Summer Flow and Arctic Grayling System Capacity

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Species Information

Common Name: Arctic Grayling
Genus: Thymallus arcticus

Stressor Details

Stressor Name: Summer Flow
Units: % of MAD
Metric: Average August Flow Standardized as % of Mean Annual Discharge (MAD)
Scale: linear
Function Type: continuous

Life Stage & Context

Life Stages: Adults
Geography: Upper Peace River Basin (British Columbia)

Descriptions

Overview

This function was adapted to be used for Arctic Grayling in the Upper Peace River Basin by Hagen et al. (2026) from Rosenfeld and Enright (2025). The original flow-ecology relationships developed by Rosenfeld and Enright (2025) were based on data from 25 different streams in 6 different countries for multiple salmonid species (including European Grayling).

Hagen et al. (2026) justifies summer flow as a stressor for Arctic Grayling as so:
"Flow is a master variable controlling the quantity and quality of stream habitat, but which is also affected by human activity (Poff et al. 1997; Rosenfeld and Enright 2025; Tenant 1976). Summer streamflow is thought to be an important factor affecting Arctic Grayling system capacity. In Arctic tundra streams, higher summer discharge has been associated with increased growth of subadult/adult Arctic Grayling (Deegan et al. 1999). Reduced stream flows in the Big Hole River, Montana, are coincidental with reduced grayling abundance and distribution (Federal Register, 2010). Potential linking mechanisms are dewatering of spawning sites, loss of connectivity among spawning, rearing, and refuge sites, and reduction of habitat volume intensifying competition and predation. In Alberta, altered surface and groundwater flows linked to agriculture, grazing, resource extraction, and recreational development are also considered threats to the species (Alberta Environment and Parks and Alberta Conservation Association 2015). Within the Williston watershed, low summer streamflow has also been suggested as a potential stressor. Large numbers of Arctic Grayling fry have consistently been captured and observed stranded in pools isolated from the main channel after water levels dropped in summer (e.g., Cowie and Blackman 2003, 2004, 2007). "

Hagen et al. (2026) adapted data from Rosenfeld and Enright (2025) to estimate the effect of summer flows on Arctic Grayling system capacity using the following logic:
"To model expected impacts of summer streamflow on Arctic Grayling system capacity, we utilized mean discharge estimates for the month of August, which were computed from recent discharge records at Water Survey of Canada streamflow gauging locations in study watersheds. August represents the core of the summer growth period in rearing habitats for both adult and juvenile Arctic Grayling following declines from freshet flows, but prior to emigration to overwinter locations. The stressor response curve is defined in terms of streamflow levels standardized as percentages of mean annual

discharge (MAD). Inflection points of the dome-shaped stressor-response curve are based on the Rosenfeld and Enright (2025) predictions for system capacity in relation to MAD, which estimate optimal flow at 57% of MAD with confidence intervals 36% to 96% MAD, with the steepest rate of decline between 13% and 0% MAD."

Function Derivation

Based on data from other species; Empirical data (standardized to ecosystem response); Expert opinion (to adapt to Arctic Grayling system capacity)

Transferability of Function

This function is broadly and adaptable and transferable amongst salmonid species. The original flow-ecology relationships developed by Rosenfeld and Enright (2025) were based on data from 25 different streams in 6 different countries for multiple salmonid species.

Source of Stressor Data

This stressor-response function was adapted to Arctic Grayling system capacity by Hagen et al. (2026) from data in Rosenfeld and Enright (2025).

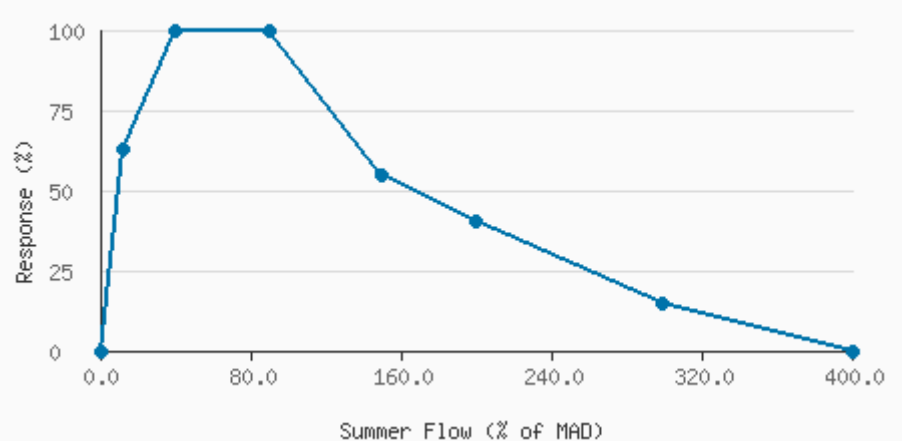
Stressor Magnitude Data

Gauging stations (Water Survey of Canada gauges in study watersheds)

Pathways of Effect

altered surface and groundwater flows (agriculture, resource extraction, etc), reduced summer streamflows, reduced habitat volume, loss of habitat connectivity

Stressor Response Data



Stressor (% MAD)	Mean System Capacity (%)	SD	low.limit	up.limit
0	0	0	0	0
12.3	62.63	0	62.63	62.63
40.43	100	0	100	100
89.65	99.64	0	99.64	99.64
150.29	54.8	0	54.8	54.8

199.51	40.21	0	40.21	40.21
199.51	40.21	0	40.21	40.21
299.71	14.95	0	14.95	14.95
400	0	0	0	0

Citations

Alberta Environment and Parks and Alberta Conservation Association. 2015. Status of the Arctic Grayling (Thymallus arcticus) in Alberta: Update 2015. Alberta Environment and Parks. Alberta Wildlife Status Report No. 57 (Update 2015). Edmonton, AB. 96 pp.

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Deegan, L.A., Golden H.E., Harvey C.J. and B. J. Peterson. 1999. Influence of Environmental Variability on the Growth of Age-0 and Adult Arctic Grayling. Trans, Am. Fish. Soc. 128(6): 1163- 1175.

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