

Survival of eggs of Atlantic salmon (*Salmo salar*) in gravel in a drawdown zone in a Norwegian regulated river influenced by groundwater

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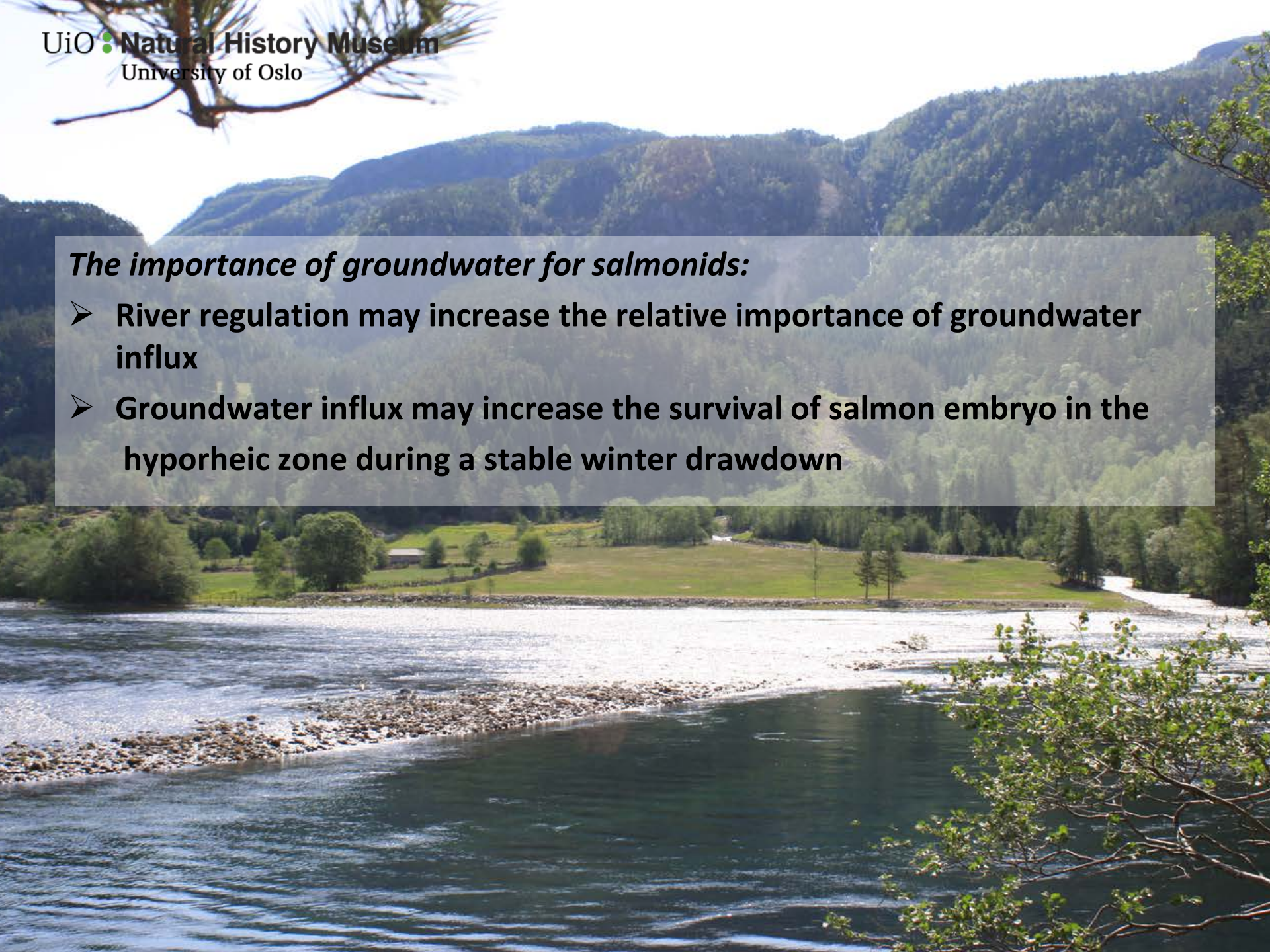


The importance of groundwater for salmonids:

- May constitute 40-100 % of total water discharge during low flow periods (Colleuille *et al.* 2005)
- Assuming no oxygen deficiency (Soulby *et al.* 2005)
- Create a heterogeneity in habitat and spawning sites (Heggenes *et al.* 2010)
- Warmer in winter, colder in summer; thermal refugia (Douglas 2006)
- Refugia during low flow or hydropeaking episodes (Saltveit *et al.* 2001)
- Little research data to substantiate the idea that groundwater outflow directly affect spawning site selection by trout and salmon (Heggenes *et al.* 2010)

The importance of groundwater for salmonids:

- River regulation may increase the relative importance of groundwater influx
- Groundwater influx may increase the survival of salmon embryo in the hyporheic zone during a stable winter drawdown



Topic:

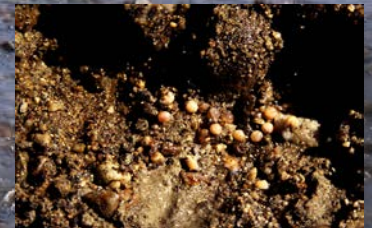
- Survival of eggs during long low flow periods

Background:

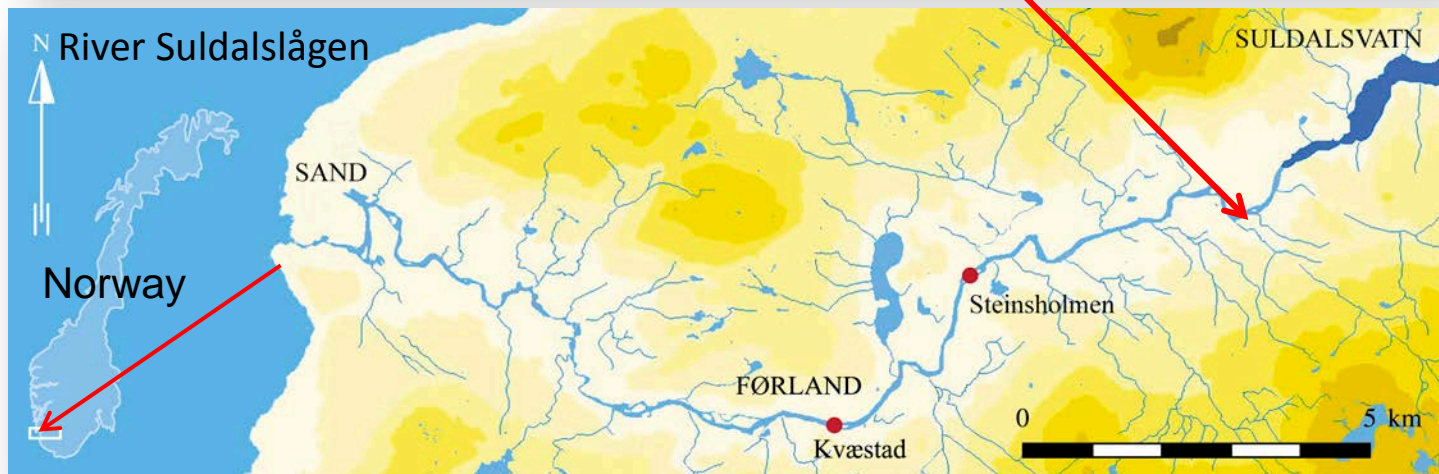
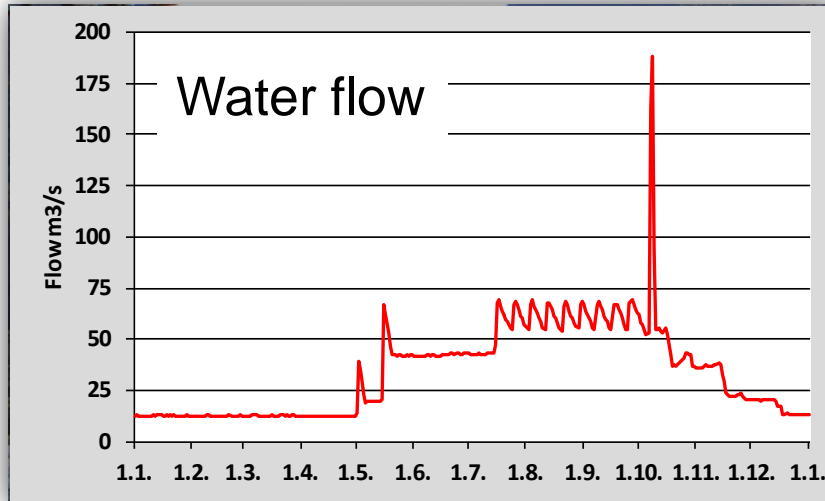
- In regulated rivers redds may be stranded after spawning
 - Also naturally, spawning areas were periodically dewatered during winter
- Survival during winter due to high influx of groundwater to redds?



Pictures: LFI-Uni Environment; B. Bäråup



Study site




Spawning area

river fan



Study site seen from river fan





Temperature
Dissolved oxygen
Conductivity
pH

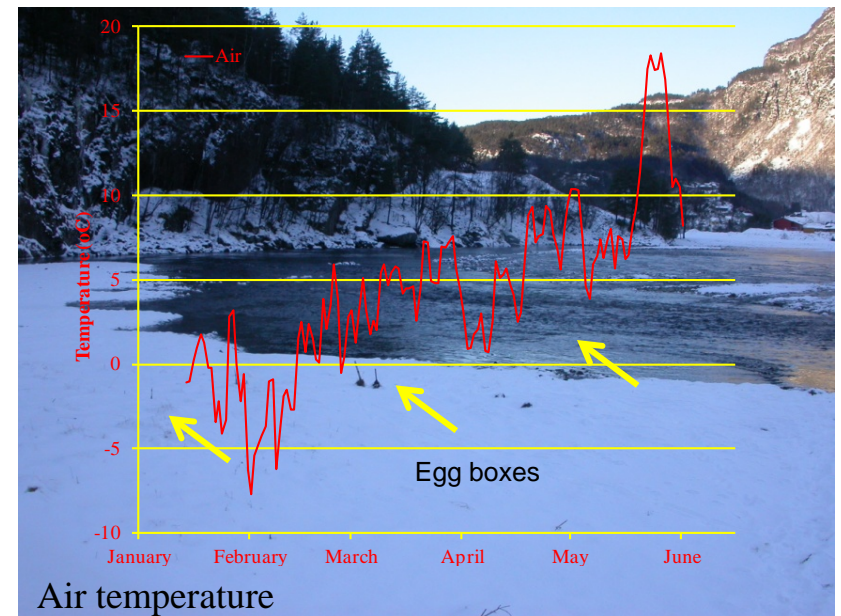


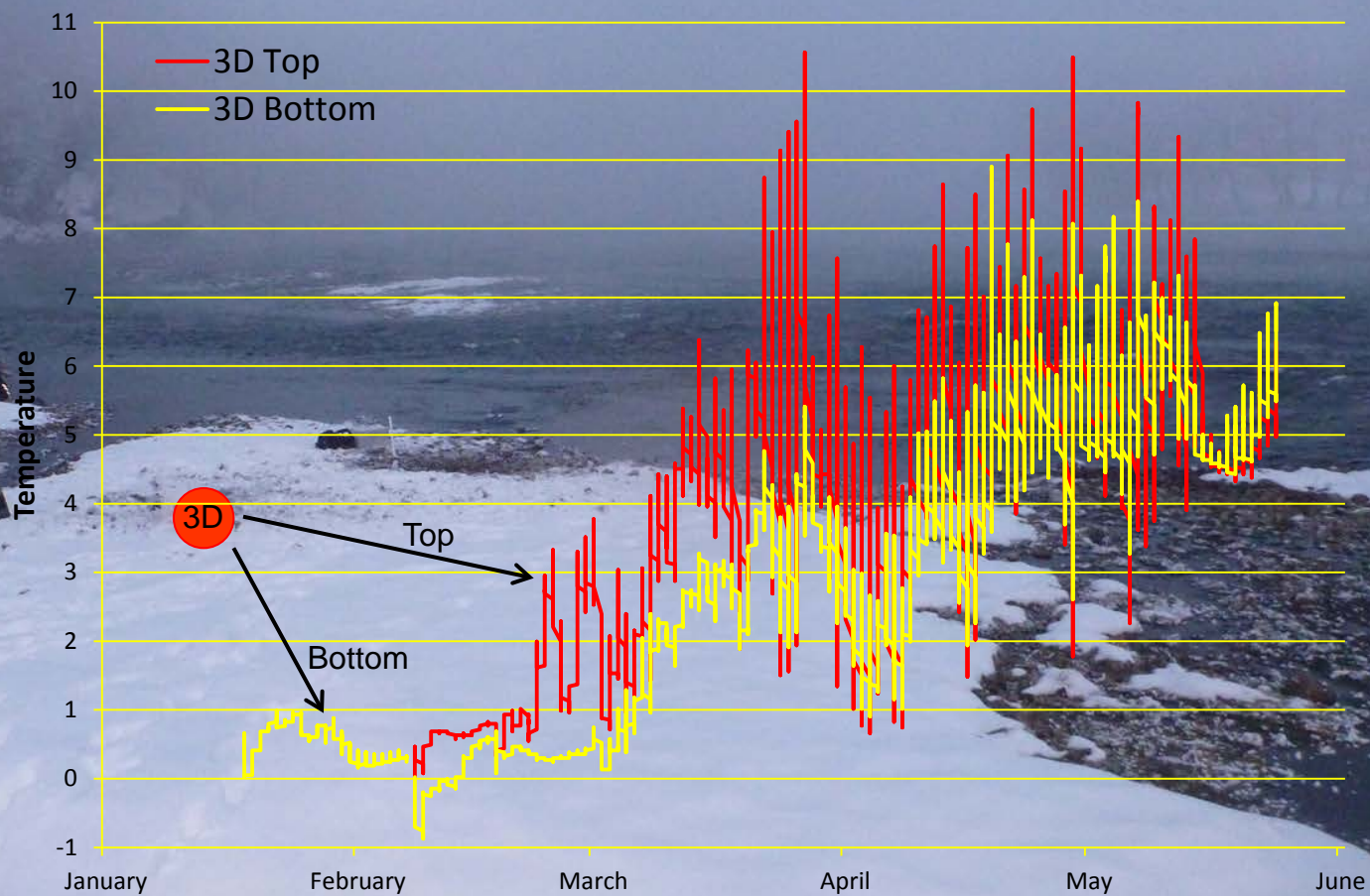
Water pressure
Temperature

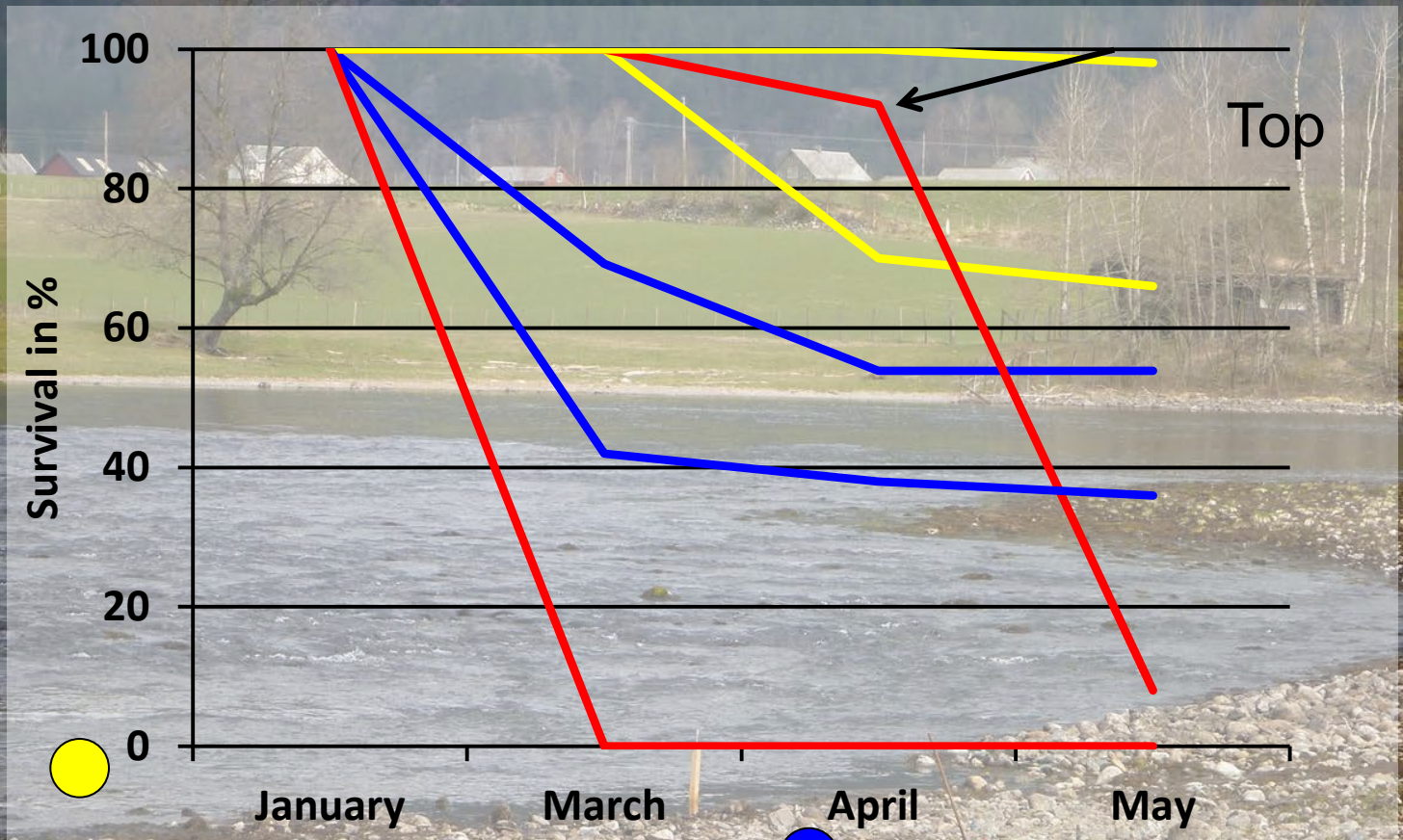


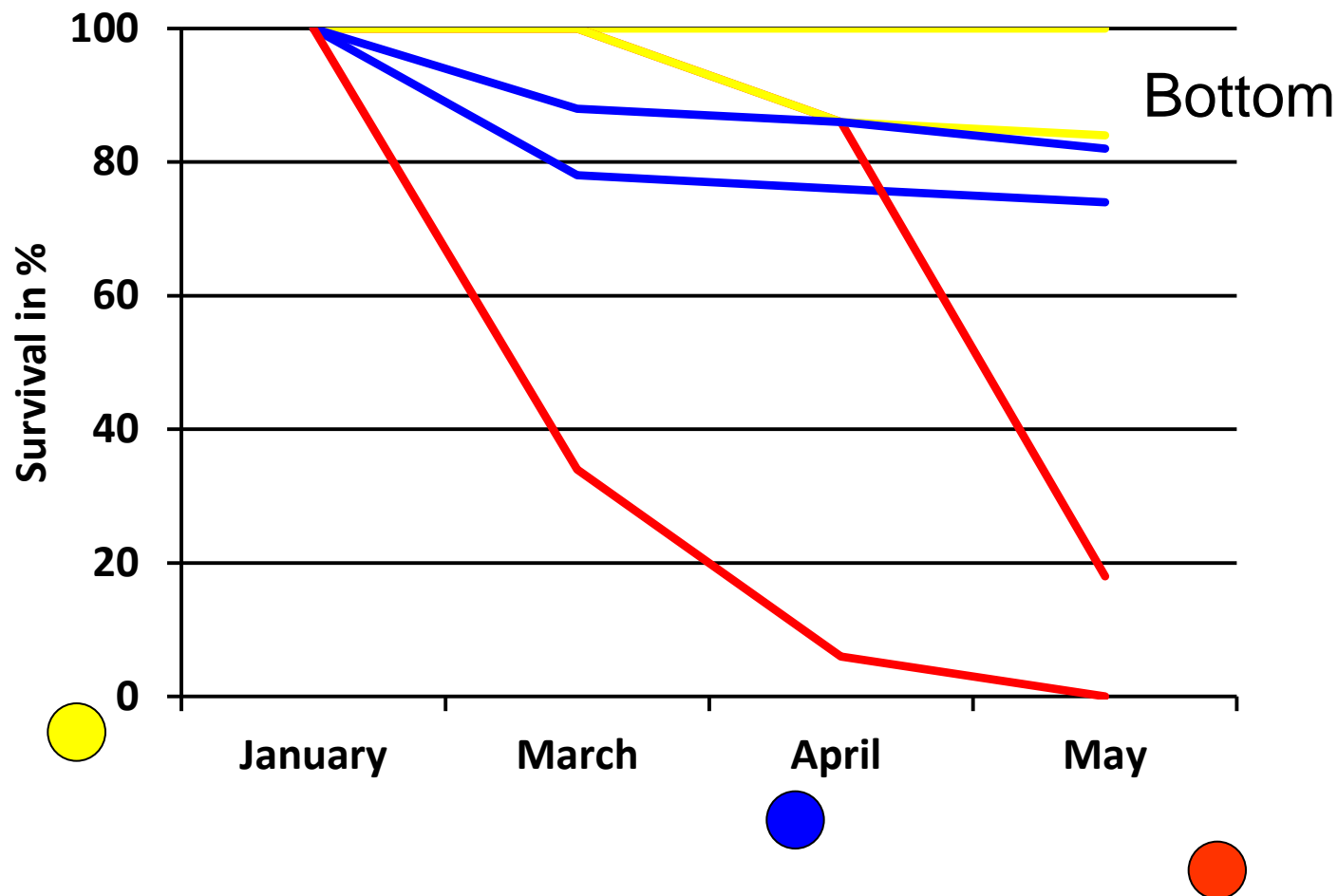


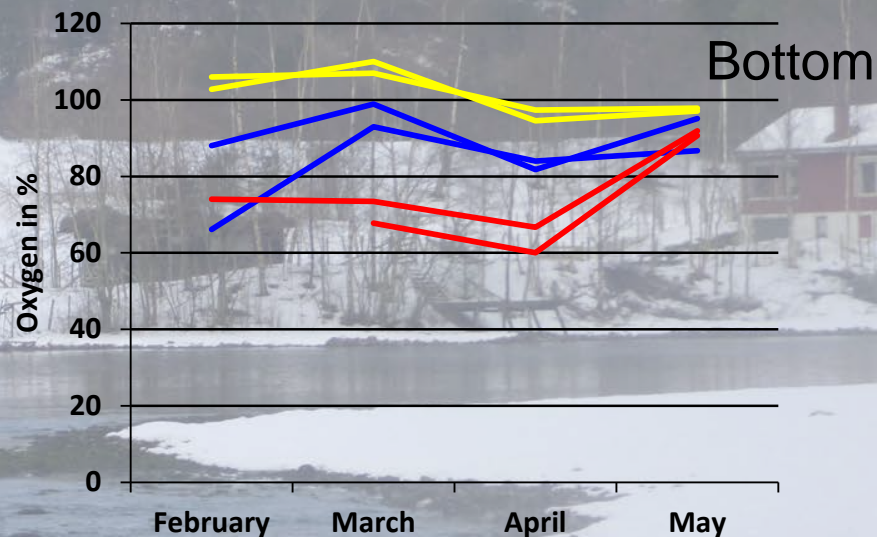
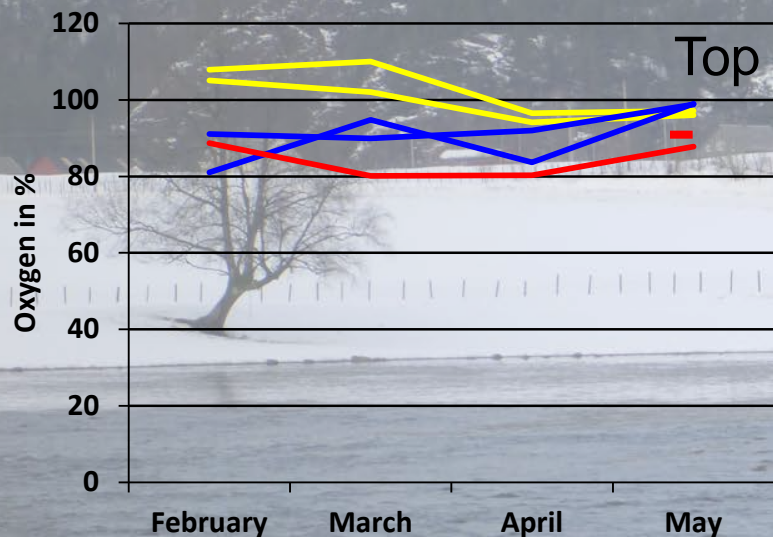
Groundwater influx points

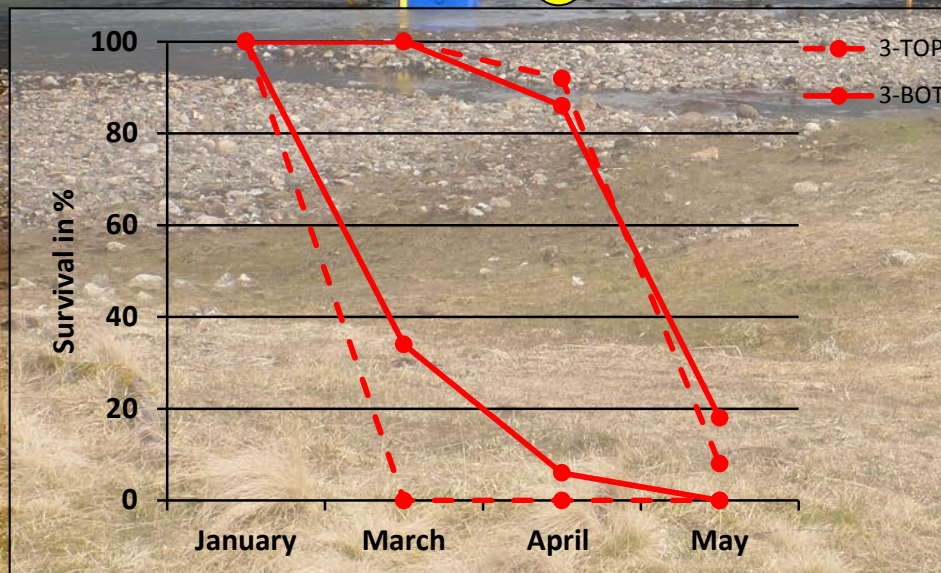
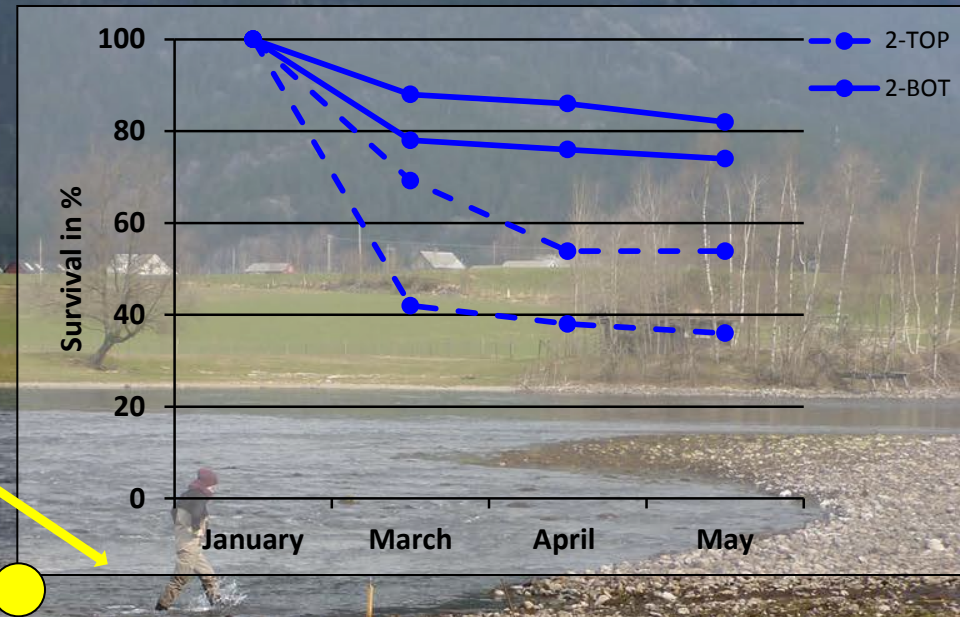
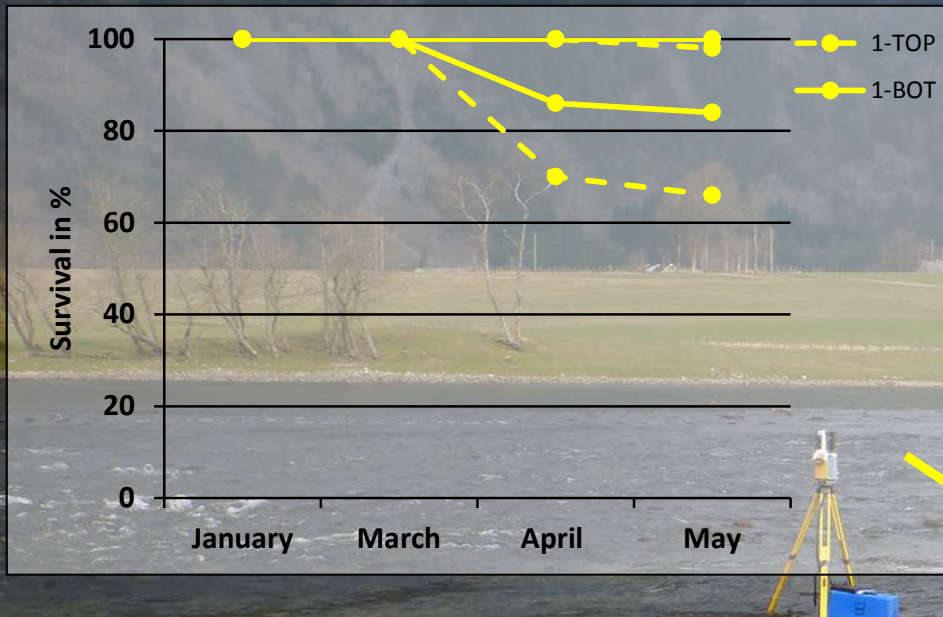


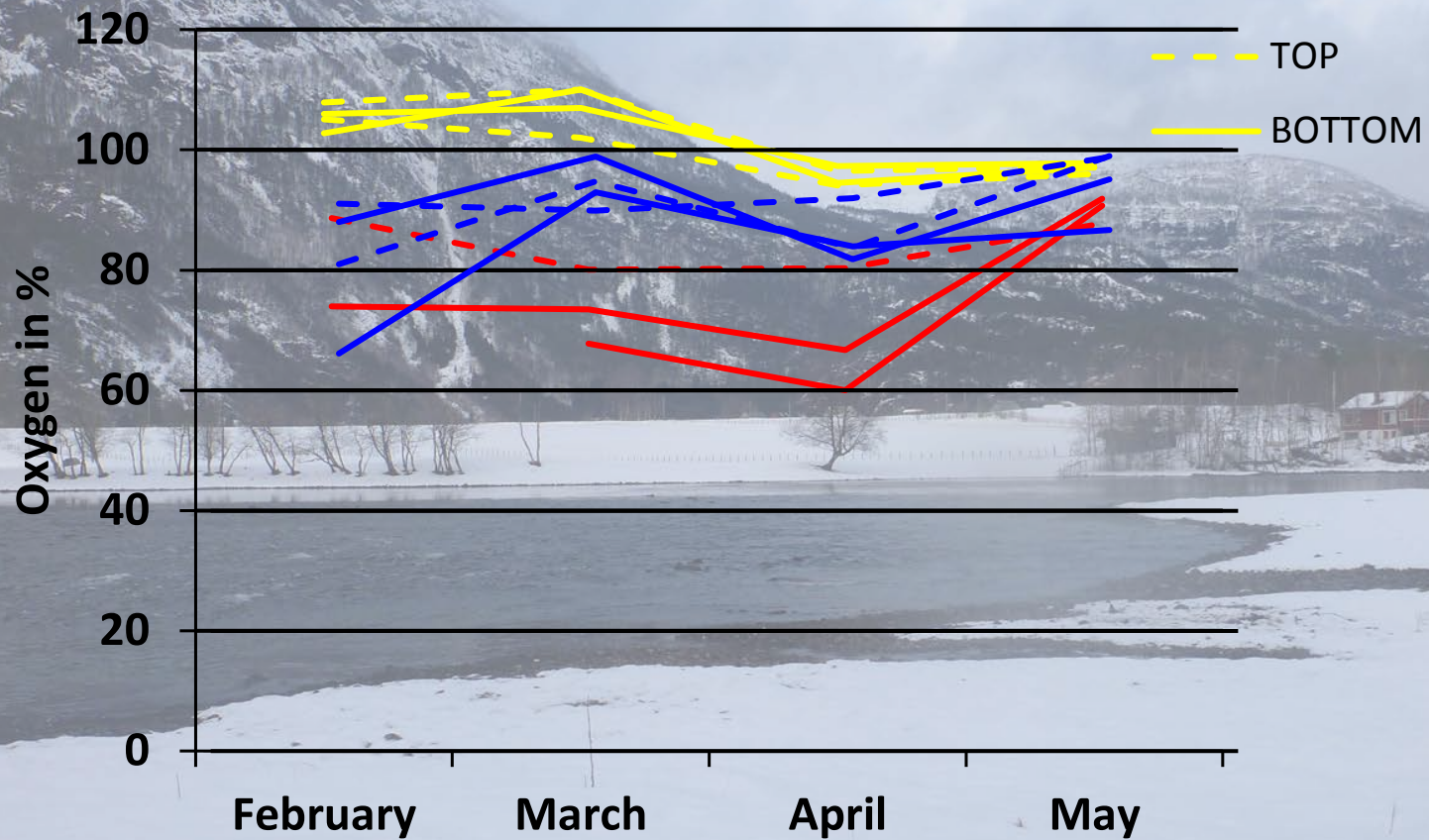












Ph: 6.7- 6.2; lowest in May

Conclusions:

Causes for mortality:

- Sedimentation
- Hatching prior to flow increase

Groundwater creates:

- Increased survival during low flow periods
- Horizontal and vertical mosaic in temperature
- Variation in hatching time and "swim-up"
- Dispersed population risk

River regulation implications:

- Change in groundwater and surface water interface
- Increased groundwater influence and earlier hatching
- Can be used actively to achieve optimal hatching time
- Can be used actively to achieve optimal survival





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Thanks for listening