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BURST SWIMMING IN AREAS OF HIGH FLOW: DELAYED CONSEQUENCES OF ANAEROBIOsis IN WILD ADULT SOCKEYE SALMON

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Fish Passage 2014
Acknowledgements

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‘Velocity Barriers’

Natural
high-gradient, constrained
rapids

Anthropogenic
dams
weirs

Migration delay and burst swimming
Impact on fitness and survival?
Seton-Anderson Watershed, BC
BC Hydro Seton Dam

- Radial gate spillway
- Siphon spillway
- Vertical-slot fishway
- Forebay
- Tailrace
- FWRG
- Fishway entrance
- FLOW

Flow direction: 0 - 5 - 10 meters
Attraction Flows

Purpose: facilitate upstream passage, minimize physiological stress
Our (Evolving) Thought Process

Gates Creek sockeye salmon (EN)  Pink salmon

2000  Unusually high contribution of burst swimming
      ‘Least economical swimmers’

2005  No burst swimming during fishway ascent (EMG)
      Burst swim in tailrace (tissue biopsy)

2007  Post passage survival consequences
      M vs. F mortality (29 vs. 60%)

Lee et al. 2003a,b, Pon et al. 2009a,b, 2012, Roscoe et al. 2011
Knowledge Gaps

1) Does burst swimming in high flows impose delayed consequences?

2) Why do females suffer exceptionally high *en route* mortality in the lakes upstream?

“important to assess the indirect effects of dams”
- Caudill *et al.* (2007) CJFAS
Objectives

1) Investigate how dam operations influence sockeye salmon swimming activity and behaviour

2) Determine whether energetic and behavioural alterations contribute to a failed migration

3) Identify operational strategies that provide optimal migration conditions for sockeye salmon
Predictions

1) Increased use of burst swimming would reduce post dam passage survival

2) Females would exhibit higher failure in dam passage and ability to reach natal sites
Methods

Gastric insertion

Acoustic accelerometer ($n = 63$)

Full-spanning fish fence (200 m DS)

Gates Creek spawning channel
BC Hydro Seton Dam

Forebay

Radial gate spillway

Siphon spillway

FWRG

Vertical-slot fishway

Fishway entrance

Tailrace

FLOW

meters

0 5 10
Influence of burst swimming on post passage survival?

Numbers below beans are sample sizes (n)

Lowercase letters: p < 0.05; Tukey HSD
Burst swimming has delayed consequences

**Key findings**

Burst swimming related to:
- Attraction flows
- Crossing attempts

*Carryover effect*

‘past experience has effect on current outcome’

O’Connor *et al.* 2014

Burnett *et al.* In press
Burst swimming has delayed consequences

**Key findings**
- Females swam with sig. more anaerobic effort
- $M$ vs. $F$ in-lake mortality
  - Roscoe *et al.* 2011: 29 vs. 60%
  - Current study: 31 vs. 56%
- …behavioural and/or physiological?
- Gates Creek (EN): high pre-spawn and *en route* mortality

*Burnett et al.* In press
Establish operational strategy
• reduce high flows without compromising attraction
• goal: optimize net survival to spawning grounds

Next step?
• experimental flow manipulations (2014)

Accelerometry – ADCP link
• bridge gap between biology and engineering
• understand what subsurface flow features challenge wild fishes
Conclusions and Implications

Burst swimming near fishway entrance
- needed to traverse areas of high flow
- strongest predictor of high in-lake mortality (females)
- carryover effect from experience in tailrace

BC Hydro operations
- attraction flows represent ‘velocity barrier’
- goal: minimize undue physiological stress

Fisheries
- (better) predict en route mortality
- manage local subsistence fisheries that target an endangered stock

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