

# Packwood Lake Entrainment Study

*Prepared for:*

Energy Northwest

December 12-13, 2006

# Study Plan Goals

- *Identify relative abundance, age/sex, timing and species composition of fishes entrained, impinged or otherwise affected by the Packwood Lake Hydroelectric intake structure.*

# Study Plan Objectives

- *Determine species relative abundance, age/size, timing and composition at the intake structure.*
- *Evaluate the effectiveness of the Project's screens in terms of protecting fish.*
- *Assess the potential entrainment or impingement impacts from the lake elevation and Project flow fluctuations.*
- *Develop a rule curve for lake level elevation and diversion rate, since approach velocities may exceed the state criteria of 0.33 fps at some operating scenarios.*

# Study Area

- The study is the vicinity of the intake structure for the Packwood Lake Hydroelectric Project.

# ***Methods – Engineering Criteria and Hydraulic Data***

- Energy Northwest provided:
  - Engineering designs of the intake structure
  - Hydraulic information related to
    - lake levels
    - project operational flows
    - lake inflows during this period.
  - March – September 2006

# ***Methods – Approach Velocities at the Intake***

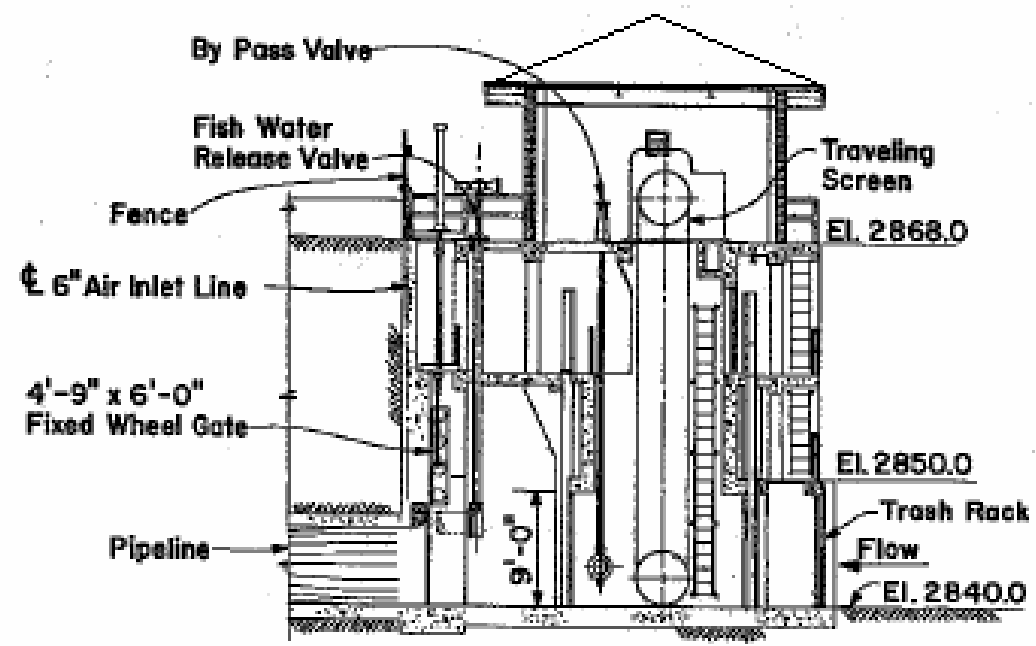
- Acoustic Doppler Current Profiler (ADCP)
  - Range of Lake Elevations
  - Range of Flows
- Rating Curve for
  - Lake Elevations
  - Plant Operating Flows

# ***Methods – Fisheries Investigations***

- Fish Behavior at:
  - Intake Structure
    - Experimental , variable-mesh gill net
  - Trash Screens
    - Video Camera
- Record of Impingement on Trash Screens:
  - Date
  - Species/Number/Size
  - Screen

# ***Results – Engineering Criteria and Hydraulic Data***

- Screen Mesh Size: 4.3 mm X 4.3 mm
- 2 Screens: Each 9 Ft Wide, Up to 28 Ft Tall
  - Base = 2840 ft MSEL
  - Area at Lake Elevation 2857 = 306 ft<sup>2</sup>



LONGITUDINAL SECTION

INTAKE STRUCTURE

# Lake Levels and Operational Flows for Packwood Lake Hydroelectric Project

March - September, 2006

| Month | Day | Lake Level | Plant Flow | Fish Flow | Inflow | Mean Velocity |
|-------|-----|------------|------------|-----------|--------|---------------|
| March | 1   | 2857.53    | 63         | 3.16      | 55     | 0.20          |
|       | 2   | 2857.48    | 62         | 3.16      | 47     | 0.20          |
|       | 3   | 2857.40    | 53         | 3.33      | 49     | 0.17          |
|       | 4   | 2857.37    | 43         | 3.29      | 46     | 0.14          |
|       | 5   | 2857.37    | 44         | 3.21      | 52     | 0.14          |
|       | 6   | 2857.35    | 55         | 3.20      | 43     | 0.18          |

Figure 3-1. Packwood Lake Monthly Elevations, 2006

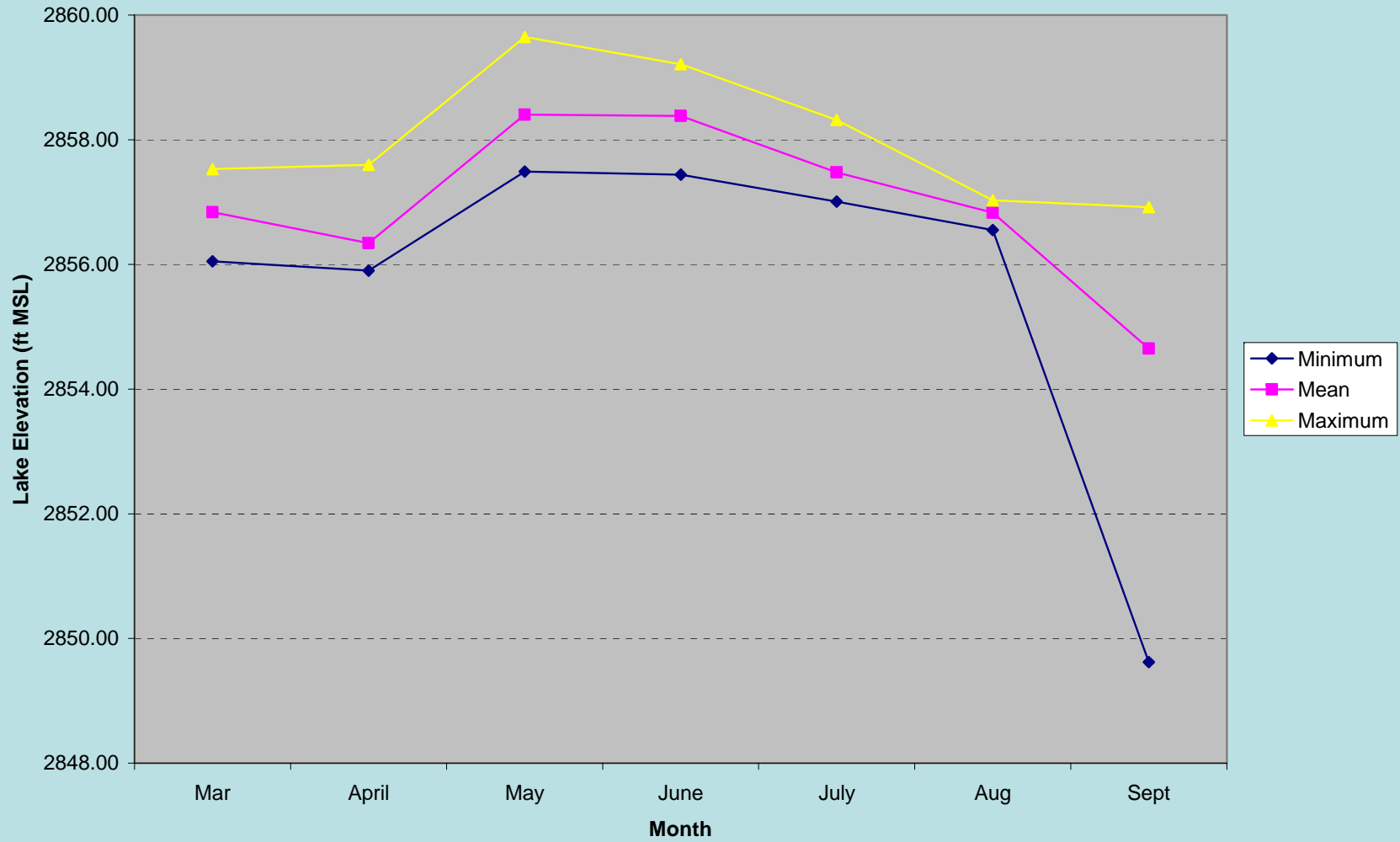


Figure 3-2. Mean Daily Lake Levels (ft)

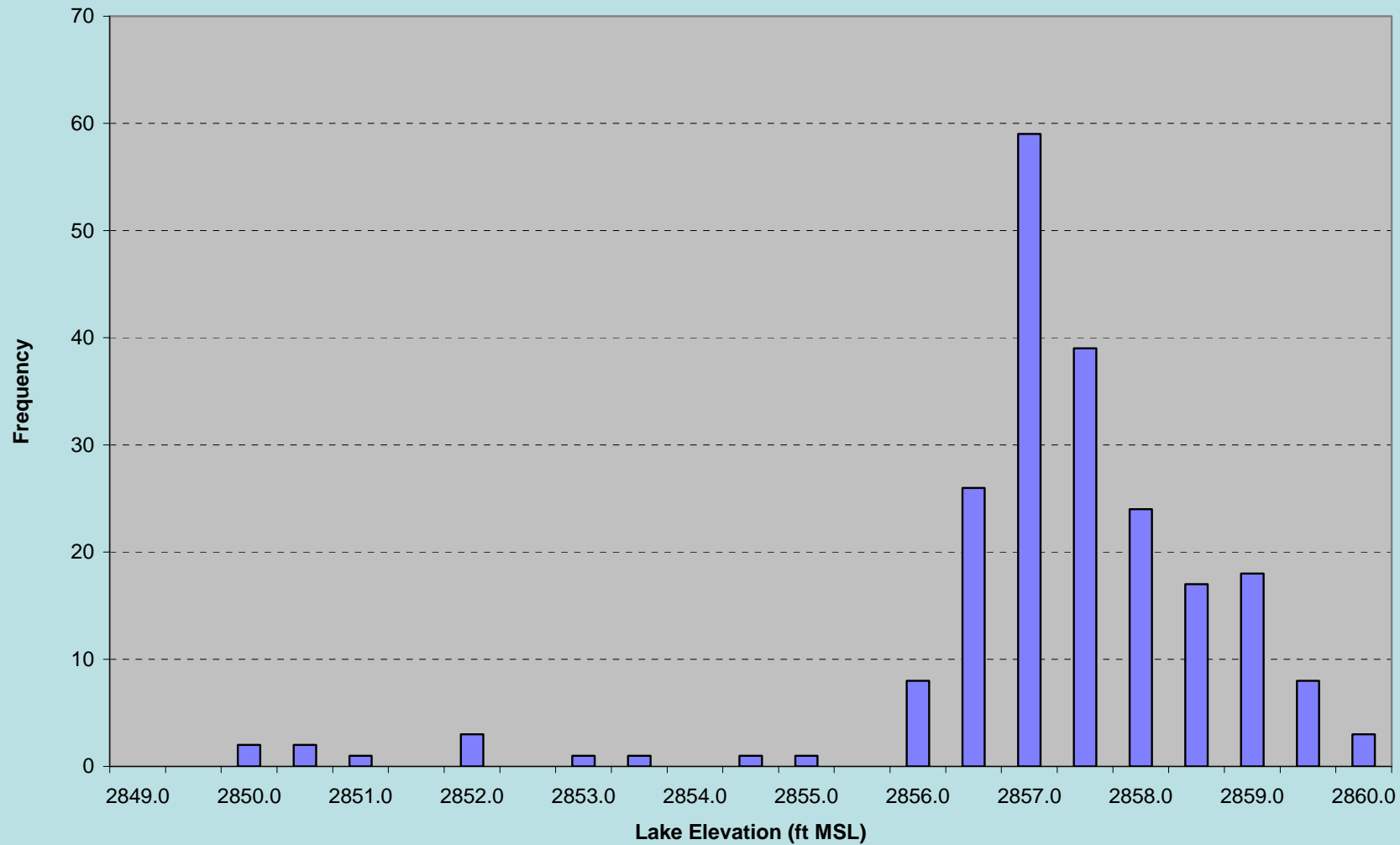


Figure 3-3. Monthly Plant Flows, Packwood Lake Project, 2006

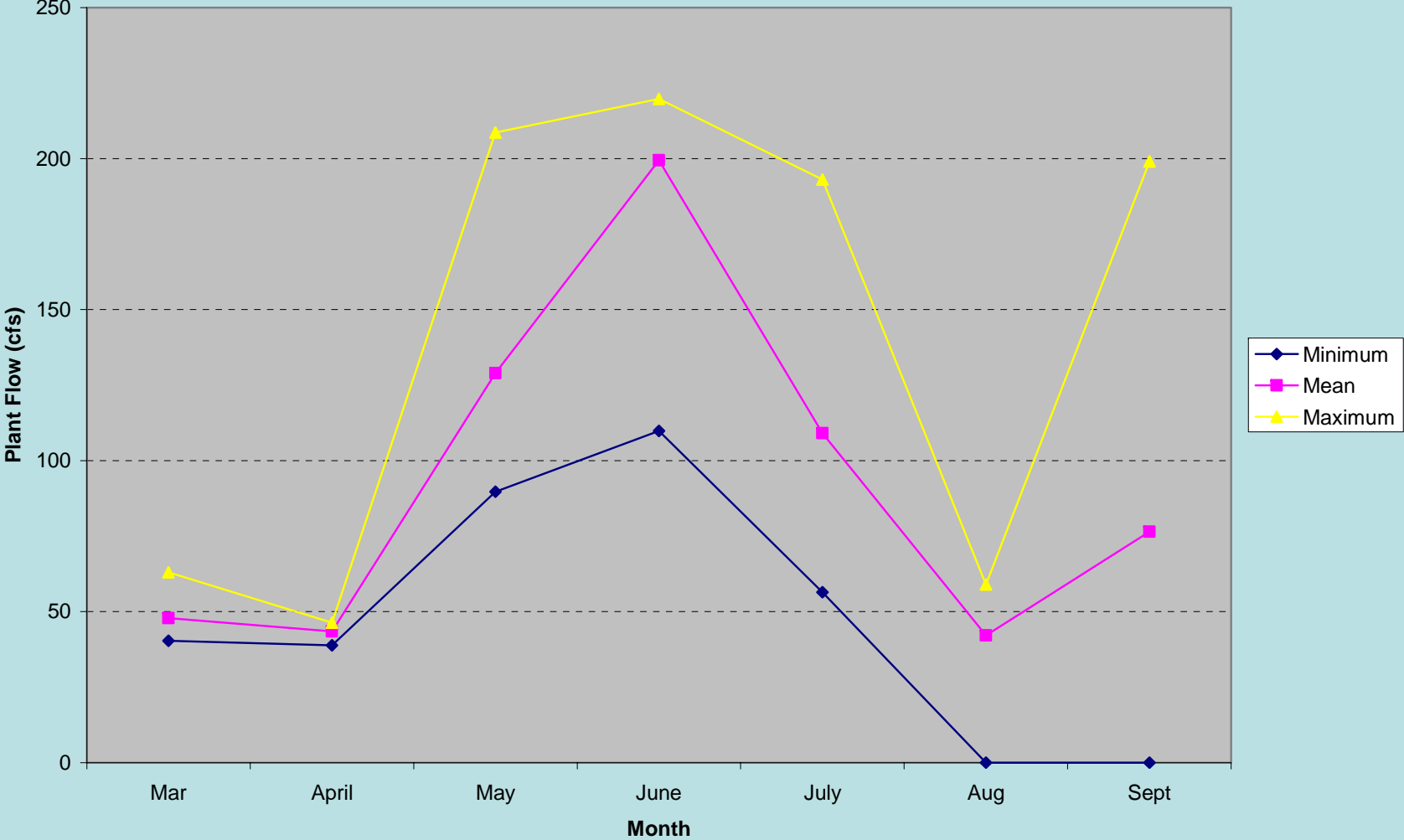


Figure 3-4. Packwood Lake Daily Plant Flow (cfs)

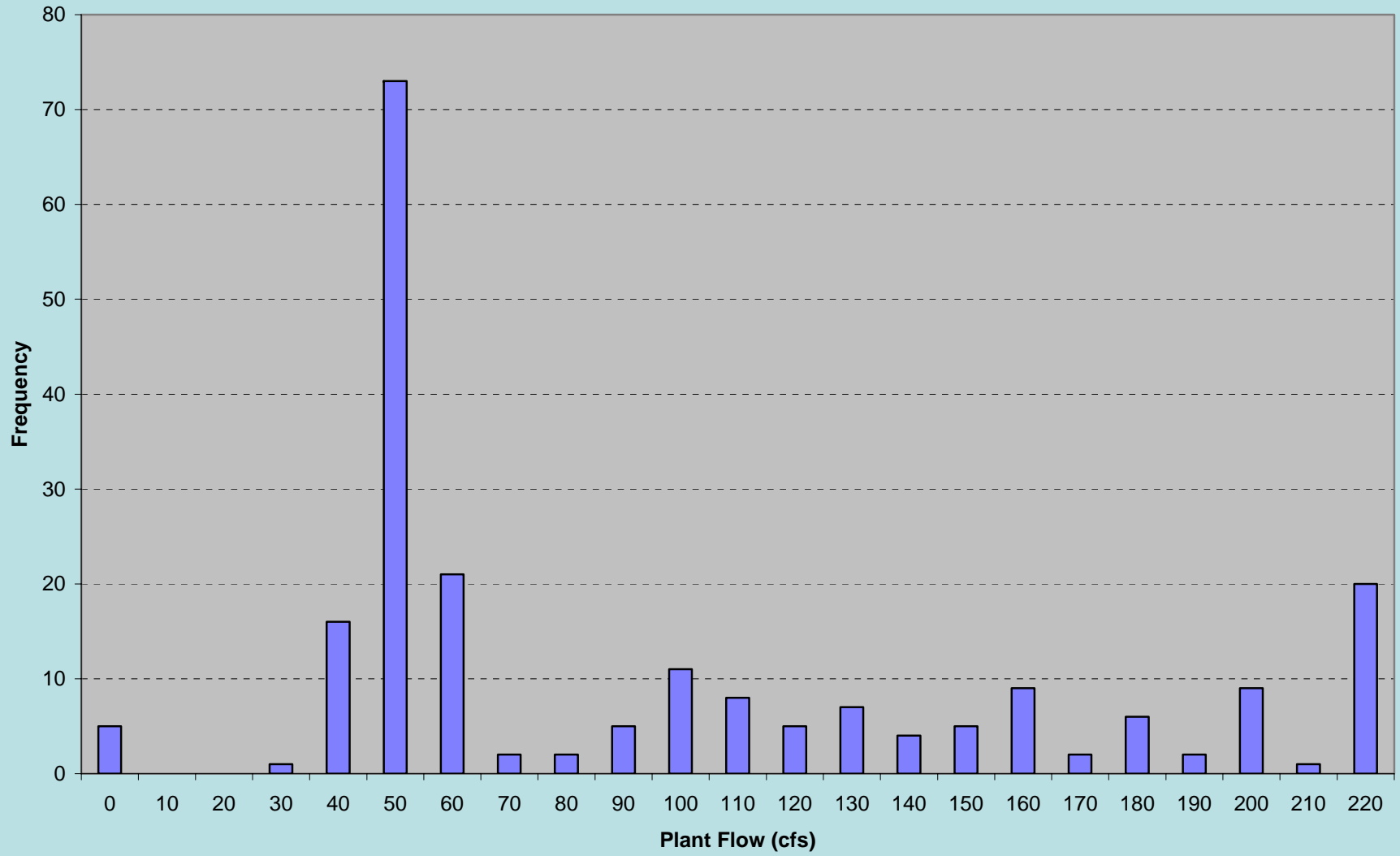


Figure 3-5. Monthly Inflow for Packwood Lake, 2006

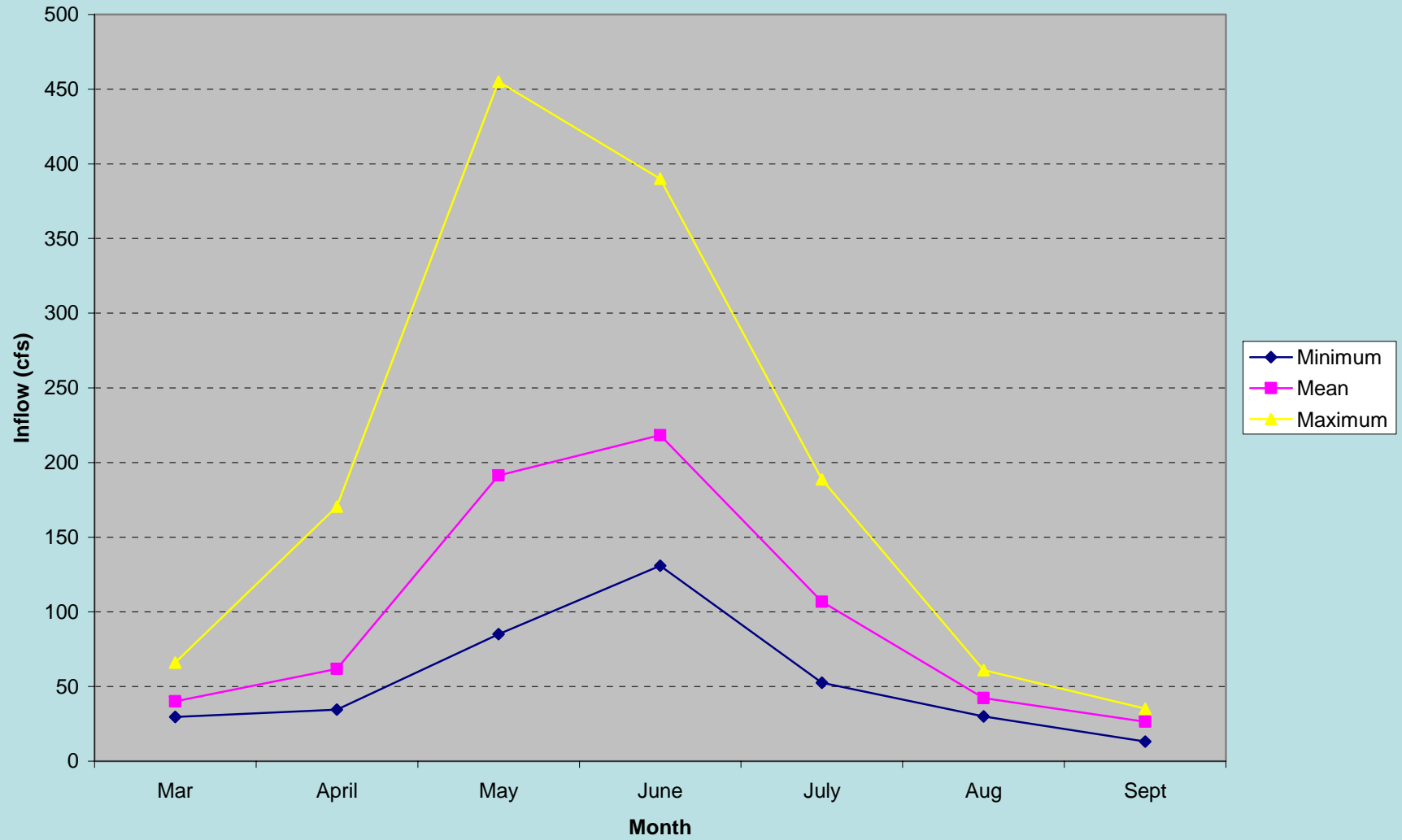


Figure 3-6. Mean Screen Velocities at Packwood Lake Intake Structure

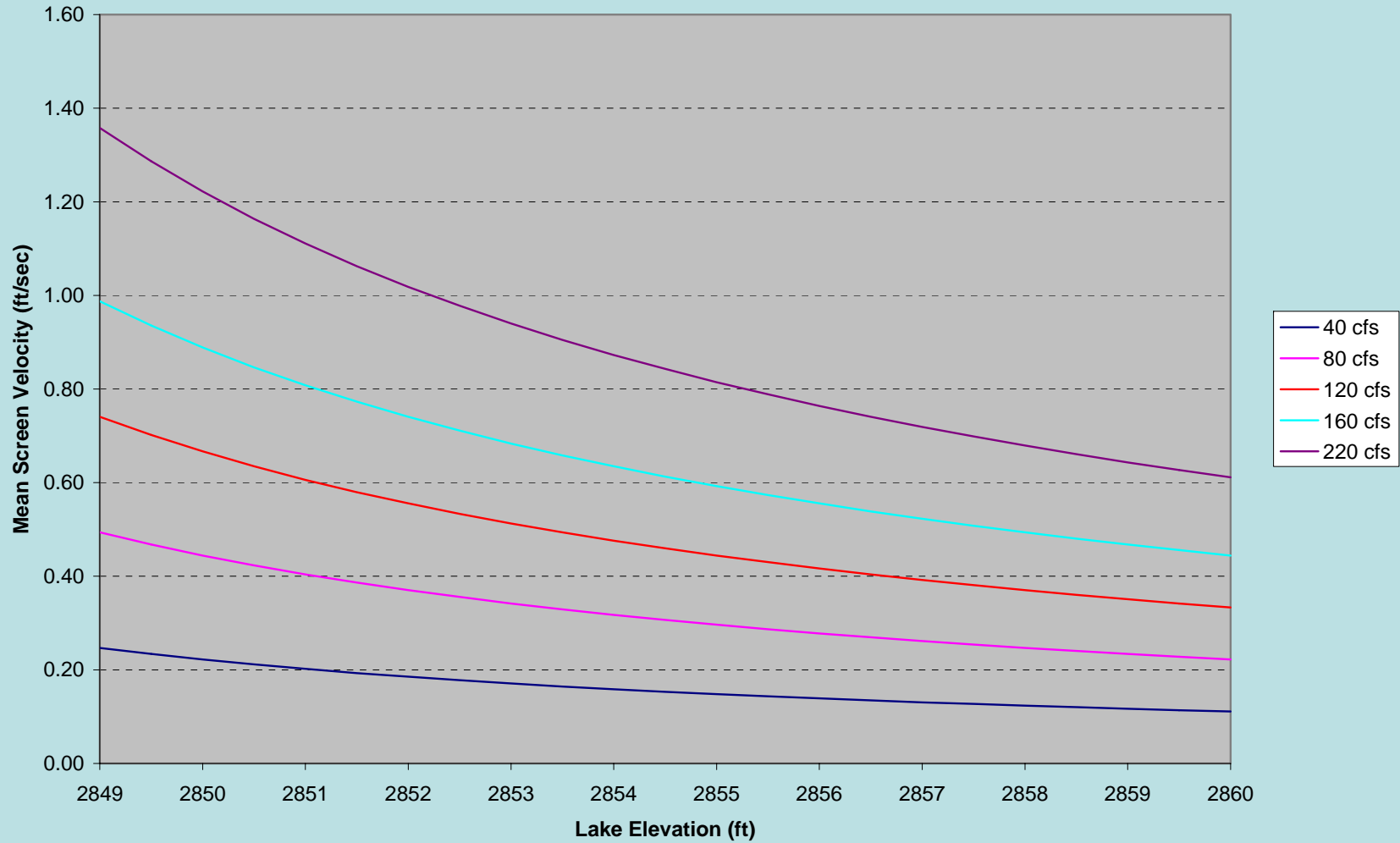


Figure 3-7. Mean Screen Velocities at Packwood Lake Intake Structure, 2006

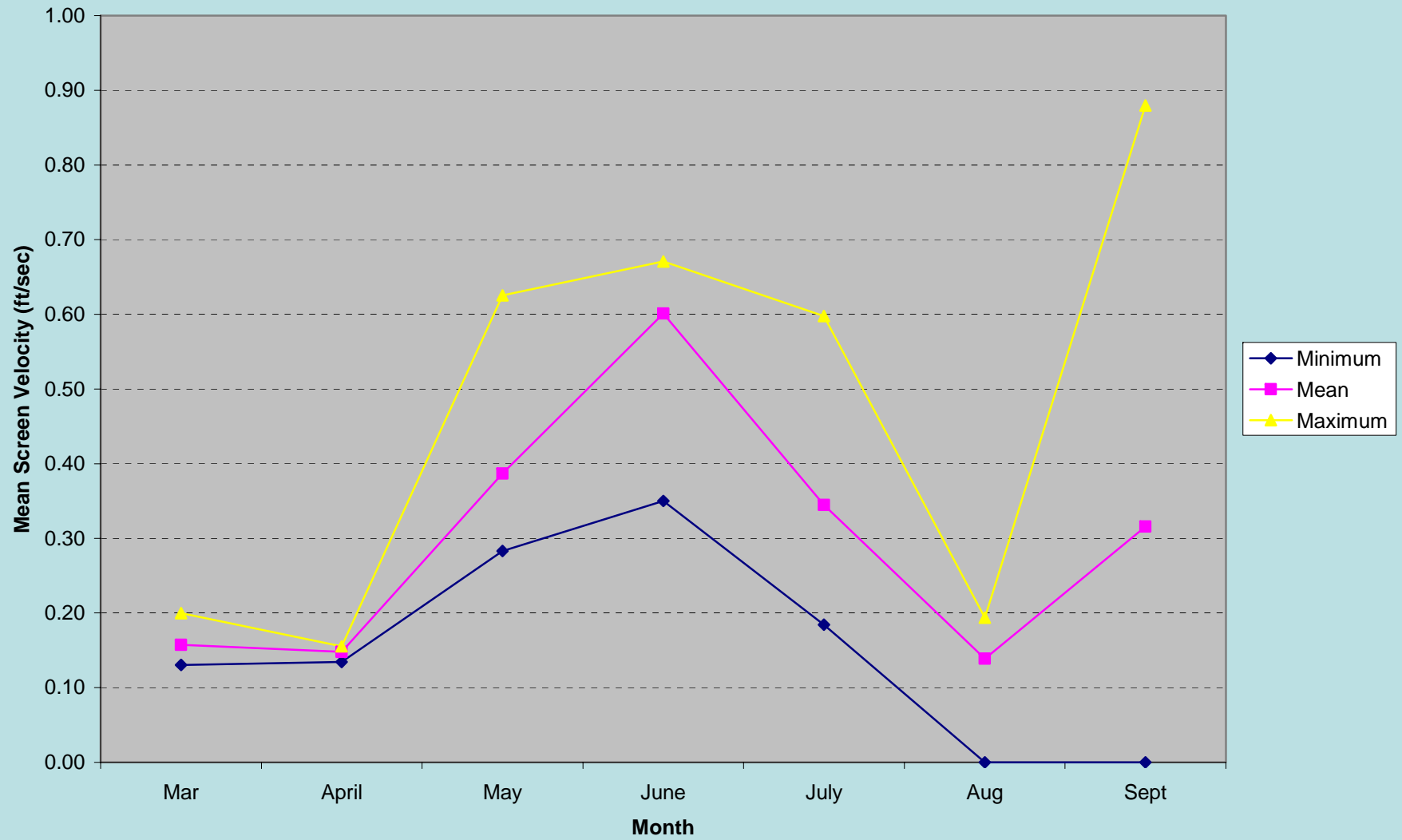
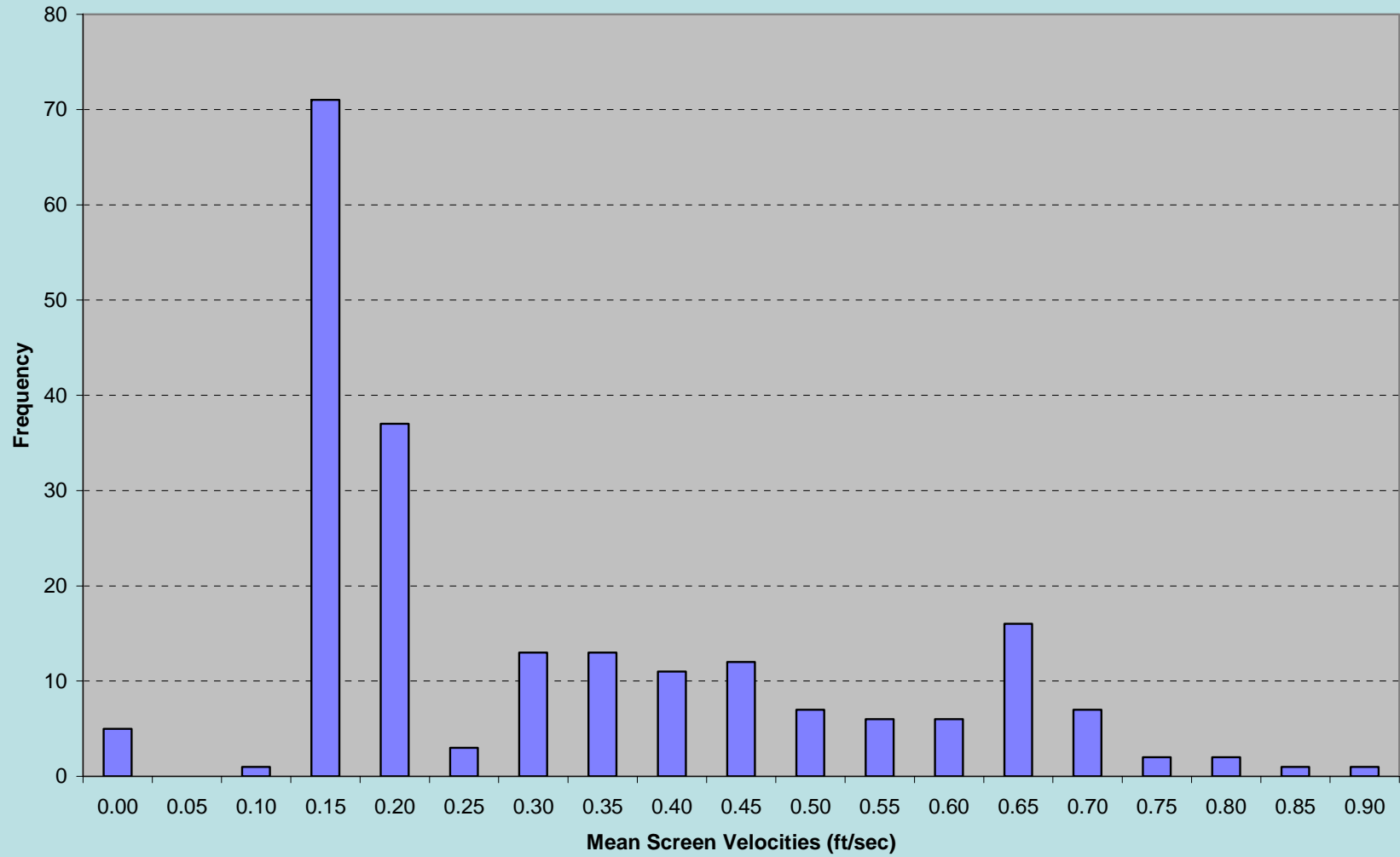
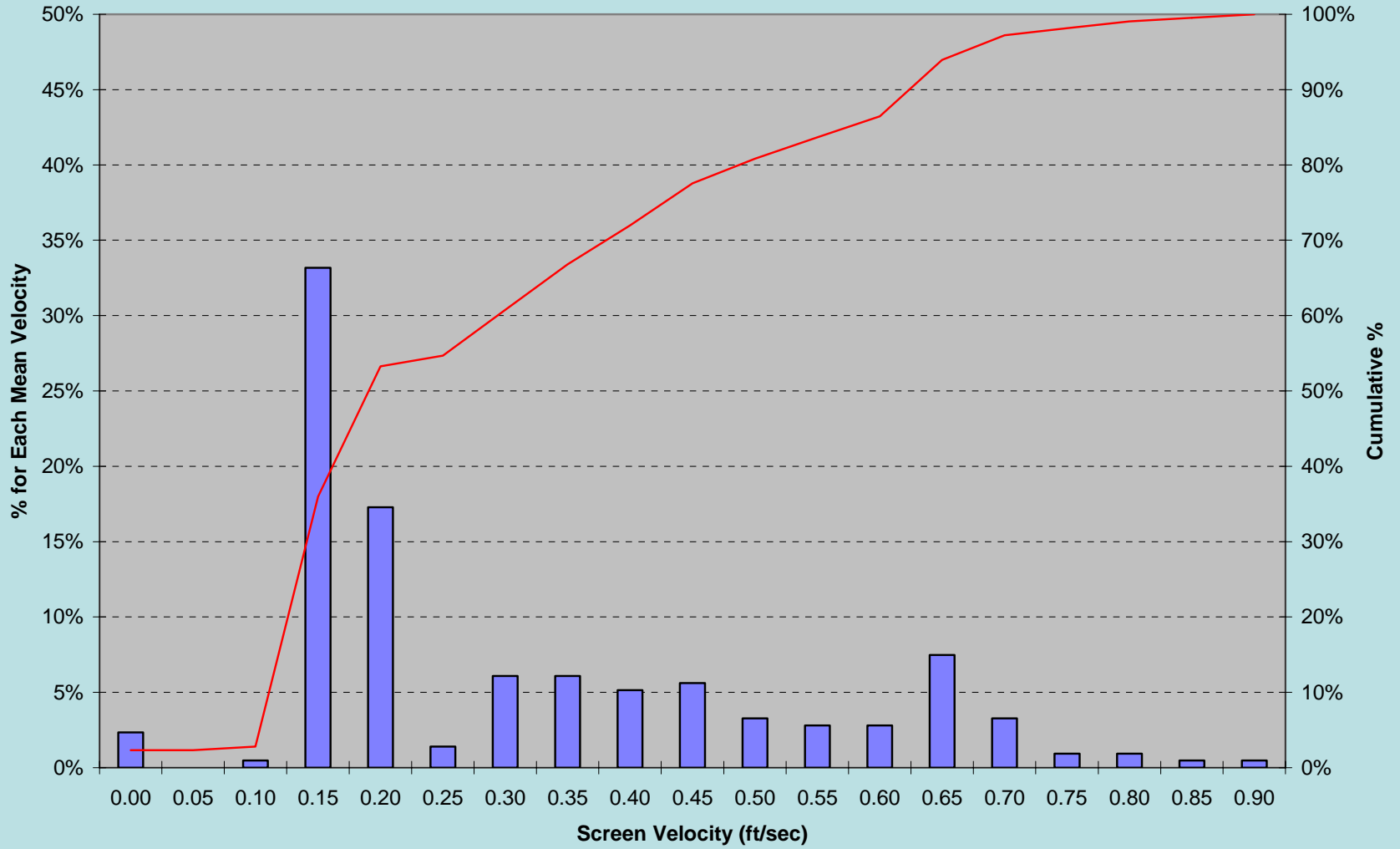


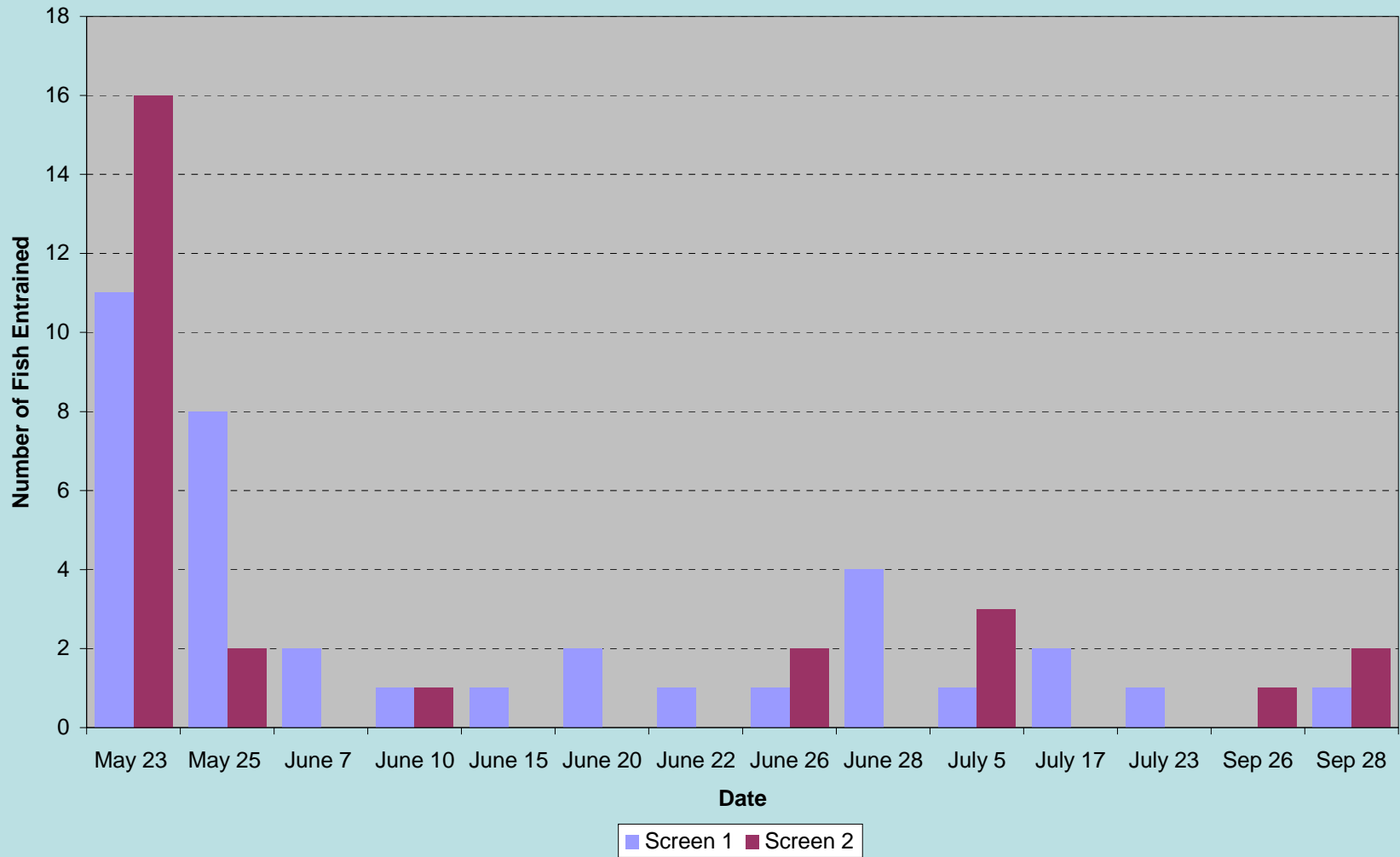
Figure 3-8. Mean Screen Velocities at Packwood Lake, 2006



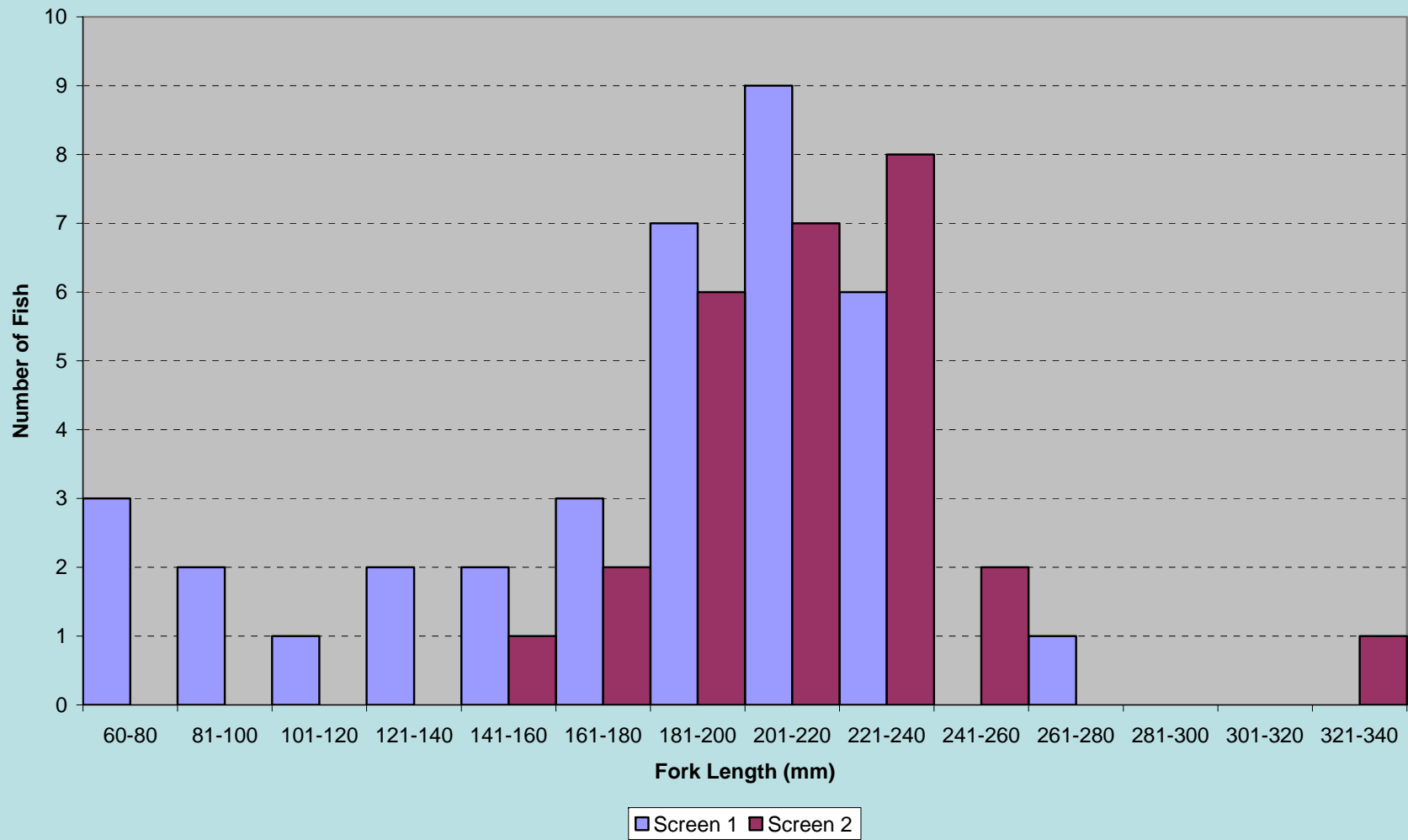
**Figure 3-9. Screen Velocities at Packwood Lake Intake Structure**



**Figure 3-10. Packwood Lake Entrainment at Intake Screens  
(2006)**



**Figure 3-11. Packwood Lake Entrainment Data  
(2006)**



**Table 3-2**  
**Fish Captured in Experimental Gillnet at Packwood Lake 2006**

| <b>•Date</b> | <b>Species</b> | <b>Length (mm)</b> |
|--------------|----------------|--------------------|
| June 29      | Rainbow trout  | 214                |
| June 30      | Rainbow trout  | 60                 |
| July 1       | Rainbow trout  | 135                |
| July 19      | None           |                    |
| July 20      | None           |                    |
| August 7     | None           |                    |
| August 8     | None           |                    |
| August 23    | None           |                    |
| August 24    | None           |                    |
| September 10 | None           | -                  |
| September 11 | None           |                    |

# *Exceptions to Study Plan*

- Access, snow and high flows prevented starting the Study as Planned:
  - Screen monitoring March – mid May
  - Net in front of intake structure March – June (high flows and debris)
  - Debris prevented ADCP until mid-July. After this date, flows and lake elevations were relatively constant, making readings redundant
  - Debris, low visibility made video cameras of limited use

# *2007 Recommendations*

- Early portions of study be re-initiated in 2007 (weather and conditions permitting)
  - Screen monitoring March – June
  - ADCP measurements at variety of lake elevations and plant flows March – June
  - Reattempt video taping March – June
  - Gillnetting in front of intake March - June