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Diagnostic evaluation of the 2013 summer juvenile salmon dam passage performance standard test at Little Goose Dam

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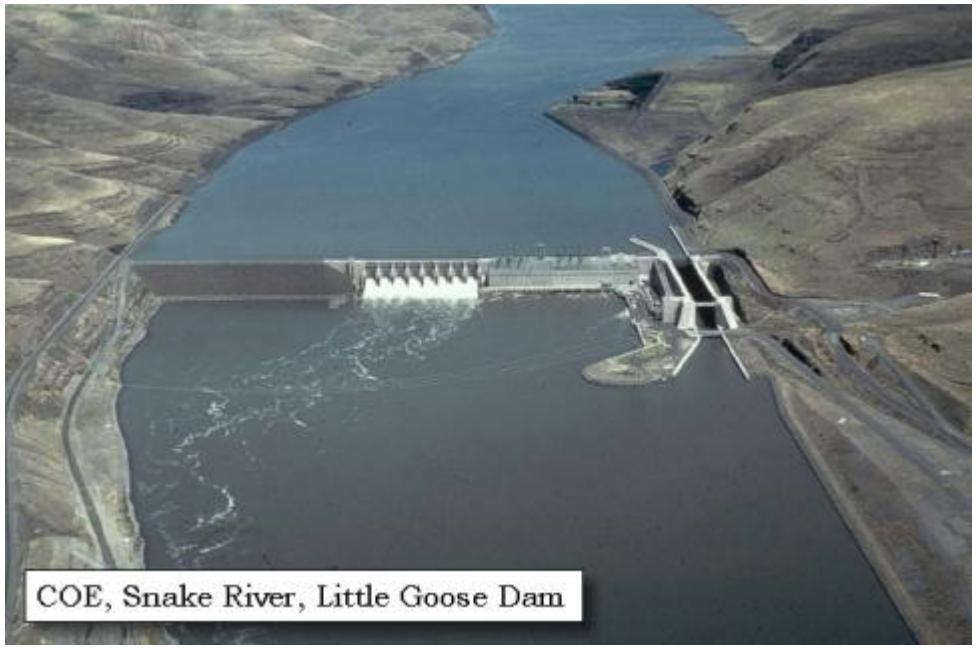
Background

- 2008 FCRPS BiOp calls for dam passage survival probability of ≥ 0.93 for subyearling Chinook salmon (CH0)
- 5,996 (total) acoustic-tagged CH0 released above LGS in 2012 & 2013 to estimate dam passage survival at LGS
  - 2012 estimate at LGS = 0.9508 (SE = 0.0097)
  - 2013 estimate at LGS = 0.9076 (0.0139)
- >5,000 passed LGS
  - 3-D tracking data
  - Route of passage
  - FB residence time
  - TR egress time
  - Survival



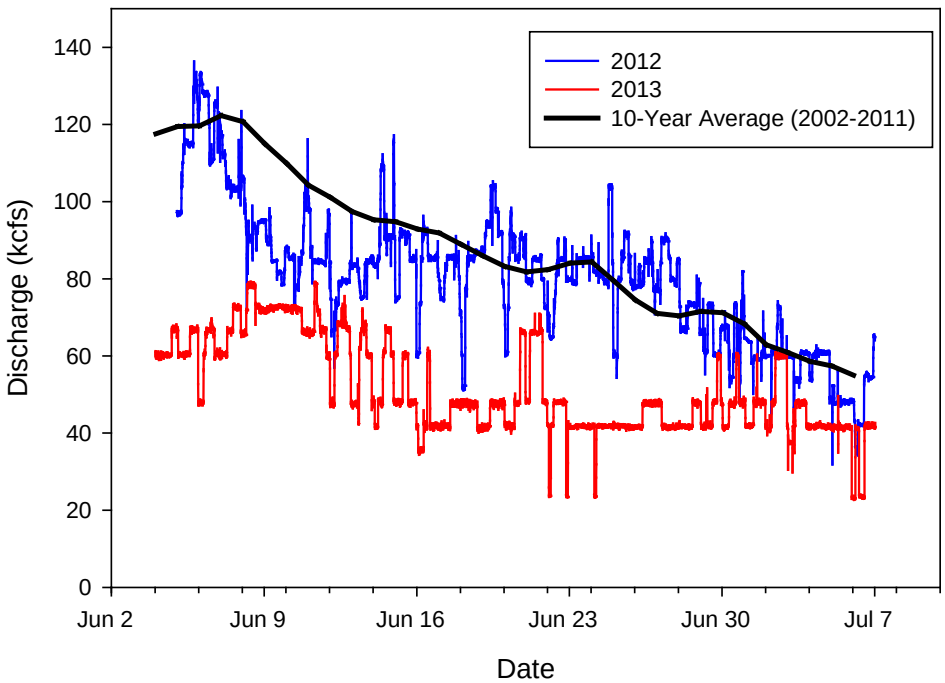
Objectives & Questions

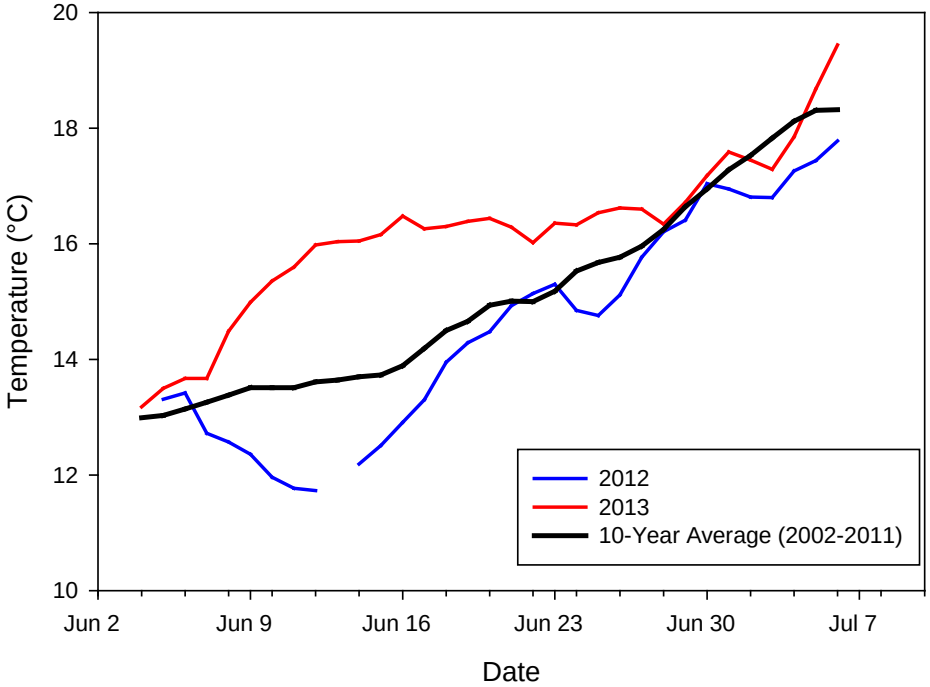
- Study objectives & questions
  - Identify the factors that influenced survival, passage routes, and passage times at LGS in 2013
  - What individual characteristics, environmental conditions, and dam operations contributed to the low survival observed in 2013?
  - If operations contributed to the low survival, what can be done differently?

- Analyses are ongoing
- Results presented today are preliminary – final report March 31, 2015

Environmental conditions were very different in 2012 & 2013

- 2012: average to high-flow year with average to cooler temperatures
- 2013: low-flow year with above-average temperatures





- Logistic regression relationship
  - Survival positively correlated with discharge: $\chi^2 = 154$; $p < 0.001$
  - Survival negatively correlated with temperature: $\chi^2 = 206$; $p < 0.001$

Methods

- Iterative process
- Starting with logistic regression modeling, using detection or non-detection of tagged fish at an array located 33 km downstream of LGS
  - Detection array ≥ 0.99 detection probability
  - Advantages
    - Fish can be assigned a value for each variable of interest that most accurately describes the conditions encountered at the time of dam passage
    - “Survival” can be estimated quickly
  - Disadvantage
    - Mortality that occurred between the TR and detection array is included in the estimate
- Bayesian model averaging to identify the “best” model
  - Pairwise correlations evaluated for multicollinearity

Variables: Survival

- Individual
  - Fork length
  - Condition (good/fair)
  - Relative condition
- Behavioral
  - Tailrace egress time
- Temporal
  - Day of dam passage
  - Diel passage (day/night)
- Environmental
  - Tailrace water temperature
  - TR TDG%
  - Total discharge
- Operational
  - % of total discharge through each route
  - % spill
  - Spillway weir crest position (high/low)

2012 & 2013 survival (all routes)

- "Best" model
  - Survival was negatively correlated with tailrace temperature
  - Survival was negatively correlated with tailrace egress time
  - Survival was positively correlated with fork length

Variable	Probability	Direction
TR temperature	1.00	–
TR egress time	1.00	–
FL	0.96	+
Model posterior probability	**0.80**	

2012 & 2013 tailrace egress time (all routes)

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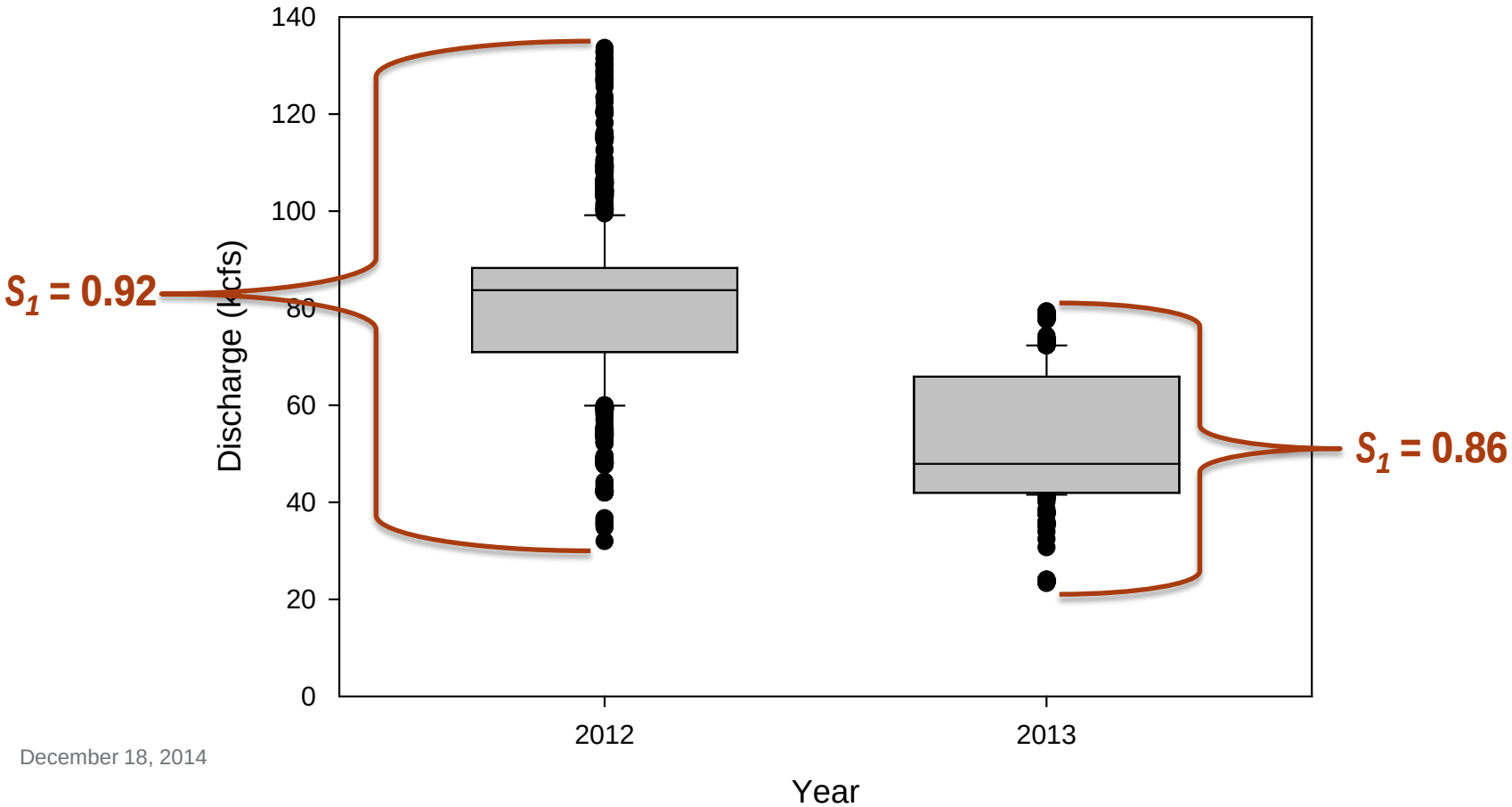
- "Best" model
  - TR egress time was positively correlated with % discharge through weir
  - TR egress time was negatively correlated with % discharge through spill bay 5
  - TR egress time was affected by route of passage
  - TR egress time was negatively correlated with total discharge

Variable	Probability	Direction
S1%Q	1.00	+
S5%Q	1.00	–
Subroute	1.00	JBS>Turbine>Deep>Weir
Discharge	0.80	–
Model posterior probability	**0.72**	

- High multicollinearity

Effect of discharge on survival

- LGS CH0 survival by passage discharge
  - 2012 vs 2013

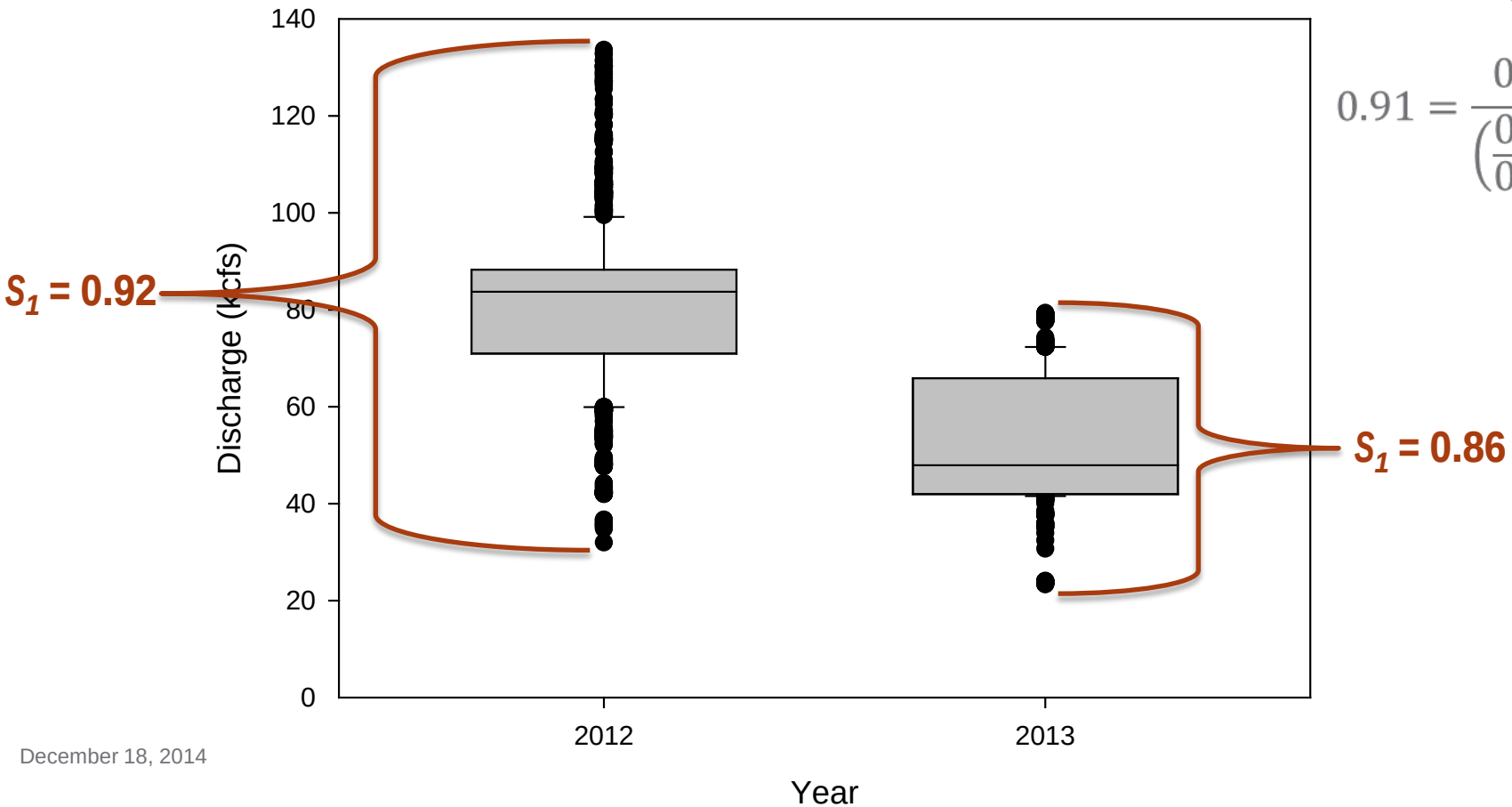


Effect of discharge on survival

- LGS CH0 survival by passage discharge
  - 2012 vs 2013

$$S_{Dam} = \frac{S_1}{\left(\frac{S_2}{S_3}\right)}$$

$$0.91 = \frac{0.86}{\left(\frac{0.83}{0.87}\right)}$$



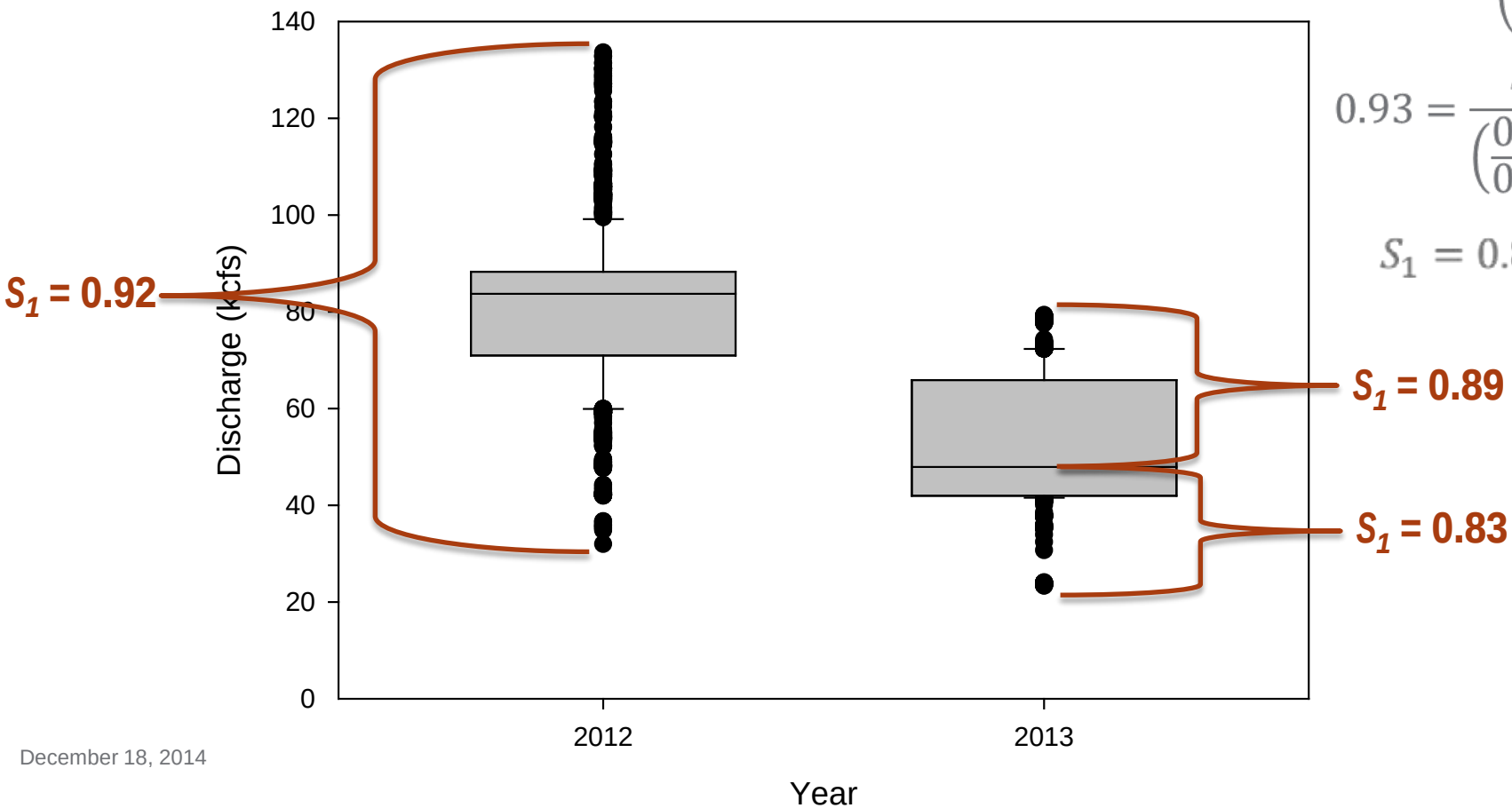
Effect of discharge on survival

- LGS CH0 survival by passage discharge
  - 2012 vs 2013
  - 2013: S_1 = 0.88 needed for S_{Dam} = 0.93

$$S_{Dam} = \frac{S_1}{\left(\frac{S_2}{S_3}\right)}$$

$$0.93 = \frac{S_1}{\left(\frac{0.83}{0.87}\right)}$$

$$S_1 = 0.88$$



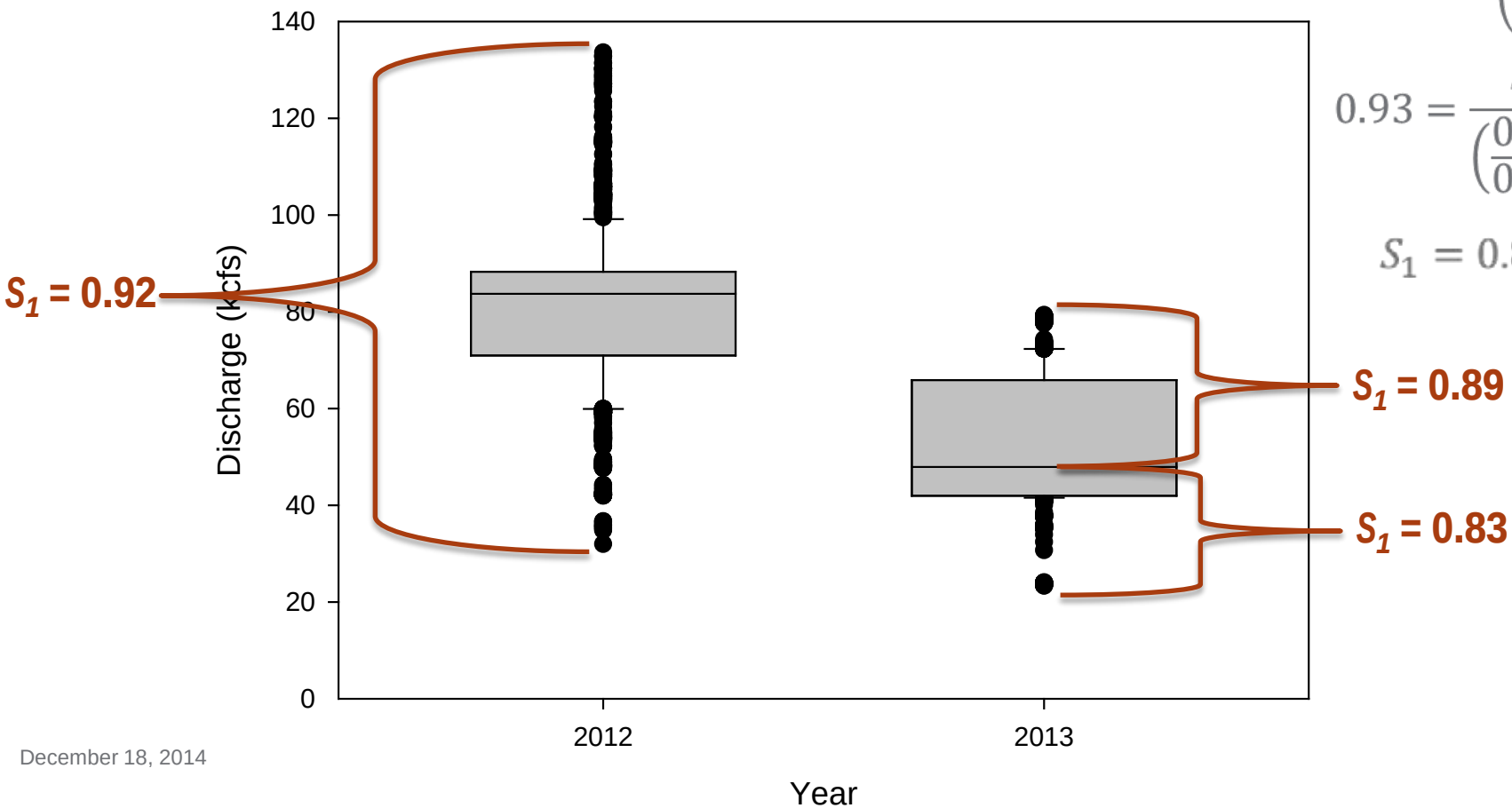
Effect of discharge on survival

- S_1 of 0.88 needed to achieve S_{Dam} of 0.93 in 2013
  - What operations (if any) used at low flows (<50 kcfs) in 2013 resulted in $S_1 \geq 0.88$ and low tailrace egress times?

$$S_{Dam} = \frac{S_1}{\left(\frac{S_2}{S_3}\right)}$$

$$0.93 = \frac{S_1}{\left(\frac{0.83}{0.87}\right)}$$

$$S_1 = 0.88$$



Dam operations

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Mean Q (kcfs)
112
86
83
72
70
66
55
61
54
48
48
42

Op	T1	T2	T3	T4	T5	T6	S1	S2	S3	S4	S5	S6	S7	S8
1														
2														
3														
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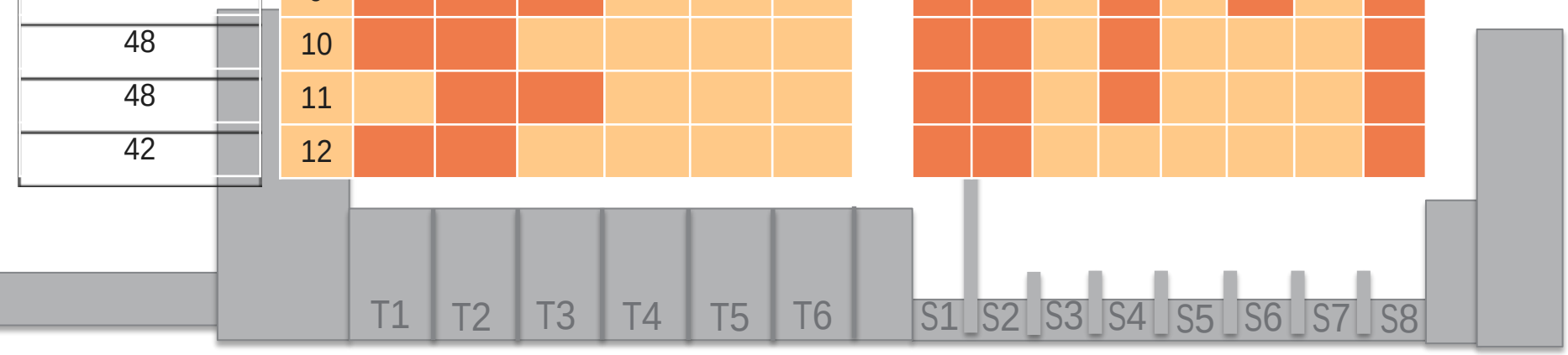
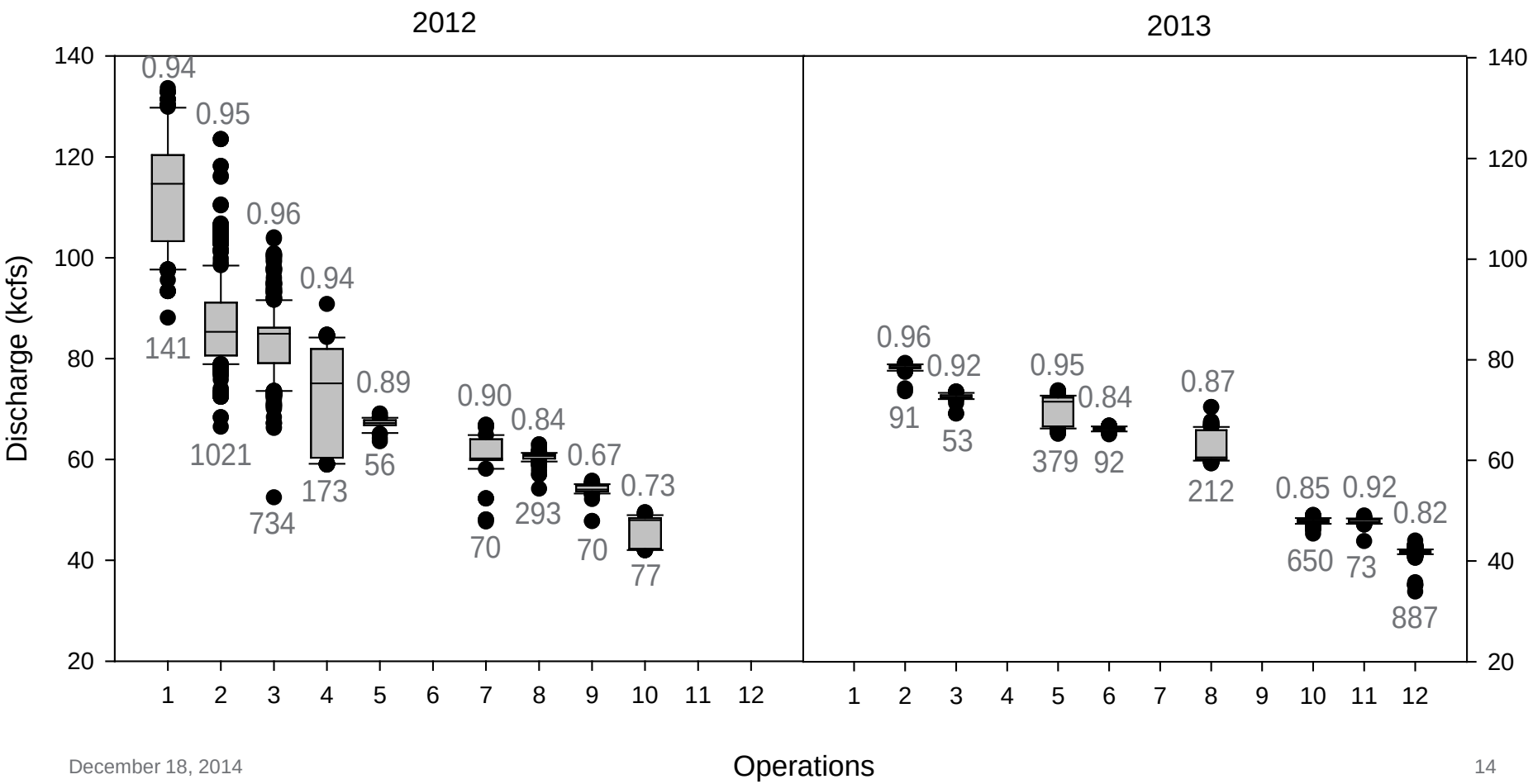


= flow through route

= no flow through route

Operations by discharge

- *N* and *S* by discharge/operation



Operations by discharge

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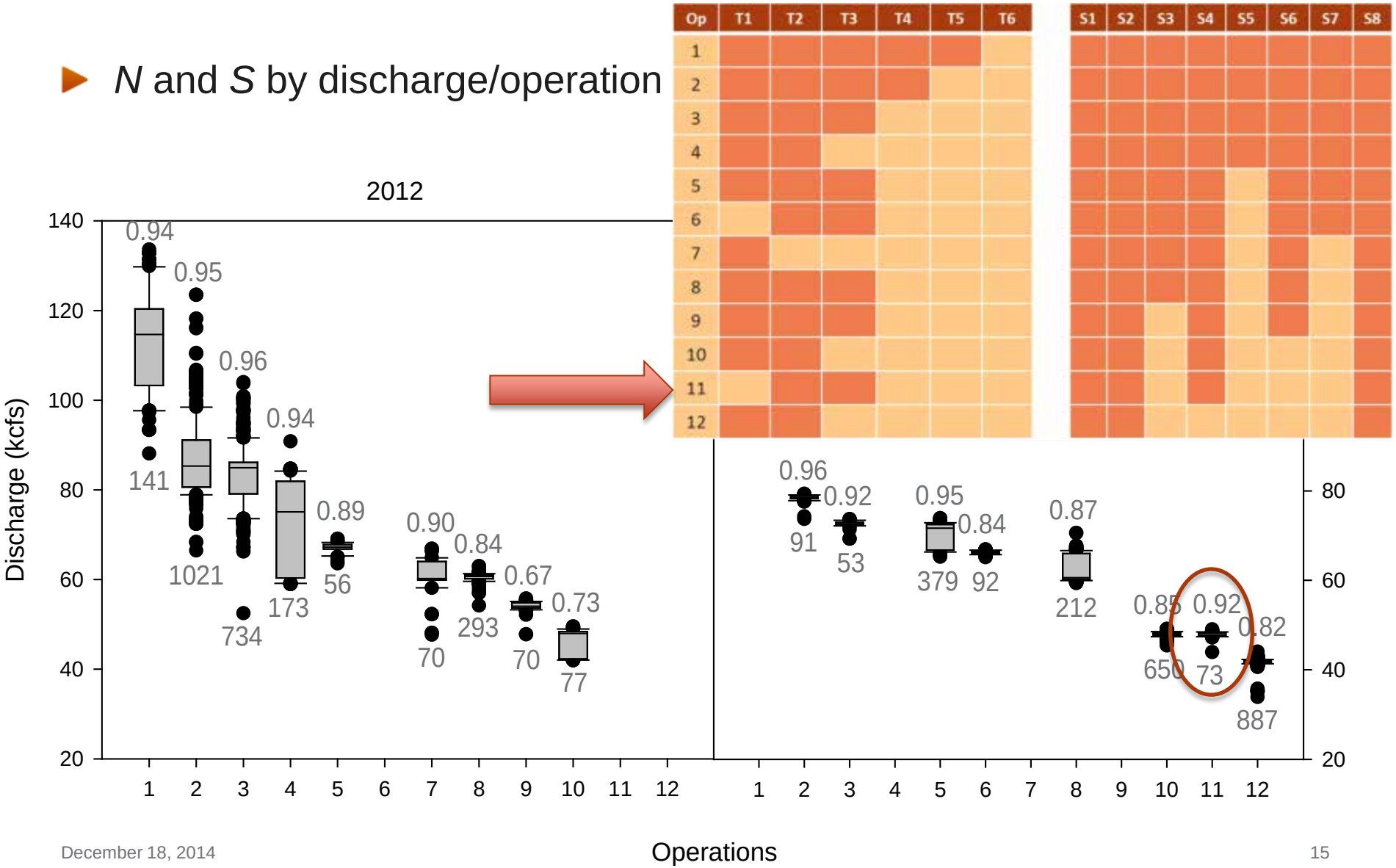
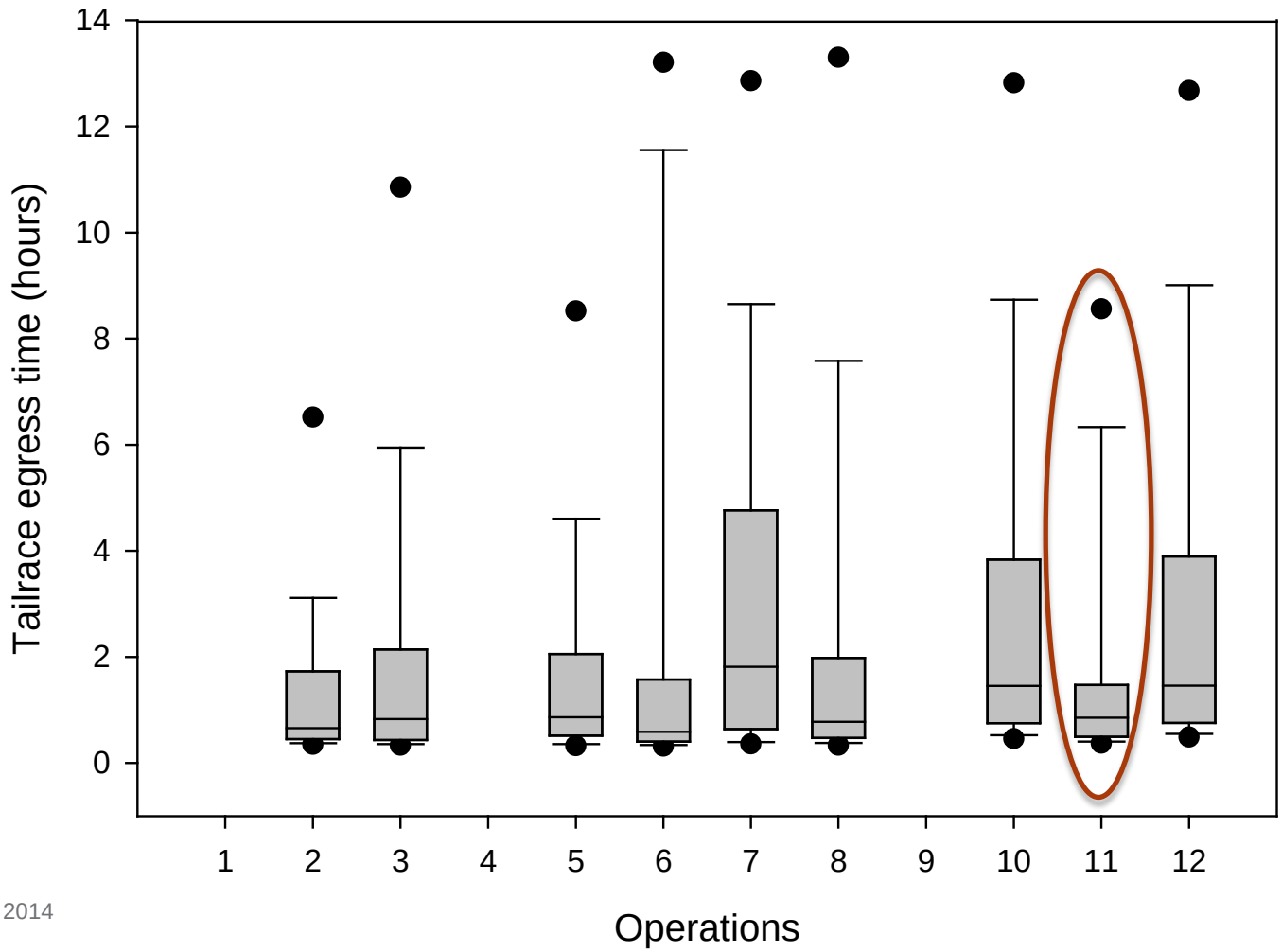
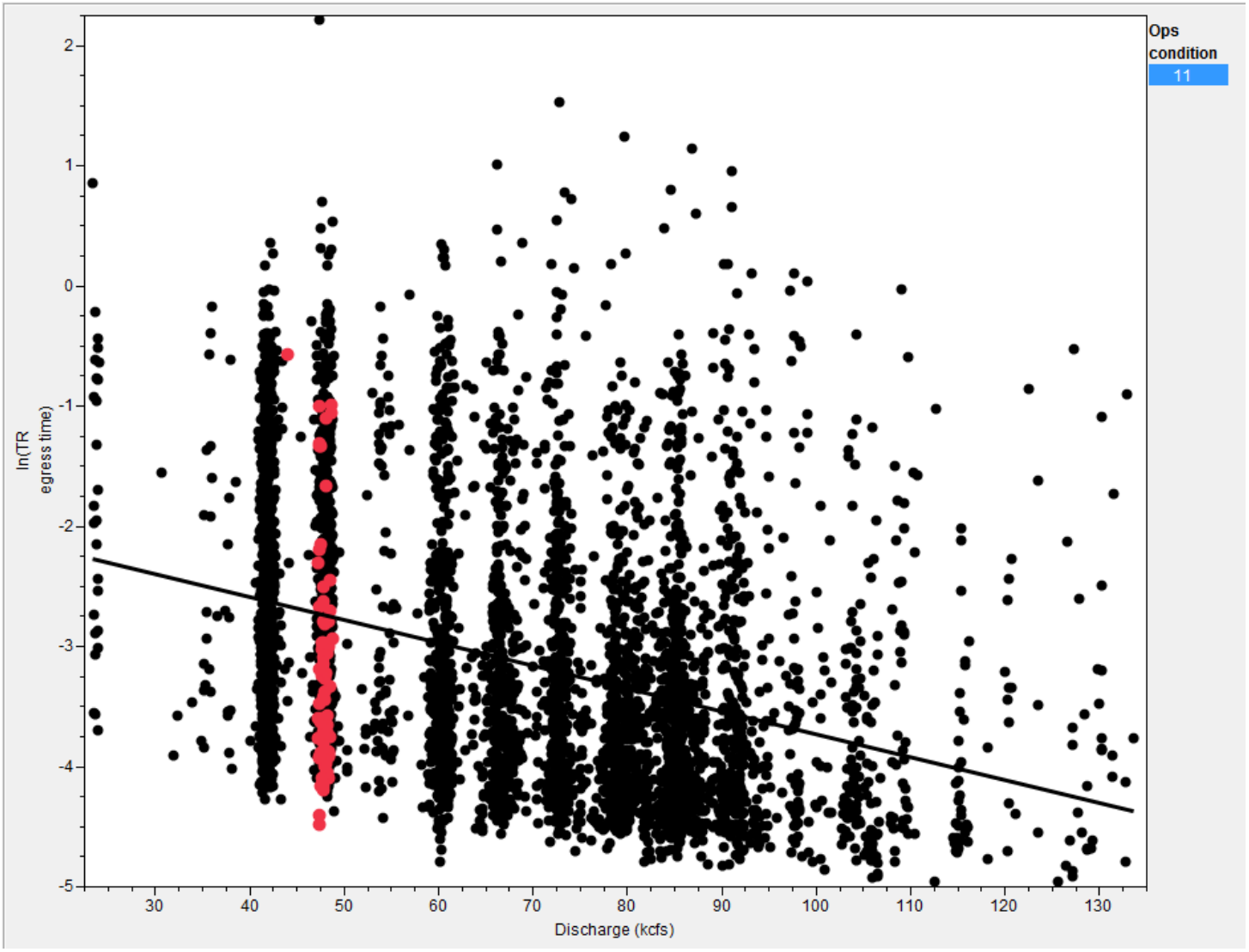


Tailrace egress times by operation

- Survival negatively correlated with tailrace egress time
  - $\chi^2 = 72$; $p < 0.001$



Distribution of op. “11” TR egress vs. model



Conclusions & future analyses

- Conclusions
  - Discharge and temperature likely contributed to lower survival observed in 2013
  - Operations may have also contributed to lower survival
  - However, it may be possible to operate the dam in such a way as to improve CH0 dam passage survival (to the BiOp standard) at LGS during periods of low flow
    - Whether or not these operations are feasible with respect to power production, adult fish ladder attraction, etc. remains to be determined
    - Need to link these results to turbine priorities and spill patterns
- Future analyses
  - Evaluate survival and tailrace egress time by route of passage under different discharges and operations
  - Assess effect of variables on dam passage survival using VIPRE model
  - Evaluate factors affecting route of passage

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