Mean Annual Discharge and Steelhead

Species Information

Common Name: Steelhead
Genus: Oncorhynchus mykiss irideus

Stressor Details

Stressor Name: Flow
Units: %
Metric: Mean Annual Discharge (MAD)
Scale: linear
Function Type: continuous
Vital Rate/Process: Over-summer survival

Life Stage & Context

Life Stages: Juvenile
Geography: Maacama Creek, Mark West Creek, Santa Rosa Creek, Green Valley Creek. California, USA
Season: Summer

Descriptions

Overview

Final curve was derived from a linear regression.

System capacity was derived from oversummer survival with data spanning years 1994-2002. The original data points represent 50-55 sites yielding 523 observations where oversummer survival. Survival was estimated by sampling twice, in midsummer and late summer through repeated census counts using pole seins and blocking nets were used until no fish were captured (typically 3-5 passes) which were then sorted as species then counted. It was then subsetted to only include large catchments (90-120 sqkm).
To normalize and rescale each ecological response, each value was scaled by the maximum ecological response observed in the study such that mean habitat capacity percentage (normalized response) = response / maximum ecological response observed.
Note: Only used 75th percentile data in overall analysis because 10th percentile flows are extremely small
Implicit pathway of effect: Oversummer survival of juvenile steelhead increases with higher summer discharge

Function Derivation

Observational data. Final curve was derived from linear regression.

Transferability of Function

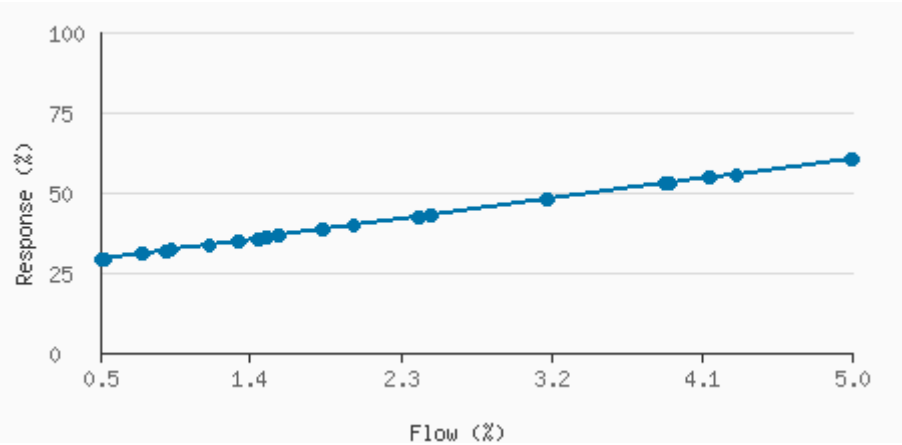
Appropriate for summer stream flow impacts on over-summer survival of juvenile steelhead. General transferability to other salmon stocks in unclear, but likely appropriate for other spring-spawning salmonids (i.e., regions with similar hydrology to the Maacama Creek, Mark West Creek, Santa Rosa Creek, Green Valley Creek system).
The relationship may be unreliable if extrapolated to a flow range outside the original data (see the Average Salmonid flow-ecology SR function entry based on Rosenfeld and Enright (2025) for a more generalizable function across a wider range of flows).

Note: This entry reflects only the subset including large catchments (90-120 sqkm), see other entries for other catchment sizes.

Source of Stressor Data

> The summer streamflow data (discharge) for each reach during the 9 years of sampling was estimated by the original authors (Grantham et al. 2012) based off a rain-fall run-off regression model based off of daily rainfall records. Data was sourced from the U.S. Geological Survey. Estimates was scaled by reach area. Estimates were later validated with measured flows at all sites with at least 12 measurements. See Grantham et al. 2012 for further details.
> Data was then standardized by dividing absolute flow by MAD to achieve %MAD values (see Rosenfeld & Enright 2024). Such standardization allows for comparison of flow metrics across a wide range of stream sizes (see Rosenfeld et al. 2017).

Stressor Response Data



?PERCENT_MAD	Mean System Capacity (%)	SD	low.limit	up.limit
0.53791	28.9807491	0	0	100
0.54323	29.0180423	0	0	100
0.54504	29.0307304	0	0	100
0.55888	29.1277488	0	0	100
0.56427	29.1655327	0	0	100
0.78606	30.7202806	0	0	100
0.78937	30.7434837	0	0	100
0.79821	30.8054521	0	0	100
0.92197	31.6730097	0	0	100
0.9271	31.708971	0	0	100
0.93066	31.7339266	0	0	100
0.93434	31.7597234	0	0	100
0.95858	31.9296458	0	0	100
0.96561	31.9789261	0	0	100
1.19094	33.5584894	0	0	100
1.36019	34.7449319	0	0	100
1.36897	34.8064797	0	0	100
1.47038	35.5173638	0	0	100
1.47382	35.5414782	0	0	100
1.4772	35.565172	0	0	100
1.48215	35.5998715	0	0	100

1.51707	35.8446607	0	0	100
1.53282	35.9550682	0	0	100
1.5958	36.396558	0	0	100
1.60272	36.4450672	0	0	100
1.86155	38.2594655	0	0	100
1.86497	38.2834397	0	0	100
1.86657	38.2946557	0	0	100
2.04641	39.5553341	0	0	100
2.04804	39.5667604	0	0	100
2.43258	42.2623858	0	0	100
2.43773	42.2984873	0	0	100
2.4999	42.734299	0	0	100
2.50359	42.7601659	0	0	100
2.50866	42.7957066	0	0	100
2.51062	42.8094462	0	0	100
2.5159	42.846459	0	0	100
3.19539	47.6096839	0	0	100
3.19766	47.6255966	0	0	100
3.2	47.642	0	0	100
3.89758	52.5320358	0	0	100
3.89968	52.5467568	0	0	100
3.90172	52.5610572	0	0	100
3.91877	52.6805777	0	0	100
3.91884	52.6810684	0	0	100
3.92541	52.7271241	0	0	100
4.16129	54.3806429	0	0	100
4.16359	54.3967659	0	0	100
4.16561	54.4109261	0	0	100
4.17467	54.4744367	0	0	100
4.3259	55.534559	0	0	100
5.00106	60.2674306	0	0	100
5.00991	60.3294691	0	0	100

Citations

Grantham, T.E., Newburn, D.A., McCarthy, M.A., and Merenlender, A.M. 2012. The role of streamflow and land use in limiting oversummer survival of juvenile steelhead in California streams. Trans. Am. Fish. Soc. 141:585-598.