Direct habitat loss from reservoirs on arctic grayling system capacity

Downloaded on: 2026-11-12, From: https://mjbayly.com/stressor-response/direct-habitat-loss-reservoirs-arctic-grayling-system-capacity
Function Updated by isutherland on Tue, 11/03/2026 - 17:23.

Species Information

Common Name: Arctic Grayling
Genus: Thymallus arcticus

Stressor Details

Stressor Name: Direct Habitat Loss
Units: System Capacity (%)
Metric: Unflooded mainstem length downstream of occurrence (km of stream order 4)
Scale: linear
Function Type: continuous

Life Stage & Context

Life Stages: Juvenile
Geography: Northeast British Columbia (Williston, Parsnip, and Findlay Valleys)
Activity: Juvenile rearing; overwintering (juveniles and adults)

Descriptions

Overview

Fish stressor mechanism: Unflooded mainstem habitat is important for the Arctic Grayling life cycle, particularly for juvenile rearing and overwintering by juvenile and adult life stages. The creation of reservoirs through dam construction can flood low-gradient mainstem river habitats, resulting in direct habitat loss and potentially limiting the ability of Arctic Grayling to complete their life cycle.

Study context: In the upper Peace Basin of northeastern BC, the creation of Williston Reservoir flooded approximately 350 km of mainstem river habitat and is considered the most plausible explanation for the extirpation of at least 24 local Arctic Grayling populations (Hagen et al. 2026).

Stressor-response function development: Hagen et al. (2026) developed a hypothesized stressor-response curve based on the length of unflooded mainstem habitat (fourth-order or larger) downstream of Arctic Grayling occurrence. The curve is informed by observed positive associations between juvenile Arctic Grayling occurrence, distance upstream from Williston Reservoir, and stream order (Hawkshaw et al. 2013; Hawkshaw and Shrimpton 2014). It was further informed by abundance observations in the Parsnip River watershed, where abundance increased with distance upstream from the reservoir, reaching a peak approximately 60 km upstream (Hagen and Stamford 2023). The empirical studies evaluated juvenile occurrence in relation to distance from the reservoir multiplied by stream order, whereas Hagen et al. (2026) used the length of unflooded mainstem habitat (fourth-order or larger) to hypothesize the response of system capacity. The quantitative transformation between these relationships was not empirically calibrated

Note that this function uses habitat as the explanatory variable and, hence, may be more appropriately characterized as a habitat-limitation relationship than a direct reservoir-impact relationship.

Application status: Hagen et al. developed the curve but excluded this stressor from their implemented CEMPRA model at the time because it was not associated with identified recovery actions within their current study.

Function Derivation

correlative, expert judgement

Transferability of Function

The ecological mechanism of direct habitat loss from reservoir flooding is likely transferable to other fluvial Arctic Grayling populations, particularly where larger mainstem rivers provide important juvenile rearing and overwintering habitats. Hagen et al. (2026) identify similar reservoir-related habitat impacts in the upper Missouri River Basin, supporting the inclusion of direct habitat loss when assessing system capacity.

The empirical basis for the S–R function comes primarily from the Williston Reservoir watershed in northeastern BC. Hawkshaw and Shrimpton (2014) identified a positive association between juvenile occurrence and distance from the reservoir multiplied by stream order, with water temperature variability also influencing occurrence. Hagen et al. (2026) interpreted this evidence, alongside subsequent abundance observations (Hagen and Stamford 2023), to develop a hypothesized relationship between system capacity and the length of unflooded mainstem habitat (fourth-order or larger). This transformation was not directly calibrated to system-capacity observations.

Transferability considerations: Expert review could help establish whether the receiving system has comparable dependence on mainstem habitats for critical life-history stages, and whether the fourth-order stream threshold and distances represented in the function are appropriate or require adjustment. Differences in life-history strategies, stream-network configuration, and habitat availability may affect the magnitude of system-capacity loss.

Source of Stressor Data

river network (including stream order), and Arctic Grayling occurrence or distribution are required to calculate the length (km) of remaining unflooded mainstem habitat (fourth-order or larger) downstream of Arctic Grayling occurrence.

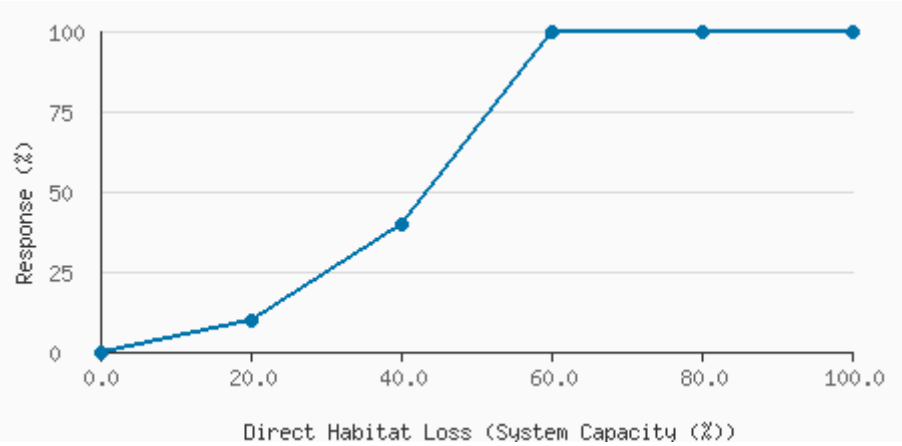
Stressor Magnitude Data

GIS analysis

Pathways of Effect

Hydroelectric dam construction, reservoir impoundment, flooding of mainstem river habitat, loss of juvenile rearing and overwintering habitat, reduced ability to complete the life cycle, reduced Arctic Grayling system capacity

Stressor Response Data



?Non-Native Trout (% System Capacity)	Mean System Capacity (%)	SD	low.limit	up.limit
0	0	0	0	100
20	10	0	0	100
40	40	0	0	100

60	100	0	0	100
80	100	0	0	100
100	100	0	0	100

Citations

Hagen, J., Stamford, M., Bottoms, J. and O'Connor, B. (2026) The Past and Future of Arctic Grayling in the Upper Peace Basin: A Synthesis of Long-Term Learning for Recovery Planning. Report prepared for the Fish and Wildlife Compensation Program – Peace, Prince George, BC. FWCP Project No. PEA-F26-F-4354-DCA. *** Source of the actual function

Supporting references (cited in entry):

Hagen, J. and Stamford, M. (2023) Parsnip Arctic Grayling Critical Habitats and Abundance: 2018–2022 Final Report. Report prepared for the Fish and Wildlife Compensation Program – Peace Region, Prince George, BC. FWCP Project No. PEA-F23-F-3631.

Hawkshaw, S.C.F., Gillingham, M.P. and Shrimpton, J.M. (2014) 'Habitat characteristics affecting occurrence of a fluvial species in a watershed altered by a large reservoir', Ecology of Freshwater Fish, 23(3), pp. 383–394. https://doi.org/10.1111/eff.12092

Hawkshaw, S.C.F. and Shrimpton, J.M. (2014) Temperature preference and distribution of juvenile Arctic grayling (Thymallus arcticus) in the Williston Watershed, British Columbia, Canada. Fish and Wildlife Compensation Program – Peace Region, Report No. 366. 40 pp. plus appendices.

Hawkshaw, S.C.F. (2011) Temperature preference and distribution of juvenile Arctic grayling (Thymallus arcticus) in the Williston watershed, British Columbia, Canada. MSc thesis. University of Northern British Columbia, Prince George, BC.

Stamford, M., Hagen, J., O'Connor, B. and Bottoms, J. (2026) Williston Watershed Arctic Grayling Cumulative Effects CEMPRA Model Stressor Response Curves. Appendix B in Hagen, J., Stamford, M., Bottoms, J. and O'Connor, B., The Past and Future of Arctic Grayling in the Upper Peace Basin. Fish and Wildlife Compensation Program – Peace, Prince George, BC. FWCP Project No. PEA-F26-F-4354-DCA.