Annex D:

EFH Impacts Assessment

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Atlantic Coast of Maryland Shoreline Protection Project
Borrow Sources for 2010 – 2044

Essential Fish Habitat (EFH) Impacts Analysis

U.S. Army Corps of Engineers, Baltimore District
November 2007

Atlantic Coast of Maryland Shoreline Protection Project
Borrow Sources for 2010 – 2044

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Executive Summary

The U.S. Army Corps of Engineers (Corps), Maryland Department of Natural Resources (DNR), Town of Ocean City (Ocean City), and Worcester County are proposing to dredge between 6,800,000 and 15,000,000 cubic yards of sand from several offshore shoals in Federal waters and place it onto Fenwick Island from the year 2010 to 2044 to maintain the Atlantic Coast of Maryland Shoreline Protection Project (Atlantic Coast Project). Offshore shoals proposed to be dredged include Isle of Wight, Weaver, and "A." An additional shoal, "B," was also evaluated. These offshore shoals are located 5 to 11 miles east of Fenwick Island in the Atlantic Ocean. Shoal "B" is currently of high value as a fishing grounds and will only be dredged in the future if its value as a fishing ground declines substantially. Sand from these sources would be dredged and placed at 4 year intervals or as needs dictate. Typical dredging volume per 4 year nourishment cycle is anticipated to be approximately 800,000 cubic yards. Total sand dredged from offshore shoal sources will largely be a function of storm occurrences over this time period. Sand from offshore shoal sources would be placed on the length of beach from the Maryland/Delaware state line to the Ocean City Inlet.

A borrow plan for the offshore shoals has been developed in coordination with resource agency personnel and academicians that would minimize impacts to geomorphic integrity[1] and long-term habitat value of those offshore shoals that are dredged. Mitigation measures include dredging no more than 5% of the total volume of any shoal, dredging uniformly over a wide area of each shoal (<10 feet thick), and avoiding the crest. Additionally, dredging would be conducted on the up or downdrift margin of the shoal where suitable sands occur at these locations. Dredging would be conducted by large sea-going dredges. Approximately 500 acres of offshore shoal bottom would be dredged during every dredging cycle. About 4,600 total acres may be dredged by the year 2044, although this total bottom impact area could be substantially less if borrow areas are redredged. Following dredging, offshore shoal topography in the dredged areas is expected to be roughly equivalent to that of pre-project conditions, albeit at a lower elevation. Surface materials would consist of sands comparable to those of the pre-dredged surface. Sessile and relatively non-motile benthos in the dredged areas would be

[1] "Geomorphologic integrity" of a shoal refers to its natural tendency to remain as a defined, bathymetric feature on the seafloor, with characteristics determined by modern physical processes and conditions acting upon those characteristics that are a function of its geologic history. A shoal could be considered to have lost its "geomorphologic integrity" if it essentially ceases to exist as a defined bathymetric feature, or is changed radically in geomorphologic character (for example, possesses large pits, trenches, or lacks a defined crest), and or separates into two or more smaller separately evolving features.

largely destroyed. It is anticipated that benthos in dredged areas would largely recover to pre-project conditions within several years of dredging.

The offshore shoals are natural geologic features. Invertebrate benthos of the offshore shoals are generally low in diversity compared to adjacent seafloor flat areas, but the shoals are likely a staging, orientation, and or foraging ground for a number of finfish species and seabirds. The Atlantic Ocean coastal waters in the vicinity of Fenwick Island and these offshore shoals are designated by the National Marine Fisheries Service (NMFS) as "Essential Fish Habitat" (EFH) for 17 species of bony finfish, 7 cartilaginous fish species, and 2 species of molluscs (NMFS, 2006). A review of impacts of the proposed project on EFH for these species was conducted in accordance with requirements of the Magnuson-Stevens Fishery Conservation and Management Act.

Bottom finfish inhabiting the offshore shoals during any dredging conducted in cold water temperatures would be most likely to be directly impacted by dredging, since they would be more sluggish and less able to avoid entrainment. However, since minimal dredging is anticipated in cold-weather conditions, direct impacts are not expected to have measurable impacts to populations of these finfish. Demersal species likely to be present in cool weather on the offshore shoals include Atlantic cod, Atlantic sea herring, red hake, scup, windowpane flounder, winter flounder, and witch flounder. Indirect impacts on the offshore shoals would also be of concern to these and other species of demersal finfish for which bottom habitat conditions are of particular importance. Additional demersal finfish species likely to be indirectly impacted by dredging the offshore shoals include black sea bass, summer flounder, Atlantic angel shark, and sandbar shark. Indirect impacts resulting from destruction of benthos and concomitant loss of prey species at each offshore shoal site will be significant for a several year period at each dredging site until such time as benthos recover to pre-project conditions. Long-term indirect impacts are expected to be very minor following invertebrate benthos recolonization of the offshore shoal sites. Surf clam inhabiting the offshore shoal borrow areas would be destroyed during dredging, but are anticipated to recolonize the borrow areas to pre-project levels within several years following dredging.

The Baltimore District has determined that the proposed project will adversely affect EFH. However, the project incorporates appropriate mitigation measures to minimize long-term detrimental impacts, and as such complies with the provisions of the Magnuson-Stevens Act, as amended.

I. Introduction

Provisions of the Magnuson-Stevens Act and amendments require that all Federal agencies consult with NMFS on all Federal actions that may adversely affect EFH. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." The EFH areas have been designated by the Fishery Management Councils and were published in March 1999 by NMFS. This EFH Assessment is being prepared pursuant to Section 305(b)(2) of the Magnuson-Stevens Act, and includes the following required parts: identification of species of concern; a description of the proposed action; an analysis of the effects of the proposed action; proposed mitigation; and the Federal agency's views regarding the effects of the proposed action.

A proposed future borrow plan for Fenwick Island was formulated under the auspices of the Atlantic Coast Project *General Reevaluation Study* from 2001 to 2006. A supplementary Environmental Impact Statement (SEIS) has been prepared which documents formulation of the borrow plan. The borrow plan was formulated with substantial input from resource agency personnel and academic experts.

The Atlantic Coast Project was formulated prior to the first EFH designations. The first EFH designations were not prepared until October 1998. However, Federal agencies must consult with NMFS regarding any of their actions authorized, funded, or undertaken that may adversely affect EFH if the action has not yet been completed. An assessment of impacts to EFH of dredging 1,800,000 cubic yards of sand from Great Gull Bank and placing it on Assateague Island for the Short-Term Restoration of Assateague project was prepared in April 2001. Subsequently, in January 2002, an EFH impacts assessment document was prepared that evaluated dredging of Borrow Area 9 for beach nourishment of Ocean City to be conducted that year. Both this and the 2001 document evaluated impacts to 19 species of finfish. Project area waters of the proposed future borrow sources cover a greater geographic area and contain designated EFH for 31 species (Section II). Since future sand sources dredged from Federal waters for Ocean City will differ from those used previously and EFH for additional species not previously evaluated will be impacted, it is necessary to prepare an additional EFH impacts assessment.

A. Sand Needs and Proposed Sources

Identified sand sources in Maryland state waters for the Atlantic Coast Project are forecast to be exhausted after about 2010. Ocean City beach has been maintained by beach nourishment since 1988 (Table 1). The economic life of the Corps' project ends in 2044. Project performance subsequent to initial recreational beach establishment provides a means to estimate future minimum and maximum volume needs. Based on beach nourishment work completed between 1998 and 2006, a period lacking severe storms, minimum total future needs through 2044 would be 6,800,000 cubic yards. Based on beach nourishment after 1991 which included three severe storms, maximum total needs would be approximately 15,000,000 cubic yards through 2044.

Table 1: History of sand placement at Ocean City from offshore sources and dredging dates. 1988 project was constructed by state of Maryland, remaining projects constructed by Federal government.

Year	Project	Volume Placed (Cubic Yards)	Dredging Dates	Offshore Shoal Borrow Source
1988	Recreational Beach Establishment	2,700,000	Completed Sept.	2 & 3
1990	Storm Protection Beach Establishment	2,198,987	7/16 to 10/21	2 & 3
1991		1,622,776	6/21 to 8/6	3
1992	Storm Rehabilitation #1	1,592,262	5/17 to 9/1	9
1994	Storm Rehabilitation #2	1,245,125	4/29 to 6/26 & 9/14 to 10/14	9
1998	Renourishment #1	1,289,817	5/27 to 7/1 & 9/15 to 10/16	9
2002	Renourishment #2	744,827	5/1 to 6/26	2 & 3
2006	Renourishment #3	931,710	9/14 to 11/30	9

B. Proposed Project Description

Because of the nature of Maryland coastal geology combined with economic, engineering, and environmental factors, large oceanic shoals contain the optimal sources of sand for Atlantic Coast Project purposes. Four detached offshore shoals are proposed as future sources of sand for Ocean City: Weaver, Isle of Wight, Shoal A, and Shoal B (Figure 1). These shoals were selected from among those off the Maryland coast based upon proximity to Ocean City, and potential for producing an adequate quantity of sand with an appropriate grain-size distribution. Within these four shoals, sub-areas have been preliminarily delineated based on grain-size of sand and presence/absence of artificial reefs (Figures 2 and 3; Table 2). Area of preliminarily delineated preferred borrow areas totals 870 acres on Shoal A, 1,690 acres on Shoal B, 1,000 acres on Weaver Shoal, and 1,030 acres on Isle of Wight Shoal. Preferred areas for dredging were selected based on compatibility of sediment grain-size of the shoal with materials on the beach at Fenwick Island and need to avoid artificial reef areas. Within these preferred areas, quantities of beachfill to the shoal base were determined. These areas may be adjusted or moved somewhat as a result of further analysis, actual quantity needed, and/or as a result of comments received. None of these offshore shoals have been dredged previously for borrow, however the surface of all has presumably been impacted by commercial fishing gear (Churchill 1989), particularly during harvesting of surf clam (USFWS, 1996). The USFWS determined in 2004 that Shoal B is of very high value as a fishing grounds through interviews with commercial and recreational fishermen and recommended against dredging from this shoal. Accordingly, the Baltimore District Corps determined that this shoal will not be dredged unless its value as a fishing grounds declines substantially in the future relative to the other three shoals. This determination would be made in coordination with USFWS and NMFS and perhaps DNR. Each shoal would be dredged in a manner incorporating mitigation measures to minimize impacts to shoal geomorphic integrity over the long-term (Section IV).

Table 2: Offshore shoal geotechnical sub-area characteristics. Note that combined quantities for Shoal A sub-areas III and IV and Isle of Wight Shoal sub-areas I and II are presented.

Shoal	Sub-area	Surface Area (acres)	Elevation Evaluated to (ft)	Sand Size Class (Wentworth)	Quantity net beachfill (Million cubic yards)*
A	I	290	-55	Medium	3.8
A	II	590		Medium	0
A	III	200		Coarse	6.8
A	IV	380		Medium	
B	I (Rev)	1690	-55	Medium	34.2
B	III	2720		Medium	0
Weaver	I	320	-60	Coarse	7.4
Weaver	II (A&B)	680		Coarse	18.9
Weaver	III	570		Medium	0
Isle of Wight	I	530	-55	Medium	30.7
Isle of Wight	II	500		Medium	
Isle of Wight	III	1070		Medium	0
Isle of Wight	IV	690		Medium	0
Total	N/A	10,230	N/A	N/A	101.8

*Preferred borrow areas have non-zero volume.

Current Atlantic Coast Project practices offer a likely description of how work would be conducted for the foreseeable future. Beach nourishment for the Atlantic Coast Project generally takes place every 4 years, however work may occur more frequently as necessary to maintain storm protection functions of the Ocean City beach. It is expected that a hopper dredge or cutterhead dredge will be used to dredge sand from the offshore shoals. One or more dredges may be used at a time. If a hopper dredge is used, sand will be dredged off the shoal and pumped into the vessel while the hopper dredge is transecting the borrow area until the hopper is full. Current Island-Class hopper dredges have an effective hopper capacity of 1,888 yd^3. Dredging may create a series of parallel furrows in the seafloor up to several feet deep, with remnant ridges left between the furrows. The hopper dredge will then travel to a pump-out point located up to several thousand feet offshore of Fenwick Island where a barge with a booster pump will be waiting. The barge mounted booster pump will pump the sand in a slurry from the dredge to the beach through a pipeline. The slurry will daylight onto the beach or into the surf zone. The pipeline will lie on the seafloor oriented perpendicularly to the shoreline and be marked with buoys. The weight of the pipe alone will keep it on the bottom; it will not be anchored. Following pumpout, the hopper dredge will then return to the borrow area and resume dredging. To produce 800,000 cubic yards for one anticipated typical nourishment cycle, approximately 425 total round-trip transits to/from the borrow area would be required at 1,888 cubic yard vessel capacity. If a cutterhead dredge is used, sand will be pumped from the borrow area through a pipeline on the sea floor to the beach. If required, a floating booster pump would be added to the pipeline.

Bulldozers will then be used to create areas to trap and shape sand as it exits the pipeline to form the beach. Water will drain from the sand and run into the ocean. Pumping of sand will be done for a maximum distance of up to 4,000 feet north or south of where the pipeline crosses up onto the beach. Beach nourishment will be completed in sections of 8,000 feet. Once an 8,000 ft section of the project is built, the barge and booster pump would be moved to a new pump out point to continue the project. Sand will be placed on the ocean shoreline of Fenwick Island in the area between the Maryland/Delaware State Line and the northern inlet jetty to maintain beach condition according to the construction template (Figure 4). Following establishment of dynamic equilibrium within several months with ocean conditions, beach widths will gradually retreat until the time of the next beach nourishment cycle.

Dredging for the Atlantic Coast Project has historically occurred predominantly between the months of April and October to avoid winter sea conditions (Table 1); minimal to no dredging typically occurs during the months of July and August. Future dredging could potentially occur during any month of the year, but substantial winter dredging would be unlikely because of greater ocean wave energy and resultant higher risk to ships and crew as well as difficulty of operation. Dredging conducted since 1998 typically took up about 8 weeks to complete. Inclement weather or equipment problems may increase the amount of time required.

C. Identification of Species of Concern

Species and their life history stages for which the project area coastal ocean waters of Maryland are designated as EFH were identified by consulting NMFS (2006) and coordinating with John Nichols of NMFS in 2006. The project area extends from the ocean beach of Fenwick Island eastward out to the coastal ocean waters of the offshore shoals. NMFS lists species for which EFH is designated by 10' squares. The project area is contained within four 10’ x 10’ squares (Table 3). These four 10' squares contain designated EFH for 20 species of bony fish, 9 species of cartilaginous fish, and 2 mollusc species. However, designated EFH for several of these species (Tables 4 and 5) lies seaward of the 25 m (80 ft) isobath; water depths of the offshore shoals and waters between the shoals and shore do not exceed approximately 60 ft depth (Table 2). Accordingly, project area waters lie landward of designated EFH for these species, and impacts to these species are not specifically assessed in this document. Project area waters contain designated EFH for 17 species of bony fish (Table 6), 7 species of cartilaginous fish (Table 7), and 2 mollusc species (Table 8). Scientific names of aquatic species evaluated in this report are provided in Tables 6, 7, and 8. For other aquatic species, the convention of listing the scientific name only on the first occurrence of the species in the report is followed.

Table 3: 10' x 10' squares covering project impact area. Text modified from NMFS (2006).

10’ x 10’ Square Description	Boundary Coordinates			
	North	East	South	West
Atlantic Ocean waters within the square one square east of the square affecting northern Assateague Island	38° 20.0’ N	74° 50.0’ W	38° 10.0’ N	75° 00.0’ W
Open ocean waters within the square within the Atlantic Ocean east of northern Assateague Island and southeast of Ocean City, MD., and within Chincoteague Bay and within Sinepuxent Bay	38° 20.0’ N	75° 00.0’ W	38° 10.0’ N	75° 10.0’ W
Atlantic Ocean waters within the square one square east of the square affecting Fenwick Island on Isle of Wight Shoal and Fenwick Shoal.	38° 30.0’ N	74° 50.0’ W	38° 20.0’ N	75° 00.0’ W
Atlantic Ocean waters within the square east of southernmost Delaware and northernmost Maryland south past Fenwick Island, MD., to Ocean City, MD. These waters also include Assawoman Bay to the Ocean City Inlet.	38° 30.0’ N	75° 00.0’ W	38° 20.0’ N	75° 10.0’ W

Table 4: Bony finfish species with EFH designated in 10' minute square waters seaward of 25 m isobath.

No.	Species common name	Scientific name	Eggs	Larvae	Juve-niles	Adults
1	bluefin tuna	*Thunnus thynnus*			x	x
2	skipjack tuna	*Katsuwonus pelamis*				x
3	swordfish	*Xiphias gladius*			x	

Table 5: Cartilaginous finfish species with EFH designated in 10' minute square waters seaward of 25 m isobath.

	Shark species common name	Scientific name	Eggs	Neonate / Early Juveniles	Late Ju-veniles / Sub-adults	Adults
1	blue	*Prionace glauca*				x
2	shortfin mako	*Isurus oxyrhyncus*		x	x	

Table 6: Bony finfish species and their life history stages for which project area waters are designated as EFH (NMFS, 2006).

No.	Species common name	Scientific name	Eggs	Larvae	Juve-niles	Adults
1	Atlantic butterfish	*Peprilus triacanthus*	x		x	x
2	Atlantic cod	*Gadus morhua*				x
3	Atlantic mackerel	*Scomber scombrus*				x
4	Atlantic sea herring	*Clupea harengus*			x	x
5	black sea bass	*Centropristus striata*	n/a	x	x	x
6	bluefish	*Pomatomus saltatrix*		x	x	x
7	cobia	*Rachycentron canadum*	x	x	x	x
8	king mackerel	*Scomberomorus cavalla*	x	x	x	x
9	monkfish	*Lophius americanus*	x	x		
10	red hake	*Urophycis chuss*	x	x	x	
11	scup	*Stenotomus chrysops*	n/a	n/a	x	x
12	Spanish mackerel	*Scomberomorus maculatus*	x	x	x	x
13	summer flounder	*Paralicthys dentatus*	x	x	x	x
14	windowpane flounder	*Scopthalmus aquosus*	x	x	x	x
15	winter flounder	*Pleuronectes americanus*			x	x
16	witch flounder	*Glyptocephalus cynoglossus*	x	x		
17	yellowtail flounder	*Pleuronectes ferruginea*		x		

"n/a" indicates there is insufficient data for the life stages listed, and no EFH designation has been made as of yet.

Table 7: Cartilaginous finfish species and their life history stages for which project area waters are designated as EFH (NMFS, 2006).

No.	Shark species common name	Scientific name	Eggs	Neonate / Early Juveniles	Late Ju-veniles / Sub-adults	Adults
1	Atlantic angel	*Squatina dumerili*		x	x	x
2	Atlantic sharpnose	*Rhizopriondon terraenovae*				x
3	dusky	*Charcharinus obscurus*		x		
4	sand tiger	*Odontaspis taurus*		x		x
5	sandbar	*Charcharinus plumbeus*		x	x	x
6	scalloped hammerhead	*Sphyrna lewini*			x	
7	tiger	*Galeocerdo cuvieri*		x	x	

Table 8: Mollusc species and life history stage for which project area waters are designated as EFH (NMFS, 2006).

	Species common name	Scientific name	Eggs	Larvae	Juveniles	Adults
1	long finned squid	*Loligo pealei*	n/a	n/a	x	
2	surf clam	*Spisula solidissima*	n/a	n/a	x	x

For these mollusks, NMFS utilizes "n/a" to indicate either that no data is available on the designated lifestages, or those lifestages are not present in the species' reproductive cycle. For population management purposes, long finned squid and surf clam are typically referred to as pre-recruits and recruits, this corresponds with juveniles and adults in the table.

II. Existing Conditions

To fairly evaluate impacts to EFH and identify appropriate potential mitigation measures for the proposed project, it is appropriate to consider impacts at the offshore shoals and Fenwick Island themselves, as well as within a larger regional context. For the purposes of this analysis, the appropriate largest regional context within which impacts should be considered for an indirect and cumulative impacts analysis would be the Mid-Atlantic bight. The Mid-Atlantic bight is the inner continental shelf region between Cape Cod and Cape Hatteras. This region possesses coherent geological and biological character distinct from shelf waters to the north and south. However, since this region is fairly vast, it is also appropriate to consider impacts at the somewhat smaller scale of the Delmarva peninsula. Both contexts will be utilized in this analysis, as appropriate.

A. Physical Environment

The seafloor of the Delmarva continental shelf gradually increases in depth proceeding offshore to about 200 m (660 ft or 110 fathoms) in depth where the Continental Slope begins and water depths increase more rapidly proceeding seaward (Figure 5). The Mid-Atlantic Bight continental shelf can be characterized as a flat seafloor plain, but it does possess large-scale bathymetric relief features, including terraces, sand ridges, sand waves, shoals, and undersea canyons. Terraces and canyons lie distant from project area waters and will not be considered further in this analysis.

The offshore shoals are natural geologic features believed to have been formed as ancient ebb-tidal deltas, but have since been maintained and undergone evolution via continental shelf processes. From this perspective, they can effectively be considered as nonrenewable resources. The offshore shoals are believed to have important habitat functions for marine life (USACE, 1998). The relative importance of several offshore shoals in the study area as habitat for highly mobile finfish and epibenthic invertebrates was recently investigated by MMS (2006). Some of the offshore shoals are recognized to be important fishing grounds. However, in some cases this may be a product of the presence of artificial reefs rather than of the character of the shoals themselves. Off Maryland's coast, the volume of sand contained in oceanic shoals contain is substantially greater than that required to maintain Ocean City. However, in Delaware where fewer offshore shoals occur NMFS has determined that those shoals present may be of high value as habitat for finfish. Accordingly, Philadelphia District USACE focused investigations to identify future beach nourishment sand sources on non-shoal areas of the seafloor (Steve Allen, Philadelphia District, personal communication).

The largest concentration of sand ridges and shoals are in the inner to middle shelf. Sand ridges and shoals range in length from 1 to 56 km (0.5 to 35 mi), 1 to 3 km wide (0.6 to 2 mi) and are up to 10 m (33 ft) high. On the average they are spaced 1.6 to 6 km (1 to 3.7 mi) apart (Amato, 1994; McBride and Moslow, 1991). The inner continental shelf along the Delmarva peninsula has a large, well-developed field of shore-attached and detached sand ridges. Shoals in the Ocean City vicinity are depicted in Figure 1. There are 22 large shore-detached offshore shoals that have been inventoried by the Maryland Geological Survey in coastal ocean waters off Maryland (Table 9). These shoals off Maryland possess a total surface area of 75.2 mi^2 (>48,000 acres) and a total sand volume in excess of 1,236,000,000 yd^3. Detached (i.e., not attached to the shoreline) nearshore and offshore shoals formed over the last several thousand years, with those in the vicinity of the Maryland/Delaware border having originated predominantly as ebb-tidal deltas. As the shoreline retreated with rising sea-level, the ebb-tidal deltas became detached from the shore, and began to migrate independently of shoreline retreat (Conkwright, personal communication; McBride and Moslow, 1991). Swift and Field (1981) reported that offshore shoals may migrate at rates of 2 to 120 m (6 to 400 ft) per year. Monitoring studies of Borrow Areas 2 and 3 recently completed by MGS found that these two shoals migrated at rates of 15 to 30 ft/yr from the 1970s through 2004 to the south. Regionally, detached shoals in Maryland waters have been reported as generally migrating to the southeast (McBride, personal communication; Swift and Field, 1981). Shoal side slopes typically average about 1° (McBride and Moslow, 1991).

Table 9: Geomorphic characteristics of large offshore shoals in Maryland coastal ocean waters*. Shoals presented geographically from north (top) to south (bottom).

Tally	Shoal (N to S)	Distance Offshore - Centroid (mi)	Total Sand (yd3)	Base Water Depth (ft)	Area (mi2)	Base Length (mi)	Maxi-mum Width (mi)	Shoal Crest Water Depth (ft)	Relief (ft)
1	Fenwick	6.8	211,000,000	-60	10.5		2.5	-12	48
2	Borrow Area 3**	3.1				3.5	0.8		
3	Borrow Area 8	1.5							
4	Weaver	7.2	93,000,000	-60	3.8	4.1	1.4	-24	36
5	Borrow Area 9	3.1							
6	Isle of Wight	7.2	136,000,000	-60	5.5	4.9	1.6	-18	42
7	Borrow Area 2**	2.5	11,000,000			2.4	0.7	-30	
8	E	6.4	31,000,000	-60	3.2	4.0	1.1	-45	15
9	A	9.6	103,000,000	-60	5.2	3.7	1.5	-32	28
10	Little Gull Bank	3.0	50,000,000	-43	2.9		0.9	-16	27
11	B	11.0	50,000,000	-60	4.4	4.7	1.2	-27	33
12	C	11.3	8,000,000	-60	0.7		0.6	-33	27
13	D	13.1	24,000,000	-60	2.5		0.9	-36	24
14	Great Gull Bank	4.5	63,000,000	-50	2.8		0.9	-17	33
15	Charlene	2.2							
16	F	4.2	55,000,000	-53	5.9	7.0	1.2	-28	25
17	K	8.6	139,000,000	-70	8.5	6.5	1.9	-21	49
18	M	4.6	20,000,000	-55	1.5	2.0	0.9	-19	36
19	H	2.3	42,000,000	-54	4.4	6.9	1.1	-23	31
20	I	3.1	65,000,000	-54	5.1	5.6	1.3	-27	27
21	J	5.9	63,000,000	-63	4.1	3.7	1.5	-22	41
22	L	9.8	72,000,000	-70	4.2	3.4	1.7	-26	44
	Total		>1,236,000,000		>75				

***Information compiled from MGS reports. Data not available for blank cells.**
****Pre-dredging. From recent MGS monitoring study.**

The seafloor on the continental shelf along the Delmarva peninsula from the mouth of Delaware Bay to about the Maryland/Virginia border is predominantly covered by medium to coarse-grained sand from the shoreline to about 100 to 200 m (330 to 660 ft) in water depth. The area of the continental shelf off the Delmarva peninsula between the mouth of Chesapeake and Delaware Bays within Federal waters out to the 100 m (330 ft) bathymetric contour is about 14,400 km^2 (5,600 mi^2); the area of the Delmarva continental shelf seafloor covered by medium to coarse-grained sands is about 11,200 km^2 (4,300 mi^2) (data derived from Amato [1994]). Most shoals contain clear, medium to coarse-grained sand that is texturally similar to onshore beaches (Amato, 1994; McBride and Moslow, 1991).

The coastal ocean off the Delmarva peninsula has one of the most extreme seasonal ranges of sea temperature in the world (MMS, 2000). Sea surface temperatures along the Maryland coastal ocean range from lows of about 43ºF in February to highs of about 76ºF in August. Sea surface temperatures are consistently cold during the months of January through March, warming from April through June, consistently warm from July through September, and then cooling from October through December (Figure 6) (USN, 2001). The salinity in the region ranges from about 30 to 33 parts per thousand. The water circulation in this region of the inner continental shelf is characterized by a general southward movement of the surface and bottom water throughout the year (USACE, 1998). Average southerly currents are on the order of 10 cm/sec (0.3 ft/sec) or about 0.2 knots (0.4 km/hr) (Brooks, 1996). However, from April to September, the surface water movement may periodically reverse and move northward in association with the prevalence of south winds (USACE, 1998). Continental shelf waters undergo progressive thermal stratification from spring through summer when the thermocline reaches a depth of 9 to 12 m (30 to 40 ft). At coastal locations within the 20 m (65 ft) contour, the stratification is somewhat less intense as the shallower depths permit some turbulent mixing through the water column. Water quality in the Atlantic Ocean off Ocean City is generally very good (USACE, 1998). The mean ocean tide range at Ocean City is 1.07 m (3.5 ft); spring tide range is 1.28 m (4.2 ft) (MMS, 2000).

B. Living Things

As a consequence of the great seasonal variation in temperature, most of the fishes of Maryland's coastal ocean migrate seasonally. Boreal species are present in winter and warm-temperate/sub-tropical species are present in summer. The coastal region provides habitat for a wide variety of demersal (bottom) and pelagic (open water) fishes with highest diversity in September and lowest diversity in late winter (February/March). Only a small percentage of species are resident year-round. In winter, the fauna is dominated by species such as sea herring, Atlantic mackerel, hakes (*Urophycis, Merluccius*),monkfish, and spiny dogfish (*Squalus acanthias*). As temperatures rise in the spring and summer, warm water species such as bluefish and weakfish (*Cynoscion regalis*) enter the region, while cold water species such as Atlantic cod, Atlantic sea herring, and American shad (*Alosa sapidissima*) migrate north. In summer, the fauna is dominated by warm temperate and sub-tropical species such as summer flounder, croakers, drums, sea trouts, menhaden (*Brevoortia tyrannus*), and large coastal sharks. As fall approaches, warm water species such as summer flounder, butterfish, and black sea bass may migrate offshore toward deeper waters and then move southward, while cold water species move south into the Mid-Atlantic bight. In spring and fall the area is an important migration corridor for striped bass (*Morone saxatilis*) and bluefish. Many of the dominant species noted above are extremely valuable and important to recreational or commercial fisheries or both (MMS, 2000).

Significant quantities of fish larvae can be found throughout the Mid-Atlantic bight all year. This may be due to the large number of spawning species, extensive dispersal of eggs and larvae, and spawning periods of long duration, as well as to the continuous influx/outflux of northern and southern species. In general, fish that spawn in the Mid-Atlantic bight broadcast pelagic eggs. Thus, eggs and larvae have the potential to be dispersed throughout the region and into habitats different than the spawning grounds. Often, offshore spawners have larvae that are transported with currents to inshore or estuarine nursery grounds. Benthic spawners, although having benthic eggs, often have larvae which exhibit a dispersive pelagic stage. Spawning and egg/larval populations vary seasonally within the Mid-Atlantic bight. The majority of the species present have a spawning period that includes spring and/or summer. Commercially and recreationally important species that utilize the Mid-Atlantic Bight inner shelf during spawning or in early life stages include bluefish, summer flounder, Atlantic mackerel, Atlantic Butterfish, scup, and black sea bass (MMS, 2000).

Potential use of the proposed dredging area by finfish life history stage varies. Some species may use the area in more than one capacity, (*i.e.*, a primary nursery area for larvae or young, a spawning and nursery area, or as a fall migration path for young and adults). Species that historically have been observed using the inshore areas as nursery grounds include tilefish (*Lopholatilis chamaeleonticeps*), bluefish, spot (*Leiostomus xanthurus*), Atlantic croaker (*Microposgon undulatus*), northern kingfish (*Menticirrhus saxatilis*), summer flounder, Atlantic menhaden, goosefish, northern sea robin (*Prionotus carolinus*), and Atlantic mackerel. Species that also may use the area as spawning grounds include bay anchovy (*Anchoa mitchilli*), striped anchovy (*Anchoa hespetus*), black sea bass, weakfish, tautog (*Tautoga onitis*), Atlantic butterfish, windowpane flounder, mummichog (*Fundulus heteroclitus*), sand lance (*Ammodytes* spp.), and winter flounder. Many of the above species as well as American shad and striped bass, which are freshwater spawners, subsequently traverse the inshore areas during fall migrations offshore (MMS, 2000). Net sampling studies conducted from fall 2002 to summer 2004 for the MMS (MMS, 2005) in study area waters (including both shoals and seafloor flats) found that spotted hake, scup, and winter skate (Raja ocellata) were the finfish collected in greatest numbers over the study period. Windowpane flounder and winter skate were highly prevalent species, being collected at nearly every site throughout the entire year.

C. Habitats and Associated Life

Generally, the deeper regions surrounding the shoals off the Maryland/Delaware coast appear to be more biologically active and productive than the shoal crests and northwest faces of the shoals. However, certain species appear to be more prevalent on the shoals; May 1999 trawls of Fenwick, Weaver, and Isle of Wight Shoals along the Maryland/Delaware border found filter-feeding epibenthos and sand dollars (*Echinarachnius parma*) to be more prevalent on the shoals. Portions of shoals containing interbedded sands and muds appeared to contain diverse and numerous epifauna and infauna. Sandy portions of the shoals appear to be preferred by moon shell (*Polinices* spp.) and sand dollar (MMS, 2000). Surf clam were among the dominant taxa of the three shoals, being collected in greater than 20% of grab samples (MMS, 2000).

Sampling of juvenile fish in 1998 and 1999 found 25 taxa (MMS, 2000; Diaz et al., 2003). Sand lance (also known as sand eels) (*Ammodytes* spp.), smallmouth flounder (*Etropus microstomus*), spotted hake (*Urophycis regia*), northern sea robin (*Prionotus carolinus*), and clearnose skate (*Raja eglanteria*) tended to be the most abundant species. Sand lance occurred only on dynamic coarser sands near the top of the shoals. Worm tube habitats off the shoals had about twice as many fish relative to the bare sand habitats on the shoals during the day, but at night the pattern reversed with more fish present on the bare sand shoal habitats. Studies of highly motile epibenthos and pelagic invertebrates and vertebrates conducted from fall 2002 to summer 2004 for the MMS (MMS, 2005) found 57 taxa of finfish. Spotted hake, scup (*Stenotomus chrysops*), and winter skate (*Raja ocellata*) were the finfish collected in greatest numbers over their study period, while windowpane flounder (*Scophthalmus aquosus*) and winter skate were highly prevalent species, being collected at nearly every site throughout the entire year. Finfish abundance and species diversity were generally higher at the seafloor flats than on the shoals. Windowpane, butterfish (*Peprilus triacanthus*), and spotted hake were caught throughout seasonal samples in higher numbers over the seafloor flats than over the shoals. Other finfish species showed seasonal patterns of distribution. Scup in fall, winter skate in winter, and northern sea robin in summer are examples of common species that were captured in daytime netting more frequently on seafloor flats than on the shoals. Sand lance were netted more frequently on the shoals. Netted finfish of the shoals and seafloor flats differed most greatly in species composition in fall and winter, and were far more similar in spring and summer. Nineteen species of finfish were collected only on either shoals or seafloor flat sites but not both. However, 18 of these species were infrequently collected and it is unclear whether their presence/absence resulted from habitat preference or chance. Among these, only bay anchovy (*Anchoa mitchilli*) was commonly captured; it was collected only at seafloor-flat sites. In nighttime bioacoustic sampling conducted from spring through fall it was found that Fenwick and Weaver Shoals showed greater concentrations of finfish (species not identified) than did Shoal B or D or adjacent seafloor flats, and attributed this to diurnal migration between the shoals and adjacent seafloor flats. Greater concentrations of fish on Fenwick and Weaver Shoals could occur as a function of the greater relief of those features; Shoal B and D possess lesser relief. However, other variables could also contribute to or control the observed fish distribution patterns. Juvenile and adult life history stages of finfish species with EFH designated in the area collected during this 2002 through 2004 effort are presented in Tables 10 and 11.

MMS (2005) found that squid (class Cephalopoda) occurred throughout study area waters in high abundance in all seasons but winter. Two species were most commonly identified: shortfin squid (*Illex illecebrosus*) and longfin inshore squid (*Loligo pealei*).

Table 10: Bony fish species with EFH designated in the project area collected by VERSAR for MMS.

Common Name	Juvenile	Adult
Black sea bass	X	X
Atlantic herring		X
Atlantic cod		X
Monkfish		X
Summer flounder		X
Butterfish	X	X
Winter flounder		X
Bluefish		X
Cobia		X
Atlantic mackerel	X	
Spanish mackerel		X
Windowpane		X
Scup	X	X
Red hake	X	

Table 11: Cartilaginous fish species with EFH designated in the project area collected by VERSAR for MMS.

Common Name	Juvenile	Adult
Dusky shark	X	
Sandbar shark	X	
Atlantic sharpnose shark		X
Atlantic angel shark		X

The offshore shoals are believed to be important features to which migrating finfish and motile epibenthos orient to for navigational purposes or stage upon at various times of the year. Finfish appear to orient to the features during fall migrations (Ruddy, personal communication). The shoals provide structure for finfish that would otherwise be lacking on the otherwise largely flat seafloor (Casey, personal communication). The shoals may serve to maintain physical habitat diversity by contributing to maintenance of adjacent lows and seafloor flats; MMS will fund investigations to look into this possibility. Finfish found to be gathering at the shoal in night conditions (MMS, 2005) are presumably foraging, although they could perhaps be engaging in other behaviors.

D. Fisheries

Species are grouped for fishery management purposes. Geographic management groups of the bony finfish are listed in Table 12. All the cartilaginous fish are included in the "Highly Migratory & Billfish" geographic management group. All Federal fisheries for sharks, except dogfish, are managed under the Fishery Management Plan for Atlantic tunas, swordfish, and sharks. Both mollusks are in the "Mid-Atlantic" geographic management group. Stock status of bony and cartilaginous finfish species for which recent compiled information is available is presented in Tables 13 and 14.

Table 12: Bony finfish species geographic management groups.

Tally No.	Species common name	Geographic Management Group
1	Atlantic butterfish	Mid-Atlantic
2	Atlantic cod	New England
3	Atlantic mackerel	Mid-Atlantic
4	Atlantic sea herring	New England
5	black sea bass	Mid-Atlantic
6	bluefish	Mid-Atlantic
7	cobia	South-Atlantic
8	king mackerel	South-Atlantic
9	monkfish	New England & Mid-Atlantic
10	red hake	New England
11	scup	Mid-Atlantic
12	Spanish mackerel	South-Atlantic
13	summer flounder	Mid-Atlantic
14	windowpane flounder	New England
15	winter flounder	New England
16	witch flounder	New England
17	yellowtail flounder	New England

Table 13: Status of bony fish fisheries stocks for mid-Atlantic and adjacent areas (NMFS, 2006).

Species	Stock	Council	FMP	Over-fishing? *	Over-fished? *	Approach-ing Over-fished?*
Atlantic butterfish	Butterfish	MAFMC	Atlantic mackerel, Squid, and Butterfish	-	Y	-
Black sea bass	Black sea bass	SAFMC	South Atlantic Snapper Group	Y	Y	-
Monkfish	North, South	NEFMC / MAFMC	Monkfish	Y	-	-
Red drum	Red drum	SAFMC	Atlantic Coast Red drum	Y	Y	-
Scup	Scup	MAFMC	Summer flounder, Scup, and Black sea bass	Y	Y	-
Summer flounder	Summer flounder	MAFMC	Summer flounder, Scup, and Black sea bass	Y	-	-
Yellowtail flounder	Mid-Atlantic	NEFMC	Northeast Multispecies	Y	Y	-
Windowpane flounder	Mid-Atlantic	NEFMC	Northeast Multispecies	-	Y	-
Winter flounder	Mid-Atlantic	NEFMC	Northeast Multispecies	Y	Y	-

*****Overfishing – Harvest rate is above a prescribed fishing mortality threshold
Overfished - Stock size is below a prescribed biomass threshold
Approaching Overfished Condition - Based on trends in harvesting effort, fishery resource size, and other appropriate factors, it is estimated that the fishery will become overfished within 2 years

Table 14: Status of cartilaginous fish fisheries stocks for mid-Atlantic and adjacent areas (NMFS, 2006).

Species	Stock	Fully fished?	Over-fishing?*	Over-fished?*	Approach-ing Over-fished?*
Sandbar shark	Large Coastal Shark Complex (a)		Y	-	-
Dusky, Sand Tiger, Scalloped Hammerhead, Tiger	Large Coastal Shark Complex		Y	Y	-
Atlantic angel, Atlantic sharpnose	Small Coastal	Y			

*See definitions provided with Table 5.
(a) Stock is part of Large Coastal Shark Complex, but is assessed separately

III. Evaluation of Impacts on EFH Species

Information for each species is only provided for the life history stage for which the area is designated as EFH for that species. This section contains official EFH description language for all species presented in Tables 6, 7, and 8. Official EFH description language describes the geographical extent in which EFH is found as well as the type of habitats utilized by each lifestage of the 26 species evaluated in this report. NMFS (2001) groups king mackerel, Spanish mackerel, and cobia and describes them collectively under the category of "coastal migratory pelagics." EFH descriptions contained below for these individual species have been subdivided from this group. The life stages of bony and cartilaginous fishes are distinct from each other at subadult stages. EFH is designated for egg, larval, juvenile, and adult life history stages of bony fish, while for cartilaginous fish EFH is designated for egg, neonate/early juvenile, late juvenile/subadult, and adult life history stages.

For each species, the life stage for which Maryland's coastal ocean waters are designated as EFH is indicated in parentheses at the heading. This impacts assessment is written based the assumption that dredging technology comparable to that used today (2006) will continue to be used or that technology advances will still produce environmental effects similar to those from equipment used today. It is possible that major advances in dredging technology could occur over the remainder of the project life. In that event, impacts to EFH may warrant reassessment.

Direct impacts to each EFH species are evaluated largely based on their likelihood of being physically present, and therefore potentially physically harmed during project construction. Individual finfish or mollusks could be directly impacted during dredging of sand by being entrained into the dredge. These potential impacts are discussed for each individual species. Finfish and squid could also potentially be struck by the dredge ship or its propellers during dredging or transit to/from the borrow sites. Strike risk for individual finfish and squid in open waters is presumed to be minimal for juveniles and adults because of their high mobility. Eggs and larvae could not avoid the propeller, and thus could be destroyed, however they are likely to be widely dispersed in the water column. Accordingly, no further consideration to propeller strike will be provided for any life history stage.

At Fenwick Island, sand would be pumped out directly onto the beach and surf in a slurry (see Section II). Sand pumped onto the beach would pose no threat of direct impacts to finfish, squid, or any water column or highly motile benthic organism. While pumped slurry material daylighting into the surf zone could pose some threat to organisms at that point, sand exceeding the competency of surf zone conditions to keep in suspension will rapidly settle out a short distance from the release point. Consequently, impacts of this release would otherwise be equivalent to those of rough surf zone conditions. Accordingly, direct impacts of sand placement are not considered.

Indirect impacts to each EFH species could occur as a result of several effects of the project. Relatively non-motile benthos that are prey for the EFH species, such as worms and molluscs, will be destroyed over much of the area to be dredged; this may result in loss of prey items for finfish following dredging until these benthos recover. Habitat alterations caused by the series of furrows and ridges that would likely be created on the shoal surface, subsequent slumping, and altered rates of sediment deposition may change the value of the shoal as habitat for EFH species. Foodweb impacts resulting from alteration of habitat quality changing benthic community composition could also occur. Indirect impacts to EFH species could potentially occur along the Fenwick shoreline as shallow ocean water surf zone habitat is converted to inter and supra-tidal beach habitat, and associated benthos are buried. For those species for which the project area is designated as EFH for only egg and or larval life history stages, no evaluation of impacts to prey, predators, or the foodweb is provided since these life history stages typically don't feed, or their prey are planktonic and not affiliated with bottom habitats.

Indirect impacts at the offshore shoals and Fenwick Island could also potentially occur from increased local turbidity. Since there is minimal fine-grained sediment within the sand to be dredged and placed, and turbidity can be pronounced naturally as a result of wave resuspension of bottom sediments at any time of year and seasonally from phytoplankton in the water column, it is assumed that indirect impacts from turbidity will be very minor (MMS, 1999). In addition, because of the open nature of the sites, turbidity should rapidly dissipate into the surrounding coastal ocean waters (USACE, 1998). Consequently, turbidity impacts at either the dredge or placement site are not specifically considered in the analyses of impacts for each species below.

Seaward translation of the shoreline and "loss" of nearshore open water habitat is not expected to cause any significant indirect impacts to EFH species; in a general sense this habitat will only be temporarily translated seaward rather than "lost" because of the relative vastness of the seafloor. The "loss" of habitat occurring as a result of this project will periodically reoccur, since shoreline erosion and retreat will convert the created beach back into surf zone habitat within several years by the tiome of the next nourishment cycle. Consequently, indirect impacts that could potentially result from the temporary "loss" of nearshore habitat are not specifically considered in the analyses of impacts for each species below.

Recovery time of the benthos within both the dredging area on the offshore shoals and within the seawardly-translated surf zone of Fenwick Island is expected to be relatively rapid because of the relatively high energy nature of the sites, mobile sand substrate, and relatively depauperate benthic community typically occurring in these areas (USACE, 1998). Substantial recovery of both areas should occur within several months. Full recovery of both sites by benthos to a condition resembling pre-project conditions may take several years (Nelson, 1993; Newell et al., 1998). Recolonization of the shoals substrate by benthos is expected to be facilitated by the likely presence of remnant patches of undisturbed bottom, such as on ridges that may occur between furrows within the otherwise dredged area of the shoal, as well as by the consistency of post-dredging substrate grain-size to that of the pre-dredge condition.. Minimal to no disturbance of the substrate of seafloor flats off the shoals, which is of relatively higher value to most benthos, will occur since those area will not be dredged.

A. Bony Fish

Information on prey, predators, and migrations is provided in narrative form below. Table 15 provides general range and fishery information. Mid-Atlantic coastal ocean general habitat preferences and occurrences for each of the bony fish species analyzed in this report are summarized in Table 16. Larvae depend largely on their yolk sac for food until they transform into juveniles. First feeding often occurs near the end of the larval stage. Food preferences for larvae are provided only occasionally in the text based upon whether authors made specific note of this. Eggs and larvae generally are planktonic and

Table 15: Range and fishery information for bony fish by life-stage.

	Species Common Name	Western Atlantic Coast N Range	Western Atlantic Coast S Range	Greatest Geographic Abundance	Other Occurrence	Range Source Information	Commercial Fishery	Recreational Fishery	Other Fishery Notes	Fishery Source Information
1	Atlantic butterfish	Newfoundland	Florida	Gulf of Maine to Cape Hatteras		(Cross et al., 1999)	Yes	No		(Cross et al., 1999; MMS, 2000)
2	Atlantic cod	Baffin Island	Cape Hatteras		Eastern Atlantic Ocean	(Robins et al., 1986)	Yes			(Robins et al., 1986)
3	Atlantic mackerel	Gulf of St. Lawrence	Cape Lookout, North Carolina			(Studholme et al., 1999)	Yes		Spring and autumn spawning populations support major commercial fisheries	(Reid et al., 1999)
4	Atlantic sea herring	Labrador	Cape Hatteras		Eastern North Atlantic Ocean & Northeast Pacific Ocean	(Reid et al., 1999; Robins et al., 1986)			Atlantic herring were extremely abundant in northeastern U.S. waters during the 1960s and were fished intensively by a large foreign fleet. The Georges Bank-Nantucket Shoals fishery stock collapsed in the early 1970s.	
5	Black sea bass	Nova Scotia	Florida		entire Gulf of Mexico	(Robins et al., 1986; Steimle et al., 1999)	Yes	Yes	Within the mid-Atlantic states, recreational landings are comparable to or exceed the commercial fishery (MMS, 2000)	(Steimle et al., 1999)
6	Bluefish	Nova Scotia	Bermuda		western south Atlantic from northern South America to Argentina. Widely but irregularly distributed elsewhere in the Atlantic and Indian Oceans	(Robins et al., 1986)	Yes	Yes	Recreational landings historically exceed commercial landings in the mid-Atlantic region.	(MMS, 2000).
7	Cobia	Massachusetts	Argentina		nearly worldwide in warm waters	(Robins et al., 1986)	Yes	Yes		Mills, 2000
8	King mackeral	Maine	Brazil			(Godcharles and Murphy, 1986)	Yes	Yes		Robins et al., 1986; Md DNR 2001
9	Monkfish (Goosefish)	Gulf of St. Lawrence	Florida			(Murdy et al., 1997)	Yes	Very Limited	Offshore fisheries take place along the edge of the continental shelf and canyon areas where deep-sea corals exist. Also caught as bycatch and marketed	New England and Mid-Atlantic Fishery Management Councils, Monkfish FMP; Murdy et al., 1997
10	Red hake	Newfoundland	North Carolina	Georges Bank to New Jersey		(Steimle, 1999)	Yes			(Steimle, 1999)
11	Scup	Nova Scotia	Florida	Massachusetts to South Carolina		(Robins et al., 1986; Steimle et al., 1999).	Yes	Yes		(Steimle, 1999)
12	Spanish mackeral	Maine	Mexico			(Godcharles and Murphy, 1986)	Yes	Yes		(MD DNR, 2001)
13	Summer flounder	Nova Scotia	Florida	Mid-Atlantic		(Packer et al., 1999)	Yes	Yes	Recreational landings typically exceed the commercial landings in the mid-Atlantic region	(MMS, 2000)
14	Windowpane flounder	Gulf of St. Lawrence	Northern Florida			(Robins et al., 1986)	No	No	Caught as bycatch in bottom trawl fisheries (Chang et al., 1999).	(Chang et al., 1999; Murdy et al., 1997)
15	Winter flounder	Labrador	Georgia			(NMFS, 2006)	Yes	Yes	Valuable commercial and recreational fisheries	(Pereira et al., 1999)
16	Witch flounder	Gulf of St. Lawrence	North Carolina			(Robins et al., 1986)				
17	Yellowtail flounder	Newfoundland	Chesapeake Bay	Georges Bank to New England		(NFMS, 2006)				

Table 16: Occurrence and habitat preferences of bony fish by life-stage in coastal ocean waters of the mid-Atlantic.

	Species Common Name	Regulated EFH Life History Stages	Habitat	Substrate	Depth (m)	Depth (ft)	Water Temperature (C)	Water Temperature (F)	Reported Months/ Seasonality of Occurrence	References
1	Atlantic butterfish	egg	Pelagic surface waters, buoyant		0 to 1829	0 to 6000	11 to 23	52 to 73	Spring and Summer; Most abundant July	NMFS 2000 and 2006 (Summary Tables)
		juvenile	Shelf surface waters to depth; common in inshore areas, including surf zone	Mud and sand	<120	<400	4 to 30	39 to 86	Winter - Shelf; Spring to Fall Estuaries	Cross et al., 1999
		adult	Pelagic		10 to 365	30 to 1200	3 to 28	37 to 82	Winter - Shelf; Spring to Fall Estuaries	NMFS 2000 (Summary Tables)
2	Atlantic cod	adult	Bottom (night)	Rocky, pebbly, gravelly. Avoid finer sediments.	<200. Prefer 40 to 130	<650. Prefer 130 to 425	0 to 20. Prefer <10	32 to 68. Prefer <50		NMFS 2006
3	Atlantic mackerel	adult	Pelagic		10 to 380	30 to 1250	5 to 16	41 to 61		Studholme et al., 1999
4	Atlantic sea herring	juvenile	Pelagic waters and bottom habitats		15 to 135	50 to 450	<10	<50		NMFS 2006
		adult	Pelagic waters and bottom habitats		20 to 130	65 to 430	>4 to <10	>39 to <50		Reid et al., 1999; NMFS, 2000
5	Black sea bass	larvae	Coastal areas, upper water column		<100	<330	11 to 26	52 to 79	May - Nov., peak Jun-Jul	NMFS, 2001; NMFS, 2006
		juvenile (YOY)	Inshore, Channels	Rough bottom, shellfish, sponge beds, man-made objects	1 to 38	3 to 125	>6, prefer 17 to 25	>43, prefer 63 to 77	April - Dec., most settle June - Nov.	Steimle et al., 1999
		juvenile (winter)	Offshore demersal	Shell patches and other shelter	>38	>125	>5	>41	Dec. - April	"
		adult (summer)	Coastal demersal	Rock, manmade structures	2 to 38	6 to 125	>6, prefer 13 to 21	>43, prefer 55 to 70	Apr. - Dec.	"
		adult (winter)	Offshore	Poorly known	30 to 240	100 to 800	>6	>43	Nov. - March	"
6	Bluefish	larvae	Pelagic waters, shelf		0 to 70, prefer upper 15 m	0 to 230, prefer upper 50	18 to 26	65 to 79	May to Sept., peak July	NMFS, 2006
		juvenile (pelagic)	Shore to offshore, surface		<180	<590	>15	>59	Apr. - June	Fahay et al., 1999
		juvenile (summer)	Estuaries	Mostly sand, but also over fine-grained bottom as well as SAV and algal beds, and salt marshes.			19 to 30	67 to 86	May to Oct.	NMFS, 2000; NMFS, 2006
		adult	Pelagic waters, nearshore to offshore				>14	>57		"
7	Cobia	egg	Neritic, bouyant		10 to 50	30 to 165	>21	>70	June to Aug.	South Atlantic Fishery Management Council, 1998; Mills, 2000
		larvae	Neritic, water column		10 to 50	30 to 165	>21	>70		South Atlantic Fishery Management Council, 1998
		juvenile	Beach to oceanic	Sand	1 to 50	3 to 165	>21	>70		"
		adult	Neritic to oceanic	Common around sea buoys and floating structures; Wrecks and pilings	10 to 50	30 to 165	>21	>70	June to Aug.	South Atlantic Fishery Management Council, 1998; Robins et al., 1986; Mills, 2000
8	King mackeral	egg	Pelagic		30 to 180	100 to 600	>20	>68		GMFMC/SAFMC/MAFMC, 2004; NMFS 2000 (Summary Tables)
		larvae	Pelagic		30 to 180	100 to 600	>20	>68		GMFMC/SAFMC/MAFMC, 2004; NMFS 2000 (Summary Tables)
		juvenile	Inshore		<9	<30	>20	>68		GMFMC/SAFMC/MAFMC, 2004; NMFS 2000 (Summary Tables)
		adult	Surface-dwelling in nearshore	Wrecks, towers, reefs, and other structures	Shore to 200	Shore to 650	>20	>68		GMFMC/SAFMC/MAFMC, 2004; NMFS 2000 (Summary Tables)
9	Monkfish (Goosefish)	egg	Surface		15 to 1000	50 to 3300	<18	<65	May, June	NMFS 2000; Murdy et al., 1997

Table 16: Occurrence and habitat preferences of bony fish by life-stage in coastal ocean waters of the mid-Atlantic.

		larvae	Pelagic		25 to 1000	80 to 3300	15	59		NMFS 2000
10	Red hake	egg	Inner shelf upper water column, buoyant						Dec. - Apr. offshore, May - Oct. widespread	Steimle et al., 1999
		larvae	Coastal pelagic then benthic	Benthic phase: live shell and other shelter	<200	<650	8-23, prefer 11-19	46-73, prefer 52-66	May - Nov., peak Aug. - Sept.	"
		juvenile	Inshore spring - fall, offshore summer & winter	Depressions, organisms (live sea scallops, anemones, egg collars), biogenic materials (shells, worm tubes), manmade objects	<120	<400	2 to 22	36 to 72		"
11	Scup	juvenile (YOY)	Coastal	Sand, mud	0 to 38	0 to 125	9 to 27, prefer 16 to 22	48 to 81, prefer 61 to 72	May - Nov.	Steimle et al., 1999
		juvenile (winter)	Offshore warmer and deeper water	Poorly known, sand.	>38	>125	>7	>44	Nov. - May	"
		adult (summer)	Coastal	Sand, mud, rock, and manmade features	2 to 38	6 to 125	7 to 25	44 to 77	April - Dec.	"
		adult (winter)	Offshore warmer and deeper water	Poorly known, sand	38 to 185	125 to 600	>7	>44	Jan. - Mar.	"
12	Spanish mackeral	egg	Neritic		10 to 50	30 to 165	>21	>70		South Atlantic Fishery Management Council, 1998
		larvae	Neritic		1 to 50	3 to 165	>16	>61		"
		juvenile	Beach - neritic	Sand	1 to 50	3 to 165	>11	>52		"
		adult	Beach - neritic	Sand	1 to 50	3 to 165	>21	>70		"
13	Summer flounder	egg	Pelagic waters		30-70 fall; 110 winter; 9-30 spring	100 to 230 fall; 360 winter; 30 to 100 spring	11 to 23	52 to 73	Oct. - May	NMFS 2000
		larvae	Pelagic waters; transforming larvae in shallow tidal flats, marsh creeks	Sand			4 to 14	39 to 57	Sept.-May	NMFS 2000, 2006; Packer et al., 1999
		juvenile	Shelf, inlets; demersal	Mud and sand	0.5 to 5	1.5 to 15	>11	>52		NMFS 2000 (Summary Tables); Packer et al., 1999
		adult (summer)	Nearshore, demersal		0 to 25	0 to 80				"
		adult (winter)	Offshore, demersal		150	500				"
14	Windowpane flounder	egg	Planktonic		<70	<230	6 to 20	43 to 68		NMFS 2006
		larvae	Planktonic		<70	<230	3 to 19	37 to 66		NMFS 2006
		juvenile	Nearshore estuaries	Mud and sand	1 to 75	3 to 250	<25	<77	May - July, Oct - Nov.	Chang et al., 1999
		adult	Nearshore estuaries	Mud and sand	1 to 75	3 to 250	<27	<80	Year-round	"
15	Winter flounder	juvenile (YOY)	Inshore	Mud to sand	0.5 to 12	1.5 to 40	2 to 30	35 to 86		Periera et al., 1999
		juvenile	Coastal	Mud to sand shell	18 to 27	60 to 90	10 to 25	50 to 77	Summer and fall	"
		adult	Inshore	Mud, sand, cobble, rocks, boulders	1 to 30	3 to 100	<23	<73		"
16	Witch flounder	egg	Pelagic over deep water		>10, most at 50 to 150	>30, most at 165 to 500	4 to 16, most at 4 to 12	39 to 61, most at 39 to 54		Cargnelli et al., 1999
		larvae	Pelagic over deep water		0 to 250, primarily 10 to 90	0 to 820, primarily 30 to 300	4 to 16, most at 4 to 13	39 to 61, most at 39 to 55		Cargnelli et al., 1999
17	Yellowtail flounder	larvae	Pelagic		10 to 1250 (most 10 to 90)	30 to 4100 (most 30 to 300)	5 to 17	41 to 63	Mar. - Apr.	NMFS 2006

have only limited swimming ability, thus are passively transported. Larvae of many species migrate vertically in the water column, occurring near the surface at night, but centered at greater depths during daylight

1. Atlantic butterfish (Eggs, Juveniles, Adults)

a. EFH Description

Eggs: Offshore, EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras, North Carolina in areas that comprise the highest 75% of the catch where butterfish eggs were collected in MARMAP ichthyoplankton surveys. Inshore, EFH is the "mixing" and/or "seawater" portions of all the estuaries where butterfish eggs are "common," "abundant," or "highly abundant" on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Generally, butterfish eggs are collected from shore to 6,000 ft and temperatures between 52 ^{o}F and 63 ^{o}F (NMFS, 2006).

Juveniles: Offshore, EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras, North Carolina in areas that comprise the highest 75% of the catch where juvenile butterfish were collected in the NEFSC trawl surveys. Inshore, EFH is the "mixing" and/or "seawater" portions of all the estuaries where juvenile butterfish are "common," "abundant," or "highly abundant" on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Generally, juvenile butterfish are collected in depths between 33 ft and 1,200 ft and temperatures between 37 ^{o}F and 82 ^{o}F (NMFS, 2006).

Adults: Offshore, EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras, North Carolina in areas that comprise the highest 75% of the catch where adult butterfish were collected in the NEFSC trawl surveys. Inshore, EFH is the "mixing" and/or "seawater" portions of all the estuaries where adult butterfish are "common," "abundant," or "highly abundant" on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Generally, adult butterfish are collected in depths between 33 ft and 1,200 ft and temperatures between 37 ^{o}F and 82 ^{o}F (NMFS, 2006).

b. Movements, Migration, Predators, and Prey

Butterfish eggs hatch after incubations of about 2 to 3 days. Atlantic butterfish juveniles and adults form loose schools, often near the surface. Butterfish eggs have been collected from Cape Hatteras to the northern Gulf of Maine from April through September. As water temperatures increased on the shelf, eggs were found progressively closer to the coast from south to north (NMFS, 2006). Juveniles and adults winter near the outer edge of the continental shelf in the mid-Atlantic bight and migrate inshore in the spring. During the summer, they occur over the entire mid-Atlantic shelf, including estuaries. In late fall, butterfish move southward and offshore in response to falling water temperatures. Butterfish juveniles and adults feed mainly on planktonic prey (Cross et al., 1999). Butterfish juveniles and adults are preyed upon by haddock, silver hake, bluefish, swordfish, weakfish, goosefish, sharks, skates, and long-finned squid (NMFS, 2006).

c. Project Impacts

Since individual butterfish eggs are buoyant, few individuals would likely be entrained and no population impacts would expected from dredging of the borrow sites. Based on temperature preferences (Table 16) and migration information, juveniles and adults could be in project area waters all seasons but winter. Because of their high mobility and general non-occurrence in winter (and thus high mobility), juveniles and adults should be readily able to relocate from the dredging areas to avoid direct physical harm. Dredging done in colder months would be unlikely to directly impact butterfish because they would probably be absent. No indirect impacts to butterfish are expected as a consequence of alterations to bottom habitat to eggs or adults since they are largely pelagic, and not closely associated with the bottom. Juveniles may make use of bottom habitats, but no indirect impacts from bottom alterations or foodweb impacts to juveniles or adults are expected. Butterfish are planktivorous (not benthic feeders), and their food items are derived from a wide area; the habitat alterations are very minor in scale compared to the wide area from which their food is derived, and foodweb impacts will be largely temporary in nature.

2. Atlantic cod (Adults)

a. EFH Description

Bottom habitats with a substrate of rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay. Generally, the following conditions exist where cod adults are found: water temperatures below 10° C, depths from 10 - 150 meters, and a wide range of oceanic salinities (NMFS, 2006).

The ocean waters along the coast of Delaware were selected for EFH designation based on their historical importance for a portion of the adult population that migrates to this area for feeding in the winter (NMFS, 1998).

b. Movements, Migration, Predators, and Prey

In the Middle Atlantic Bight as far south as Chesapeake Bay cod only occur during winter and spring. They tend to move in schools, usually on the bottom, although they may also occur in the water column. They occur usually on bottom during day, but may move up into the water column at night. They consume a varied diet, including fish and benthic invertebrates. Large sharks, spiny dogfish, and, as juveniles, older cod, prey upon cod (NMFS, 2006).

c. Project Impacts

Based on their temperature preferences (Table 16), Atlantic cod would be most likely in project area waters from December through April, although they could potentially occur all months but July, August, and September. Atlantic cod adults are unlikely to occur on the offshore shoals in substantial numbers because of their preference for depths greater than about 130 ft. During dredging of the offshore shoals conducted in warm weather months, it is expected that because of their high mobility any adult cod present should easily be able to avoid detrimental impacts of the dredge. Because of the tendency for demersal finfish to be less active in cold water, cod adults within the borrow area on the offshore shoals may have substantial risk of being entrained into the dredge and destroyed during any dredging conducted during winter months. However, detrimental impacts to the population from destruction of individual adults are expected to be insignificant because few individuals would be likely to be destroyed. Foodweb disturbance caused by destruction of benthos and alteration of bottom habitat on the offshore shoals would be unlikely to have a substantial detrimental impact to adults because of their preference for deeper habitats. Additionally, because of the localized nature of detrimental foodweb impacts when compared to abundant comparable bottom habitat elsewhere on the continental shelf, as well as temporary nature of these impacts, no detrimental impacts to the Atlantic cod population are expected. Increased bathymetric relief left by the dredge as a series of ridges and furrows may favor Atlantic cod. This potential beneficial impact would be very minor because of the relatively small size of the area impacted, and would be expected to gradually dissipate as physical forces rework and smooth the shoal surface.

3. Atlantic mackerel (Adults)

a. EFH Description

Offshore, EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras, North Carolina, in areas that comprise the highest 75% of the catch where adult Atlantic mackerel were collected in the NEFSC trawl surveys. Inshore, EFH is the "mixing" and/or "seawater" portions of all the estuaries where adult Atlantic mackerel are "common," "abundant," or "highly abundant" on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Generally, adult Atlantic mackerel are collected from shore to 1,250 ft and temperatures between 39 ^{o}F and 61 ^{o}F (NMFS, 2006).

b. Movements, Migration, Predators, and Prey

Atlantic mackerel is a fast swimming, schooling species. Atlantic mackerel overwinter in deep water of the shelf from Nova Scotia to Cape Hatteras. In spring, fish move inshore and northward along coast, joined by northern group moving inshore. Atlantic mackerel return to the shelf edge between Long Island - Chesapeake Bay in October. They are opportunist feeders, and either filter feed or select individual prey. Adults eat small crustaceans, small pelagic mollusks, larval fish. Large mackerel eat larger prey such as squids (*Loligo*) and fishes (silver and other hakes, sand lance, herring, and sculpins). Atlantic mackerel serve as prey for a wide variety of predators including other mackerel, dogfish, tunas, bonito, and striped bass (Studholme, 1999).

c. Project Impacts

Based on temperature preferences (Table 16) and movement information provided above, Atlantic mackerel adults may be in project area waters in spring from March to June and then again in Fall in November. Atlantic mackerel individual adults would be unlikely to be impacted by dredging at the offshore shoals because they are noted to have a preference for pelagic rather than bottom habitat. Any Atlantic mackerel adults occurring on the bottom in the borrow areas during dredging in warm weather months could easily swim away and relocate to adjacent areas to avoid direct detrimental impacts. Indirect impacts form alterations of bottom habitat and foodweb impacts are unlikely to impact Atlantic mackerel adults because of their pelagic orientation and because their prey items are derived from a wide area.

4. Atlantic sea herring (Juveniles, Adults)

a. EFH Description

Juveniles: Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where Atlantic herring juveniles are found: water temperatures below 10°C, water depths from 15 - 135 meters (50 - 440 ft), and a salinity range from 26 - 32‰ (NMFS, 2006).

Adults: Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where Atlantic herring adults are found: water temperatures below 10ºC (50ºF), water depths from 20 - 130 m (65 - 100 ft), and salinities above 28‰ (NMFS, 2001).

b. Movements, Migration, Predators, and Prey

Atlantic herring juveniles and adults undergo complex north-south and inshore-offshore migrations for feeding, spawning, and overwintering. The Georges Bank/Nantucket Shoals stock overwinters south of Cape Cod and along the mid-Atlantic coast. The stock moves north onto Georges Bank and into the Gulf of Maine in the spring before congregating on spawning grounds southeast of Nantucket and on Georges Bank in the fall. Adults generally occur in large schools. Vertical migrations linked to changing light intensity are pronounced and are probably related to movements of prey and avoidance of predatory seabirds (Reid et al., 1999). Juveniles and adults eat primarily zooplankton

(NMFS, 2000 and 2006). Adult herring are preyed on by many marine fish, bird, and mammal species (Reid et al., 1999). Atlantic herring is only infrequently observed in study area waters (MMS, 2000).

c. Project Impacts

Based on temperature preferences (Table 16), juvenile and adult Atlantic sea herring could be present in project area waters from December through May. Juvenile and adult sea herring would probably not be present during dredging of the offshore shoals conducted during warmer weather months, accordingly direct impacts to individual juveniles or adults would be unlikely. During any dredging conducted in cooler months when they may be present on the offshore shoals, because of their benthic orientation and tendency for finfish to be less active in cold water, individual sea herring within the borrow area on the offshore shoals may have substantial risk of being entrained into the dredge and destroyed. However, no detrimental impacts to the sea herring population are expected because there is no reason to expect that sea herring individuals will be concentrated at the offshore shoals borrow sites. Atlantic sea herring juveniles and adults may suffer minor indirect impacts from foodweb disturbance caused by destruction of benthos and altered habitat conditions on the offshore shoals. However, because of the temporary nature of the impacts, utilization of pelagic waters by Atlantic sea herring in addition to bottom habitats, and relatively small area of bottom to be disturbed compared to the total area of comparable bottom habitat available, no impacts to the Atlantic sea herring population are expected.

5. Black sea bass (Larvae, Juveniles, Adults)

a. EFH Description

1. Larvae: 1) North of Cape Hatteras, EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all ranked ten-minute squares of the area where black sea bass larvae are collected in the MARMAP survey. 2) EFH also is estuaries where black sea bass were identified as common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Generally, the habitats for the transforming (to juveniles) larvae are near the coastal areas and into marine parts of estuaries between Virginia and New York. When larvae become demersal, they are generally found on structured inshore habitat such as sponge beds (NMFS, 2001).

2. Juveniles: 1) Offshore, EFH is the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked squares of the area where juvenile black sea bass are collected in the NEFSC trawl survey. 2) Inshore, EFH is the estuaries where black sea bass are identified as being common, abundant, or highly abundant in the Estuarine Living Marine Resource (ELMR) database for the "mixing" and "seawater"

salinity zones. Juveniles are found in the estuaries in the summer and spring. Generally, juvenile black sea bass are found in waters warmer than 43 F (6ºC) with salinities greater than 18 parts per thousand (ppt) and coastal areas between Virginia and Massachusetts, but winter offshore from New Jersey and south. Juvenile black sea bass are usually found in association with rough bottom, shellfish and eelgrass beds, man-made structures in sandy-shelly areas; offshore clam beds and shell patches may also be used during the wintering (NMFS, 2001).

3. Adults: 1) Offshore, EFH is the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares of the area where adult black sea bass are collected in the NEFSC trawl survey. 2) Inshore, EFH is the estuaries where adult black sea bass were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Black sea bass are generally found in estuaries from May through October. Wintering adults (November through April) are generally offshore, south of New York to North Carolina. Temperatures above 43 F (6ºC) seem to be the minimum requirements. Structured habitats (natural and man-made), sand and shell are usually the substrate preference (NMFS, 2001).

b. Movements, Migration, Predators, and Prey

Black sea bass distribution changes seasonally as they migrate from coastal areas to the outer continental shelf while water temperatures decline in the fall, and migrate from the outer shelf to inshore areas as temperature warms in the spring. Larvae use yolk sac reserves within a few days of hatching and begin feeding on zooplankton (NMFS, 2006). Juveniles prey upon small epibenthic invertebrates, especially crustaceans and molluscs. Adults prey upon benthic and near-bottom invertebrates and small fish (Steimle et al., 1999). Black sea bass larvae are preyed upon by most planktivores. Juveniles and adults are preyed upon by sharks, dogfish, hakes, searobins, summer flounder, and others (NMFS, 2006).

c. Project Impacts

Based on temperature preferences and reported months of occurrence, larvae, juvenile, and adult black sea bass could be in project area waters from April through December (Table 16). Since larvae are associated with the upper water column, dredging at the borrow sites would not be expected to entrain many individuals, and no impact to the black sea bass population would be expected. Juveniles and adults while inshore are typically associated with structure that is absent from the borrow sites, thus few individuals would be expected in the dredging area, and no direct impacts to the black sea bass population would be expected. Further, any juveniles or adults in the dredging area should be able to avoid detrimental impacts because of their high mobility and ready ability to relocate from the project area. However, any black sea bass remaining on the bottom or venturing too close to the dredge intake could be entrained and destroyed; juveniles would probably be more vulnerable than adults because of their slower swimming speed. Black sea bass juveniles and adults may suffer minor indirect impacts from foodweb disturbance caused by destruction of benthos and altered habitat conditions on the offshore shoals. However, because of the temporary nature of the impacts, and relatively small area of bottom to be disturbed compared to the total area of comparable bottom habitat available, impacts are expected to be very minor. Ridge and furrow topography on the shoal seafloor following dredging may provide a benefit to black sea bass by increasing bottom heterogeneity and habitat topographic complexity. However, population benefits would be very minor because of the relatively small scale of the area impacted in comparison to seafloor area, and any beneficial impacts will diminish as the seafloor is reworked by natural processes and any furrows fill in.

6. Bluefish (Larvae, Juveniles, Adults)

a. EFH Description

1. Larvae: 1) North of Cape Hatteras, EFH is pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ) most commonly above 49 ft (15 m), from Montauk Point, New York south to Cape Hatteras, in the highest 90% of the area where bluefish larvae were collected during the MARMAP surveys. 2) South of Cape Hatteras, EFH is 100% of the pelagic waters greater than 45 feet over the Continental Shelf (from the coast out to the eastern wall of the Gulf Stream) through Key West, Florida. 3) EFH also includes the "slope sea" and Gulf Stream between latitudes 29°00 N and 40°00 N. Bluefish larvae are not generally collected inshore so there is not EFH designation inshore for larvae. Generally, bluefish larvae are collected April through September in temperatures greater than 64°F (18°C) in normal shelf salinities (>30 ppt).

2. Juveniles: 1) North of Cape Hatteras, EFH is pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ) from Nantucket Island, Massachusetts south to Cape Hatteras, in the highest 90% of the area where juvenile bluefish are collected in the NEFSC trawl survey. 2) South of Cape Hatteras, EFH is 100% of the pelagic waters over the Continental Shelf (from the coast out to the eastern wall of the Gulf Stream) through Key West, Florida. 3) EFH also includes the "slope sea" and Gulf Stream between latitudes 29°00 N and 40°00 N. 4) Inshore, EFH is all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Generally juvenile bluefish occur in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from May through October, and South Atlantic estuaries March through December, within the "mixing" and "seawater" zones. Distribution of juveniles by temperature, salinity, and depth over the continental shelf is undescribed.

3. Adults: 1) North of Cape Hatteras, EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from Cape Cod Bay, Massachusetts south to Cape Hatteras, in the highest 90% of the area where adult bluefish were collected in the NEFSC trawl survey. 2) South of Cape Hatteras, EFH is 100% of the pelagic waters over the Continental Shelf (from the coast out to the eastern wall of the Gulf Stream) through Key West, Florida. 3) Inshore, EFH is all major estuaries between

Penobscot Bay, Maine and St. Johns River, Florida. Adult bluefish are found in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from April through October, and in South Atlantic estuaries from May through January in the "mixing" and "seawater" zones. Bluefish adults are highly migratory and distribution varies seasonally and according to the size of the individuals comprising the schools. Bluefish generally found in normal shelf salinities (> 25 ppt).

b. Movements, Migration, Predators, and Prey

Bluefish larvae are seasonally distributed from Cape Canaveral through the mid-Atlantic Bight along the shelf edge to mid-shelf, with a seasonal more northwardly progression of occurrence. Larvae transform to juveniles at an age of 18 to 25 days (NMFS, 2006). Juveniles in the spring gradually migrate onshore reaching shore in June in the mid-Atlantic Bight. Bluefish travel in schools of like-sized individuals and undertake seasonal migrations, moving into the mid-Atlantic bight during spring and south or farther offshore during fall (Fahay et al., 1999). Larvae eat copepods; juveniles prey upon Atlantic silversides (*Menidia menidia*), herrings, striped bass (*Morone saxatilis*), bay anchovy, and other fish. Adults are sight-feeders and almost exclusively eat fish (NMFS, 2006). Young of the year bluefish are preyed upon by oceanic birds. Adult bluefish are eaten by sharks, tunas, and billfish (NMFS, 2006). Large population fluctuations are common (Fahay et al., 1999).

c. Project Impacts

Based on temperature preferences, larval bluefish could potentially be present in project area waters from June to October, juveniles from May to November, and adults from May to November (Table 16). Larvae could be entrained into the dredge and destroyed during borrow activities. However, larvae are primarily pelagic and thus individuals would not be anticipated to be concentrated on the bottom. Although individuals may be destroyed, since bluefish larvae are not expected to be concentrated in project waters, no impacts to the bluefish population are expected. Juveniles and adults because of their high mobility and occurrence in project area waters during the warmer half of the year should be readily able to relocate from the project area to avoid direct detrimental impacts of dredging or burial. Because of their open water orientation, disturbance to and alteration of bottom habitat at the borrow sites are expected to have minimal indirect impact to oceanic bluefish juveniles and adults. Foodweb impacts caused by benthos destruction and alteration of bottom habitat at the offshore shoals are unlikely to impact bluefish because of the relatively small scale of the area to be impacted compared to the great abundance of comparable habitat on the continental shelf, and prey items will be readily available from elsewhere. In addition, foodweb impacts at the offshore shoals will be generally temporary in nature, further reducing their potential impact to bluefish.

7. Cobia (Eggs, Larvae, Juveniles, Adults)

a. EFH Description

Essential fish habitat for cobia includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including Sargassum. In addition, all coastal inlets, all state-designated nursery habitats of particular importance to cobia (NMFS, 2001).

For cobia, essential fish habitat also includes high salinity bays, estuaries, and seagrass habitat. In addition the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse coastal migratory pelagic larvae (NMFS, 2001).

For cobia, essential fish habitat occurs in the South Atlantic and Mid-Atlantic Bights (NMFS, 2001).

b. Movements, Migration, Predators, and Prey

Cobia have been documented to spawn at the mouth of Chesapeake Bay (Mills, 2000). Cobia move from one area to another and seek prey wherever local resources happen to be abundant (South Atlantic Fishery Management Council, 1998). Cobia adults tend to move about as individuals or occasionally in small groups of two or three. East coast cobia stocks move up the coast from the Carolinas and points south, reaching the Chesapeake Bay area in late May and early June. Fish in the Chesapeake region migrate out of the region to deeper offshore and more southerly waters in September (Mills, 2000). Cobia are not caught offshore along the Maryland coast (Wesche, personal communication), indicating that they are few in number and or infrequent in Maryland's coastal ocean waters. Many of their prey species are estuarine-dependent in that they spend all or a portion of their lives in estuaries (South Atlantic Fishery Management Council, 1998). Studies conducted in Chesapeake Bay found that cobia adults forage on bottom-dwelling prey such as shrimp, crab, small fishes, and cownose ray (Mills, 2000).

c. Project Impacts

Cobia may be in the project area during construction occurring from about July to September based on their temperature preferences (Table 16). Based on their reported shoreline (neritic) and water depth habitat preferences (which are somewhat contradictory), eggs, larvae, juveniles, and or adults may be present on the borrow areas during dredging conducted during these months. Eggs are buoyant and would be unlikely to be entrained into the dredge, however larvae could be. However, cobia larvae would be widely distributed and there is no reason to believe they would be concentrated in the direct impact areas, therefore although individuals could be destroyed no impacts to the cobia population are expected. Because cobia adults forage on bottom-dwelling prey, individuals could be present on the bottom. Any cobia juveniles or adults that are present in the project area during construction could easily swim away and relocate to adjacent areas to avoid detrimental impacts. Destruction of benthos and alterations of bottom habitat will likely reduce the suitability of the borrow areas as a foraging area for several months to years following dredging. These disturbances are unlikely to impact cobia because abundant undisturbed bottom will remain elsewhere on the continental shelf, and foodweb impacts will be temporary in nature.

8. King Mackerel (Eggs, Larvae, Juveniles, Adults)

a. EFH Description

Essential fish habitat for king mackerel includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including Sargassum. In addition, all coastal inlets, all state-designated nursery habitats of particular importance to king mackerel.

For king mackerel, essential fish habitat occurs in the South Atlantic and Mid-Atlantic bights.

b. Movements, Migration, Predators, and Prey

King mackerel major spawning areas occur off Louisiana and Texas in the Gulf; and off the Carolinas, Cape Canaveral, and Miami in the western Atlantic. Spawning occurs generally from May through October with peak spawning in September (GMFMC/SAFMC/MAFMC, 2004). The species moves from one area to another and seeks prey wherever local resources happen to be abundant (Murdy et al., 1997). Juveniles and adults are pelagic carnivores and eat fish, shrimps, and squid. Principal fish species consumed include anchovies (*Anchoa* spp.), menhaden (*Brevoortia* spp.), and Atlantic thread herring (*Opisthonema oglinum*). King mackerel larvae and juveniles are preyed upon by little tunney (*Euthynnus alletteratus*) and dolphin (*Coryphaena hippurus*). Relatively large king mackerel are eaten by pelagic sharks, little tunny, and dolphin (Godcharles and Murphy, 1986).

c. Project Impacts

King mackerel may be in the project area during construction occurring from about late June to early October based on their temperature preferences (Table 16). Based on their depth preferences/occurrences which exceed 100 ft, it is unlikely that substantial numbers of king mackerel eggs or larvae would be present in borrow areas during these months, however. Additionally, eggs and larvae are typically pelagic and not associated with the bottom or shoreline. Accordingly few individuals in these life history stages are expected to be directly or indirectly impacted by dredging and no impacts to the king mackerel population would be expected. King mackerel juveniles and adults could be present in substantial numbers during dredging and sand placement conducted during these months. However, any king mackerel juveniles or adults that are present in the project area during construction could easily swim away and relocate to adjacent areas to avoid direct detrimental impacts. Alterations of bottom habitat and destruction of benthos at the borrow sites are unlikely to indirectly impact king mackerel because the species is not strongly affiliated with bottom habitats. Abundant undisturbed bottom habitat of comparable value occurs elsewhere, and foodweb impacts would be temporary, further reducing the likelihood of indirect impacts to juvenile or adult king mackerel.

9. Monkfish (Goosefish) (Eggs, Larvae)

a. EFH Description

Eggs: Surface waters of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras, North Carolina. Generally, the following conditions exist where monkfish egg veils are found: sea surface temperatures below 18° C and water depths from 15 - 1000 meters. Monkfish egg veils are most often observed during the months from March to September (NMFS, 2006).

Larvae: Pelagic waters of the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras, North Carolina. Generally, the following conditions exist where monkfish larvae are found: water temperatures 15° C and water depths from 25 - 1000 meters. Monkfish larvae are most often observed during the months from March to September (NMFS, 2006).

b. Movements, Migration, Predators, and Prey

American goosefish spawn from North Carolina to Maine along the U.S. Atlantic Coast (Bigelow and Schroeder, 1953). Eggs float at or near the surface (NMFS, 2000). Spawning occurs progressively later proceeding northwards. Eggs and larvae have been recorded in May off N.C. (Bigelow and Schroeder, 1953). Incubation ranges from 7 to 22 days, after which larvae and juveniles spend several months in a pelagic phase before settling to a benthic existence (Richards, 2000). Goosefish larvae feed on various small pelagic animals such as copepods, crustacean larvae, and glass worms (*Sagitta*). Goosefish larvae in aquarium jars have been observed to be devoured by spiny lobster (*Palinurus*) larvae, by large copepods, by ctenophores, and by hydroids (Bigelow and Schroeder, 1953).

c. Project Impacts

Monkfish eggs and larvae may be in the project area during construction occurring from about May to early fall. Any monkfish eggs or larvae present at the offshore shoals would be widely distributed and there is no reason to believe they would be concentrated in the project area. Eggs would be unlikely to be entrained during dredging since they float. Since larvae are pelagic, dredging entrainment of larvae would also likely be minimal. Accordingly, no impacts to the monkfish population are expected. Alterations of bottom habitat and destruction of benthos at the borrow sites are unlikely to impact monkfish eggs or larvae because they lack an orientation to or dependency on bottom habitats.

10. Red Hake (Eggs, Larvae, Juveniles)

a. EFH Description

1. Eggs: Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where hake eggs are found: sea surface temperatures below 10ºC (50ºF) along the inner continental shelf with a salinity less than 25‰. Hake eggs are most often observed during the months from May - November, with peaks in June and July.

2. Larvae: Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where hake larvae are found: sea surface temperatures below 19ºC (66ºF), water depths less than 200 m (650 ft), and a salinity greater than 0.5‰. Red hake larvae are most often observed from May through December, with peaks in September - October.

3. Juveniles: Bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops, in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where red hake juveniles are found: water temperatures below 16ºC (61ºF), depths less than 100 m (330 ft) and a salinity range from 31 - 33‰.

b. Movements, Migration, Predators, and Prey

Red hake spawning occurs in the summer. Major spawning areas occur on the southwest part of Georges Bank and on the continental shelf off southern New England and eastern Long Island, and in southern New England estuaries. The pelagic eggs of red hake are not separated from eggs of similar species in field collections, thus the characteristics of the habitat in which red hake eggs are commonly found are poorly known. Eggs hatch in 3 to 7 days. Larval red hake dominate the summer ichthyoplankton in the Middle Atlantic Bight and were most abundant at mid- and outer continental shelf stations. The distribution of juveniles varies with season. Recently metamorphosed juveniles remain pelagic for about two months. They then gradually descend to the bottom. Demersal settlement generally occurs between September and December with peaks in October-November. Shelter is a critical habitat requirement for red hake (Table 16). Larger juveniles remain near structures in coastal areas and embayments; later they join older fish in an offshore migration in the Middle Atlantic Bight. In the Middle Atlantic Bight, red hake juveniles occur most frequently in coastal waters in the spring and fall; they move offshore to avoid the warm summer temperatures. In the winter, most of the population moves offshore, but the degree of movement probably depends on the severity of the winter. Winter migrants return inshore the following spring. Larvae prey mainly on micro-crustaceans. Juvenile red hake commonly prey on small benthic and pelagic crustaceans, bristle worms, and arrow worms. Red hake juveniles are eaten by larger predatory fish, harbor porpoise (*Phocoena phocoena*) and other predators (Steimle, 1999).

c. Project Impacts

Red hake eggs are likely to be present in the borrow areas, but predominantly near the water surface and widely dispersed. Accordingly, few red hake eggs are likely to be entrained and destroyed during dredging of the borrow areas. Demersal red hake larvae may be present in association with structure and depressions on the seafloor of the borrow sites in spring through fall. Larvae may be entrained and destroyed during dredging conducted during these months. However, because there is no reason to expect that red hake larvae will be concentrated in the borrow areas, and because of the relatively small scale of the area to be impacted compared with the area of the continental shelf over which larvae are likely to occur, no significant impacts to red hake populations are expected. Based on temperature preferences, juvenile red hake may be in the borrow areas all year. It is expected that because of their high mobility juveniles should easily be able to avoid detrimental impacts of dredging conducted during warm weather months. Because of the tendency for demersal finfish to be less active in cold water, red hake juveniles within the borrow areas may have substantial risk of being entrained into the dredge and destroyed during any dredging conducted during cold weather months. However, detrimental impacts to the red hake population from destruction of individual juveniles are expected to be insignificant because there is no reason to expect that red hake will be concentrated at the borrow sites. Foodweb disturbance caused by destruction of benthos and alteration of bottom habitat on the offshore shoals may have a detrimental impact to red hake juveniles. However, because of the localized nature of detrimental foodweb impacts when compared to abundant comparable bottom habitat elsewhere on the continental shelf, any detrimental impacts to the red hake population should be very minor. In addition, the foodweb impacts will be temporary in nature, further minimizing detrimental impacts. Increased bathymetric relief left by the dredge as a series of ridges and furrows may favor red hake larvae and juveniles. This beneficial impact would be very minor because of the relatively small size of the area impacted, and would be expected to gradually dissipate as physical forces rework and smooth the shoal surface.

11. Scup (Juveniles, Adults)

a. EFH Description

1. Juveniles: 1) Offshore, EFH is the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares of the area where juvenile scup are collected in the NEFSC trawl survey. 2) Inshore, EFH is the estuaries

where scup are identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Juvenile scup, in general during the summer and spring are found in estuaries and bays between Virginia and Massachusetts, in association with various sands, mud, mussel and eelgrass bed type substrates and in water temperatures greater than 45ºF (7ºC) and salinities greater than 15 ppt.

2. Adults: 1) Offshore, EFH is the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares of the area where adult scup are collected in the NEFSC trawl survey. 2) Inshore, EFH is the estuaries where scup were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Generally, wintering adults (November through April) are usually offshore, south of New York to North Carolina, in waters above 45ºF (7ºC).

b. Movements, Migration, Predators, and Prey

Scup are a demersal species that use several benthic habitats from open water to structured areas for feeding and possibly shelter. Their distribution changes seasonally as fish migrate from estuaries to the edge of the continental shelf as water temperatures decline in the winter and return from the edge of the continental shelf to inshore areas as water temperatures rise in the spring. During warmer months, juveniles live inshore in a variety of coastal habitats. The presence of structure can be important to juvenile scup. Juveniles utilize biogenic depressions, troughs, and possibly mollusc shells, particularly during colder months. Adult habitats include soft sandy bottoms, on or near structures, such as rocky areas and manmade structures. Juveniles feed on small benthic invertebrates, fish eggs, and larvae. Adults prey on benthic and near bottom invertebrates, and small fish. Juveniles are preyed upon by bluefish, cod, hake, summer flounder, weakfish, striped bass, and other fish. Adults are preyed upon by sharks, stingrays, dogfish, bluefish, silver hake, black sea bass, and other fish (Steimle et al., 1999).

c. Project Impacts

Dredging on the offshore shoals will likely occur in large part during warmer months when juvenile and adult scup are likely to be in project waters. Because of their great mobility, it is expected that juvenile and adult scup should easily be able avoid direct detrimental impacts from dredging and easily relocate to adjacent waters. However, because they are demersal, individual scup may remain on the seafloor of the offshore shoals during dredging. Any scup remaining on the bottom or venturing too close to the dredge intake could be entrained and destroyed; juveniles would probably be more vulnerable than adults because of their slower swimming speed. No significant impacts to the scup population from potential destruction of individuals would be expected however, because there is no reason to expect that scup would be concentrated in the area to be dredged. Any construction occurring in cooler months would be unlikely to directly impact scup because juveniles and adults are typically associated with warmer water temperatures. Because of their association with the bottom, foodweb impacts caused by destruction of benthos and bottom habitat impacts on the offshore shoals will cause a detrimental indirect impact to scup. However, because of the relatively small scale of the area to be impacted compared to abundant habitat elsewhere, these detrimental impacts will be very minor. The impacts will also be temporary in nature, further decreasing their significance. Increased bathymetric relief created by the dredge as a series of ridges and furrows may favor scup juveniles and adults. This beneficial impact would be very minor because of the relatively small area impacted when compared to comparable habitat elsewhere on the continental shelf. This impact would be temporary, and the shoal surface would be expected to gradually smooth as physical forces rework the shoal surface.

12. Spanish mackerel (Eggs, Larvae, Juveniles, Adults)

a. EFH Description

Essential fish habitat for Spanish mackerel includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including Sargassum. In addition, all coastal inlets, all state-designated nursery habitats of particular importance to Spanish mackerel.

For Spanish mackerel, essential fish habitat occurs in the South Atlantic and Mid-Atlantic bights.

b. Movements, Migration, Predators, and Prey

Spanish mackerel move northward each spring, spending summer in the northern part of their range, and migrating south in fall (Godcharles and Murphy, 1986). They migrate in large schools (Murdy et al., 1997). Spanish mackerel spawn from Florida to New York (Godcharles and Murphy, 1986). Larval habitat is the water column. This species moves from one area to another and seeks prey wherever local resources happen to be abundant. Many of their prey species are estuarine-dependent in that they spend all or a portion of their lives in estuaries (South Atlantic Fishery Management Council, 1998). Spanish mackerel principally eat small fish, shrimp, and squid (Murdy et al, 1997). Spanish mackerel larvae and juveniles are preyed upon by little tunney (*Euthynnus alletteratus*) and dolphin (*Coryphaena hippurus*). Relatively large Spanish mackerel are eaten by pelagic sharks, little tunny, and dolphin (Godcharles and Murphy, 1986).

c. Project Impacts

Spanish mackerel may be in the project area during construction occurring from about July to September based on temperature preferences (Table 16) and migration information. Any Spanish mackerel eggs or larvae present at the offshore shoals would be widely distributed. Therefore, although individual eggs and larve may be destroyed, there is no reason to believe they would be concentrated in the project area, and no significant impacts to the Spanish mackerel population are expected. Spanish mackerel juveniles and adults could be present during dredging at the borrow sites conducted during these months. However, any Spanish mackerel juveniles or adults that are present in the project area during construction could easily swim away and relocate to adjacent areas to avoid direct detrimental impacts. Alterations of bottom habitat are unlikely to impact Spanish mackerel because they are not noted to be strongly bottom oriented. Additionally, likelihood of impacts is low because of the minor scale of impact compared to abundant bottom, temporary nature of foodweb impacts, and ability of Spanish mackerel to obtain prey over a wide area.

13. Summer flounder (Egg, Larvae, Juveniles, Adults)

a. EFH Description

1. Eggs: North of Cape Hatteras, EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of the all the ranked ten-minute squares for the area where summer flounder eggs are collected in the MARMAP survey. In general, summer flounder eggs are found between October and May, being most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 miles of shore off New Jersey and New York. Eggs are most commonly collected at depths of 30 to 360 ft.

2. Larvae: North of Cape Hatteras, EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares for the area where summer flounder larvae are collected in the MARMAP survey. Inshore, EFH is all the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database, in the "mixing" (defined in ELMR as 0.5 to 25.0 ppt) and "seawater" (defined in ELMR as greater than 25 ppt) salinity zones. In general, summer flounder larvae are most abundant nearshore (12-50 miles from shore) at depths between 30 to 230 ft. They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February, and in the southern part from November to May.

3. Juveniles: North of Cape Hatteras, EFH is the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares for the area where juvenile summer flounder are collected in the NEFSC trawl survey. Inshore, EFH is all of the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database for the "mixing" and "seawater" salinity zones. In general, juveniles use several estuarine habitats as nursery

areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in water temperatures greater than 37ºF (3ºC) and salinities from 10 to 30 ppt range.

4. Adults: North of Cape Hatteras, EFH is the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares for the area where adult summer flounder are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where summer flounder were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Generally summer flounder inhabit shallow coastal and estuarine waters during warmer months and move offshore on the outer Continental Shelf at depths of 500 ft (150 m) in colder months.

b. Movements, Migration, Predators, and Prey

Eggs generally hatch within 3 days. Summer flounder exhibit strong seasonal inshore-offshore movements. Juvenile and adult summer flounder normally inhabit shallow coastal and estuarine waters during the warmer months of the year, and remain offshore during the fall and winter. Transforming larvae exhibit some pelagic feeding, but by late stage are benthic feeders. Transforming larvae prey upon copepods and polychaetes. Smaller juveniles feed upon infauna such as polychaetes; larger juveniles feed upon fish, shrimp, and crabs in relation to their environmental abundance. Adults are opportunistic feeders with fish and crustaceans making up a substantial portion of their diet. Transforming larvae are preyed upon by large shrimp. Blue crab eat juvenile summer flounder, particularly when in macroalgal beds (Packer et al., 1999).

c. Project Impacts

Based on known occurrences and habitat preferences (Table 16), eggs and larvae would most likely be in project area waters in spring. Juveniles and adults may be in the project area during dredging which occurs during warmer months. Because of their great mobility, juvenile and adult summer flounder should easily be able to relocate elsewhere and avoid any detrimental impacts. However, because they are demersal, summer flounder may remain on the bottom during dredging. Any summer flounder remaining on the bottom or venturing too close to the dredge intake could be entrained and destroyed; juveniles would probably be more vulnerable than adults because of their slower swimming speed. No significant impacts to the summer flounder population would be expected from destruction of individuals, however, because there is no reason to believe that summer flounder will be concentrated in the area to be dredged. Construction taking place during colder months would be unlikely to impact summer flounder because they would be unlikely to be present in project waters and instead are likely to be further offshore. Because of their demersal nature, destruction of benthos and alterations in bottom habitat impacting the foodweb may cause detrimental impacts to summer flounder. Following recovery of benthos of the borrow areas, it is unclear whether altered habitat conditions at the offshore shoals will have any other indirect impact on summer flounder. All impacts will be very minor in scale, however, when compared to abundant habitat elsewhere on the continental shelf. Foodweb impacts will be temporary in nature, further diminishing their impact. Any impacts associated with altered bottom habitat on the offshore shoals would be expected to gradually dissipate as physical environment forces rework and smooth the shoal surface.

14. Windowpane flounder (Eggs, Larvae, Juveniles, Adults)

a. EFH Description

1. Eggs: Surface waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where windowpane flounder eggs are found: sea surface temperatures less than 20°C and water depths less than 70 meters. Windowpane flounder eggs are often observed from February to November with peaks in May and October in the middle Atlantic and July - August on Georges Bank (NMFS, 2006).

2. Larvae**:** Pelagic waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where windowpane flounder larvae are found: sea surface temperatures less than 20°C and water depths less than 70 meters. Windowpane flounder larvae are often observed from February to November with peaks in May and October in the middle Atlantic and July through August on Georges Bank (NMFS, 2006).

3. Juveniles: Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where windowpane flounder juveniles are found: water temperatures below 25°C (77°F), depths from 1 - 100 m (3 - 330 ft), and salinities between 5.5 - 36‰ (NMFS, 2001).

4. Adults: Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border. Generally, the following conditions exist where windowpane flounder adults are found: water temperatures below 26.8°C (80°F), depths from 1 - 75 meters (3 - 250 ft), and salinities between 5.5 - 36‰ (NMFS, 2001).

b. Movements, Migration, Predators, and Prey

Windowpane in the northwest Atlantic inhabit estuaries, nearshore waters, and the continental shelf. Eggs hatch within 8 days at typical spawning temperatures. Larvae are planktonic and then settle to the bottom. Larvae are found primarily in estuaries in the spring, but primarily on the continental shelf in autumn. Windowpane juveniles that settle in shallow inshore waters move to deeper waters as they grow. Juveniles and adults may migrate to nearshore or estuarine habitats in the southern mid-Atlantic bight in the autumn. Larvae prey upon zooplankton. Juvenile and adult windowpane feed on small crustaceans and various fish larvae. Spiny dogfish, thorny skate, goosefish, Atlantic cod, black sea bass, weakfish, and summer flounder are important windowpane predators. Eggs, larvae, and juveniles are also eaten by adult windowpane flounder (Chang et al., 1999).

c. Project Impacts

Based on temperature preference data (Table 16) eggs and larvae could be in project area waters all months but July, August, and September. EFH description language however would put eggs and larvae present during all months between February and November. Based on temperature preferences, juveniles could be present all year. Based on trawling data, adult windowpane flounders are likely to be in project waters during dredging conducted at any time of year. Because of their great mobility, juveniles and adults should be able to avoid direct detrimental impacts at the dredging sites during warmer months. However, because they are demersal, individual may remain on the bottom during dredging. Any windowpane remaining on the bottom or venturing too close to the dredge intake could be entrained and destroyed; juveniles would probably be more vulnerable than adults because of their slower swimming speed. Because of the tendency for demersal finfish to be less active in cold water, windowpane flounder in the borrow area on the offshore shoals may have substantial risk of being entrained into the dredge and destroyed during any dredging conducted during winter months. However, detrimental impacts to the windowpane flounder population are expected to be insignificant because there is no reason to expect that windowpane flounder will be concentrated at the site. Because of their demersal nature, destruction of benthos and alterations in bottom habitat impacting the foodweb may cause detrimental impacts to windowpane flounder. It is unclear whether altered habitat conditions at the offshore shoals will have any other indirect impact on windowpane flounder. However, these impacts will be very minor because the scale of the area impacted is very minor when compared to abundant habitat elsewhere on the continental shelf. Foodweb impacts will be temporary in nature, further diminishing their impact. Any impacts associated with altered bottom habitat on the offshore shoals would be expected to gradually dissipate as physical environment forces rework and smooth the shoal surface.

15. Winter flounder (Juveniles, Adults)

a. EFH Description

1. Juveniles:

a. Young-of-the-Year: Bottom habitats with a substrate of mud or fine grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where winter flounder young-of-the-year are found: water temperatures below 28°C (82°F), depths from 0.1 - 10 meters (0.3 - 30 ft), and salinities between 5 - 33‰ (NMFS, 2001).

b. Age 1+ Juveniles: Bottom habitats with a substrate of mud or fine grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where juvenile winter flounder are found: water temperatures below 25°C (77ºF), depths from 1 - 50 meters (3 - 165 ft), and salinities between 10 - 30‰ (NMFS, 2001).

2. Adults: Bottom habitats including estuaries with a substrate of mud, sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where winter flounder adults are found: water temperatures below 25°C (77ºF), depths from 1 - 100 meters (3 - 330 ft), and salinities between 15 - 33‰ (NMFS, 2001).

b. Movements, Migration, Predators, and Prey

Winter flounder young of the year occur in very shallow inshore waters. Older juveniles occur in cooler, deeper water much of the year. Adult winter flounder migrate inshore in the fall and early winter and spawn in late winter and early spring throughout most of their range. After spawning, adults typically leave inshore areas although some remain inshore year-round. Winter flounder are omnivorous opportunistic feeders, and consume a wide variety of prey with polychaetes and crustaceans making up the bulk of their diet. Winter flounder juveniles and adults are preyed upon by other fish species, as well as marine mammals and birds (Pereira et al., 1999).

c. Project Impacts

Based on their temperatures of occurrence/preference (Table 16), juvenile and adult winter flounder may be in project waters April through December and all months but August, respectively. Because of their great mobility, juveniles and adults should be able to avoid direct detrimental impacts at the dredging and placement sites during warmer months. However, because they are demersal, winter flounder may remain on the bottom during dredging. Any winter flounder remaining on the bottom or venturing too close to the dredge intake could be entrained and destroyed; juveniles would probably be more vulnerable than adults because of their slower swimming speed. Because of the tendency for demersal finfish to be less active in cold water, individual winter flounder in the borrow area on the offshore shoals may have substantial risk of being entrained into the dredge and destroyed during any dredging conducted during winter months. However, detrimental impacts to the winter flounder population are expected to be insignificant because there is no reason to expect that winter flounder will be concentrated at the site. Because of their demersal nature, destruction of benthos and alterations in bottom habitat impacting the foodweb may cause detrimental impacts to winter flounder. It is unclear whether altered habitat conditions at the offshore shoals will have any other indirect impact on winter flounder. However, these impacts will be very minor because the scale of the area impacted is very minor when compared to abundant habitat elsewhere on the continental shelf. Foodweb impacts will be temporary in nature, further diminishing their impact. Any impacts associated with altered bottom habitat on the offshore shoals would be expected to gradually dissipate as physical forces rework and smooth the shoal surface.

16. Witch flounder (Eggs, Larvae)

a. EFH Description

Eggs: Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where witch flounder eggs are found: sea surface temperatures below 13 C over deep water with high salinities. Witch flounder eggs are most often observed during the months from March through October (NMFS, 2006).

Larvae: Surface waters to 250 meters in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where witch flounder larvae are found: sea surface temperatures below 13 C over deep water with high salinities. Witch flounder larvae are most often observed from March through November, with peaks in May - July (NMFS, 2006).

b. Movements, Migration, Predators, and Prey

In the Middle Atlantic Bight, spawning occurs from April to August, peaking in May or June. Spawning occurs in dense aggregations which are associated with areas of cold water at 0-10 C (Bigelow and Schroeder 1953). Spawning occurs at or near the bottom. The buoyant eggs then rise into the water column where subsequent egg and larval development occurs. Eggs incubate in 7 to 8 days; the planktonic larval stage is lengthy and last from 4 months to a year. Eggs and larvae undergo a general southerly drift in the water column. Eggs and larvae are preyed upon by a wide range of pelagic predators (Cargnelli et al., 1999).

c. Project Impacts

Based on their temperature and depth of known occurrence (Table 16), eggs may occur in the deeper waters at the borrow sites. Based on their temperature and depth of known occurrence, larvae may be physically present at the borrow sites in cooler weather months from November through April. During dredging conducted during cooler water conditions, eggs and larvae may be entrained into the dredge and destroyed. However, since borrow area waters appear to be at or near the shallower end of the vertical distribution for these life stages, it is unlikely that high population concentrations of eggs or larvae would be located in the project area. Accordingly, although individuals may be destroyed, no impacts to the winter flounder population of eggs or larvae would be expected. Since eggs and larvae generally have little to no dependency on benthic prey items for survival, no impacts to the winter flounder population of eggs and larvae would be expected by destruction of benthic habitat that would occur at the borrow sites.

17. Yellowtail flounder (Larvae)

a. EFH Description

Larvae: Surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, the southern New England shelf and throughout the middle Atlantic south to the Chesapeake Bay. Generally, the following conditions exist where yellowtail larvae are found: sea surface temperatures below 17̥ C, water depths from 10 - 90 meters, and a salinity range from 32.4 - 33.5‰. Yellowtail flounder larvae are most often observed from March through April in the New York bight and from May through July in southern New England and southeastern Georges Bank (NMFS, 2006).

b. Movements, Migration, Predators, and Prey

The ocean serves as yellowtail flounder's nursery grounds. Ichthyoplankton surveys showed little spawning activity March when eggs appeared on the continental shelf off New Jersey. Yellowtail flounder larvae first appeared on the shelf in April from the New York Bight south to the Delmarva peninsula. Larvae were collected more frequently from May through July. The highest larval concentrations in the New York Bight occurred in the mixed layer during May-July. Larval movements are limited to advection in water currents (NMFS, 2006).

c. Project Impacts

Based on known depth occurrences, yellowtail larvae would be expected to occur in borrow area waters at depth. Based on NMFS (2006) data indicating spawning is limited to late winter and early spring, larvae could be present during the months of April through June in borrow area waters. Larvae could thus be entrained into the dredge and destroyed during dredging conducted during these months. However, given that there is no reason to expect concentrations of larvae in project area waters, and larvae are likely to be distributed over a wide region, no impacts to yellowtail flounder populations are expected. Since larvae generally have little to no dependency on benthic prey items for survival, no impacts to the yellowtail flounder population of larvae would be expected by destruction of benthic habitat that would occur at the borrow sites.

B. Cartilaginous Fish

Range and fishery information for cartilaginous fish is provided in Table 17. Pertinent life history information is provided in narrative form for each species below. There are many aspects of shark life history and habitat associations that are unknown. Most species are highly mobile or migratory, and utilize diverse habitats in apparently non-specific or poorly understood ways. During migrations, most sharks traverse a variety of habitats, however, the migrations of sharks are generally poorly understood. The different life stages of shark species are often found in different habitats, with the

Table 17: Cartilaginous fish ranges and fisheries.

	Species Common Name	Western Atlantic Coast N Range	Western Atlantic Coast S Range	Greatest Northwestern Atlantic Geographic Abundance	Other Occurrence	Range Source Information	Commercial Fishery	Recreational Fishery	Other Fishery Notes	Fishery Source Information
1	Atlantic angel shark	New England	Carribbean			(Robins et al., 1986)	No	No		(Murdy et al., 1997).
2	Atlantic sharpnose shark	Bay of Fundy	Florida	Rare north of North Carolina		(Robins et al., 1986)	No	Yes	Bycatch of shrimp trawling	(NMFS, 2006)
3	dusky shark	Georges Bank	Florida		Temperate and tropical waters nearly worldwide	(Robins et al., 1986)		Yes		(Murdy et al., 1997).
4	sand tiger shark	Maine	Florida		Tropical and warm temperate waters worldwide	(NMFS, 1999; Robins et al., 1986)				
5	sandbar shark	Massachusetts	Brazil		Nearly world-wide in temperate and tropical waters	(Robins et al., 1986)	Yes		It is one of the most important commercial species in the shark fishery of the southeastern U.S.	(NMFS, 1999)
6	scalloped hammerhead shark	New Jersey	Uruguay		Nearly worldwide in tropical waters	(Robins et al., 1986)				
7	tiger shark	Massachusetts	Uruguay	Most common from Florida to the Caribbean	Nearly worldwide in warm waters	(Robins et al., 1986)			Frequently caught in coastal shark fisheries, but usually discarded due to low fin and meat value	(NMFS, 1999)

neonates (newborns) often occupying different habitats than the adults. However, there is little information correlating life stages and migratory movements to habitat types. Temperature is a primary factor affecting the migration and distribution of sharks. Movements of sharks in coastal waters are usually correlated with seasonal changes in water temperature. Atlantic sharks have been found to use shallow coastal areas for mating and pupping. The pups (neonates) typically remain in these areas throughout their early life stages, which may last from a few to many months. For fisheries management purposes, the sharks considered in this impacts assessment are divided into two groups: large coastal sharks (tiger, scalloped hammerhead, sand tiger, dusky, and sandbar), and small coastal sharks (Atlantic angel and Atlantic sharpnose).

1. Atlantic angel shark (Neonate/Early Juveniles, Late Juveniles/Subadults, Adults)

a. EFH Description

1. Neonate/early juveniles (50 cm total length [TL]): Off the coast of southern New Jersey, Delaware, and Maryland from 39° N to 38° N, in shallow coastal waters out to the 25 m (80 ft) isobath, including the mouth of Delaware Bay (NMFS, 2001).

2. Late juveniles/subadults (51 to 105 cm TL): Identical to neonate EFH (NMFS, 2001).

3. Adults (106 cm TL): Identical to neonate EFH (NMFS, 2001).

b. Natural History and Fisheries Information

Atlantic angel sharks are bottom-dwelling, benthic burrowers, and feed on bottom fishes, crustaceans, and molluscs (Murdy et al., 1997). Atlantic angel shark inhabits coastal waters but very little is known about its life history or habitat associations (NMFS, 1999). It is common in summer along mid-Atlantic states, moving offshore and possibly farther south in winter (Robins et al., 1986). They are frequently caught in Maryland's coastal ocean waters (Wesche, personal communication). It has been recorded at depths of up to 1290 m (4260 ft) (Robins et al., 1986).

c. Project Impacts

Atlantic angel shark may be present during warmer months during dredging on the offshore shoals. Neonates, juveniles, and adults should easily be able to avoid any direct negative impacts because of their ready mobility. Any individuals remaining on the bottom or venturing too close to the dredge intake could be entrained and destroyed, however. Neonates and juveniles would probably be more vulnerable than adults because of their slower swimming speed. There is no reason to expect that Atlantic angel shark will be concentrated in the dredging area, therefore no significant impacts to this species' population is expected. Atlantic angel shark would be unlikely to be present during any dredging conducted during colder months, therefore no direct impacts would be expected at those times. Because of the limited information available on this species life history, it is unknown how the project will indirectly impact this species. Since it is a bottom-dwelling species, indirect impacts to the foodweb caused by destruction of benthos and alterations in bottom habitat conditions on the offshore shoals would probably be detrimental over the short-term. However, since these impacts will be very minor in scale when compared to the size of the range of the species, it is expected that no significant indirect impacts to Atlantic angel shark populations will occur. In addition, since foodweb impacts will be temporary in nature, any detrimental impacts will be further minimized.

2. Atlantic sharpnose shark (Adults)

a. EFH Description

Adults (85 cm TL): From Cape May, NJ south to the North Carolina/ South Carolina border; shallow coastal areas north of Cape Hatteras, NC to the 25 m isobath; south of Cape Hatteras between the 25 and 100 m isobaths; offshore St. Augustine, FL to Cape Canaveral, FL from inshore to the100 m isobath, Mississippi Sound from Perdido Key to the Mississippi River Delta to the 50 m isobath; coastal waters from Galveston to Laguna Madre, TX to the 50 m isobath (NMFS, 2006).

b. Natural History and Fisheries

Adult sharpnose shark live in coastal ocean habitats and enter bays and estuaries (Robins et al., 1986). Although primarily coastal, they have been found to depths of 280 m (Murdy et al., 1997). They occur year-round from South Carolina to the Gulf of Mexico (NMFS, 2006). Atlantic sharpnose shark feed on a wide variety of small fish and invertebrates (Murdy et al., 1997).

c. Project Impacts

Limited distribution information suggests that Atlantic sharpnose shark would most likely occur in project area waters during warmer weather months. Adults should easily be able to avoid any direct negative impacts from dredging because of their ready mobility. Because of the limited information available on this species life history, it is unknown how the project will indirectly impact this species. However, since any impacts will be very minor in scale when compared to the size of the range of the species, it is expected that no significant indirect impacts to Atlantic angel shark populations will occur. In addition, since foodweb impacts will be temporary in nature, any detrimental impacts will be further minimized.

3. Dusky shark (Neonate/Early Juveniles)

a. EFH Description

Neonate/early juveniles (115 cm TL): Shallow coastal waters, inlets and estuaries to the 25 m (80 ft) isobath from the eastern end of Long Island, NY at 72° W south to Cape Lookout, NC at 34.5° N; from Cape Lookout south to West Palm Beach, FL (27.5° N), shallow coastal waters, inlets and estuaries and offshore areas to the 100 m (330 ft) isobath.

b. Natural History and Fisheries

The dusky shark is a common species (Robins et al., 1986). It ranges from the surf zone to far offshore and from the surface to water depths of 400 m (1,300 ft) depth (Murdy et al., 1997). It feeds on numerous species of bony fishes and smaller sharks (Castro, 1993), as well as crustaceans, molluscs, and sea stars (Murdy et al., 1997). Dusky shark migrates north and south with the seasons along the Atlantic coast. Coastal waters are nursery areas. NMFS (1999) states that neonates occur in coastal waters of Chesapeake Bay from April through July (NMFS, 1999). In contrast, Murdy and others (1997) note that the species does not normally enter estuaries and is infrequently encountered in Chesapeake Bay. Presumably information presented in Murdy and others (1997) applies only to juveniles and adults. The species is particularly vulnerable to overfishing because of its long period until maturity (17 years), slow growth, and limited reproductive potential. The Highly-Migratory-Species Fisheries Management Plan prohibits possession of dusky shark because of significant declines in catch rates in the last two decades (NMFS, 1999).

c. Project Impacts

Dusky shark may be present during dredging on the offshore shoals that takes place during warmer months and into the fall, however neonates and juveniles because of their ready mobility should easily be able to avoid any direct negative impacts. Because the species moves out of the Maryland coastal ocean during colder months, it is unlikely that any dusky shark would be present during construction activities taking place during colder months. No detrimental indirect impacts to the dusky shark population are expected because of the relatively small area to be impacted compared to the range of the species and the ready availability of comparable habitat on the mid-Atlantic bight continental shelf, and because any impacts to the foodweb are expected to be insignificant and temporary.

4. Sand tiger shark (Neonate/Early Juveniles, Adults)

a. EFH Description

1. Neonate/early juveniles (125 cm TL): Shallow coastal waters from Barnegat Inlet, NJ south to Cape Canaveral, FL to the 25 m (80 ft) isobath.

2. Adults (221 cm TL): Shallow coastal waters to the 25 m (80 ft) isobath from Barnegat Inlet, NJ to Cape Lookout; from St. Augustine to Cape Canaveral, FL.

b. Natural History and Fisheries

It was perhaps the most common shark found in coastal waters from Cape Cod to Chesapeake Bay (Robins et al., 1986). Sand tiger shark is a coastal species often found in shallow coastal waters less than 4 m (13 ft) deep. The neonates are born in March and April in southern portions of its range and migrate northward to summer nurseries in coastal estuaries. Sand tiger shark is extremely vulnerable to overfishing because adults congregate in large numbers in coastal areas during the mating season. There was a severe population decline in the 1990s, and in 1997 NMFS prohibited possession of this species in U.S. waters (NMFS, 1999).

c. Project Impacts

Sand tiger shark may be present during dredging of the offshore shoals, however neonates, juveniles, and adults because of their ready mobility should easily be able to avoid any direct negative impacts. Because the species moves out of the coastal ocean during colder months, it is unlikely that any sand tiger shark would be present during the portion of project construction activities that will occur during colder months. Indirect impacts to this species are expected to be nonsignificant because the habitats disturbed at the site and any detrimental foodweb impacts would be nonsignificant compared to the scale of the Mid-Atlantic bight. Furthermore, any foodweb impacts would be temporary, further minimizing any detrimental impacts.

<u>5. Sandbar shark (Neonate/Early Juveniles, Late Juveniles/Subadults, Adults)</u>

a. EFH Description

1. Neonates/early juveniles (90 cm): Shallow coastal areas to the 25 m (80 ft) isobath from Montauk, Long Island, NY at 72° W, south to Cape Canaveral, FL at 80.5° W (all year); nursery areas in shallow coastal waters from Great Bay, NJ to Cape Canaveral, FL, especially Delaware and Chesapeake Bays (seasonal-summer); also shallow coastal waters to up to a depth of 50 m (165 ft) on the west coast of Florida and the Florida Keys from Key Largo at 80.5° W north to south of Cape San Blas, FL at 85.25° W. Typical parameters: salinity-greater than 22 ppt; temperatures-greater than 21°C (70°F).

2. Late juveniles/subadults (91 to 179 cm): Offshore southern New England and Long Island, all waters, coastal and pelagic, north of 40° N and west of 70° W; also, south of 40° N at Barnegat Inlet, NJ, to Cape Canaveral, FL (27.5° N), shallow coastal areas to the 25 m (80 ft) isobath; also, in the winter, from 39° N to 36° N, in the Mid-Atlantic bight, at the shelf break, benthic areas between the 100 and 200 m (330 and 660 ft) isobaths; also, on the west coast of Florida, from shallow coastal waters to the 50 m (165 ft) isobath, from Florida Bay and the Keys at Key Largo north to Cape San Blas, FL at 85.5° W.

3. Adults (180 cm): On the east coast of the United States, shallow coastal areas from the coast to the 50 m (165 ft) isobath from Nantucket, MA, south to Miami, FL; also, shallow coastal areas from the coast to the 100 m (330 ft) isobath around peninsular Florida to the Florida panhandle at 85.5° W, near Cape San Blas, FL including the Keys and saline portions of Florida Bay.

b. Natural History and Fisheries

It is a common bottom-dwelling shark found in many coastal habitats (NMFS, 1999). Sandbar shark prey on bottom fish, other sharks, rays, and invertebrates including blue crab (Murdy et al., 1997). NMFS (1999) and Castro (1993) note that it is most common in 20 to 55 m (65 to 180 ft) of water. Robins and others (1986), however, note that it is a common inhabitant of shallow coastal waters and estuaries, where it occurs in muddy coastal waters and bays that are shallower than 18 m (60 ft). Sandbar shark is a migratory species, and migrates south in schools to wintering grounds that range from North Carolina to Central America (Robins et al., 1986). In the U.S., the sandbar shark has its nurseries in shallow coastal waters from Florida to N.J. Occurrence of sandbar shark in Delaware Bay, some 25 miles to the north of the coastal bays, provides an indication of their likely seasonality in Maryland's coastal bays. Juveniles return to Delaware Bay after a winter absence around May 15th. Neonates have been caught in Delaware Bay in late June. Young-of-the-year were present in Delaware Bay until October when the temperature fell below 21ºC (70ºF). All life stages of sandbar shark are found along the Maryland coast; neonates are found from March through July in the mid-Atlantic. The species is highly vulnerable to overfishing because of its long period until maturity (15 or more years), and two-year reproductive cycle. There have been declines in catch per unit effort in U.S. fisheries for this species as a consequence of heavy fishing pressure (NMFS, 1999).

c. Project Impacts

Sandbar shark may be present during dredging at the offshore shoals, however neonates, juveniles, and adults because of their ready mobility should easily be able to avoid any direct negative impacts. However, since it is bottom-dwelling, individuals may remain on the bottom during dredging of the offshore shoals. Any individuals remaining on the bottom or venturing too close to the dredge intake could be entrained and destroyed; neonates and juveniles would probably be more vulnerable than adults because of their slower swimming speed. However, there is no reason to expect that sandbar shark will be concentrated in the dredging area, therefore no significant impacts to this species' population is expected. Because the species moves out of the Maryland coastal ocean waters during colder months, it is unlikely that any sandbar shark would be present during construction activities taking place during colder months. It is unknown how the project will indirectly impact this species. However, since it is a bottom-dwelling species, indirect impacts to the foodweb caused by destruction of benthos and alterations in bottom habitat conditions at the offshore shoals would probably be detrimental. However, since these impacts will be very minor in size when compared to the size of the Mid-Atlantic bight, it is expected that no significant indirect impacts to sandbar shark populations will occur. In addition, since foodweb impacts will be temporary in nature, any detrimental impacts will be further minimized.

6. Scalloped hammerhead shark (Juveniles)

a. EFH Description

a. Late juveniles/subadults (46 to 249 cm TL): All shallow coastal waters of the U.S. Atlantic seaboard from the shoreline to the 200 m isobath from 39° N, south to the vicinity of the Dry Tortugas and the Florida Keys at 82° W; also in the Gulf of Mexico, in the area of Mobile Bay, AL and Gulf Islands National Seashore, all shallow coastal waters from the shoreline out to the 50 m isobath.

b. Natural History and Fisheries

Scalloped hammerhead is a warm water species seldom found in water cooler than 22°C (72°F). It is a common species found both in coastal and in oceanic waters (Castro, 1993). Juveniles utilize shallow coastal bay and estuarine habitat in waters less than 5 m (16 ft) deep from April through October. Adults utilize both inshore and offshore waters. Scalloped hammerhead school and migrate seasonally north-south along the eastern United States. Because it forms large schools in coastal areas, it is targeted by many fisheries and its fins are highly valued. It is probably vulnerable to overfishing (NMFS, 1999).

c. Project Impacts

Scalloped hammerhead juveniles may be in project waters during any construction that takes place between July and September. However, juveniles because of their ready mobility should easily be able to avoid any direct negative impacts of dredging. Scalloped hammerhead would be unlikely to be in project waters during construction that takes place during colder months, therefore no direct impacts would be expected at those times. No indirect impacts to scalloped hammerhead are expected from dredging on the offshore shoals because any foodweb impacts resulting from this are expected to be temporary and local, and abundant comparable habitat is available elsewhere.

7. Tiger shark (Neonate/Early Juvenile, Late Juveniles/Subadults)

a. EFH Description

Neonate/early juveniles (120 cm TL): From shallow coastal areas to the 200 m (660 ft) isobath from Cape Canaveral, FL north to offshore Montauk, Long Island, NY (south of Rhode Island); and from offshore southwest of Cedar Key, FL north to the Florida/Alabama border from shallow coastal areas to the 50 m (165 ft) isobath.

Late Juveniles/Subadults

b. Natural History and Fisheries

Tiger shark is mostly pelagic, but commonly enters shallow bays and harbors to feed, particularly at night (Robins et al., 1986). Very little is known about the tiger shark's distribution and habitat characteristics. Nursery areas are believed to be offshore, but have not been fully described. The neonates/juveniles occur in shallow coastal waters (NMFS, 1999). The tiger shark feeds on all kinds of marine animals, including turtles, horseshoe crabs, bony fishes, smaller sharks, ray egg cases, and seagulls. It is also one of the few species of sharks that will scavenge dead animals (Castro, 1993).

c. Project Impacts

Tiger shark may be present during dredging on the offshore shoals, however neonates and juveniles because of their ready mobility should easily be able to avoid any direct negative impacts. Because the species moves to the south out of the coastal ocean during colder months, it is unlikely that any tiger shark would be present during dredging on the offshore shoals that occurs during colder months. No indirect impacts to tiger shark are expected because habitat alterations on the offshore shoals are expected to have only local and temporary impacts to the foodweb.

C. Molluscs

Table 18 provides range and fishery information for mollusks. Habitat information is provided in Table 19. Information on prey, predators, movements, and migrations is provided in narrative form below.

1. Long finned squid (Juveniles, Adults)

a. EFH Description

Pre-recruits: EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras, North Carolina in areas that comprise the highest 75% of the catch where pre-recruit *Loligo* were collected in the NEFSC trawl surveys. Generally, pre-recruit *Loligo* are collected from shore to 700 ft and temperatures between 39 ^{o}F and 81 ^{o}F (NMFS, 2006).

Recruits: EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras, North Carolina in areas that comprise the highest 75% of the catch where recruited *Loligo* were collected in the NEFSC trawl surveys. Generally, recruited *Loligo* are collected from shore to 1000 ft and temperatures between 39 ^{o}F and 81 ^{o}F (NMFS, 2006).

Table 18: Mollusc ranges and fisheries.

	Species Common Name	Western Atlantic Coast N Range	Western Atlantic Coast S Range	Greatest Northwestern Atlantic Geographic Abundance	Range Source Information	Commercial Fishery	Recreational Fishery	Other Fishery Notes	Fishery Source Information
1	Long finned squid	Newfoundland	Gulf of Venezuela	Georges Bank to Cape Hatteras	(Jacobson, 2005; NMFS, 2006)	Yes		Managed by MAFMC	(MAFMC, 2006)
2	Surf clam	Gulf of St. Lawrence	Cape Hatteras	Georges Bank, south of Cape Cod, off Long Island, southern New Jersey, and the Delmarva Peninsula	(NMFS, 2006)	Yes		Managed by MAFMC	(Cargnelli et al., 1999)

Table 19: Occurrence and habitat preferences of molluscs.

	Species Common Name	Regulated EFH Life History Stages	Habitat	Substrate	Depth (m)	Depth (ft)	Water Temperature (C)	Water Temperature (F)	Months/ Seasonality of Occurrence	Reference
1	Long finned squid	Juvenile	Continental shelf waters	Not applicable	Upper 10 at depths of 50-100	Upper 30 at depths of 165-330	10 to 26	50 to 79	Found in coastal inshore waters in spring/fall, offshore in winter	(NMFS, 2006)
		Adult	Continental shelf waters	Mud or sandy mud	Shallow to 180 m Mar. - Oct.; deep to 400 m in winter	Shallow to 600 Mar. - Oct.; deep to 1300 in winter	Surface: 9 to 21; Bottom: 8 to 16	Surface: 48 to 70; Bottom: 46 to 61		(Jacobson, 2005; NMFS, 2006)
2	Surf clam	Juvenile & adult	Seafloor, most common in turbulent areas beyond breaker zone	Found in coarse sand/gravel to silty sand. Prefer well-sorted, medium sand	8 to 66. Off the Delmarva Peninsula, greatest concentrations recorded from 18 to 36	30 to 215. Off the Delmarva Peninsula, greatest concentrations recorded from 60 to 120	Full annual fluctuation range		Year-round resident	(NMFS, 2006)

Loligo pre-recruits are less than or equal to 8 cm and recruits are greater than 8 cm.

b. Movements, Migration, Predators, and Prey

The terms ‘pre-recruit’ (unexploited sizes) and ‘recruit’ (exploited sizes) are often used in reference to longfin inshore squid (Table 8). Exploitation begins at a minimum mantle length of about 9 cm. Minimum length for sexual maturity is about 10 cm mantle length (Jacobson, 2005).

The longfin inshore squid is a schooling species. Total life span is typically 1 year; the juvenile stage lasts about 1 month. Longfin inshore squid makes seasonal migrations related to bottom water temperatures; they move offshore during late autumn to overwinter along the edge of the continental shelf. They return inshore during the spring and early summer. Juveniles prefer warmer bottom temperatures and shallower depths in fall than adults. Both juveniles and adults migrate towards the surface at night. The diet of the longfin inshore squid changes with size; small immature individuals feed on planktonic organisms. Cannibalism is observed in juveniles larger than 5 cm. Studies have shown that smaller juveniles fed on euphausiids and arrow worms, while larger juveniles fed mostly on small crabs, but also on polychaetes and shrimp. Larger individuals feed on crustaceans and small fish (Jacobson, 2005). Many pelagic and demersal fish species, as well as marine mammals and diving birds, prey upon juvenile and adult longfin inshore squid. Marine mammal predators include longfin pilot whale (*Globicephala melas*) and common dolphin (*Delphinus delphis*). Fish predators include bluefish, sea bass, mackerel, cod, haddock, pollock, silver hake, red hake, sea raven, spiny dogfish, angel shark, goosefish, dogfish, and flounder (Jacobson, 2005; NMFS, 2006)).

c. Project Impacts

Based on their temperature preferences/occurrences (Table 19), long-fin squid are likely to be in project area waters from March or April to December. However, migration information indicates that they are unlikely to be in project area waters later than October. Because of their ready mobility, juveniles (pre-recruits) and adults (recruits) should easily be able to avoid any direct negative impacts during dredging or sand placement at this time. No indirect impacts are expected because habitat alterations on the offshore shoals are expected to have only local and temporary impacts to the foodweb.

2. Surf clam (Juveniles, Adults)

a. EFH Description

Juveniles and adults: Throughout the substrate, to a depth of three feet below the water/sediment interface, within federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90%

of all the ranked ten-minute squares for the area where surfclams were caught in the NEFSC surfclam and ocean quahog dredge surveys. Surfclams generally occur from the beach zone to a depth of about 200 feet, but beyond about 125 feet abundance is low.

b. Prey, Predators, and Fisheries.

Currents play an important role in determining patterns of distribution and settlement of developing juveniles. Oceanic storms and currents may displace adults considerable distance from burrows; survivors reburrow at new sites (NMFS, 2006). Atlantic surfclams are planktivorous siphon feeders. Atlantic surfclams have many predators, including several snail and crab species, the sea star *Asterias forbesi*, and sevenspine bay shrimp (*Crangon septemspinosa*). Fish predators include haddock (*Melanogrammus aeglefinus*) and Atlantic cod. Surf clam reach reproductive age from several months to several years after larval settlement and metamorphosis to juvenile life stage (which typically occurs about month after egg fertilization). Surf clam have been recorded to live as long as 31 years. The terms pre-recruit and recruit are used to describe Atlantic surfclam life history stages for fishery purposes. They refer to the exploited and unexploited portions of the stock. Atlantic surfclams are exploited at a minimum size of 12 cm; prerecruits are < 11 cm and recruits are >= 12 cm. Atlantic surfclams are managed under the Mid-Atlantic Fishery Management Council Atlantic Surfclam and Ocean Quahog Fishery Management Plan (Cargnelli et al., 1999).

c. Project Impacts

Dredging each cycle would destroy approximately 500 acres of surf clam habitat. The majority of surf clam living within the dredged area would be killed. Over the project life, about 4,600 acres of surf clam habitat would be temporarily destroyed and the majority of surf clams living within that habitat would be killed. While this would represent a significant short-term loss of surf clam in the impact areas, since it is expected that habitat conditions for surf clam will be equivalent to those before dredging over time, it is anticipated that surf clam populations would gradually recover to pre-project levels after a several year period. Surf clam recruitment potential to disturbed sites would be good anytime of year (MMS, 2000). Surf clam predators, including Atlantic cod, would be adversely affected by loss of food until such time as surf clam populations recovered in each borrow site.

IV. Mitigation Measures

Coordination was undertaken with a number of resource agency personnel and academic scientists/engineers (Table 20) in order to identify appropriate mitigation measures for dredging on the offshore shoals that would minimize environmental impacts. (A summary of this plan formulation process is provided in the "Borrow Plan" section of the SEIS, and a record of coordination is contained in Annex C). In recognition of its high value as a fishing grounds and based on the specific recommendation of the USFWS, dredging of Shoal B will not be dredged unless its value declines substantially.

Coordination with resource agency personnel would be undertaken prior to making this determination in the future. In event Shoal B is determined to be suitable, artificial reef areas there would be avoided to maintain the quality of these features as recreational fishing areas and to avoid damage to dredging gear.

Table 20: Persons coordinated with to formulate mitigation measures.

Person	Agency/Organization
George Ruddy	USFWS
Jim Casey	Maryland Department of Natural Resources
Robert Nairn	Baird & Associates Engineering, Science & Planning
Mark Byrnes	Applied Coastal Research and Engineering
Randy McBride	George Mason University
Darlene Wells	MGS,
Bob Conkwright	MGS,
Tim Goodger	NMFS
John Nichols	NMFS

Several general guidelines to minimize detrimental impacts to the offshore shoals' geomorphic integrity and their current quality as finfish and shell fish habitat were identified and incorporated into the borrow plan (Table 21):

Table 21: Mitigation measures.

	Dredging Guideline/Constraint	Purpose
1	Dredge no more than 5% of the total volume of any offshore shoal	Maintain each existing shoal geomorphic integrity rather than sacrificing any since relative individual ecological value unknown.
2	Avoid dredging crest	Maintain shallowest water habitat and maximum crest relief to maintain habitat associated dependent habitat functions
3	Dredge uniformly over as wide an area as possible at less than about 10 feet thickness removed	Maintain shoal profile and slope so post-project conditions resemble pre-project conditions
4	Dredge on the updrift or downdrift (accreting) side of the shoal where suitable sand occur	Minimize risk of destabilizing the shoal as a distinct geomorphic feature

Guideline 3 will be incorporated into the dredging plan for each site by wording the dredging contract stipulations to limit the maximum thickness of material that could be removed from any one point. At this time it is anticipated that the maximum would be 10 feet. Additional language will be incorporated into the contract encouraging the contractor to spread out impacts over as wide an area as possible within each borrow area. This latter point may be difficult to implement because of dredging logistics, and difficult to enforce because not until a post-borrow survey is completed can this be fully evaluated. However, it is expected that stating a maximum thickness of material that can be removed will serve to promote relatively uniform dredging and maintain the shoal profile and slope. In order to meet volume needs while minimizing the thickness of sand to be removed, it may be necessary to expand the borrow areas.

Coordination with the individuals listed at the beginning of this section determined that no specific mitigation measures were necessary to minimize impacts to benthos on the offshore shoals, because benthos of the shoal are of relatively low diversity and abundance compared to adjacent deeper waters, and it was expected that shoal benthos would recover relatively rapidly (as discussed in Section III). Coring conducted by the Corps has determined that sand in the shoals subsurfaces that could be utilized for placement on the beach at Fenwick is comparable to surficial sand on the shoal to the base of the shoals (Table 2). Therefore, dredging to any depth up to the shoal base should leave post-dredging surficial sediments of comparable grain-size to the existing surface. Consequently, no additional mitigation measures would be required to avoid areas of finer or coarser grain sizes since this consideration is already effectively incorporated into the project by the criteria used to select the borrow area. Maintaining smooth shoal topography should also serve to minimize any grain-size changes that could occur if deep holes or other more dramatic changes were made to the shoal as a consequence of dredging.

No mitigation measures are incorporated into the proposed sand placement on Fenwick. The proportion of silts and clays of material to be placed has been shown to be perhaps the principal concern in minimizing impacts to surf zone benthos in beach nourishment projects. The sand to be placed on Fenwick has only a very minor proportion of fine-grained sediments, ameliorating concern over this potential impact. The surf zone is naturally a high energy area and the shoreline very dynamic. Consequently, surf zone benthic organisms are expected to rapidly colonize the newly placed beach sands, and foodweb impacts are expected to be only minor and temporary (MMS, 1999).

Incorporating a time-of-year restriction into the dredging schedule to protect finfish species that are present only during months when water temperatures are warmer was not possible. Restrictions on open-ocean dredging operations posed by dangerous winter conditions limit the opportunity to dredge during colder times of year.

Although not strictly a mitigation measure, a post-borrow hydrographic survey will be required to be conducted by the contractor following dredging. This will enable the Corps to evaluate whether the dredging contractor has met the dredging guidelines above.

V. Conclusion

Mitigation measures incorporated into the proposed borrow plan should help ensure that long-term geomorphic stability of the shoals, and their accordant habitat functions, are maintained. That said, it is expected that the individual shoals that are dredged will not naturally recover the volume of sand taken from them within many human lifetimes, if ever. Approximately 4,600 acres of bottom on the offshore shoals could be directly impacted over the project life from 2010 through 2044. This impact is significant by virtue of scale alone, and by consideration of the total area of each shoal that would be impacted (Table 22). However, it is small in size compared to the total acreage of large shoals off the Maryland coast, and very small in size relative to the seafloor on the continental shelf off the Delmarva peninsula. The lattermost of these areal comparisons fails to put any different relative value on any particular substrate type, water depth, geomorphic feature, or proximity to the shoreline within this region, however, so implications that sand mining is not an important issue with regard to management of the offshore shoals should not be drawn. From a finfish perspective, demersal species will be most greatly impacted. The pelagic species should be impacted minimally if at all (MMS, 1999). However, the relatively small-size of the impact area relative to the large geographic ranges of transitory fishes (MMS, 2000) indicates that dredging the offshore shoals and placing sand on the shoreline of Fenwick Island, even when considered cumulatively with dredging sand to restore the geological integrity of Assateague Island, would have essentially no impact on the populations of finfish evaluated in this analysis. Accordingly, the Baltimore District has determined that the proposed project will have an adverse effect on EFH but complies with the provisions of the Magnuson-Stevens Act, as amended.

Table 22: Direct impact areas.

Shoal	**Total Shoal Area (mi^2) MGS**	**Total Shoal Area (acres) MGS**	**Total Shoal Area (acres) USACE**	**Impact Area (acres) USACE**	**Percent of MGS Shoal Surface Area Impacted**	**Percent of USACE Shoal Surface Area Impacted**
A	5.2	3,300	1,460	870	26%	60%
B	4.4	2,800	4,410	1,690	60%	38%
Weaver	3.8	2,400	1,570	1,000	42%	64%
Isle of Wight	5.5	3,500	2,790	1,030	29%	37%
Totals	18.9	12,000	10,230	4,590	38%	45%

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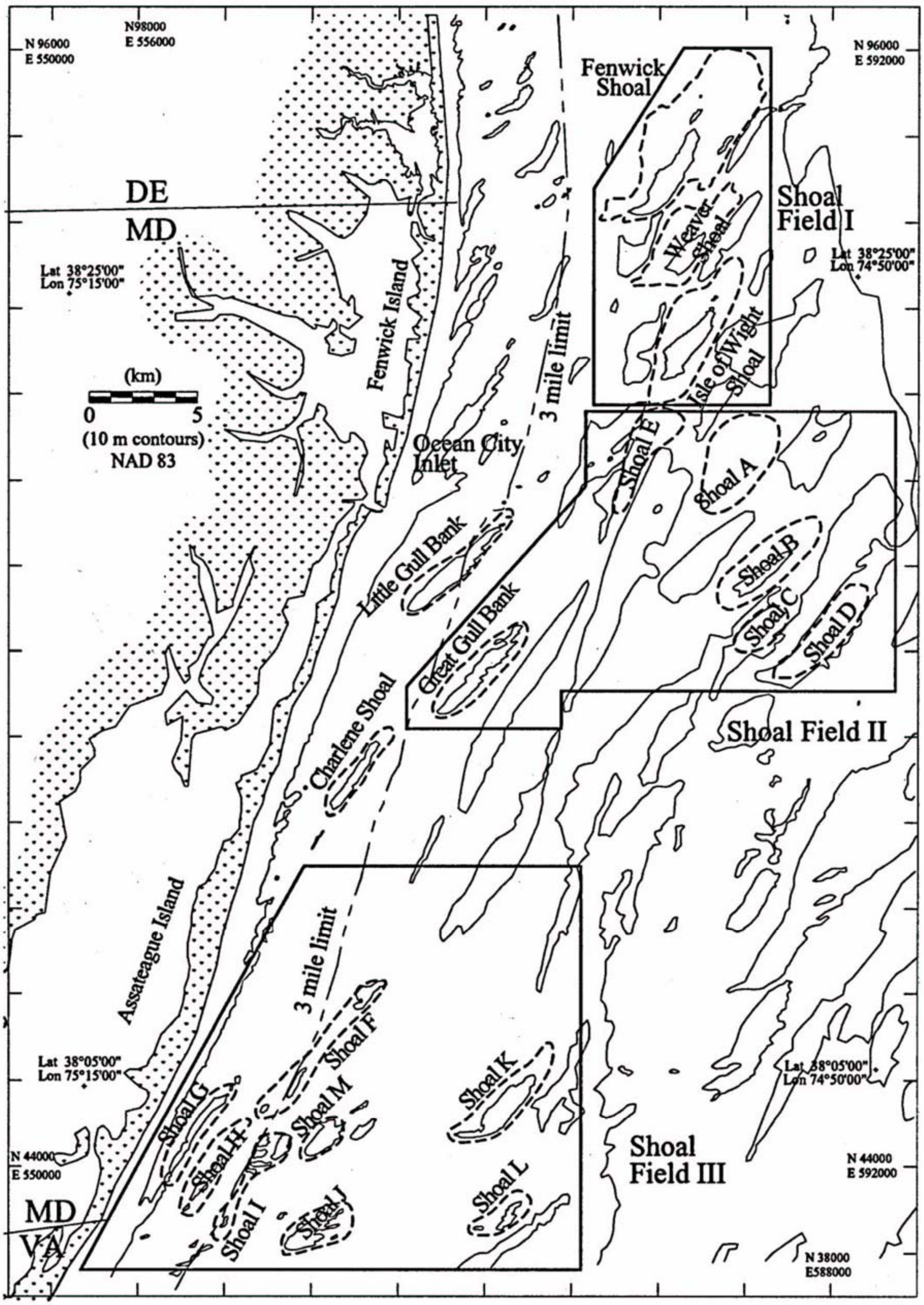

Figure 1: Maryland Geological Survey index of shoal Fields. Grid: MD State Plane Coordinates, NAD 1983, meters.

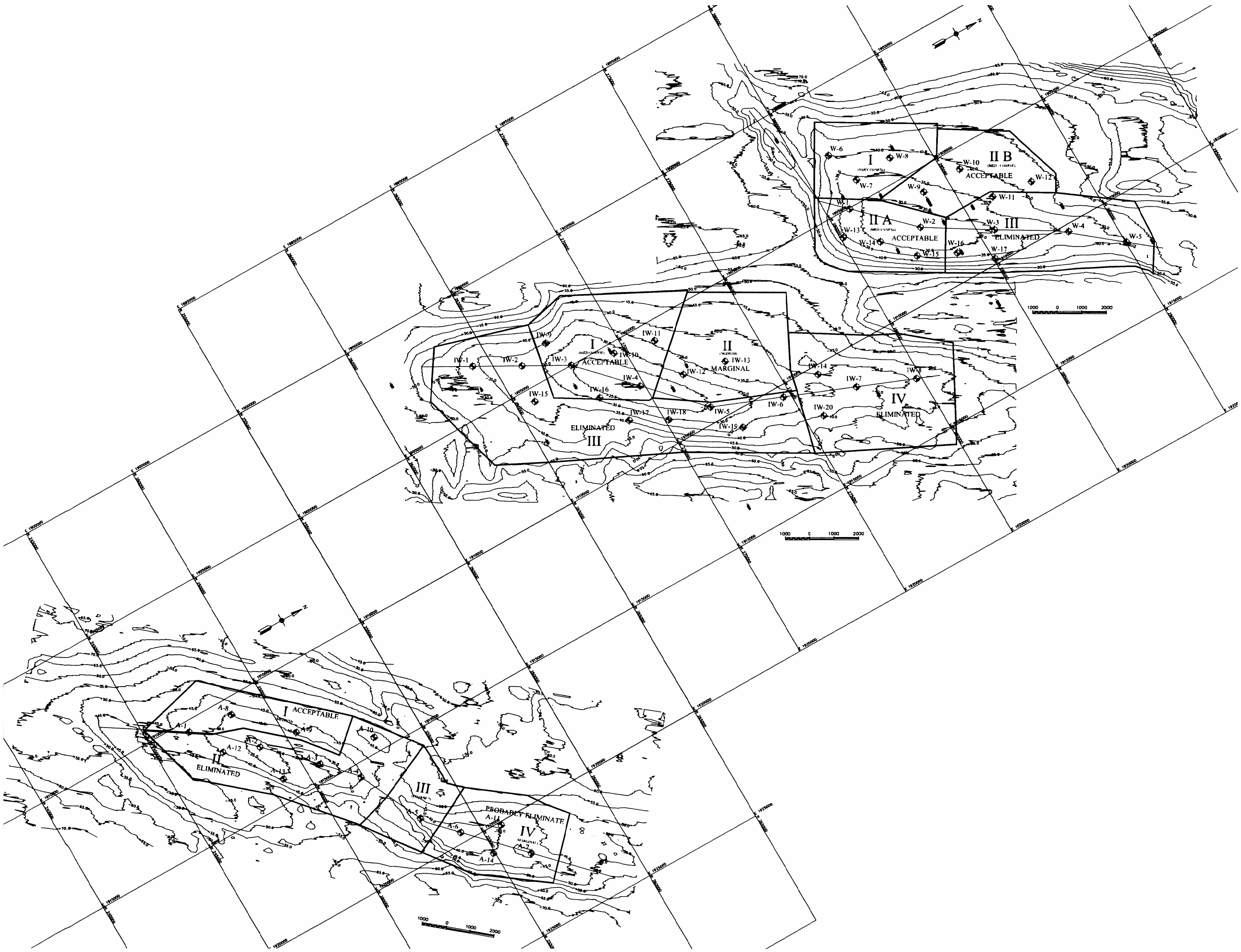

Figure 2: Isle of Wight Shoal, Weaver Shoal, and Shoal A. Ordered north to south, respectively.

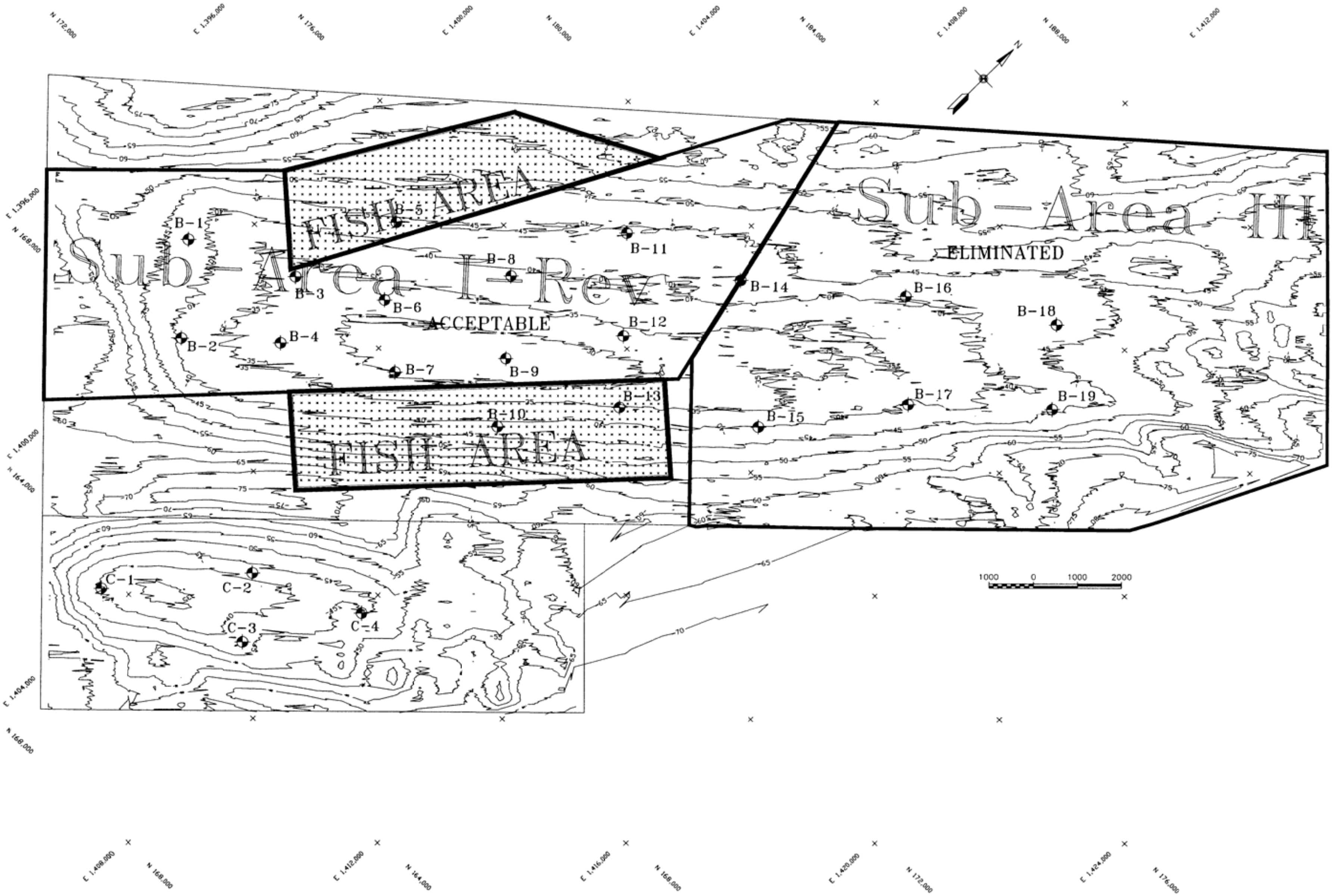

Figure 3: Shoal B.

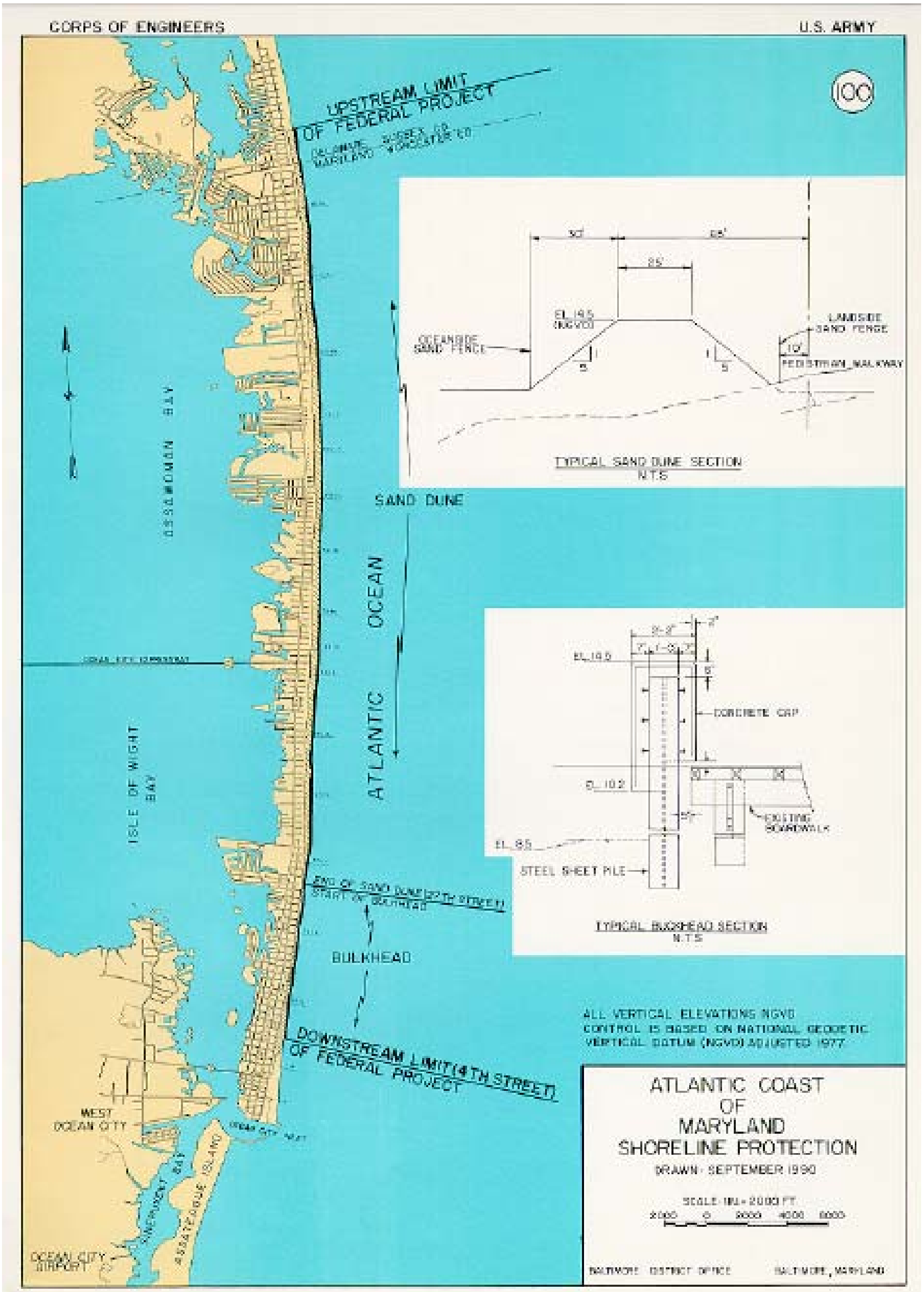

Figure 4: Atlantic Coast of Maryland Shoreline Protection Project: Fenwick Island.

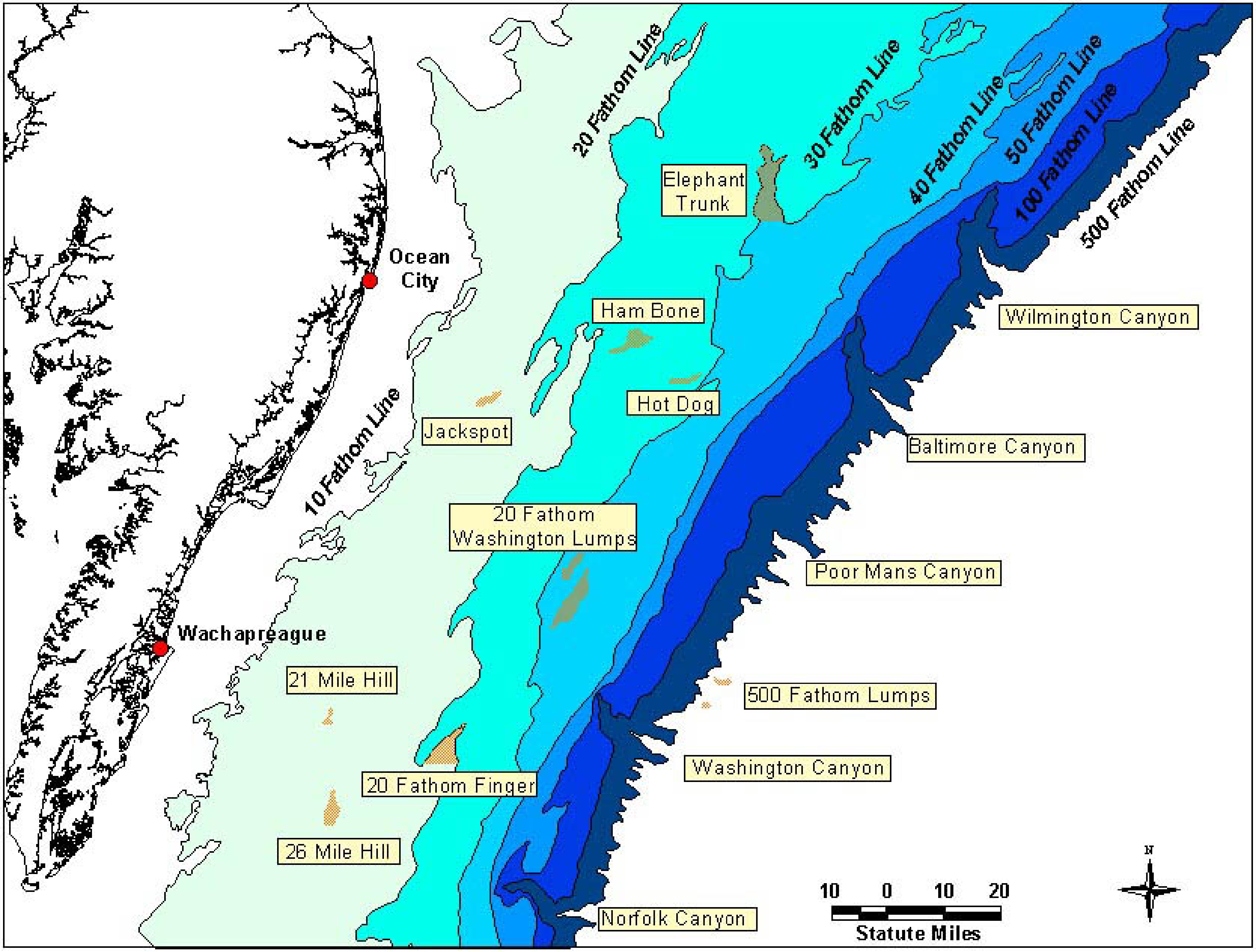

Figure 5: A general map of the offshore waters. Includes canyons and commonly referred to offshore fishing locations (DNR, 2006).

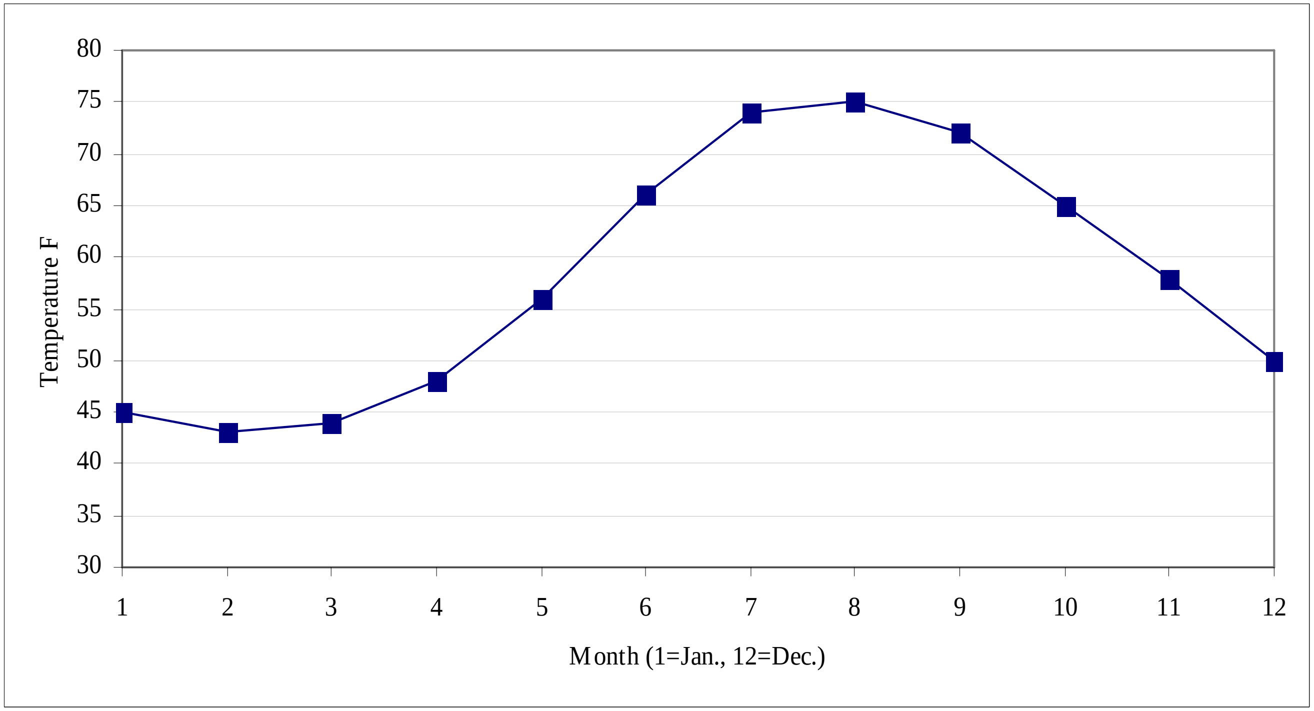

Figure 6: Mean monthly sea surface temperatures of Maryland coastal ocean waters off Fenwick Island (U.S. Navy, 2001).

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