Straying, stress, and performance on the spawning grounds by hatchery-produced chum salmon in Southeast Alaska*

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* In review. Email me if interested in advanced copy
What do we know about straying?

- A biological phenomenon, not an aberration (Quinn 2005)
- Facilitates (re)colonization (Hendry et al. 2004)
- Differs among species, populations, and life history types (Westley et al. 2013)
- Is influenced by climate, water temperature, and population density (social interactions?) (Westley et al. 2015, Berdahl et al. 2016)
- Can be elevated by human disturbance (Keefer et al. 2008, Bond et al. 2017)
- Mediates hatchery wild interactions on spawning grounds
What we do **not** know?

- A failure to home or a choice to stray?
- At what point in the life history is the ‘choice’ determined?
- Why are some sites attractive to strays while others are not?
- What about wild fish?
- What are key proximate factors of influence?
- Very little known about pink or chum salmon straying
Towards a better understanding

- A failure to home or a choice to stray?
- At what point in the life history is the ‘choice’ determined?
- Why are some sites attractive to strays while others are not?
- What about wild fish?
- What are key proximate factors?
- Comparably nothing known about pink or chum salmon straying
Driving questions

Is stress associated with ‘choice’ to home or stray?

Is stress associated with performance (stream-life and egg retention) on the spawning grounds?
Plasma surges of cortisol are associated with olfactory imprinting by juveniles and memory recall of odors by migrating adults (Hasler and Scholz 1983, Dickhoff et al. 1990, Carruth et al. 2002)
Our approach (stress and straying)

Compare two proxies of stress, vateritic otoliths and blood plasma cortisol concentrations between:

1. Wild-born fish on the spawning grounds (presumed home)
2. Hatchery-born fish on the spawning grounds (strays)
3. Hatchery-born fish returned to hatchery (home)
Our approach (stress and performance)

Compare two proxies of reproductive performance, stream life and egg retention between:

1. Wild-born fish on the spawning grounds (presumed home)
2. Hatchery-born fish on the spawning grounds (strays)
Study sites and sample collection

Sawmill Creek ca. 40 km north of Juneau
~500m of spawning habitat

Macaulay Salmon Hatchery

Hatchery-born fish that returned home (vaterite)
Salmon Creek (adjacent to hatchery)

Wild-born vs. hatchery-born fish on spawning grounds (vaterite, cortisol, performance)
Sampling methods

step 1: catch fish entering creek

Sampling methods
step 2: blood draw

Sampling methods

step 3: tag and measure

Sampling methods

step 4: track and recover fish and otoliths

Sampling methods
step 5: quantify egg retention

Results

Is stress associated with ‘choice’ to home or stray?

• Vaterite levels and straying
  – Hatchery home: 45% vaterite (n=181)
  – Hatchery Strays: 40% vaterite (n=191)
Results

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Results

Is stress associated with ‘choice’ to home or stray?

• Vaterite levels and straying
  – Hatchery home: 45% vaterite (n=181)
  – Hatchery Strays: 40% vaterite (n=191)
  – Wild: 24% vaterite (n=220)
Results

Is stress associated with ‘choice’ to home or stray?

Cortisol Concentration (ng/ml)

Hatchery Home  Hatchery Stray  Wild
Results

Is stress associated with ‘choice’ to home or stray?

\[ p = 0.73 \]
Results

Is stress associated with ‘choice’ to home or stray?

![Graph showing cortisol concentration (ng/ml) for Hatchery Home, Hatchery Stray, and Wild fish. The graph indicates higher cortisol levels in Hatchery Stray compared to Hatchery Home and Wild fish.]
Is stress associated with ‘choice’ to home or stray?

Results

\[ p < 0.001 \]
Results

Is stress associated with performance on the spawning grounds?
Results

Is stress associated with performance on the spawning grounds?

![Graph showing the relationship between cortisol concentration (ng/ml) and streamlife (days). The graph indicates a negative correlation, with hatchery strays having a lower streamlife as cortisol concentration increases.](graph.png)
Results

Is stress associated with performance on the spawning grounds?

- Cortisol concentration (ng/ml)
- Streamlife (days)
- Hatchery strays
- Wild ‘home’
- p > 0.05

Graph showing the relationship between cortisol concentration and streamlife for hatchery strays and wild ‘home’. The graph indicates no significant association with p > 0.05.
Results

Is stress associated with performance on the spawning grounds?

Cortisol concentration (ng/ml)

Proportion eggs retained

Hatchery strays

Wild ‘home’

Cortisol and egg retention not significantly associated

P=0.7
Results

Is stress associated with performance on the spawning grounds?

Cortisol concentration (ng/ml) vs. Proportion eggs retained.

- Hatchery strays: Cortisol and egg retention not significantly associated, P=0.7
- Wild ‘home’: Egg retention decreases with increasing cortisol concentration.
Results

Is stress associated with performance on the spawning grounds?

Average retention rates
- Hatchery = 47%
- Wild = 19%
Why might hatchery fish retain more eggs?

Average retention rates:
- Hatchery = 47%
- Wild = 19%

Wild males > Hatchery females > Hatchery males & wild females

McConnell et al. 2018
Summing it up

Is stress (cortisol & vaterite) associated with ‘choice’ to home or stray?

No evidence: Hatchery home, hatchery stray, and wild fish had similar cortisol concentrations. but, Females appeared more stressed than males (both wild and hatchery strays)

Wild fish had 50% less occurrence of vaterite than hatchery fish, but vaterite (or intensity of thermal marking) not associated with straying
Summing it up

Is stress associated with performance (stream-life and egg retention) on the spawning grounds?

Yes and no. Stream life declined in individuals with higher cortisol concentrations irrespective of whether they were hatchery or wild.

Rates of egg retention were not associated with cortisol, though hatchery fish retained ca. ½ of their eggs while wild fish 1/5.
Where to from here?

• Causes and consequences of higher vaterite in hatchery fish?
• Where are the strays coming from? And do they go first to release sites and then stray? Or choose to stray without ever going ‘home’?
• What makes sites attractive to strays?

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