#### Geomorphology and Aquatic Habitat

Geomorphic Effects of Run-of-River Hydropower Projects Assessment, Monitoring, and Lessons Learned Canadian Water Resources Association, BC Branch

Adam Lewis Ecofish Research Ltd.

<sup>\*</sup>fjalewis@ecofishresearch.com

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# Why fish habitat?

- Environmental Assessment Acts (CEA, BCEAA)
  - Fish habitat is a VEC



#### • Fisheries Act

• "fish habitat" means spawning grounds <u>and any other areas</u>, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes;



#### Context of effects on fish habitat

- You can't seriously harm fish habitat for 'fish'
  - No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal **fishery**, or to fish that support such a **fishery**
- Serious harm is permanent damage
  - For the purposes of this Act, serious harm to fish is the death of fish or any **permanent** alteration to, or destruction of, fish habitat



#### Fish Habitat

Energy



Matter

Ryder and Kerr 1987



## Aquatic habitat

- Location
  - Upstream (headpond)
  - Diversion
  - Downstream
- Types
  - Primary and secondary producers
    - Periphyton
    - Invertebrates
  - Fish
    - Summer rearing
    - Overwintering
    - Migration
    - Spawning
    - Incubation



#### Upstream

Rearing habitat Spawning?





#### Diversion

- Rearing
- Key spawning and incubation
- Migration





#### Downstream

- All habitat types
- Relies on headwaters for gravel supply





## Effects linkage



#### Potential habitat impacts from geomorphic effects

Issue	Operational Changes in Flow	Physical Habitat Variable	Potential Impact Mechanism	Biological Attribute Affected
Channel structure maintenance	flow magnitude and duration	depth, velocity, wetted area, substrate composition	Reduced flow magnitude may decrease sediment transport, leading to channel aggradation and changes in habitat suitability and access.	Reduced fish growth, survival and reproductive success
Egg survival - scour and erosion	flow magnitude, duration	substrate composition	Increased erosion and deposition may increase sedimentation of incubating eggs, decreasing egg-fry survival.	Egg-fry survival
Flushing flow	Flow magnitude, duration, timing	substrate composition	Decreased sediment transport may increase deposition of fine sediment, reducing habitat suitability for invertebrates and fish.	Food supply and fish growth
Floodplain connectivity	flow magnitude and duration	depth	Reduced floodplain inundation may isolate off-channel habitats, impairing movements of aquatic species and nutrients, decreasing growth, survival, and reproductive success.	Habitat connectivity
Tributary access	flow magnitude	depth	Reduced flow levels may expose barriers at tributary confluences, decreasing upstream migration.	Reduced fish growth, survival and reproductive success
Fish passage	flow magnitude, duration, frequency and timing	depth	Reduced flow levels may reduce depths and back flooding, increasing velocities and impairing upstream migration.	Reduced survival and reproductive success

Lewis, A., T. Hatfield, B. Chilibeck and C. Robert. 2003. Assessment methods for fish, fish habitat and instream flow characteristics in support of applications to dam, divert, or extract water from streams in British Columbia. Prepared for Ministry of Water, Land & Air Protection and Ministry of Sustainable Resource Development.



#### Interstitial habitat





# **Overwintering** habitat























## Incubation





#### **Invertebrate** Habitat





#### **Channel Change**





#### Spawning habitat affected



## Suspended sediment









# Summary of Effects

- Channel change
  - Altered channel shape  $\rightarrow$  velocity, depth
  - Altered sediment composition less gravel
  - Effects to rearing, spawning, incubation and migration?
- Deposited sediment
  - Spawning and incubation habitat gravel permeability intragravel flow and oxygen delivery
  - Entrapment of incubating eggs
  - Fry survival eliminates rearing interstitial habitat
  - Pool infilling reduced rearing habitat
- Suspended sediment
  - Changes in concentration, duration, timing
  - Potential effects to rearing, spawning, incubation



## Metrics

- Channel cross-section
  - Change in hydraulic unit type?
  - Weighted usable area?
- Channel sediment
  - Sediment composition (area or % gravel, % fines, % silt)
  - Gravel distribution and scour
- Suspended sediment
  - Concentration, duration, frequency, timing
- Magnitude of effect
  - One size class? e.g. small gravel  $\rightarrow$  large gravel



#### End Thank you for your attention

#### Questions?

Contact: fjalewis@ecofishresearch.com



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