# REVIEW OF AN ENVIRONMENTAL ASSESSMENT FOR A WHARF DREDGING PROJECT IN SYDNEY HARBOUR

## Context

Fisheries and Oceans Canada's (DFO) Habitat Management Division, Maritimes Region, is participating in an Environmental Assessment (EA) for a proposed dredging of approximately 160,000 cubic meters of contaminated sediments immediately in front of Provincial Energy Venture's (PEV) existing wharf in Sydney Harbour, Nova Scotia, to determine if the project is likely to result in negative impacts to fish and fish habitat. As a responsible authority under the *Canadian Environmental Assessment Act*, DFO is required to assess and make a determination of the significance of the environmental effects associated with the project. DFO's Ecosystem Management Branch requested that DFO Science review the draft EA and address some specific questions.

Advice provided by DFO Science will be used by DFO's Habitat Management Division to meet its regulatory requirements under the *Fisheries Act* and *Canadian Environmental Assessment Act*. DFO Science advice will be shared with the other federal (Transport Canada, Environment Canada, Public Works and Government Services, and Health Canada) and provincial (Nova Scotia Department of the Environment) departments involved in the EA. Environment Canada may use the advice in support of their regulatory requirements under Section 36 of the *Fisheries Act*.

The specific questions to DFO Science were:

- What are the potential risks to fish health associated with the resuspension of contaminated sediments identified in the EA (Appendix C) and with the decanting of water at the site of the confined disposal facility?
- Are there any mitigation measures that should be considered in addition to those that are proposed to address contaminated sediments, water quality, and fish health?
- Are there any monitoring components and analyses that should be incorporated into the environmental effects monitoring plan to address contaminated sediments, water quality, and fish health?

This Science Response report is from the regional Science Special Response Process (SSRP) of May 2012 on the Review of an Environmental Assessment for a Wharf Dredging Project in Sydney Harbour.

DFO's SSRP was used to review the EA and provide input due to the short deadline for advice and the fact that the advice will contribute to a broader *Canadian Environmental Assessment Act* process.

## Background

The work for the proposed PEV Wharf Approach Deepening Project involves the removal of bottom sediments to -16.5 m elevation in a 178,620 $m^2$ area in front of the PEV wharf in Sydney Harbour, Nova Scotia. The estimated volume to be dredged is 160,000 $m^3$, with an over-dredge allowance of up to 40,000 $m^3$. The 178,620 $m^2$ footprint of area to be disturbed by dredging is used for the purpose of calculating requirements for habitat compensation. Other areas of the project, described later, will also factor into the calculations for habitat compensation. Dredging will be by marine-based hydraulic or mechanical dredge equipment: either a suction dredge or a barge-assisted crane with environmental bucket. All the dredged sediment will be transferred to and disposed within a newly constructed Confined Disposal Facility (CDF) in Blast Furnace Cove on the PEV leased property. The Canadian Environmental Assessment Registry (project number 11-01-65139) includes more information on the proposed development project.

## Analysis and Response

**Question 1:** What are the potential risks to fish health associated with the re-suspension of contaminated sediments identified in the EA (Appendix C) and with the decanting of water at the site of the confined disposal facility?

A multitude of effects can be associated with exposure to the water, suspended particles, and sediments from the South Arm of Sydney Harbor. The concentrations reported for contaminants present in sediments can cause toxic effects ranging from molecular (lipid), biochemical (enzymes represent the first line of biochemical defense), sub-cellular or cellular (immune system), tissue (tumors), organ (deformities), individual (behavior, growth, reproduction), up to the population (genetics), community (species abundance and diversity), and ecosystem (reaching species at risk) level. An example of possible toxic effects, listed at levels of increasing complexity, is in parenthesis beside each of these possible levels of toxicity. It has been demonstrated that the lower levels of effects (e.g. chemical, biochemical) appear after shorter–term exposure, while those at the population, community and ecosystem level appear after exposure during a longer period of time. The time needed to generate toxicity depends on the concentration and mixture of contaminants, plus the bioavailability of these and the sensitivity of a species. The challenge with investigating toxicity is that results are dose, time, and species dependent.

The organic contaminants will be more available to organisms when they ingest contaminated prey and/or particles than from respiring water, because the organic contaminants are lipophilic and prefer to bind to organic rich particles than remain in seawater. It is mentioned in the EA that levels are above Canadian Council of Ministers of the Environment (CCME) sediment quality guidelines for polycyclic aromatic hydrocarbon (PAH) and polychlorinated biphenyls (PCB), meaning they have a high probability of toxicity. Of the 18 metals included in these CCME guidelines, however, only Arsenic exceeded the guideline values in all 20 samples, with 5 other metals having exceedances in some of the 20 samples taken, including: Copper- 3/20, Lead- 2/20, Selenium- 2/20, Thallium- 1/20 and Zinc- 6/20) (p. 34, 39, and 96 of the EA). The PAH concentrations vary for individual compounds in terms of expected associated probability of toxicity. Metals differ with their bioavailability depending on if they are organometallic (behaving like PAH and PCB) or not.

Different countries have published a range of higher and lower values linked to toxicity that have been refined over time. A more recent example is for pyrene, which is also abundant in the presently analyzed samples. The Oslo/Paris convention for the Protection of the Marine

Environment of the North-East Atlantic (OSPAR) recommends that background levels of pyrene in sediments of the East Atlantic not exceed 13 ng/g. Of the 27 concentration values reported for pyrene in Table 1 of the EA (p. 100), two values are below 0.05 µg/g and two values are below 0.40 µg/g, with the rest ranging from 6.2 to 200 µg/g. The mean and median for the concentration values are 30.9 and 15 µg/g, respectively, which is above the CCME sediment quality guidelines and more than 10,000 times higher than what is recommended by OSPAR. The second line of Table 1 of the EA does not have a description of what the sample titles mean, so it was not possible to provide comments on what these higher concentrations relate to in terms of samples used in the identification. PAHs are expected to have additive toxicity. PAH, PCB, and metals can have synergistic or antagonistic effects. When the concentration of metals along with PAH and PCB are above sediment quality guidelines, they highlight that the sediments should be examined with substantial effort for determining risk to biota.

A publication by Smith et al. (2009) describes the contamination across Sydney Harbour and particle settlement rates. It indicates lower levels of chemicals in the top 20-50 cm of sediments overlaying the more contaminated industrially derived material. This top layer comes from atmospheric transport and sewage outfalls. Although this layer is relatively less contaminated than deeper sediments, a series of studies in Halifax Harbour and elsewhere have demonstrated the negative impacts such effluents can have on resident biota (Hellou et al. 2003, 2008, 2009, 2012; Marklevitz et al. 2008a and b). In addition to animals living in areas directly on/around the dredged sediments, animals outside of the dredge area or living in the water column that are exposed to suspended sediments can also be impacted by transported material. The re-suspension of sediments and removal of nearly a meter of sediments plus water runoff from sediments taken to shore can all have an impact. Animals can be at risk of oxygen deprivation, as well as toxicity from the abundant priority pollutants. The floc formed with the re-suspension of sediments and/or decanting of water from shore will be available to filter feeders for a shorter period of time than for sediment dwelling organisms (i.e. fish and invertebrates). Bivalve filter feeders are able to close up and escape the presence of particles; however, sediment dwellers will need more time to escape and will be more impacted depending on their behavioral response.

It is difficult to make specific comments on which species will be impacted the most because the survey provides qualitative rather than specific data on abundance and species taxonomy. The survey is limited as it only represents a snapshot in time from November 27 to December 4, 2011, and the dredging is anticipated to take place in July 2012. Also, there is no comparison between the video approach used for the South Arm and that for a reference site. A more thorough comparison may support conclusions about annual and seasonal species diversity and abundance estimates.

The dredging related effects of concern include the impact on species that may have eggs or may be spawning during that time. These fish species includes Atlantic silverside, rock gunnel, cunner, hake, and flatfish, as indicated in the document (page 5/7 of Appendix D of the EA) the. Rock gunnel and winter flounder spawn in the winter and the others during summer. Crabs would also hatch eggs in summer. Lobsters are known to move to deeper waters at the time when the video was taken; at other times, including the time when dredging is like to occur (July 2012), they could be located in the South Arm. Egg extrusion (eggs being fertilized and attached to the underside of the tail of the lobster) occurs over the summer months and again can vary from mid-June to August or even September depending on water temperatures (Pezzack, pers. comm. 2012).

**Question 2**: Are there any mitigation measures that should be considered in addition to those that are proposed to address contaminated sediments, water quality, and fish health?

This question is not fully addressed in the EA and, instead, refers to the earlier project on dredging the main channel. The previous case differs in terms of type of sediments (sandy, coarse grain) and level of contaminants. The South Arm has much finer and higher levels of contaminants. There are limited means to minimize the re-suspension of sediments, and what is proposed is not very explicit, but realistic.

Mitigation procedures should account for lost ecosystem services from destroyed benthic communities as well as physical habitat and could include habitat compensation measures. An effort should be made to determine if lobsters are present prior to the actual dredging and, if deemed necessary, efforts could be made to re-locate them. In order to mitigate the potential effects on lobsters, the dredging could be completed in the winter; however, other species seen in the video, such as rock gunnel and winter flounder, could be spawning (Scott and Scott 1988). Similar to what was done for the main channel, attempts should also be made to contain dredging fluids.

**Question 3**: Are there any monitoring components and analyses that should be incorporated into the environmental effects monitoring plan to address contaminated sediments, water quality, and fish health?

The document is lacking in information on fish health. This and previous EAs in Sydney Harbour have relied on investigating the presence of contaminants in sediments, the transport of particles, three survival/lethality tests, and examining what species are present in the benthic and pelagic habitat from a qualitative perspective.

In terms of biota, this habitat has been contaminated for nearly half a century and to make sense of results obtained from a monitoring program after dredging, it is important to have quantitative expectations (age and abundance of species) for pre versus post dredging.

The responses under question 1 demonstrate the potential impacts on biota, and ideally, monitoring should include toxicity tests other than the cheaper and least sensitive $LC_{50}$ (lethality of 50% of a population). Sensitivity tests should have been performed before and after dredging to determine if a change has occurred. At minimum, there should be 3 separate tests for algae; sediment dwelling invertebrate, and finfish, covering combined endpoints of survival, growth and reproduction (for longer than a one week period, i.e., published 28 days tests). These tests would inform on the population level effects.

If there is a significant impact observed with the three tests, tests on the bioavailability of contaminants to resident biota along with effects at lower levels of complexity (i.e. sub-cellular or cellular) should be performed post dredging. In the absence of species that selectively inhabit the South Arm, a bivalve representative of a filter feeder, and an amphipod or polychaete sediment dweller would be needed for monitoring after an appreciable length of time > 28 days (depending on the time to reach steady state known in the literature).

# Conclusions

A multitude of effects can be associated with exposure to the water, suspended particles and sediments from the South Arm of Sydney Harbour. The concentrations reported for contaminants present in sediments can cause toxic effects ranging from molecular (lipid), biochemical (enzymes represent the first line of biochemical defense), sub-cellular or cellular (immune system), tissue (tumors), organ (deformities), individual (behavior, growth, reproduction), up to the population (genetics), community (species abundance and diversity), and ecosystem (reaching species at risk) level.

PAH and PCB levels exceed CCME sediment quality guidelines, meaning they have a high probability of toxicity. Of the 18 metals included in these CCME guidelines, however, only Arsenic exceeded the guideline values in all 20 samples, with 5 other metals having exceedances in some of the 20 samples taken, including: Copper- 3/20, Lead- 2/20, Selenium- 2/20, Thallium- 1/20 and Zinc- 6/20).

The mean and median pyrene concentration values are 30.9 and 15 µg/g, respectively, which is above the CCME sediment quality guidelines and more than 10,000 times higher than what is recommended by OSPAR. PAH are expected to have additive toxicity, and PAH, PCB, and metals can have synergistic or antagonistic effects. When the concentration of metals, along with PAH and PCB, are above sediment quality guidelines, they highlight that the sediments should be examined with substantial effort for determining risk to biota.

It is difficult to make specific comments on which species will be impacted the most because the survey provides qualitative rather than specific data on abundance and species taxonomy. The survey is limited as it only represents a snapshot in time from November 27 to December 4, 2011, and the dredging is anticipated to take place in July 2012. Also, there is no comparison between the video approach used for the South Arm and that for a reference site. A more thorough comparison may support conclusions about annual and seasonal species diversity and abundance estimates.

Lobsters are known to move to deeper waters at the time when the video was taken; at other times, including the time when dredging is like to occur (July 2012), they could be located in the South Arm. Spawning can occur during the time when the dredging is proposed.

The South Arm has much finer sediments and higher levels of contaminants than the main channel of Sydney Harbour. There are limited means to minimize the re-suspension of sediments, and what is proposed in the EA is not very explicit, but realistic. Similar to what was done for the main channel, attempts should also be made to contain dredging fluids.

The document is lacking information on fish health. This and previous EAs in Sydney Harbour have relied on investigating the presence of contaminants in sediments, the transport of particles, three survival/lethality tests, and examining what species are present in the benthic and pelagic habitat from a qualitative perspective. There is a wide array of potential impacts on biota, and, ideally, monitoring should include toxicity tests other than the cheaper and least sensitive LC50 (lethality of 50% of a population). Sensitivity tests should have been performed before and after dredging to determine if a change has occurred. At minimum, there should be three separate tests for algae; sediment dwelling invertebrate, and finfish, covering combined endpoints of survival, growth and reproduction (for longer than a one week period, i.e., published 28 days tests). These tests would inform on the population level effects. If there is a significant impact observed with the three tests, tests on the bioavailability of contaminants to resident biota along with effects at lower levels of complexity (i.e. sub-cellular or cellular) should be performed post dredging.

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## Sources of Information

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