Passage bottlenecks and prioritization planning: Highlights from the adult lamprey data synthesis

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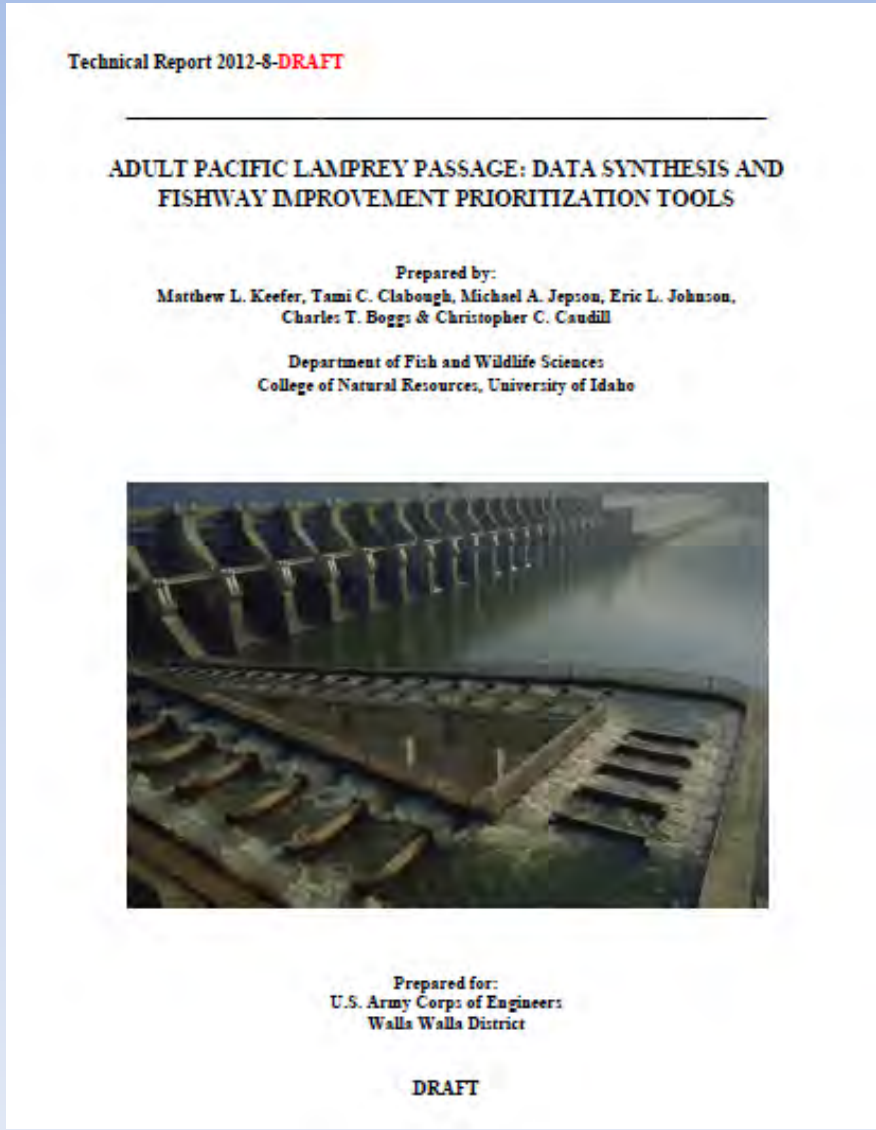
Synthesis overview: Literature

- Literature review
  - Lamprey swim performance & behavior
  - Known fishway passage problems
  - Information gaps



Technical Report 2012-8-DRAFT

ADULT PACIFIC LAMPREY PASSAGE: DATA SYNTHESIS AND FISHWAY IMPROVEMENT PRIORITIZATION TOOLS

Prepared by:
Matthew L. Keefer, Tami C. Clabough, Michael A. Jepson, Eric L. Johnson, Charles T. Boggs & Christopher C. Caudill

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Prepared for:
U.S. Army Corps of Engineers
Walla Walla District

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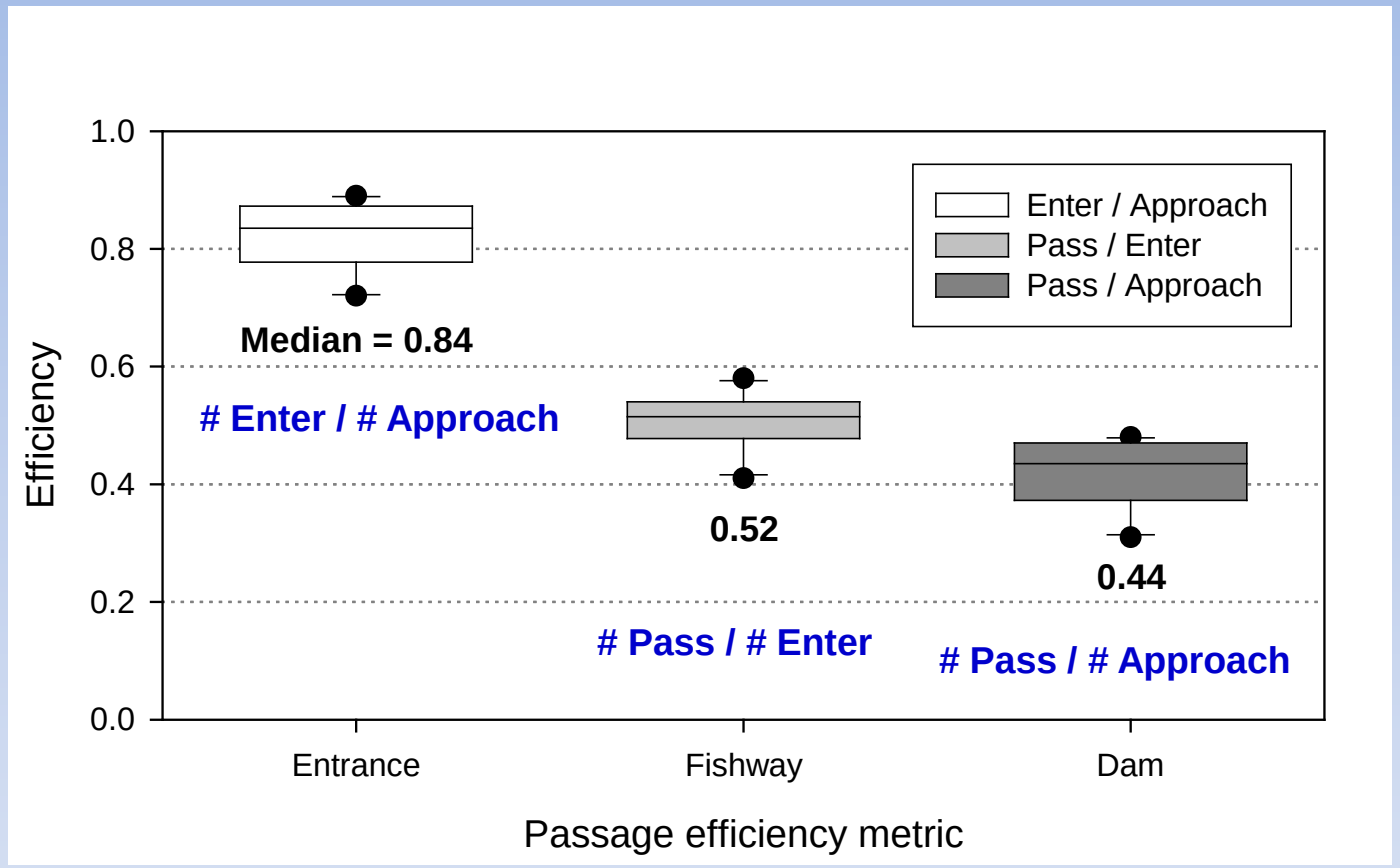
http://www.cnr.uidaho.edu/uiferl/Reports.htm#Technical_Reports

Synthesis overview: Data

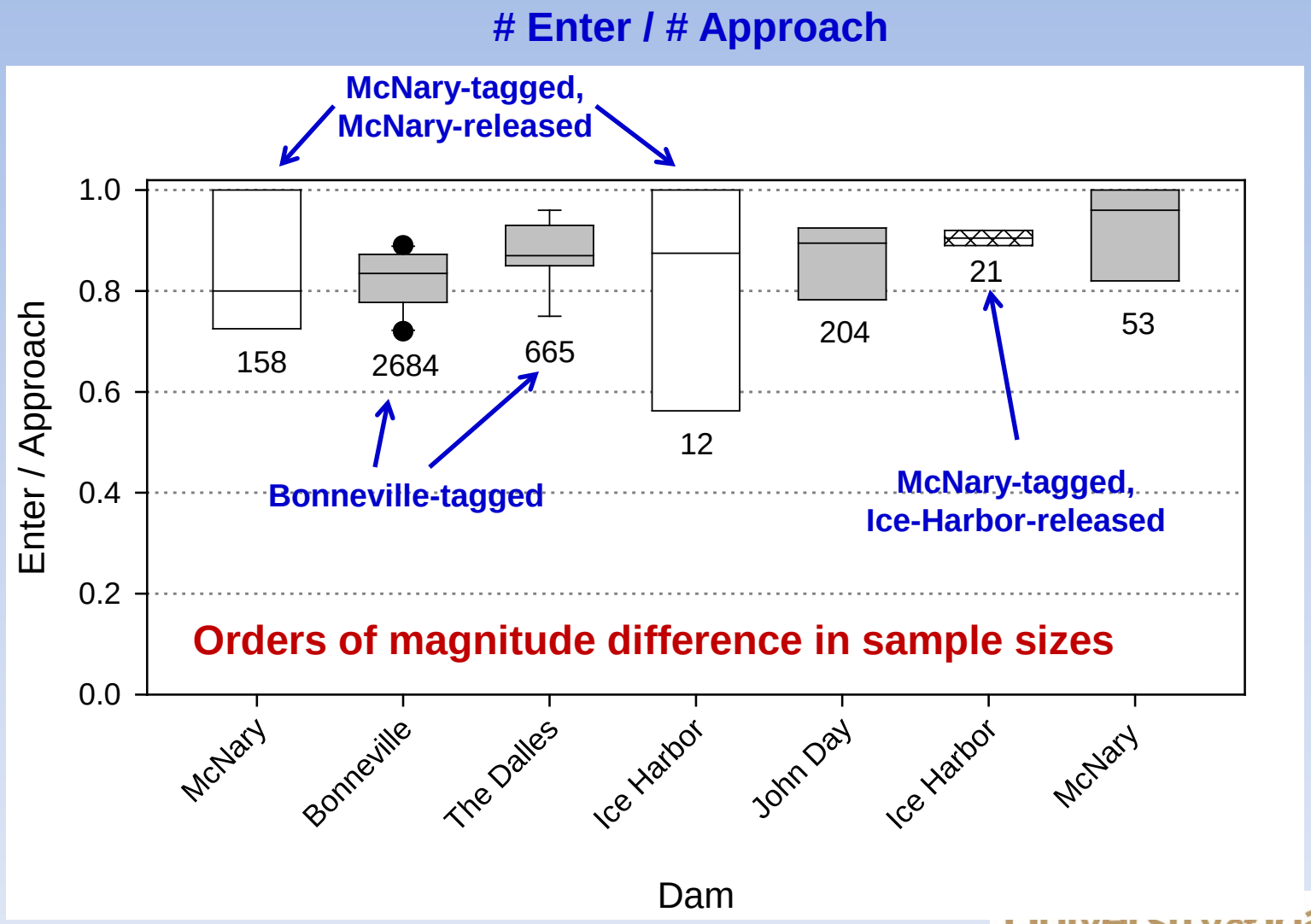
- Data synthesis from tagging studies
  - Single-dam summaries
  - Among-dam comparisons
- Prioritization models
  - Bottleneck prioritization at single dams
  - Upriver escapement – where to invest among projects?

Bonneville Dam: 'trickle up' escapement (2011 AFEP presentation)

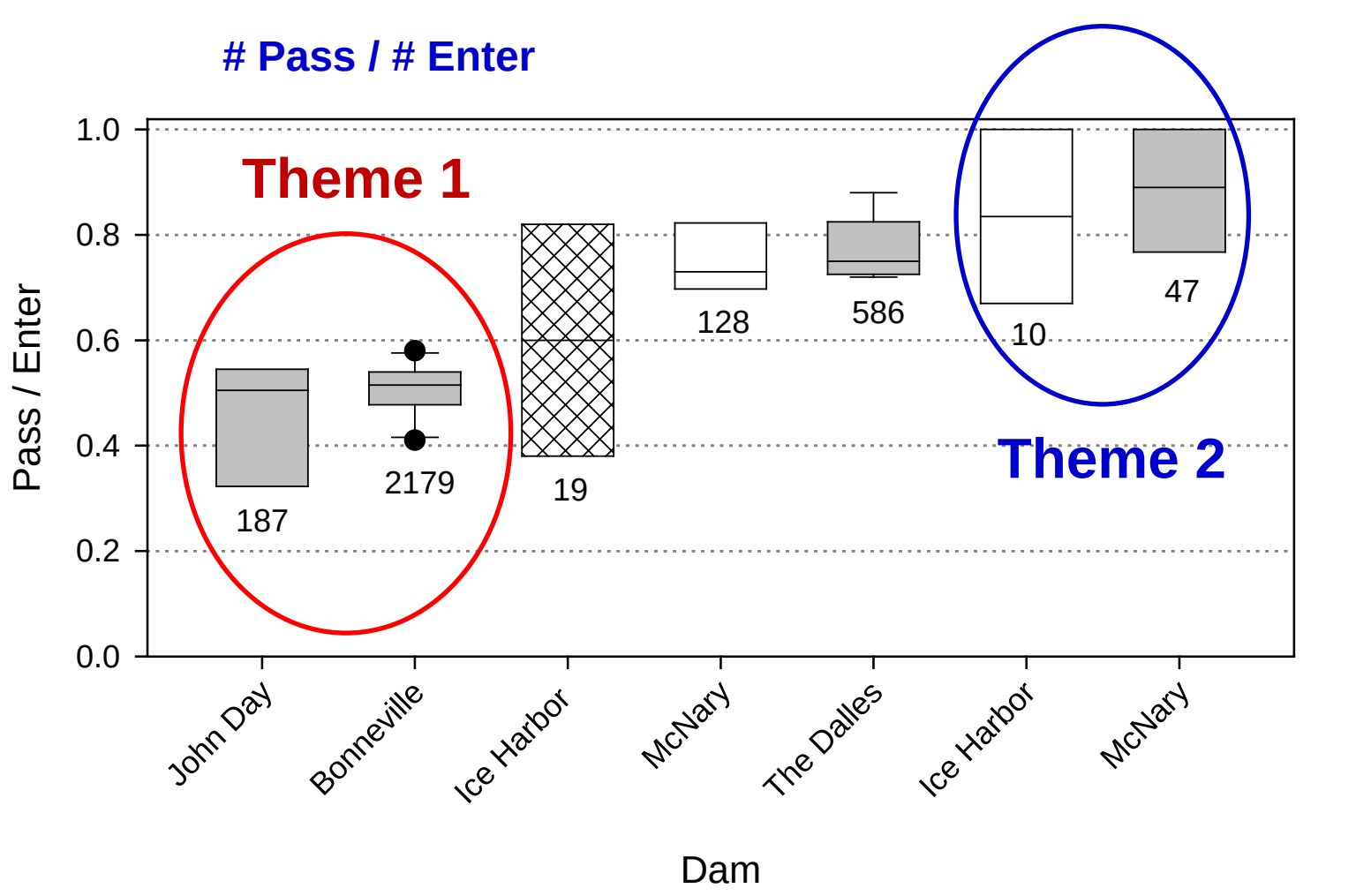
Bonneville: dam-wide efficiencies



Dam-wide entrance efficiency



Dam-wide fishway passage efficiency



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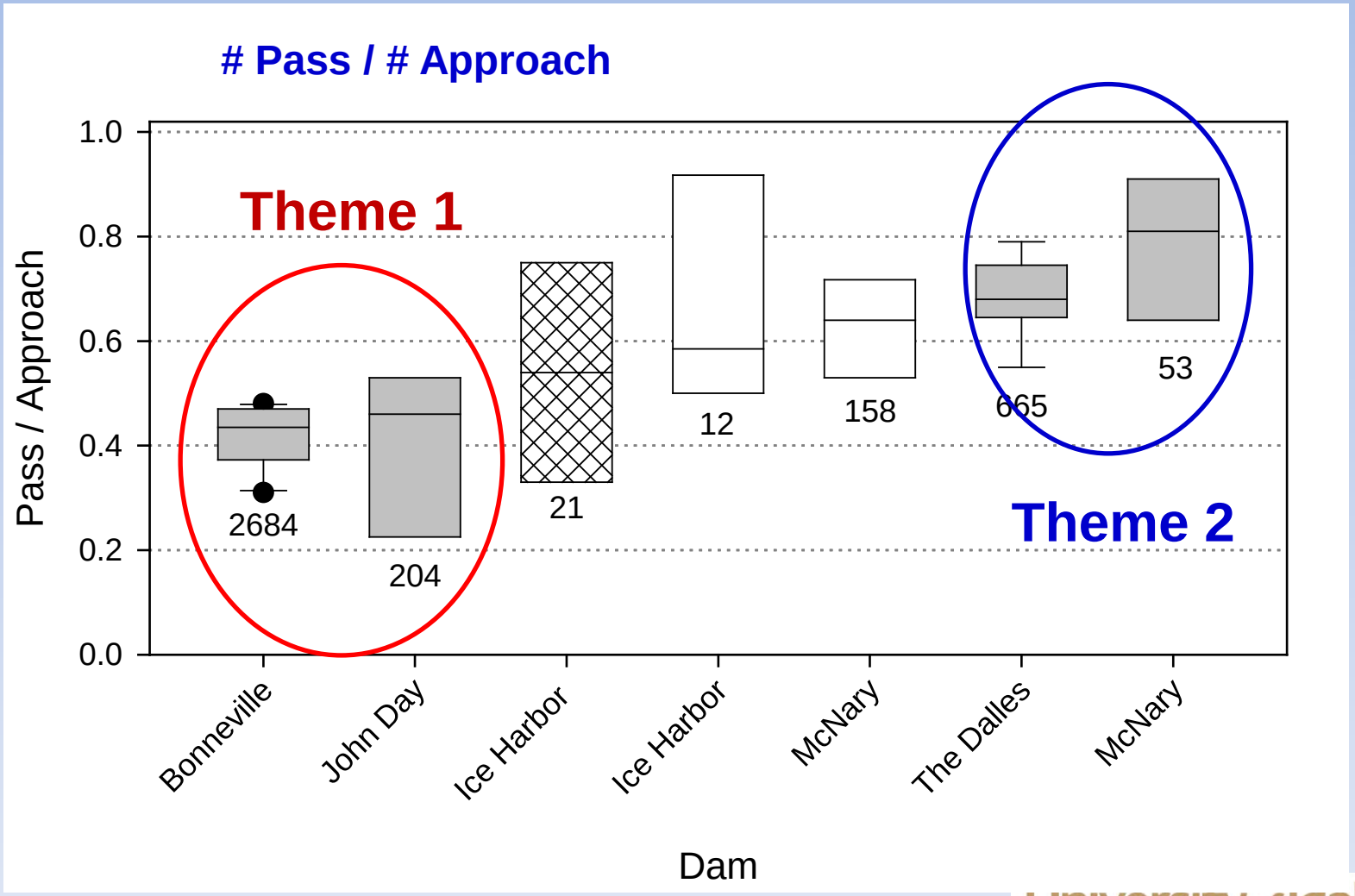
Dam-wide dam passage efficiency



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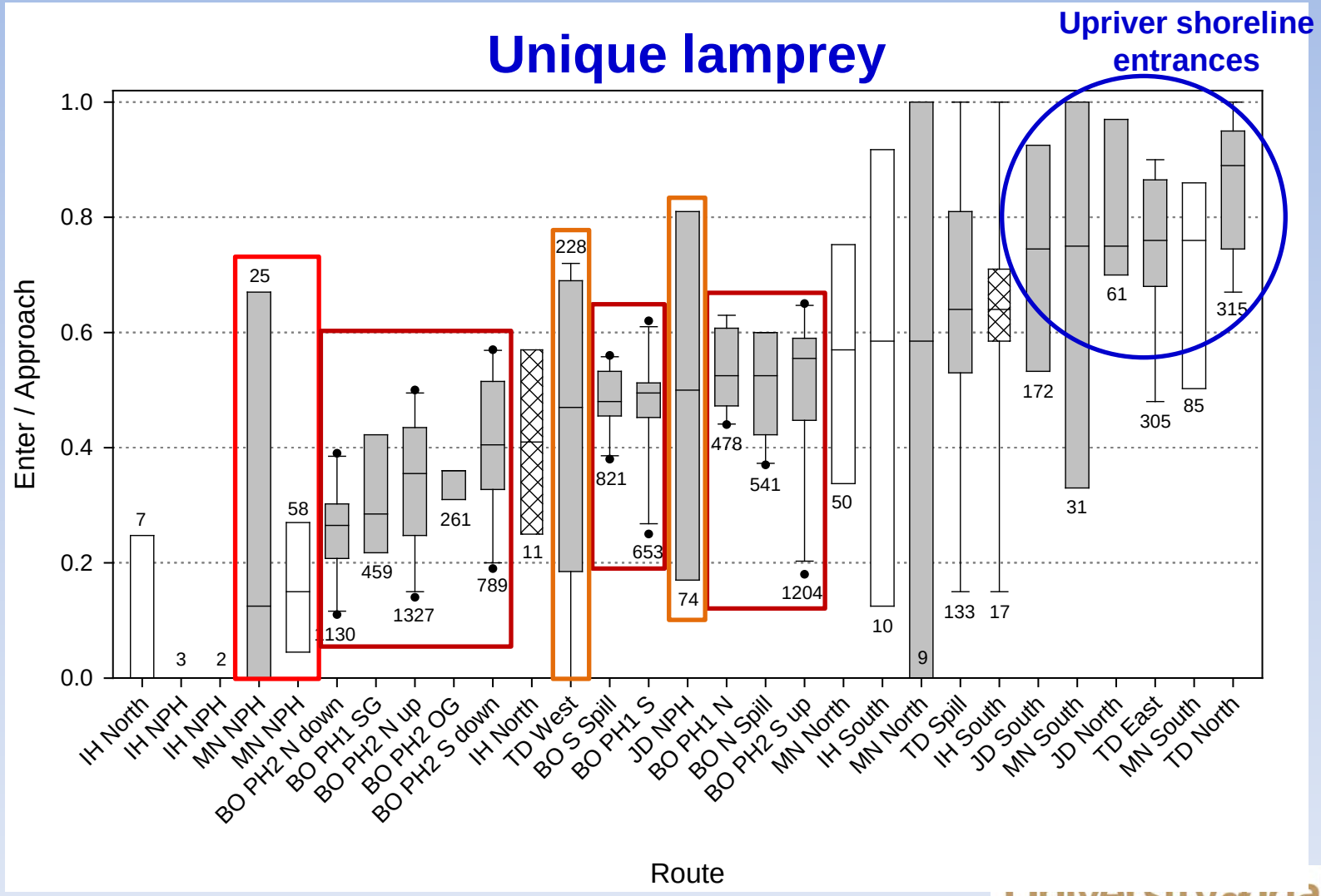
Site-specific entrance efficiency



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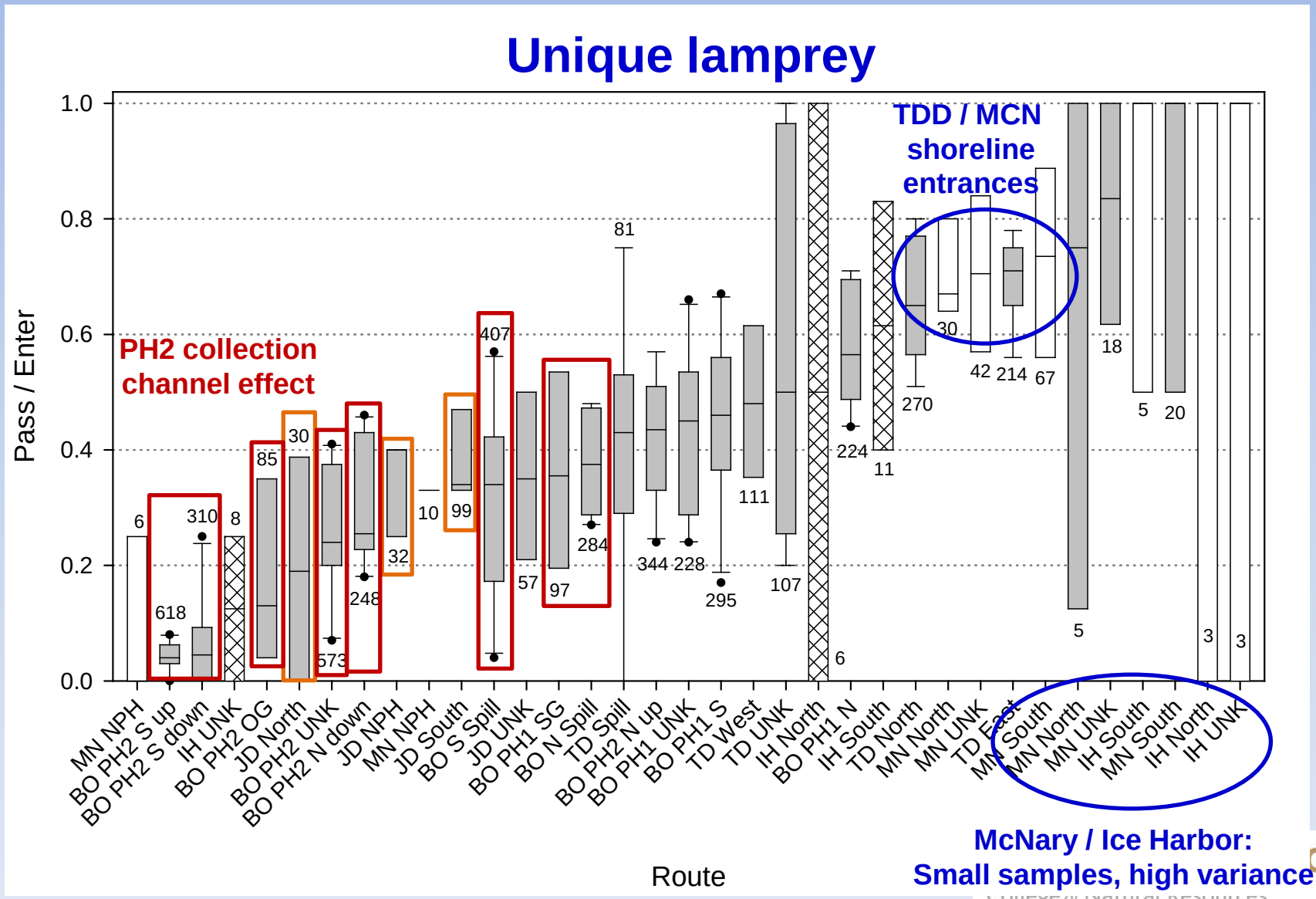
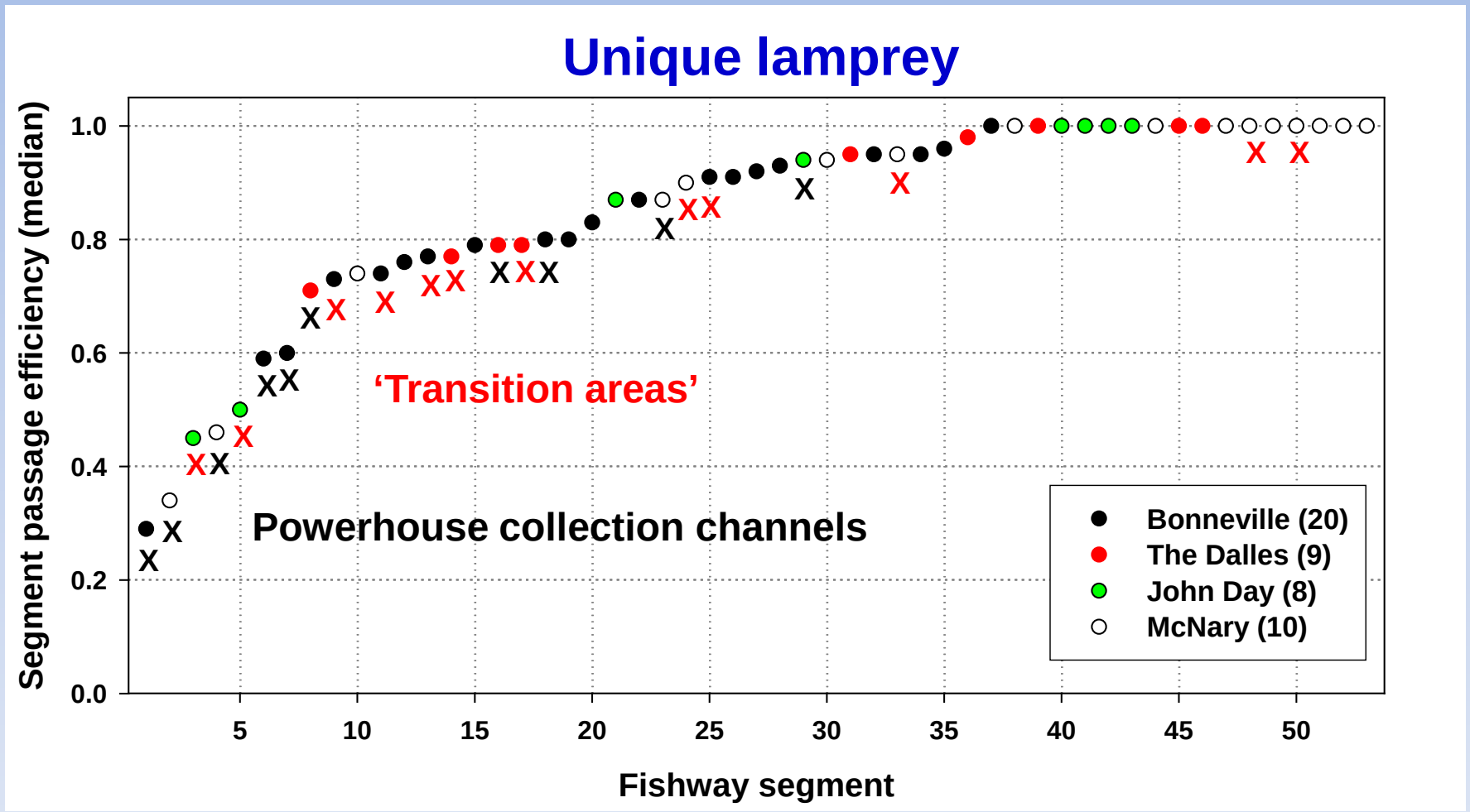
Route-specific dam passage efficiency



Fishway segment efficiency



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Conclusions?

- Among-dam comparisons = Apples & Oranges
- That said, lamprey performance clearly differs among projects

Dam-wide fishway and dam passage efficiency:
Bonneville ~ John Day << The Dalles ~ McNary

Weight of evidence approach: Priority sites?

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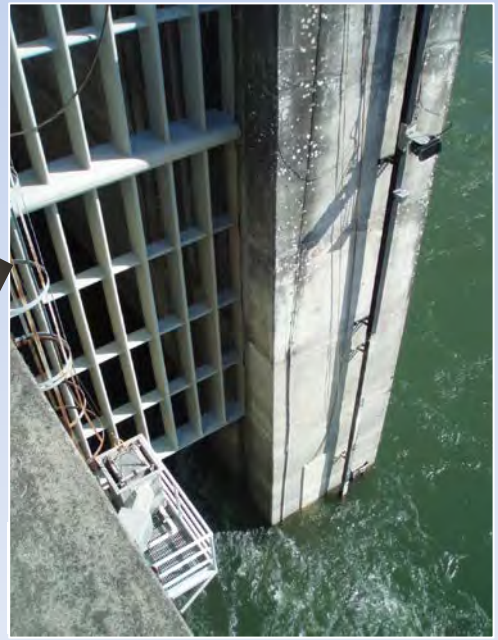
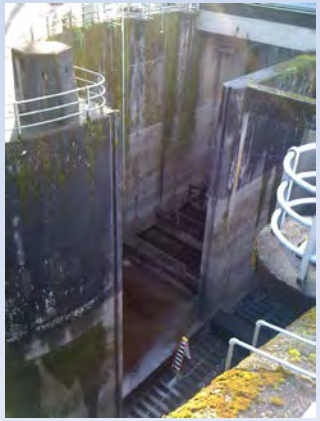
Conclusions

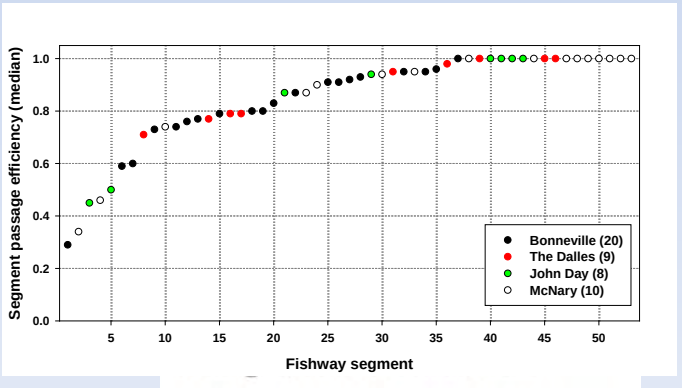
- Entrance efficiency varies 5-10 fold among sites
  - Site configuration differences
    - Some swim-bys complicate interpretation
    - Velocity, turbulence, structures all differ
    - Attachment surface availability



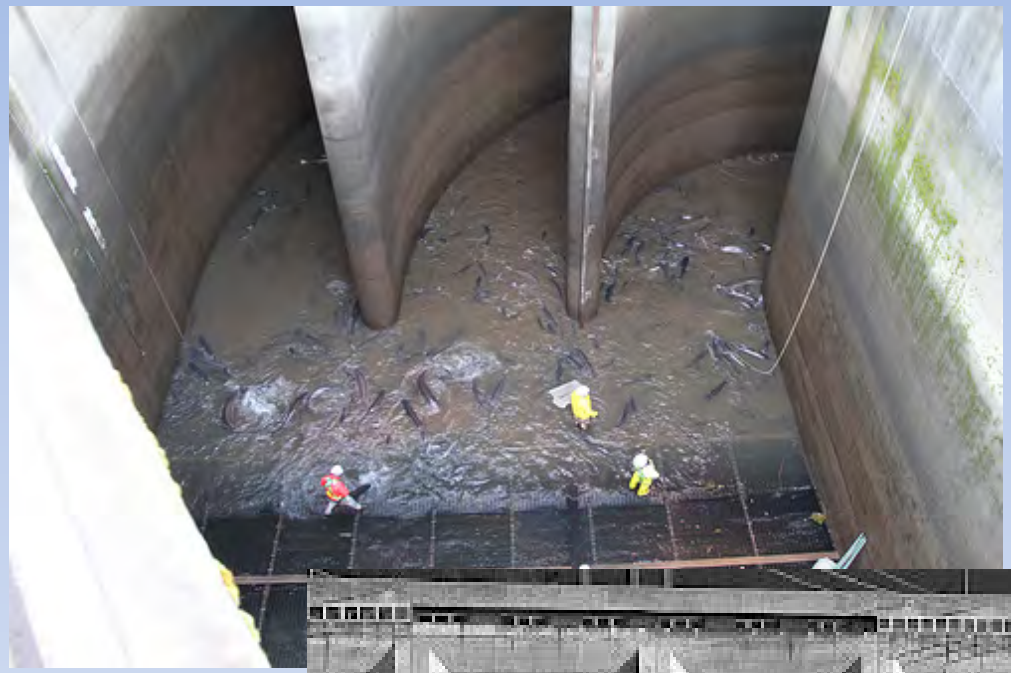
Conclusions

- Fishway segments vary widely in the difficulty they present to lamprey passage
  - Truism 1: powerhouse collection channels are relatively ineffective for passing lamprey
  - Truism 2: transition pools present significant passage challenges (*not just for lamprey*)
  - Truism 3: there is scope for improvement at most fishway entrances and many fishway segments





Bottleneck relief models



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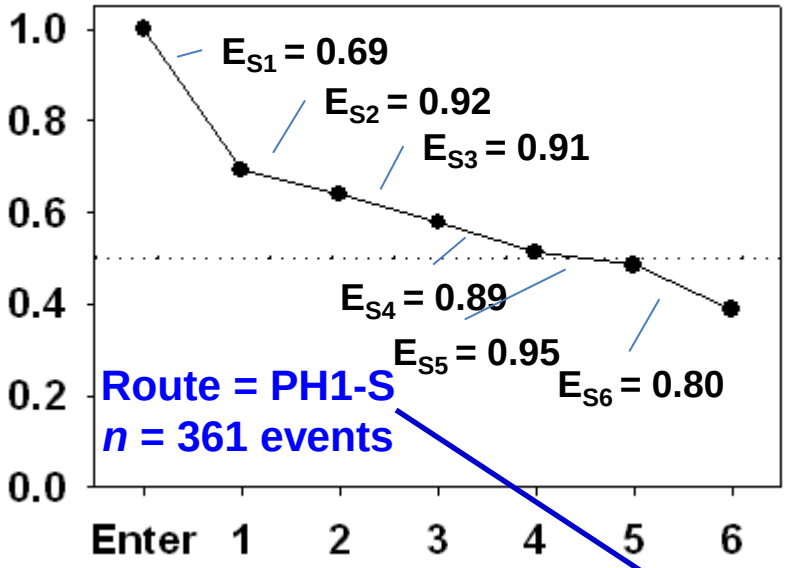
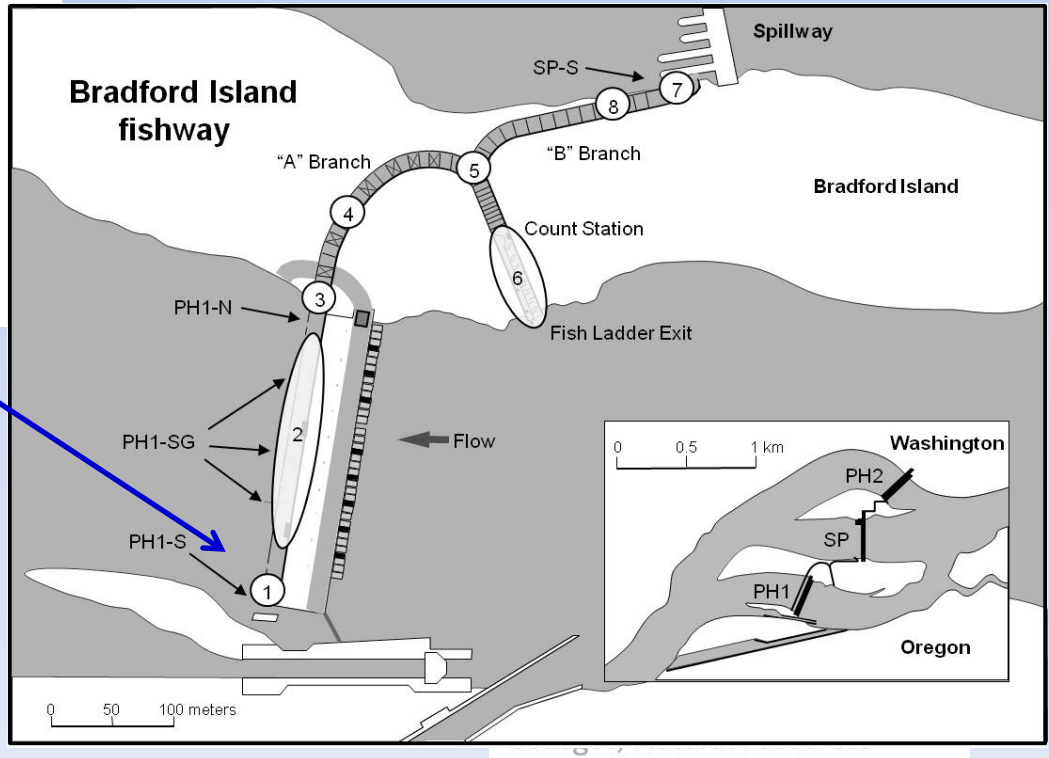
Bottleneck model objectives

- Assess the potential benefits of reducing lamprey passage bottlenecks at single dams
- Compare relative passage benefits of 'equal' improvements across fishway segments
- Prioritization recommendations
  - At the scale of individual projects
    - i.e., where to spend your Dam dollars

Bottleneck model methods



Source data = route×segment efficiency at event scale



Dam Passage =

$$(N_{events} \times E_{S1} \times E_{S2} \times E_{S3} \times E_{S4} \times E_{S5} \times E_{S6})$$

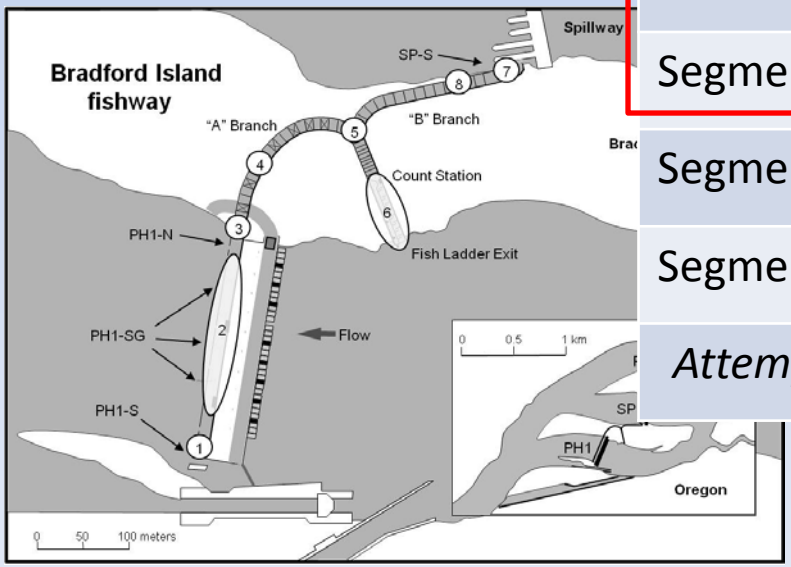
= 141 lamprey past dam

Bottleneck model methods

Dendritic fishways result in unequal numbers of lamprey in each segment

Bradford Route×Segment efficiency matrix

	PH1-S	PH1-SG	PH1-N	PH1-UNK	SP-S
Segment 1	0.69			0.96	
Segment 2	0.92	0.68		0.79	
Segment 3	0.91	0.74	0.77	0.77	
Segment 4	0.89	0.85	0.84	0.87	
Segment 5	0.95	0.88	0.91	0.92	0.98
Segment 6	0.80	0.88	0.83	0.82	0.82
Segment 7					0.51
Segment 8					0.79
Attempt n	361	114	264	255	541



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Bottleneck model methods

Bottleneck model approach

1) Hyp: Increase segment efficiency (E_S) by Y%

Bradford Routes

	PH1-S	PH1-SG	PH1-N	PH1-UNK	SP-S
Segment 1	0.69			0.96	
Segment 2	0.92	0.68		0.79	
Segment 3	0.91	0.74	0.77	0.77	
Segment 4	0.89	0.85	0.84	0.87	
Segment 5	0.95	0.88	0.91	0.92	0.98
Segment 6	0.80	0.88	0.83	0.82	0.82
Segment 7					0.51
Segment 8					0.79
Attempt n	361	114	264	255	541

0.80×1.05 = 0.84
0.80×1.10 = 0.88
0.80×1.20 = 0.96

Bottleneck model methods

Bottleneck model approach

1) Increase a segment efficiency (E_x) by Y%

2) Apply to each route that includes segment

3) Recalculate *n* past dam

Baseline = 581 past

New (E_6 ×1.10) = 637 past

4) Calculate increase in lamprey passage

= (New-Baseline) / Baseline

= (637-581) / 581

= 9.7% increase

Bradford Routes

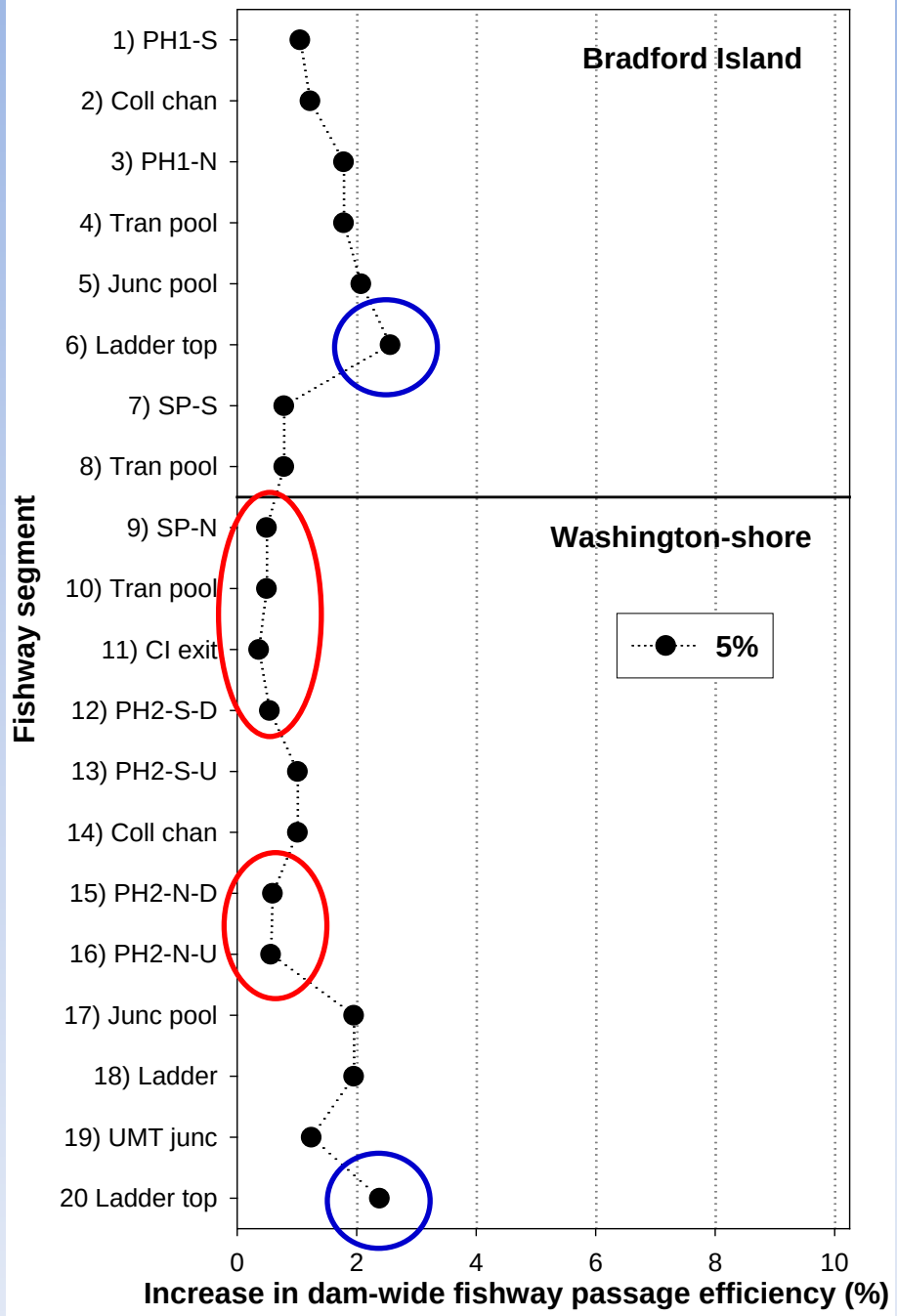
	PH1-S	PH1-SG	PH1-N	PH1-UNK	SP-S
Segment 1	0.69			0.96	
Segment 2	0.92	0.68		0.79	
Segment 3	0.91	0.74	0.77	0.77	
Segment 4	0.89	0.85	0.84	0.87	
Segment 5	0.95	0.88	0.91	0.92	0.98
Segment 6	0.80 ×1.10=0.88	0.88 ×1.10=0.97	0.83 ×1.10=0.91	0.82 ×1.10=0.90	0.82 ×1.10=0.90
Segment 7					0.51
Segment 8					0.79
Attempt n	361	114	264	255	541

Bottleneck model methods

- Identify ‘priority’ sites: Estimate effect of the same % increase segment by segment
  - Systematic, ‘relative’ comparison of benefits
- Tested 5%, 10%, and 20% increases at 4 Lower Columbia dams
  - ‘Scope for improvement’ limited at efficient sites
    - $E_x = 0.95 \times 1.10 = 1.05$, but efficiency > 100% impossible
    - In these cases, E_x capped at 1.00

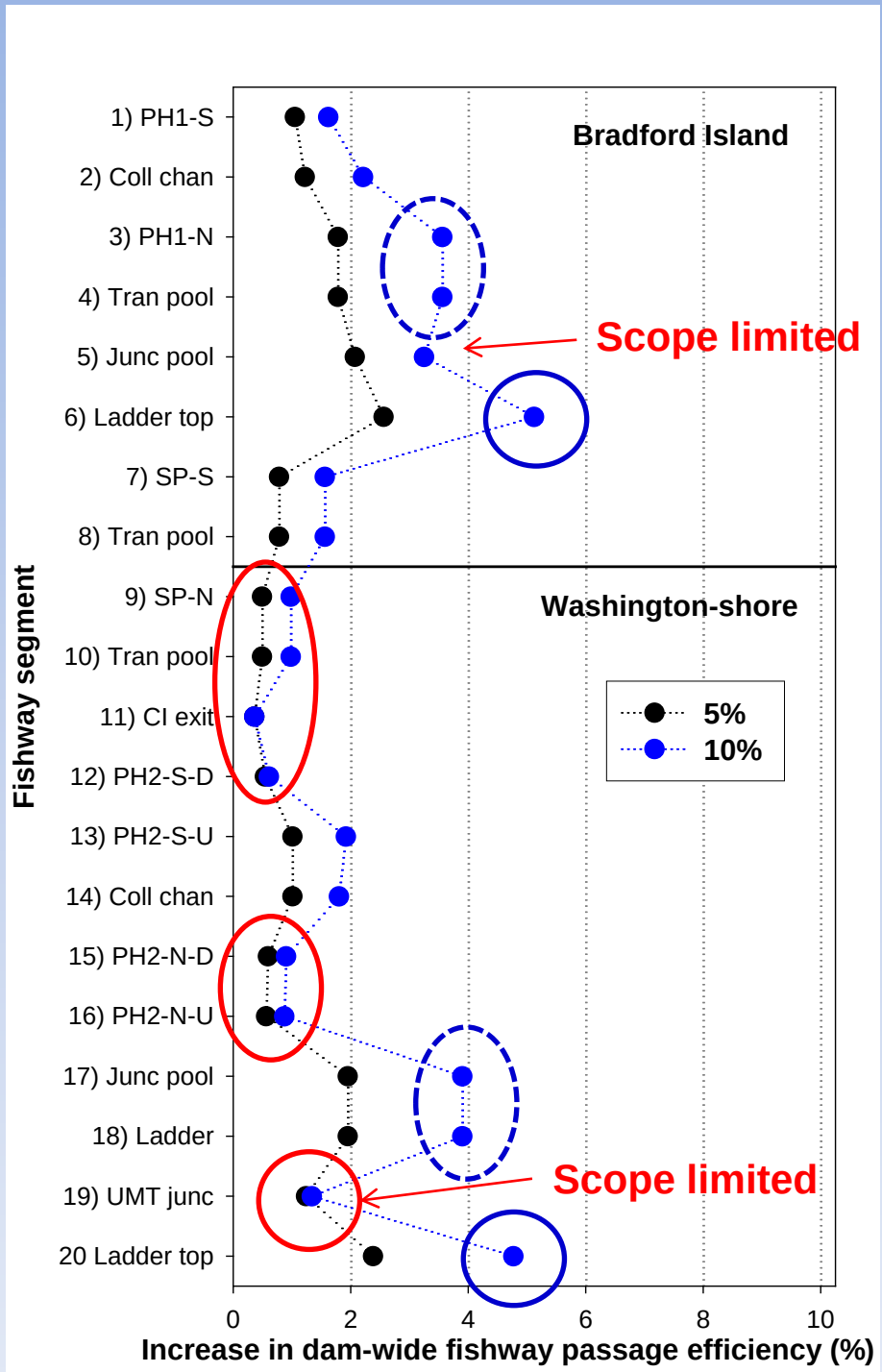
Bonneville results

- Test = +5%
- Lowest benefit
  - Cascades Is. segments
  - PH2 South coll. chan.
  - PH2 North coll. chans.
- Highest benefit
  - WA-shore top (+2.4%)
  - Bradford top (+2.6%)



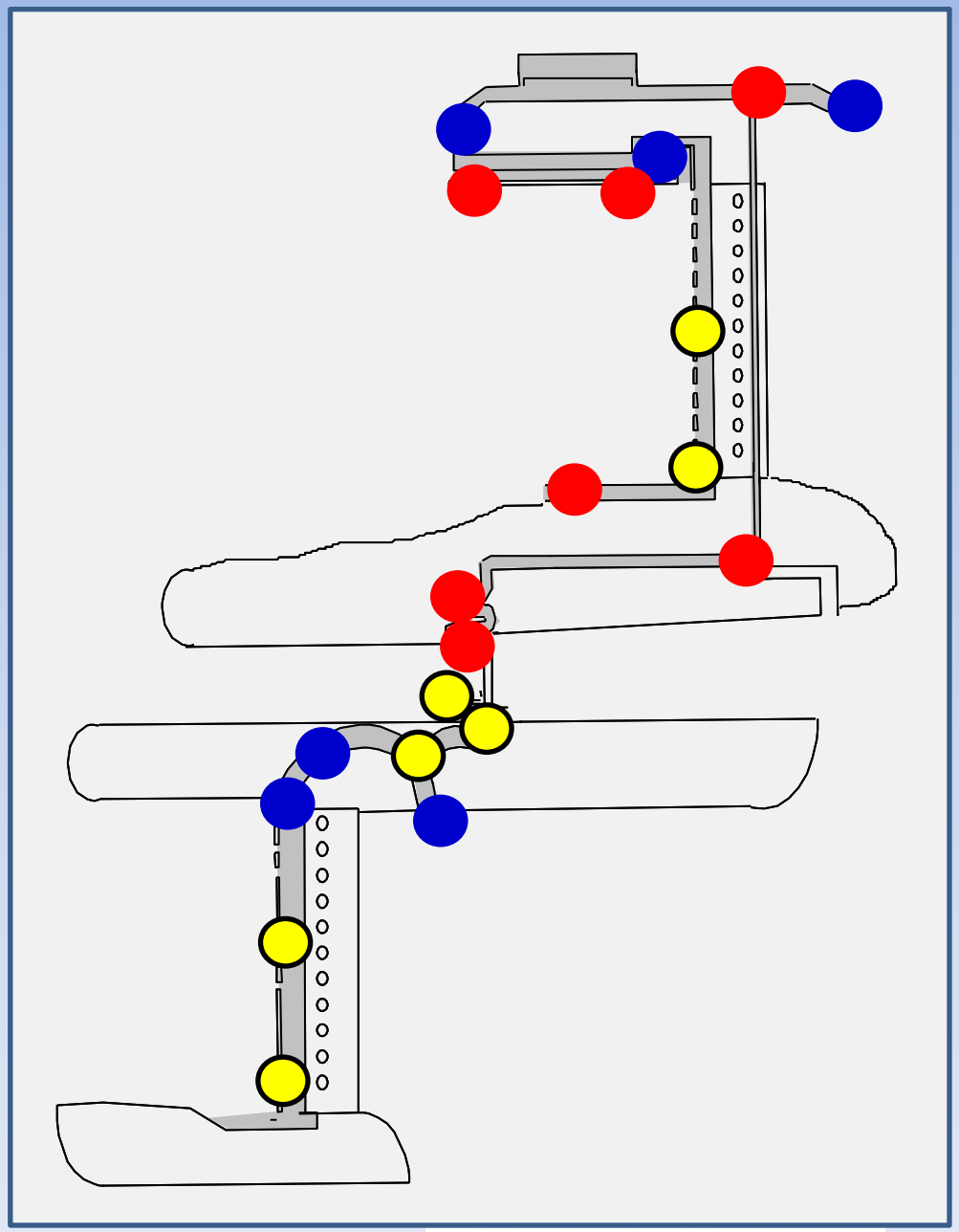
Bonneville results

- Test = +10%
- Highest, lowest benefits
  - Same sites
- Tier 2
  - WA-shore junction pool
  - WA-shore lower ladder
  - PH1 north coll. channel
  - A-branch transition pool

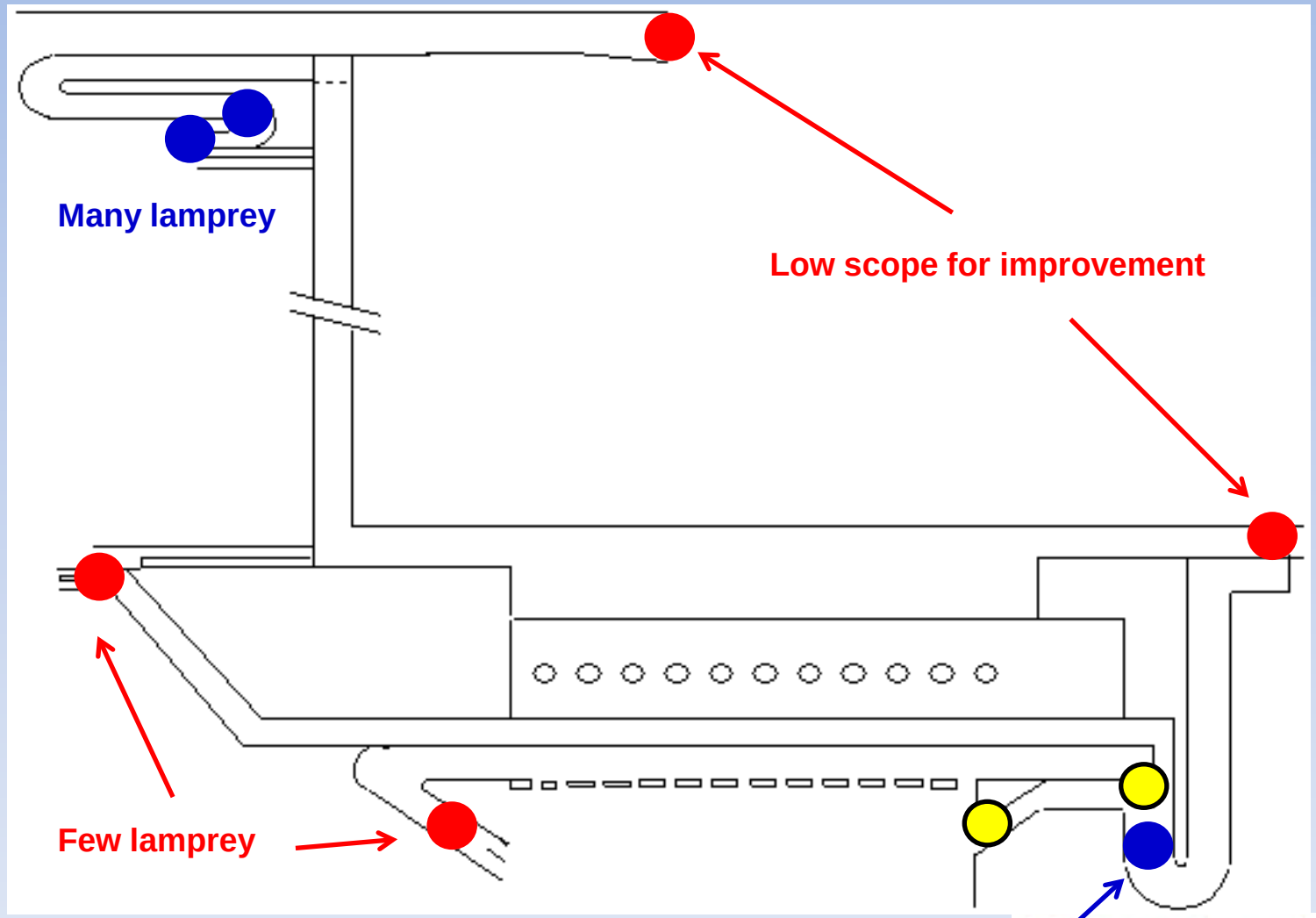


Bonneville results

- High benefit sites
  - Many lamprey
  - Multiple routes
  - Sufficient ‘Scope for improvement’
- Low benefit sites
  - Few lamprey (CI)
  - Limited ‘scope for improvement’ (UMT)
  - Serious bottlenecks upstream



The Dalles results



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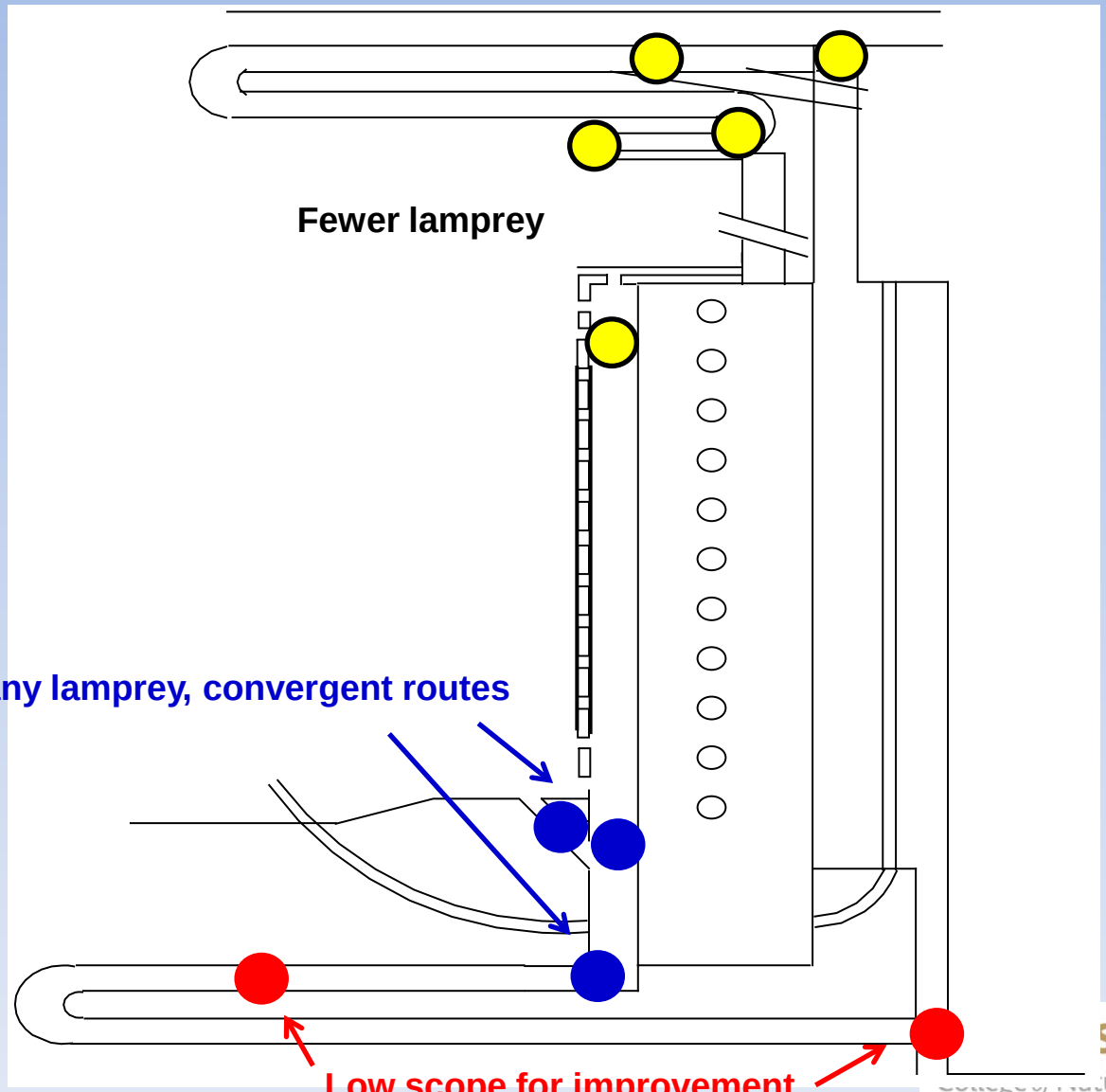
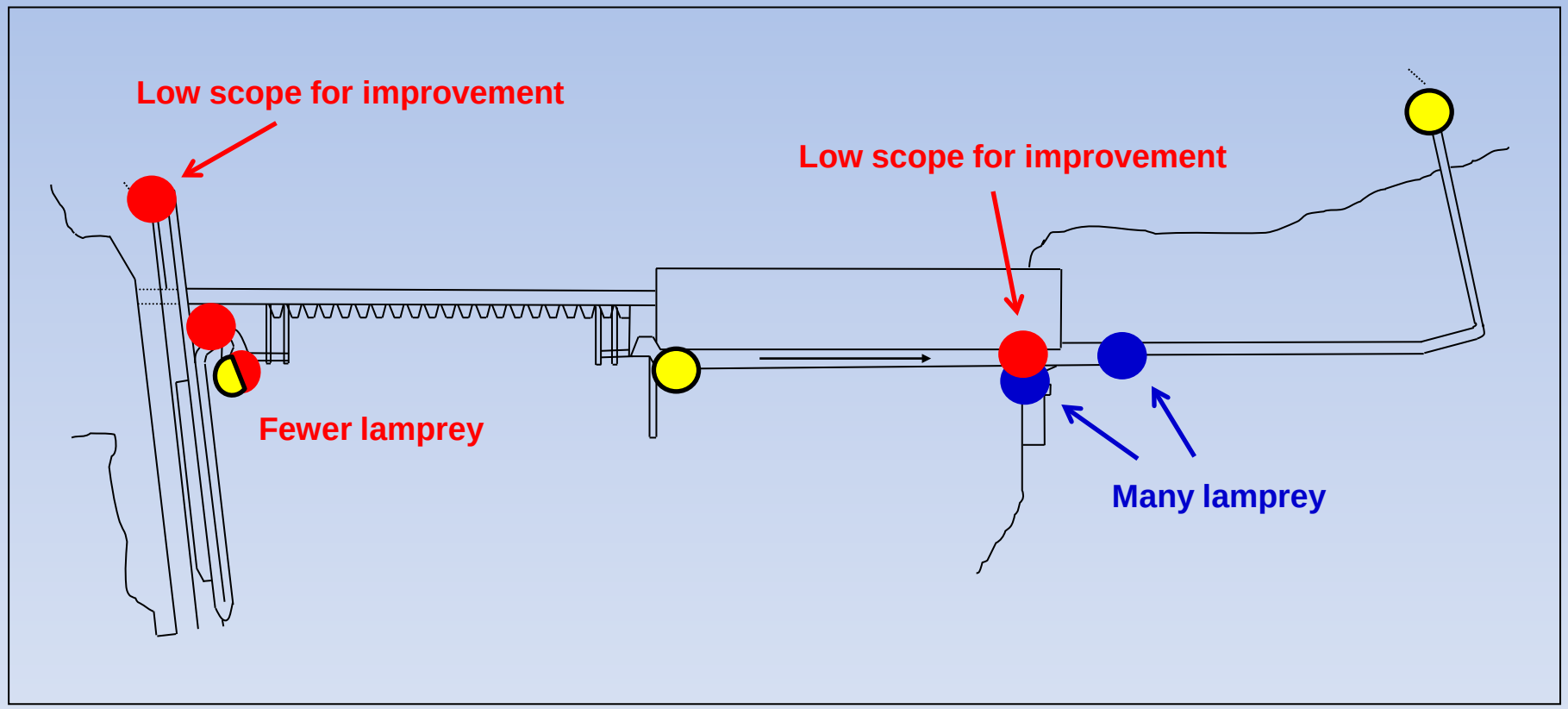
John Day results



Note: JD North is different today than during study years, and monitoring was inconsistent

McNary results



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Potential sites to prioritize

- Bonneville
  - Top-of-ladder serpentine weirs
  - WA-shore junction pool
  - A-branch transition area
    - Truism: Multiple-route sites may be higher priority
- The Dalles, John Day, McNary
  - Truism: Transition pool solutions sorely needed
  - Truism: Failure mechanisms in powerhouse collection channels are unknown

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Questions?

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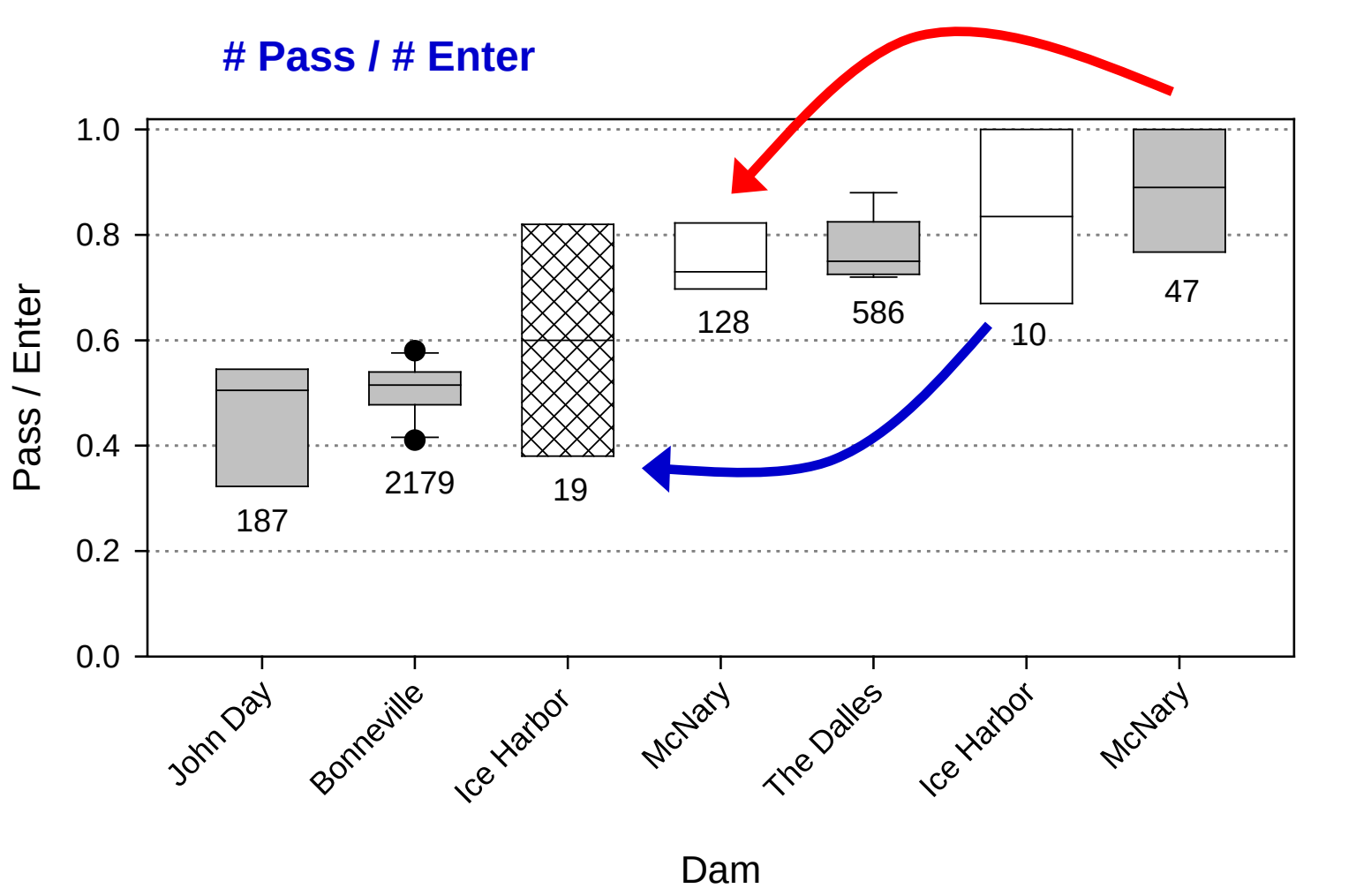
Dam-wide fishway passage efficiency



Downstream-released fish generally had higher efficiency than on-site releases

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