Authorized net losses of fish habitat demonstrate need for improved habitat protection in Canada

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Rapid Communication

Authorized net losses of fish habitat demonstrate need for improved habitat protection in Canada

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Abstract

Fish habitat is essential to stability and productivity of fisheries. In Canada, the primary legal tool for protecting fish habitat is the federal *Fisheries Act*. In 2012, this law was changed to narrow the scope of habitat protection. The government's position was that the previous regime went beyond what was necessary to protect fish and fish habitat. Here, we tested that assertion by examining *Fisheries Act* authorizations to harmfully alter, disrupt, or destroy fish habitat issued by Fisheries and Oceans Canada during a six-month period in 2012, obtained using access to information processes. We found the majority of projects (67%) were authorized to impact more habitat than proponents were required to compensate for, likely resulting in a net loss of fish habitat. Our analysis show an aggregate net loss – defined as authorized impact minus required compensation – of 2,919,143 m² authorized across 78 projects. Drawing from these results, we present four recommendations for an improved habitat protection regime under a renewed *Fisheries Act*, emphasizing the need to establish a public registry for authorizations and monitoring data.

Keywords: Fisheries, freshwater, management, policy, conservation, access to information

Introduction

Intact habitat is essential for the persistence and recovery of biodiversity (Venter et al. 2006). This is true for both terrestrial and aquatic species. In Canada, the primary legislative tool for managing fisheries is the federal *Fisheries Act* R.S.C. 1985 c. F-14, which also sets out the rules for the protection of fish habitat. Prior to 2012, subsection 35(1) of the Act prohibited the carrying on of "any work or undertaking that results in the harmful alteration or disruption, or the destruction, of fish habitat" (commonly referred to as HADD) unless authorized by the Minister pursuant to subsection 35(2). In 2012, this law was amended to prohibit the carrying on of "any work, undertaking, or activity that results in serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery, or to fish that support such a fishery," where serious harm was defined as "the death of fish or any permanent alternation to, or destruction of, fish habitat." Although introduced in 2012, these changes did not come into effect until November 2013.

At the time of their introduction, these changes were extremely controversial because they introduced ambiguity and unscientific terminology into what was then widely regarded as one of Canada's most important, if also imperfect, environmental laws (Olszynski, 2015). In particular, there was concern about the lack of clarity in how the term "permanent" would be interpreted by managers, incoherence around the concept of differentiating between fish that do and do not support a fishery (Hutchings 2014), and the perception that the new wording seemed to exclude protection for any fish habitat not under immediate use by humans (Hutchings and Post 2013). The changes were broadly opposed by the scientific community, Indigenous groups, and civil society – including four former Ministers of Fisheries and Oceans (see Olszynski 2015 for review).

According to Keith Ashfield, the then Minister of Fisheries and Oceans, the changes were necessary because the HADD prohibition went “well beyond what is required to protect fish and fish habitat,” (Hume, 2012). Beyond offering anecdotes, however, the case was never clearly made with respect to the alleged burdens imposed by the previous prohibition, nor was any assessment with respect to the actual state of fish habitat in Canada provided.

Subsequent studies have cast doubt on the claim that the previous law was unduly burdensome. Favaro et al. (2012) showed that between 2007 and 2011, there were only 21 habitat-related convictions, or 1.6% of all Fisheries and Oceans Canada (abbreviated as DFO) convictions during that period. Olszynski (2015) demonstrated that well before 2012 DFO had already gone to great lengths to reduce the regulatory burden associated with the section 35 regime through the adoption of a risk-based approach that diverted over 95% of project referrals away from the authorization process (see also de Kerckhove et al. 2013). Instead, proponents of projects that were considered as posing a “low risk” to habitat were either issued a Letter of Advice advising them on best practices to avoid impacts to fish habitat or were referred to an applicable Operational Statement – essentially generic Letters of Advice for certain kinds of projects available on DFO's various regional websites. For those projects that did require authorization and triggered an environmental assessment under the previous *Canadian Environmental Assessment Act* S.C. 1992 c. 37, de Kerckhove et al. (2013) showed that most authorizations were issued within two years.

With respect to the-then state of fish habitat, as recently as 2009 the Auditor General of Canada noted that DFO “does not measure habitat loss or gain. It has limited information on the state of fish habitat across Canada... [and] cannot determine the extent to which it is progressing toward [its 1986] Policy's long-term objective of a net gain in fish habitat” (Auditor General,

2009). Moreover, while initial assessments of the habitat protection program were optimistic (Goodchild 2004), subsequent investigations have consistently raised concerns. Reviews to date have generally found that the habitat protection program was generating net losses in habitat area (Carter et al. 2012), that the productive capacity of restored areas was not achieving the policy goal of No Net Loss (NNL; Quigley and Harper 2006, Quigley et al. 2006), and that monitoring was incomplete or at least poorly documented, making assessment of the program difficult (Auditor General of Canada 2009, see also Poulton 2016 for review).

Following the election of the Liberal Party of Canada in the fall of 2015, both Parliament and the Minister of Fisheries and Oceans commenced reviews of the *Fisheries Act*. More specifically, both the Standing Committee on Fisheries and Oceans (FOPO) and DFO have begun to review the 2012 changes, including those pertaining to habitat protection. We appeared as witnesses before FOPO on October 31, 2016. In that context and in light of questions from some members seeking to quantify the impact of the 2012 changes, we were again forcefully reminded that DFO did not in 2012 and in fact has never reported comprehensively on the state of fish habitat in Canada, including whether it was achieving NNL of productive capacity of fish habitat (Fisheries and Oceans Canada 1986, Auditor General of Canada 2009).

In this paper, we sought to provide a partial estimate of fish habitat loss using the best available evidence. To this end, we examined HADD authorizations issued to project proponents during the period in which the 2012 changes were introduced. Because DFO does not maintain a public registry for authorizations, these were obtained through the *Access to Information Act* R.S.C., 1985, c. A-1, the federal law that provides Canadians with access to government records in the public interest (Government of Canada 2016). Our primary objective was to assess the extent to which proponents were being required to compensate, *i.e.* offset, for the area of habitat

that they were authorized to impact. Although DFO's NNL principle specified "productive capacity" rather than strictly habitat area (Fisheries and Oceans Canada 1986), defining and measuring productive capacity is complex (Minns et al. 2011), and authorization documents do not explicitly measure for this factor (Carter et al. 2012). Consequently, like Carter et al. (2012) we used the areal net loss or gain of habitat as a surrogate for assessing whether NNL was being required through the HADD authorization regime.

We asked four basic questions. First, what were the number and sizes of projects that received HADD authorizations? Second, what proportion of authorizations required compensation area equal to or greater than the authorized impact area? Third, and with a view towards the then government's rationale for the 2012 changes, was there any evidence that compensation requirements were overly burdensome, especially with respect to small projects (e.g. were small projects assigned higher compensation ratios than large projects)? Fourth, across all projects, what was the authorized net gain or loss of habitat area and how might the net change be affected if compliance with respect to compensation requirements was less than perfect? We conclude the paper with a series of recommendations that we believe would enhance DFO's ability to conserve fish habitat in Canada and that would allow all Canadians to better track whether this conservation program is effective.

128 **Materials and Methods**

129 *Acquiring authorizations using the Access to Information Act*

130 As noted above, data on authorized habitat impacts are not easily available to the public;
131 DFO has never maintained a public registry of section 35 authorizations, nor has it ever produced
132 a comprehensive report on the status of fish habitat in Canada. The only way to obtain this
133 information is through a federal access to information request (ATIP request) pursuant to the
134 *Access to Information Act*. Unfortunately, ATIP requests can take a long time to process
135 (Information Commissioner of Canada 2015). Consequently, for the purposes of this paper, we
136 extracted data from the authorizations obtained by the ATIP request filed by Olszynski for the
137 purposes of his 2015 paper, *i.e.*, all subsection 35(2) authorizations issued over a six month
138 period (May 1 to October 1) for the years 2012, 2013, and 2014 by DFO's two largest (and
139 busiest, in terms of authorization activity) regions, the Pacific region and the Central and Arctic
140 region (encompassing the provinces of British Columbia through to Ontario, as well as the three
141 territories, but excluding Quebec and the Atlantic provinces).

142 That request generated one hundred and eighty-three authorizations: 86 for 2012, 63 for
143 2013, and 37 for 2014. Because the 2013 and 2014 vintages were issued during a period of
144 transition from the previous regime to the current one (brought into force in November 2013),
145 including the further diversion of projects from the authorization regime based on impact size
146 and the increasing deferral of offsetting plans (over 50% in 2014: Olszynski 2015), we focused
147 our analysis on the 2012 authorizations only. While these were issued around the time that the
148 2012 changes were introduced, their number (86) over six months is consistent with both
149 regions' yearly authorization rate in the preceding five fiscal years (164, 236, 172, 185 and 219,
150 respectively), suggesting little – if any – effect from the mere introduction of the changes. This is

also consistent with de Kerckhove's 2013 findings that authorizations usually took up to two years to process; therefore many of the 2012 authorizations are the result of referrals from either 2010 or 2011, well before the potential changes to the *Fisheries Act* were made public.

Recording data from authorizations

Generally speaking, each subsection 35(2) authorization contains information about the project proponent, project type (*e.g.* a bridge, a mine, a dam), project location, the size and kind of impacts to habitat, and the amount of compensation or offsetting habitat required – if any. In addition to basic information about the proponent (Appendix 1), we recorded the total area that each project was authorized to impact (in m²). Of the 86 authorizations in 2012, eight authorized impacts that were not described in terms of area (*e.g.* the proponent was authorized to destroy 1,500 eelgrass plants, or to dewater a stream killing all its fish); these were excluded from our analysis (N remaining = 78). In six cases, authorizations described “linear impacts,” which were impacts that occurred, for example, along the length of a river. We assumed that these linear impacts would produce effects at least one meter in width to make them comparable with the rest of the dataset. Many authorizations contained information about additional impacts that were not expressed in terms of area (*e.g.* habitat fragmentation, altering shade levels of habitat) but we did not systematically record data on these because they were project-specific, inconsistently reported, and difficult to compare. Eleven project descriptions made a specific mention that some impacts were temporary; we included those in the measure of total impact because prior to 2012 the prohibition explicitly captured disruptions (*i.e.* temporary impacts). Authorizations often separated impacts into ‘riparian’ and ‘aquatic.’ However, authorizations were not always explicitly clear about what specific type of habitat was approved for impact. To avoid

introducing errors or subjectivity, we combined all impacts such that for each project, we have one measure of total authorized impact on fish habitat (hereafter: authorized HADD).

For the 78 authorizations that included measures of authorized HADD, we recorded the area of compensatory habitat that the proponent was required to restore or create. If an authorization did not include an explicit requirement for compensation expressed in terms of area, then we recorded its required compensation as zero. Raw data are included as an online supplement (Appendix 2).

Analysis

For each authorization, we calculated the difference between authorized HADD and area required for compensation, and expressed it as a compensation ratio (CR: compensation area:HADD area – see Minns 2006). We created exploratory plots and used descriptive statistics to examine the number and proportion of projects with compensation ratios above 1, between zero and 1, and zero. We calculated the total net difference between authorized HADD and required compensation across all projects, expressed in m². To examine the net change in habitat area assuming imperfect compliance (as reported, for example, by Quigley and Harper 2006), we calculated two alternative compensation ratios for each project based on the assumption that projects achieved 80% and 50% of required compensation, respectively. We conducted all analysis with R Statistical software (R Development Core Team 2014), using the packages dplyr and tidyR to manipulate data (Wickham 2015, 2016). We built all graphics using the ggplot2 package (Wickham 2009).

Results

HADD authorizations ranged in size from 50 to 2,994,330 m² (median = 4,747, Figure 1A). Required compensation ranged from 0 to 882,461 m² (median = 469), producing compensation ratios ranging from 0 to 7.1 (median = 0.36). There were 26 projects with CRs $\geq$ 1, 24 with CR < 1, and 28 projects for which no required compensation area was articulated in the authorization (Figure 1B). Excluding 28 projects for which no habitat compensation area was clearly articulated, the required compensation ranged from 33 to 882,461 m² (median = 1,881) with CRs ranging from less than 0.1 to 7.1 (median = 1). Some projects had compensation requirements that were not described in terms of area (*e.g.* proponent must donate money to charity, proponent must add vegetation). We followed the practice of (Carter et al. 2012) and focused solely on area-based measures of compensation in our review.

Adjusting each project's required compensation by multiplying their assigned compensation area by a factor of 0.8 resulted in 62 projects (80%) having CRs of less than 1, and multiplying by 0.5 resulted in 71 projects (91%) having CRs less than 1 (Figure 1C). Excluding projects with zero compensation area, multiplying required compensation by 0.8 produced a range of 26 to 705,969 m² (median = 1,504), with CRs of less than 0.1 to 5.7 (median = 0.8). Likewise, multiplying projects with non-zero compensation area by 0.5 produced a range of 17 to 441,231 m² (median = 940), with CRs of less than 0.1 to 3.6 (median = 0.5).

de Kerckhove et al. (2015) binned projects as fitting into four size categories: < 100 m², < 1,000 m², < 10,000 m², and > 10,000 m². In our dataset, there were 3, 22, 26, and 27 projects in each of these categories, respectively (Figure 2A). There was no clear relationship between project size and compensation ratio (Figure 2B). Overall, the authorized net impact area on habitat was far greater than required compensation area (Figure 2C). Across all projects, projects that were required to compensate more than their HADD impact were assigned an increase in

1,746,283 m² of fish habitat, while projects with CRs below 1 had authorizations totaling a loss of 4,665,426 m². On summation, a net loss (defined as authorized HADD area minus compensation area) of 2,919,143 m² of fish habitat was authorized. Assuming projects only achieve 80% of the required compensation assigned to them, a net loss of 3,775,878 m² could be expected from the authorizations included in our dataset. If they achieve 50% of compensation requirements, a net loss of 5,060,931 m² would be produced.

Discussion

We found a substantial net loss of fish habitat authorized across the projects examined in this paper. While acknowledging again that DFO's NNL principle required NNL of productive capacity rather than strictly area (Fisheries and Oceans Canada 1986), the only way for Canada to be achieving NNL of productive capacity despite compensation ratios below 1 would be if restored habitat outperformed unimpacted habitat in terms of productive capacity. Without using artificial production (lowest on DFO's hierarchy of compensation options: Fisheries and Oceans Canada 2002), it is very unlikely that this is the case. Even if compensatory habitat were fully twice as productive as the habitat impacted by HADD (*i.e.* one square metre of compensation could be treated as two), the present set of projects would still have produced a net loss of more than 1.1 million m². A much more realistic and precautionary assumption is that restored habitat was less productive than intact habitat. Quigley and Harper (2006) showed that the productivity of restored habitat generally did not match natural ecosystems. Moore and Moore (2013) argued that the concept of restoration itself is fundamentally misleading due to widespread underperformance of restored habitat relative to intact ecosystems. Consequently, our focus on area impacts and compensation is a reasonable one.

Moreover, it is likely that the true magnitude of habitat loss in Canada is far greater than what we were able to capture in these authorizations. First, there were a total of 199 authorizations issued across the country in fiscal year 2012/13 (Fisheries and Oceans Canada 2014), meaning that the authorized losses we report represent only a subset of all projects. If the other 113 projects had CRs similar to those included in the present study, then the total additional authorized net loss of habitat would also be substantial. Second, applying realistic correction factors (i.e. within the range of achieved CR vs required CR values reported by Quigley and Harper 2006) to area required for compensation increased the cumulative lost impact. In fact, we found that reducing assigned compensation area by 20% actually resulted in a 30% predicted increase in net loss of habitat because it caused several projects with assigned CRs on or near 1 to experience net losses in fish habitat. In reality, achieved CR could be lower because of both imperfect compliance with compensation requirements and restored habitat being less productive than native habitat. Third, Harper and Quigley also found that projects often produced HADD footprints that were larger than what was authorized (Harper and Quigley, 2006); in the interest of being conservative, we did not account for this possibility in our calculations.

Fourth, although losses due to large projects dominated the absolute amount of habitat loss in the present dataset (a finding that agrees with that of de Kerckhove et al. 2015), due to the DFO's adoption of a risk-based approach whereby projects deemed "low risk" were diverted away from authorization regime, it is likely that there is a substantial number of such projects – possibly upwards of 10,000 annually (Olszynski 2015) – which may be exerting a large cumulative impact on fish habitat. A sample of the types of projects considered low risk and for which Operational Statements were drafted include beach creation, dock and boathouse

construction, ice bridges and snow fills, maintenance dredging, mineral exploration activities, high-pressure directional drilling, pond construction, and more. That some impact is likely to have occurred from these projects can be inferred from the (admittedly limited) research on Operational Statements' effectiveness. As one example, a 2011 study of 30 trenchless watercourse crossings in Alberta (both high-pressure directional drilling and punch and bore) identified several compliance issues, including evidence of frac-out and open-cut crossing methods (Nugent 2011). Although there were 1,413 such crossings identified in Alberta between 2005-2010 (Nugent 2011), any impacts from such projects in 2012 are not included in our analysis. Similarly, small projects like culverts can have detectable impacts on species assemblages (Favaro et al. 2014) but these are not included in the present study.

Importantly, we did not find a relationship between project size and compensation requirements. This refutes the hypothesis that the HADD provisions were overly burdensome for small projects. If that were the case, we would have expected to see compensation ratios well above one for small projects, which we did not (Figure 2). We also note that Minns (2006) recommended CRs of 2:1 or higher to achieve no net loss of productive capacity – ratios far higher than assigned to most of the projects in the present dataset.

Some authorizations made reference to qualitative compensatory activities. This was particularly prevalent in projects where compensation by area was not specified. The only way to measure whether no net loss is being achieved is to insist on quantifiable values being included in authorizations. The widespread reliance on qualitative compensation instructions as opposed to discrete compensation areas assigned was deemed problematic by the Auditor General of Canada (2009). That this problem was noted in 2009 but still prevalent in 2012 is concerning.

The scale of human activity in and around fish habitat in Canada is sizable, and so our findings are cause for concern. DFO received 94,434 project referrals between 2001 and 2011 and issued 4,409 HADD authorizations (Olszynski 2015). If these projects resulted in habitat losses (i.e. impacts not fully compensated for) at rates anywhere near those authorized in the projects in the present study, then the aggregate impact on fish habitat in Canada would be serious. If enough habitat is damaged or destroyed, it follows that fish populations will eventually decline. While policies were crafted around the revised law to afford some means of protection for fish habitat (as described in Rice et al. 2015), the apparently dire state of Canadian habitat protection suggests that any changes that made it easier to harmfully alter, disrupt, or destroy fish habitat were counterproductive to the goal of sustainable fisheries.

Recommendations

Our findings lead us to make four key recommendations. First, with the exception of the addition of “activities” which should remain in place, the previous version of section 35 should be restored and unauthorized HADD should once again be clearly prohibited for fish habitat. In light of our findings that the previous authorization regime was failing to ensure adequate habitat conservation, there is simply no basis for retaining legally and scientifically ambiguous language intended to reduce the requirements to protect fish habitat. Second, any further revision to the *Fisheries Act* should be done in a transparent, data-rich manner and this would be facilitated by the establishment of a public registry for authorizations. This registry should include basic information about projects, their authorized impacts, their required compensation or offsetting habitat (with habitat type specified), and a space to report follow-up monitoring data so that the effectiveness of the compensation regime can be independently assessed. Researchers should not have to rely on ATIP requests to glean information about Canada’s fish habitat. With respect to

allegations of unfair or disproportionate burdens being placed on certain sectors or proponents, a public registry would facilitate the evaluation of these impacts as well, such that this recommendation should be entirely uncontroversial. Third, the government should recommit to the principal of no net loss of productive capacity of fish habitat, with a high priority placed on minimizing impacts on intact habitat. In addition to increased monitoring, enforcement, and policy compliance, this will require some mechanism for tracking those thousands of projects that DFO currently exempts as “low risk”; a general permit scheme with a notification requirement would facilitate this. Fourth, to safeguard against the kind of implementation gap that occurred under the previous habitat protection regime (Olszynski, 2015), there should be a recommitment to public education on the importance of fish habitat, how individuals can protect habitat when conducting projects in and around fish-bearing waters, and extensive support for community groups and non-governmental organizations that conduct habitat stewardship at the local level. This was identified as a priority by DFO in the past (Fisheries and Oceans Canada 1986), and is widely understood as critical to the success of fish and fisheries conservation (Cooke et al. 2013).

Our findings indicate that the status of fish habitat in Canada was not secure enough to warrant a reduction of protection in 2012. On the contrary, large habitat losses were being authorized under the previous regime. With respect to the current law, our interpretation is that there are many ways in which it weakens protection of fish habitat, and few pathways by which it could strengthen it. Sustainable freshwater fisheries are underpinned by intact habitat (Lapointe et al. 2014) so the findings of our present study should be cause for alarm. We believe that our recommendations, if accepted, would help establish the conditions necessary for the rebuilding of an effective habitat protection regime in Canada and would provide the platform

334 necessary for all future discussions to be informed by transparent and accurate data on the
335 matter.

336

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References

- Auditor General of Canada. 2009. Chapter 1: protecting fish habitat. *In* Report of the Commissioner of the Environment and Sustainable Development - Spring 2009. p. 52. Available from http://www.oag-bvg.gc.ca/internet/docs/parl_cesd_200905_01_e.pdf.
- Carter, D.W., Bonamis, A.N., Major, S.M., Gagnon, J.F., Hussey, D.C., and Pulvermacher, H.A. 2012. 2002-2006 Section 35 (2) Pacific region authorization file audit results. *Can. Manusc. Rep. Fish. Aquat. Sci.* 3010: 35.
- Cooke, S.J., Lapointe, N.W.R., Martins, E.G., Thiem, J.D., Raby, G.D., Taylor, M.K., Beard, T.D., and Cowx, I.G. 2013. Failure to engage the public in issues related to inland fishes and fisheries: Strategies for building public and political will to promote meaningful conservation. *J. Fish Biol.* **83**(4): 997–1018. doi:10.1111/jfb.12222.
- Favaro, B., Reynolds, J.D., and Côté, I.M. 2012. Canada's weakening aquatic protection. doi:10.1126/science.1225523.
- Favaro, C., Moore, J.W., Reynolds, J.D., and Beakes, M.P. 2014. Potential loss and rehabilitation of stream longitudinal connectivity: fish populations in urban streams with culverts. *Can. J. Fish. Aquat. Sci.* **71**(12): 1–12. doi:10.1139/cjfas-2014-0199.
- Fisheries and Oceans Canada. 1986. Policy for the management of fish habitat. Ottawa, ON.
- Fisheries and Oceans Canada. 2002. Practitioners guide to habitat compensation for DFO habitat management staff. Available from <http://www.dfo-mpo.gc.ca/Library/270280.pdf>.
- Fisheries and Oceans Canada. 2014. Annual report to parliament on the administration and enforcement of the fish habitat/fisheries protection and pollution prevention provisions of the Fisheries Act, April 1, 2012 to March 31, 2013. Available from http://publications.gc.ca/collections/collection_2014/mpo-dfo/Fs1-57-2013-eng.pdf.
- Goodchild, G.A. 2004. Fish habitat is everyone's business, Canada's fish habitat management programme. *Fish. Manag. Ecol.* **11**: 277–281. doi:10.1111/j.1365-2400.2004.00409.x.
- Government of Canada. 2016. Access to Information and Privacy (ATIP) Online Request. Available from <https://atip-airpr.apps.gc.ca/atip/welcome.do>.
- Hutchings, J. 2014. Potential consequences of a perceived relaxation of the habitat-protection provisions of the Fisheries Act. Available from http://www.oag-bvg.gc.ca/internet/English/pet_361_e_39680.html.
- Hutchings, J.A., and Post, J.R. 2013. Gutting Canada's Fisheries Act: no fishery, no fish habitat protection. *Fisheries* **38**: 497–501. JOUR.
- Information Commissioner of Canada. 2015. Striking the right balance for transparency: recommendations to modernize the Access to Information Act. Ottawa, ON. Available from http://www.oic-ci.gc.ca/telechargements-downloads/userfiles/files/eng/reports-publications/Special-reports/Modernization2015/OIC_14-418_Modernization_Report.pdf.
- de Kerckhove, D.T., Minns, C.K., and Chu, C. 2015. Estimating fish exploitation and aquatic habitat loss across diffuse inland recreational fisheries. *PLoS One* **10**(4): 1–20.

- doi:10.1371/journal.pone.0121895.
- de Kerckhove, D.T., Minns, C.K., Shuter, B.J., and Kidd, K. 2013. The length of environmental review in Canada under the *Fisheries Act*. *Can. J. Fish. Aquat. Sci.* **70**(4): 517–521. NRC Research Press. doi:10.1139/cjfas-2012-0411.
- Lapointe, N.W.R., Cooke, S.J., Imhof, J.G., Boisclair, D., Casselman, J.M., Curry, R.A., Langer, O.E., McLaughlin, R.L., Minns, C.K., Post, J.R., Power, M., Rasmussen, J.B., Reynolds, J.D., Richardson, J.S., and Tonn, W.M. 2014. Principles for ensuring healthy and productive freshwater ecosystems that support sustainable fisheries. *Environ. Rev.* **22**(2): 110–134. doi:10.1139/er-2013-0038.
- Minns, C.K. 2006. Compensation ratios needed to offset timing effects of losses and gains and achieve no net loss of productive capacity of fish habitat. *Can. J. Fish. Aquat. Sci.* **63**(5): 1172–1182. doi:10.1139/f06-025.
- Minns, C.K., Randall, R.G., Smokorowski, K.E., Clarke, K.D., Vélez-Espino, A., Gregory, R.S., Courtenay, S., LeBlanc, P., and Sprules, G. 2011. Direct and indirect estimates of the productive capacity of fish habitat under Canada's Policy for the Management of Fish Habitat: where have we been, where are we now, and where are we going? *Can. J. Fish. Aquat. Sci.* **68**(12): 2204–2227. doi:10.1139/f2011-130.
- Moore, K.D., and Moore, J.W. 2013. Ecological restoration and enabling behavior: a new metaphorical lens? *Conserv. Lett.* **6**(1): 1–5. Blackwell Publishing Inc. doi:10.1111/j.1755-263X.2012.00300.x.
- Nugent, S. 2011. A review of trenchless watercourse crossings in Alberta with respect to species at risk. *Can. Manuscr. Rep. Fish. Aquat. Sci.* (2947): vi + 69 p.
- Olszynski, M. 2015. From badly wrong to worse: An empirical analysis of Canada's new approach to fish habitat protection laws. *SSRN Electron. J.* doi:10.2139/ssrn.2652539.
- Poulton, D.W. 2016. Offsetting for “serious harm”: the recent evolution of section 35 of the *Fisheries Act*, 1985. *J. Environ. Law Pract.* **29**: 19.
- Quigley, J.T., and Harper, D.J. 2006. Effectiveness of fish habitat compensation in Canada in achieving no net loss. *Environ. Manage.* **37**(3): 351–366.
- Quigley, J.T., Harper, D.J., and Galbraith, R. V. 2006. Fish habitat compensation to achieve no net loss: Review of past practices and proposed future directions. *Can. Tech. Rep. Fish. Aquat. Sci.* (2632): vi+22p.
- R Development Core Team. 2014. R: A language and environment for statistical computing. GEN. Available from <http://www.r-project.org>.
- Rice, J., Bradford, M.J., Clarke, K.D., Koops, M.A., Randall, R.G., and Wysocki, R. 2015. The science framework for implementing the Fisheries Protection Provisions of Canada's *Fisheries Act*. *Fisheries* **40**(6): 268–275.
- Venter, O., Brodeur, N.N., Nemiroff, L., Belland, B., Dolinsek, I.J., and Grant, J.W.A. 2006. Threats to endangered species in Canada. *Bioscience* **56**: 903–910. JOUR.

417 Wickham, H. 2009. ggplot2: elegant graphics for data analysis. Springer-Verlag New York.
418 Available from <http://ggplot2.org>.

419 Wickham, H. 2015. dplyr: A grammar of data manipulation. Available from [http://cran.r-](http://cran.r-project.org/package=dplyr)
420 [project.org/package=dplyr](http://cran.r-project.org/package=dplyr).

421 Wickham, H. 2016. tidyr: Easily tidy data with spread() and gather() functions. [http://CRAN.R-](http://CRAN.R-project.org/package=tidyr)
422 [project.org/package=tidyr](http://CRAN.R-project.org/package=tidyr).

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Figure captions

Figure 1: A) Boxplots depicting area of HADD authorized compared with the area of compensation required, excluding projects for which no area-based compensation was explicitly required. B) Comparison of the area of HADD authorized and compensation area required for each project in our dataset, where each pair of points is a single project. C) Violin plots showing the density of projects assigned a given compensation ratio (left), and adjusted distribution assuming proponents only restored 80% of area required (centre) or 50% of area required (right). The blue line represents a compensation of 1, and red dots indicate median CRs in each category.

Figure 2: A) Histogram showing the number of HADD authorizations across project sizes. B) Compensation ratios assigned to projects across project size. The blue line depicts a compensation ratio of 1, which would indicate no net loss. C) Depiction of the magnitude of habitat gained or lost, expressed as a sum of the authorized impact and the required compensation area. The blue line depicts a net change of zero, which would indicate no net loss. The red line is a 1:1 reference line, where values on that line indicate projects for which no compensation was ordered. Across all projects, there was an authorized net loss of 2,919,143 m² of habitat.

443 **Appendix 1:** Select example of an authorization, and additional explanation as to where data
444 were located within authorizations.

445

446 **Appendix 2:** Spreadsheet of raw data extracted from authorizations, and incorporated into the
447 present paper

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Figure 1: A) Boxplots depicting area of HADD authorized compared with the area of compensation required, excluding projects for which no area-based compensation was explicitly required. B) Comparison of the area of HADD authorized and compensation area required for each project in our dataset, where each pair of points is a single project. C) Violin plots showing the density of projects assigned a given compensation ratio (left), and adjusted distribution assuming proponents only restored 80% of area required (centre) or 50% of area required (right). The blue line represents a compensation of 1, and red dots indicate median CRs in each category.

Figure 1
211x188mm (300 x 300 DPI)

Figure 2: A) Histogram showing the number of HADD authorizations across project sizes. B) Compensation ratios assigned to projects across project size. The blue line depicts a compensation ratio of 1, which would indicate no net loss. C) Depiction of the magnitude of habitat gained or lost, expressed as a sum of the authorized impact and the required compensation area. The blue line depicts a net change of zero, which would indicate no net loss. The red line is a 1:1 reference line, where values on that line indicate projects for which no compensation was ordered. Across all projects, there was an authorized net loss of 2,919,143 m^2 of habitat.

Figure 2
211x188mm (300 x 300 DPI)

Appendix

Collecting Data from Authorizations

We obtained all data on authorized harmful alteration, disruption, and destruction (HADD) of fish habitat from authorizations provided by Fisheries and Oceans Canada under the Access to Information Act, as described in the manuscript body. Here, we describe where data were located within each authorization.

Every authorization contained a header containing basic information about the proponent and the nature of the project (Figure A1: A). In most cases, the authorization contained an explicit HADD area, which in some cases was described in a table (Figure A1: B) or was located in the body of the text. To record assigned compensation, we examined the body of the text of the authorization (Figure A1: C) and noted the specific values described in the authorization. In the present example, it said “approximately” to described the assigned compensation, but for the purposes of this manuscript we ignored this qualifier and assumed that 100 m² was the actual value that the proponent was mandated to restore.

Document Released Under the Access to Information Act / Document divulgué en vertu de la Loi sur l'accès à l'information.

Authorization No: 04-HPAC-PA1-00061 43 km

FISHERIES ACT SUBSECTION 35(2) AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

Authorization issued to:

Name: Toba Montrose Hydro Inc. (TMHI)

Attention: Removed to protect privacy

Address:

Telephone:

FAX:

Herein referred to as the "Proponent".

Location of Project

The East Toba River and Montrose Creek Hydroelectric Project (the Project) is located within the Coast Range of southern British Columbia in the Toba River drainage approximately 100 km north of Powell River. The works or undertakings are located within and adjacent to the Toba River at or near km 43 of the Toba Mainline access road.

Latitude and longitude: 50°40'03" North, 123°57'51" West.

Authorized Riparian and In-stream Impacts:

Location	Aquatic HADD	Riparian HADD
NW road ditch	242	0
SE Road refuge area	15	0
S2 Alcove	12	0
S3 Stream	11	0
S2 bridge (new)	22	0
Road Right of Way	0	7,100
Transmission line Right of Way	0	34,100
Totals	302 ¹	41,200 ¹

4. Conditions that relate to the **compensation** for the destruction of 302 square metres of aquatic fish habitat and the destruction of 41,200 square metres of riparian habitat:

4.1. Approximately 100 square meters of aquatic (deep pool) habitat is described in the "Toba Montrose Hydroelectric Project, Relocation of Road and Transmission Powerline at 43 Km on the Toba Main", by Shawn Hamilton and Associates, dated April 27, 2012 (Schedule C) shall be created as compensatory fish habitat to offset the in-stream impacts associated with the 43 Km Road and Transmission Powerline Relocation.

Figure A1: Screenshots from a HADD authorization demonstrating where data were located within these reports. General information about the proponent was present in the header of each document (A) and authorized impacts were described in a table (B) or in some cases, in the body of the text. Compensation requirements (C) were generally described in the text of the document.