Fishway passage, water diversion and warming temperatures: Factors limiting successful spawning migration of Seton-Anderson watershed sockeye salmon

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Background

- Research by the IPSFC in the 70s / 80s found that sockeye were attracted to powerhouse tailrace on the Fraser River.

- Their experiments suggested potential dilution with Cayoose Ck for Gates (20%) and Portage (10%) sockeye would maximize attraction into Seton River (these dilution rates used today).

- Still, migration mortality rates were ~ 10% and 30% for these stocks respectively with these dilution levels.

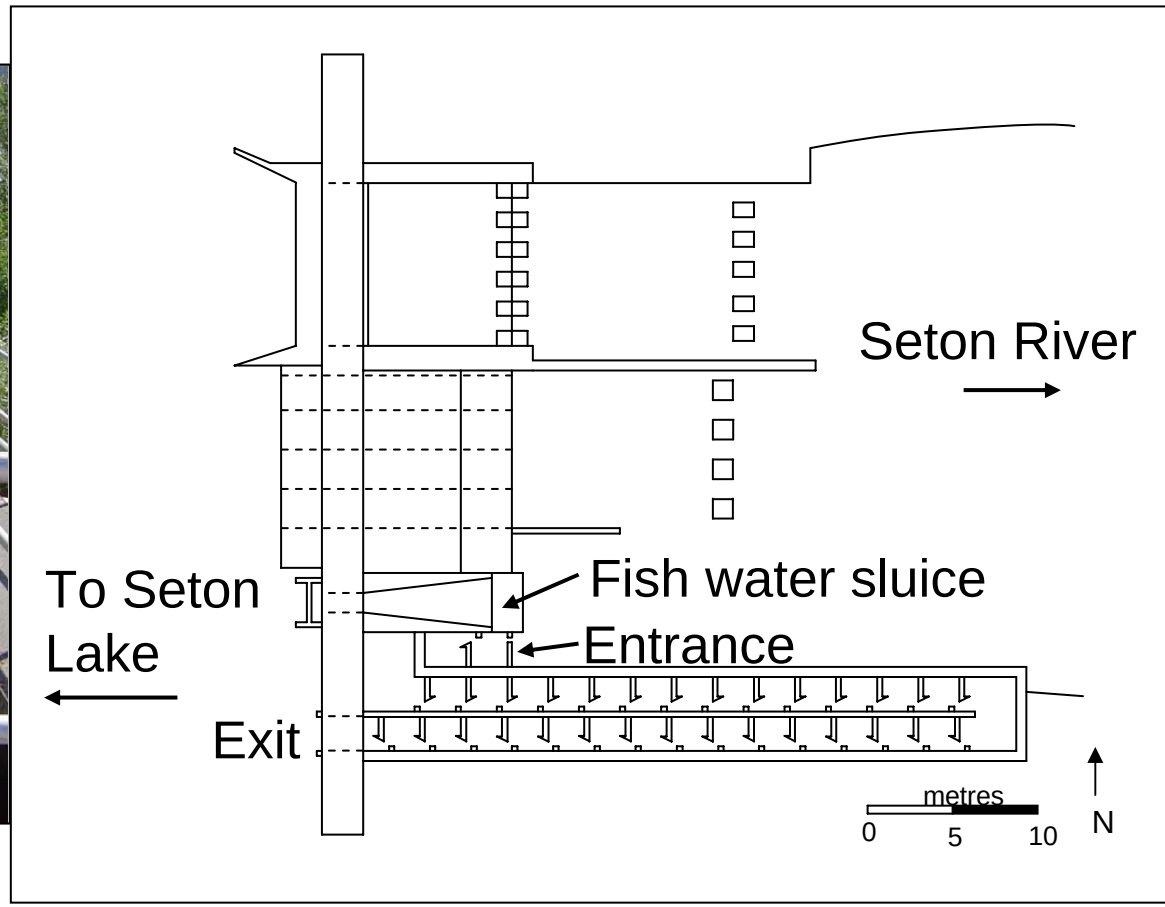
Background

- First thorough evaluation of fishway attraction and passage in 2005 by UBC
- Found 23% failure to enter fishway, but ~ 0% failure to ascend fishway
- Found 33% of fish that exited fishway disappeared before reaching spawning grounds; another 13% that exited were reported captured in fisheries
- Thus, previous work suggests cumulative mortality may be high in the Seton Anderson watershed (~50% of fish that approach tailrace on Fraser do not reach spawning grounds).
- Needed was a study to examine relative levels of mortality throughout the Seton system in a single year

Objectives of UBC 2007 study

- Quantify mortality along the migratory route in the Seton-Anderson watershed
- Evaluate fishway effectiveness
- Assess impact of fishway on migration success
- Identify needs for management experiments and future research

Seton dam fishway – capture locale at top pool

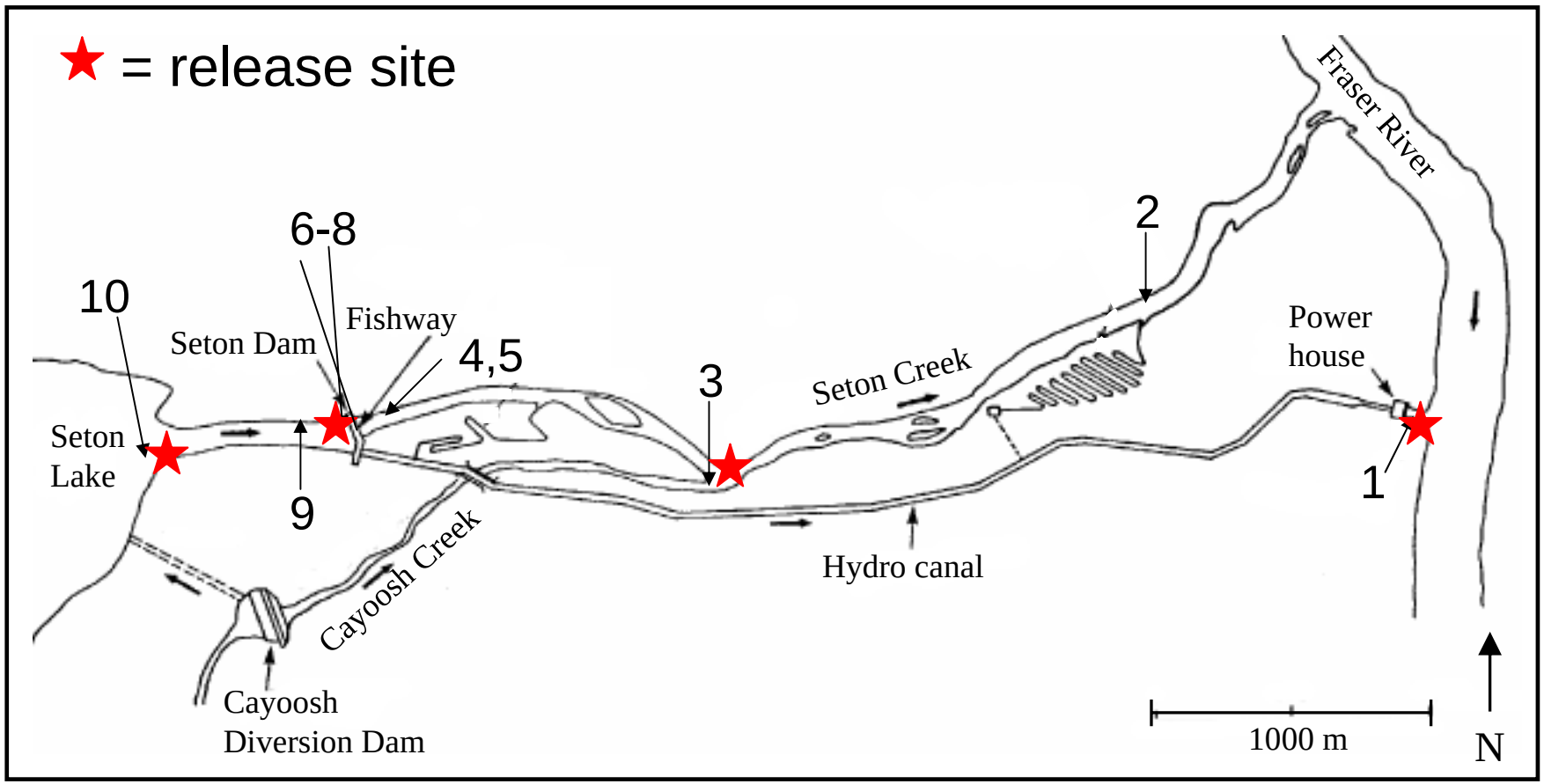


Methods

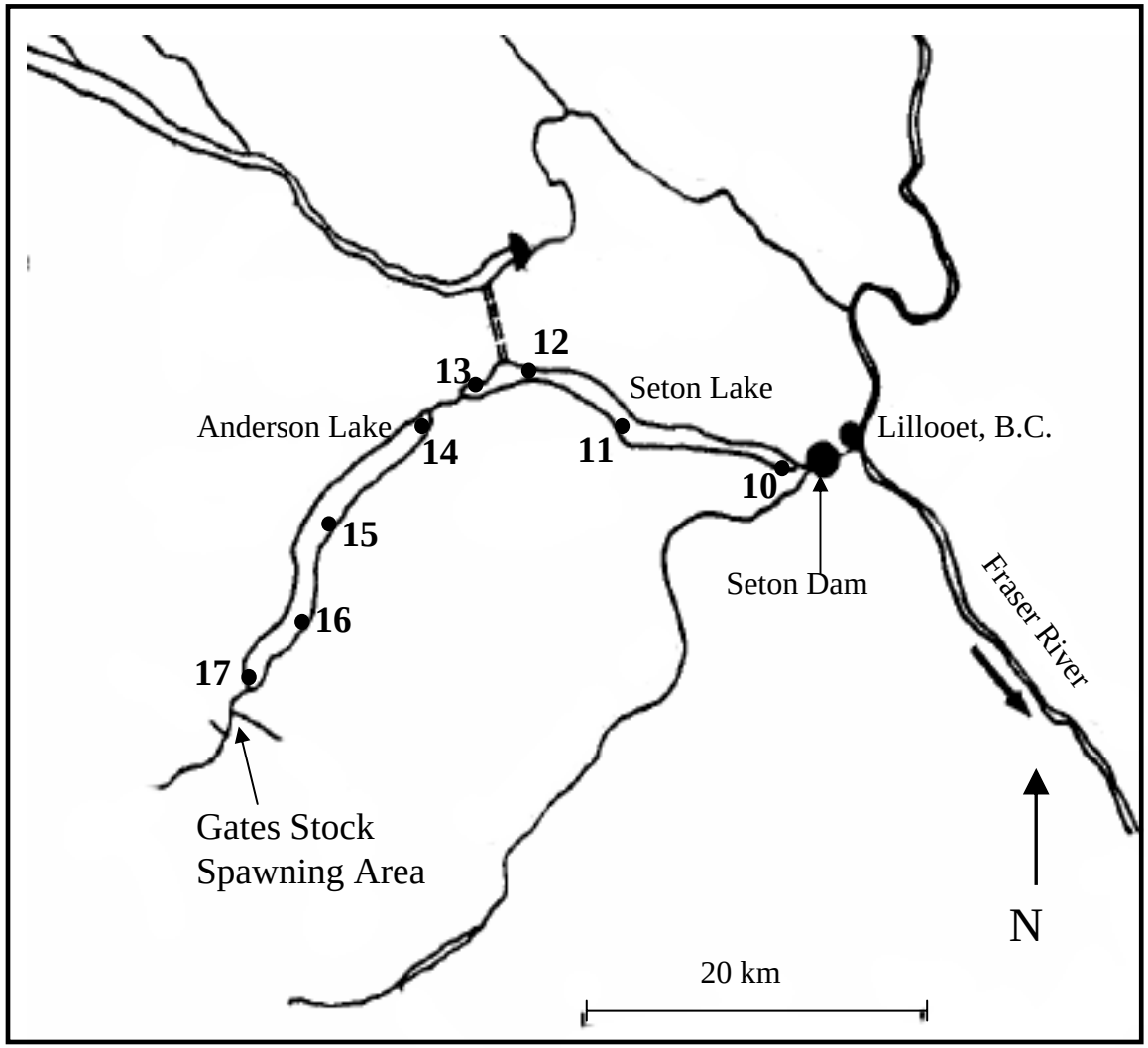
- Captured 88 sockeye from top of Seton dam fishway
- Sockeye transported by truck to release site and held for recovery in river
- Blood sampling (ions, lactate, glucose, hormones)
- Energy sampling (microwave fat meter)
- Implant acoustic telemetry transmitter, temperature data logger

Methods

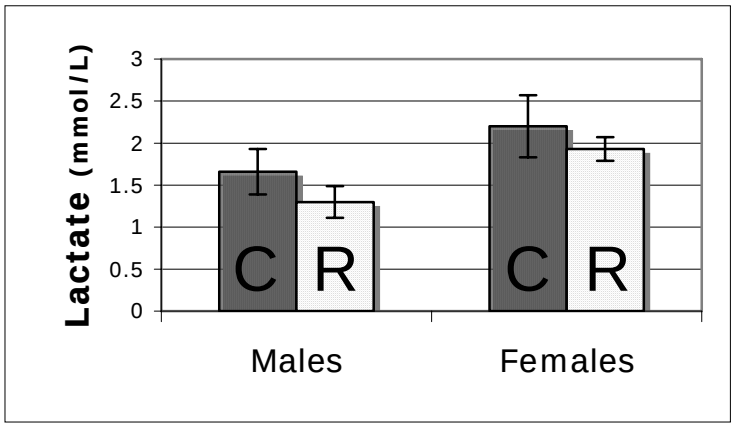
- Fish release sites
- Acoustic telemetry receiver array (lower section)

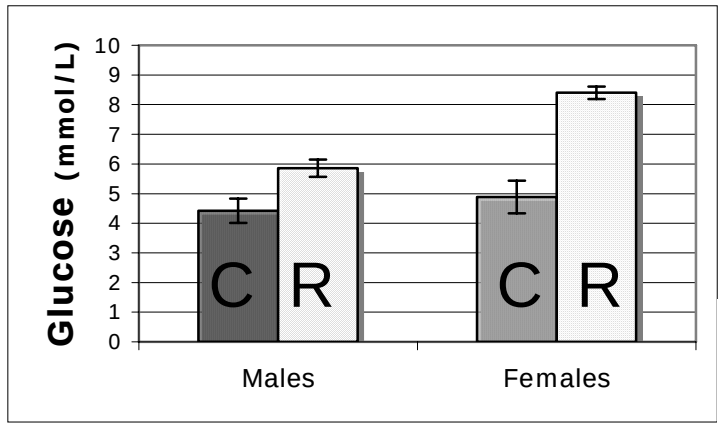


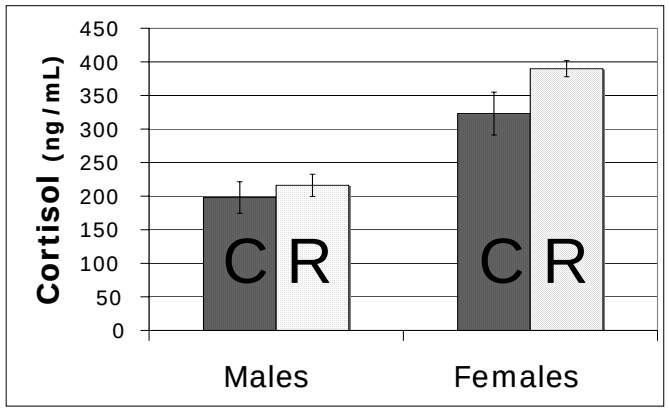
- Acoustic telemetry receiver array (upper section)

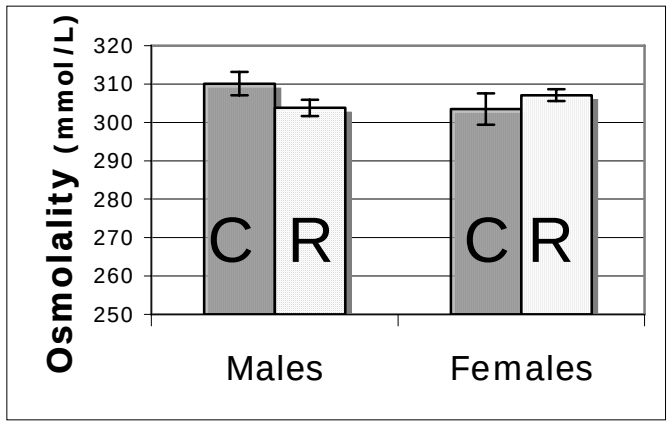


Results – Physiological Stress Indices









Control

Recovered

- Sockeye not physiologically stressed or exhausted after fishway ascent or transport (same as 2005 results).
- Mortalities and successful migrants did not differ in terms of most physiological measures.

Results: Mortality along the migratory route

Fish released downstream of dam

Fate	#	%
Successful migrant	27	48
Failed in Lake	10	18
Failed at dam/fishway	10	18
Did not reach dam	8	14
Fishery removal	1	2
Total	56	

Total loss = 52%

Survival to spawning grounds was greater for males (71% of 17 fish) than females (40% of 38 fish; *P*=0.03).

Fish released upstream of dam

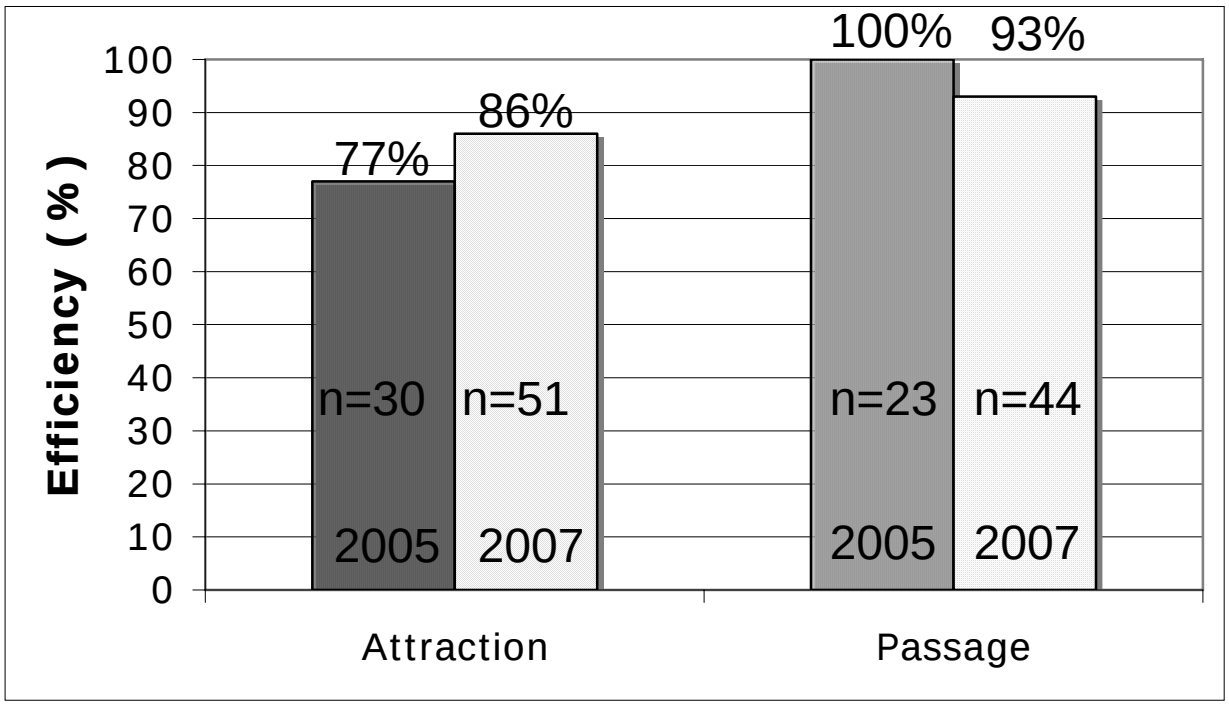
Fate	#	%
Successful migrant	26	93
Failed in Lake	2	7
Total	28	

No significant difference in survival between fish held for recovery and those released immediately.

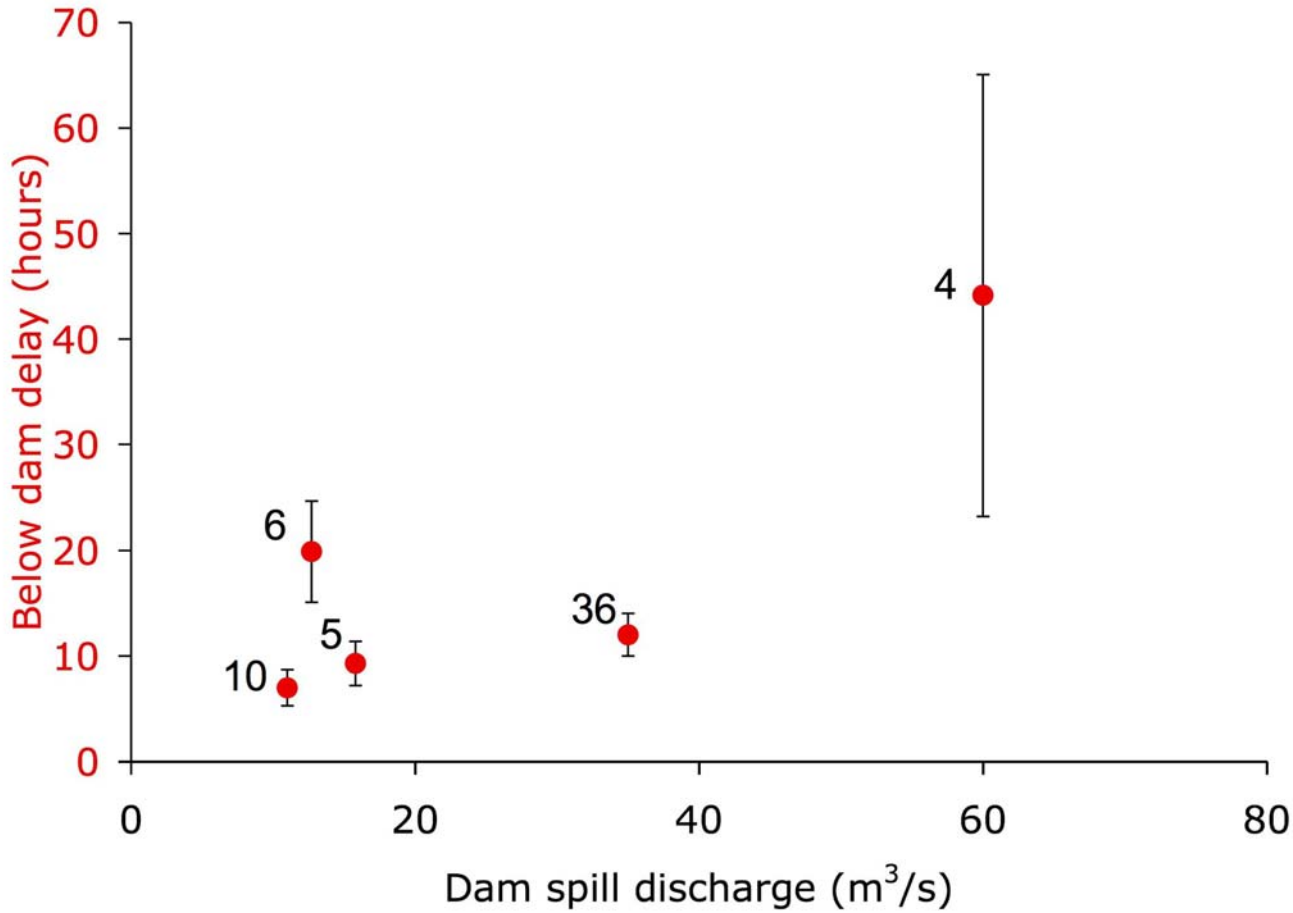
Results: Fishway evaluation

- 20% of tagged fish that reached the dam failed to pass fishway in 2007.

- Failure largely due to ‘attraction’ to entrance rather than passage through fishway.

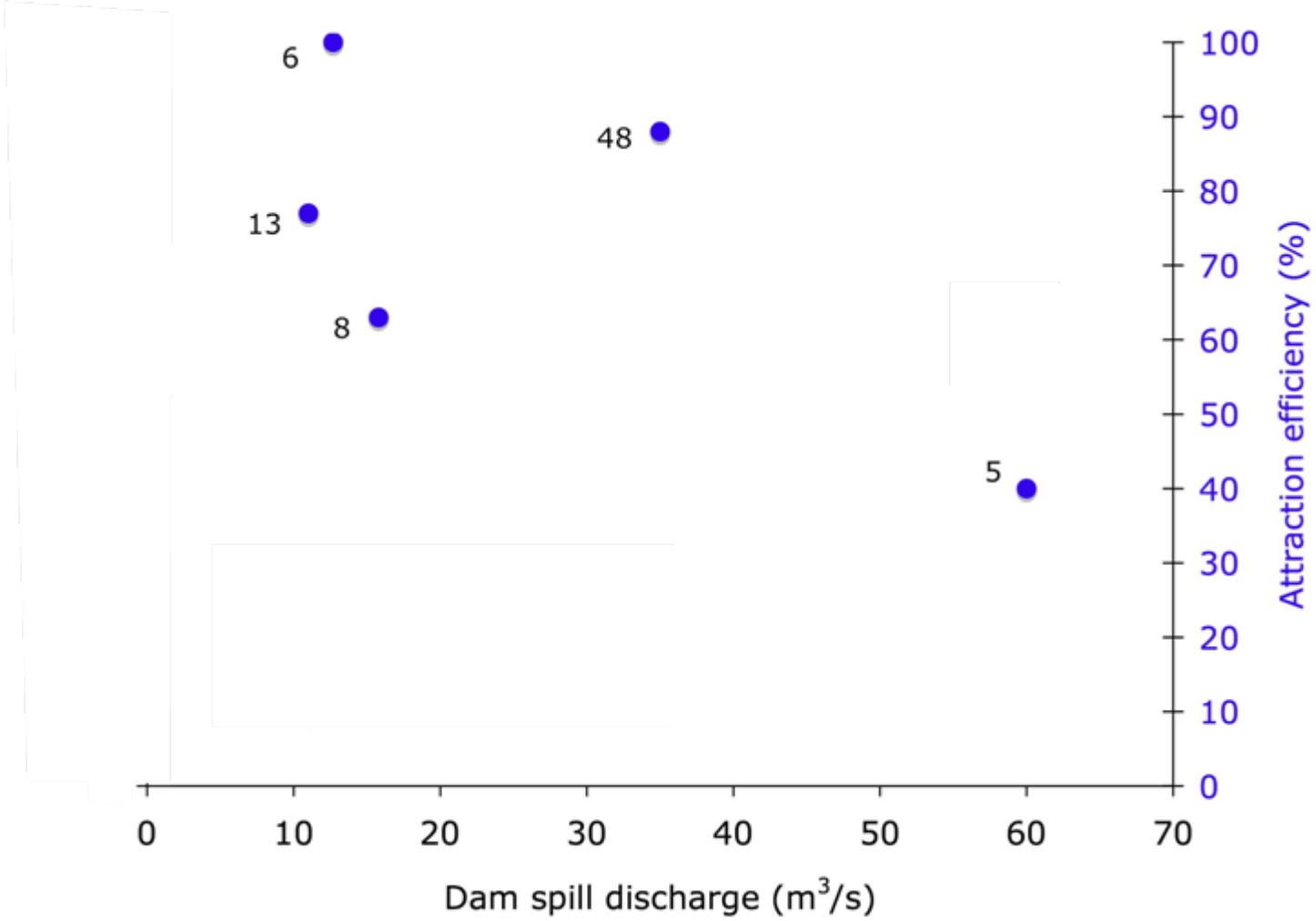


Results



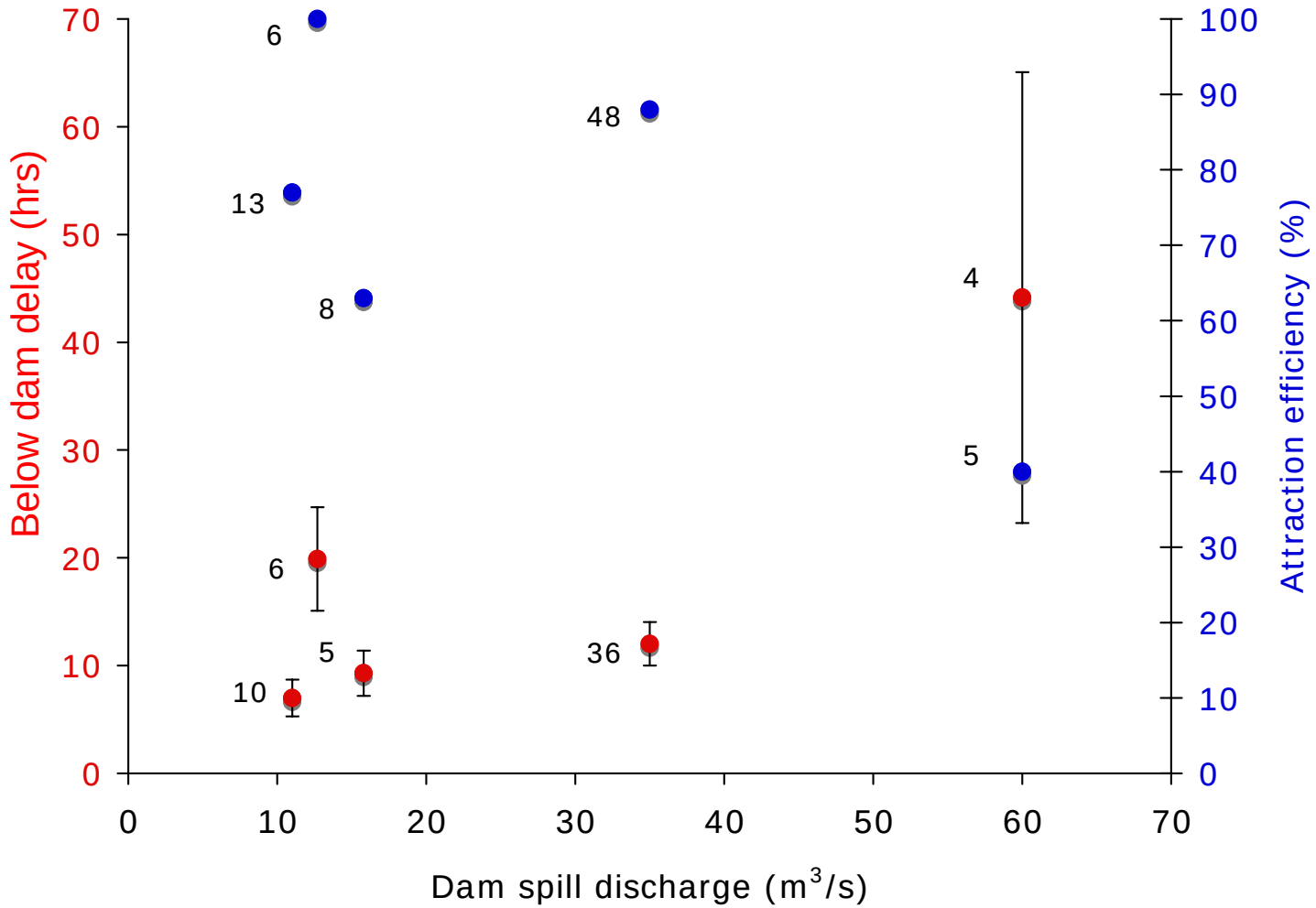
Delay at different discharges in 2005 and 2007

Results

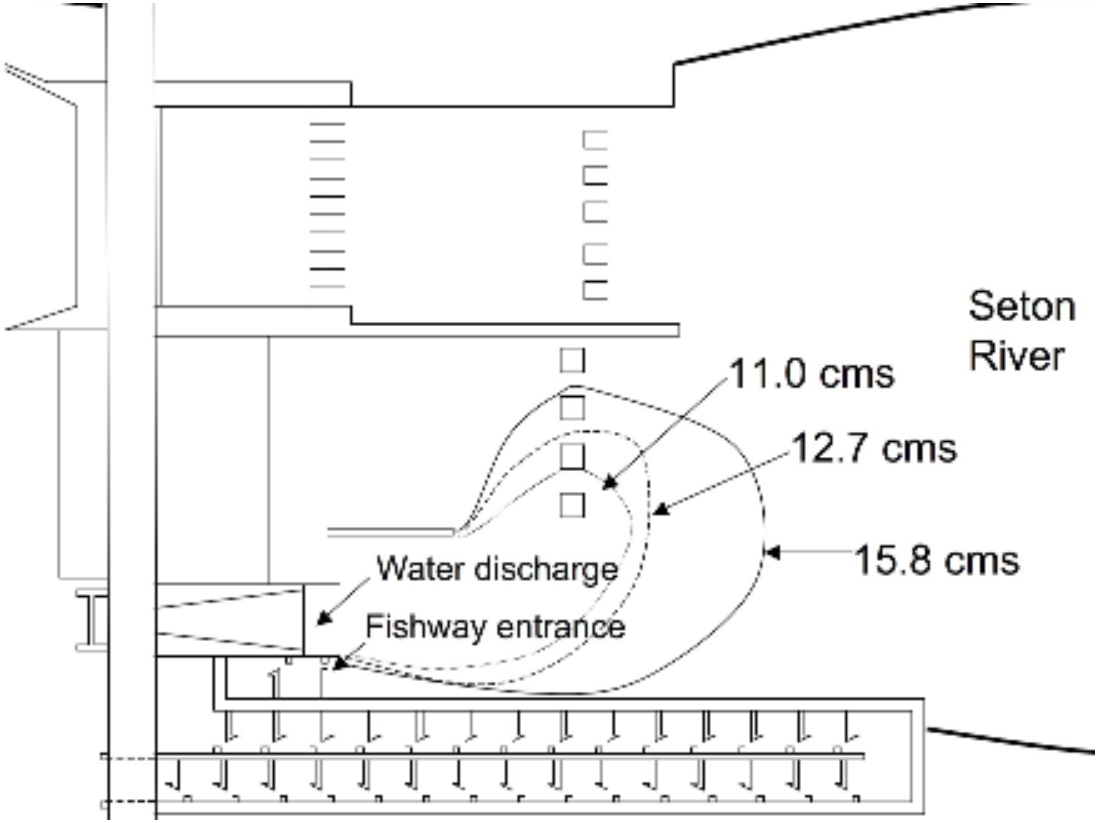


Attraction efficiency at different discharges in 2005 and 2007

Results



- Lowest attraction and longest delay at highest discharge
- Not a simple relationship between discharge and attraction

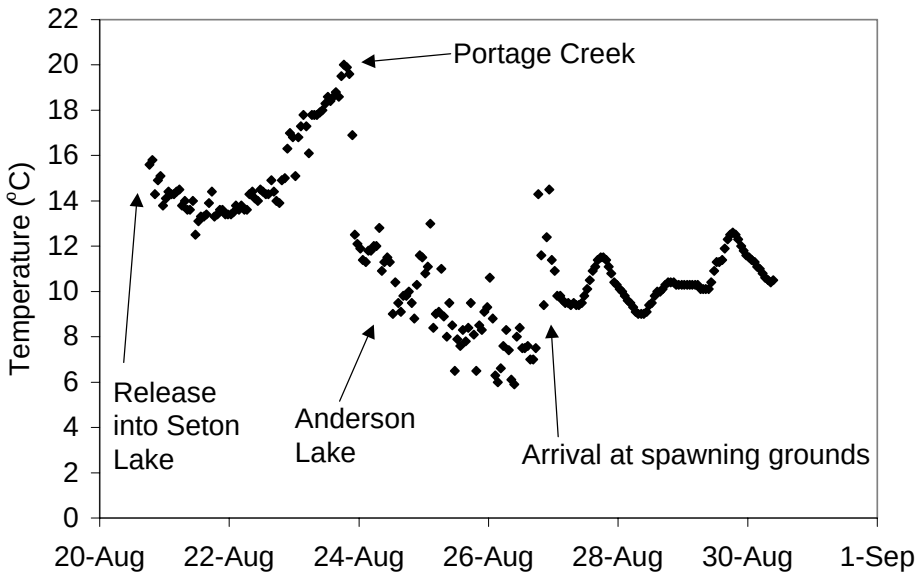

Seton
River
11.0 cms
12.7 cms
15.8 cms
Water discharge
Fishway entrance

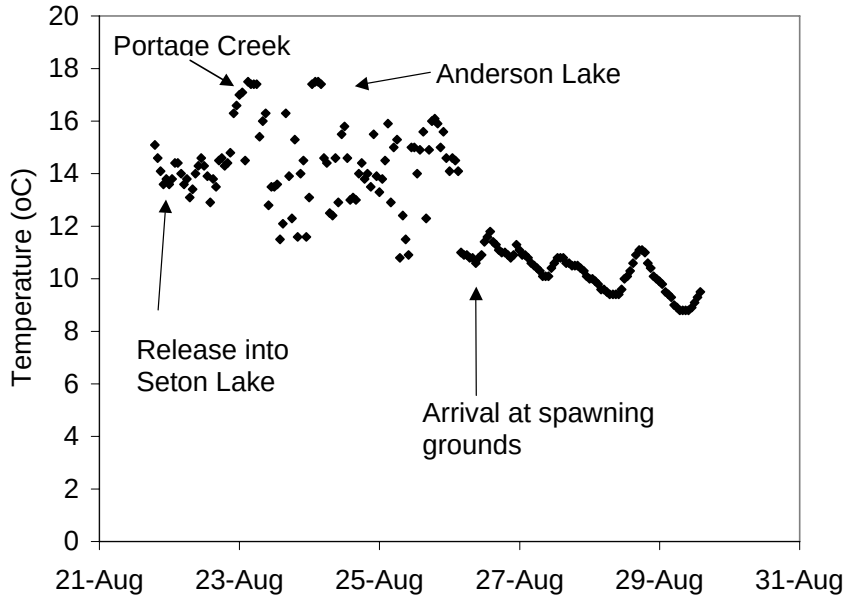

35 cms

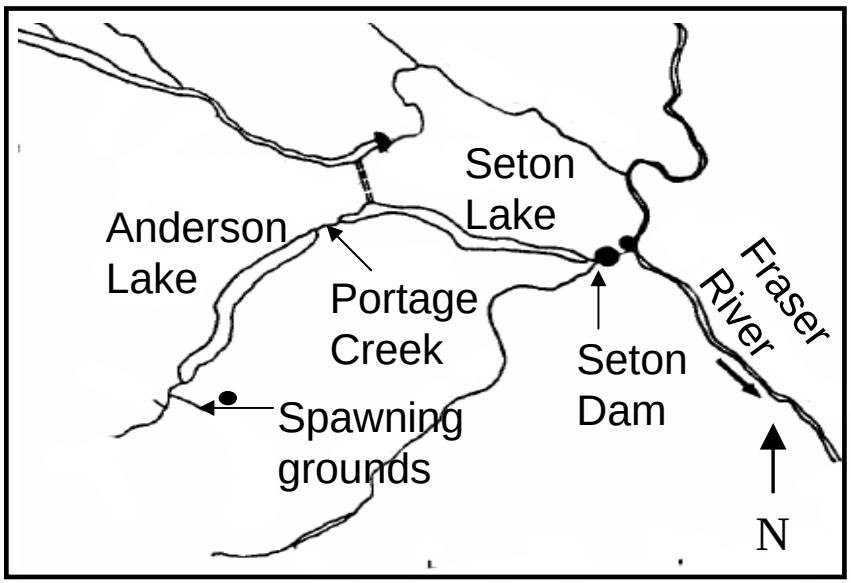

12.7 cms


60 cms

Results Temperature profiles of sockeye







- No thermal data for mortalities
- Very high and stressful temperatures rarely experienced
- Thermal refuges utilized by some individuals

Summary

- Sockeye were in good physiological conditions after fishway and ascent and transport.
- 48% of fish released downstream, and 93% of fish released upstream of the dam reached spawning grounds.
- Mortality was higher for females (71%) than males (40%).
- 20% of sockeye unable to pass fishway and most of failure associated with attraction to the entrance.
- Attraction into fishway and delay affected by discharge.
- Some fish (n = 5) were attracted to tailrace after falling back out of lower Seton River. Could be related to seeking an alternate route or a cool water refuge.

Recommendations

1) Temporary blockage in fishway could have serious consequences for populations of migrating sockeye.

   When fishway was temporarily blocked in 2007, some tagged sockeye (n = 3) moved out of the fishway and downstream to the Fraser River, and never returned to the fishway.

   The fishway exit should be monitored and maintained frequently (daily) during migration.

   Previous resistivity counter did not accurately count fish and may have impeded migration (UBC 2005 study).

   Managers should carefully consider effects of fish enumeration devices on passage and validate counts with videography and spawning escapement.

Recommendations

2) Some (n=5) fish in our study were attracted to the powerhouse tailrace on the Fraser River.

13% of tailrace ‘releases’ never made it to dam.

Research is needed to quantify delay when sockeye initially encounter the powerhouse tailrace on the Fraser River.

Recommendations

3) Relationship between attraction and discharge is complex.

High spill discharges (~60cms) from dam were associated with poor passage efficiency and long delays, small sample size.

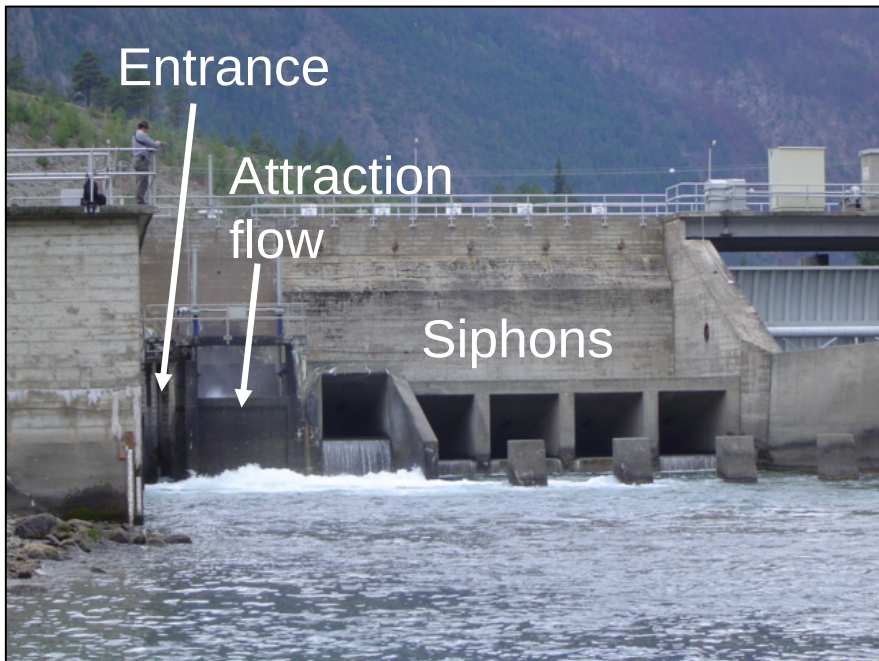
Management experiments are needed to examine relationships between discharge, flow patterns, attraction and delay.

Important questions to study:

- How do different discharges affect hydraulics and attraction?
  - use Acoustic Doppler Current Profiler

Can flow patterns (hence migration cues) be favourably altered via changes in water release at siphons?

- What are consequences of delay?



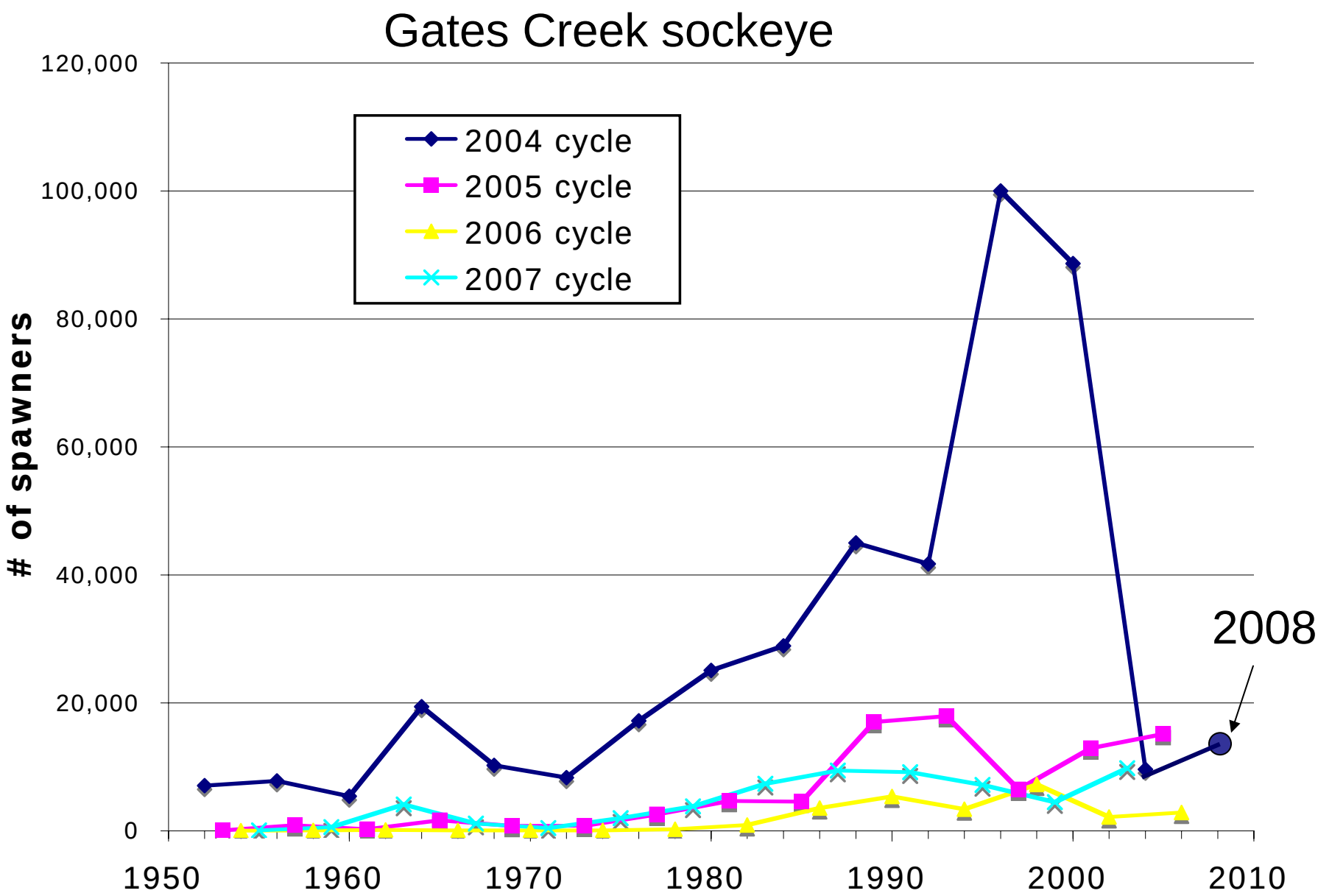
Recommendations

4) Annual population assessments needed downstream of dam.

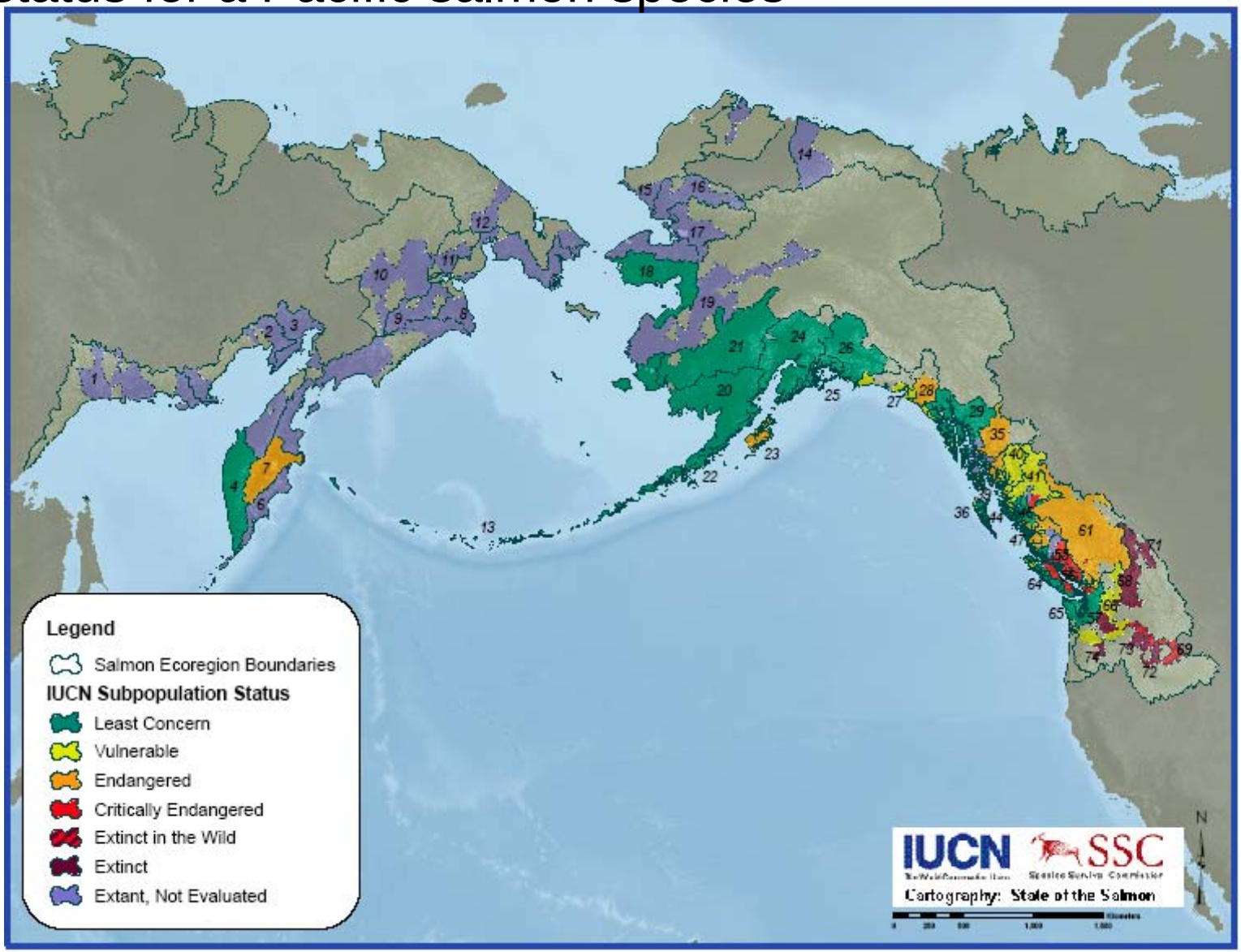
These data should be used in conjunction with fishway counts, spawning ground escapements and telemetry experiments.

We specifically recommend that research:

- use “fishway-naïve” individuals caught downstream of the dam
- minimize handling and capture stress (use trap-net / weir approach)

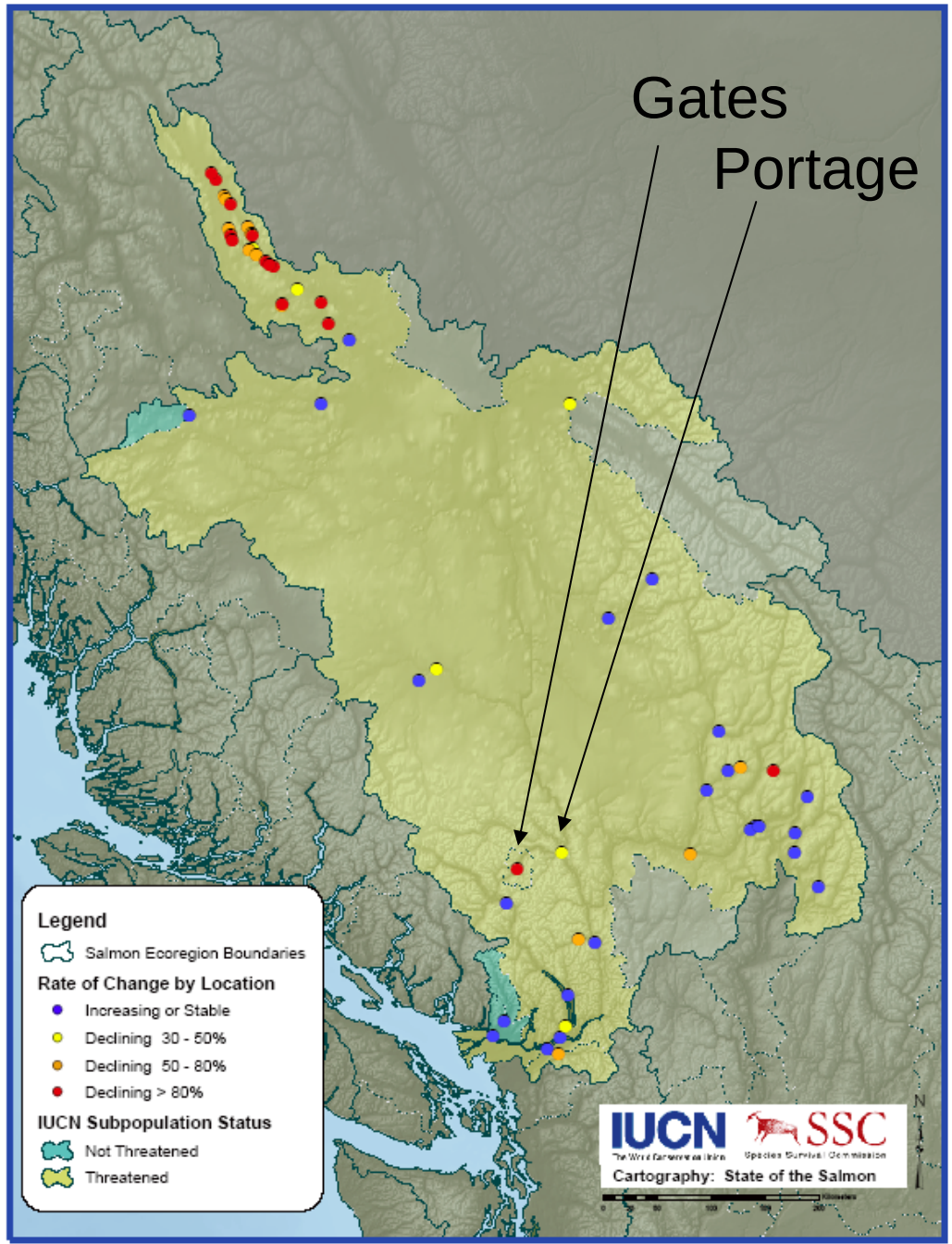

Gates Creek sockeye
120,000
100,000
80,000
60,000
40,000
20,000
0
# of spawners
2004 cycle
2005 cycle
2006 cycle
2007 cycle
2008
1950
1960
1970
1980
1990
2000
2010

- IUCN Report on sockeye salmon to be released next week
- First ever global assessment of endangerment status for a Pacific salmon species



Fraser sockeye stock status

- 51 populations assessed
- 21 least concern
- 6 vulnerable
- 10 endangered
- 14 critically endangered



Least Concern (no decline)
Vulnerable (30% decline 3 generations)
Endangered (50% decline)
Critically Endangered (80% decline)
Extinct in Wild
Extinct

IUCN Conclusions

- Gates Creek (“critically endangered”) and Portage Creek (“vulnerable”) sockeye populations have had declining escapements in recent cycles (Salmonid Specialist report for IUCN)

Thanks to …

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