Fish Entrainment Control at Ballard Locks in 2002

Peter Johnson

MEVATEC Corp.

Acknowledgements

MEVATEC - Kyle Bouchard
Amy Carroll
Adrienne Fox
Jenny Husby
Mark VanderVen

Seattle Dist - Fred Goetz
Chuck Ebel

Locks - John Post
Bill Livermore
Lockmasters

Presentation Outline

- Flume Passage and Relative Guidance Efficiency
- Strobe Light Evaluation
- Large Lock Entrainment

Flume Passage

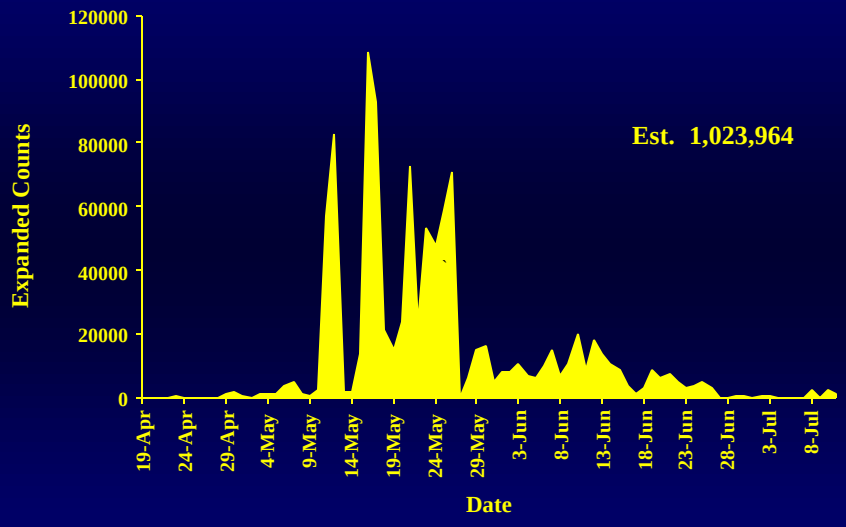
Objectives

- Characterize Run Timing
- Estimate Abundance
- Describe Hourly Trends
- Passage per Water Volume
- Estimate Relative Fish Guidance Efficiency

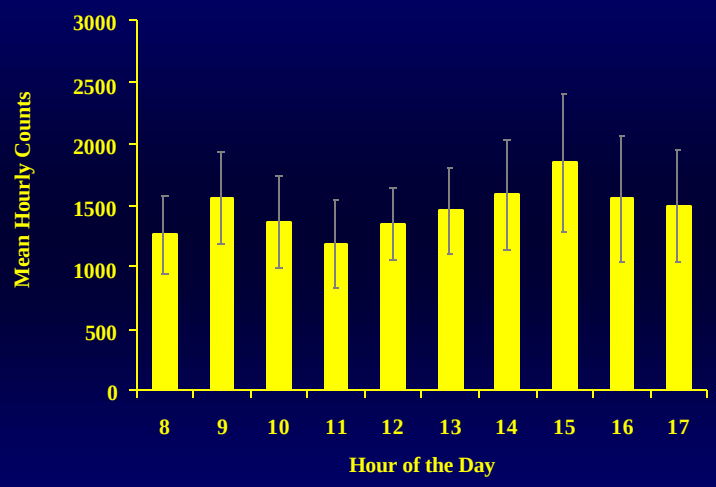
Flume Passage - Methods

- Counting
- Sub-sampling
- Expansions

Flume Passage – Run Timing

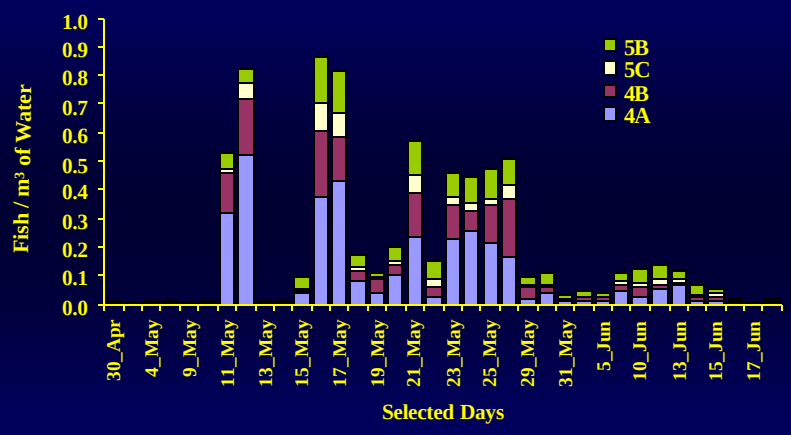


Flume Passage - Hourly



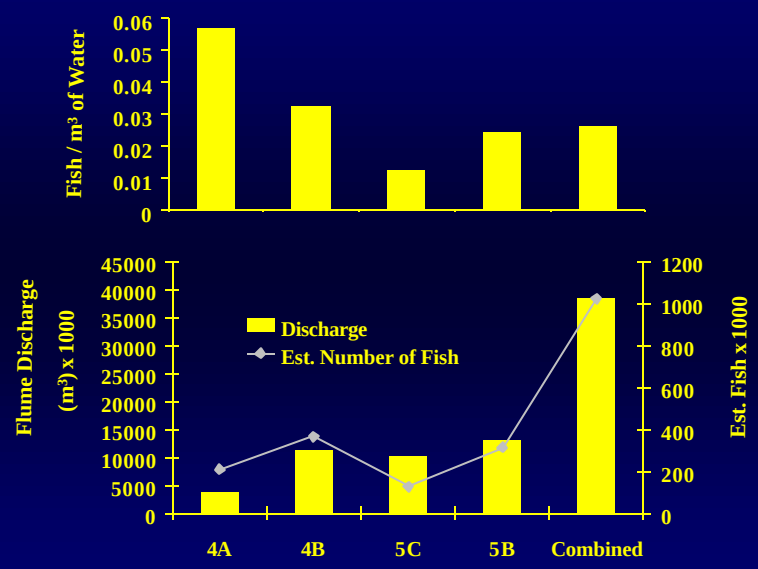
MEVATEC Corp. 7

Fish Passage / Water Volume



MEVATEC Corp. 8

Fish Passage / Water Volume



MEVATEC Corp. 9

RFGE Study

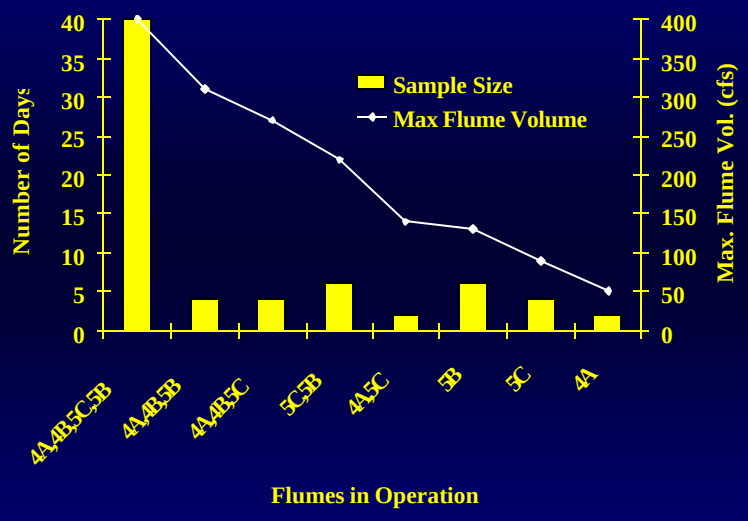
Objective

- Determine Relative Fish Guidance Efficiency of Flumes for Variable Flume Volumes

$$\text{RFGE} = \frac{\text{Flume Passage}}{(\text{Flume Passage} + \text{Culvert Entrainment})} \times 100\%$$

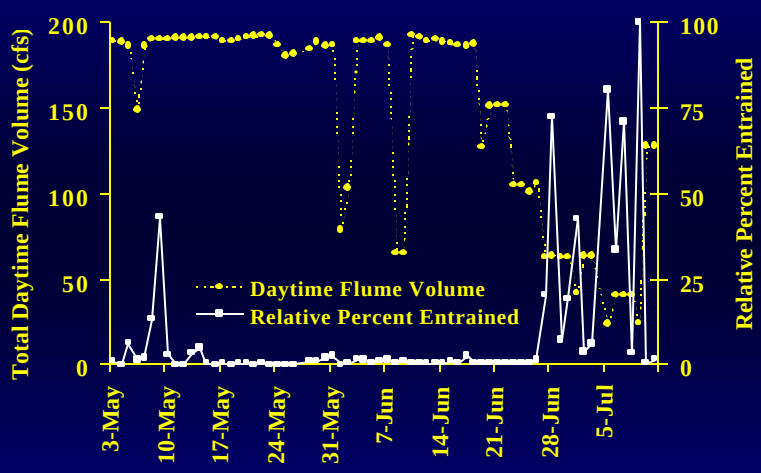
MEVATEC Corp. 10

RFGE Study – Sample Size



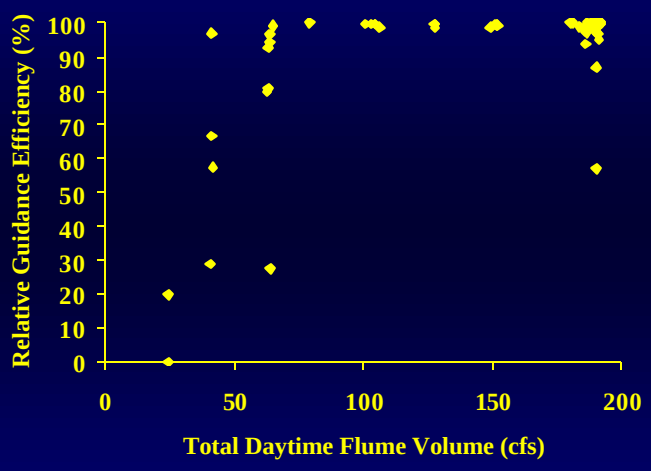
MEVATEC Corp. 11

RFGE - % Entrainment and Vol.



MEVATEC Corp. 12

RFGE vs Flume Volume



Strobe Light Study

Objective: Reduce Entrainment

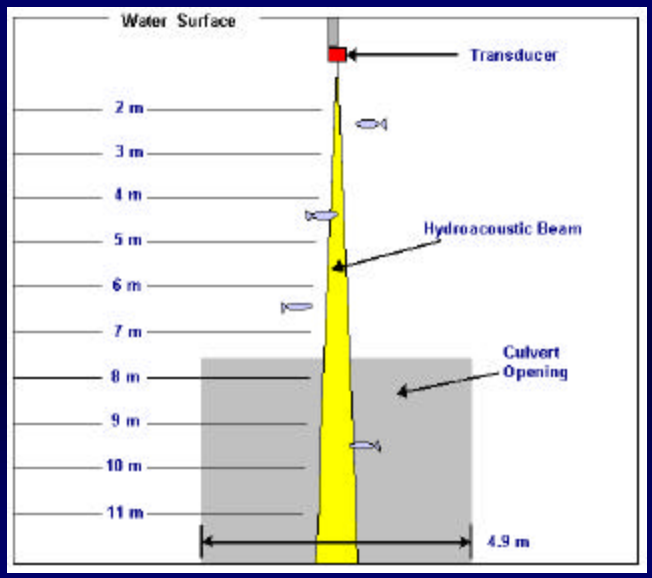
Prior Research at Locks

- Net Pen Tests in 1997 (proof of concept)
- Test of 10 lights around north culvert in 1998

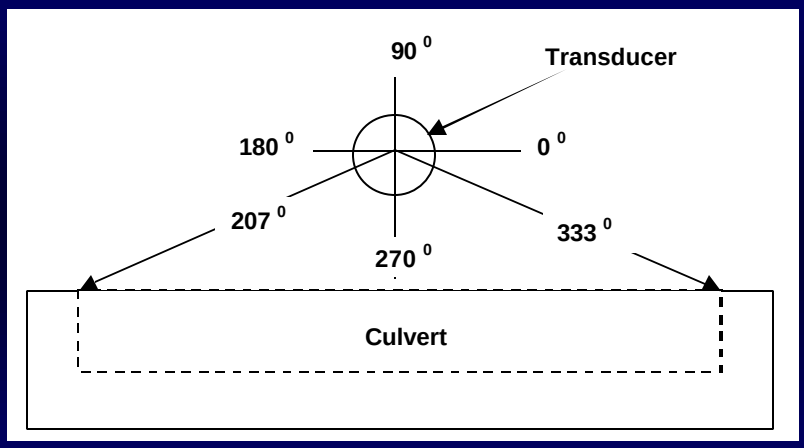
Strobe Light Layout

Strobe Lights

Sampling for Entrainment



Determining Entrainment

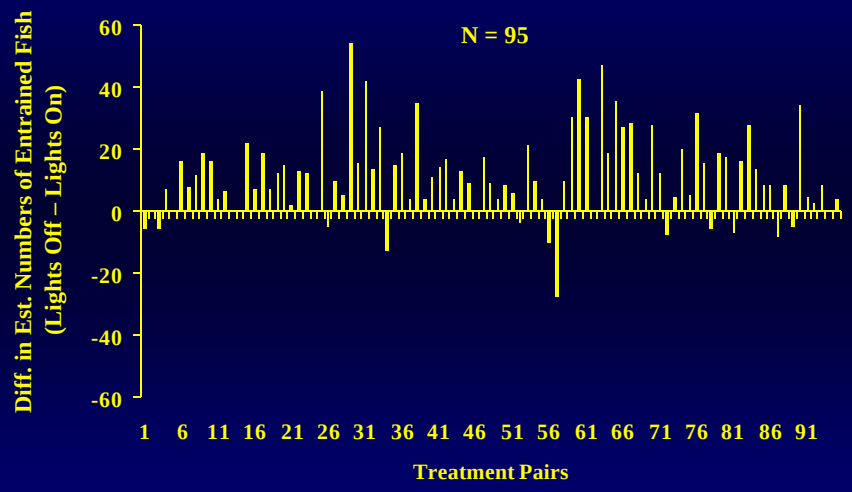


Strobe Light Study Design

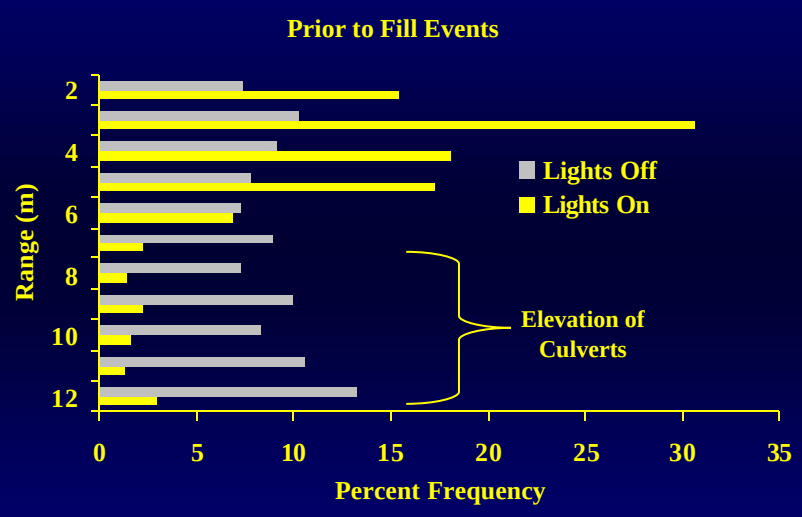
- Paired light-on / light-off tests
- Randomized initial treatment
- No more than 60 min between treatments
- Treatment condition 15 min prior to fill
- Conducted between 0800 and 1700 hrs
- 3 May – 14 June
- Upper lock chamber fills only
- Use of false lockages

Strobe Lights - Results

Entrained Fish: 1,427 Off, 350 On
75% Reduction; P < 0.0001



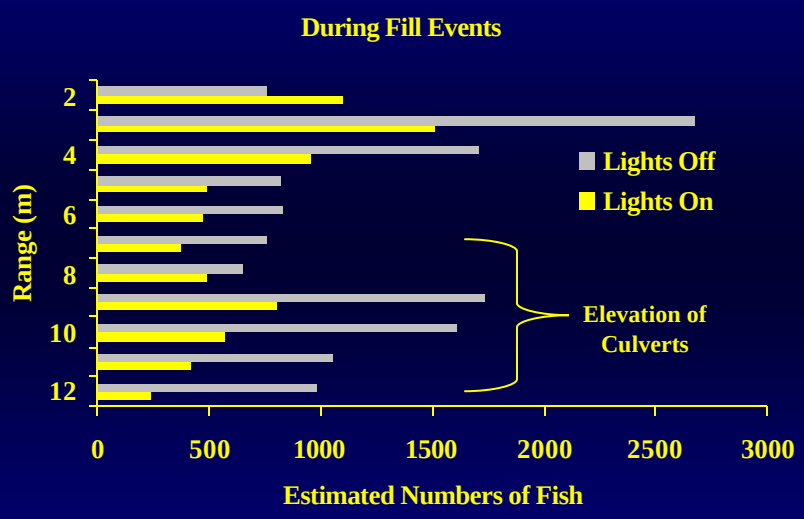
Strobe Tests – Vertical Distribution



MEVATEC Corp.

21

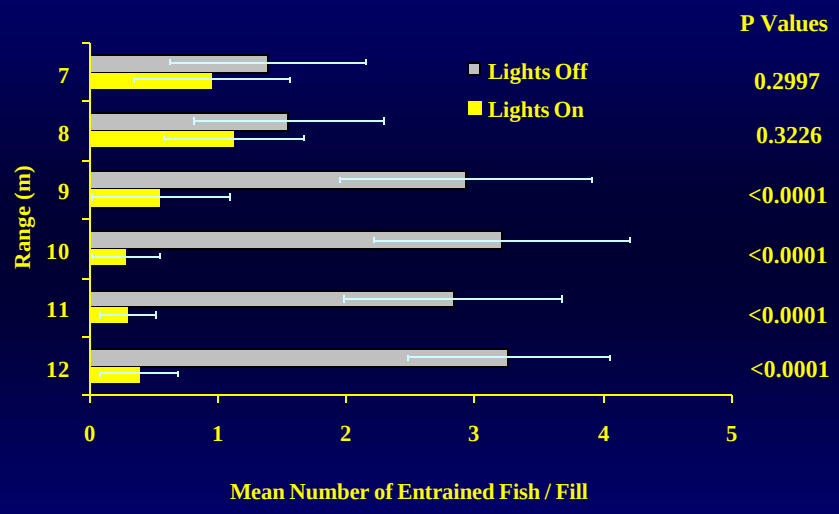
Strobe Tests – Vertical Distribution



MEVATEC Corp.

22

Strobe Tests – Vertical Distribution

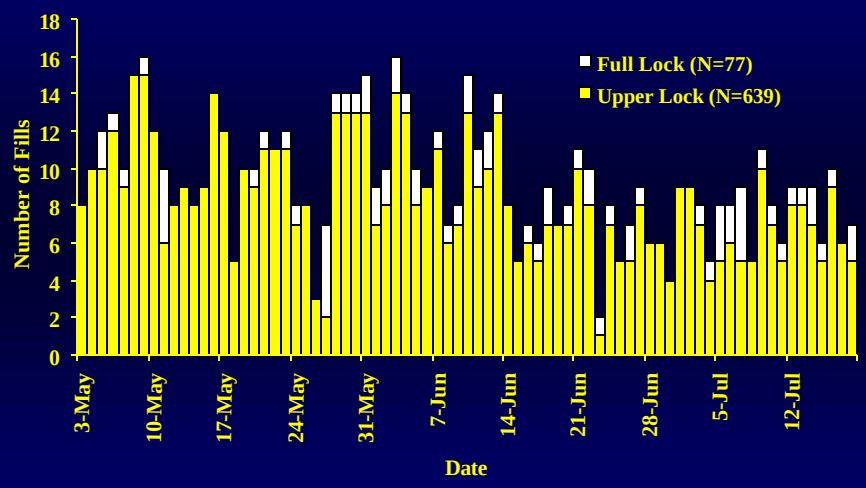


Entrainment

Objectives

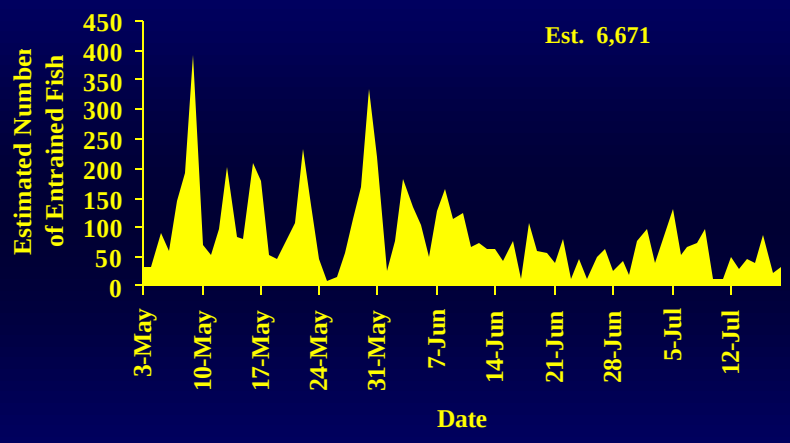
- Estimate daily entrainment through migration period
- Describe entrainment on an hourly basis
- Describe vertical distribution patterns during daytime and nighttime hours

Entrainment – Sample Size



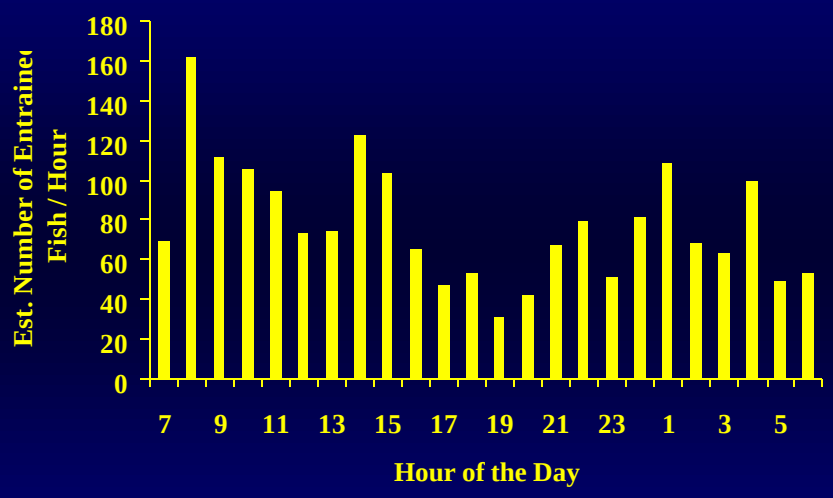
MEVATEC Corp. 25

Entrainment – Run Timing



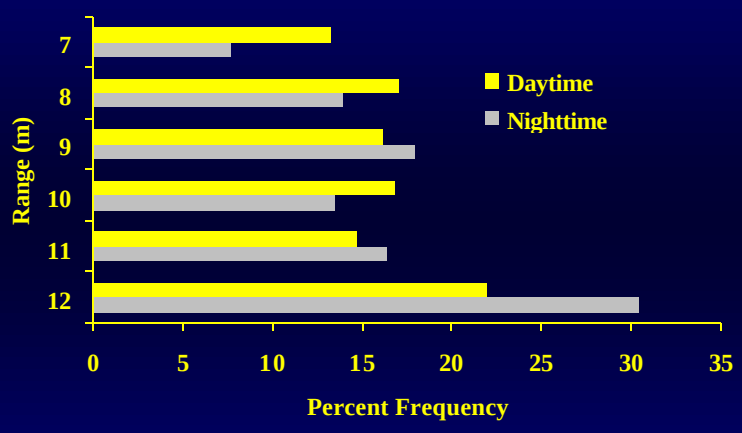
MEVATEC Corp. 26

Entrainment - Hourly



MEVATEC Corp. 27

Entrainment – Vert. Distribution



MEVATEC Corp. 28

Conclusions – Flume Passage

- Based on observer calibrations, it appears that we are underestimating flume passage, and the degree of undercounting varies by flume volume
- It appears that Flume 5C passed fewer fish / water volume as compared to the other flumes
- Based on a limited data set, high values of RFGE can be achieved by discharging 90 to about 150 cfs (aggregate daily) through the flumes

Conclusions
Entrainment and Strobe Lights

- Strobe lights were highly effective in reducing fish entrainment into the large lock filling culverts during periods when sockeye and coho were the predominant out-migrants
- Entrainment was not confined to just daylight hours, and habituation to strobe lights appears to have occurred

Data Gaps - Recommendations

- Accuracy of Flume Counts
- Flume Volume vs RFGE
- Strobe Light Effectiveness during Chinook Out-migration
- Habituation to Strobe Lights, especially at Night