# Stressor: Stream Temperature (°C)

# Species: Coho Salmon

# Life Stage/Season: Summer Rearing (All Freshwater Life Stages)

## Citation

## *Beechie, T. J., C. Nicol, C. Fogel, J. Jorgensen, J. Thompson, G. Seixas, J. Chamberlin, J. Hall, B. Timpane-Padgham, P. Kiffney, S. Kubo, and J. Keaton. 2021. Modeling Effects of Habitat Change and Restoration Alternatives on Salmon in the Chehalis River Basin Using a Salmonid Life-Cycle Model. U.S. Department of Commerce, NOAA Contract Report NMFS-NWFSC-CR-2021-01.*

## Stressor-Response Relationship

### Rationale

Coho salmon have different thermal tolerances than Chinook and Steelhead and thus have been independently modelled by Beechie et al. (2021). Increasing stream temperature decreases Coho Salmon abundance and productivity via changes in summer rearing capacity and productivity. This function was previously used in Beechie et al. (2021) in the Chehalis River in Oregon as a productivity (survivorship) multiplier for Age-1+ stage classes. Stressor magnitude values are provided as the 7-day average daily maximum (7-DADM) stream temperature.

### Function

Derived relationship between fry/parr summer rearing capacity and productivity and 7-day average daily maximum stream temperature. At stream temperatures < 18°C, there is no effect on summer rearing capacity/productivity. From 18°C to 24°C summer rearing capacity decreases linearly from 1 to 0. Summer rearing capacity is zero for stream temperatures equal to or greater than 24°C.

#### **Type:**

Empirical (Real data)

#### **Original Function:**

Where T is temperature in °C. The productivity/capacity multiplier is 0 at 24°C and above, and 1 at temperatures < 18°C.

## Known Covariates or Stressor Interactions

### Covariate(s)

Covariates embedded within stream temperature model (e.g., drainage area, channel slope, basin characteristics). Equivalent stream temperature models in British Columbia include estimates of MWAT from methods provided in Moore et al (2013).

## Considerations

See rubric in Appendix A for explanations of the data classifiers below.

Data Source: Stream temperature was derived using a stream temperature model (Beechie et al., 2021 Appendix A). Equivalent stream temperature models in British Columbia include estimates of MWAT from methods provided in Moore et al (2013).

Data Type: Combination of Empirical Data & Theory/Mechanistic Model

Data Quality: Function is based primarily on field data from ASEP (2014) Appendix C. Data collection was conducted in the Chehalis Basin in 2013-2014.

Confidence in SR function: Moderate uncertainty of a generalized thermal window. Strength, direction, and relative magnitude are well known, but there is less certainty with respect to absolute values. The SR function is based on a small amount of data from a single empirical study. Pacific Salmon and Steelhead are known to have a high degree of plasticity in the relationships between stream temperature across different systems. Local periodicity (timing) of critical rearing periods, watershed attributes, and the general availability of cold-water refuge may have large implications on the magnitude of local effects.

### Notes and User Recommendations

None.

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## Stressor-Response Curve

Chart, line chart

Description automatically generated

**Figure 1:** Stressor-response relationship between 7-day average daily maximum stream temperature (°C) and the derived summer rearing productivity multiplier (0-1), interpreted as system capacity in the model. Data are from Beechie et al. (2021).

## Stressor-Response Table

**Table 1:** The table shows the discrete stressor-response relationship between raw stressor values and the mean system capacity (0-100%). The standard deviation of the mean system capacity is defined by the user and represents the inherent stochasticity or noise in the relationship. The set lower limit and upper limit of the mean system capacity are also presented. Data are from Beechie et al. (2021).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Temperature (°C)** | **Mean System Capacity (%)** | **SD** | **Lower Limit** | | **Upper Limit** | |
| 8 | 100 | 0 | | 0 | | 1 | |
| 10 | 100 | 0 | | 0 | | 1 | |
| 12 | 100 | 0 | | 0 | | 1 | |
| 14 | 100 | 0 | | 0 | | 1 | |
| 16 | 100 | 0 | | 0 | | 1 | |
| 18 | 100 | 0 | | 0 | | 1 | |
| 20 | 66 | 0 | | 0 | | 1 | |
| 22 | 32 | 0 | | 0 | | 1 | |
| 24 | 0 | 0 | | 0 | | 1 | |
| 26 | 0 | 0 | | 0 | | 1 | |
| 28 | 0 | 0 | | 0 | | 1 | |
| 30 | 0 | 0 | | 0 | | 1 | |
| 32 | 0 | 0 | | 0 | | 1 | |