Impacts of the 2010 Testalinden Dam Breach on Aquatic Food Webs and Planktivores (*Oncorhynchus nerka* and *Mysis diluviana*) at Osoyoos Lake

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Outline

- Testalinden Dam breach and debris flow
- Indicators of possible impacts downstream
  - Chemical changes
  - Phytoplankton and zooplankton responses
  - Planktivore responses
    - Mysis
    - Sockeye
- Causal mechanism
- Potential economic impact
Study Site

- Skaha Lake 35 km upstream from Osoyoos L.
- Testalinden Creek 6 km upstream of Osoyoos
- Road 18 is 1300m downstream of Testalinden Creek
Mud and debris flows and associated earth dam failures in the Okanagan region of British Columbia

Dwayne D. Tannant and Nigel Skermer
Testalinden Creek Fan

- 100 ha vineyards destroyed
- Damage to 200m of Highway 97
- 200,000 m$^3$ of material passed into Testalinden Creek
- Estimated peak discharge rate of 25-30 m$^3$/s
- Sheds in the debris path with possible fuel oil tanks, old stashes of pesticides and herbicides
- Dike-like structures prevented immediate access to the Okanagan River
- Sediment plume seen the next day in Osoyoos Lake

Tannant and Skermer (2012)
Agricultural pesticide residues of farm runoff in the Okanagan Valley, British Columbia, Canada


- Spring: 17 residues
- Fall: 12 residues
- Not monitored by Environment Canada
- No DDT or its breakdown products
Heavy metals downstream from Testalinden

Road 18

- Routine sampling every 22 days (ave.)
- Heavy metals well known to be toxic to aquatic organisms
- 19 / 45 compounds were the highest in the time series (01/07-05/15); 2 x 2nd highest
- Agricultural chemicals not monitored there
Heavy metals downstream from Testalinden

**Sequence**

- June 13: Testalinden Dam breach
- June 14: sediment plume in North end of Osoyoos Lake
- June 21: the Okanagan River flushed by dumping water from Penticton Dam
- June 22: Road 18 sampling
Phytoplankton

- $1^0$ production changes
- *Cryptobia* & other ciliated protozoans are a human health concern
- BACI assumption not met for individual phytoplankton species
Chlorophyll-a

- $1^0$ production changes
- Significant decrease shown using BACI design
Bosmina

- $2^0$ production changes
- More tolerant of suspended sediments than *Daphnia*
- 8% of diet of *Mysis* and fish (Osoyoos)
Other zooplankton

- Unable to use BACI

- Sockeye and *Mysis* together eat 38% by weight of *Daphnia*, 9% *Epischura*, 2% *Leptodiaptomus* (Osoyoos)

- The biomasses of *Daphnia* and *Epischura* showed strong linear relationships with fry survival (Osoyoos)
Mysis diluviana

- BACI significant
- Recruitment failure of juveniles in 2010 post-TL
- Failure of adults in 2011
- Failure of embryos in 2011
Osoyoos juvenile Sockeye

- A. High egg to emergent fry survival (late Mar-mid-April)

- Well before the TL event
Osoyoos juvenile Sockeye

- A. High egg to emergent fry survival (late Mar-mid-April)
- Well before the TL event
- B. Low survival to peak summer fry numbers
Osoyoos juvenile Sockeye

- A. High egg to emergent fry survival (late-Mar to mid-April),
- Well before the TL event
- B. Low survival to peak summer fry numbers
- C. Low pre-smolt per spawner survival
Comparison to Skaha kokanee

- Possible common regional drivers 1: decreased survival in 2010
- Regional drivers 2: in Skaha 2011, a common regional driver immediately restored survival to well above average
- In Osoyoos, the same driver was present, but survival only gradually returned to the all-year average. Why?
Potential economic impact?

- Possible common regional drivers

- But… the pattern of survival differs between the lakes

- Potential loss (BY 2009-2012) of 913,105 adult sockeye @ $US10 / fish
Mechanism of impact

- **Trophic cascade hypothesis**
  - Effects at every trophic level
  - But no cascade: food-consumption energetics
  - *Bosmina*: increased (*Daphnia* & *Mysis* decreased)
  - Sockeye juvenile size: did not decrease

- **“Toxic soup” hypothesis**
  - Mortality in *Mysis* embryos & Sockeye juveniles
  - Unknown in-lake compounds and their concentrations, but the compounds are capable of producing mortality in aquatic food webs
Conclusions

- The Testalinden Dam breach and debris flow were associated with
  - Multi-year changes to the food web in Osoyoos Lake
  - Changes at multiple trophic levels
  - Therefore stronger case for a genuine impact
- Evidence-based potential economic impact
- Lessons for the Mount Polley mine tailings pond disaster?