Operation of DIDSON: Sub-Sampling

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Two Approaches to Estimating Escapement Using a DIDSON

- Escapement estimates:
  - Total census.
  - Sub-sampling.
Total Census or Sub-sample?

- Decision will be influenced by expected run size.
- Estimation error from sub-sample:
  - Error can be estimated in larger populations.
  - Realistically, it may not be possible to estimate error in small populations.
  - Small observational errors in estimating escapement in small populations may be unacceptable.
Sub–Sample of Larger Populations

- Temptation is to conduct a total census.
  - However a total census is not practical and is not the best use of staff time.

- Sub–sampling temporally allows for:
  - An estimate of escapement.
  - Calculation of confidence intervals on the escapement estimate.
  - Evaluation of sub–sample size (number of minutes).
Sub-Sample of Larger Populations

- Assumptions in sub-sampling:
  - There is no “fine scale” variation in fish migration, fine scale being $< 1$ hour.
  - Counts are not biased by undetected fish. Undetected fish being those moving behind obstructions, beyond the range of DIDSON detections, etc.
Confidence intervals for total fish passage estimates with different sampling rates. Solid curves are based on 1\textsuperscript{st} 10 min count, dotted curves are based on 2\textsuperscript{nd} 10 min count.

DIDSON Sampling Effort

Optimized sampling rate at four levels of precision. Values plotted are medians, + 95% confidence intervals.

Net Upstream Migration or Flux of Salmon

\[ F = U - D \]

Where:
- \( F \) = net upstream flux of fish
- \( U \) = upstream detections
- \( D \) = downstream detections
Expanding Net Upstream Flux

\[ F_{xi} = [6x_1, 6x_2, 6x_3, \ldots, 6x_N] \]

Where:  
\( N \) = total number of 1-hour sample periods, and  
\( x_i \) = the net upstream fluxes of fish during 10 minute sampling periods.
Variance of Total Fish Passage Estimate ($F_{\text{hat}}$), or Flux Upstream

$$v(\hat{F}_{xi}) = \frac{N^2 s^2_z}{n_z} (1 - f)$$

Where:  
$N =$ total number of 1-hour sample periods,  
$n_z =$ the total time sampled in hours (sum of subsamples),  
$f =$ the sample fraction ($n_z/N$) and  
$s^2_z =$ the sample variance of the $F_{xi}$ count.
Variance of the Flux Estimator

\[ S_z^2 = \sum_{i=5}^{N} \left( \frac{F_{x_i}/2 - F_{x_{i-1}} + F_{x_{i-2}} - F_{x_{i-3}} + F_{x_{i-4}}/2}{3.5(N - 4)} \right)^2 \]

Where:  
- \( s_z^2 \) = the sample variance of the \( F_{xi} \) count.  
- \( N \) = total number of 1-hour sample periods,  
- \( F_{xi} \) = the estimated net upstream flux of fish during hour \( i \) based on the subsample (10 or 20 minutes).
Net Upstream Migration or Flux of Steelhead

Season

F = U - D  F = U

Escapement

11/18/2010
Cross Section of Redwood Creek DIDSON Site and Occurrences of Fish (below 500 cfs)

Percent of observations:
- 9% at 34 cm
- 4% at 38 cm
- 7% at 49 cm
- 20% at 40 cm
- 20% at 48 cm
- 11% at 60 cm
- 22% at 51 cm
- 6% at 55 cm

Average fish length:
- 34 cm
- 38 cm
- 49 cm
- 40 cm
- 48 cm
- 60 cm
- 51 cm
- 55 cm

<----- East

West ----->
Temporal Migration in Redwood Creek, Nov. 2009 – Jan. 2010

n = 1,149
Size of Fish Migrating in Redwood Creek during Nov. 17 – Jan. 14.

Week of Water Year

Length (cm)

180
150
120
90
60
30
0

7 8 9 10 11 12 13 14 15

Week of Water Year
Discussion and Questions