Direct Mortality and Bull Trout

Downloaded on: 2026-11-09, From: https://mjbayly.com/stressor-response/direct-mortality-and-bull-trout
Function Updated by mbayly on Thu, 04/24/2025 - 19:09.

Species Information

Common Name: Bull Trout
Genus: Salvelinus confluentus

Stressor Details

Stressor Name: Direct mortality
Units: % mortality
Metric: Total annual mortality
Scale: linear
Function Type: continuous
Vital Rate/Process: Survival

Life Stage & Context

Life Stages: Adults
Geography: Alberta foothills watersheds, excluding National Parks
Activity: All activities
Season: All seasons

Descriptions

Overview

> In the Joe model, direct mortality was separated into natural causes, entrainment and research and monitoring, although more variables can be added as required. Using these three mortality sources, the total annual mortality rate (A) can be calculated using the conditional rates of natural mortality (n), entrainment mortality (en) and research and monitoring mortality (r), by applying the following equation adapted from Ricker (1975):
>
> A=1-1-n1-en1-r
> The stressor-response curve for direct mortality (Figure 1) is based on the results from modelling using a modified version of the Bull Trout model of Post et al. (2003). Assuming a conditional mortality rate of 20% from natural causes (Post et al. 2003), a Bull Trout population shown to switch from growth overfishing to recruitment overfishing (assumed to occur at ½ of maximum system capacity) if the combined conditional rate of mortality from other sources exceeded 8% and extirpation was expected when additional mortality exceeded 12% (Figure 1). Similar to the Angling Effort (incidental angling mortality and illegal harvest) function, there is an assumption that there is a portion of fish in a population that are less vulnerable or invulnerable to direct mortality hence the system capacity does not reach zero. For all three species, the upper limit of direct mortality was not exceeded so the stressor-response curve does not have a flat-tail on the x-axis but this could be seen in the future if the threat of entrainment or research and monitoring increase.

Function Derivation

> Based on data for Bull Trout; Empirical data; Published/non peer-reviewed; Mechanistic theory

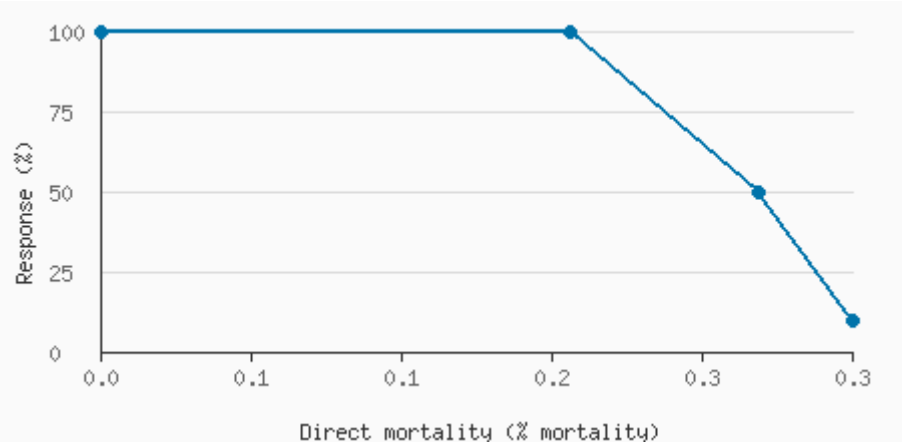
Transferability of Function

> This function was developed and applied to Bull Trout in Alberta foothills watersheds. Parameters used to derive inflection points are specific to Bull Trout on the Alberta east slopes, so it should be applied to other species with caution.

Source of Stressor Data

a. Entrainment Mortality
Fish can become entrained in irrigation canal headworks and killed if not rescued before the canal is dewatered at the end of the irrigation season. Entrainment rates are expected to be variable between canals, however, there have been no recent studies to determine the total number of entrained fish and the overall effect on population sustainability. The primary data source to inform the potential severity of this threat is the Trout Unlimited Canada annual fish rescue program, which includes most but not all canal headworks within the current Bull Trout and Westslope Cutthroat Trout range. Typically, no or small numbers of entrained Bull Trout (

Stressor Response Data



Direct Mortality (proportion)	Mean System Capacity (%)	SD	low.limit	up.limit
0	100	0	0	100
0.2	100	0	0	100
0.28	50	0	0	100
0.32	10	0	0	100

Citations

Government of Alberta. 2024. Direct mortality (natural, entrainment, and research) stressor-response function for Bull Trout. Environment and Protected Area Native Trout Cumulative Effects Model.

AESRD - Alberta Environment and Sustainable Resource Development. 2013a. Standards for the ethical use of fishes in Alberta. 5 p.

AESRD - Alberta Environment and Sustainable Resource Development. 2013b. Standard for sampling of small streams in Alberta. 18 p.

AFMD - Alberta Fisheries Management Division. 2004. Electrofishing Policy Respecting Injuries to Fish. 3 p.

Clayton, T.B. 2001. Movements and status of Bull Trout (Salvelinus confluentus) in the Belly River, Alberta and Montana. Pages 141-145 in Brewin, M.K., A.J. Paul, and M. Monita, editors. Bull Trout II conference proceedings. Trout Unlimited Canada, Calgary, Alberta, Canada.

FERC - Federal Energy Regulatory Commission. 1995. Preliminary assessment of fish entrainment at hydropower projects, a report on studies and protective measures, volumes 1 and 2 (appendices). FERC Office of Hydropower Licensing, Washington, D.C. Paper No. DPR-10. June 1995 (volume 1) and December 1994 (volume 2).

Langford, M.T. 2016. Predicting the Hydraulic Influence of Hydropower Operations on Upstream Aquatic Habitat. A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Water Resources Engineering Department of Civil and Environmental Engineering. University of Alberta. 222 p.

Lindsay, E., L. Peterson, H. Tunna, J. Dubnyk, and T. Urquhart. 2015. Late Fall Fisheries Investigations in Irrigation Canals of Southern Alberta, 2014 Trout Unlimited Technical Report No. AB-037.

Ma, B., E. Parkinson, and D. Marmorek. 2012. Using single species population models of Bull Trout, Kokanee and Arctic Grayling to evaluate Site C passage alternatives. Site C Clean Energy Project Technical Data Report: Vol. 2, App. Q3,

Attachment B.

Martins, E., L. Gutowsky, P. Harrison, D. Patterson, M. Power, D. Zhu, A. Leake, and S. Cooke. 2013. Forebay use and entrainment rates of resident adult fish in a large hydropower reservoir. Aquatic Biology 19: 253–263. Post, J., C. Mushens, A. Paul, and M. Sullivan. 2003. Assessment of alternative harvest regulations for sustaining recreational fisheries: model development and application to Bull Trout. North American Journal of Fisheries Management 23:22–34.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada, Bulletin 191. Ottawa, ON. 401 pp.

Salow, T and L. Hostettler. 2004. Movement and mortality patterns of adult adfluvial Bull Trout (Salvelinus confluentus) in the Boise River basin Idaho. U.S. Bureau of Reclamation, Denver, Colorado.

Underwood, K., and S. Cramer. 2007. Simulation of human effects on Bull Trout population dynamics in Rimrock Reservoir, Washington. American Fisheries Society Symposium 53:191-207.

USFWS - U.S. Fish and Wildlife Service. 2000. Revised section 7 programmatic consultation on issuance of section 10(a)(1)(A) scientific take permits and section 6(c)(1) exemption from take for Bull Trout (Salvelinus confluentus) (6007.2100). Memorandum from Acting Supervisor, Snake River Basin Office, Boise, Idaho, to Regional Director, Region 1, Portland, Oregon. February 14, 2000. 22 p.

USFWS - U.S. Fish and Wildlife Service. 2015. Recovery plan for the coterminous United States population of Bull Trout (Salvelinus confluentus). Portland, Oregon. xii + 179 pages

Westslope Fisheries Ltd. 2012. BC Hydro Aberfeldie dam fish entrainment strategy Bull River fish entrainment – telemetry study. Prepared for BC Hydro. 94 pp.