Liquefied Natural Gas
Anthropogenic Activity Background Document

I. Activity Overview

Liquefied Natural Gas (LNG) is super-cooled methane gas, converted into liquid form. In this energy-dense state, LNG takes up significantly less space than gaseous methane, providing for more efficient transport over long distances. The process for transporting LNG requires specialized facilities to convert methane between gaseous and liquid states and connect to distribution pathways, large ships to move the liquefied gas, and large ports to accommodate these vessels.

Shipping

LNG is shipped between facilities in very large double-hulled cryogenic tanker ships, which may be received in shoreside or offshore ports. For shoreside ports, maintenance dredging is often required to maintain the depth and width of shipping channels and port facilities to accommodate the draft of these vessels. Offshore ports are generally sited in deepwater and do not require dredging.

Infrastructure

Specialized LNG facilities are necessary to support the import and export of LNG, which can be located onshore or offshore. Both configurations require shoreside infrastructure to support distribution. Onshore plants are sited in close proximity to the ports receiving the transport vessels, and transfer LNG to the plant for regasification. The construction of onshore LNG plants and associated upland facilities and pipelines can involve a number of coastal development activities, such as dredging, filling, and shoreline stabilization. The U.S. Department of the Interior's Federal Energy Resources Commission (FERC) permits the development of LNG facilities onshore; additional state and federal permits may also be required.

LNG can also be received at offshore facilities constructed on offshore platforms. The construction of offshore receiving ports includes the installation and maintenance of a receiving facility and pipelines to either transport LNG to shoreside facilities and distribution networks, or connect to existing pipelines. The U.S. Coast Guard and the U.S. Department of Transportation's Maritime Administration (MARAD) share joint responsibility for permitting offshore import/export facilities also known as deepwater ports pursuant to the Deepwater Port Act of 1974, as amended by the Maritime transportation Security Act of 2002.

Within LNG facilities, specialized equipment is necessary to conduct the liquefaction and regasification processes. Currently, all plants in the Mid-Atlantic region are configured to regasify imported LNG. Regasification can be conducted by closed-cycle and open-cycle processes. Closed-cycle facilities rely on a mixture of water and chemicals to warm and gasify the super-cooled LNG and to cool machinery within the facility; open-cycle facilities rely on the intake of large amounts of seawater to perform these functions. LNG received offshore is regasified onboard a specialized vessel, and transferred in submerged buoys that connect the vessel to the offshore facility; gaseous methane is then piped to shore and connected to onshore distribution pipelines.

Activity in the Mid-Atlantic Region

LNG is an important, marketable product that supplies fuel for heating in the Northeast. All existing onshore LNG facilities in the Mid-Atlantic are closed-loop import facilities, though a few combined import and export facility configurations are currently proposed for construction. At this time, all transport vessels dock in existing nearshore ports. With its large population centers and increasing demand for energy for heating, the region will continue to import LNG in the near future as a result of the increasing availability of relatively cheap natural gas reserves around the world. In addition, increasing domestic production of natural gas may prompt the construction and re-configuration of facilities to export LNG in the future. Recently, FERC authorized construction and operation of a facility on the Chesapeake Bay to liquefy and export LNG from the Marcellus shale formation in the Northeast, and authorized another existing facility at Calvert Point in the Chesapeake Bay to export LNG.

National Oceanic and Atmospheric Administration (NOAA) Fisheries Habitat Conservation Division staff are actively engaged in the consultation process with federal partners before and during permitting of LNG activities. In addition to providing comments through Essential Fish Habitat (EFH) and Endangered Species Act consultations, and the National Environmental Protection Act (NEPA) process undertaken by FERC and the U.S Coast Guard, NOAA Fisheries also engages early to suggest alterations to the siting and design of potential LNG developments to minimize habitat impacts.

II. Habitat Impacts from LNG by Habitat Type

LNG activities can potentially impact all habitat types, though most impacts are believed to be site-specific. Impacts to marine habitat are described below, organized by distribution and depth of habitat types.

Distribution (Nearshore (Including Estuarine)/Offshore)

a) Nearshore

The construction of onshore plants and associated upland infrastructure can lead to habitat destruction and conversion through dredging and filling shoreline habitat, installation of structures such as piles and foundations, and shoreline stabilization and hardening. Changes in runoff, sedimentation and siltation can also occur as a result of changes to hydrology from impervious surfaces, structures, and changes to intakes and outfalls. Once operational, LNG facilitates may impact habitat, water quality and species behavior through the discharge of seawater, debris and contaminants. Open-cycle LNG plants located in nearshore, confined water bodies can disrupt hydrology and ecosystem function through changes in salinity and temperature resulting from the intake and discharge of large volumes of water. These facilities can also impinge and entrain fish eggs and larvae and impact species survival, behavior and physiology (see Indirect Impacts). Closed-cycle systems also intake and discharge water, but to a lesser degree.

Vessels used to transport LNG between onshore facilities may necessitate dredging to establish and maintain shipping channels. The ballast water exchange of these vessels may have similar impingement and entrainment effects and impact water quality through the release of contaminants into the nearshore environment, and may introduce invasive species (see Indirect Impacts).

The use of offshore receiving facilities can have additional impacts on the nearshore environment. The construction of pipelines linking to onshore LNG plants can lead to habitat destruction and conversion, suspension of sediments including contaminated sediments, and alteration of sediment movement and water flows around pipes. Construction and maintenance barges may also impact habitat through anchoring, use of seawater for cooling and ballast, and expelling debris. Biocides like copper and aluminum compounds are used to coat pipeline surfaces to prevent the growth of marine organisms. These compounds can leach into surrounding waters and accumulate in substrates, potentially exposing organisms living or feeding on the bottom to toxins (see Indirect Impacts).

Estuarine
In addition to the impacts listed above, LNG plant construction and operation can impact estuarine habitats by damaging emergent vegetation and wetland habitat like eelgrass and microalgae beds as a result of dredging, siltation and changes in hydrology and temperature. Shoreline hardening and installation of stabilization structures for onshore facilities can also have direct impacts on vegetation, mudflats, salt marshes and other nursery areas critical to certain species and life stages.

b) Offshore
Where LNG is received offshore, the construction of offshore ports can result in habitat conversion or destruction and suspension of sediment as a result of driving piles or other means of attaching the ports to the seafloor. The use of construction and maintenance barges, and installation and maintenance of pipelines, may also impact offshore benthic habitat as described below.

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

a) Pelagic
Pelagic environments may be impacted by LNG activities through the exchange of ballast water and noise impacts from construction, operation and maintenance activities (see Indirect Impacts). In shallow pelagic waters, sedimentation and runoff may reduce water quality. Impingement and entrainment of fish eggs and larvae may also occur with closed-cycle processing (see Indirect Impacts).

b) Demersal
Nearshore and offshore demersal environments can be impacted by the suspension and resuspension of sediments caused by dredging, construction of facilities and pipelines, laying cables, and moving vessels in confined areas. The resulting increase in turbidity can result in temporary physical impacts to demersal species and changes in light

penetrability. Toxicity impacts from resuspension of contaminated sediment and leaching of biocides from coated pipelines may also occur.

c) Benthic

In addition to construction and maintenance activities associated with offshore ports, the large scale dredging of shipping channels to accommodate LNG vessels can also have permanent and temporary impacts. Impacts from dredging result from the direct removal of substrate, relocation of substrate through plowing, trenching and side casting, and disposition of dredged materials. These activities can result in direct loss of habitat, conversion of substrate and habitat types, and changes in bathymetry and sedimentation. These impacts may result in a net decrease of habitat availability and changes in the distribution of species for all or some life stages, including spawning locations for species with substrate---specific spawning behaviors.

Benthic Substrate (Submerged Aquatic Vegetation/Structured/Soft)

a) Submerged Aquatic Vegetation

In addition to direct impacts from construction, shoreline hardening and dredging, submerged aquatic vegetation (SAV) may also be indirectly impacted by changes in sedimentation, siltation, water quality, and hydrology.

b) Structured

While the extent of construction, dredging and pipeline installation occurring in structured habitat (hard bottom, shell and manmade substrate) may be less than that in soft bottom substrates, these activities can damage and convert structured habitats, which typically take longer to recover than soft substrates.

c) Soft

The construction of offshore ports and pipelines, and dredging of shipping channels are most likely to occur in soft bottom habitat such as sand and silt. In addition to direct habitat impacts from these activities, soft bottom habitats may also be exposed to changes in substrate type, bathymetry, and sediment location and flows.

III. Potential Impacts of LNG to MAFMC Managed Stocks

Depending on the configuration, location, and scale of LNG activities, all Mid---Atlantic Fishery Management Council (MAFMC) managed stocks have the potential to be impacted to some degree. Given the existing configuration of LNG activity in the region, the majority of impacts are expected to occur close to shore, and result from onshore infrastructure construction and operation, and shipping channel/port dredging. Thus, nearshore, estuarine, demersal and benthic habitats (particularly SAV and soft bottoms) are most likely to be harmed or disrupted. Offshore, pelagic and structured benthic habitats are less likely to be impacted, unless offshore receiving facilities are considered in the Mid---Atlantic. The use of offshore receiving ports would also increase impacts to nearshore and benthic habitats from the construction and maintenance of pipelines used to transport LNG from offshore terminals to onshore facilities.

The following table lists the habitat types designated as 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 LNG activities; cells highlighted in yellow indicate a lower potential for impacts. Aside from specific life stages of shortfin squid (*Illex*) squid and golden tilefish, there is overlap between habitat use and potential impacts for all species and life stages from LNG development. Areas designated as HAPC for summer flounder may be particularly vulnerable to impacts from LNG development.

Visual Overlay of Potential Impacts from LNG Activities and MAFMC Species' EFH/HAPC

Legend
- **Orange** = potential for adverse impacts
- **Yellow** = low potential for adverse impacts
- **Green** = no potential for adverse impacts

	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)
MAFMC Species									
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 its liquid state, methane can be highly explosive when it comes in contact with water. As a result, the U.S. Coast Guard may utilize exclusion zones to ensure LNG port safety. These exclusion zones could displace fishing effort to other areas and increase congestion of shipping traffic around these zones. In addition to the habitat impacts described above, activities associated with LNG can also have impacts on the survival and productivity of marine species:

a) Noise

Construction, operation and shipping activities associated with LNG can cause underwater noise, vibrations and changes in pressure, which can damage marine life and disrupt behavior, such as avoidance of areas with loud or persistent noise. Larvae and juvenile fish are most susceptible to underwater noise impacts, particularly where it occurs in estuaries. Marine mammals may also be impacted through damage to hearing organs, disruptions in communication and echolocation, and changes in behavior and migration patterns.

b) Impingement and Entrainment

Open---cycle LNG facilities utilize seawater for warming and cooling, and can entrain (capture) and impinge (press against intake screens) marine species, including fish eggs, larvae and juveniles, as well as phyto--- and zoo---plankton. Closed---cycle facilities use small volumes of seawater to start and stop the regasification process, thus the impacts are less significant. Offshore ports used for regasification and vessels used in transporting LNG also intake and expel seawater, which can result in similar impacts. Impingement and entrainment associated with LNG activities has been linked to high mortality with eggs and larvae of several species in New England waters.

c) Impacts to Species Survivability

LNG facilities may disrupt the temperature, salinity, and quality of surrounding waters, which can reduce the fitness of marine organisms by altering respiration, metabolism, reproduction, growth, and behavior. Benthic and demersal species may also be exposed to toxins from biocides used to coat LNG pipelines that become resuspended in demersal waters; exposure to biocides such as copper at low concentrations has been shown to impact the survival of herring eggs and larvae. In the event of a spill or leak, LNG may be introduced into the surrounding waters, potentially exposing marine organisms to hydrocarbons. In such cases, acute impacts to marine organisms can be reasonably expected, though there is limited information available on these impacts.

d) Invasive Species

Ballast water exchange occurring during the loading and offloading of LNG from tankers in inshore and offshore facilities can introduce non---native and invasive species. Invasive species pose a large threat to fisheries, habitat, and community structure and dynamics. Invasive species can lower the fitness of organisms, reduce genetic diversity, and introduce exotic diseases.

V. References

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