Alevin Movement, Emergence, and Initial Fry Behavior

1. Sub-Surface Movements
   a) Geotaxis
   b) Lateral movements
   c) Phototaxis
   d) Dissolved Oxygen and CO$_2$
   e) Upward

2. Emergence
   a) Timing
      • What time?
      • What date?

3. Initial Movements of Fry
   1. Rheotaxis and diel activity
   2. Sockeye fry orientation
Sub-gravel movements

Phase One

1. Alevins move downward after hatching

Alevins are negatively phototactic but downward movement seems to be also gravity-related. Nunan and Noakes (1987) reported that rainbow trout alevins moved down, then later up, regardless of light regime or flow.

Alevins move deeper in larger gravel
Coho alevin vertical movements in simulated nests of large and small gravel

Mean height of fish above tank bottom (cm)

Days after hatching

Dill (1969)
Vertical movement patterns of rainbow trout alevins

Carey and Noakes (1981)
Phototactic behavior of chum salmon alevins from hatching to yolk absorption

Time (Days after Hatching)

Phototactic Response (%)
Sub-gravel movements

Phase 2
- About a month after hatching, alevins are more active; mostly lateral movements.
  - Larger gravel facilitates movement
  - Alevins show positive rheotaxis (towards water flow)

Phase 3
- Upward phase
  - Orientation is both upward and towards current
  - Light seems to inhibit movement
  - Orientation is also geotactic
Ontogenetic changes in the photoresponse of coho salmon fry during the course of emergence

Mason 1976
Ontogenetic changes in the photoresponse of rainbow trout from hatching to emergence

%C of fry in the lighted section

Days after hatching

Carey and Noakes 1981
Oxygen and carbon dioxide

• Low DO: hatching takes place early to increase scope for $O_2$ capture; fry can move to high DO.

• Buildup of $CO_2$ around alevins induces “ventilation-swimming” (rapid, brief swimming in place to circulate water).
Responses of alevins given a choice between two levels of dissolved oxygen (Fast 1987)

Contrasting DO levels (mg/L)

% of alevins in the higher concentration

Responses of alevins given a choice between two levels of dissolved oxygen (Fast 1987)
Yolk is converted into fish tissue but energy is required for resting and active metabolism (Bams 1969).
Emergence

What date?
– Temperature influences rate and efficiency of yolk absorption

What time?
– emergence generally at night, but later in the season more day-time emergence.

Warmer water stimulates emergence
After all the yolk has been used up the alevins are said to be “buttoned-up” and emerge. However, some emerge with yolk showing, and there is overlap between endogenous and exogenous feeding.
Emergence can be difficult if the redd is poorly located.
Humans can cause instability in flow regimes in rivers.
Releases of water from dams may be timed to produce electricity, and so river flows can go up and down considerably.

Water may be released early in the morning because people wake up, turn on the lights and the coffee pot, the hot water heater for the shower kicks in, etc.
50% survival curves for salmon alevins in successive dewatering experiments, from hatching to yolk absorption.
Initial Fry Migration

• Downstream migration vs. upstream
  – Downstream generally at night
  – Upstream during the day
Floating inclined plane or "scoop" trap: Conuma River

Fyke net
Latitudinal variation in median date of downstream migration of salmonid fry populations

- Pink salmon
- Chum salmon
- Sockeye salmon
- Chinook salmon
- Coho salmon
- Arctic charr

Date (Feb - Jul) vs. Latitude (°N)
Diel pattern of fry migrating down stream after gravel emergence

Godin 1982. In: Brannon and Salo
Diel patterns of upstream fry migration

% of largest hourly catch

Sockeye in the Lower Babine River, B.C. (Clarke and Smith 1972)

Rainbow trout (Northcote 1962)

Godin 1982. In: Brannon and Salo
Sockeye salmon fry migrate up the banks of the Chilko River to reach Chilko Lake.
Orientation of newly emerged fry

- How do sockeye salmon fry find their nursery lake? In most cases it is downstream but in some cases they must swim upstream.
- Brannon hypothesized that there were population-specific responses to water flow (rheotaxis) that guided the fry to the lake.
Stellako fry migrate downstream, Chilko fry migrate upstream, Weaver Creek do both, and Cultus Lake fry emerge in the lake itself.

Adults were spawned at various sites, embryos incubated in a lab, newly emerged fry (100) tested in the rheotaxis tank.

(Brannon. 1972. IPSFC Bull. 21)

<table>
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<tr>
<th>Stock</th>
<th>Number of Fry</th>
<th>% upstream</th>
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<tbody>
<tr>
<td></td>
<td>Up</td>
<td>Down</td>
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<tr>
<td>Stellako</td>
<td>611</td>
<td>4280</td>
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<td>Cultus</td>
<td>2301</td>
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<td>Weaver</td>
<td>1421</td>
<td>735</td>
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<td>Chilko</td>
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<td>Chilko x Stellako</td>
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<td>2957</td>
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Effect of temperature on emergence activity: hourly fry output from two darkened tanks.
Timing of spawning in relationship to egg to fry survival

Sashin Creek (McNeil 1969)

Freshwater survival (%)

Date of 50% spawners in the stream
# Response of chum alevins to different dissolved oxygen levels

<table>
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<th>Oxygen levels</th>
<th>Preference</th>
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<td>Late developmental stage</td>
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*** P < 0.001  ** P < 0.01