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Asking the Fish: Using Acoustic Telemetry Data (2008-2012) to Identify Safest Operating Conditions for Juvenile Salmonid Passage at Bonneville Dam

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US Army Corps of Engineers® Portland District

ERDC Engineer Research and Development Center

Introduction

- Bonneville Dam (rkm 234)
  - Powerhouse 1 (B1)
    - 10 minimum gap runner turbines
    - Sluiceway
    - No in-turbine screens
  - Spillway
    - 18 spillbays
      - Bays 1-3, 16-18 modified deflectors
      - Bays 4-15 unmodified deflectors
  - Powerhouse 2 (B2)
    - 8 turbine units
    - Corner collector
    - Submerged traveling screens

Current Operations

- B2 operates at low to mid range of 1% peak efficiency
  - Improve conditions for guided fish in the gatewell
    - May result in unfavorable conditions for turbine passed fish
- B1 increase flow to offset reduced discharge at B2
  - Compare survival within to above the 1% operating range
    - Need to operate outside of upper 1% operating range
- Spillway 85,000-120,000 cfs (variable survival)
  - Erosion of stilling basin and ogees in several spill bays and accumulation of rock may be affecting survival

Background

- Survival studies using the Juvenile Salmon Acoustic Telemetry System (JSATS) where conducted at Bonneville Dam to evaluate passage and survival
- Between 2008 and 2012, 73,549 juvenile Chinook salmon and steelhead were surgically implanted with JSATS acoustic micro-transmitters and released upstream of Bonneville Dam
- Bonneville Dam was equipped with JSATS cabled receiver arrays for detection and route of passage determination
- Autonomous receivers were deployed downstream for estimating survival rates

Objectives

- Analyze 2008-2012 JSATS and operations data to examine survival rates for juvenile salmonids at BON

  - B2 Turbine Survival Comparison:
    - Examine survival for fish passing turbines operating across the 1% peak efficiency range

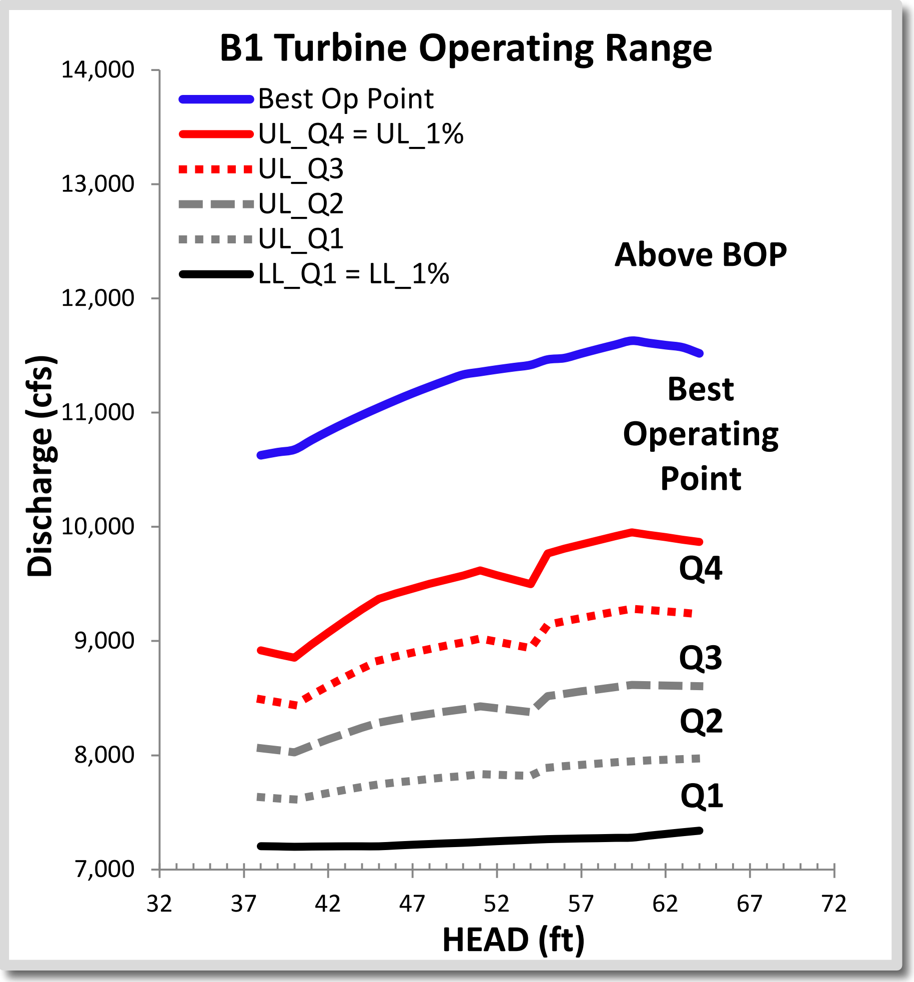
  - B1 Turbine Survival Comparison:
    - Examine survival for fish passing turbines operating within the 1% peak efficiency range and above the upper limit of the 1% operating range

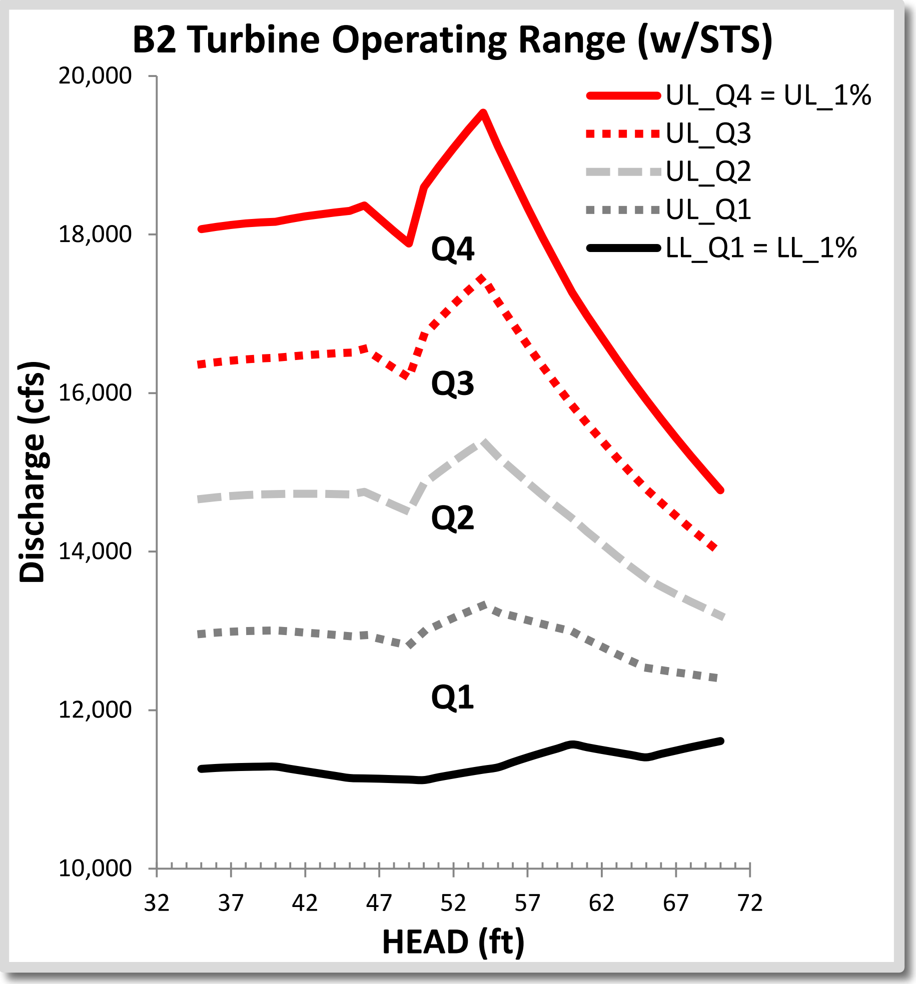
  - Bonneville Spillway:
    - Examine spillway survival by spillbay with focus on those bays where erosion of the ogee or stilling basin immediately downstream had occurred

Methods

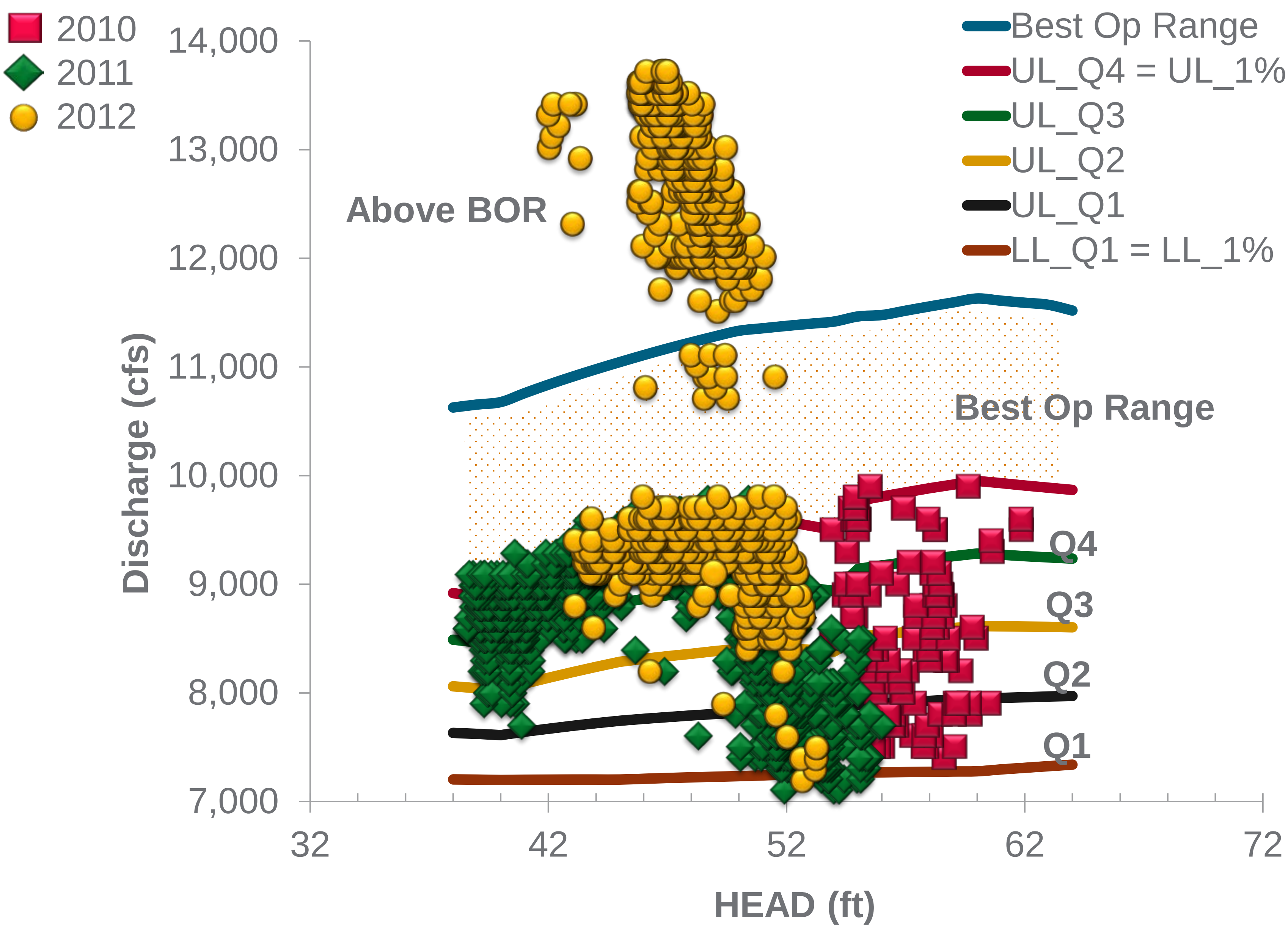
- B1 turbines
  - Lower quarter of 1% efficiency (Q1)
  - Lower middle quarter of 1% efficiency (Q2)
  - Upper middle quarter of 1% efficiency (Q3)
  - 1% of peak efficiency (Q4)
  - Best operating point/range (BOP)
  - Above best operating point to generator limit (ABOP)
- B2 turbines
  - Lower quarter of 1% efficiency (Q1)
  - Lower middle quarter of 1% efficiency (Q2)
  - Upper middle quarter of 1% efficiency (Q3)
  - 1% of peak efficiency (Q4)
- BON spillway
  - By bay
  - Group bays

Methods: B1 and B2 Binned Operating Ranges

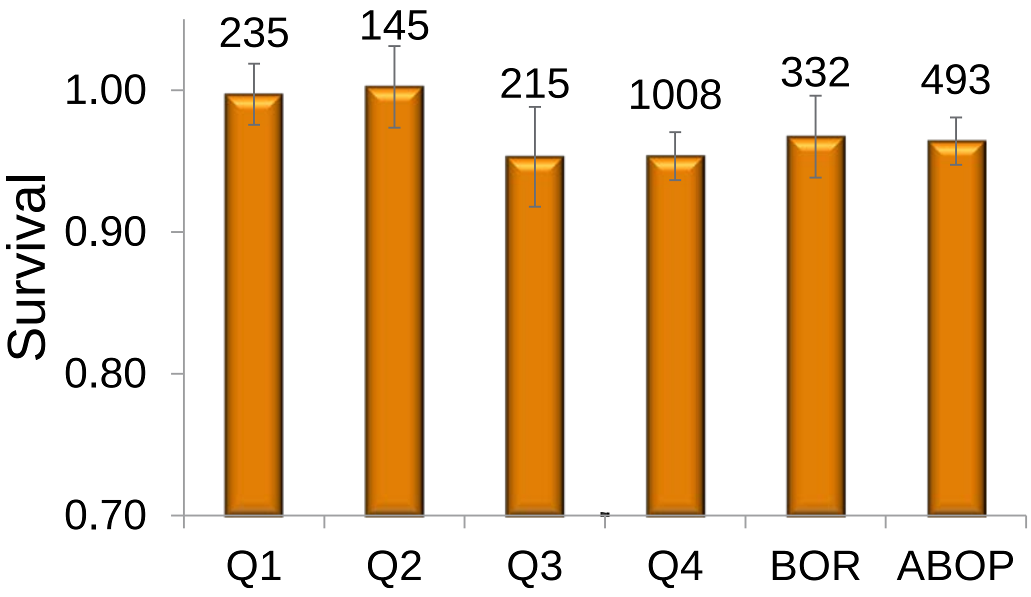


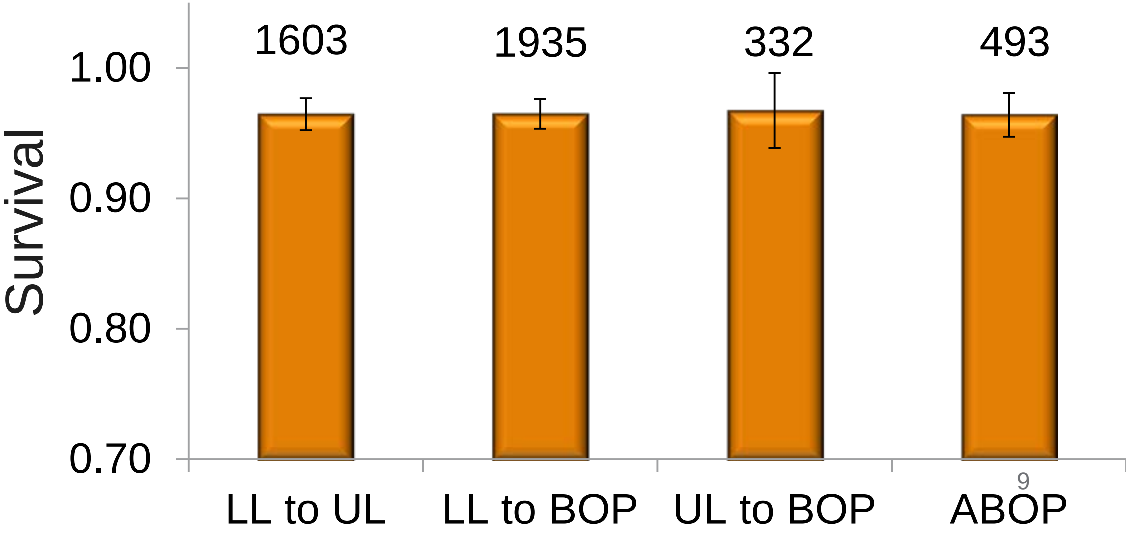


Analyses: BON
B1 CH1 Passage Distribution



Analyses: BON
B1 CH1 Survival by Operating Condition





Analyses: BON
B1 STH Passage Distribution

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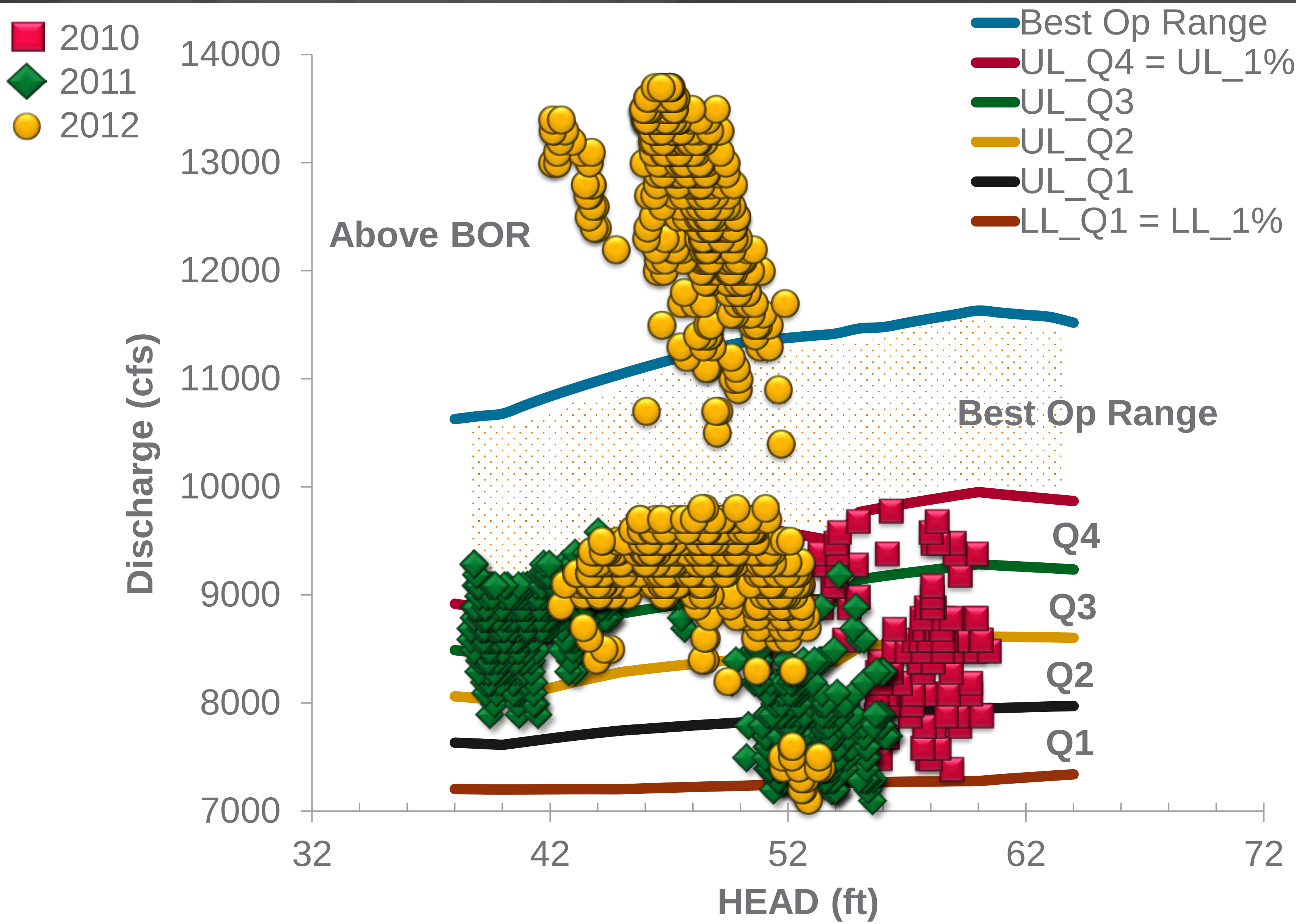
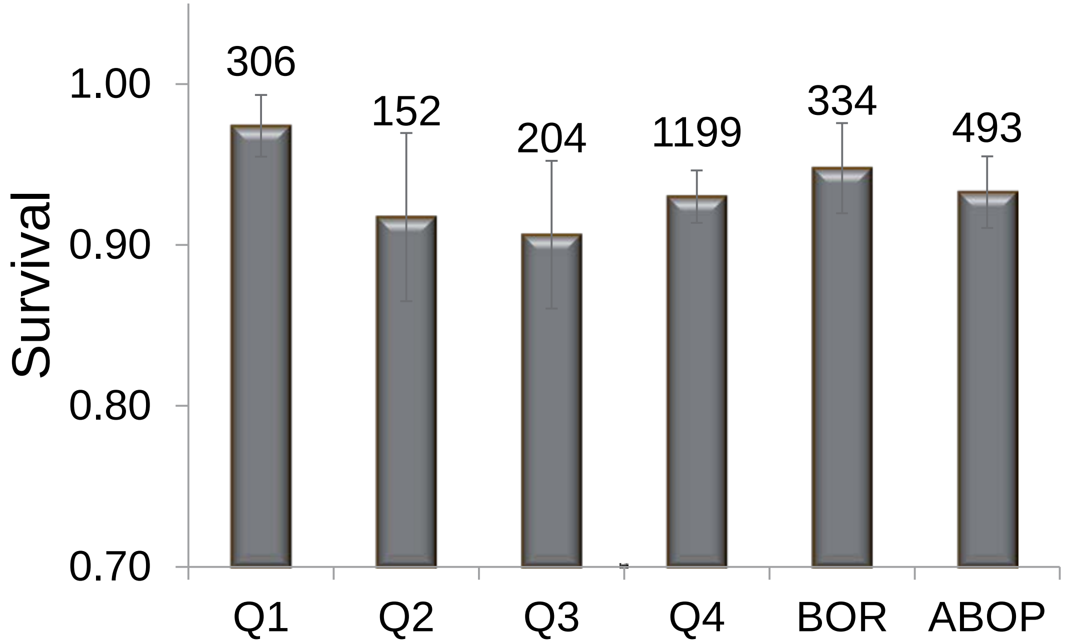
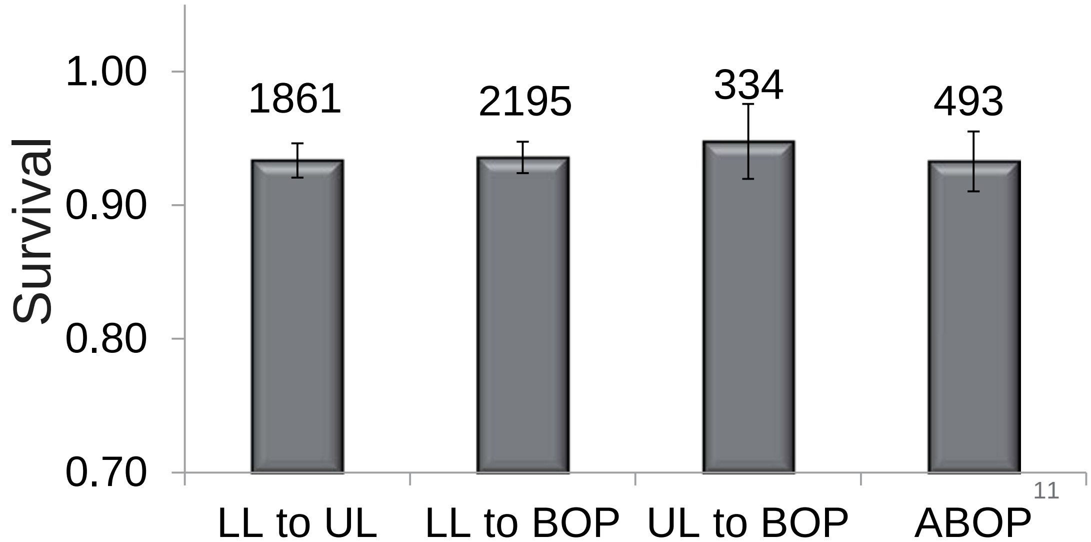


Analyses: BON
B1 STH Survival by Operating Condition





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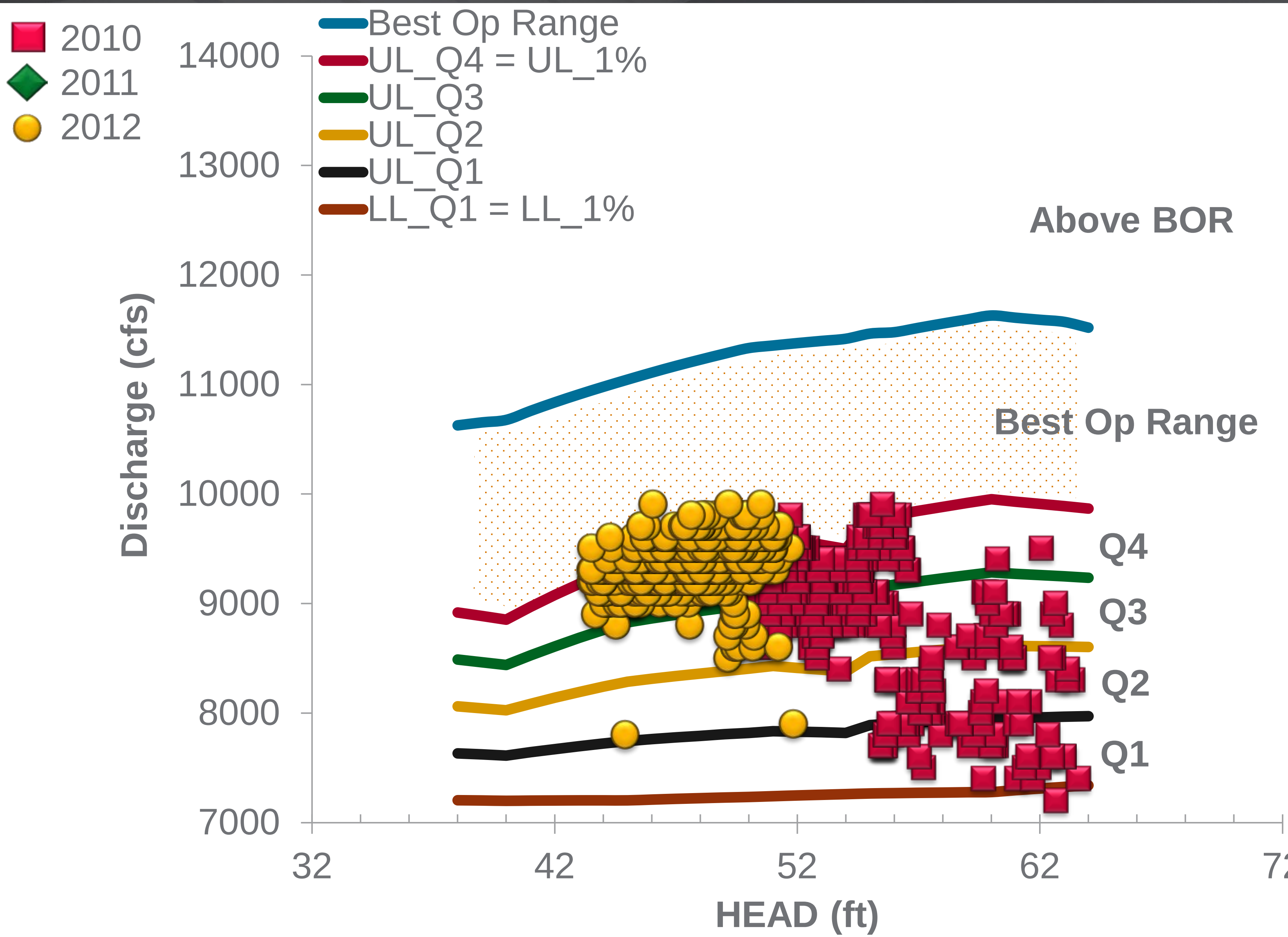
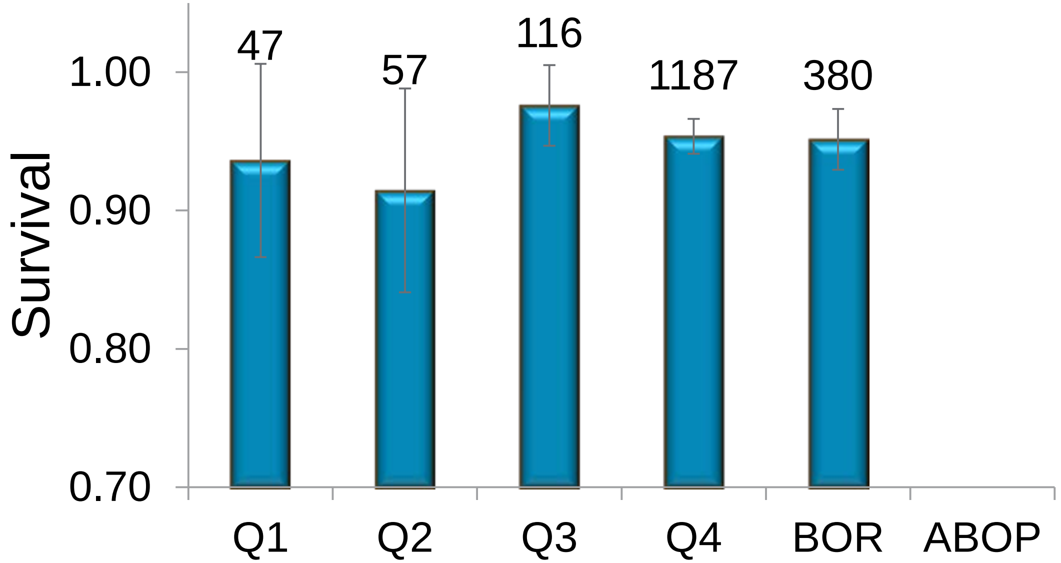
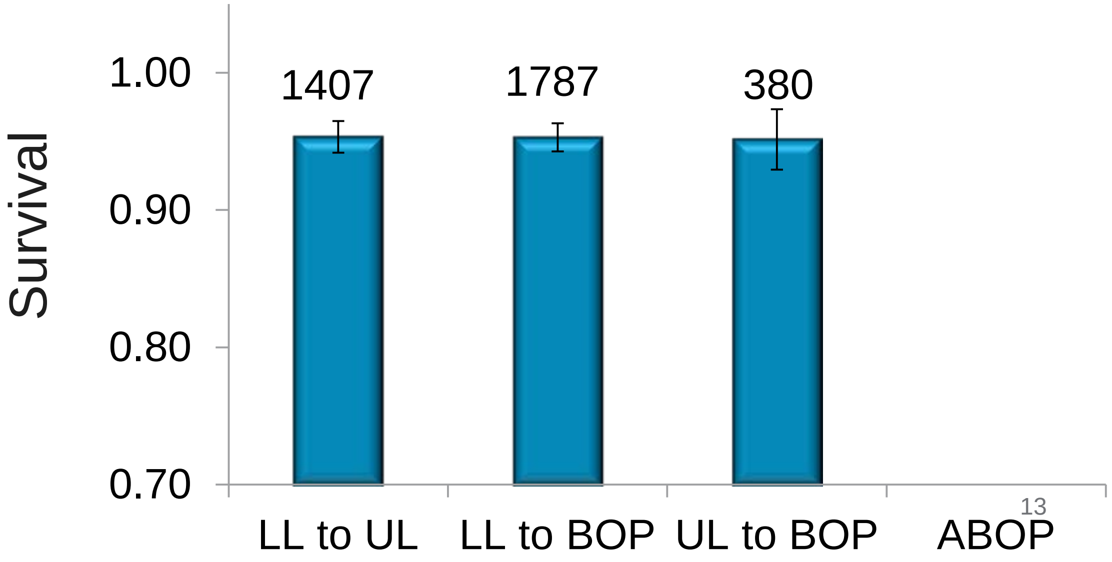
B1 CH0 Passage Distribution

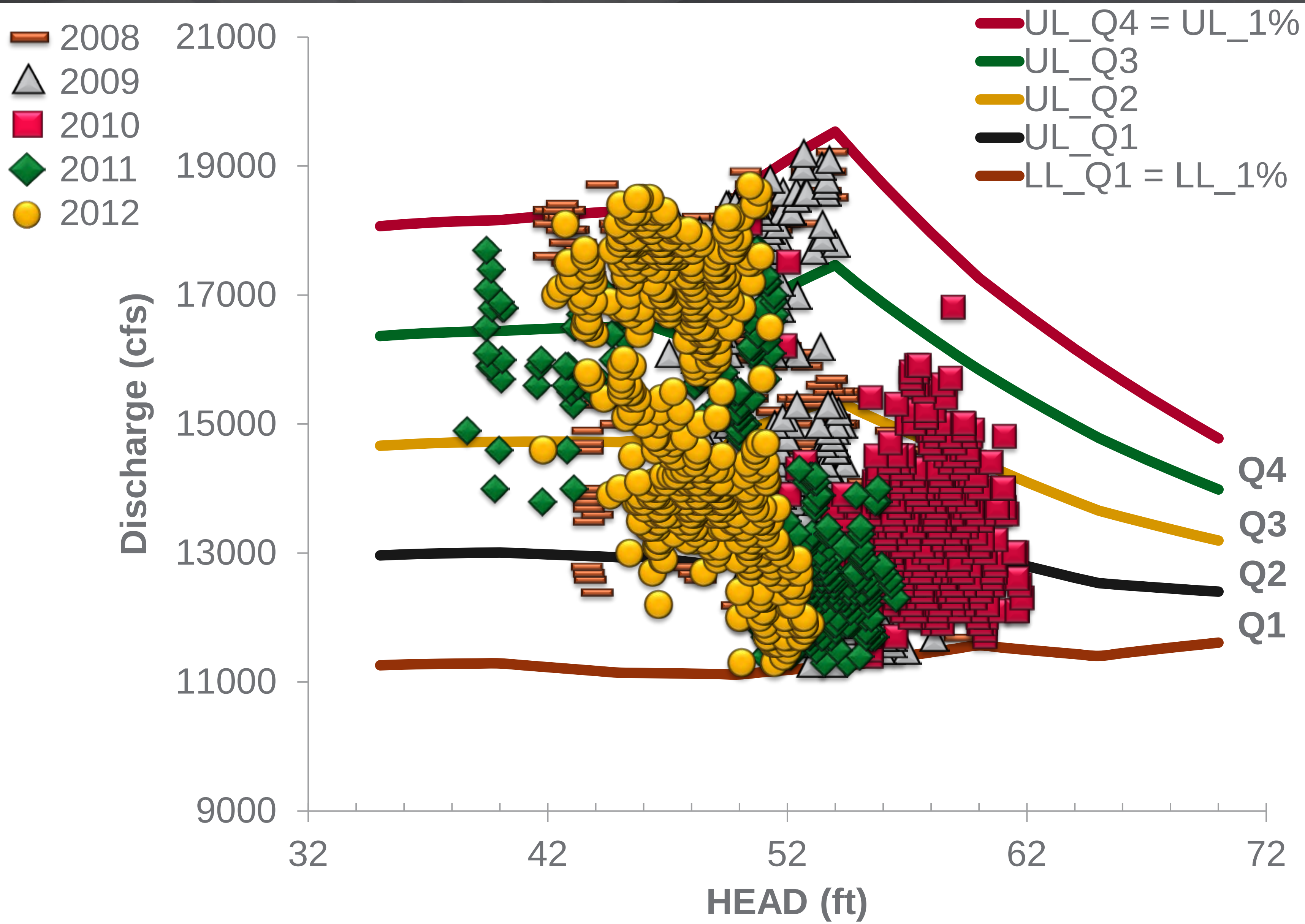


Analyses: BON
B1 CH0 Survival by Operating Condition

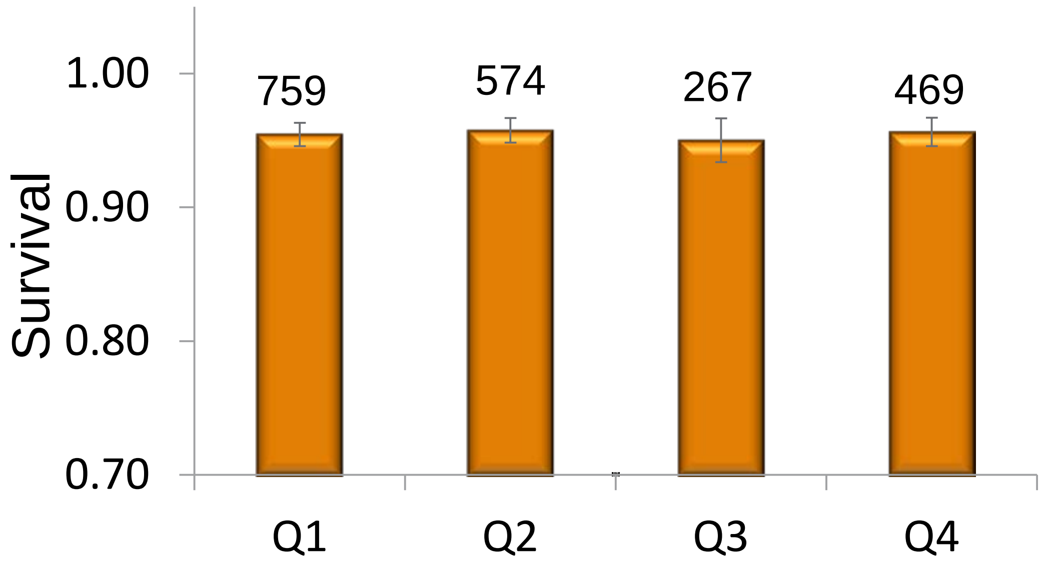




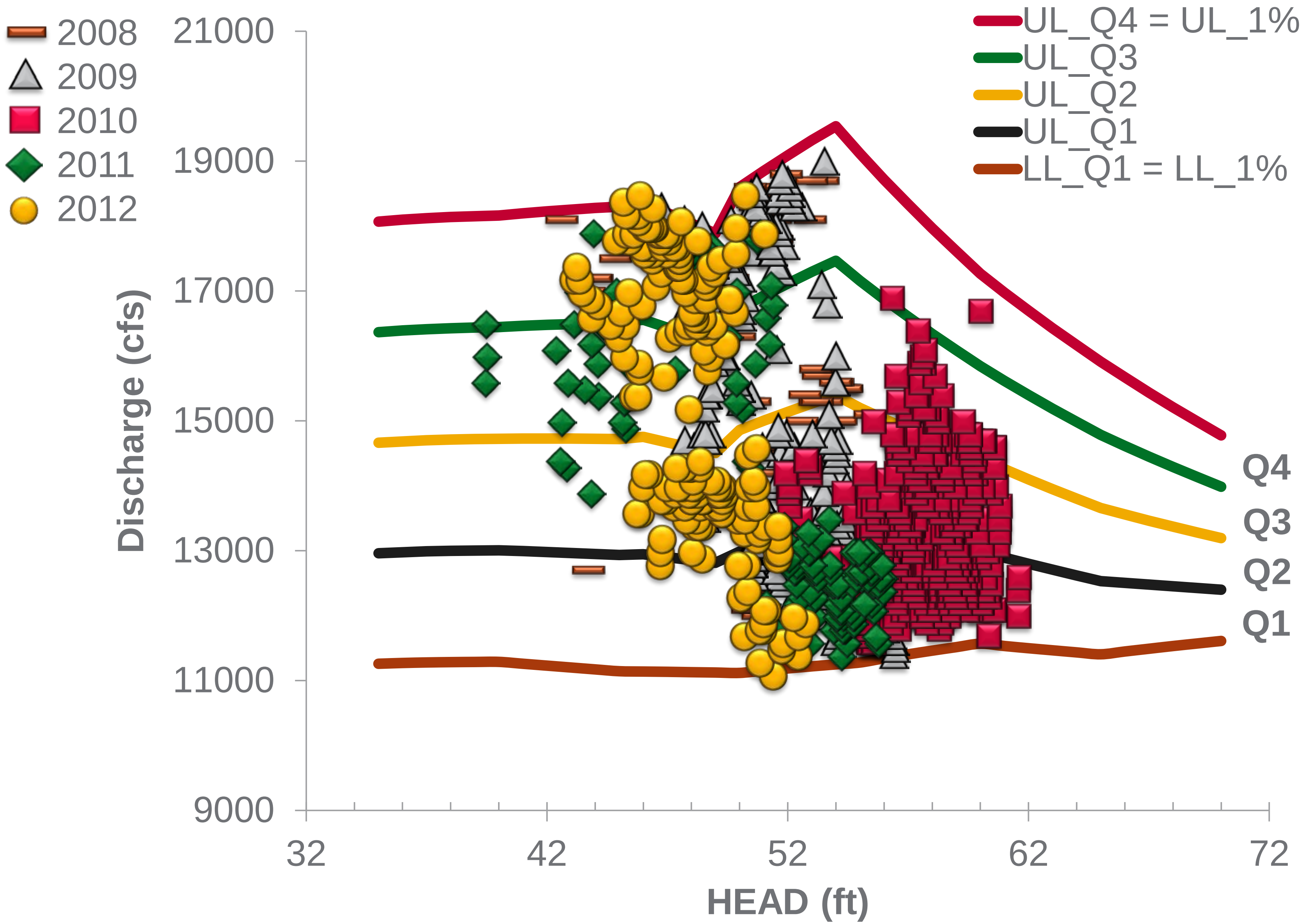
Analyses: BON
B2 CH1 Passage by Quartile



Analyses: BON
B2 CH1 Survival by Operating Condition



Analyses: BON
B2 STH Passage Distribution



Analyses: BON
B2 STH Survival by Operating Condition

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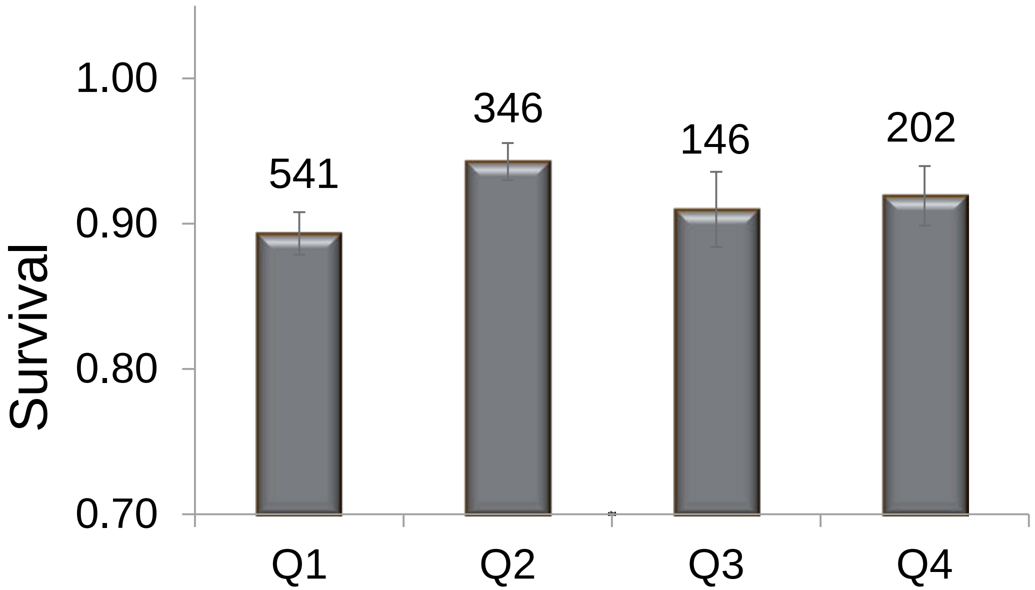

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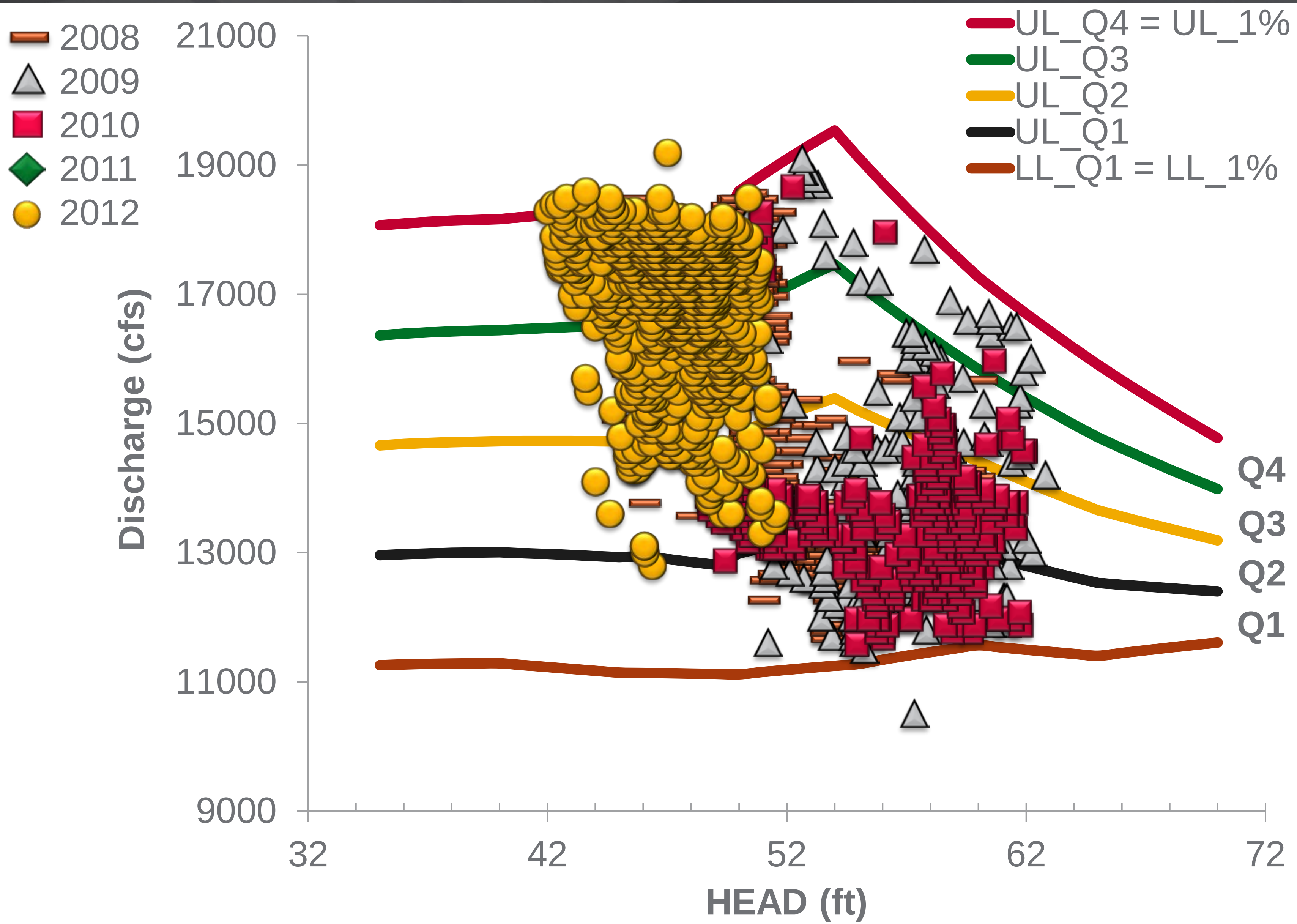

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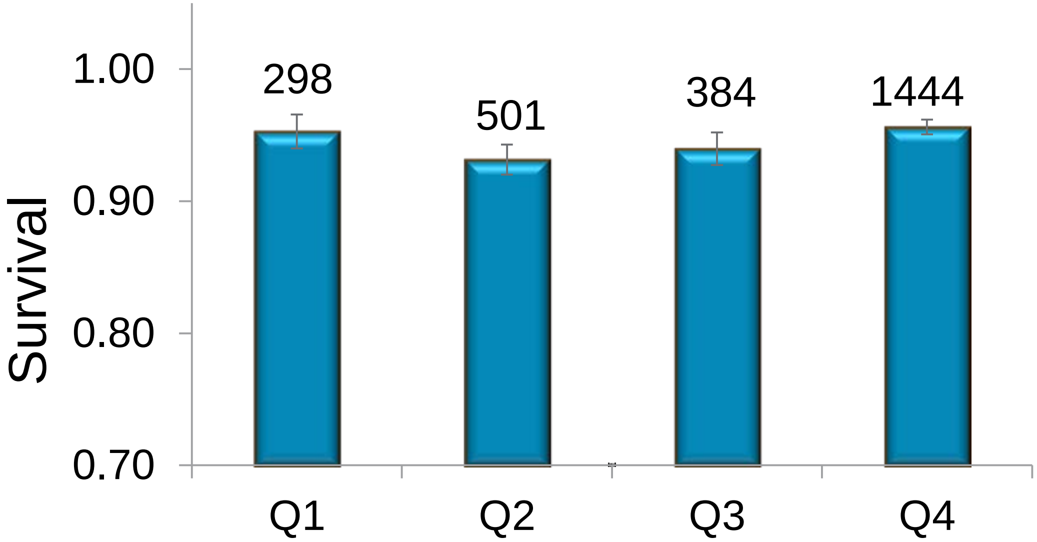
B2 CH0 Survival by Operating Condition



Analyses: BON
Spillway CH1 and STH Survival by Bay

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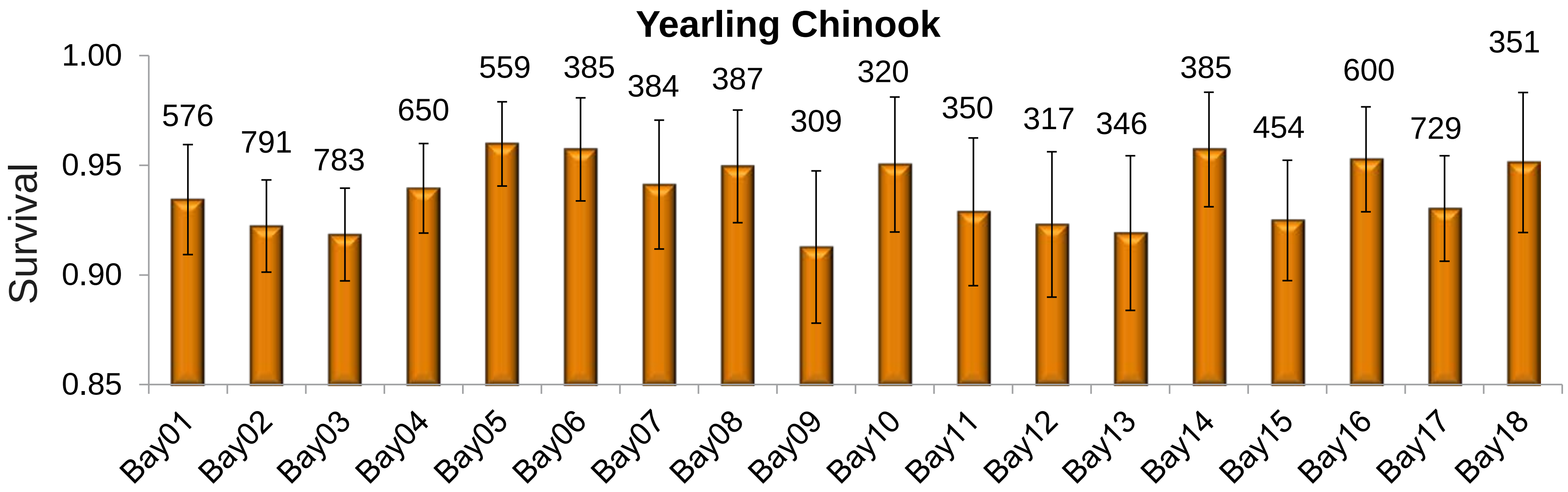

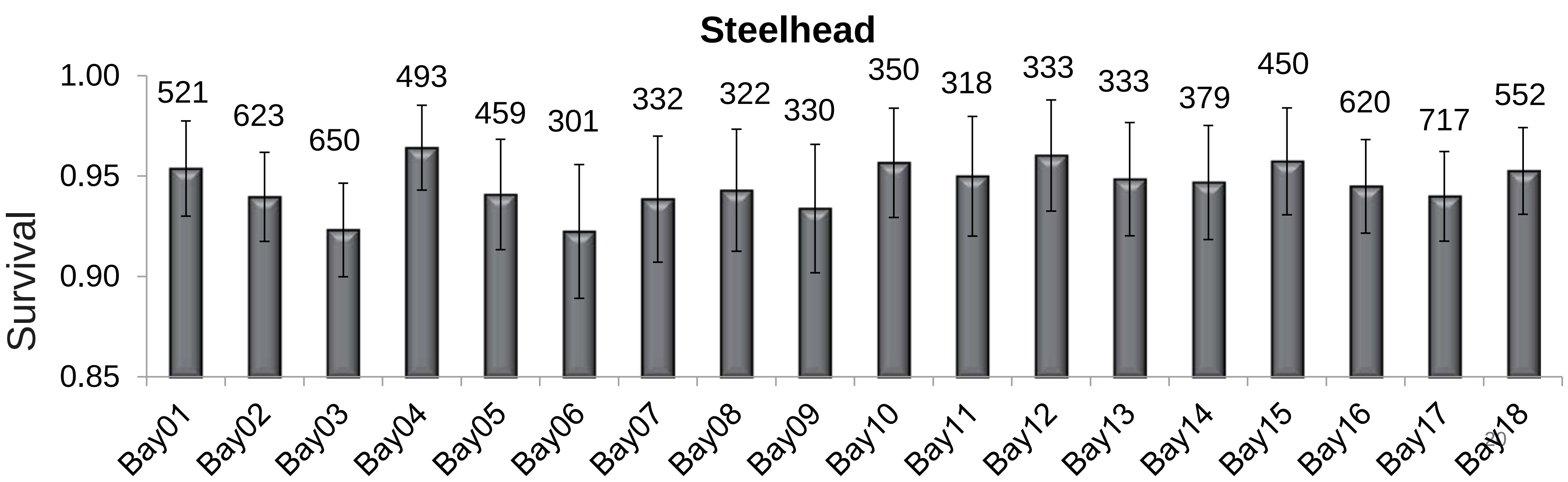

Analyses: BON
Spillway CH0 Survival by Bay

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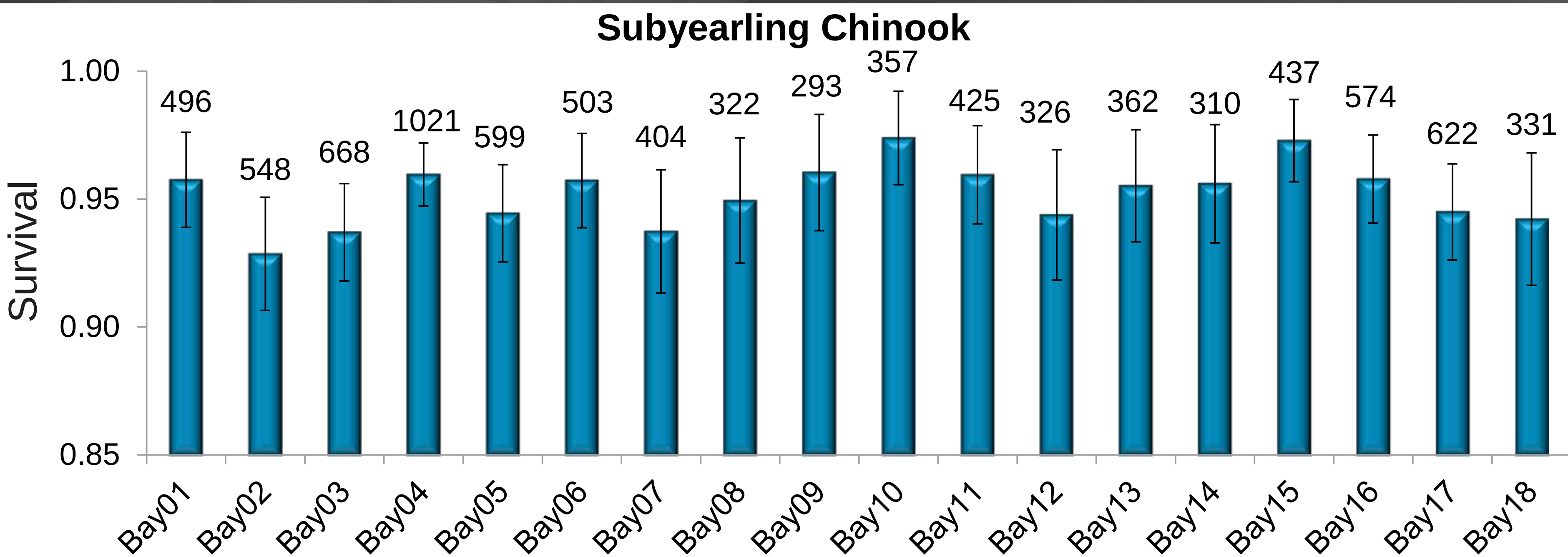

Analyses: BON
Spillway Survival, Grouped Bays

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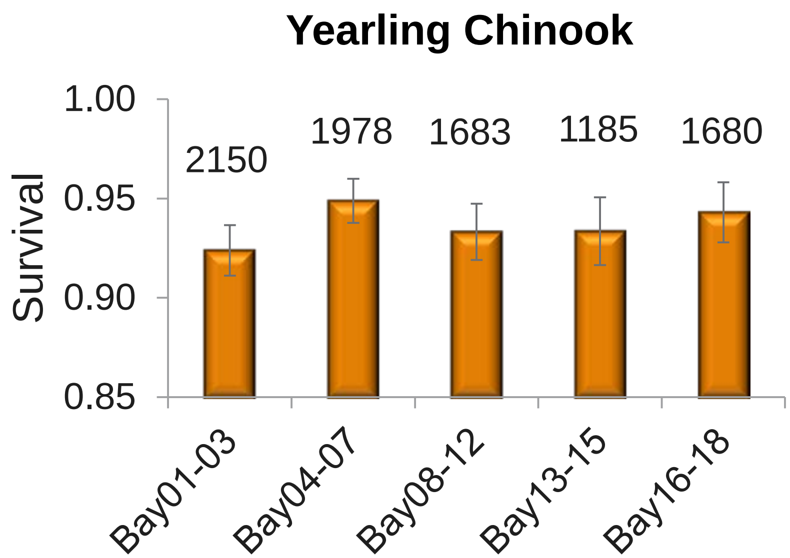
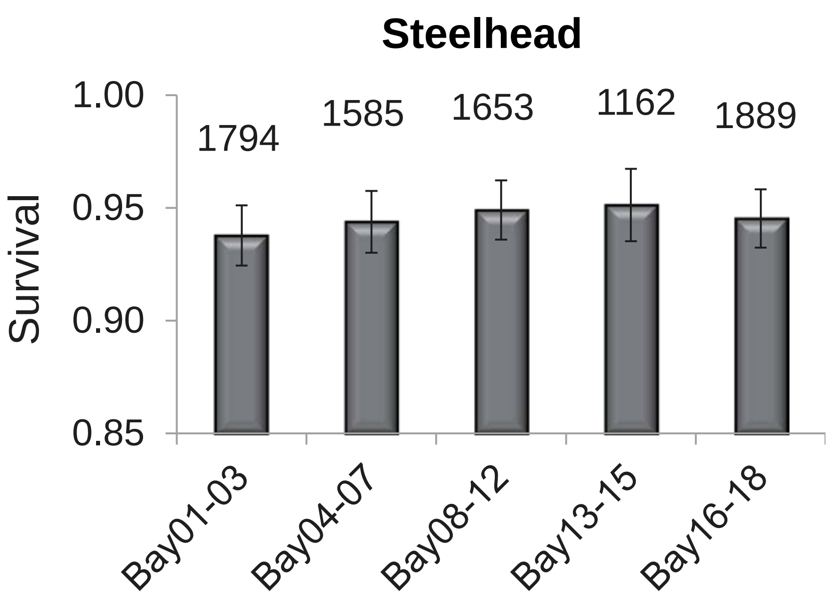
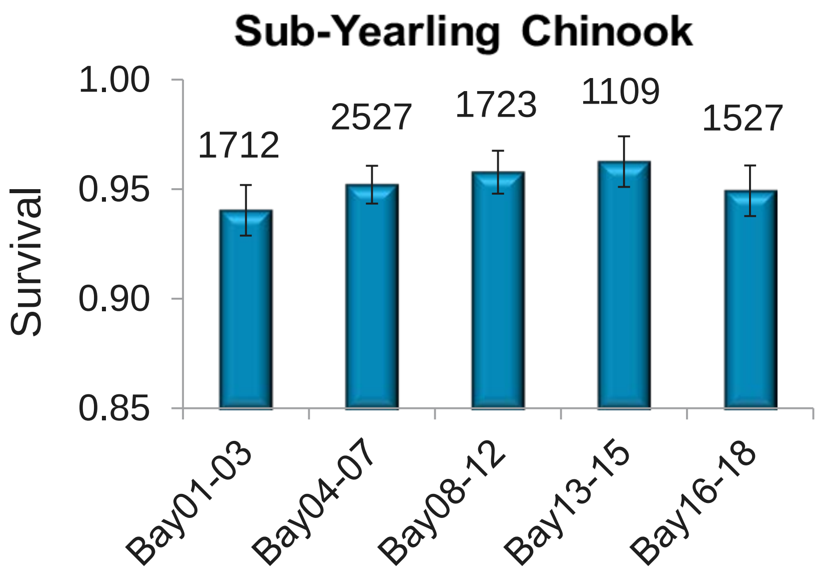
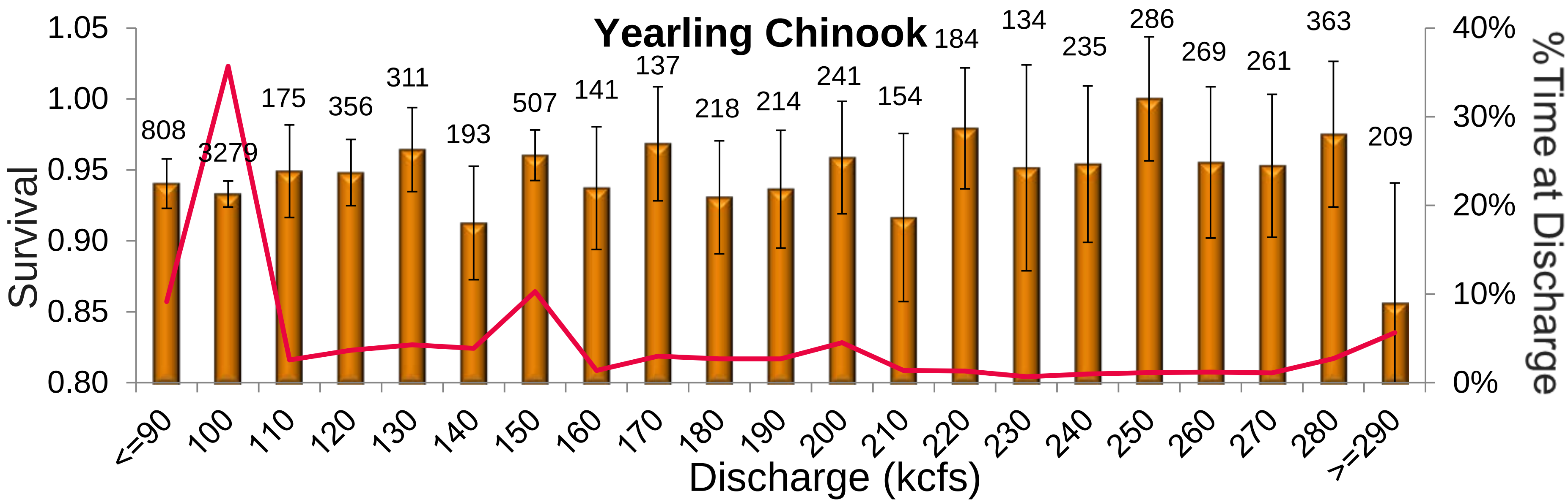
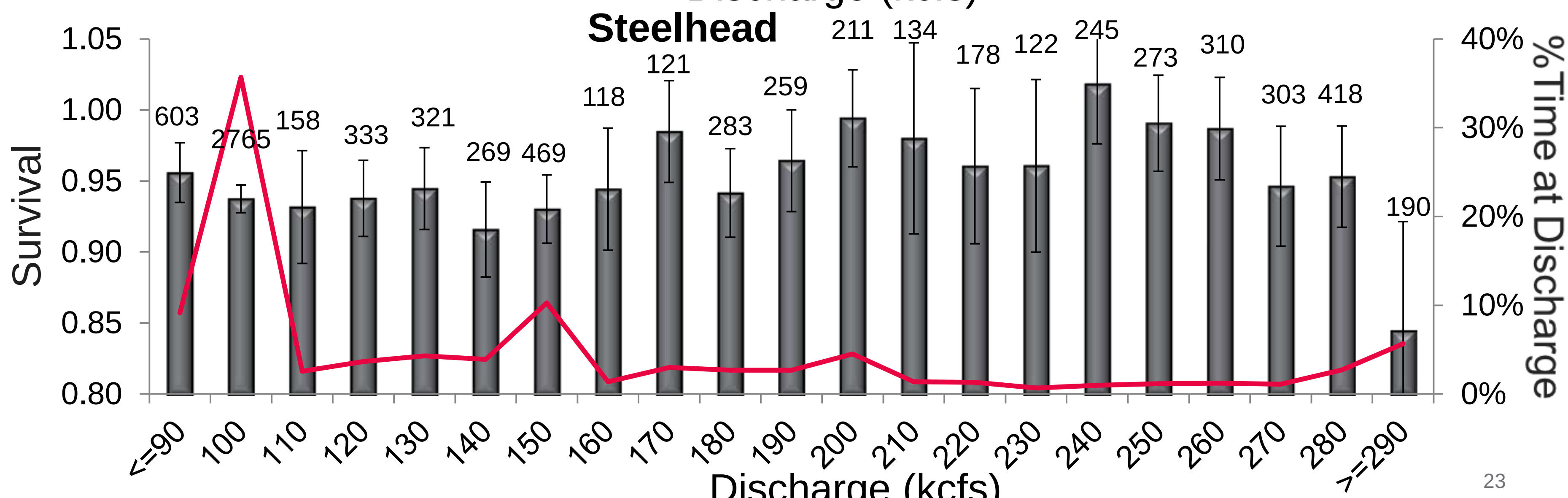




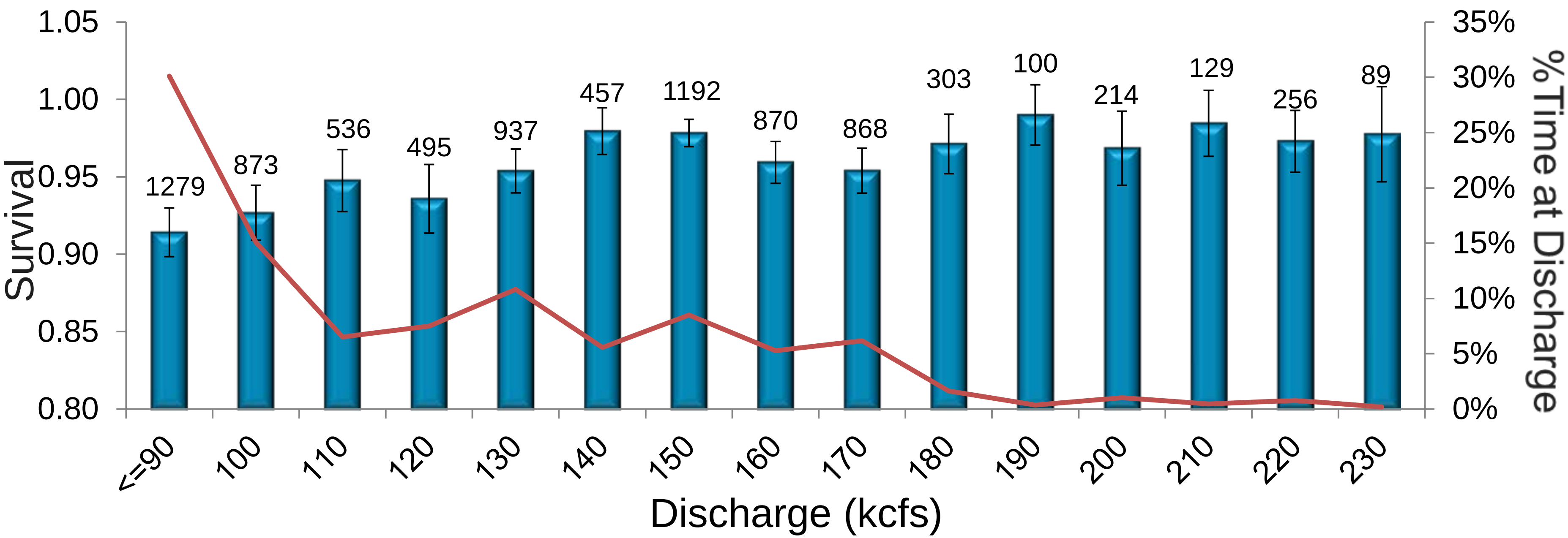


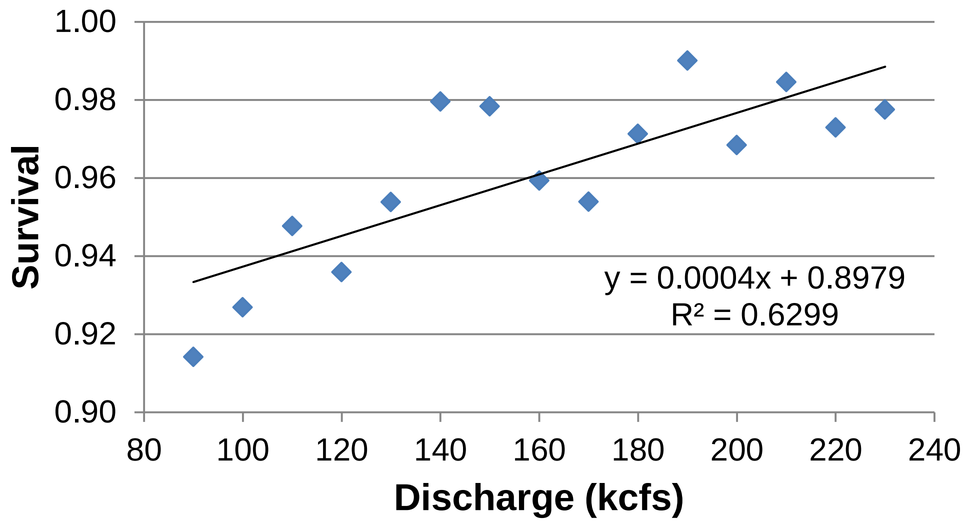
Analyses: BON
Spillway CH1 and STH Survival by Discharge





Analyses: BON
Spillway CH0 Survival by Discharge





Conclusions: BON

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- B1
  - There was not a difference in survival for salmonids passing within the 1% of peak operating efficiency and salmonids passing at operations above the upper 1% operating efficiency
- B2
  - No difference in survival across operating range
- Spillway
  - No obvious bay affect
  - Lower survival of CH1 and STH above 290 kcfs discharge
  - Trend of lower survival for CH0 at low discharge levels

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