EVALUATION OF A FISHERIES RISK ASSESSMENT TOOL (FRAT) FOR THE MACKENZIE GAS PIPELINE

Figure 1. Map showing route of proposed Mackenzie Gas Pipeline.

Context:

Increasing northern development will place significant pressure on the Fisheries Protection Program of Fisheries and Oceans Canada (DFO) for regulatory review of development proposals pursuant to the fisheries protection provisions of the Fisheries Act*. Large linear developments like the Mackenzie Gas Pipeline will cross many water courses, potentially impacting fish and habitat that supports commercial, recreational or aboriginal fisheries. DFO's Fisheries Risk Assessment Tool (FRAT) was developed to allow users to prioritize pipeline stream crossings according to the risk of adverse impact, from sedimentation, to fish and fish habitat that support commercial, recreational or aboriginal fisheries. Several consultant reports have been produced which describe the current state of the FRAT and recommendations for future work. To address a need for transparent, consistent, risk-based assessment tools in the Fisheries Protection Program, Science is proposing to continue development and improvement of the FRAT, and outline necessary steps for completion of a scientifically rigorous tool.*

A peer review meeting was held on November 27-29, 2013 to assess both the sediment risk and consequences to fish and fish habitat models of the FRAT. This meeting brought river hydrologists/geomorphologists and fisheries scientists together to examine the tool for the purpose of reviewing the current input variables, risk scoring methods and algorithms used to calculate overall risk. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- The Fisheries Risk Assessment Tool (FRAT) is relevant; however, substantial changes are required to simplify the tool so that it aligns with the new Fisheries Protection Program (FPP) policy and can be tested.
- A decision framework should be built into the front end of the tool that asks basic questions regarding species that are part of, or support, a commercial, recreational or aboriginal (CRA) fishery and the likelihood of an activity being carried out in a manner that would result in sediment entering an active channel.
- Existing fish sensitivity categories should be removed and refined to reflect a broader suite of species present and habitat use by life history stage; including CRA/Species at Risk (SAR), and the species supporting CRA; and those which are most sensitive to sedimentation.
    - Assessment should be done at the level of individual species instead of communities or biodiversity.
- Sediment fate prediction should be developed as part of the tool.
- The tool should incorporate hydrodynamic flow modelling to support the sediment fate model.
- Future research should focus on:
    1) improving knowledge of habitat use by life history stage for species that are part of a CRA fishery, starting with those that are most sensitive to sediment,
    2) acquiring data to inform distribution/occupancy models,
    3) examining climate impacts on functionality of the tool, and
    4) developing additional models to capture other physical inputs to broaden applicability of the tool.
- The FRAT will need to align with the new *Fisheries Act* and FPP once policy guidelines are set.
- A comparative analysis of species sensitivity to sedimentation needs to be undertaken, starting with species from this region.
- The final product should be a web-based tool.

INTRODUCTION

The impetus for the development of the FRAT was the proposed Mackenzie Gas Project (MGP), which called for development of gas production fields and buried gathering pipelines in the Mackenzie Delta, a buried natural gas liquids pipeline between Inuvik and Norman Wells, and a buried gas pipeline along the Mackenzie Valley to a location in Alberta where it would connect with the existing Alberta system (Figure 1). The proposed pipeline routes crossed 643 identified streams. In anticipation of the increased regulatory workload associated with the project, DFO required a tool to optimize and streamline the process of pipeline stream crossing application review and, later, construction and operations inspection requirements.

Prior to this Canadian Science Advisory Secretariat (CSAS) peer review, the FRAT consisted of a geophysical database that characterizes physical attributes of the river valley and channel in the vicinity of a crossing, plus a fisheries database that characterizes the fisheries resources

and habitat of the stream. Algorithms were developed to quantitatively estimate sedimentation hazard likelihood and volume, and fisheries sensitivity, which were coupled in a qualitative risk matrix that assigned an overall risk rating to each stream crossing.

The CSAS meeting was undertaken to evaluate the current version of the FRAT, and to make recommendations for future improvements of the tool. Two research documents were prepared for the meeting. The first described the development of the tool (Porter and Mochnacz 2014), including attributes and algorithms used to estimate sediment volumes at crossings, fish consequences based on fish presence and habitats at crossing locations, and the combined risk score from these two components of the tool. The second document (Burge et al. 2014) provided a discussion on approaches to examine the spatial and temporal fate of sediment once it has entered the watercourse. This document addressed concerns raised in relation to impacts on CRA fishes and their habitats downstream of the crossing location. During the meeting, each of the attributes of the FRAT was examined as to its appropriateness in the FRAT, and special consideration was given to the relevance of the tool in light of recent changes to the *Fisheries Act* and the FPP.

ASSESSMENT

Terminology

The science of risk assessment for the sustainable management of natural ecosystems is complex and often uses technical language to describe the underlying concepts. To provide clarity towards the fisheries protection obligations of the Department, some of the most commonly used terms that were discussed, and a consensus definition suitable for fisheries protection purposes in Canada, are provided. This is not an exhaustive list, and for a more comprehensive treatment of the various terminologies, including references and citations, the reader is referred to Burge et al. (2014) and Porter and Mochnacz (2014).

The current scientific review considered these terms within the context of the regulatory and management responsibilities of the Department. The relevant aspects of these terms were discussed, and these definitions are intended to explain the context and scope for which this tool can be used to assess risk of sedimentation to CRA fisheries from linear development.

Active channel: permanent, intermittent, or ephemeral streams and rivers that, under natural conditions, may not have continuous flows during all times of the year.

Commercial, recreational, Aboriginal (CRA) fishery: fishes that fall within the scope of applicable federal or provincial fisheries regulations as well as those that can be fished by Aboriginal organizations or their members for food, social or ceremonial purposes or for purposes set out in a land claims agreement, or those fishes that contribute to the productivity of a fishery.

Risk: the likelihood (expressed as a probability) of an event occurring and the consequences or impact of that event (ranging from insignificant to significant).

Sediment load: the combination of bed load (larger material moving downstream without losing contact with the river bed), and suspended load (smaller material moving downstream while suspended in the water).

Species at Risk (SAR): those species listed under the *Species at Risk Act* (SARA) and assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as being at risk of extinction (e.g., threatened, endangered, special concern). Consult with DFO-SAR program for more information.

Value of the FRAT

Once recommended changes are made to the tool, it will be relevant to all stakeholders, including industry and regulators, specifically DFO's FPP. This tool will improve the precision and accuracy of impact assessment on fisheries from linear development activities. It will provide a more streamlined and consistent method to assess risk of sedimentation to fisheries during pipeline development.

Tool Evaluation

Each of the attributes and algorithms that made up the sediment volume and fish consequences scores for the original FRAT were evaluated during the meeting (Porter and Mochnacz 2014). Additional information related to assessing the probability of sediment deposition in reaches downstream (spatial/temporal fate) of the crossing location (Burge et al. 2014) was assessed. Based on these evaluations, several modifications to the tool were recommended.

Spatial and temporal scale

The area that will be impacted by a particular linear crossing will be expanded from the previous version of the FRAT to encompass the downstream fate of sediment entering the water course. This will be based on a sediment fate model that must still be developed. A sediment input model should consider timing and duration of sediment release, and should contribute to the consequence component (biological). The temporal scope of the sediment input model will align with the most sensitive species present at a particular site and how that site is used (e.g., spawning, rearing).

Design of the tool

It was decided that the current version of the tool is too complicated. Rather, the initial steps of the tool should be hierarchical (Figure 2), with an initial decision tree to triage stream crossings to determine whether the crossing requires a more detailed risk assessment. The decision tree leads to a full sediment risk analysis to determine the consequences to fish if the stream supports a CRA, as determined by the fish presence/habitat module; sediment is likely to enter the waterway as a result of development activities; and that the stream is a sediment sensitive waterway.

With respect to the fish species categories in the previous version of the FRAT, it was thought that it was overly complicated, and that emphasis should be placed on the most sensitive life history stage of those species that are "most sensitive" CRA species (or species that support CRA), as opposed to a full suite of species. This will be determined early on in the decision tree based on fishes present, or likely to be present, based on local stream characteristics or predictive models.

The length of stream reach (and associated fish presence/life stage, habitat use) should be tied to the fate of sediment model outcomes. Habitat sensitivity should be related to morphological features and hydrology. The diversity index should be removed from the fish consequences model, and replaced with a list of species present and life history traits. This should evolve to include a species trait-based index of sensitivity to sedimentation as data becomes available.

It was decided that the sediment risk model could be simplified, while still maintaining its predictive power. Landslides were considered to be secondary parameters, while bank erosion was considered redundant, as it is covered in surface run-off parameters.

The risk matrix should be re-designed so that its two axes are symmetrical. Moreover, the risk matrix should align with different seasonal conditions (e.g., winter, summer). Uncertainty associated with each parameter should, wherever possible, be quantified.

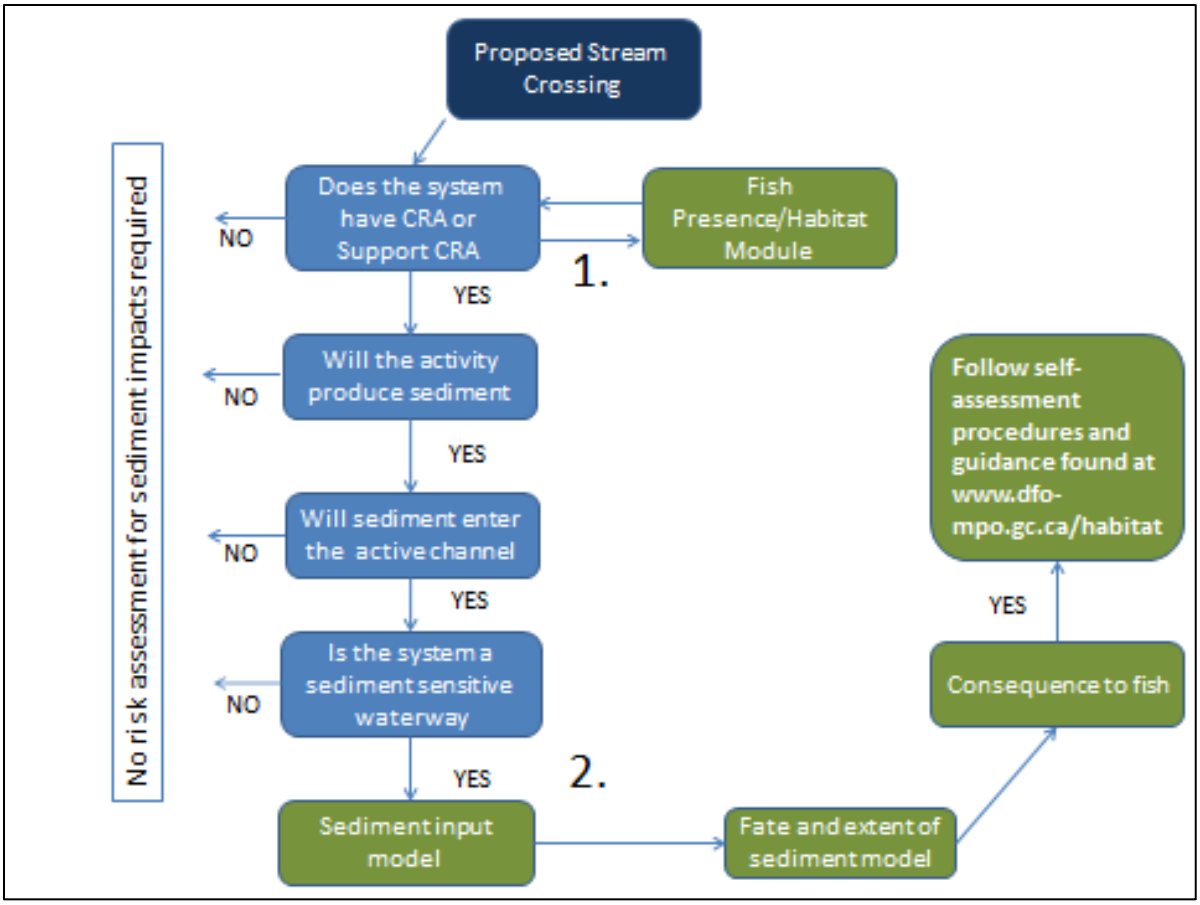

Figure 2. Proposed hierarchical approach to determine level of assessment for linear development activities.

Broad-scale applicability

There was consensus that the conceptual approach used in the FRAT has broader application for linear developments in Canada. However, the group agreed that a broader suite of parameters would likely be necessary for application to other regions. In addition, some of the parameters used in the current tool would need to be changed to align with regional conditions. For example, the current tool takes permafrost into account for sediment input estimates, but these would need to be removed if the tool was used in areas further south.

Sources of Uncertainty and Knowledge Gaps

When assessing risk to stream fishes from linear development, knowledge of the distribution and essential habitats used by stream fishes is considered the most significant source of uncertainty in the Mackenzie Valley. It is unclear if sufficient data are available to develop a quantitative fish consequence component that is scientifically defensible. However, the group agreed that a semi-quantitative approach may be possible with refinement over time.

Several knowledge gaps were identified during the meeting, and if addressed should strengthen the tool. Occupancy and/or species distributions within the Mackenzie Valley and within sub-basins is a critical information gap in remote northern streams, specifically in the context of essential habitat (e.g., spawning, overwintering habitat). Identification of key habitats for

sensitive species feeds directly into a sensitivity analysis for species present. A simple model based on species life history and ecological traits would facilitate this analysis.

The presence of groundwater, which for many sensitive species contributes to essential overwintering and spawning habitat, has not been quantified in a suitable fashion for much of the Mackenzie Valley. Better information on groundwater would help the development of predictive models of fish occupancy.

Consideration should be given to pre-existing stressors; however, this information either does not exist, or is difficult to gather.

CONCLUSIONS AND ADVICE

1. The FRAT is a useful tool that, with substantial modifications, will be relevant to the new *Fisheries Act* and FPP by identifying the risk of causing serious harm to fishes that are part of or support a CRA fishery along the proposed Mackenzie Gas Pipeline route.
2. Substantial modifications required include:
    - a decision tree as a first step to triage stream crossings;
    - removal of landslides from the sediment hazard model is recommended;
    - incorporation of predictive models of fish presence (occupancy) and habitat use;
    - removal of bank erosion is still being considered in the sediment hazard model, since bank erosion is usually managed well through application of best practices;
    - changing sediment volume during construction to probability or magnitude of sediment load;
    - adding a temporal component to the probability of sediment load;
    - adding a model/algorithm to estimate the probability of sedimentation and spatial/temporal aspects (fate) of sediment to reaches downstream of a crossing;
    - re-design of fish consequence model to consider the most affected species instead of biodiversity and community-level impacts;
    - refining the fish consequence model by focusing on fish species presence, habitat use by life history stage (spawning, rearing, foraging, overwintering), and sensitivity to sediment.
3. The revised tool will be useful for industry and DFO FPP biologists in prioritizing crossings that will require consideration of crossing methods to prevent the serious harm to fishes that are part of or support a commercial, recreational or Aboriginal fishery.
4. It was recognized that many of the elements of the FPP are still evolving within DFO, and that changes to the tool will likely be required to align with program elements.
5. The FRAT risk matrix needs to be re-examined to ensure, to the greatest extent possible, that the two axes are symmetrical and that the diagonal line defining “Moderate” risk represents DFO’s limit of tolerability. Proposed crossings assigned a risk rating of “Moderate” or higher would require further action, while those ranked as “Low” or lower would require no further action.
6. Recommendations for future work on the FRAT include:
    - exploring whether industry has historic data from the Norman Wells pipeline which could be used to validate the model;

- developing a trait-based fish sensitivity scoring system for species of interest;
- use of Lidar data to improve physical attributes of the sediment and fate models;
- conducting field work to ground truth stream crossing and fisheries attributes.

7. The tool has potential for broader application for linear developments in Canada.

OTHER CONSIDERATIONS

The FRAT has been developed to examine fish consequences related to sediment resulting from construction and operation of the MGP. It was deemed that in all likelihood, sediment impacts are the most important aspect of pipeline construction that could impact CRA fisheries. In this regard, the FRAT is somewhat limiting in its broader use by FPP practitioners and industry. It does not examine some of the other factors (e.g., climate change, and other regional development activities) within a watershed that could cumulatively impact CRA fishes or habitats that support them.

Knowledge of sediment dynamics and hydraulics under ice is incomplete. Although open channel hydraulics and sediment dynamics are fairly well understood, the effect of ice of varying thickness and extent complicates localized hydraulics and thus the ability to predict fate and effect of sediment.

The FRAT is a tool designed to assist with screening multiple stream crossing applications to identify those crossings most at risk of fish consequences. It is not meant to replace the review of projects with the potential to cause serious harm to fishes that are part of or support a CRA fishery.

Proponents will still need to plan and conduct crossing related activities by applying best management practices to avoid causing serious harm to fish. Relevant existing federal and territorial acts and regulations still apply to all crossings.

SOURCES OF INFORMATION

This Science Advisory Report is from the November 27-29, 2013, Evaluation of a Fisheries Risk Assessment Tool (FRAT) for the Mackenzie Gas Pipeline meeting**.** Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Burge, L.M., Guthrie, R.H., and Chaput-Desrochers, L. 2014. Hydrological factors affecting spatial and temporal fate of sediment in association with stream crossings of the Mackenzie Gas Pipeline. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/029.

Porter, M., and Mochnacz, N. 2014. Methods and geophysical attributes for the Fisheries Risk Assessment Tool. DFO. Can. Sci. Advis. Sec. Res. Doc. 2014/030.

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