlife Management Area	Massachusetts Division of Fisheries and Wildlife	Natural Heritage
Neponset River Estuary Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Winter Flounder Spawning Closure Area	Massachusetts Division of Marine Fisheries	Sustainable Production
North Shore Groundfish Closure Area	Massachusetts Division of Marine Fisheries	Sustainable Production
Demarest Lloyd State Park	Massachusetts Department of Conservation and Recreation	Natural Heritage
Right Whale Critical Habitat	Massachusetts Division of	Natural Heritage

and Adjacent Waters Restricted Gear Area	Marine Fisheries	
Cape Cod Bay Year-Round Fish Pot Trawl Floating Ground Line Prohibition Area	Massachusetts Division of Marine Fisheries	Natural Heritage
Parker River/Essex Bay Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Pleasant Bay Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Pocasset River Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Rumney Marshes Area of Critical Environmental Concern	Massachusetts Department of Conservation and Recreation	Natural Heritage
Jenness State Beach	New Hampshire Division of Parks and Recreation	Natural Heritage
Wallis Sands State Beach	New Hampshire Division of Parks and Recreation	Natural Heritage
North Hampton State Beach	New Hampshire Division of Parks and Recreation	Natural Heritage
Hampton Beach State Park	New Hampshire Division of Parks and Recreation	Natural Heritage
Odiorne Point State Park	New Hampshire Division of Parks and Recreation	Natural Heritage
Rye Harbor State Park (Ragged Neck)	New Hampshire Division of Parks and Recreation	Natural Heritage
Closed Area I Habitat Closure Areas	National Marine Fisheries Service	Sustainable Production
Closed Area I	National Marine Fisheries Service	Sustainable Production
Closed Area II Habitat Closure Area	National Marine Fisheries Service	Sustainable Production
Georges Bank Seasonal Closure Area	National Marine Fisheries Service	Sustainable Production
Nantucket Lightship Habitat Closure Area	National Marine Fisheries Service	Sustainable Production
Western Gulf of Maine Habitat Closure Area	National Marine Fisheries Service	Sustainable Production
Closed Area II	National Marine Fisheries Service	Sustainable Production
Cashes Ledge Habitat Closure	National Marine Fisheries Service	Sustainable Production
Jeffrey's Bank Habitat Closure	National Marine Fisheries	Sustainable Production

Area	Service	
Cashes Ledge Closure Area (Multispecies)	National Marine Fisheries Service	Sustainable Production
Nantucket Lightship Closed Area	National Marine Fisheries Service	Sustainable Production
Oceanographer Canyon Closed Area	National Marine Fisheries Service	Sustainable Production
Lydonia Canyon Closed Area	National Marine Fisheries Service	Sustainable Production
Cape Cod Bay Restricted Area	National Marine Fisheries Service	Natural Heritage
Oceanographer Canyon Gear Restricted Area	National Marine Fisheries Service	Sustainable Production
Lydonia Canyon Gear Restricted Area	National Marine Fisheries Service	Sustainable Production
Veatch Canyon Gear Restricted Area	National Marine Fisheries Service	Sustainable Production
Great South Channel Restricted Trap/Pot Area	National Marine Fisheries Service	Natural Heritage
Western Gulf of Maine Closure Area	National Marine Fisheries Service	Sustainable Production
Great South Channel Sliver Restricted Area	National Marine Fisheries Service	Natural Heritage
Great South Channel Restricted Gillnet Area	National Marine Fisheries Service	Natural Heritage
Cashes Ledge Closure Area	National Marine Fisheries Service	Natural Heritage
SAM West	National Marine Fisheries Service	Natural Heritage
Massachusetts Bay Management Area	National Marine Fisheries Service	Natural Heritage
Offshore Closure Area	National Marine Fisheries Service	Natural Heritage
SAM East	National Marine Fisheries Service	Natural Heritage
Stellwagen Bank/Jeffreys Ledge Restricted Area	National Marine Fisheries Service	Natural Heritage
Gerry E. Studds/Stellwagen Bank National Marine Sanctuary	National Marine Sanctuaries	Natural Heritage
Block Island National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Mashpee National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage

Great Bay National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Monomoy National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Ninigret National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Nomans Land Island National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Parker River National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
John H. Chafee National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Pond Island National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Rachel Carson National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Sachuest Point National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Narrow River	Rhode Island Department of Environmental Management	Natural Heritage
Salt Ponds Region	Rhode Island Department of Environmental Management	Natural Heritage
Bissel Cove/Fox Island Shellfish Management Area	Rhode Island Department of Environmental Management	Sustainable Production
Greenwich Bay Shellfish Management Area	Rhode Island Department of Environmental Management	Sustainable Production
Mill Gut, Colt Park Shellfish Management Area	Rhode Island Department of Environmental Management	Sustainable Production
Sakonnet River Shellfish Management Area	Rhode Island Department of Environmental Management	Sustainable Production
Kickemuit River Shellfish Management Area	Rhode Island Department of Environmental Management	Sustainable Production
Potowomut River Shellfish Management Area	Rhode Island Department of Environmental Management	Sustainable Production
High Banks Shellfish Management Area	Rhode Island Department of Environmental Management	Sustainable Production
Jenny's Creek Shellfish Management Area	Rhode Island Department of Environmental Management	Sustainable Production
Bristol Harbor Shellfish Transplant Area	Rhode Island Department of Environmental Management	Sustainable Production
Newcastle Conservation Area I	Maine Department of Marine Resources	Sustainable Production
Harrington River Seed Mussel Conservation Area	Maine Department of Marine Resources	Sustainable Production

Jordan River Seed Mussel Conservation Area	Maine Department of Marine Resources	Sustainable Production
West Bay Seed Mussel Conservation Area	Maine Department of Marine Resources	Sustainable Production
Narraguagus Bay Seed Mussel Conservation Area	Maine Department of Marine Resources	Sustainable Production
Cross Island National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage
Mid-Atlantic Coastal Waters Area	National Marine Fisheries Service	Natural Heritage
Offshore Trap/Pot Waters	National Marine Fisheries Service	Natural Heritage
Southern Mid-Atlantic Waters Closure Area	National Marine Fisheries Service	Natural Heritage
Southern Nearshore Trap/Pot Waters	National Marine Fisheries Service	Natural Heritage
Northeastern United States Closed Area	National Marine Fisheries Service	Sustainable Production
Cape Cod South Closure Area	National Marine Fisheries Service	Natural Heritage
Northern Inshore State Trap/Pot Waters Area	National Marine Fisheries Service	Natural Heritage
Northern Nearshore Trap/Pot Waters Area	National Marine Fisheries Service	Natural Heritage
Coastal Salt Ponds Shellfish Management Area	Rhode Island Department of Environmental Management	Sustainable Production
Gulf of Maine Rolling Closure Areas	National Marine Fisheries Service	Sustainable Production
Northeast Closure Area	National Marine Fisheries Service	Natural Heritage
Mid-Coast Closure Area	National Marine Fisheries Service	Natural Heritage
Hudson River National Estuarine Research Reserve	New York Department of Environmental Conservation & National Oceanic and Atmospheric Administration	Natural Heritage
Jacques Cousteau National Estuarine Research Reserve	Rutgers University, Institute of Marine and Coastal Sciences & National Oceanic and Atmospheric Administration	Natural Heritage
Narragansett Bay National Estuarine Research Reserve	Rhode Island Department of Environmental Management & National Oceanic and Atmospheric Administration	Natural Heritage

Waquoit Bay National Estuarine Research Reserve	Massachusetts Department of Conservation and Recreation & National Oceanic and Atmospheric Administration	Natural Heritage
Wells National Estuarine Research Reserve	Wells Reserve Management Authority & National Oceanic and Atmospheric Administration	Natural Heritage
Delaware National Estuarine Research Reserve	Delaware Department of Natural Resources and Environmental Control & National Oceanic and Atmospheric Administration	Natural Heritage
Great Bay National Estuarine Research Reserve	New Hampshire Department of Fish and Game & National Oceanic and Atmospheric Administration	Natural Heritage
Acadia National Park	National Park Service	Natural Heritage
Fire Island National Seashore	National Park Service	Natural Heritage
Gateway National Recreation Area	National Park Service	Natural Heritage
Cape Cod National Seashore	National Park Service	Natural Heritage
Lydonia Canyon	National Marine Fisheries Service	Sustainable Production
Oceanographer Canyon	National Marine Fisheries Service	Sustainable Production
Other Northeast Gillnet Waters Area	National Marine Fisheries Service	Natural Heritage
Moosehorn National Wildlife Refuge	U.S. Fish and Wildlife Service	Natural Heritage

10. Appendix C: Wampanoag Coastal Resources and Lifeways

Author: Elizabeth James Perry, Senior Cultural Resource Monitor for the Wampanoag Tribe of Gay Head Aquinnah

Wampanoag people have utilized our coastal homes for 20,000 years: for obtaining a large portion of our diet and for recreation, and ceremony. Our traditional stories tell us the lands now submerged under the ocean were once above water village and ceremonial places. Wampanoag derived many of our traditional clans from marine species. Ocean harvests including spearing lobster in the shallows (to use as food and as bait), setting crab traps, gathering heaps of edible seaweeds to eat or for steaming food in a traditional clambake, gathering rushes for weaving patterned mats and baskets. We held and continue to hold celebrations and ceremony and to swim and have boat races for recreation in our ancestral homelands in Massachusetts and Rhode Island into the Gulf of Maine and the Mid-Atlantic. As ocean going people, we have also held memorial Native canoe trips, such as the 22 mile paddle down the Charles River from (the village of Nonantum) out to Deer Island in 2010, the historic Wampanoag paddle in 2002 from Falmouth to Marthas Vineyard; the 2015 paddle in the Connecticut River out to Watch Hill in the largest dugout made in New England for two hundred years (36 feet long); and to commemorate the various Wampanoag crew members onboard the refurbished *Charles W Morgan* whaleship on its historic 38th Voyage in 2014. Aquinnah Tribal men and women continue to make their living off the sea in commercial fishing and shell fishing, in charter boat fishing, as tug boat captains and in related industries such as hatchery work, as marine scientists, scientific illustration, in natural resources, as divers, historians, in restaurants, catering, and as Merchant Marines. Making fakeshaw has replaced scrimshaw as a practice, due to changes in the laws governing the use of ivory and bone.

Spring and Fall anadromous and catadromous fish runs were and continue to be important important parts of our annual harvest from the sea and rivers: species included Atlantic eel, Atlantic salmon, shad, herring, Atlantic sturgeon and whitefish. Additionally, as these fish headed up river to spawn in huge numbers, seals and whales followed them up to feed on them; and this enabled individuals who were not living right on the coast to hunt and fish, too. Small craft warnings were issued on the Merrimac River in the 18th century due to the abundance of large spawning Atlantic Sturgeon. Fish roe was an important part of our diet into the mid-twentieth century when herring became scarce; fall spawning fish were of the right consistency to be dried and stored well for Wampanaog winter food supplies. Seal and whale meat were both eaten fresh and also dried and smoked for storage; whale, sturgeon and seal fat were rendered into oil and used for food as well. One early account talks about a Wampanoag woman who was entertaining some English visitors. She reached up and cut off a chunk of dried whale meat hanging by the fire and added it into a steaming pot of succotash (corn, beans and squash). Whalebone was used for tools and as a wood substitute at times when there weren't many forests, and on islands, where timber was less numerous. Large ocean birds such as Labrador Duck and Great Auk (extinct-see the 18th century Great Auk breastbone spoon from a Papineau Wampanoag man on the Elizabeth Islands in the collection of the British Museum), were sometimes hunted, along with sea mink (also extinct following the fur trade-see various archeological reports). The bones of

seagulls, gannets, brown cranes and other species are represented in numerous shell middens, the meat was roasted or stewed with the down feathers being kept for weaving and insulation. Whales and dolphins were harvested on beaches where they would commonly strand on the Cape and islands especially, and represented a community resource (many early accounts, Native land deeds and wills reference clan whale portion rights). They were also speared and towed in by Native crews in dugout and bark canoes.

Travel was accomplished on the coast and rivers via *mushoon*, dugout canoes ranging from small to adequate for a party of 40, some outfitted with sails, presumably woven of basswood or milkweed bast. During severe winters travel was also accomplished on iced-over harbors and rivers via Native wood and sinew snowshoes and wooden toboggan assisted by our dogs. Celestial observation points, lookouts for boats, signal points, lookouts for whales, seals and fish were maintained in certain high places throughout our territory including in Bourne, along with shade arbors and tool storage places at boat launch sites (Jonathan Perry, personal communication, also see MA Archives Billingsgate documents, Nantucket Whaling Museum). The path down to the beach on Chappaquiddick Island for example, is documented as an Ancient Way, and is where Native canoes where launched (MHC, Mass Archives). Blackfish Point on Cape Cod was so named by the Separatists who landed there prior to going to what became Plymouth, Massachusetts. When they saw and tried to approach 10-12 Native people processing a Grampus orc for food on the beach, the Native party picked up their meat and tools and left, declining to engage with the strangers.

Roger Williams, in his "Key Into the Language of America", notes that Natives hunted whales and sturgeons but said the sturgeon was not something they were willing to sell to the 17th century English arrivals; this source mentions fish and shellfish as well. Sharks were also caught and cooked with the teeth of whales and sharks and baleen from whales along with whalebone and fish vertebrae used as ornaments by coast Native people and the inland Nations we traded with; shark skin is abrasive and served as sandpaper. Seal leather with or without fur, eel skins, and whale skins were tanned though few sources mention it; sinew from these species were used for sewing thread, fish line and bow strings. Sea turtles were harvested, for food and the shells were used; eggs being collected for food in spring and summer were mainly bird, and from turtle species that nest in the Northeast such as Terrapin and snapping turtles.

Certain places along the coast and in fresh and brackish rivers are known (or rediscovered with archeology) to have been where Native people built and maintained fish weirs for concentrating and trapping fish; Boston Common is one such place that was wetland and now covered with fill, and Wampanoag people take part in an annual educational celebration there during the Herring Run season each year (www.fishweir.org). In a few ponds and lakes very old dugouts have been found that were preserved from decay by being buried in mud and being underwater, and a few are on display at historical societies and museums.

Fishing by hook and line, harpoon, Indian hemp net, dip net, fish traps went on as a regular part of subsistence off the coast of MA and Eastern Rhode Island both at night and during

the day, depending upon the species targeted, from land and by traditional dugout vessel (collections at Peabody Harvard museum, Peabody Essex Museum, Robins Museum and various Historical Societies). Echinoderms such as sea cucumbers and urchins were harvested. Men and women fished singly or in groups, and some traded fish to the Separatists at Plymouth. Men and women also gathered shellfish of various species including razor clams, soft shell clams, quahogs and blue mussels; some of this harvest was also dried for winter use, while the shells of quahog, whelk and oyster (and oyster and quahog pearls) were used to manufacture white and purple *peage* or shell beads for ornament, trade and diplomacy termed *wampum* in our language. Several names of North Atlantic fish species continued to be used by Native fishermen and women and were adopted, like many other things, by immigrants to our homes: *scuppoag/scup, tautog, squeategue*/weakfish and *squid* are just a few; our word *squid* first appears in late 16th-very early 17th century written records. Horseshoe crabs and seaweed, along with herring were used as garden fertilizers by Native women on an annual basis.

During the 16th century onwards, Wampanoag men, women and children on the coast were vulnerable to European slave ships. Wampanoag men continued to hunt whales in the Industrial whaling of the 18th to early 20th centuries, and worked as navigators, harpooners, traders, translators, first mates and captains, all over the world. Shipwrecks of Native boats are documented in the region and dealing with piracy was another serious risk, as well as capture and death at sea during the various wars Wampanoag men fought in including King Philips War, the French and Indian Wars and the Revolutionary War. English colonists sent Native prisoners to lifelong and temporary enslavement in places like Barbados during the Colonialization Period wars.

11. Appendix D: Commercial Fishing Activity, Supplemental Maps

These map images are drawn from NE RPB projects on commercial fishing vessel activity (LaPointe Phase 2 report). Figure 56 to 62 illustrate fishing vessel activity density for the period from 2006 to 2010 for vessels permitted to pursue certain species, and include vessel activity in transit to/from port as well as actual fishing on the fishing grounds. Figures 63 to 69 show vessel activity density only below specified vessel speed thresholds (in most cases, 4 knots), and better represent vessels actually engaged in fishing, as opposed to in transit. All data are drawn from NOAA's Vessel Monitoring System (VMS) Program.

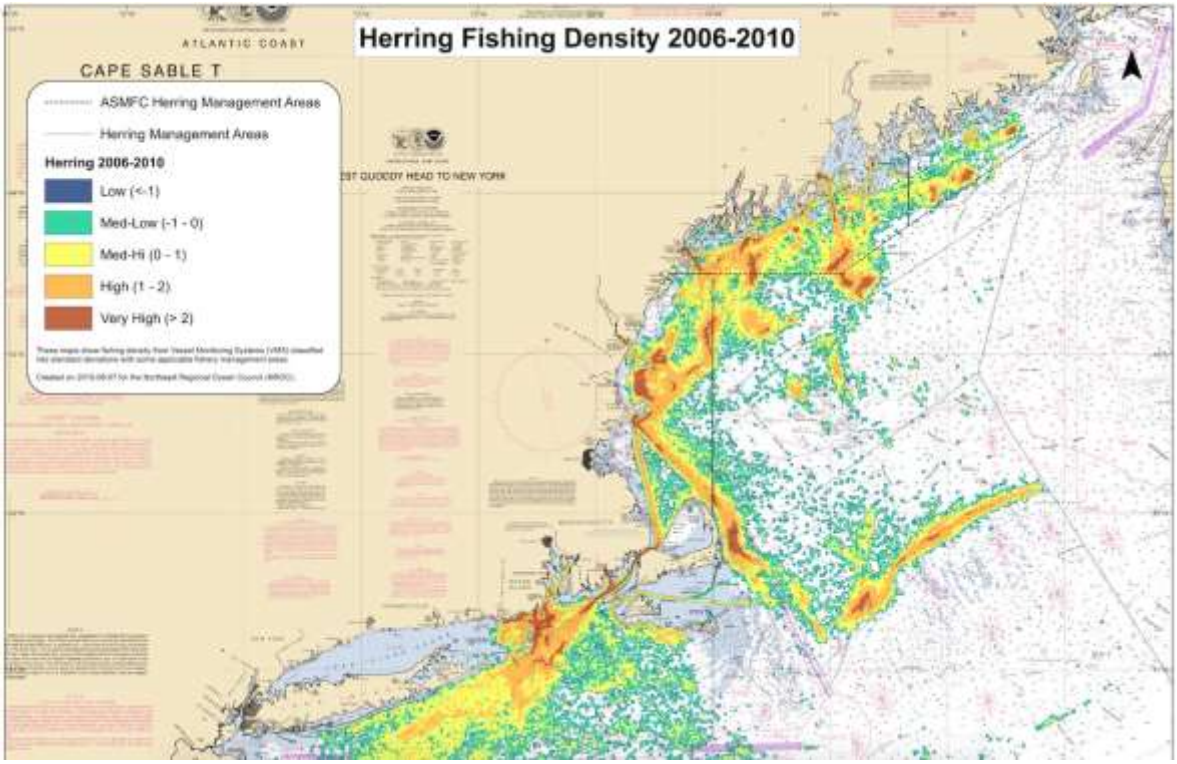

Figure 56 Herring fishing density, 2006-2010

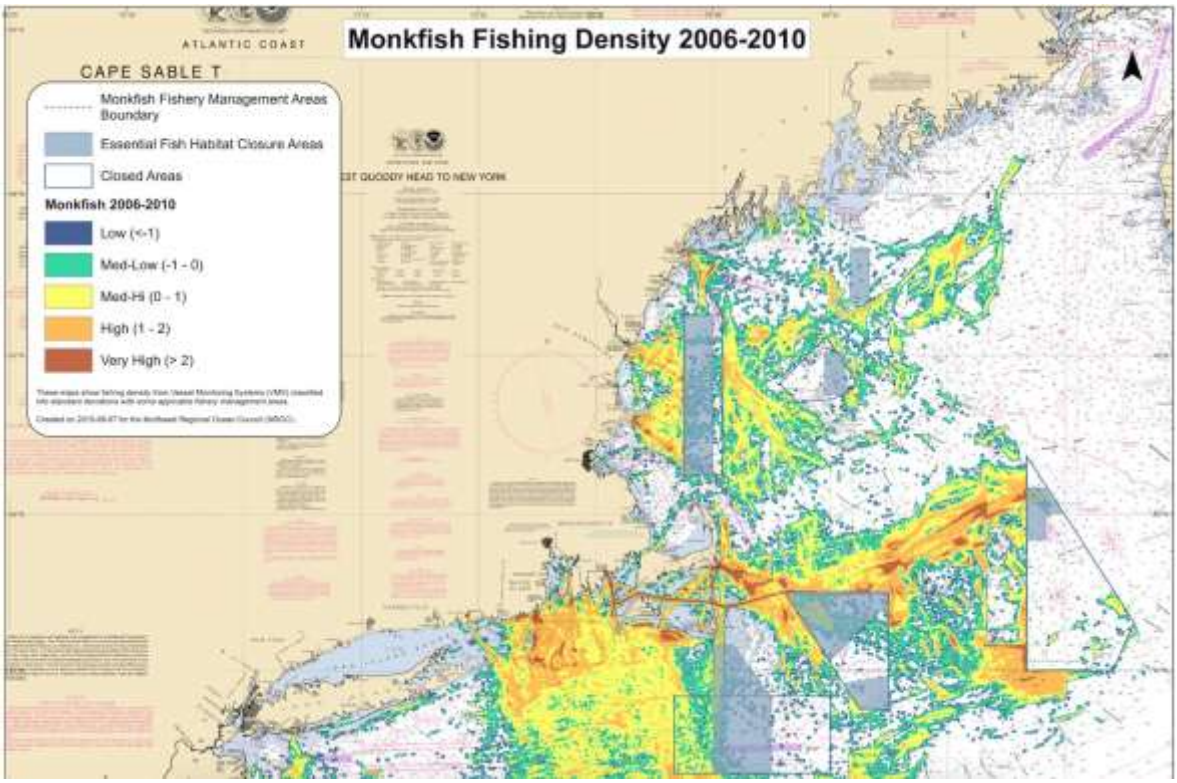

Figure 57 Monkfish fishing density, 2006-2010

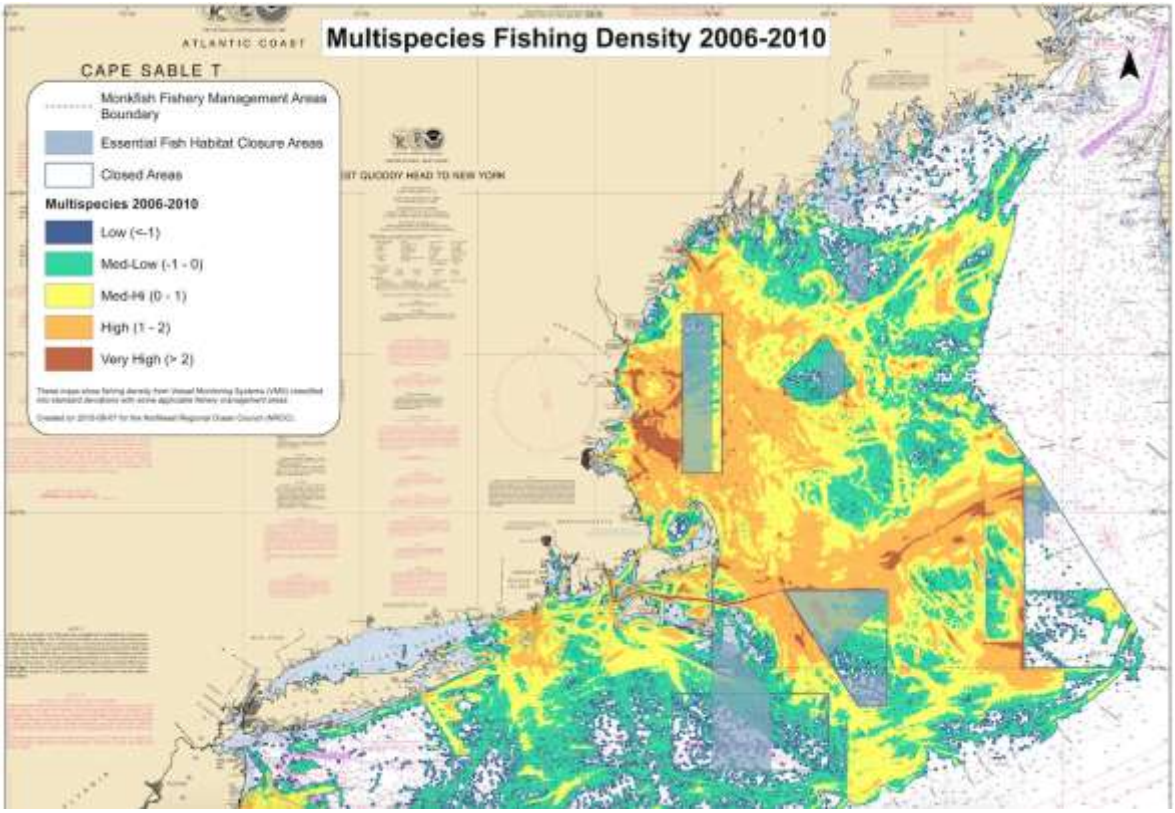

Figure 58 Multispecies fishing density, 2006-2010

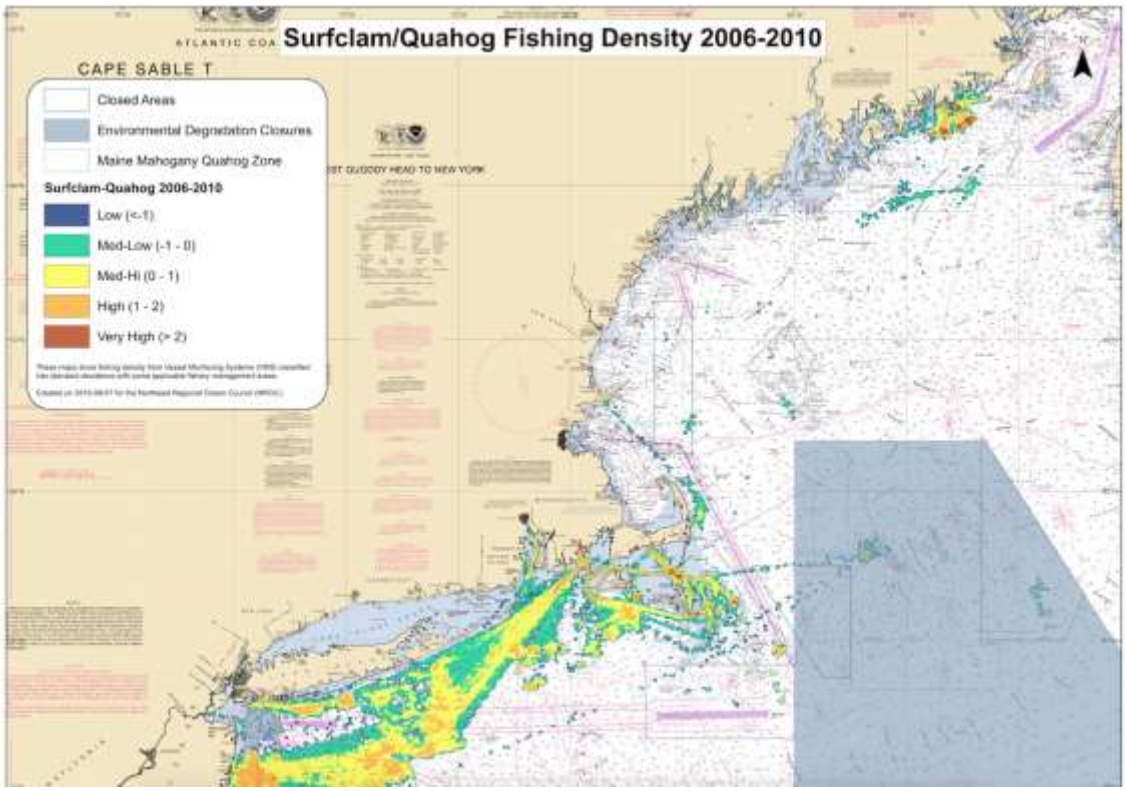

Figure 59 Surfclam/quahog fishing density, 2006-2010

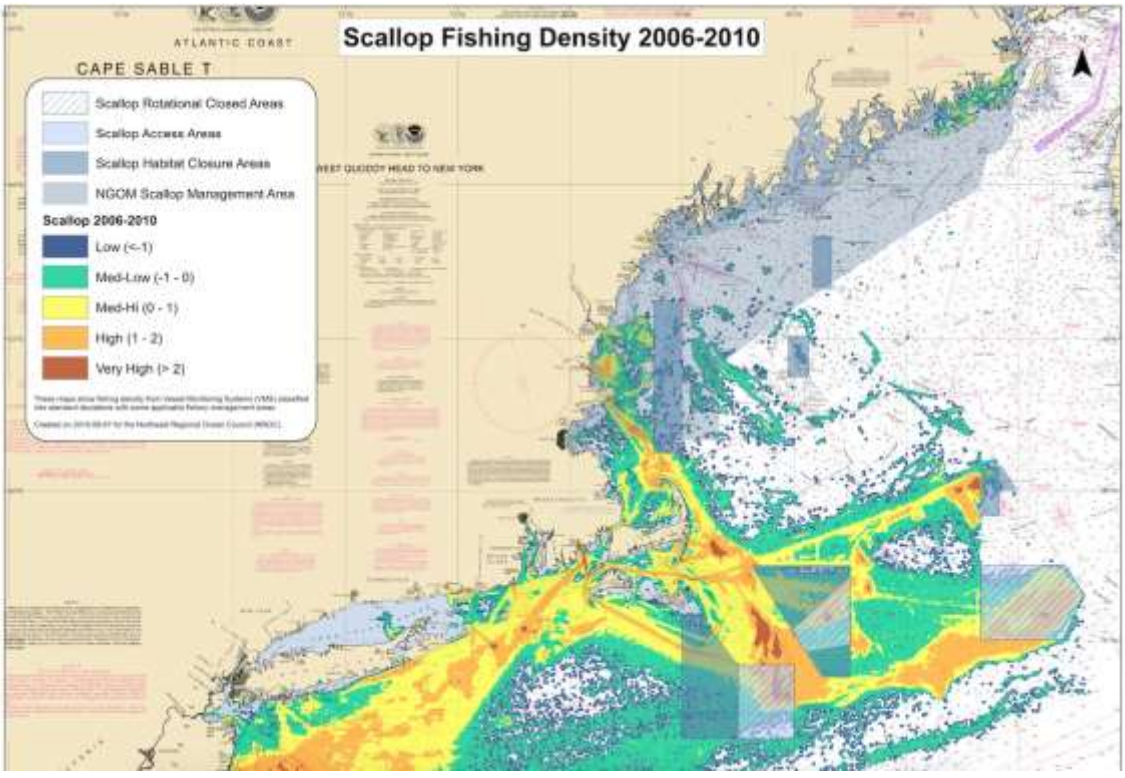

Figure 60 Scallop fishing density, 2006-2010

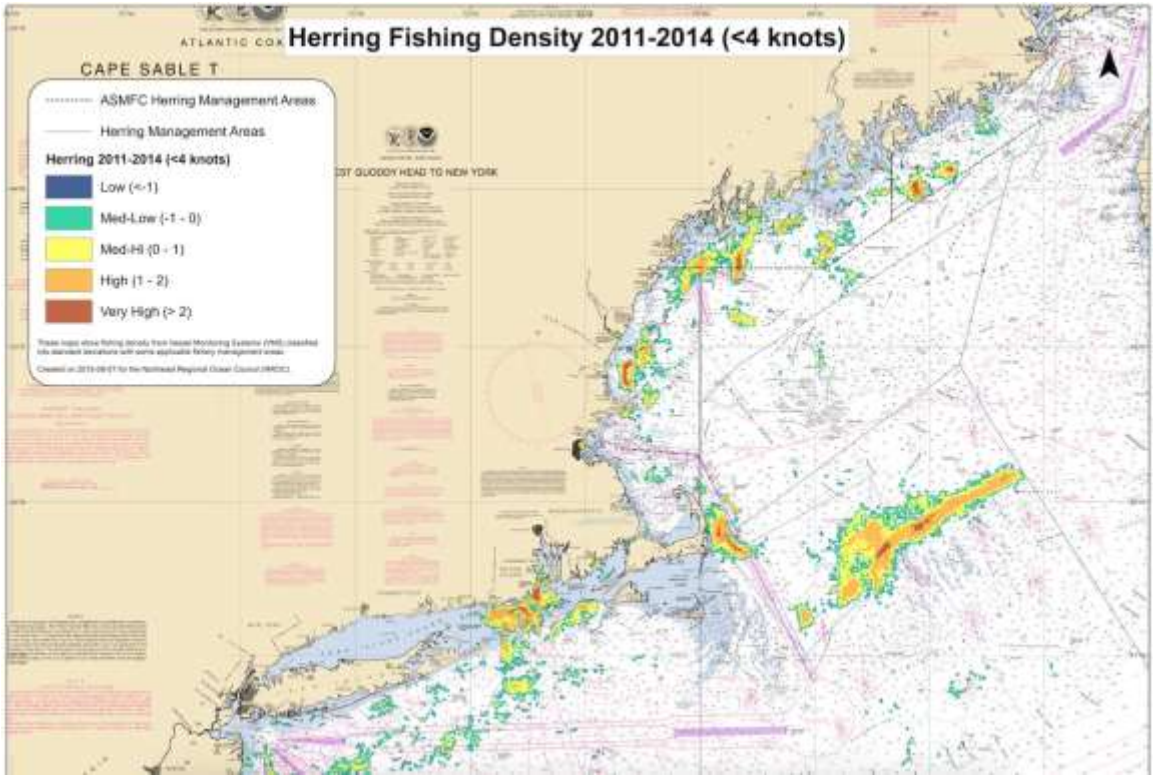

Figure 61 Herring fishing density, 2011-2014 (<4 knots)

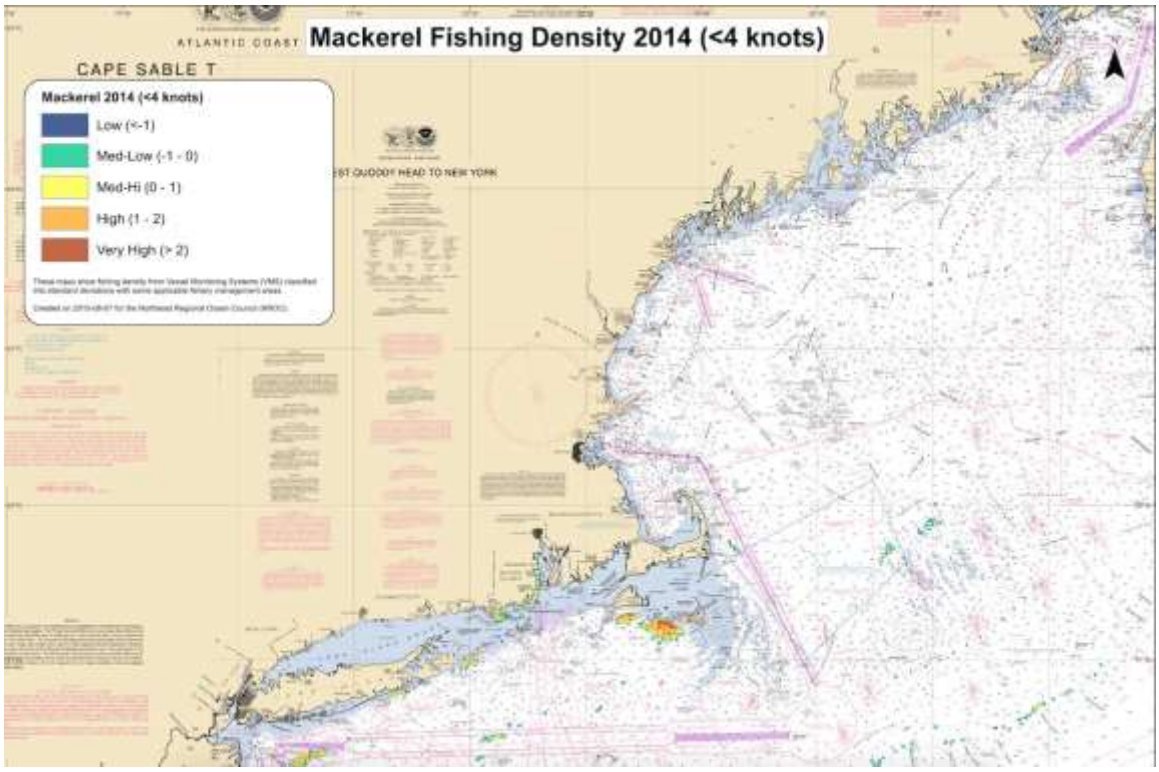

Figure 62 Mackerel fishing density, 2014 (<4 knots)

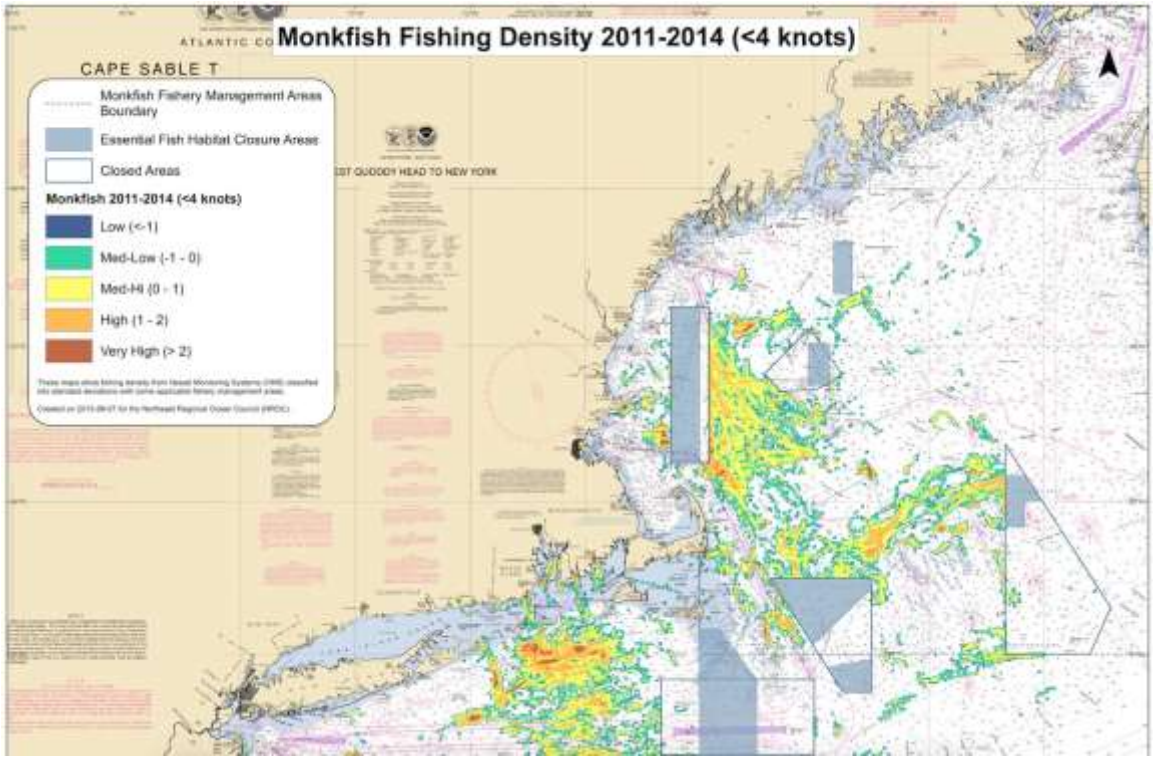

Figure 63 Monkfish fishing density, 2011-2014 (<4 knots)

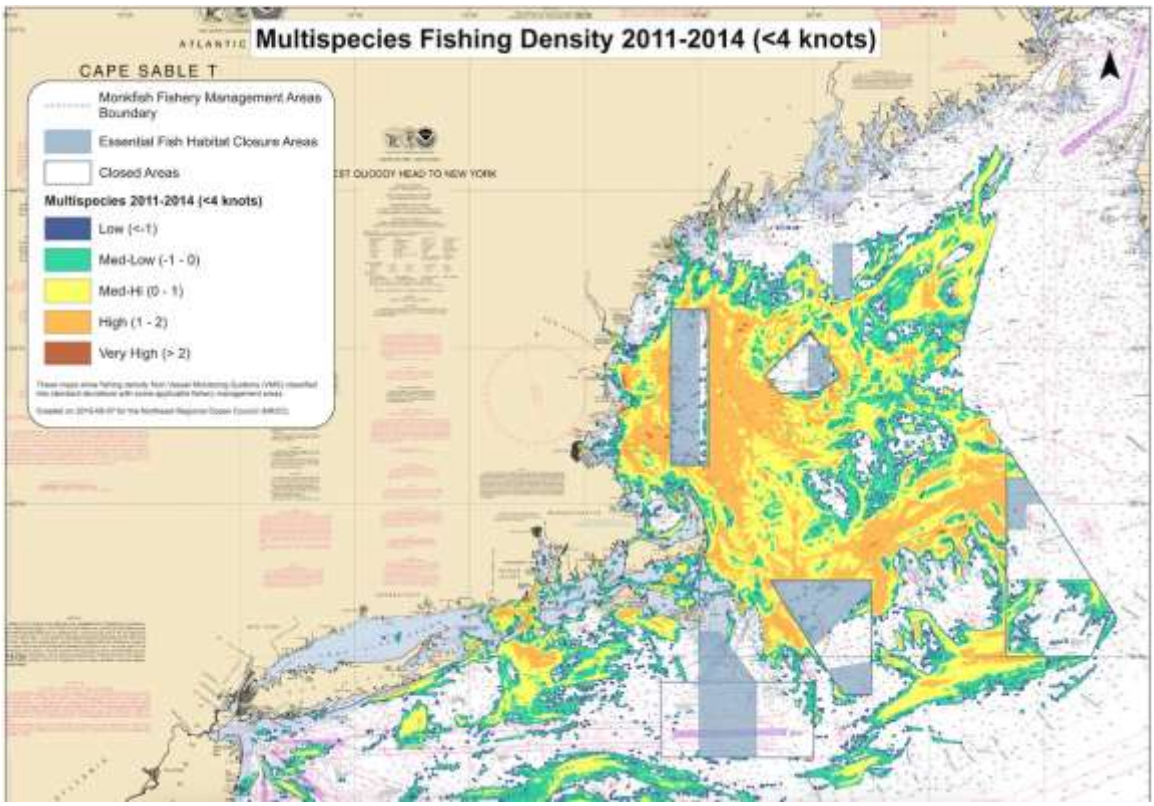

Figure 64 Multispecies fishing density, 2011-2014 (<4 knots)

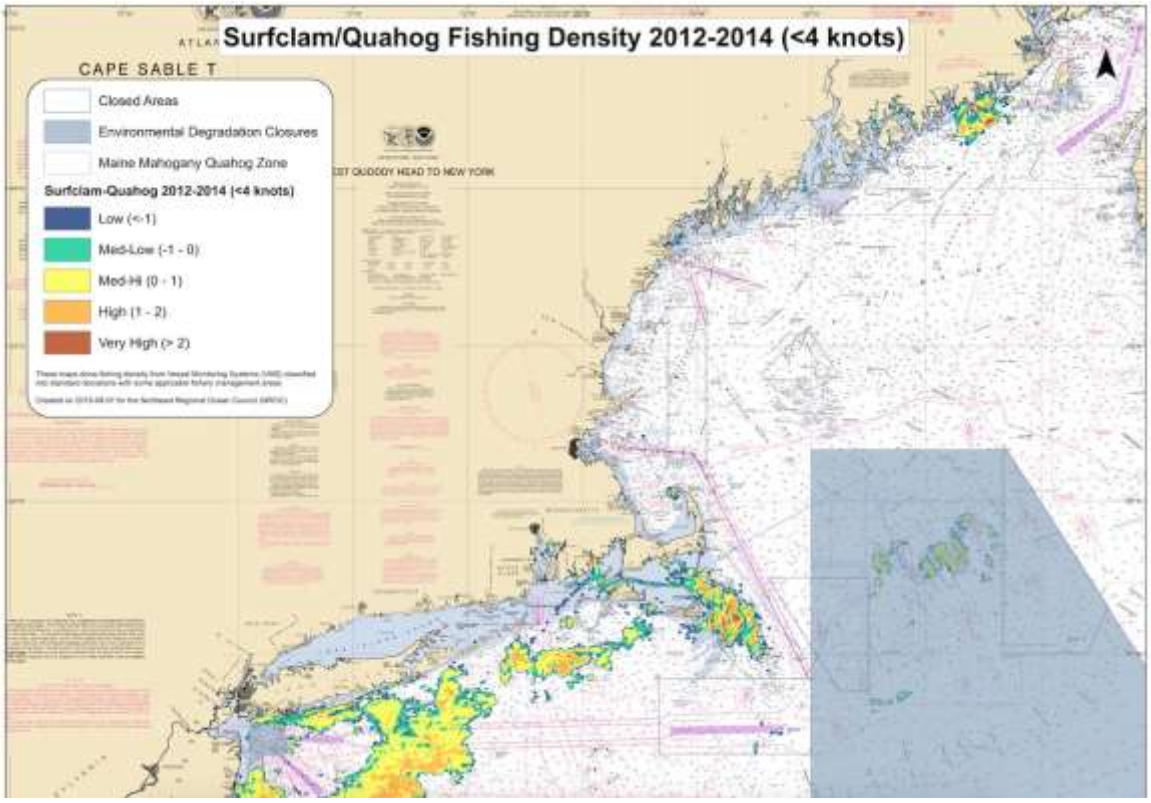

Figure 65 Surfclam/quahog fishing density, 2012-2014 (<4 knots)

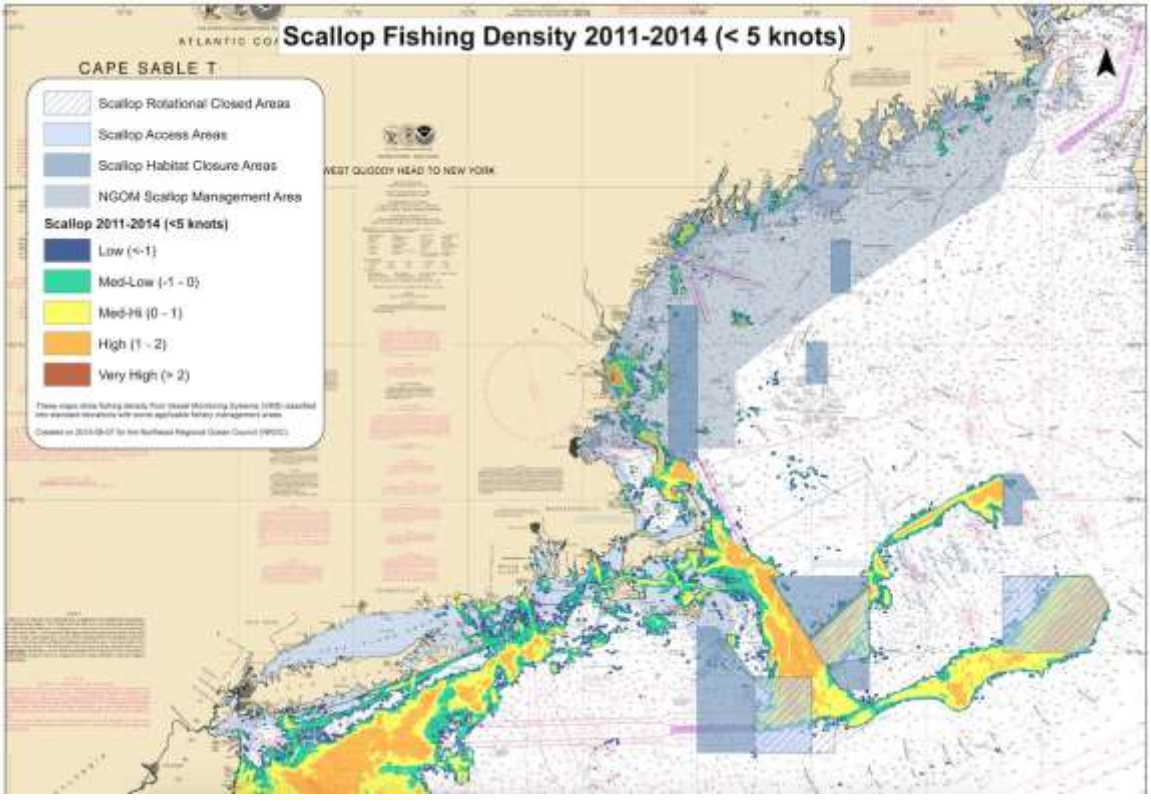

Figure 66 Scallop fishing density, 2011-2014 (<5 knots)

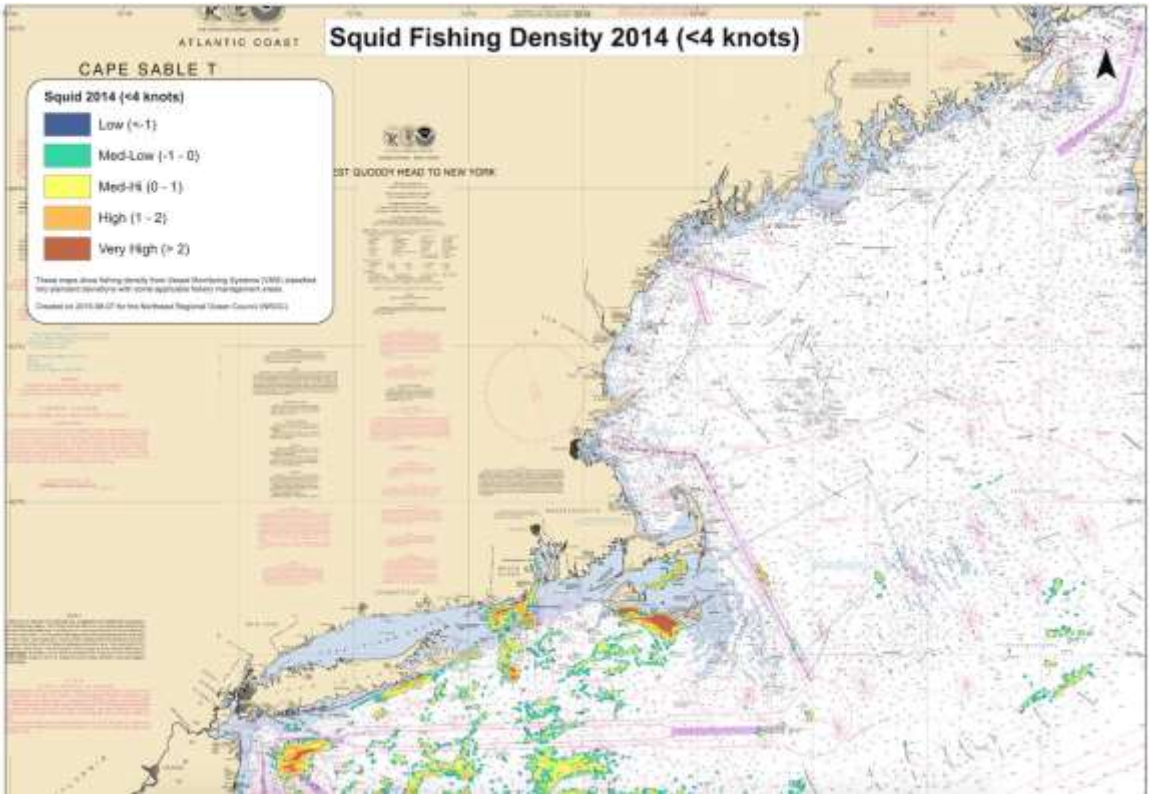

Figure 67 Squid fishing density, 2014 (<4 knots)

12. Appendix E: Ecosystem Services

12.1. The nature of ecosystem service value

This section presents estimates of ecosystem service (ES) values for the coastal and marine resources of the Northeast region. The region comprises physical features or "endpoints," such as wetlands, beaches, bays, estuaries, ocean space, and submerged lands. Many of these features consist of resources that can be used in alternative ways, thereby benefiting different groups, and service values are likely to differ across alternative resource uses and beneficiaries. Some alternative resource uses are compatible in a specific location, implying that ES values are additive; some are incompatible, leading potentially to user conflicts, and implying that some ES values may be diminished or obviated when resource uses overlap.

We have identified and compiled both published and unpublished estimates of ES values, and we have characterized gaps in value estimates that may need filling. In this section, we present the estimates first, then the gaps. The ES values that we present are unit values, expressed in dollars per geographic area per year. The values are broadly indicative of orders of magnitude for ecosystem services, but, as planning tools, they should be used with care. The relevance of these values in any particular allocation context necessitates a careful characterization of specific resources, the ways in which the resources are used and valued, the gains or losses that result from incremental management actions, and the identities of potential gainers and losers (Johnston and Russell 2011).

Following current thinking in environmental economics (*e.g.*, Lipton *et al*. 2014), we focus this assessment mainly on direct human uses of the coastal and ocean ecosystem. These uses may be linked to broader biophysical features of the ecosystem, known as "endpoints" (Boyd and Banzhaf 2006). It may be helpful to think of the ES values presented here as the valuation of endpoints in specific uses, such as ocean used for commercial fishing or for renewable energy generation. Importantly, we do not consider values for "supporting" services, such as, for example, seagrass beds in their specific role as providing habitat for bay scallops, because doing so could lead to double counting when both the habitat value of the seagrasses and the recreational or commercial value of harvested scallops are assessed (Freeman 2013).[2]

The uses are listed in Table 14. These uses involve resources that may or may not be traded in existing markets, implying that the methodologies for developing estimates of value may be non-uniform (Johnston *et al*. 2002). This assessment focuses on estimates of net economic values, such as consumer or producer surpluses, not estimates of gross revenues, such as the output impacts reported in another section.

[2] Some of the studies that we use for comparison purposes constitute composite estimates of the valued characteristics of physical features, such as wetlands, estuaries, or coastal oceans. Unless carefully constructed, such composite estimates may include values for supporting services.

Endpoints	OoM $ 10e__/ha/yr	Sources	Est. % Coverage	Gaps
Navigation		AIS data on shipping routes; avoided costs of route changes	0%	Valuation is limited to specific routing change scenarios
Coastal tourism (beach visits, boating)	4	Compilation of nonmarket estimates	~100%	Limited number of valuation studies
Commercial fishing	0-2	VCR data and cost models	~100%	Estimate is resource rents only; no consumer surplus
Aquaculture	4-7	DCF models	~100%	Nearshore shellfish aquaculture incorporated into NMFS commercial fishing data; open-ocean aquaculture is still hypothetical
Aesthetic views	2	Hedonic pricing models of coastal real estate	~5%	Few studies for the NE Region
Recreational fishing	1-2	Compilation of nonmarket estimates	~100%	MRIP estimates could be distributed over NERBS
Marine wildlife viewing	1-2	Compilation of nonmarket estimates	~100%	Few studies; bird-watching is important
Pipelines and cables		States	0%	State submerged lands license fees could be explored
Ocean science		NERACOOS; NSF; NOAA; oceanographic laboratories; value of information studies	0%	OOS stations and some vessel surveys available; no valuation estimates
Deepwater ports	2	Mitigation payments	100%	Ports not currently operational
Renewable energy	0-2	Lease bonuses	100%	Energy facility siting still hypothetical
Sand and gravel production		BOEM, ACoE, States	0%	BOEM agreements with states to "donate" OCS materials for beach nourishment; limited use in NE Region; some local ACoE dredge and fill activities
Underwater cultural resources		State historic preservation officers for some location data; geographic distribution data are low-resolution	0%	Few non-market values; may be incorporated into recreational boating estimates
C-sequestration		Carbon price and sequestration potential of alternative environmental features (salt marshes, seabeds, etc.)	0%	Can be filled in with sequestration estimates for salt marshes; sequestration potential of other coastal and ocean areas are uncertain
Waste disposal		Avoided costs of sewering or water treatments	0%	Point sources regulated; coastal non-point sources significant in nearshore regions
N-, P-assimilation		Avoided costs of denitrification	0%	Few studies
Hydrocarbon production		n.a.	--	Not applicable in NE Region

Table 14 Northeast region ecosystem service endpoints and value estimates

A comprehensive understanding of ES values can help planners assess the compatibility among different human uses (or non-uses) that may be in conflict. This Baseline Assessment focuses on characterizing extant estimates without explicit consideration for how such estimates would be used by planners. In practice, the separation of estimates and applications may be difficult to carry out, as many planning exercises would need to consider not only the identity of relevant beneficiaries but also the nature of dynamic linkages among ecosystems and beneficiaries (Johnston and Russell 2011).

Following international practice (*e.g*., de Groot *et al*. 2012), we adjust estimates from the literature so that they are expressed in common units, *i.e*., dollars per hectare per year ($/ha/yr).[3] Using the US consumer price index (CPI), we convert all dollar estimates into 2014 dollars. Similar to the recent compilation of ES values for Long Island Sound (Kocian *et al*. 2015), we compile unit, not marginal, values, but, unlike those authors, we do not calculate composite estimates of the "total asset value" of natural capital for the Northeast region. Total asset value estimates have little use to planners in assessing local compatibility of potentially competing uses.

Where relevant, we compare point estimates or ranges from studies (or our own calculations) that compile valuation estimates from a number of sources (Freeman 1995; Pendleton 2008; de Groot *et al*. 2012; Kocian *et al*. 2015). Some of these studies, especially de Groot *et al*. (2012) and Kocian *et al*. (2015), present composite estimates across the broader resource categories (ecological "endpoints"), such as for wetlands, coasts, estuaries, or oceans.[4] There is some overlap in the coverage of individual studies that comprise composite estimates developed by different authors. While such representations undoubtedly involve some degree of double-counting of ES values, we present descriptive statistics from these studies so that planners can have a sense of the orders of magnitude for what are still quite rough estimates of economic value. These comparisons also demonstrate the extent to which the central tendencies and ranges of ES values from different compilations agree or disagree, and they illustrate the wide variability in estimates from the literature.

Figure 68 depicts a typology of human uses of coastal and marine resources. At the top of the figure is "total economic value," which consists of both active and passive uses. Active uses include the direct or indirect physical uses of ecosystem resources. Direct uses involve uses that can be valued in market contexts, such as commercial fish yields, electricity generation by ocean wind farms, or the aesthetic views priced

[3] A hectare is 0.01 square kilometers, or approximately 2.5 acres, 0.004 square miles, or 0.003 square nautical miles.

[4] The studies that develop composite estimates for broader categories ("endpoints") tend to compile estimates across the four categories of ES values that were identified through the Millennium Ecosystem Assessment (MEA 2005). These categories comprise provisioning, regulating, supporting, and information services.

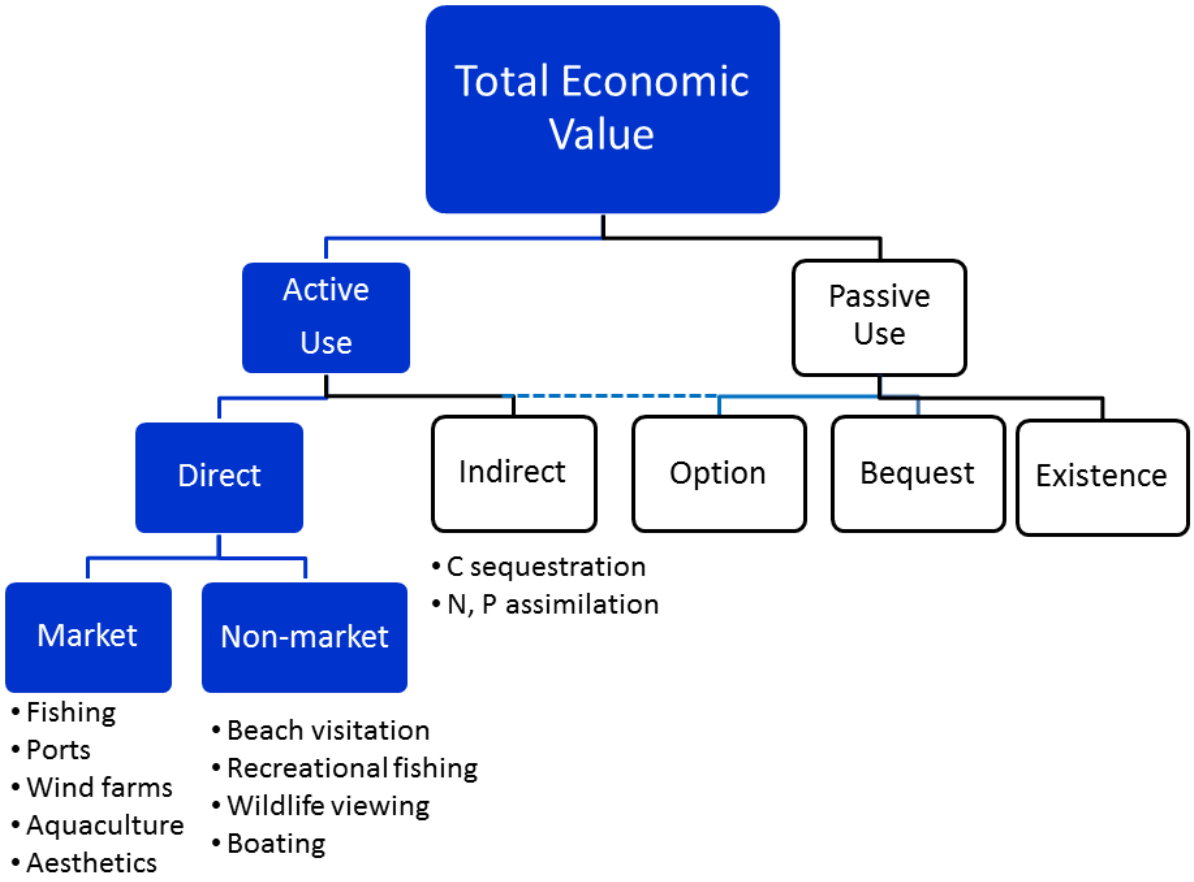

Figure 68 Typology of ecosystem service (ES) values
The Baseline Assessment focuses on those categories in blue.

into coastal real estate. Direct uses also involve non-market uses, such as beach visits or recreational fishing, typically do not involve explicit markets, and they must be valued using methods that examine travel costs or that question the user about her willingness-to-pay (WTP) for the particular use. Indirect uses involve waste assimilation, such as carbon sequestration, denitrification, or phosphorous removal. Passive uses involve no physical use of ecosystem services, but they recognize that humans may value the existence of these services or may value options to use them in the future or to ensure that they are available for future generations.

This assessment focuses mainly on values of direct, active uses (both market and nonmarket) for the coastal and marine resources of the Northeast region. This coverage is indicated by the solid blue elements of the typology in Figure 68. The values of passive uses are more uncertain, and little work has been undertaken to develop estimates of the scale of these uses in the Northeast. Passive uses are an obvious gap in ES valuation in this region, and they present a clear, albeit low priority, target for future valuation research.

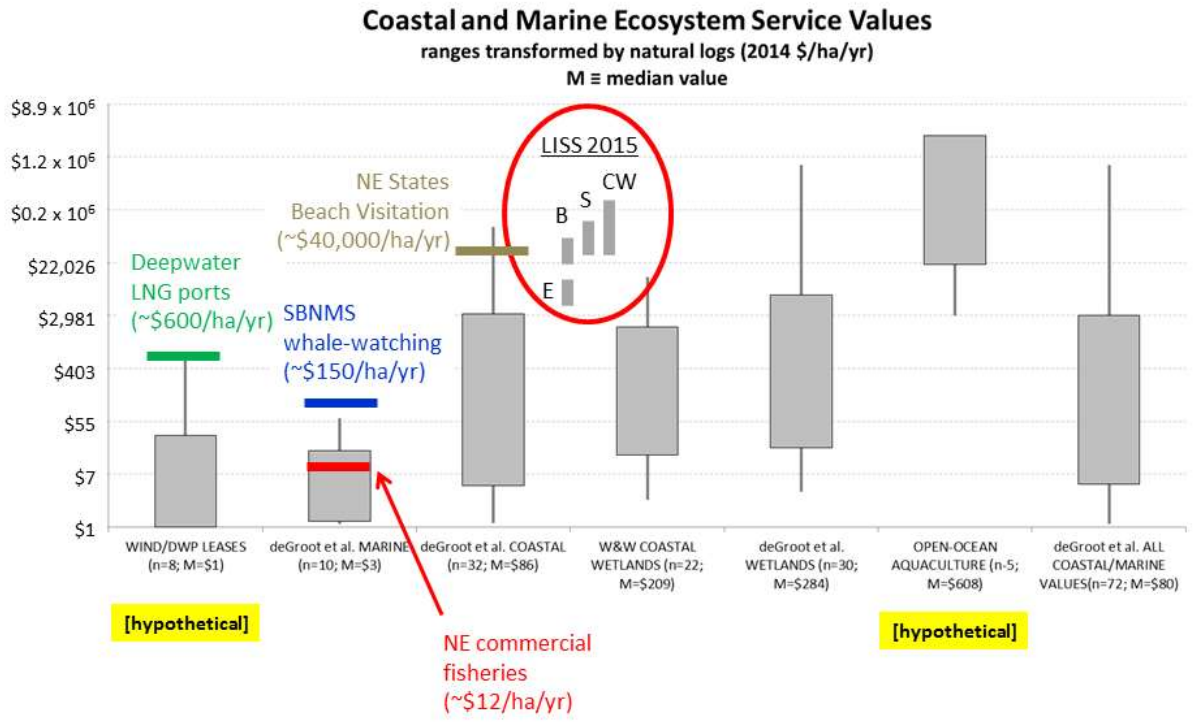

Figure 69 Comparison of coastal and marine ES values ($/ha/yr) from studies that develop composite resource estimates and with point estimates or ranges relevant to ES values in the Northeast region. Ranges in the red ellipse are from the recent study of ES values for the Long Island Sound Basin (E=estuary; B=beaches; S=seagrasses; CW=coastal wetlands). The values on the ordinate are log transformed but presented in real 2014 dollars. Sample size (n) and median values (M) are reported for each box-and-whisker plot. "Hypothetical" values relate to uses that have not yet been realized.

12.2. Assessment of Northeast region ecosystem service value studies

Figure 69 summarizes the general results of the assessment. The box-and-whisker plots comprise ± one standard deviation around mean values (the boxes) and minimum to maximum values (the whiskers). For comparison purposes, we report relevant composite (endpoint) estimates from de Groot *et al*. (2012), including marine, coastal, wetlands, and an all-combined category. For reference with respect to wetland ES values, we include also a box-and-whisker plot from an earlier compilation by Woodward and Wui (2001). The values on the ordinate have been transformed by natural logs, but they are expressed in real (2014) dollars. Sample sizes and median values are reported in the labels along the abscissa. These plots

were transformed for comparison purposes because the ranges are so broad; this figure highlights the very wide range (several orders of magnitude) of ES value estimates for coastal and marine ES values in the literature.

Estimates of annualized rents associated with leases of outer Continental Shelf (OCS) lands for renewable energy (wind power) are included in the first box-and-whisker plot on the left. The minimum value is zero (*i.e.*, Cape Wind was not required to compete for a lease, and so there exists no estimate of resource rent for that proposed project). The green line above this plot shows the approximate level of annualized "mitigation payments" for the two deepwater liquefied natural gas (LNG) ports located off Boston. Just to the right, the red line in the "marine" plot shows the approximate mean level of net revenues (2014 $/ha/yr) for New England commercial fisheries. The blue line above the "marine" plot shows the point estimate of the approximate level of nonmarket (travel cost) value for whale-watching at the Stellwagen Bank National Marine Sanctuary. The brown line above the "coastal" plot is a mean for beach visitation across states in the Northeast. In the second box-and–whisker plot from the right, we include the range of model-based estimates of the per hectare value of open-ocean aquaculture (OOA). Both the deepwater ports and the OOA plots are characterized as "hypothetical," because these uses have not yet occurred in the Northeast region's ocean area. (Atlantic salmon is grown out in nearshore netpen operations in Downeast Maine, and the results from salmon growout models are included in the OOA range.) Note that nearshore shellfish aquaculture occurring throughout the region typically is incorporated into estimates of commercial fisheries values.

The red ellipse in Figure 69 surrounds recent ranges of estimates of composite values (endpoints) for the Long Island Sound estuary (E) and its beaches (B), seagrass beds (S), and coastal wetlands (CW) (Kocian *et al*. 2015). As composite values, these estimates are at the high end of values reported in the literature, particularly those for coastal wetlands, although the values for beaches are very close to the regionwide average for the Northeast.

As one prominent example of ES values for a marine resource, we present our calculations for commercial fisheries here. Figure 70 summarizes the results of Jin *et al*. (2013), who analyze the spatial and temporal distributions over 674 ten-minute squares (TMS or 10' squares) during 1999-2008 for all commercial fisheries (including all gears and species) in New England (the Gulf of Maine, Georges Bank, and Southern New England).[5] Data are log-transformed but the labels on the abscissa are expressed in real (2014) dollars. Commercial fishing in about four percent of TMSs comprise net losses (zero or negative rents) during this period. Figure 70 also includes an earlier estimate of potential resource rents over two large-scale NAFO statistical areas (5Y and 5Ze) during 1976-1989 (Edwards and Murawski [E&M] 1993). This older study comprises the results of a bioeconomic

[5] Jin *et al*. (2013) discuss sampling issues, including the absence of data on trips that are considered to be proprietary.

optimization model for all groundfish landed by the otter trawl fishery (Atlantic cod, haddock, and yellowtail flounder comprised about half of the resource rents in this analysis). This work emphasizes the spatial and temporal variability in ES value data that must be taken into account when such values are employed in planning decisions.

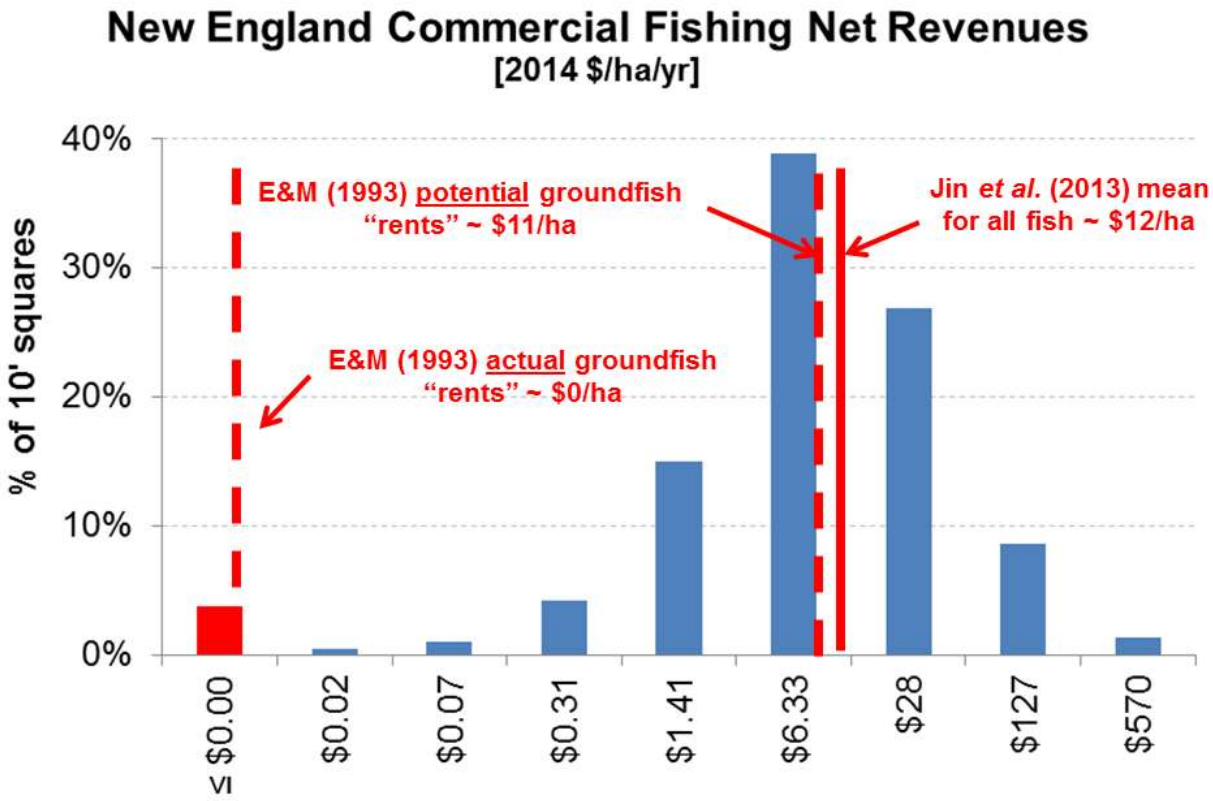

Figure 70 Histogram of the distribution of commercial fishing net revenues across ten-minute squares (10' squares or TMS) for all species in the Northeast region. Values along the abscissa have been transformed by logs but the labels constitute real 2014 dollars. Source: Jin et al. (2013). Included is a comparison with a modeling study by Edwards and Murawski (E&M 1993) for New England groundfish. The mean values from both studies are very close in value.

12.3. Gaps in present knowledge

Details on the calculations for each of the uses reported here and some of the issues that arise can be found in the appendix to the Baseline Assessment. Discussions for each of the uses include characterizations of the gaps in ES values. A literature exists on some of the drawbacks associated with benefits transfers and meta-analyses

(e.g., Walsh *et al*. 1992; Allen and Loomis 2008), which we do not review here. We summarize some of the most important gaps:

- ***Incomplete coverage***. Very few studies of the ES values in the Northeast region have been undertaken to date. Some ES values are difficult to estimate (navigation, underwater cultural resources, waste assimilation, ocean science, among others). Consequently, relevant values must be transferred from other studies pertaining to similar ESs from other locations and times. Such transfers often are subject to significant uncertainties, and the wide ranges of estimates from compilations of studies render planning problematic.
- ***Influential studies***. A corollary to the problem of incomplete coverage is that some local studies may be relied upon extensively to estimate ES values for the region. One the most important and influential set of studies include those that develop estimates for the Peconic Estuary System undertaken by researchers at the University of Rhode Island in the late 1990s (Johnston *et al*. 2002). These studies are still quite influential, forming one basis for recent estimates of the ES values for the Long Island Sound Basin (Kocian *et al*. 2015).
- ***Hypothetical future uses***. Many projected human uses of the coasts and oceans are only hypothetical at present (wetland restoration, renewable energy, OOA). The potential emergence of such uses is a fundamental driver of contemporary coastal and ocean planning. Estimates for ES values associated with such uses are few in number, and there is a clear priority for modeling studies and benefit transfers for these uses.
- ***Non-uniform spatial and temporal distributions***. ES values may arise at different locations and different points in time. Variables comprising geography (distance), environment (weather, climate, water quality, seabed features, currents, natural hazards), human uses (congestion, permanent vs. temporary occupation), or human preferences (cultural norms) can influence ES values strongly.
- ***Estimating unit values is difficult***. Many nonmarket valuation studies have focused mainly on developing WTP estimates without explicit reference to the spatial extent of coastal or ocean area that is being valued.[6] In many cases, careful characterization of the relevant areas can be developed through combining information about use patterns with valuation studies. Such work is a clear priority for establishing ES values for important human uses of the coasts and oceans, such as those for recreational fishing or boating.
- ***Passive uses unstudied***. Almost no work has been undertaken on the passive use components of total economic value. Indirect, active uses, such as waste assimilation, sometimes also are categorized as a component of passive uses, and developing estimates of ES values for C-sequestration and denitrification in near coastal waters is a clear priority. For the former, the effectiveness of

[6] In a meta-analysis of international wetland ES values, for example, Brouwer et al. (1999) estimate that two-thirds of the studies that they examined did not include information about the size of the area.

sequestration across coastal and marine environments (salt marshes, intertidal zones, seabeds, ocean waters) will be important.