Selenium and Athabasca Rainbow Trout

Species Information

Common Name: Athabasca Rainbow Trout
Genus: Oncorhynchus mykiss

Stressor Details

Stressor Name: Selenium
Units: µg/g egg wet weight
Metric: Selenium in eggs
Scale: linear
Function Type: continuous
Vital Rate/Process: Survival

Life Stage & Context

Life Stages: Egg
Geography: Alberta foothills watersheds, excluding National Parks
Activity: Egg incubation and development
Season: All seasons

Descriptions

Overview

> Selenium is a naturally occurring element, necessary in trace amounts for metabolic processes but toxic at high concentrations (Frost and Lish 1975; Wang and Gao 2001). A variety of natural and human causes can lead to increases in selenium in fish, including open-pit mining that exposes limestone, increases in sedimentation and run-off, and atmospheric deposition from coal-burning power plants (Barceloux 1999; Lemly 2004). In salmonid fish, observed individual-level effects of selenium toxicity include a decrease in egg incubation time, hatch rate, fry survival, juvenile survival, and juvenile growth (e.g. Hodson et al. 1980, Hamilton et al. 1986, Hamilton et al. 1990). High concentrations of selenium have been detected in east slopes streams in the range of Athabasca Rainbow Trout, apparently caused by open-pit coal mining (Palace et al. 2004). Extensive reviews of selenium in Alberta fishes and waters are found in Fortin (2010) and Pilgrim (2012).
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> At a population level, decreased juvenile survival could result in decreased population size. However, to date most studies have focused on individual-level effects, but results have rarely been extrapolated to the population. The selenium stressor-response curves for Athabasca rainbow trout were derived based on the research of Pilgrim (2012). Units of selenium concentration that best described population-level effects on Rainbow Trout were egg Se (microgram/gram wet-weight) (Figure 1).
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> Although the ecotoxicology of elevated selenium levels in warm and cold-water fish has been studied by numerous authors, the effects of selenium contamination remain somewhat controversial (Kennedy et al. 2000, Sappington 2002, Hardy et al. 2010). Therefore, as new population-level literature becomes available, the dose-response curve should be updated.

Function Derivation

> Experimental data

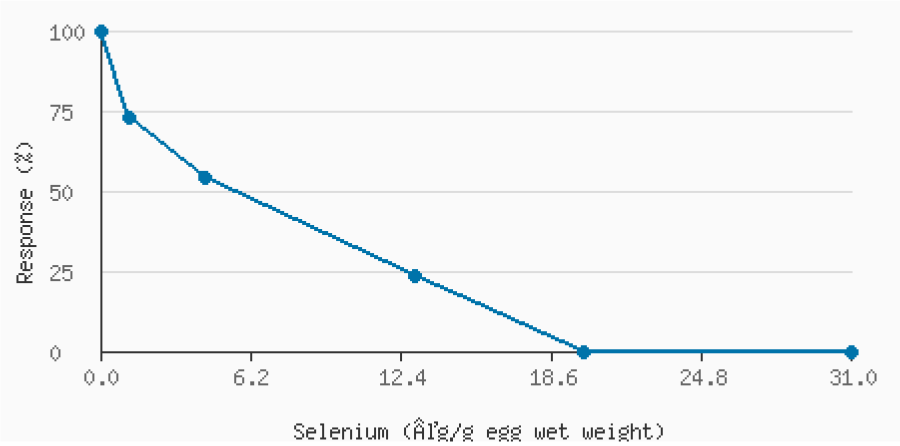
Transferability of Function

> This function was created for Athabasca Rainbow Trout but was based on laboratory experiments on hatchery Rainbow Trout. It should be used in other Rainbow Trout systems with caution.

Source of Stressor Data

> Athabasca Rainbow Trout and Westslope Cutthroat Trout values at this time are set to 0 but it is our expectation that monitoring from industry will have taken place and whole-body tissue concentrations would be available.

Stressor Response Data



Selenium (ug/gram egg wet weight)	Mean System Capacity (%)	SD	low.limit	up.limit
0	100	0	0	100
1.17	72.51855257	0	0	100
4.3	54.08974454	0	0	100
13	23.67942532	0	0	100
20	0	0	0	100
31	0	0	0	100

Citations

Government of Alberta. 2024. Selenium stressor-response function for Athabasca Rainbow Trout and Westslope Cutthroat Trout. Environment and Protected Area Native Trout Cumulative Effects Model.

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Hamilton, S.J., and R.H. Wiedmeyer. 1990. Concentrations of boron, molybdenum, and selenium in Chinook salmon. Transactions of the American Fisheries Society 119:500–510.

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Hodson, P.V., D.J. Spry, and B.R. Blunt. 1980. Effects on rainbow trout (Salmo gairdneri) of a chronic exposure to waterborne selenium. Canadian Journal Fisheries and Aquatic Science 37:233–240.

Kennedy, C.J., L.E. McDonald, R. Loveridge, and M.M. Strosher. 2000. The effect of bioaccumulated selenium on mortalities and deformities in the eggs, larvae, and fry of a wild population of cutthroat trout (Oncorhynchus clarkii lewisi). Archives of Environmental Contamination and Toxicology 39: 46-52.