**Mission Sockeye smolt CPUE calibrations**

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*Last update: 22-Feb-2019 @ 17:10  
Code in github repository: https://github.com/khdavidson/chum-et-al.git "2017CPUE\_calibrations.R”*

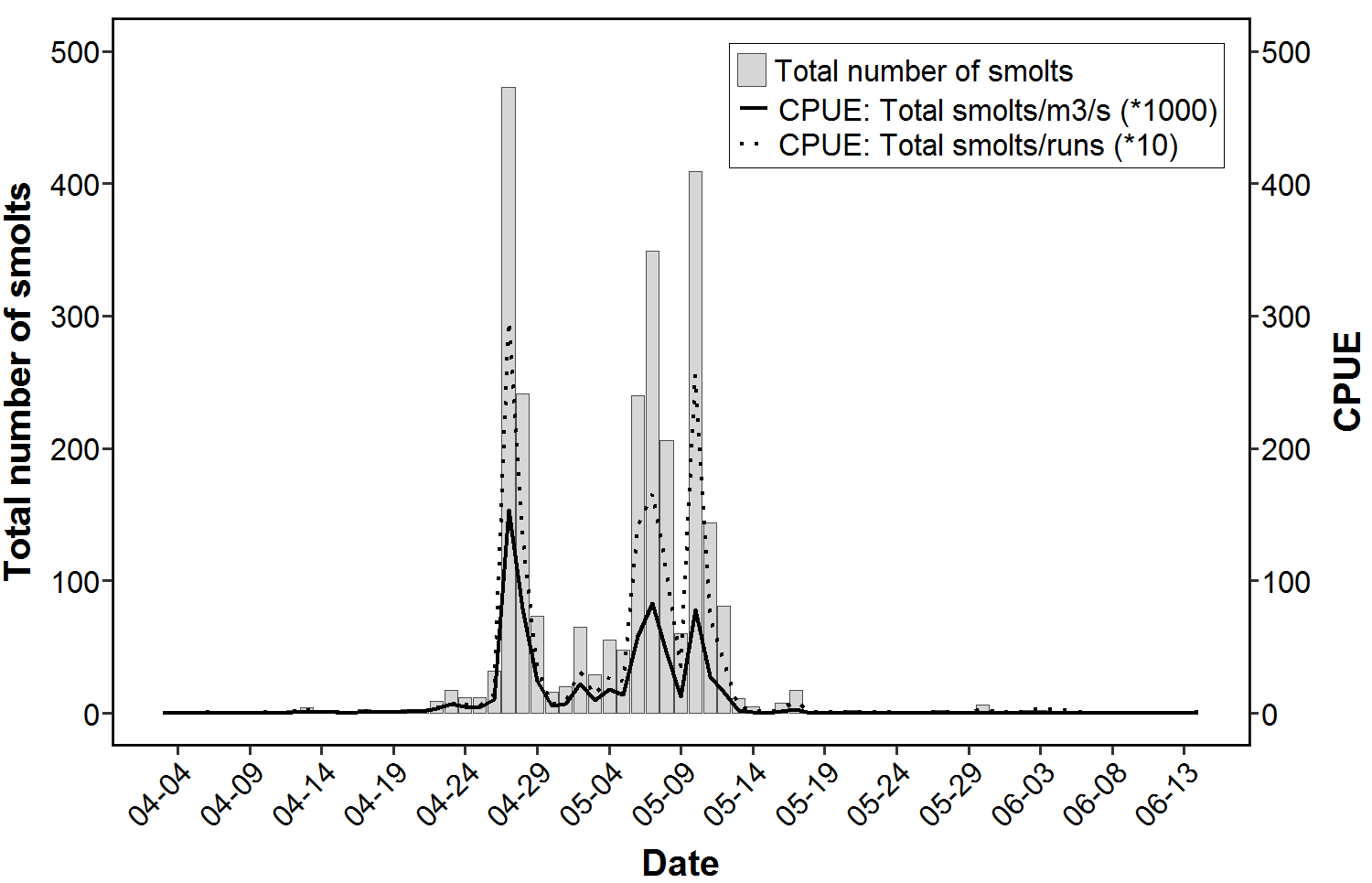
**Objective/Overview**

Exploratory calibration (and comparison) of raw catch numbers by daily number of runs, daily discharge, and flow differences among bays and sampling depths. Previous CPUE has been given as the number of smolts per run, or as the total number of smolts/number of runs (e.g., Townsend et al 2017). The next methods to trial are: 1) daily catch controlling for daily discharge; 2) finer-scale catch by bay, controlling for flow differences among bays; 3) finer-scale catch by depth, controlling for flow differences among sampling depths.

**Method 1.1: Daily catch/daily discharge (scale: “Day”)**

The daily discharge data was measured at Hope (station #08MF005) by Environment Canada (<https://wateroffice.ec.gc.ca>). For these calculations, discharge data included in the “2017 Mission RST – Main File SOCKEYE” obtained in-season were used as 2017 data are not available online yet.

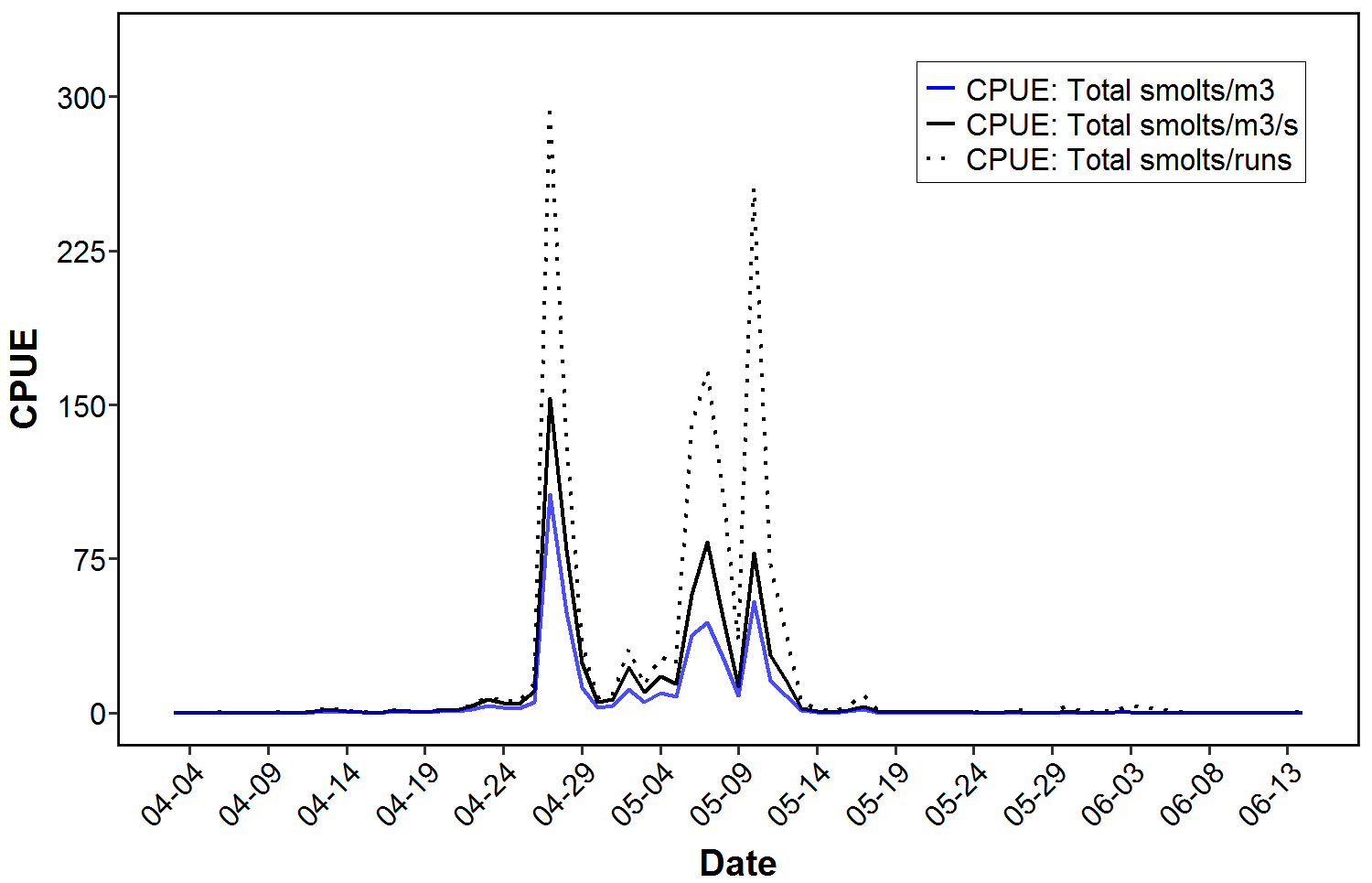
Starting with a coarse “day” scale, we can divide the total number of sockeye smolts by the daily discharge for an estimate of the number of smolts/m3•s-1 and compare visually to the previous CPUE calculation (Figure 1).



**Figure 1.** Total number of smolts (gray bars), original CPUE increased 1 order of magnitude (smolts/run; dotted line) and new CPUE increased 3 orders of magnitude (smolts/m3•s-1 water; black line) for each sampling day in 2017. Only 15 minute run times were included. All traps considered.

**Method 1.2: Daily catch/daily discharge and sampling time (scale: “Day”)**

However, this method of calculating CPUE by discharge does not include the sampling effort associated with the previous method (number of runs per day). By including a second level of calculation, dividing again by the daily total of seconds of sampling, we obtain a CPUE estimate that is calibrated for both river discharge over time, and varied sampling effort (given as seconds of fishing) among days. This also gives a potentially more intuitive unit of effort: daily number of fish per cubic-metre of water (i.e., density of fish; Figure 2). This also allows for the inclusion of all runs (n = 4026), and does not have to reduce the dataset to only runs of 15 minute lengths (n = 3996). While the 15-minute runs represent 99% of the total number of runs in 2017, this could vary among years. However, number of fish/m3 could be misleading as it suggests fish are distributed equally (any given cubic-metre of water is equivalent), when we know fish are typically more concentrated at the surface (1 m3 of water at the surface is not equivalent to 1 m3 at 20 ft when it comes to fish vertical distribution).



**Figure 2.** Original CPUE increased 1 order of magnitude (smolts/run; dotted line), CPUE accounting for daily discharge and increased 3 orders of magnitude (smolts/m3•s-1 water; black line), and CPUE accounting for daily discharge and sampling time, increased 7 orders of magnitude (smolts/m3 water; blue line) for each sampling day in 2017. All traps and run times were considered.

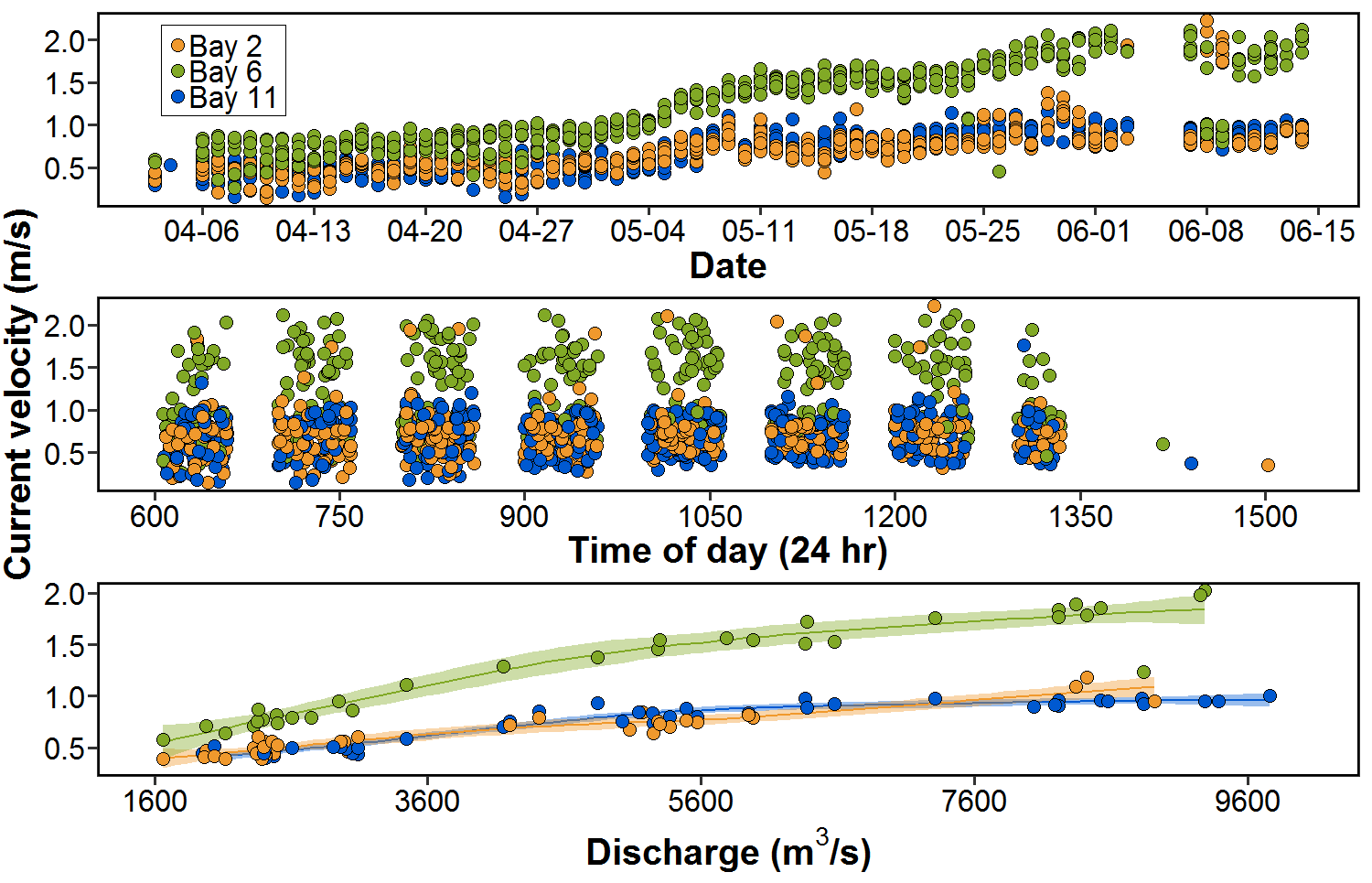
Although it is helpful to have one value for total catch, corrected for discharge and sampling time (seconds), the result is very small numbers that have to be scaled up several orders of magnitude to give meaningful CPUE estimates (see Figure 2 figure caption). It may be possible to convert discharge into a relatively smaller number (m3/min, or m3/hr) and calibrate by total sampling time (minutes or hours, respectively), but this moves away from the standard m3/s discharge measure which may not be ideal.

**Method 2: CPUE adjusted horizontally (scale: run)**

As documented throughout the field seasons, preliminary analysis confirms that water current velocity (m/s) varies significantly across the river (One-way ANOVA, *F* = 323.4, *df* = 2, *p* < 0.001). Current velocity is significantly higher in Bay 6 (Tukey post-hoc, both *p* < 0.001), but there is no significant difference in current velocity between Bays 2 and 11 (Tukey post-hoc, *p* = 0.94). For future calibrations using current velocity, Bays 2 and 11 could likely be grouped for simplicity if needed.

Current velocities also increases over time (intra-annual variation) with discharge. As the season progresses, the difference between current velocity in the centre (Bay 6) and edges (Bays 2 and 11) increases disproportionately (Figure 3A and C).

Bay current velocity will also vary as a function of the date and time of sampling due to changes in tidal currents. Figure 4B confirms that current velocity in Bay 6 remains consistently higher throughout the day, although at this scale the effect of tide cannot be determined. ‘Date-time’ combinations may help reveal the effect of tidal cycle on current velocity in each Bay.



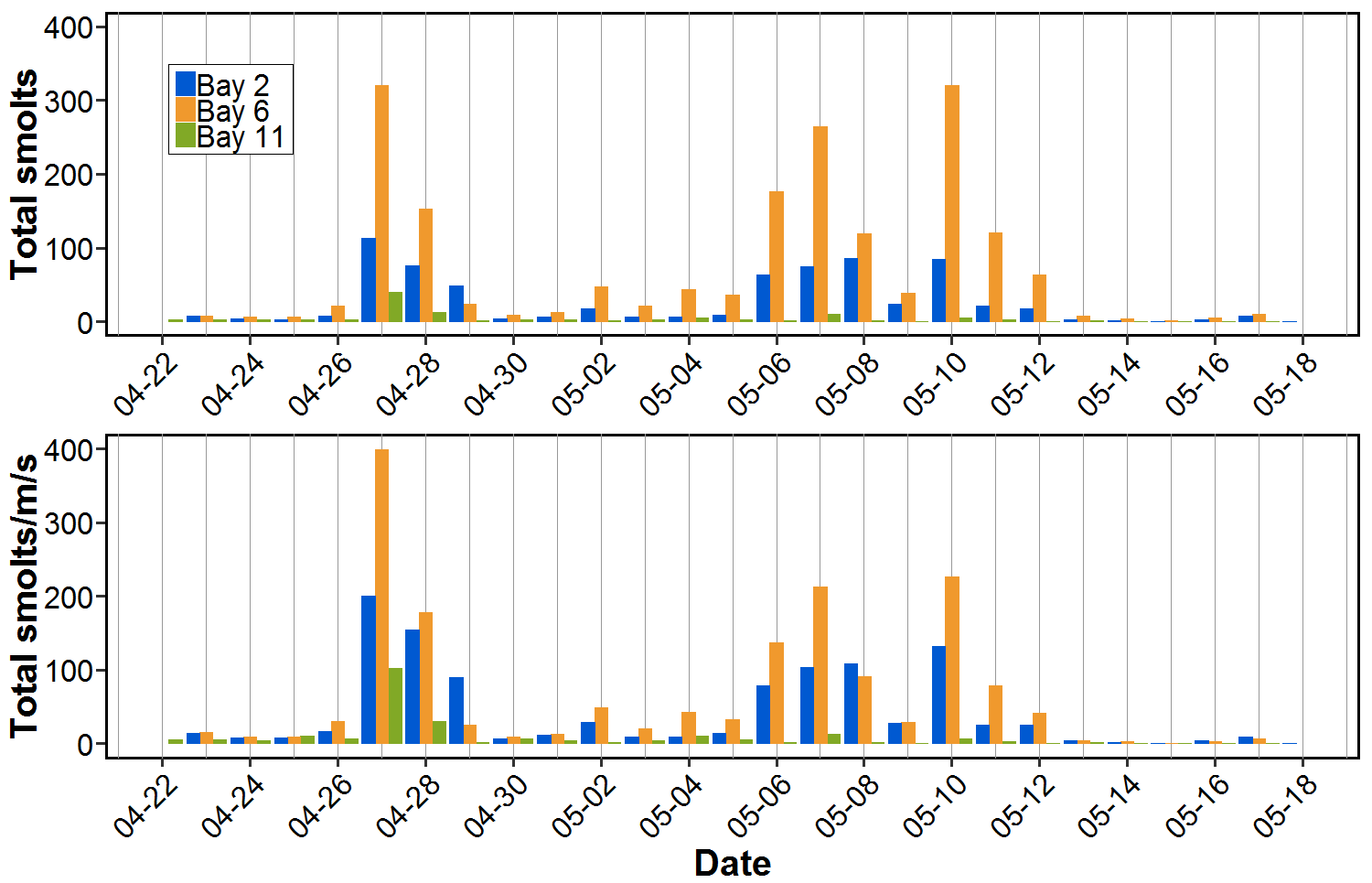
**A**

**B**

**C**

**Figure 3.** Change in current velocity (m/s) a) throughout the year (2017), b) over the course of a sampling day, and c) with daily discharge (m3/s) for each Bay. All runs and traps considered.

Given the disproportionate change in Bay current velocity (due to discharge) over time, CPUE calibrations using flow should be done on a ‘date-run’ scale to incorporate these changes in velocity over time. Dividing run catch by current gives an estimate of number of fish/m•s-1, and alters the abundance estimates, particularly among Bays (e.g., note catch differences on April 27 and 28; Figure 4A and B).



**A**

**B**

**Figure 4.** a) Total ‘raw’ catch (number of smolts) in each bay and b) Total smolts calibrated for average daily Bay current velocity (number of smolts/m•s-1). All runs and traps considered.

* Future thoughts: fish/m3/s for each bay (can we get river x-section area to calculate this?)
* Plot sea level change with current velocity change over time?

**Method 3: CPUE adjusted vertically (scale: Depth, 4 levels)**