

Determining Fish Productivity Compensation at a Proposed Mine Site in Remote Yukon Using Instream Flow Methods

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ABSTRACT

Although its use is fairly widespread and generally accepted throughout North America, the use of instream flow modeling for the determination of impacts to fish habitat due to mining related activities in Canada is far less common. Recent updates to the Canadian federal *Fisheries Act* (2013) have also seen a shift towards assessment of impacts on the productivity of 'Commercial, Recreational and Aboriginal fisheries'. At a proposed mine site in the far north of Canada (Yukon), application of instream flow modeling is a useful tool to assess impacts, but implementing the model predictions requires integration of ecological and social (local community and First Nation fisheries use) considerations, to fulfill permitting requirements on behalf of the mining proponent.

Using a combination of the Physical Habitat Simulation Model (PHABSIM) and the Habitat Evaluation Procedure (HEP), separate models were developed for creeks where reduced flows were predicted to affect fisheries, as well as models to determine the impact of complete removal of eight fish-bearing tributaries. These models largely focused on Arctic grayling (*Thymallus arcticus*). To compensate or 'offset' for this loss, stakeholder engagement identified options aimed at habitat to enhance Chinook salmon (*Oncorhynchus tshawytscha*) productivity. A River2D model was then used to determine the potential habitat gain from the reinstatement of a one kilometer stretch of creek to its original historic channel, near the Yukon River.

The benefit of this approach in remote sites is especially valuable, and as a relatively new application for instream flow modeling. Modeling outputs will further benefit from feedback from regulators and technical reviewers.

BACKGROUND

The Casino mine is a proposed copper and gold mine in the central Yukon Territory of northern Canada. With a mine lifespan of up to 20 years, alterations to the physical landscape, including mine infrastructure, are inevitable. Potential impacts to fish and fish habitat will occur within the area of the mine site due to a large tailings impoundment area (TIA), and the subsequent reduction in downstream flows on some watercourses.



Proctor Gulch, a small Casino Creek tributary, with the Casino deposit in the background

The objectives of the study were to:

- Determine flow-related impacts to fish habitat in 8 streams which will be permanently eliminated due to proposed mine infrastructure;
- Determine changes to fish habitat quantity and quality due to flow alterations in 3 streams, due to mine infrastructure construction and mine operations;
- Contribute to an estimate of offsetting (compensation) to maintain or enhance fisheries productivity, as required under the Canadian federal *Fisheries Act*.



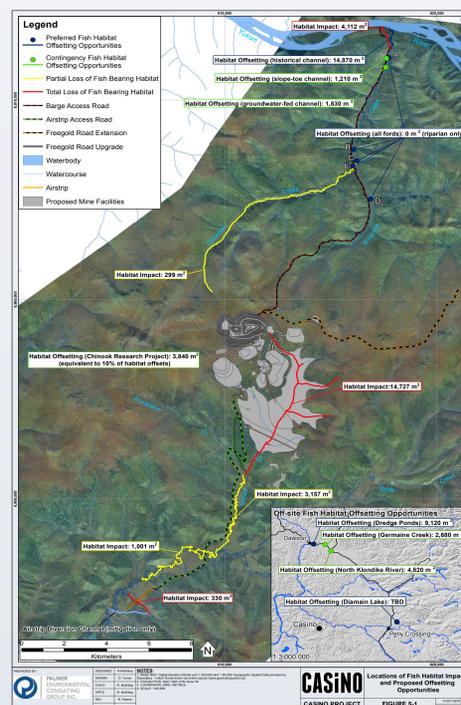
Arctic grayling, Casino Creek

METHODS



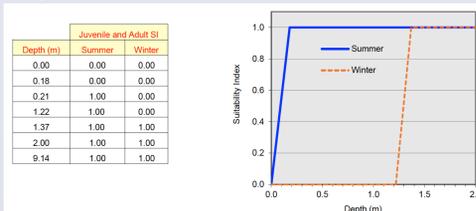
Access to streams at the site is almost entirely helicopter only. Flow measurements were taken at established PHABSIM transects using a Flo-Mate 2000.

In order to quantify the effects that the proposed mine site and infrastructure will potentially have on the aquatic environment, and to determine compensation for loss of useable habitat, instream flow modeling was used. Separate models were created in stages, as various mine impacts were identified.



Pictured is the Casino mine plan, overlaid with the impacts to fish habitat due to the project

Habitat Evaluation Procedure was used to model impact to Arctic grayling weighted useable area (WUA) where proposed mine infrastructure will remove all flow in, or access to, a creek. It was important to focus on the type of habitat and how this is used by fish species at different life stages, particularly as regulations have shifted to fisheries productivity and not a 'like for like' habitat compensation.



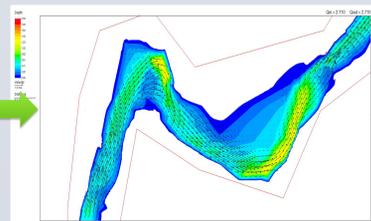
As the most common species found within the system, Arctic grayling was chosen as the representative species for all modeling. Shown here are habitat suitability curves for winter and summer depth preferences, taken from Hubert et al., 1985

PHABSIM models were used to develop modeled impact to Arctic grayling habitat (weighted useable area) in 3 creeks, where proposed mine infrastructure will effect flows in downstream reaches.

To offset these potential impacts, a River 2D model was created of a dry, historic creek channel – Britannia Creek- and "virtual HEP" performed. Reinstatement of the channel is a proposed offsetting option to maintain fisheries productivity. The WUA of the channel was determined for Arctic grayling, and compared against calculated habitat loss. The River 2D raster grid was created for the dry channel, populated with an average low flow for the adjacent existing Britannia Creek, and a HEP mapping exercise was conducted on the resulting model. HEP results indicated much higher WUA than the current "roadway" channel.



Dry, historic Britannia Creek channel



Sample of River 2D model output of lower Britannia Creek channel

RESULTS

Watercourse or Subwatershed (project impact in parentheses)	Impacted Stream Length (m)		Impacted Stream Area (m ²)		Impacted Modelled Area (m ²)	
	Fish-bearing	Non-fish-bearing	Fish-bearing	Non-fish-bearing	Fish-bearing	Non-fish-bearing
Total Habitat Loss within project footprint*						
Lower Britannia Creek (reinstatement of historical channel for offsetting)	1,405	0	11,263	0	4,112	n/a
Upper Canadian Creek (diversion into Open Pit)	0	3,483	0	17,415	n/a	n/a
Upper Casino Creek watershed above Reach 2/3 break (TMF footprint) ²	7,217	4,509	19,375	7,572	8,900	n/a
Upper Casino Creek watershed below Reach 2/3 break (TMF footprint) ²	12,832	0	25,384	0	5,827	n/a
95 watercourse crossings (Freegold Extension)	0	1,031	0	787	n/a	n/a
37 watercourse crossings (Freegold Upgrade)	0	30	6	24	6	n/a
Unnamed tributary of Dip Creek (diversion around Airstrip)	1,479	0	2,203	0	330	n/a
10 watercourse crossings (Airstrip Access Road)	0	91	0	54	n/a	n/a
Wetted Habitat Loss due to stream flow reductions³						
Lower Canadian Creek (downstream of open pit)	7,000	0	801	0	299	n/a
Lower Casino Creek (downstream of TMF) ²	6,500	0	1,438	0	3,157	n/a
Dip Creek (downstream of TMF)	8,500	0	2,342	0	1,001	n/a
Total	44,933	9,144	62,812	25,852	23,632*	n/a

Results of all models, combined, were a total modeled habitat impact of **23,632 m²**, based on useable habitat for the predominant species on site – Arctic grayling.

Stakeholder engagement identified offsetting measures that should be focused on improvements to Chinook salmon productivity, due to its cultural and economic importance to local communities.

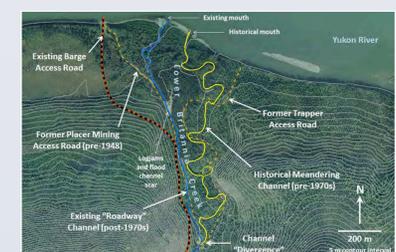
CONCLUSIONS

New *Fisheries Act* regulations (2013) now require offsetting of impacts based on the alterations to productivity, not just 'like for like' compensation of total lost habitat.

Challenges lie in integrating old and revised *Fisheries Act* with regards to the creation of productivity offsetting. As comments are received from technical reviewers, additional modeling may be performed in order to better attempt to capture potential alterations to productivity in affected streams.

As no major projects in the Yukon have been granted authorizations under the updated *Fisheries Act*, we have a unique opportunity to "set the tone" of offsetting plans moving forward.

Fisheries offsetting opportunities have been identified both at the site of the proposed mine, as well in nearby communities. These opportunities will maintain or enhance fisheries productivity, and are focused specifically on local fisheries management objectives.



Offsetting Option: Restoration of Historic Britannia Creek Channel

Proposed restoration of the lower Britannia Creek channel involves moving the creek back to an historic channel, which was abandoned in the 1970's when the creek shifted to flowing down an exploration trail.

REFERENCES

- Palmer Environmental Consulting Group Inc. and Normandeau Associates, Inc., 2014. Casino Project Instream Flow and Habitat Evaluation Procedure Study. Compilation report submitted to Casino Mining Corporation.
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- Hubert, W. A., R. S. Helzner, L. A. Lee, and P. C. Nelson. 1985. Habitat suitability index models and instream flow suitability curves: Arctic grayling riverine populations. U.S. Fish Wildlife Service Biological Rep. 82(10.110). 34 pp.

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