PROJECT TO INSTALL UNDERWATER GENERATORS IN THE ST. LAWRENCE RIVER – IMPACT OF TURBINES ON FISH PASSAGE

Context

A technology demonstration pilot project using underwater generators is currently under development in the St. Lawrence River near the port of Montreal at the Concorde Bridge. This project represents the first phase of a larger project that will include the installation of twenty underwater generators in Phase II, with an additional 200 underwater generators installed in the same area in subsequent phases. Fish Habitat Management Branch (FHMB) conducted an analysis of the monitoring program proposed by the proponent and, on January 17, 2012, requested the collaboration of scientists from the Regional Science Branch to provide advice on hydroacoustic monitoring techniques. The concerns of the FHMB deal primarily with the assessment of fish passage through the turbines, in particular the passive downstream migration of eels and larvae and the movement of fish in this area given their life cycle requirements. (e.g.: reproduction). This aspect of the monitoring program is considered a necessary component for evaluating the need to develop specific management measures to avoid or minimize fish mortality as a result of their passage in the area (e.g.: turbine stoppage during critical downstream migration periods). Given the short notice (advice required by February 17, 2012), a *Science Special Response Process* (SSRP) was introduced to provide scientific advice to FHMB.

This Science Response report stems from the analysis conducted between February 13 and 17, 2012 under the SSRP on the review of turbine impacts on fish passage as part of an underwater generator installation project in the St. Lawrence River by Fisheries and Oceans Canada, Canadian Science Advisory Secretariat. An underwater acoustics expert participated in the analysis.

The proposed monitoring plan for the project to install a collection of underwater generators in the St. Lawrence River requires special measures, in view of the environment in which the turbines will be installed. The physical environment throughout the study area will be undoubtedly very energetic, leading to high variability in both the spatial and temporal dynamics in the fish community. Spatial patchiness and temporal variability in movements will be important variables to consider. Multiple surveys must be performed, both before and after installation, to estimate this natural variability if one is to detect an effect of the turbine installation in fish densities, species composition and behaviour. Stationary, horizontal acoustic surveying is a well-tried approach for monitoring fish movements in riverine environments. However, one must be aware of the constraints and limitations of the method to ensure a successful deployment.

Background

Within the framework of the pilot project, a TREK-type underwater generator (Kinetic Energy Recovery Turbine) consisting of four blades 2 m in diameter is currently installed at a depth of about 8 m at Concorde Bridge in the St. Lawrence River near the Port of Montreal. A flow rate of 30 m^3/s streams through the turbine. Current speed in the area is estimated at about 2.5 to 3.5 m/s.

Analysis and Responses

Item 1 : To identify resident and migratory fish species in project area

With high flow rates, the physical environment throughout the study area will be undoubtedly very energetic, leading to high variability in both the spatial and temporal dynamics in the fish community. Spatial patchiness and temporal variability in movements will be important variables to consider. Therefore multiple surveys must be performed, both before and after installation, to estimate this natural variability if one is to detect an effect of the turbine installation. Comparing sites with and without the turbines will not account for inter-site natural differences in fish movements, composition and behaviour.

Estimates of fish densities will vary greatly according to season, depending upon species-specific migration patterns. Sampling must be designed to cover periods of known fish migration, both upstream and downstream. This includes both active (migratory) and passive (transported) movements of adults and younger stages (eggs, larvae and juveniles).

Gillnets would not be appropriate in fast-flowing sections of the study area. It would be very difficult to quantify catches, if any were obtained, due to variability in gear efficiency. Also, gillnets will not be appropriate for the capturing of younger stages.

The usefulness of a surface-deployed sounder will be limited unless there is sufficient water depth (~10 m) throughout the study area for the acoustic beam to be effective. In shallow water, the ensonified water volume decreases greatly and the surface blind-zone becomes a significant proportion of the water column. Aeration from water turbulence would most likely be an issue as well, limiting the range of acoustic surveying.

Item 2 : To characterize fish movement and passage around and through the turbine with respect to disruption in flow fields caused by the TREK

Stationary, horizontal acoustic surveying is a well-tried approach for monitoring fish movements in riverine environments. However, one must be aware of the constraints and limitations of the method to ensure a successful deployment. Boundary layers (e.g. the river bed and the water surface) limit range unless the installation site and beam configuration are carefully chosen. A narrow beam or oval transducer is recommended to extend range. Depending on the water velocity and obstacles at the site location, aeration from turbulence will mask acoustic backscatter. Cavitation on the downstream side of the turbines may also be a factor limiting data quality.

Although the split-beam allows for target tracking analyses, identifying targets to species, or even as fish, is not straight forward, especially in the presence of river debris and limited echoes per individual fish. This technique is also only appropriate for species that are not associated with the bottom and are of sufficient size to be detected above the signal/noise ratio (SNR). The Didson acoustic camera may be a useful approach close to the turbine installation, within the above mentioned constraints of the acoustic technique, e.g. aeration and/or cavitation masking and limited range due to its high frequency. However, this technology comes with the advantages of much higher resolution and less ambiguous target identification.

Item 4 : To assess the long-term attraction to or avoidance of the TREK turbine by fish

Again, multiple surveys must be performed both before and after the TREK installation to attempt to account for the natural variability, both spatial (throughout the study area) and temporal (periods of migration, day to day, day/night, etc) in fish densities, species composition and behaviour. Several replicate surveys will be required to assess the natural system dynamics if an effect of the turbine installation is to be detectable.

Size estimation from acoustic split-beam data will only be possible with information on species groups if not species. Target strength can vary greatly depending on physiology, e.g. swimbladdered fish or not, insonifying angle, etc., therefore for this level of analyses, detailed biological information will be required as well.

Item 6 : To assess the impact of the TREK turbine on fish upstream and downstream migration

See comments on Item 2. Tagging fish may be a useful approach, however, as with all acoustic technics, SNR will decrease with turbulence and will affect data quality. Again, sample size must be high enough, both before and after the turbine installation, to detect a change in fish behaviour which is notoriously variable.

Conclusions

The proposed monitoring plan for the project to install a collection of underwater generators in the St. Lawrence River in the area of the Port of Montreal requires special measures, in view of the environment in which the turbines will be installed. The physical environment throughout the study area will be undoubtedly very energetic, leading to high variability in both the spatial and temporal dynamics in the fish community. Spatial patchiness and temporal variability in movements will be important variables to consider. Therefore multiple surveys must be performed, both before and after installation, to estimate this natural variability if one is to detect an effect of the turbine installation in fish densities, species composition and behaviour.

Stationary, horizontal acoustic surveying is a well-tried approach for monitoring fish movements in riverine environments. However, one must be aware of the constraints and limitations of the method to ensure a successful deployment. Several replicate surveys will be required to assess the natural system dynamics. In addition, sample size must be high enough to detect a change in fish behaviour.

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