ASSESSMENT OF THE EFFECTS OF UNDERWATER NOISE FROM THE PROPOSED NEPTUNE LNG PROJECT

Supplementary Biological Effects Report

By

For

Ecology and Environment, Inc.
Rosslyn Center
1700 North Moore Street
Arlington, VA

LGL Report No. 4200-2a

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Rolph A. Davis, Ph.D.

LGL Limited
environmental research associates
22 Fisher St., P.O. Box 280
King City, ON
L7B 1A6

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Introduction

In October 2005, LGL Limited and JASCO Research Ltd. submitted a report entitled "*Assessment of the effects of underwater noise from the proposed Neptune LNG Project"* to Ecology and Environment, Inc. Since then, there have been design modifications to the SRV thrusters and additional acoustical modeling was conducted. The results of this additional modeling are discussed in this supplementary report. A companion report by JASCO Research Ltd. contains the results of new acoustical modeling that underpins the biological effects discussion presented here.

This supplementary report on biological effects needs to be read in conjunction with the main 2005 report where the rationale and methods used for the assessment are presented.

Assessment of Noise Effects from LNG Carriers in the TSS

In our previous assessment of the Neptune project (LGL and JASCO Research 2005), we did not specifically examine the effects of the LNG carriers when they were traveling along the main shipping channel (Transportation Separation Scheme or TSS) into, and out of, the Boston area. The rationale for that approach was that the Neptune vessels would only add a small increment to the present levels of ship traffic in the TSS and that analyses of the Neptune vessels in the absence of data on all of the other large vessels using the route would not be useful. However, given agency interest in such an analysis, the necessary modeling has been conducted and the results discussed herein.

The results of the acoustic modeling are presented in JASCO's supplementary report dated August 2006. The received levels of ship noise were modeled at two power settings, 45 and 60 rpm equating to approximate speeds of 10 and 14 kts, respectively, three receiver water depths (1, 50 and bottom m), and for four seasons (spring, summer, fall, and winter).

In previous studies, it has been shown that in some instances baleen whales show avoidance reactions to continuous broadband noise sources at received levels of about 120 dB re 1µPa [see LGL and JASCO Research (2005) for a review]. These studies were all conducted in areas where there was little other ship traffic or other industrial noise. Therefore, it was not possible to examine the question of habituation by the whales to repeated sounds.

The key question in the present analysis is whether the presence of the LNG carriers in the TSS will disturb whales that are resident in the area or likely to pass through the shipping lanes. In general, marine mammals habituate quite well to regular sounds that are non-threatening to them (Richardson et al. 1995). Such a situation already occurs in the TSS as indicated by plans to move the location of the TSS further north to a location where fewer whales occur. Given that it is thought that there are already too many whales in the TSS, it is apparent that the whales have habituated to the high levels of ship noise that already occur in the area. The addition of the passages by the LNG carriers is unlikely to change that situation. In fact, it would actually be beneficial if the carriers did disturb baleen whales since this would reduce the likelihood of their being struck by vessels in the shipping lanes.

Examination of the noise from the LNG carriers traveling at 14 kts indicates that the ships may be detected a few nautical miles (nm) outside the TSS lanes but that potentially disturbing levels (>120 dB) do not extend very far (see Supplemental Acoustic Modeling Report). The average distance from the vessel to the point at which received levels fall below 120 dB ranges from 0.40 nm (0.75 km) in summer to 0.43 nm (0.79 km) in winter for a receiver at the water surface (1 m). For a receiver at a depth of 50 m or the bottom, the average distance from the LNG carrier to the 120 dB isobath would range from 1.2 nm (2.2 km) in summer to 1.3 nm (2.4 km) in winter.

The average area ensonified with sound over 120 dB is predicted to be about 1 nm^2 (2 km^2) throughout the year for a receiver at the water surface (1 m). For a receiver at a depth of 50 m or the bottom, the average area ensonified by the LNG carrier to the 120 dB level would range from 4 nm^2 (15 km^2) in summer to 5 nm^2 (18 km^2) in winter.

Clearly, the incremental noise from the LNG carriers traveling through the TSS will have little, if any disturbing, effect on marine mammals in the area. This conclusion is based on the modeling results which assumed a propeller rpm rate of 60 or a speed of ~14kts. Increasing the rpm rate will result in substantially larger areas ensonified.

The reader is reminded that the received level of ship noise that will actually disturb marine mammals in the Boston region is likely to be higher than the 120 dB level used here because the animals have already been exposed to high levels of ship traffic and associated noise and have exhibited apparent habituation to the higher noise levels.

Assessment of Noise Effects for Thrusters on the LNG Carrier

There are two situations where ship's thrusters may be used. They will be used to dynamically position the vessel at the DWP when it arrives. Thrusters may also be used under certain conditions during strong winds to maintain the heading of the vessel into the wind when competing tides operate to push the vessel broadside to the wind. The two situations are discussed here.

Dynamic Positioning

In October 2005, LGL and JASCO Research prepared a report entitled "Assessment of the effects of underwater noise from the proposed Neptune LNG Project". The scenario chosen in this report for modeling noise from thrusters on the LNG carriers was based on the use of three thrusters. However, as the design of the project has progressed, more details on the engineering parameters of the ship's thrusters and their use during operation of the DWP are now known with more certainty. Specifically, the sizes of the thruster blades and their operating rpm have been changed since the 2005 report. During DWP docking operations, the ship's four thrusters (two bow and two stern) will operate at 100% loads for dynamic positioning. These new parameters are modeled in the JASCO 2006 supplementary report. It should be noted that the underwater noise levels associated with thruster use have been greatly reduced (on the order of a 90% reduction is the area contained within the 120 dB contour) and consequently, far fewer animals will be exposed to increased noise levels compared to the scenario modeled in 2005.

The scenario evaluated in this supplementary analysis is as follows. When a carrier arrives at the DWP, the thrusters will be used for 10-30 minutes to position the ship at the available buoy. This will occur at alternate buoys every 4-8 days since only one buoy is occupied at a time, with a small overlap (two ships docked during a changeover). If it is assumed that the thrusters would be used every 6 days (mid-point of 4-8 days) on average and that the average period of use would be 20 minutes per session (mid-point of 10-30 minutes), then the total period of use of the thrusters over the course of the year would be about 20 hours. The noise from the thrusters will be continuous during the periods of use, and they will always be used by SRVs while mooring at one of the two DWP buoys. The effects of noise from the operation of the thrusters while dynamically positioning at the DWP are examined in the following sections:

Baleen Whales

Operation of the thrusters will create higher noise levels than the other continuous project noise sources. The modeled scenario at the DWP with four thrusters operating predicted that there would be an average area ensonified by noise levels of over 120 dB ranging from 6.0 to 115.2 km² (1.8 to 33.6 nm²) and extending out to 1.4 to 6.1 km (0.8 to 3.3 nm) from the source (see Supplemental Acoustic Modeling report by JASCO Research Ltd.). Based on the Department of the Navy's (2005) geospatial analysis model, the average densities of baleen whales in the Neptune area during the year are predicted to be as listed here (see Tables 4 and 5 in Section 1 of LGL and JASCO Research 2005).

North Atlantic right whale	0.01-21.14 per 1000 km²
Humpback whale	13.85-27.71 "
Fin whale	0.00-16.45 "
Sei whale	0.00-17.27 "
Minke whale	0.00-4.66 "

Assuming that the highest number whales in the range are present all year and that the largest area (115 km²) is subject to 120 dB, then about 2 right whales, 3 humpback whales, 2 fin whales, 2 sei whales, and possibly 1 minke whale would be subjected to potentially disturbing levels of noise during each exposure over the course of the year. There are no data on turnover rates, making it impossible to determine the number of different whales that might be exposed to the noise. Given the very small numbers of baleen whales involved, the small amount of exposure (20 hours per year), and the fixed locations of the noises sources, it is not likely that there will be any effects on baleen whale populations or on individual whales from the use of the carrier's thrusters for positioning at the DWP.

Toothed Whales or Odontocetes

Noise emanating from thruster operations would ensonify an area with noise levels of over 120 dB ranging from 6.0 to 115.2 km² (1.8 to 33.6 nm²) and extending out to 1.4 to 6.1 km (0.8 to 3.3 nm) from the source (see Supplemental Acoustic Modeling report by JASCO Research Ltd.). Based on the Department of the Navy's (2005) geospatial analysis model, the

average densities of toothed whales in the Neptune area during the year are predicted to be as listed here (see Tables 4 and 5 in Section 1 in LGL and JASCO Research 2005).

Long-finned pilot whale	0.01-271.42 per 1000 km²
Bottlenose dolphin (fall only)	0.03-278.81 "
Atlantic white-sided dolphin	0.00-265.21 "
Risso's Dolphin (fall only)	0.00-503.06 "
Common Dolphin (fall only)	0.00-464.07 "
Harbor Porpoise	0.00-162.36 "

It should be remembered that dolphin distribution is generally patchy with a few large pods being present rather than an even distribution.

Assuming that the highest number whales in the range are present and that the largest area (115 km²) is subject to 120 dB, then about 31 pilot whales, 31 white-sided dolphins, and 19 harbor porpoises would be subjected to potentially disturbing levels of noise during each exposure over the course of the year. During the fall period, an additional 32 bottlenose dolphins, 58 Risso's dolphins, and 53 common dolphins might be exposed during this three-month period. Again, there are no data on turnover rates, making it impossible to determine the number of different whales that might be exposed to the noise. Given the patchy distribution of toothed whales involved, the small amount of exposure (20 hours per year), and the fixed locations of the noises sources, it is not likely that there will be any important effects on odontocete populations or on individual whales caused by the proposed use of thrusters to dynamically position the carrier at the DWP.

Pinnipeds or Seals

Noise emanating from the dynamic positioning operation would ensonify an area with noise levels of over 120 dB ranging from 6.0 to 115.2 km² (1.8 to 33.6 nm²) and extending out to 1.4 to 6.1 km (0.8 to 3.3 nm) from the source (see Supplemental Acoustic Modeling report by JASCO Research Ltd.). According to the Department of the Navy's (2005) geospatial analysis model, the only seal that regularly occurs in the Neptune area is the harbor seal in winter (see Tables 4 and 5 in Section 1 of LGL and JASCO Research 2005). Using the assumptions developed for whales, it can be calculated that about 8 harbor seals would be exposed to noise levels above 120 dB during winter. Given the infrequency of the use of the thrusters (5 hours during winter) and the observed ability of harbor seals to habituate to human activities including noise, it is unlikely that that there will any deleterious effects on the harbor seal population or on individual seals from the positioning operations of the LNG carriers.

Sea Turtles

Two species of sea turtle occur in the Neptune area and Massachusetts Bay in summer (see LGL and JASCO 2005). The leatherback turtle was not recorded on systematic surveys in the Neptune area but was found in densities of 0-3.46 per 1000 km² in the Massachusetts Bay area. The loggerhead turtle was recorded at densities of 0.00-47.27 per 1000 km² in the Neptune area (U.S. Navy 2005).

The effects of underwater noise on sea turtles are not well studied. There are no safety criteria for sea turtles similar to those used by NMFS for marine mammals. A criterion of 130 dB for continuous sounds was calculated in LGL and JASCO (2005). Based on the modeled results in JASCO 2006, I estimated a 130 dB ensonified zone of 1 to 17 km² extending out to 0.5 to 2.4 km. The high end of the density estimate for loggerhead turtles in the Neptune area during summer was 47.27 per 1000 km². Assuming a maximum area (17 km²) ensonified by received levels above 130 dB and assuming that the maximum density of turtles are present and evenly distributed, then about 1 loggerhead turtle would be present in the area ensonified by potentially disturbing noise levels. It is possible that single leatherback and Kemp's Ridley Turtles could be exposed in summer. It is concluded, based on the small area ensonified, the short period of exposure (5 hours per season), and the small number of turtles that might be disturbed, that the effects of noise would be negligible on turtle populations and on individual turtles.

Maintain Position

In order to maintain SRV heading into the seas at the DWP under certain sea state conditions (for when wind and currents cause the SRV to drift broadside to the waves), there would be a need to use the two stern thrusters at 100% load to reposition the SRV to reduce rolling and sloshing of LNG contained in the cargo tanks. It should be recognized that in those circumstances when it would be necessary to operate the two thrusters, ambient noise will likely already be high as a result of the wind and associated wave noise. It is not known how often the two stern thrusters would be needed while the vessel is regasifying at the DWP. The noise from the thrusters will be continuous during the periods of use, and they will be needed by SRVs while regasifying LNG at one of the two DWP buoys. The effects of noise from the operation of the stern thrusters while moored to the DWP are examined in the following sections:

Baleen Whales

The modeled scenario of a ship moored at the DWP with two thrusters operating predicted that there would be an average area ensonified by noise levels of over 120 dB ranging from 3 to 48 km² (0.8 to 14 nm²) and extending out to 0.9 to 3.9 km (0.5 to 2.1 nm) from the source (see Supplemental Acoustic Modeling report by JASCO Research Ltd.). Based on the Department of the Navy's (2005) geospatial analysis model, the average densities of baleen whales in the Neptune area during the year are predicted to be as listed here (see Tables 4 and 5 in Section 1 of LGL and JASCO Research 2005).

North Atlantic right whale	0.01-21.14 per 1000 km²
Humpback whale	13.85-27.71 "
Fin whale	0.00-16.45 "
Sei whale	0.00-17.27 "
Minke whale	0.00-4.66 "

Assuming that the highest number whales in the range are present all year and that the largest area (48 km²) is subject to 120 dB, then about 1 right whale, 1 humpback whale, 1 fin whale, 1 sei whale, and less than 1 minke whale would be subjected to potentially disturbing levels of

noise during each exposure over the course of the year. There are no data on turnover rates, making it impossible to determine the number of different whales that might be exposed to the noise. Given the very small numbers of baleen whales involved, the relatively small amount but unknown amount of exposure, and the fixed locations of the noises sources, it is not likely that there will be any important effects on baleen whale populations or on individual whales from the use of the carrier's thrusters at the DWP.

Toothed Whales or Odontocetes

Noise emanating from thruster operations would ensonify an area with noise levels of over 120 dB ranging from 3 to 48 km² (0.8 to 14 nm²) and extending out to 0.9 to 3.9 km (0.5 to 2.1 nm) from the source (see Supplemental Acoustic Modeling report by JASCO Research Ltd.). Based on the Department of the Navy's (2005) geospatial analysis model, the average densities of toothed whales in the Neptune area during the year are predicted to be as listed here (see Tables 4 and 5 in Section 1 in LGL and JASCO Research 2005).

Long-finned pilot whale	0.01-271.42 per 1000 km²
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Risso's Dolphin (fall only)	0.00-503.06 "
Common Dolphin (fall only)	0.00-464.07 "
Harbor Porpoise	0.00-162.36 "

It should be remembered that dolphin distribution is generally patchy with a few large pods being present rather than an even distribution.

Assuming that the highest number whales in the range are present and that the largest area (48 km²) is subject to 120 dB, then about 13 pilot whales, 13 white-sided dolphins, and 8 harbor porpoises would be subjected to potentially disturbing levels of noise during each exposure over the course of the year. During the fall period, an additional 13 bottlenose dolphins, 24 Risso's dolphins, and 22 common dolphins might be exposed during this three-month period. Again, there are no data on turnover rates, making it impossible to determine the number of different whales that might be exposed to the noise. Given the patchy distribution of toothed whales involved, the relatively small but unknown amount of exposure, and the fixed locations of the noises sources, it is not likely that there will be any important effects on odontocete populations or on individual whales caused by the proposed use of thrusters to maintain the carrier at the DWP.

Pinnipeds or Seals

Noise emanating from the maneuvering operation would ensonify an area with noise levels of over 120 dB ranging from 3 to 48 km² (0.8 to 14 nm²) and extending out to 0.9 to 3.9 km (0.5 to 2.1 nm) from the source (see Supplemental Acoustic Modeling report by JASCO Research Ltd.). According to the Department of the Navy's (2005) geospatial analysis model, the only seal that regularly occurs in the Neptune area is the harbor seal in winter (see Tables 4 and 5 in Section 1 of LGL and JASCO Research 2005). Using the assumptions developed for

whales, it can be calculated that about 3 harbor seals would be exposed to noise levels above 120 dB during winter. Given the infrequency of the use of the thrusters and the observed ability of harbor seals to habituate to human activities including noise, it is unlikely that that there will any deleterious effects on the harbor seal population or on individual seals from the maneuvering operations of the LNG carriers.

Sea Turtles

Two species of sea turtle occur in the Neptune area and Massachusetts Bay in summer (see LGL and JASCO 2005). The leatherback turtle was not recorded on systematic surveys in the Neptune area but was found in densities of 0-3.46 per 1000 km² in the Massachusetts Bay area. The loggerhead turtle was recorded at densities of 0.00-47.27 per 1000 km² in the Neptune area (U.S. Navy 2005).

The effects of underwater noise on sea turtles are not well studied. There are no safety criteria for sea turtles similar to those used by NMFS for marine mammals. A criterion of 130 dB for continuous sounds was calculated in LGL and JASCO (2005). Based on the modeled results in JASCO 2006, we estimated a 130 dB ensonified zone of 1 to 17 km² extending out to 0.5 to 2.4 km. The high end of the density estimate for loggerhead turtles in the Neptune area during summer was 47.27 per 1000 km². Assuming a maximum area (17 km²) ensonified by received levels above 130 dB and assuming that the maximum density of turtles are present and evenly distributed, then about 1 loggerhead turtle would be present in the area ensonified by potentially disturbing noise levels. It is concluded, based on the relatively small area ensonified, and the small number of turtles that might be disturbed, that the effects of noise would be negligible on turtle populations and on individual turtles.

Conclusions

The present supplementary report examined the potential effects of the LNG carrier traveling in the TSS, a revised scenario for dynamically positioning the carrier at the DWP, and a scenario on the use of thrusters to maintain position while moored at the DWP. It is clear that the LNG carriers traveling at 14 kts in the TSS will have minimal effect on the already habituated marine mammals in the TSS area. The revised design of the thrusters has greatly reduced noise levels from the thrusters used to dynamically position the vessel at the DWP. The 120 dB ensonified zone is much reduced and consequently the numbers of animals exposed to 120 dB is dramatically reduced. The noise levels associated with the use of the two stern thrusters to maintain position at the DWP are low and expose few animals.

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