Marine Transport
Anthropogenic Activity Background Document

I. Activity Overview

To facilitate the use of marine waters for transport, fishing and recreation, coastal infrastructure is necessary to dock, receive and launch vessels and their associated goods and/or services. Ports and marinas are constructed and maintained along with nearshore shipping channels and harbors to facilitate access. The physical structures vary greatly in size and scale, from backyard docks used to launch personal vessels, to marinas that house many small boats or yachts, to commercial port facilities that accommodate large passenger and cargo vessels and facilitate the loading, unloading and storage of cargo. Similarly, harbors and shipping channels range in depth and breadth to accommodate the associated vessel traffic. Marine transport development activities will continue to grow in the future to keep up with the expansion of global trade and shipping needs.

<u>Construction and Maintenance of Ports and Marinas</u>
Depending on the size and function of the port or marina, the physical infrastructure may be affixed to the shore or seafloor, or float on the surface of the water. Larger structures are often constructed by driving piles into the seafloor to support the raised infrastructure. Over-water, floating structures, such as piers, barges, booms, rafts and mooring buoys have less direct contact with the seafloor, but may still contact benthic habitat through installed guide piles, anchors, and chains.

Port facilities, and to a lesser extent marinas, have often been constructed by filling wetlands or shallow water habitat to create upland areas for associated infrastructure. Bulkheads or seawalls can be constructed to contain the fill, provide a straight upland edge for wharf structures, and a platform for equipment operations and material transfer. In some cases, underwater explosives may be used in the construction of marine transport and hardening structures. The construction of associated onshore facilities, such as cargo handling and storage space, fueling areas, washing and repair facilities, and boat storage may also replace shoreline habitat with impervious surfaces. Marinas, mostly used for recreational boating, are smaller than ports and require less upland infrastructure. Once in place, ports and marinas require periodic maintenance that may involve applying sealants, removing algal buildup, and repairing damaged or weathered structures. The scale of the construction and maintenance activities depends on the size and types of vessels that are expected to use the port or marina.

In addition to ports and marinas, infrastructure is commonly constructed on private property to facilitate access and use of marine and coastal waterways, such as backyard docks and small vessel moorings. These projects have a smaller total footprint and fewer impacts to marine habitat than the commercial activates described above. However, the size and number of these small projects in a given area could potentially result in significant cumulative impacts that degrade coastal habitats.

Dredging of Harbors and Shipping Channels

Dredging is a major component of marine transport activities. To facilitate the construction of ports and marinas, nearshore areas may need to be dredged to create harbors that serve as turning basins, anchorages and berthing docks for different sizes and types of vessels. The dredging of sediments from intertidal and subtidal habitats is often necessary to create shipping channels that facilitate vessel traffic into and out of ports and marinas. Harbors and shipping channels also require routine dredging or “maintenance” dredging to remove accumulated sediments and maintain established depth and width profiles. Maintenance dredging occurs frequently, but “improvement” dredging, which creates new shipping channels or expands the operating profiles of existing channels, has increased along with the demand to accommodate larger capacity commercial cargo vessels.

Dredging uses hydraulic or mechanical equipment; the type of equipment used depends on the characteristics of the sediments to be removed and the type of sediment disposal required. Hydraulic dredging removes a slurry of water and sediment, which is pumped through a pipeline onto a barge or a hopper bin for off-site disposal, or directly to a confined disposal site onshore. Mechanical dredging uses a clamshell dredge, which is suspended from a crane, to grab and deposit the sediments onto a barge for transport. Depending on the chemical and biological profile of the sediments, the dredged material can be placed in confined disposal facilities, open-water disposal sites, or be used for secondary uses. Dredged materials can be repurposed to support a number of beneficial activities, such as restoring sensitive habitats and stabilizing eroded shorelines. The impacts to the environment from a navigational dredging project can have cumulative effects on benthic communities and are proportional to the location and scale of the activities, length of time it takes to complete the project, frequency of maintenance dredging, and resilience of the benthic habitat and associated communities.

Activity in the Mid-Atlantic Region

Marine transport infrastructure is well developed in the Mid-Atlantic region, and thus the majority of proposed marine transport projects are for maintenance dredging. As the Panama Canal expansion is underway, ports will need deeper shipping channels to accommodate larger vessels, improve efficiency, remain competitive, and expand or protect their market share. Projects for deepening and widening of existing ports are larger in scope than maintenance dredging. Port deepening projects have occurred or are underway in New York Harbor, the Delaware River, Baltimore, and Norfolk. National Oceanic and Atmospheric Administration (NOAA) Fisheries Habitat Conservation Division staff are involved during the consultation process for permitting marine transport activities. All types of marine transport projects go through a federal permitting process led by the U.S. Army Corps of Engineers (Corps), who has permitting authority for navigational improvements and construction in navigable waters and oversees dredged material placement. In addition to NOAA Fisheries Habitat Conservation Division staff, the Corps consults with other federal agencies such as the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service as needed for project proposals. The permitting process can be quite complex depending on the size of the projects and the engagement of local governments and port authorities.

II. Habitat Impacts from Marine Transport by Habitat Type

Marine transport activities occur solely in nearshore waters, though they may impact a number of different habitat types. The severity of impact is proportional to the size and duration of construction, maintenance or dredging project. Of all the marine transport activities, dredging and filling are likely to cause the most significant impacts to marine habitat. While filling aquatic habitat with sediment is currently a less common practice, fill may be proposed to expand a port's upland area to gain additional storage space. Potential habitat impacts from marine transport activities are described below, organized by distribution and depth of habitat types.

Distribution (Nearshore (Including Estuarine)/Offshore)

a) Nearshore

The construction and maintenance activities that facilitate marine transport all occur in the nearshore environment, thus habitat impacts will be concentrated in the coastal zone. The construction, expansion and maintenance of ports and marinas and associated activities such as dredging, filling and shoreline hardening can result in direct habitat destruction and conversion, altered habitat function, increased sedimentation, and decreased water quality. Dredging in particular can result in disruptions to physical and biochemical habitat properties and reduce the suitability of benthic habitat. The scale and severity of habitat impacts depends on the size, type and configuration of the port or marina, the size and frequency of vessel traffic, the type of habitat on which they are sited, and the timing and frequency of dredging.

The construction and expansion of ports and marinas can result in direct habitat destruction or damage as a result of placing hardened support structures in the water, such as piles or concrete docks. Anchors and guide piles associated with floating structures may also damage nearshore benthic habitat, though to a lesser degree. Filling nearshore habitat to create uplands for port and marina facilities and hardening of adjacent shorelines with erosion control structures such as bulkheads, seawalls or jetties can also result in direct habitat loss, particularly of nearshore benthic habitats. Construction activities may resuspend sediments, including contaminated sediments, increase turbidity, and reduce localized water quality. If underwater explosives are used to construct bulkheads, seawalls and concrete docks, habitat destruction and suspension of sediments can be amplified. Explosives can also impact the survival and behavior of fish (see Indirect Impacts).

Once in place, marine transport infrastructure may continue to impact nearshore habitats. The presence of ports and marinas over the surface of the water can change light regimes of the habitats below, impacting primary production and the behavior of fish species (see Indirect Impacts). In-water structures and shoreline hardening structures can change tidal and current patterns, which may alter longshore sediment transport processes, nearshore beach building processes, and nearshore organism assemblages and their associated food webs. The presence of these structures in the water column can also create new habitat for sessile organisms and alter the surrounding benthic substrate (see Indirect Impacts).

Marine transport infrastructure and associated activities may have significant impacts on water quality. Contaminants such as oil, fuel, chemicals (e.g. paint and solvents), and metals (e.g. mercury and lead) can be released directly into the water during construction and maintenance activities and through incidental spills. Wooden piles and treated concrete can also leach chemicals into the water column and expose organisms to toxins (see Indirect Impacts). As a result of decreased tidal and current flows from in-water structures, contaminants may become trapped in nearshore waters and sediments, thus concentrating toxins, and creating areas of low dissolved oxygen and algal blooms (see Indirect Impacts). Shoreline hardening structures and associated shoreside development that often accompanies marine transport projects can increase the footprint of impervious surfaces and lead to more stormwater runoff. An increase in runoff can exacerbate water quality degradation through increasing suspended sediments and introducing land-based contaminants such as petroleum hydrocarbons, metals, pesticides and fertilizers into coastal waters.

The construction, expansion and maintenance of harbors and shipping channels can have significant and long-term impacts on the nearshore environment, particularly where frequent maintenance dredging is required. Both mechanical and hydraulic dredging may directly destroy, convert and disturb habitat, particularly in nearshore and estuarine areas. Through removing and displacing benthic substrates, sediments are suspended in the water, which can result in increased sedimentation, turbidity and resuspension of contaminants into the water column. Dredging may also alter the physical and biochemical properties of benthic habitat through changing depth profiles and current circulation patterns.

Estuarine

Marine transport activities can be particularly detrimental in estuarine areas. Direct habitat destruction and conversion from construction, maintenance, dredging and shoreline filling and hardening can eliminate critical intertidal and wetland habitats and the ecological functions they provide to many life stages of marine organisms. Impacts associated with sedimentation, siltation, turbidity and stormwater runoff can decrease the productivity of estuarine habitats and exacerbate water quality impacts.

b) Offshore
The habitat impacts from marine transport activities are concentrated in the nearshore environment, and are not expected to result in any impacts to offshore habitat.

<u>Depth (Pelagic/Demersal/Benthic)</u>

a) Pelagic
In-water structures such as piles may reduce water quality by impacting water circulation and leaching biocides and other chemicals. Large over water structures can cause pelagic shading, which affects fish behavior. Vertical structures may introduce habitat for new shellfish communities to develop (see Indirect Impacts). Though these impacts span the water column, they are likely to be concentrated in nearshore, pelagic waters.

b) Demersal
Construction and maintenance activities associated with marine transport, particularly dredging, can suspend sediments in the water column. The resulting sedimentation, siltation and turbidity can cause temporary physical and behavioral impacts to benthic species. The resuspension of contaminated sediments can also degrade benthic habitats and decrease the fitness of benthic organisms (see Indirect Impacts). If required, the use of underwater explosives may exacerbate the spatial extent and duration of these sediment impacts.

c) Benthic
The construction of ports, marinas and shoreline hardening structures can result in direct loss and conversion of benthic habitat. The placement of in-water structures such as piles, concrete docks, bulkheads, jetties and breakwaters can alter tidal and current patterns, thus impacting the distribution and flow of benthic sediments. These structures can hinder natural sediment transport, cause scour of surrounding sediment, or increase the suspension and resettlement of sediment. Benthic organisms may be buried or exposed as a result of these changes in sediment flows. Shellfish communities that settle on introduced structures such as piles can create shell deposits on the surrounding seafloor, changing the composition of the benthic substrate and shifting the benthic community structure to species associated with shell habitat.

Dredging can have significant detrimental impacts to benthic habitat, though the extent of damage depends on the type of benthic substrate, the frequency and scale of disturbance, and the ability of the affected habitat and associated species to recover. Through the physical removal and destruction of benthic substrate, dredging is likely to result in decreased biomass and species diversity (see Indirect Impacts). Dredging of shipping channels can change the physical contours and depth profile of the seafloor. Deepening channels can reduce light penetration and lower water temperatures, which may influence biochemical processes and reduce productivity. When channels become significantly deeper than surrounding areas, natural mixing can decrease, resulting in anoxic or hypoxic water conditions. Altered circulation patterns around dredging projects may change sediment composition from sand or shell substrate to fine particles. This shift may increase the suspension of sediments, reduce the viability of shellfish beds and aquatic vegetation, and negatively impact the survival of species during critical life stages (see Indirect Impacts).

Marine transport activities, particularly dredging of shipping channels, can suspend sediment in the water column. Reductions in pervious surfaces around marinas and ports can also increase stormwater runoff and the direct flow of silt and sediment into adjacent waterways. The resulting increase in sedimentation and siltation can bury benthic organisms, decrease the productivity of submerged vegetation and plankton, and change the structure and/or complexity of benthic habitat. Contaminants in suspended sediments and stormwater runoff can be toxic to benthic organisms and degrade the habitability of nearby areas (see Indirect Impacts).

Benthic Substrate (Submerged Aquatic Vegetation/Structured/Soft)

a) Submerged Aquatic Vegetation

Marine transport activities may directly replace submerged aquatic vegetation (SAV) habitat with hardened structures, or deepen areas to depths that have insufficient light to support SAV, resulting in a loss of the critical ecological functions this habitat provides. In addition to directly burying SAV beds, increased sedimentation, siltation and turbidity that result from construction and dredging can decrease primary productivity through reduced light penetration and reduce dissolved oxygen levels. The placement of structures over the water can also alter light regimes by casting shadows. Shading impacts are greatest directly below structures, but reductions in primary productivity can extend to nearby areas as shadows change from the presence and movement of vessels and docks. Development of shoreside infrastructure associated with marine transport may also increase stormwater runoff, exacerbating sedimentation and siltation impacts and causing eutrophication of SAV beds through nutrient loading.

b) Structured

Structured habitat is less likely to be impacted by marine transport activities since the majority of these activities are taking place in established ports or shipping channels, where structured habitat is not found. Marine transport activities in shipping channels may however affect nearby structured habitat by increased sedimentation burying or converting structured habitat as particles settle.

c) Soft

Marine transport activities, especially dredging, can cause damage to soft bottom habitats through the direct removal and relocation of sediment. Dredging in intertidal mud and sand flats can result in a loss of critical ecological function. Dredging may also change the flow of soft substrate, and alter the contours of soft benthic habitat. Altered circulation patterns may change the nature of soft bottom habitat from coarse sand to finer particle sediments, which can affect benthic community composition. Finer, more organic particles are also more likely to bind with contaminants than coarse particles, which can leader to greater accumulation in sediments (see Indirect Impacts).

III. Potential Impacts of Marine Transport to MAFMC Managed Stocks

Depending on the scale, duration, location and specific activities involved, nearly all habitat types used by Mid-Atlantic Fishery Management Council (MAFMC) stocks have the potential to be impacted to some degree from marine transport projects. Given that most current projects are for maintenance dredging of ports and shipping channels, benthic habitats in nearshore or estuarine areas are most likely to be impacted. Marine transport activities occur strictly nearshore, and thus no impacts are expected to offshore habitats. Impacts to the pelagic environment are likely less destructive than those to benthic and demersal habitats due to the distribution of dredging impacts.

The following table lists the habitat types designated as Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for the different life stages of MAFMC managed stocks (see *Impacts to Fish Habitat from Anthropogenic Activities: Introduction and Methods*). Cells highlighted in orange indicate an overlay between the habitat type used and the potential for the habitat type to be adversely impacted by marine transport activities; cells highlighted in yellow indicate a lower potential for adverse impacts; cells highlighted in green are unlikely to be impacted.

Given the intersection of where marine transport activities occur and the dependence of MAFMC stocks on the nearshore environment, many MAFMC managed species may potentially be impacted. Benthic habitats used by some or all life stages of black sea bass, longfin squid (*Loligo*), ocean quahogs, scup, summer flounder, and Atlantic surfclams are more likely to be exposed to impacts from marine transport activities, especially dredging. Pelagic habitats, which are important for Atlantic mackerel, Atlantic bluefish, butterfish, and shortfin squid (*Illex*) recruits, are less likely to be impacted by marine transport activities. If marine transport activities take place in estuarine or SAV habitats, the impacts could be severe; they are important for the majority of MAFMC species and are designated as HAPC for summer flounder. Shortfin squid (*Illex*) (eggs and pre-recruits) and golden tilefish (all life stages) are the only MAFMC stocks that are not linked to the nearshore environment and do not have the potential to be impacted by these activities.

Visual Overlay of Potential Impacts from Marine Transport and MAFMC Species' EFH/HAPC

Legend

Orange = potential for adverse impacts

Yellow = low potential for adverse impacts

Green = no potential for adverse impacts

MAFMC Species	Distribution			Water Column			Benthic Substrate/Structure		
	Estuary	Nearshore (state waters)	Offshore	Pelagic (upper/mid/ entire column)	Demersal (lower water column)	Benthic (seafloor substrate)	SAV	Structured (e.g. shell, manmade)	Soft (sand, silt)
Atlantic Mackerel									
Eggs	x	x	x	x					
Larvae	x	x	x	x					
Juveniles	x	x	x	x					
Adults	x	x	x	x					
Black Sea Bass									
Eggs	x	x	x	x					
Larvae	x	x	x	x	x	x		x	
Juveniles	x	x	x		x	x	x	x	x
Adults	x	x	x		x	x		x	x
Atlantic Bluefish									
Eggs		x	x	x					
Larvae		x	x	x					
Juveniles	x	x	x	x					
Adults	x	x	x	x					
Butterfish									
Eggs	x	x	x	x					
Larvae	x	x	x	x					
Juveniles	x	x	x	x					
Adults	x	x	x	x					
Shortfin Squid (*Illex*)									
Eggs			x	x					
Pre-Recruits			x	x					
Recruits		x	x	x					
Longfin Squid (*Loligo*)									
Eggs	x	x	x		x	x	x	x	x
Pre-Recruits	x	x	x	x					
Recruits	x	x	x	x	x	x	x	x	x
Ocean Quahogs									
Juveniles		x	x			x			x
Adults		x	x			x			x
Scup									
Eggs	x	x							
Larvae	x	x							
Juveniles	x	x	x		x	x	x	x	x
Adults	x	x	x		x	x			
Spiny Dogfish									
Juveniles		x	x	x	x				
Sub-Adults		x	x	x	x				
Adults		x	x	x	x				
Summer Flounder									
Eggs		x	x	x					
Larvae	x	x	x	x					
Juveniles	x	x	x		x	x	x		x
Adults	x	x	x		x	x	x		x
HAPC	x						x		
Atlantic Surfclams									
Juveniles		x	x			x			x
Adults		x	x			x			x
Golden Tilefish									
Eggs			x	x					
Larvae			x	x					
Juveniles			x		x	x		x	x
Adults			x		x	x		x	x
HAPC			x			x		x	x

IV. Indirect Impacts

In addition to the habitat impacts described above, activities associated with marine transport can have impacts on the survival and productivity of marine species.

a) Contaminants

The release of contaminants during port and marina construction and maintenance activities, suspension of contaminated sediments from dredging, increased stormwater runoff from impervious surfaces, and leaching from chemically treated wood piles and docks can expose marine species to toxins. Organisms can suffer from tissue damage, changes in hormone regulation, and disturbances to cellular and immune function if exposed to toxins. Chronic exposure to contaminants can cause bioaccumulation in fish species and relay impacts through food webs. Contaminants commonly released during port and marina activities include oil, fuel, chemicals (e.g. paint, detergents, and solvents), and metals (e.g. copper, zinc, arsenic, mercury, lead, nickel, and cadmium).

b) Benthic Community Structure

Changes in habitat caused by marine transport activities can alter the distribution of invertebrates and fish, expose or bury sessile organisms, and change predator-prey interactions. Changes in water quality and primary productivity can also alter plant and animal assemblages and shift nearshore food webs. Dredging can alter the physical and chemical properties of habitat, including sediment composition, and disrupt communities of native species. This may cause a shift in the types of benthic organisms that re-colonize dredged areas and could provide opportunities for invasive species to spread. In-water structures such as shoreline hardening structures, vertical piles, and docks may create artificial habitat for sessile organisms or cause shading underwater, which can alter nearby community structure and local productivity.

c) Survival and Productivity

Marine transport activities can impact the survival and productivity of marine species at the individual and stock level. Dredging activities are particularly harmful to marine species and can result in large reductions in benthic species diversity, the total number of individuals, and overall biomass. Eggs and larvae can be entrained and harmed in dredging equipment. Turbidity, sedimentation and siltation can reduce primary productivity and dissolved oxygen levels, thus reducing food availability and creating anoxic conditions. High levels of suspended sediment can also hinder the respiration of fish and invertebrates, diminish the effectiveness of sight feeders, and reduce the growth and survival of filter feeders. Light regimes changed by over-water structures may inhibit feeding, schooling and migratory behaviors that are driven by visual cues. Changes in sedimentation and current patterns can also have population level impacts by inhibiting the dispersal, settlement and recruitment of eggs and larvae, burying eggs, and impacting juvenile predation rates. If underwater explosives are used to construct port or marina infrastructure, the shock wave can directly impact fish behavior.

d) Invasive Species

Marine transport activities can introduce invasive species through the exchange of ballast water from large commercial vessels, and the presence of fouling organisms on vessel hulls. Invasive species can alter nearshore habitats and threaten the survival and productivity of native marine species.

V. References

1. Personal Communication with Karen Greene, Habitat Conservation Division, James J. Howard Marine Sciences Laboratory, NOAA Fisheries. 01/07/2015.
2. National Oceanic and Atmospheric Administration. 2008. "Impacts to Marine Fisheries Habitat from Nonfishing Activities in the Northeastern United States." NOAA Technical Memorandum NMFS-NE-209. 339p.
3. New England Fishery Management Council. 2014. "Omnibus Essential Fish Habitat Amendment 2 Draft Environmental Impact Statement. Appendix G: Non-Fishing Impacts to Essential Fish Habitat." 168p. Web: <http://www.nefmc.org/library/omnibus-habitat-amendment-2>. Accessed December 16, 2015.
4. Atlantic States Marine Fisheries Commission. 2013. "Harbor Deepening: Potential Habitat and Natural Resource Issues." 12p. Web: <http://www.asmfc.org/files/Meetings/Winter2013/ISFMPPolicyBoardSupplemental.pdf>. Accessed December 19, 2015.
5. U.S. Army Corps of Engineers and the Port of West Sacramento. 2011. "Draft Supplemental Environmental Impact Statement/Subsequent Environmental Impact Report for the Sacramento River Deep Water Ship Channel." 289p. Accessed January 14, 2015.