Dissolved Oxygen and Salish Sucker System Capacity

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Species Information

Common Name: Salish Sucker
Genus: Catostomus sp.

Stressor Details

Stressor Name: Dissolved Oxygen
Units: mg/L
Scale: linear
Function Type: continuous
Vital Rate/Process: Specific growth rate

Life Stage & Context

Life Stages: Adults
Geography: Lower Fraser Valley (British Columbia)
Activity: All activities
Season: All seasons

Descriptions

Overview

> The effects of DO on system capacity was mainly inferred based on a meta-analysis examining the effect of Dissolved Oxygen (DO) concentration on specific growth rate of fish, which evaluated data from 38 studies on 30 freshwater and marine species (Rosenfeld and Lee 2022). The shape of the curve and threshold value (5.1 mg/L) is based on segmented regression of specific growth rate as a function of dissolved oxygen averaged across 30 species. The inference implicit in using growth as the response variable is that threshold effects of low DO on individual growth will be similar to population-level effects. Although the average segmented regression across all species is highly significant and the threshold or 5.1 mg/L is consistent with previous analyses and regulatory guidelines for water quality, there remains great inter-specific variation around the mean response. Salish sucker is not a cold-water species and therefore, less sensitive to hypoxia compared to salmonids (Rosenfeld et al. 2021; Zinn et al. 2021). Based on observation and experience, and the assumption that Salish sucker are selected for some degree of hypoxia tolerance because they have evolved in small streams subject to seasonal drying and low flows (and also prefer deep pool or wetland habitat that is subject to intermittent hypoxia), the threshold DO for sublethal effects on Salish sucker has been set at 4 mg/L (Fisheries and Oceans Canada 2019). We set the x-intercept at 0.5 mg/L to reflect the higher known tolerance of Salish sucker compared to salmonids (x-intercept ? 3 mg/L) and the average across all species (0.8 mg/l DO; Rosenfeld et al. 2021, Rosenfeld and Lee 2022). The habitat suitability index model for Longnose Sucker (Edwards, 1983) generally supports the shape of the function, but has a higher threshold (6 mg/L) and x-intercept (4.5 mg/L), reflecting the fact that Longnose sucker (the sister-species to Salish sucker) are a cool-water species.

Function Derivation

> Based on data from other species; Empirical data (correlative model); Published

Transferability of Function

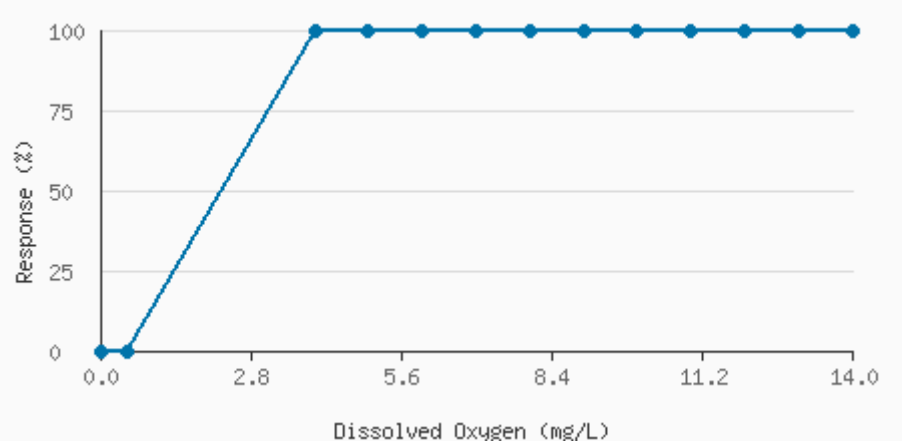
> As local adaptations are likely minimal among different Salish Sucker populations, we would not expect much variation in true tolerance among populations. This function should therefore be broadly applicable to all populations of the species,

with the caveat that it is partly based on data from other related species.

Source of Stressor Data

DO data is available for several reaches in Bertrand, Pepin, Fishtrap Creeks, and the Salmon River, collected as part of reconnaissance surveys to assess fish distribution, monitoring associated with habitat restoration, and mark–recapture population assessments that took place between 2003 and 2018. A predictive model to estimate DO as a function of temperature, flow, and associated covariates will need to be generated to create the dissolved oxygen stressor dataset.

Stressor Response Data



DO (mg/L)	Mean System Capacity (%)	SD	low.limit	up.limit
0	0	0	0	100
0.5	0	0	0	100
4	100	0	0	100
5	100	0	0	100
6	100	0	0	100
7	100	0	0	100
8	100	0	0	100
9	100	0	0	100
10	100	0	0	100
11	100	0	0	100
12	100	0	0	100
13	100	0	0	100
14	100	0	0	100

Citations

Usoof, A.M. and Rosenfeld, J.S. 2024. Relationship between system capacity and Dissolved Oxygen concentration for Nooksack Dace.

Fisheries and Oceans Canada. 2019. Recovery strategy for the Salish Sucker (Catostomus sp .) in Canada [Proposed]. 1st amendment. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. vii - 78 pp.

Rosenfeld, J., and Lee, R. 2022. Thresholds for Reduction in Fish Growth and Consumption Due to Hypoxia: Implications for Water Quality Guidelines to Protect Aquatic Life. Envirnmental Manag. Springer US. doi:10.1007/s00267-022-01678-9.

Rosenfeld, J., Pearson, M.P., Miners, J., and Zinn, K. 2021. Effects of landscape-scale hypoxia on Salish sucker and salmonid habitat associations?: implications for endangered. 1233(February): 1219–1233.

Zinn, K.R., Rosenfeld, J.S., and Taylor, E.B. 2021. Effects of experimental flow manipulations on water quality, hypoxia, and growth of threatened salish sucker (Catostomus sp. cf. catostomus) and juvenile coho salmon (oncorhynchus kisutch). Can. J. Fish. Aquat. Sci. 78(9): 1234–1246. doi:10.1139/cjfas-2020-0135.