

MEMORANDUM

Date:	March 12, 2015
To:	Nathan Gloag, Balance of Plant Manager, Woodfibre LNG Limited
From:	Lara Taylor, Project Manager Jamie Slogan, Senior Biologist, Hemmera
File:	1662-002.04
Re:	Interim Summary Report of Herring Spawn Surveys 1(February 17 and 20) and 2 (March 5), 2015

1.0 INTRODUCTION

Woodfibre LNG Limited (WLNG) is proposing a liquefied natural gas (LNG) production facility with marine storage and off-loading at the former Woodfibre Pulp and Paper Mill site near Squamish, British Columbia. The Application is currently in an environmental review; however, WLNG will continue to conduct marine studies and geotechnical testing in anticipation of Project approval. In preparing the marine fish sections of the Application, it was determined that information on herring spawn in the Project area was deficient, particularly since local knowledge indicated that herring have spawned along this shoreline of Howe Sound (David Suzuki Foundation 2015). Herring spawn is a sensitive life stage and one of the drivers for the sensitive fisheries window in Howe Sound from February 1 to August 15. Since WLNG proposes to conduct marine activities during this fisheries window, it is important to ensure sensitive marine life stages are monitored.

The objective of these surveys is to document the potential distribution and timing of herring spawn, and any other observed sensitive marine life stages (i.e., ling cod egg masses), along the Project area shoreline and existing marine infrastructure. Information will be used to inform the environmental review and measures to mitigate marine activities conducted during the sensitive fisheries window.

2.0 METHODS

To assess whether herring use the nearshore habitat within the Project area for spawning, a series of one to two-day intertidal and subtidal surveys on SCUBA were planned during the spawning window; approximately early February through to the end of March. Surveys are planned to be 15 days apart, as this is the typical period it takes herring eggs to hatch after fertilization (Fort et al. 2013). The first day of each survey was designed to map the presence or absence of herring spawn onsite. If spawn was observed, then a second day was added to collect more detailed information with transect surveys.

Reconnaissance mapping was conducted by a team of three Worksafe BC certified SCUBA divers, all professional marine biologists, which dove the nearshore area from the water's surface to 12 m depth

(approximately -10 m CD). The start and end of each survey were recorded with a Garmin GPS and named according to dive number and survey date (e.g. D2.0217 for dive 2 on February 17th). When spawn was observed, the start and end of bed were georeferenced with a Garmin GPS to allow for more detailed surveys once all spawning beds were identified. A high definition GoPro camera was also used during the survey to document the presence or absence of herring spawn and other organisms and habitat features.

A detailed survey was conducted following the DFO Herring Spawn Protocol (Fort et al. 2013); however, methods had to be modified due to the narrow width of the spawn. A minimum of three transects were selected throughout the spawning bed once its extent was documented. Because the width of the bed was narrow, limited mainly to attachment to rockweed, transects were paired in each location to collect more complete information (**Figure 1**). Paired transects were selected from the surface to be approximately 20 m to 30 m apart; while sample locations were selected to be evenly distributed throughout the observed spawn area. Transects were run perpendicular to shore, from above the rockweed layer, to where the spawn was no longer observed. A minimum of five 0.25 m² quadrats (**Photo 1**) were distributed evenly through the width of the herring spawn along the sampling transect. At each quadrat the diver recorded: transect position, depth, substrate, vegetation cover, egg cover and egg layer.

3.0 RESULTS

Survey 1 (February 17 and 20, 2015)

On February 17th and 20th, habitats of high likelihood such as rockweed (*Fucus distichus*) or Laminarian kelp (i.e., large brown kelp) were targeted for herring spawn throughout each dive. Observation of the above water intertidal habitat and infrastructure (i.e., piles) were also made from the boat or by divers at the surface. Mapping of herring spawn for the Project area included rip rap, piles, old loading facilities and natural shoreline (**Figure 1**). Herring spawn was observed from southwest of Woodfibre Creek to just northeast of the active dock, mainly associated with rockweed growing on the riprap habitat (**Photos 2 and 3**). No herring spawn was observed northwest of the riprap adjacent to the active dock (**Photos 4 and 5**); except a small patch less than 10 m long on the rockweed attached to the piles immediately northeast of the outlet to Mill Creek. In addition to herring spawn, three lingcod (*Ophiodon elongatus*) egg masses were observed at depth, between 3 and 5 m below the water's surface, in crevices with in the bedrock and among boulders during the Dive 1, February 17, 2015 (**Photo 6**).

Herring spawn occurred mainly along intertidal and shallow subtidal rip rap that was covered with rockweed (*Fucus distichus*); except at the outlet of Woodfibre creek where herrings eggs were observed attached to bare rock and sea lettuce (*Ulva intestinalis*). Overall, eggs appeared to be clear and recently spawn. Eggs typically covered less than 15 percent cover within quadrats, commonly observed in trace amounts (<5% cover), and was not found to exceed one layer. Spawn was estimated to occur between 1.2 m and 2.9 m above chart datum (CD) with an average width of 3.8 m.

Survey 2 (March 5, 2015)

On March 3, habitats of high likelihood such as rockweed or Laminarian kelp were again targeted for herring spawn throughout each dive. Mapping of herring spawn for the Project area included rip rap, piles, old loading facilities and natural shoreline (**Figure 2**). No new herring spawn was observed during the March 5th survey. Herring eggs attached to rockweed growing on rip rap immediately northeast and southwest of the active boat dock was still present; however, the number of eggs appeared to be very sparse (<1%) and mainly unhatched (**Photo 7**). The low number of eggs remaining is a positive sign that a high percentage of the eggs observed during the initial survey may have hatched successfully.

As divers swam further southwest towards the sheet pile and rail car barge ramp, spawn became more abundant (**Photo 8**) and appeared to be mature eggs ready to hatch. A small sample taken to observe the life-stage indicates late-stage eggs with eyes of the embryo visible (**Photo 9**). The survey extended south of Woodfibre Creek, past the gravel and cobble beach with no further observations of herring spawn.

No herring spawn was observed on dive 3, which surveyed infrastructure towards the northwest including: the deep sea berth, old timber wharf, abandoned rail car barge ramp, hog fuel unloading facility, chip unloading facility and barge lay-by berths.

4.0 RECOMMENDATIONS

Based on our observations we recommend that Woodfibre continue the herring spawn survey program through to the end of March. The next survey is planned for between March 18th and 20th, 2015. Findings from the survey should be used to guide mitigation around any works in sensitive areas observed to contain herring spawn or lingcod egg masses.

5.0 CLOSURE

We appreciate the opportunity to work with you on the Woodfibre LNG project. If you have any questions regarding our report, please feel free to contact us at your convenience.

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6.0 REFERENCES

David Suzuki Foundation. 2015. Sound Investment: Measuring the return on Howe Sound's assets. Vancouver, BC. 77 p.

Fort, C., Daniel, K., and M. Thompson. 2013. Herring Spawn Survey Manual. Fisheries and Oceans Canada.

FIGURES

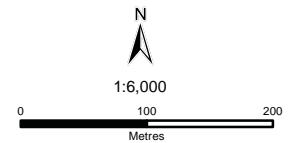


LEGEND

- PROJECT
- WATERCOURSE
- Bathymetry
- Project Infrastructure Lines
- LNG Storage Vessels
- Dive Survey
- Lingcod egg masses
- Herring eggs - observed
- Herring Transect Survey

SOURCES

Data courtesy of Canvec - GeoGratis, Government of British Columbia, ESRI



WOODFIBRE LNG LIMITED.
WOODFIBRE, HOWE SOUND, B.C.

HERRING SPAWNING SURVEY

Figure 1

27/02/2015



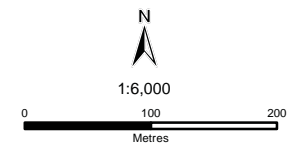




LEGEND

- PROJECT AREA
- WATERCOURSE
- BATHYMETRY
- EXISTING INFRASTRUCTURE
- PROJECT INFRASTRUCTURE LINES
- LNG STORAGE VESSELS
- DIVE SURVEY
- HERRING EGGS - OBSERVED

SOURCES

Data courtesy of Canvec - GeoGratis, Government of British Columbia, ESRI



WOODFIBRE LNG LIMITED. WOODFIBRE, HOWE SOUND, B.C.	
HERRING SPAWNING SURVEY MARCH 5 th , 2015	
Figure 2	3/12/2015
 HEMMERA	

PHOTOGRAPHS



Photo 1: One-quarter metre square quadrat used to during detailed herring spawn surveys (February 20, 2015)

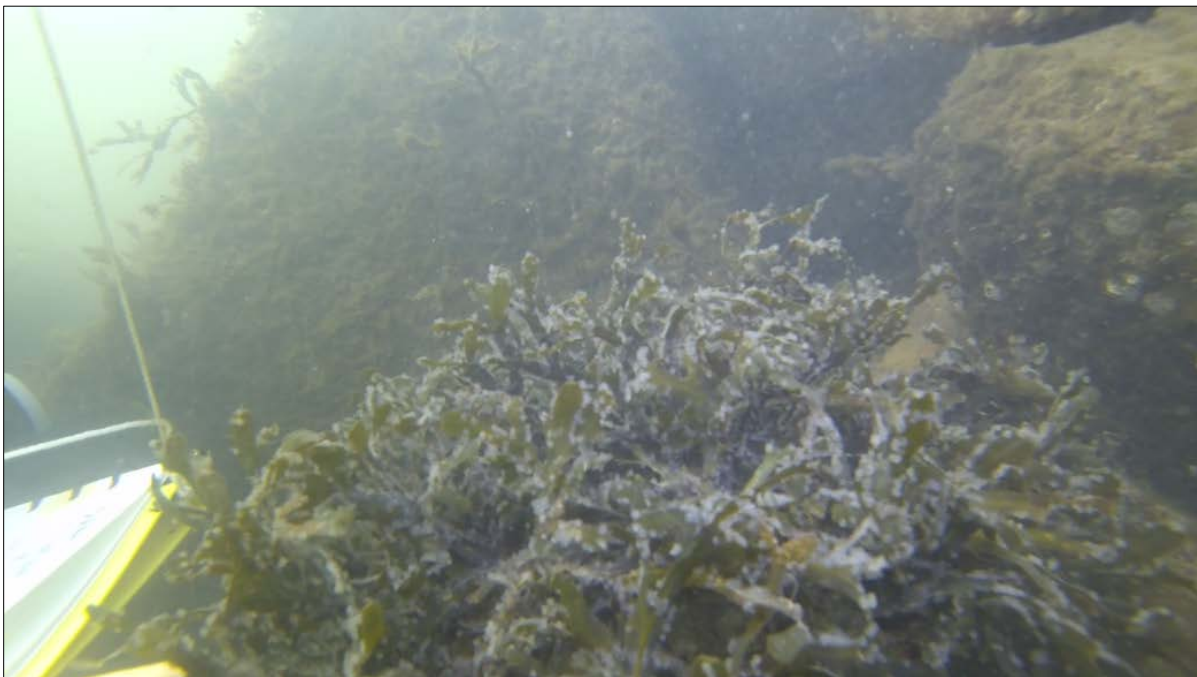


Photo 2: Herring spawn observed on rockweed growing on rip rap west of dock (February 17, 2015)



Photo 3: Herring spawn observed on rockweed growing on rip rap northeast of dock (February 20, 2015)



Photo 4: No herring spawn observed on piles northeast of Mill Creek – marine consisted mainly of mussels (*Mytilus trossulus*) and barnacles (*Balanus glandula*) (February 20, 2015)



Photo 5: No herring spawn observed on timber piles northeast of Woodfibre Creek – marine consisted mainly of diatoms with some rockweed (February 17, 2015)



Photo 6: Lingcod egg mass observed among boulders on dive 1 (February 17, 2015)



Photo 7: Empty herring egg cases, unfertilized eggs and unhatched eggs on rockweed from rip rap adjacent to active dock, March 5, 2015



Photo 8: Mature eggs, soon to hatch, attached to rockweed on rip rap between the rail car barge ramp and Woodfibre Creek, March 5, 2015.



Photo 9: Mature herring eggs with eyes of the embryo clearly visible, March 5, 2015