# 2022 State of Salmon
# Water Analysis Project

# #1 -- Discharge (cfs) Analysis Methods

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## DISCHARGE ANALYSIS METHODS

Discharge Definitions:

The discharge patterns that would constitute "low flow" and "peak flow" for USGS and Dept. of Ecology datasets containing stream discharge data were determined to be:

- Any discharge rate (cubic feet per second) that fell within the bottom quartile for all discharge data of a given dataset (bottom 25th percentile) **for low flow.**
- Any discharge rate (cubic feet per second) that fell within the upper quartile for all discharge data of a given dataset (upper 25th percentile) **for peak flow.**

Because of the incongruence across their respective temporal ranges and widely variable discharge patterns and amounts, each data set had its data calculated relative to its whole set. The water bodies from which the utilized data were sampled consisted of different, pre-defined "system types"—glacial, mixed snow and rain, and regulated—which was an additional factor in concluding that calculating data relative to its own dataset would be most appropriate. The United States Geological Survey proved to have the most consistent data in terms of discharge measurements over time.

**Methodology For Analyzing Low Flow and Peak Flow for Gauges Located in Western Washington (West of the Cascade Range):**

## LOW FLOW

1. From the dataset, determine the number of low flow days for the dry season of each year analyzed (Jul 1 - Sept 30)
   a. Calculate the low flow metric by taking the bottom 25th percentile of discharge values for the whole dataset.
   b. Filter the data for the pre-determined, seasonal temporal range being assessed (Jul 1 - Sept 30).
   c. Filter the discharge values of the seasonal temporal range by the bottom 25th percentile metric that was calculated.
   d. Determine the frequency of data collection for the gauge being analyzed. The intervals at which gauges are programmed to collect data vary from hourly measurements to half-hourly measurements to quarter-hourly measurements and can vary over time within a single gauge's dataset.
   e. Determine the "count" of the remaining data values—the number of data points that remain after being filtered for the determined date and discharge ranges.
   f. One count represents one fraction of a day where a low flow measurement was present (1/24, 1/48, or 1/96, for an hour, half-hour, or fifteen-minute interval, respectively). Divide the count by the number of 15 min., 30 min., or 1 hr. intervals per day to determine the total number of low-flow days for the year being analyzed.
   g. Repeat all steps for each year in the dataset.

2. Determine the percentage of low flow days.
   a. Calculate the number of days for the measured time period (92).
   b. Divide the total number of low flow days calculated by the number of days within the low flow time period and multiply by 100.
   c. Repeat all steps for each year in the dataset.

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## PEAK FLOW

1. From the dataset, determine the number of peak flow days for the wet season of each year analyzed (Nov 1 - Jan 30)
   a. Calculate the peak flow metric by taking the upper 25th percentile of discharge values for the whole dataset.

b. Filter the data for the pre-determined, seasonal temporal range being assessed (Nov 1 - Jan 30).

c. Filter the discharge values of the seasonal temporal range by the upper 25th percentile metric that was calculated.

Steps d - g. Repeat the steps outlined for low flow.

2. Determine the percentage of peak flow days

a. Calculate the number of days for the measured time period (91).

Steps b - c. Repeat the steps outlined for low flow.

**FINDING CHANGE OVER TIME FOR LOW AND PEAK FLOW**

1. Calculate a linear regression for the percentage of each year's low flow or peak flow days for the dataset.

2. Input the dataset's first year analyzed into the equation for the resulting linear regression, then, separately input the dataset's last year analyzed into the same equation.

3. Calculate the change between the equation's solution for the first and last year. The result will represent the percentage change of low or peak flow days over time for the dataset.

4. Gather the percentage changes described in step 3 for every gauge's dataset within a salmon recovery region.

5. Average the number of years represented in each gauge's dataset and, separately, average the percentage change of low or peak flow days for each gauge's dataset.

6. Take the resulting value from the averaged percentage change described in step 5 and multiply it by the number of days for the measured time period (92 days for low flow, 91 days for peak flow).

7. Compare the value calculated in step 6 with the average number of years calculated in step 5. The result is the overall change in days of low or peak flow for a salmon recovery region for the average number of years represented within the region's collective datasets.

**Methodology For Analyzing Low Flow and Peak Flow for Gauges Located in Eastern Washington (East of the Cascade Range):**

1. All steps for analyzing low flow and peak flow in eastern Washington streams are congruent with those described in the methodology for analyzing flow in western Washington except for one difference:
   a. The wet season in eastern Washington encompasses days from Jan 1 - Jun 30. This is quite different from the wet season determined for western Washington and amounts to a total of 181 days comprising the wet season.
   b. Considering the change in date range and number of total days within the peak flow season, all calculations otherwise remain the same as those described in the western Washington methodology.