Direct Mortality and System Capacity

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Species Information

Common Name: Westslope Cutthroat Trout, Athabasca Rainbow Trout
Genus: Oncorhynchus lewisi, Oncorhynchus mykiss

Stressor Details

Stressor Name: Direct Mortality
Units: Total Annual Mortality (%)
Metric: Natural, Entrainment, and Research Mortality
Scale: linear
Function Type: continuous
Vital Rate/Process: System Capacity

Life Stage & Context

Life Stages: Adults
Geography: Rocky Mountain foothills, Alberta
Season: year-round

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):
>
> $A=1-[(1-n)\times(1-en)\times(1-r)]$
> 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%. This model was modified for the assessment of Athabasca Rainbow Trout and Westslope Cutthroat Trout populations in Alberta foothills streams (Sullivan 2007) which assumed there was a conditional mortality rate of 35% from natural causes (Post et al. 2003; Sullivan 2007). An Athabasca Rainbow Trout or Westslope Cutthroat Trout population may be at high risk of extirpation if the combined conditional rate of mortality from other sources exceeds 15% (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

> mechanistic/theory-based relationships, empirical studies

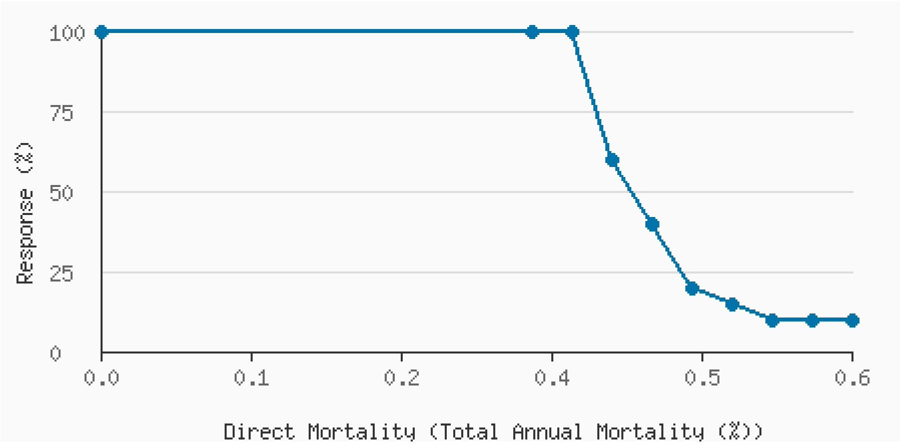
Transferability of Function

This function was developed and applied to Athabasca Rainbow Trout in Alberta foothills watersheds. The theoretical model behind the function was originally designed for Bull Trout but modified with inflection points to match Athabasca Rainbow Trout and Westslope Cutthroat Trout. The function should only be applied to other species if additional data is available to customize mortality rates.

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	
0.35	100	0	0	100	
0.3825	100	0	0	100	
0.415	60	0	0	100	
0.4475	40	0	0	100	
0.48	20	0	0	100	
0.5125	15	0	0	100	
0.545	10	0	0	100	
0.5775	10	0	0	100	
0.61	10	0	0	100	

Citations

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