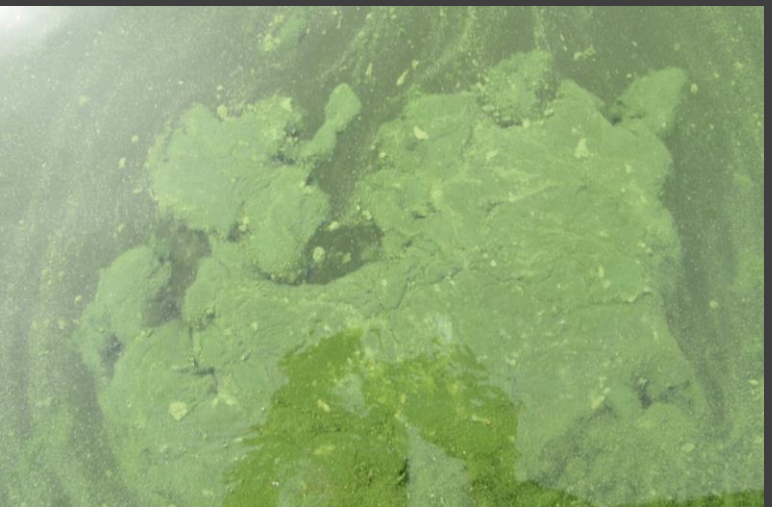
Pictures ca. 1992-95

Fisheries and food web research at the IISD-ELA

Gaining new & unexpected insights from whole-ecosystem experiments and long-term research

Mike Paterson, Michael Rennie, Paul Blanchfield, Lee Hrenchuk, Chandra Rodgers, Joseph Tonin, Ken Mills, Sandy Chalanchuk, Doug Allan, Lori Tate, Cheryl Podemski, Alex Salki, Alain Dupuis, Laurie Wesson, Diane Malley, and many others

Picture: Lee Hrenchuk



Some of the greatest concerns about freshwater involve changes in food webs

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Up to 50 years of regular sampling of major components of the food webs of ELA lakes

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The importance of scale for understanding food web impacts

- Community dynamics
- Immigration & emigration
- Habitat complexity
- Time – some fish species live for decades
- Ecosystem experiments to better understand why impacts arise

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Acid rain (begun 1974)

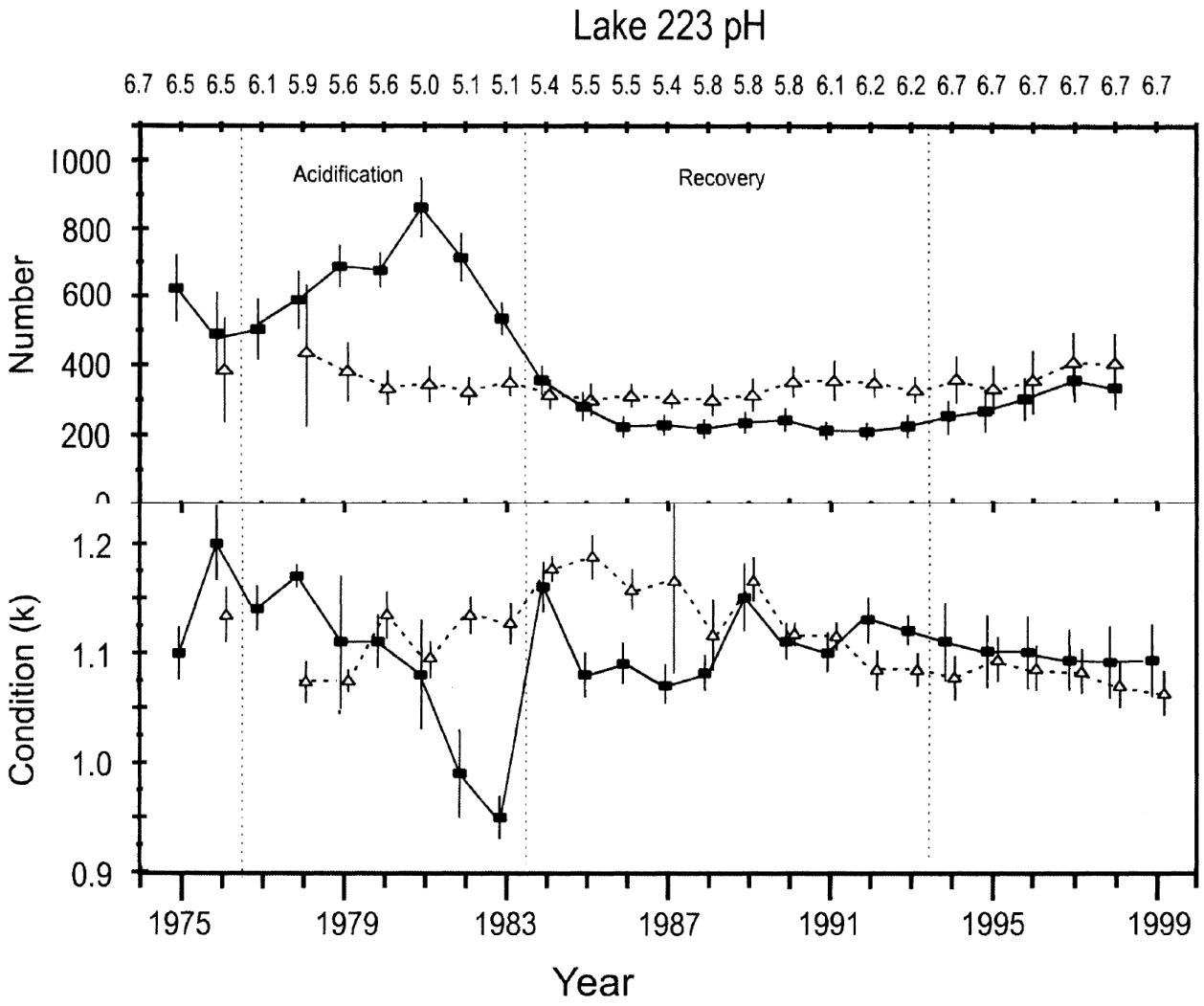

Starving Lake Trout

Lake 223

Acidification effects occurred sooner than expected

Effects on trout were the result of food web impacts, not direct toxicity from acid

These impacts could only be identified at the ecosystem scale



Mills et al. 2000
CJFAS 57:192-204

Condition declined as abundance declined - indication of food limitation

Trout declined as prey disappeared, well in advance of any direct pH impacts

Hg concentrations are currently 2X pre-acidification levels

At ELA, we are developing and applying new methods to better understand changes in food webs

- Over the years, we have developed and applied a wide range of new tools to better understand changes in ELA food webs
- This development and application continues to this day
- Among many examples:
  - non-lethal sampling methods
  - stable isotopes and food web tracers
  - acoustic telemetry

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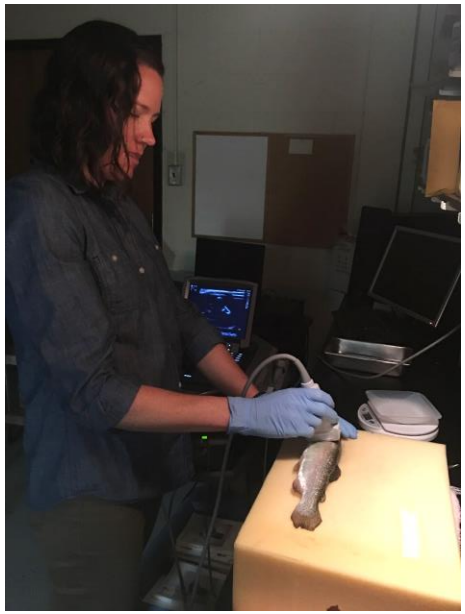
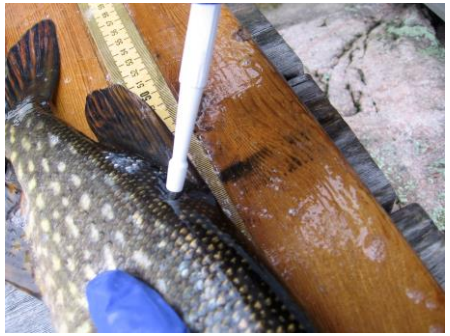
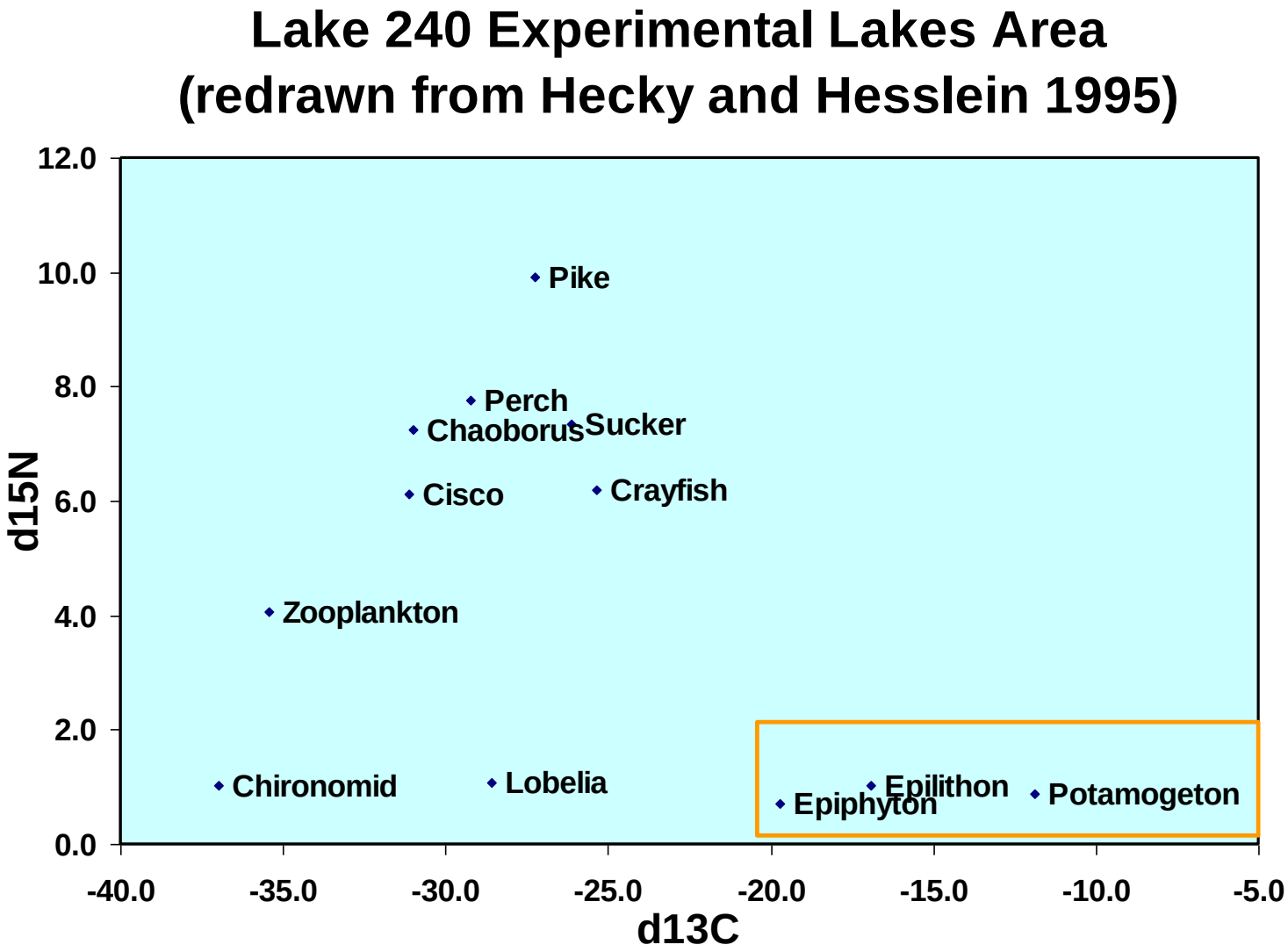
Non-Lethal sampling methods

- Population estimation (mark-recapture)
- Aging structures (fin rays, cleithra, opercula)
- Muscle biopsies
- Mucus – stress markers, proteins
- Blood collection – stress markers (hormones, etc.)
- Fish diet (gastric lavage)
- Ultrasound (GSI, HSI measurements)





Using stable isotopes to determine food web relationships



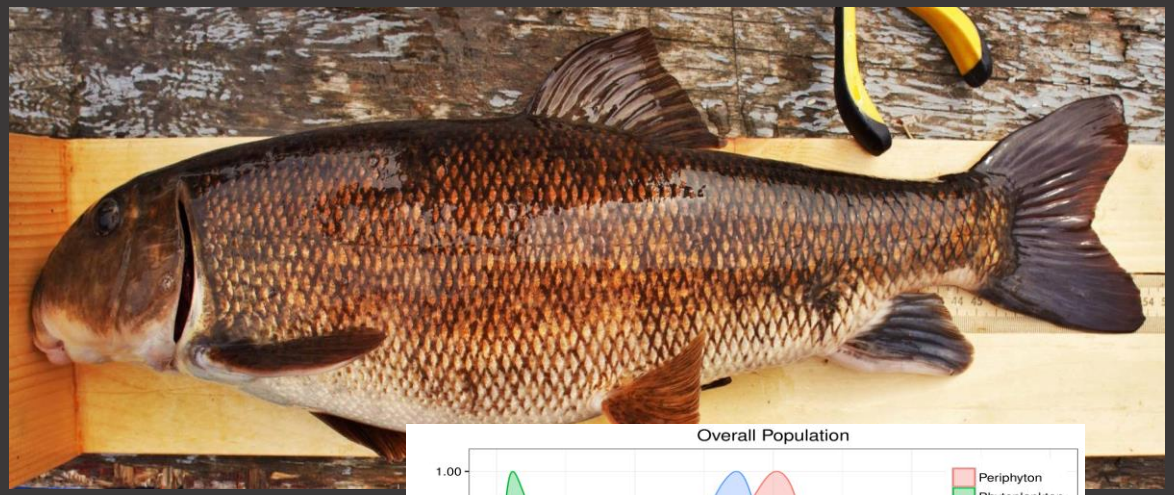
New tracers are improving our ability to determine food web relationships

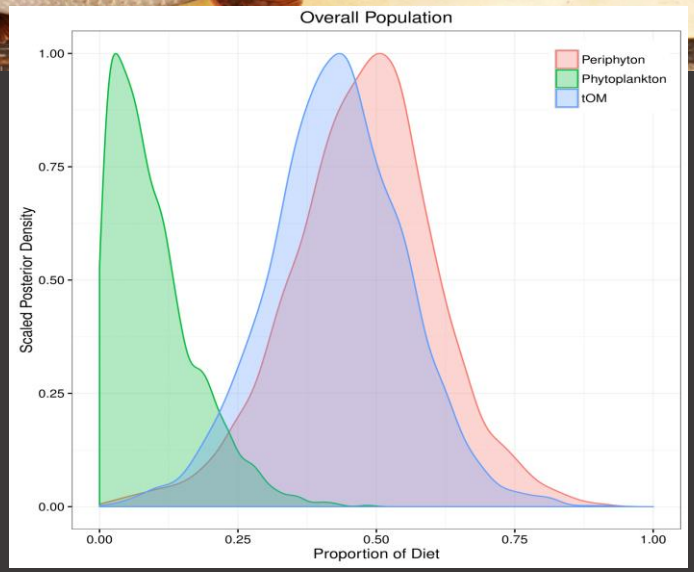
- 3 source (periphyton, phytoplankton, t-OM, 3 isotope (H,C,N) Bayesian mixing model)

Terrestrial Organic Matter **42.9%**

Benthic Primary Production **48.1%**

Pelagic Primary Production **9.6%**

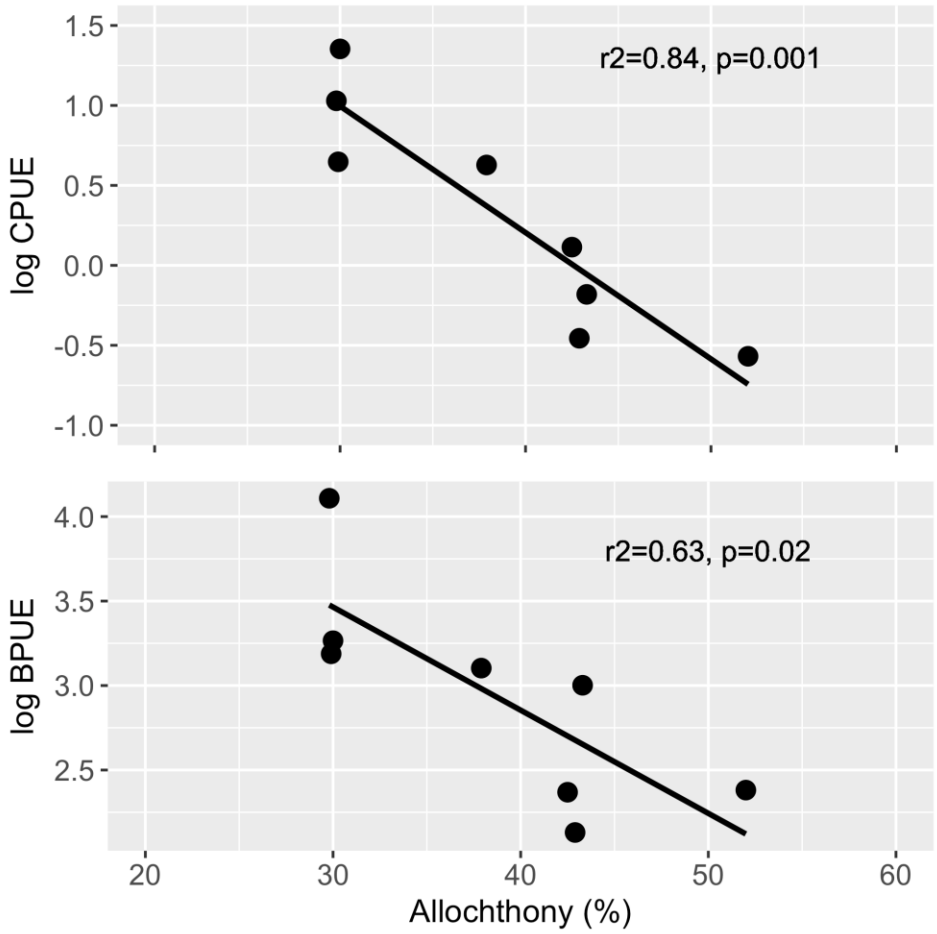




Further developments using fatty acids

Joseph Tonin

Terrestrial OM suppresses White Sucker biomass

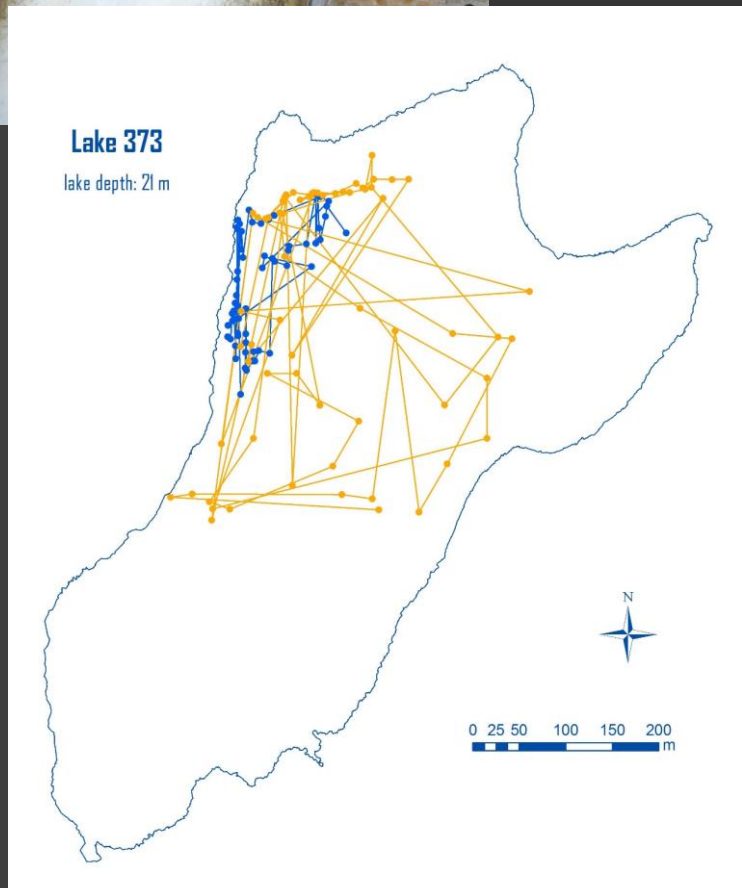


CPUE: catch per unit effort
BPUE: biomass per unit effort

Joseph Tonin

Acoustic telemetry

- non-lethal
- 3D tracking of individuals over multiple years (24 h/day)
- detailed analysis of habitat use/avoidance and activity levels



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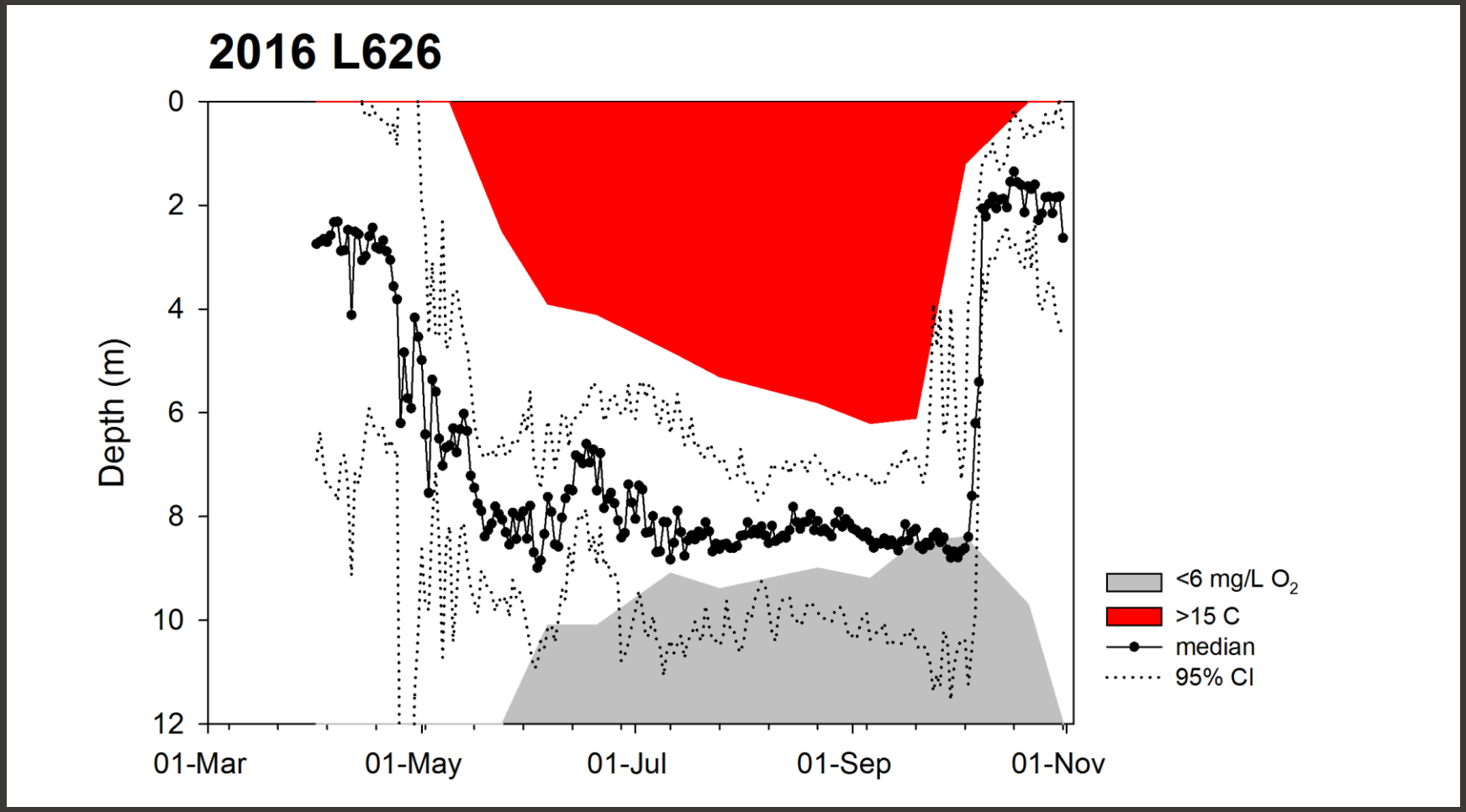
Lee Hrenchuk

Seasonal changes in lake trout habitat use



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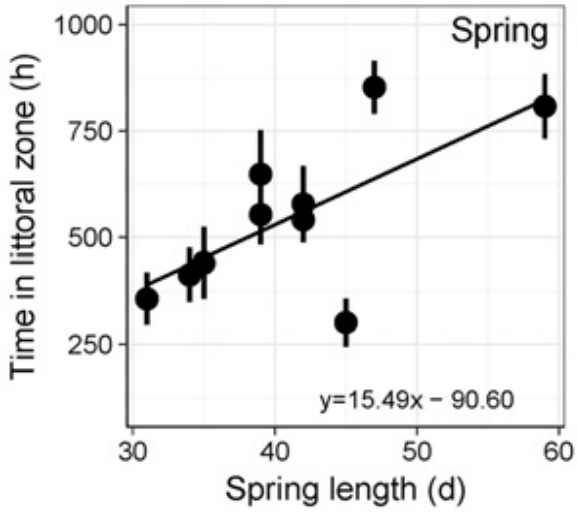
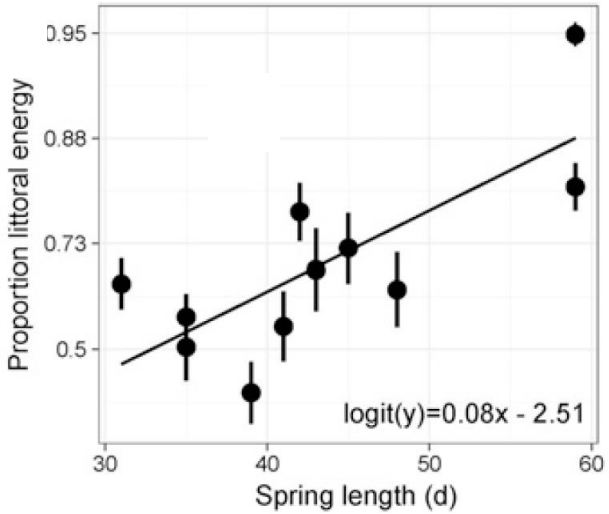
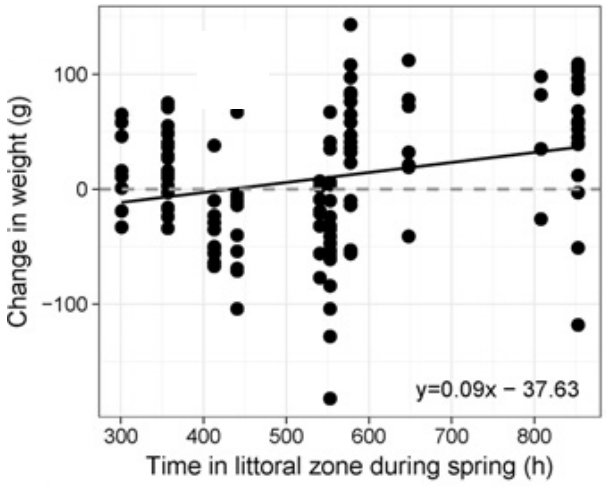
Paul Blanchfield, Lee Hrenchuk

Climate change







Guzzo et al 2017
PNAS 114:9912-7


Experimental fish farm
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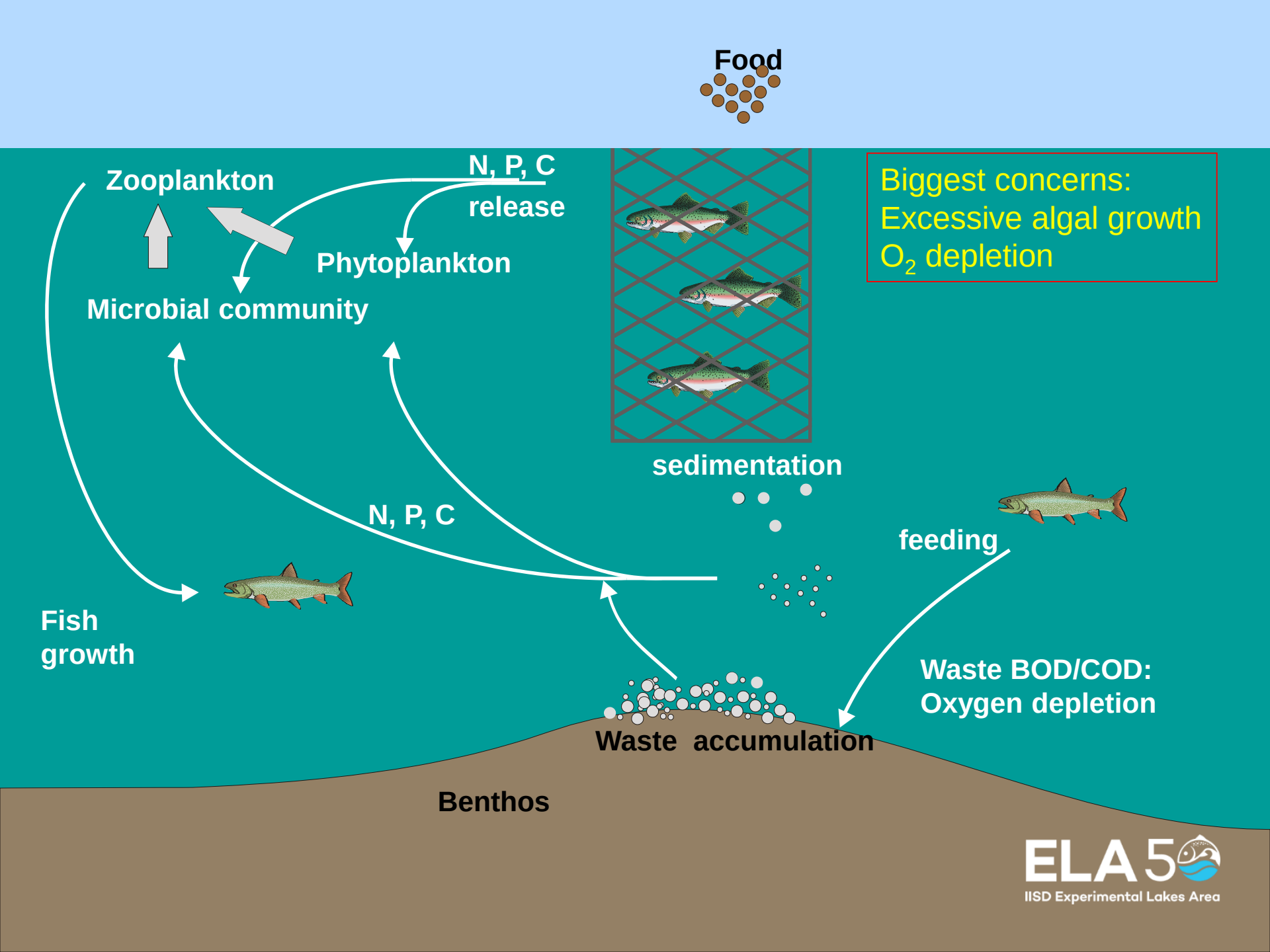
Food
Zooplankton
N, P, C
release
Phytoplankton
Microbial community
Biggest concerns:
Excessive algal growth
O_2 depletion
sedimentation
N, P, C
feeding
Fish
growth
Waste BOD/COD:
Oxygen depletion
Waste accumulation
Benthos
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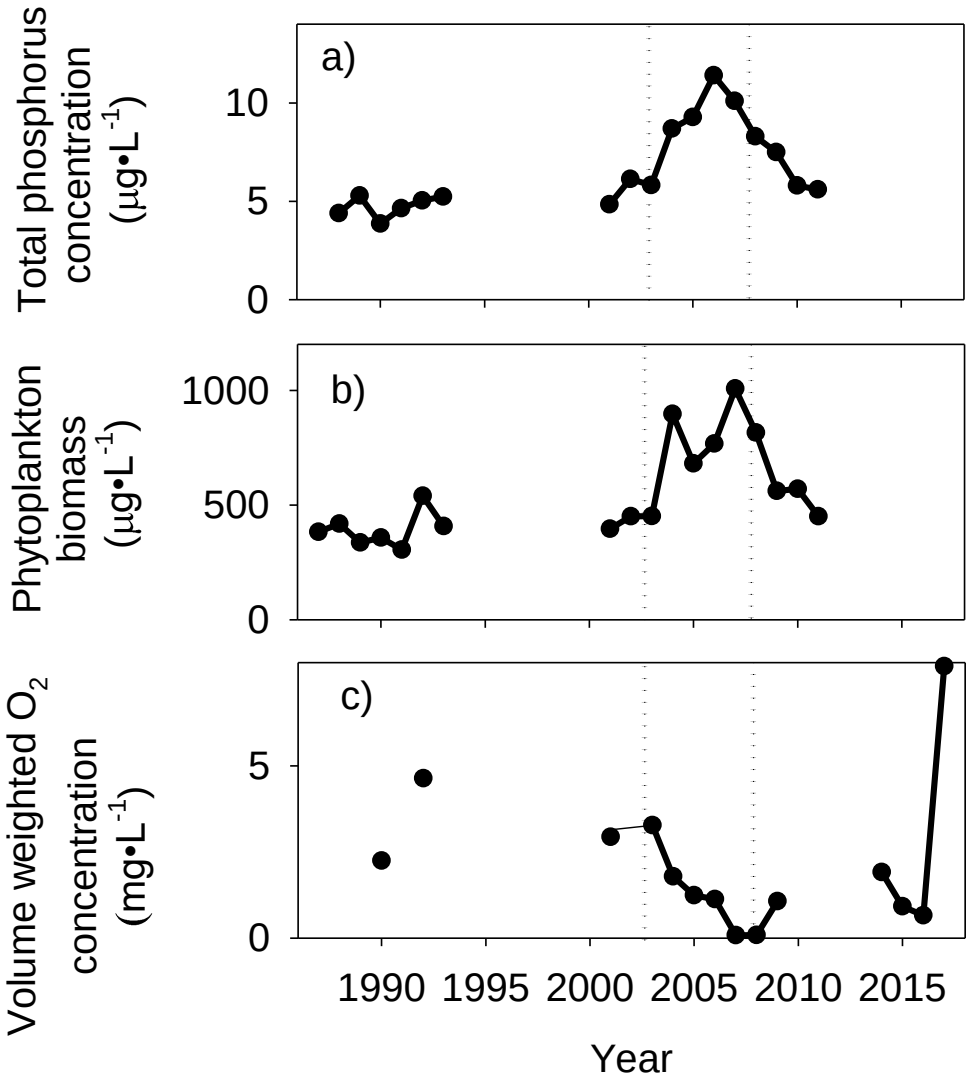
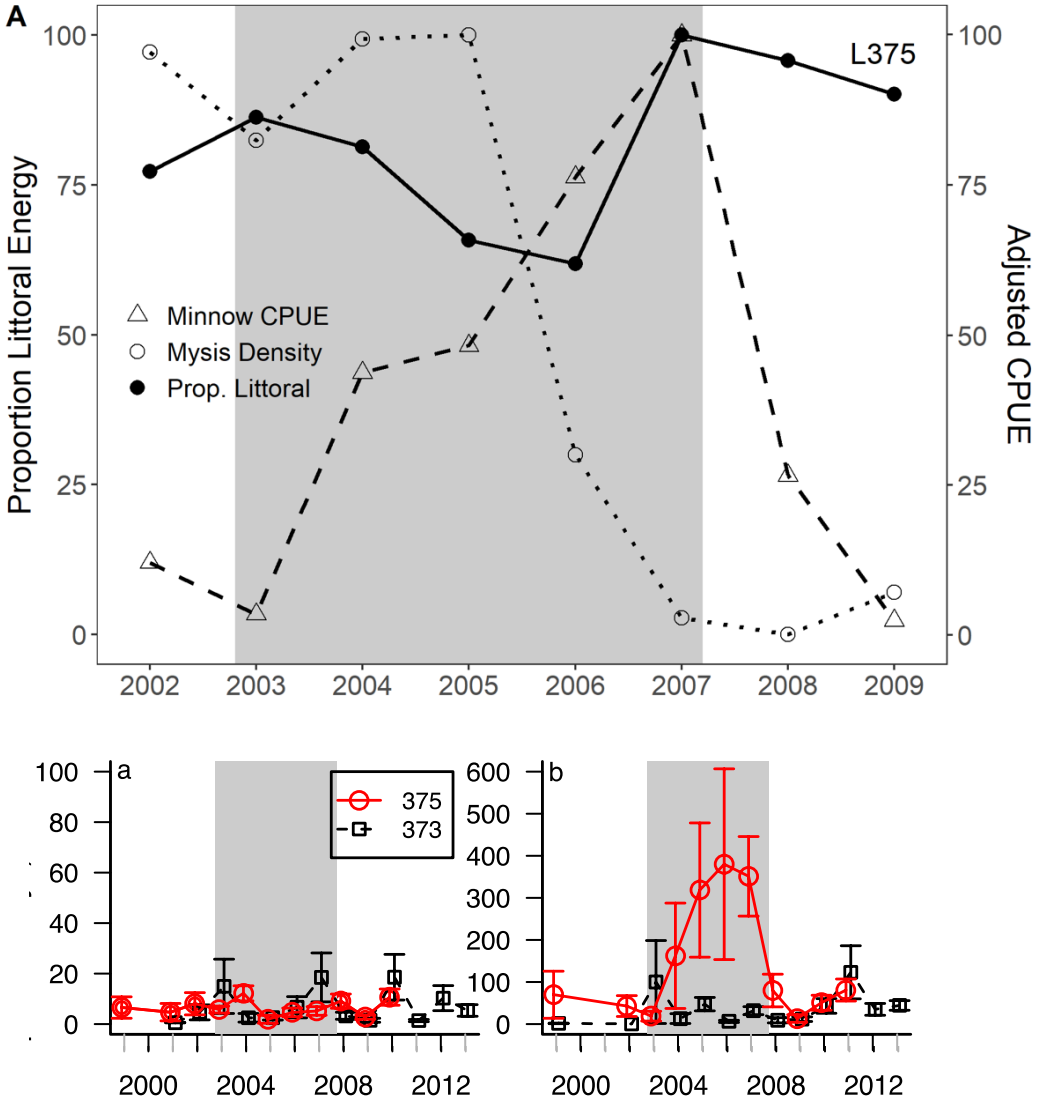
Aquaculture experiment



- Aquaculture resulted in increased concentrations of TP and phytoplankton
- Hypolimnetic O2 decreased and only recovered >10 years after cessation of aquaculture

Modified from Paterson et al. 2010 CJFAS 67: 1852-1861

- Mysis abundance declined by 90%
- Fall minnow abundance increased, but spring densities were unaffected

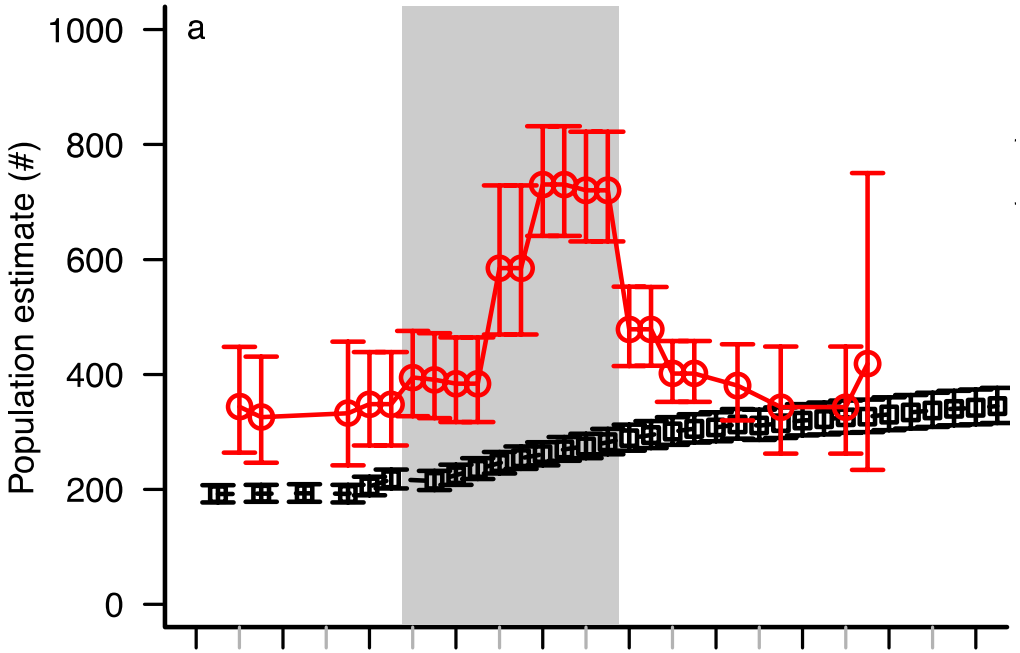


Kennedy et al. in review; Rennie et al. in review

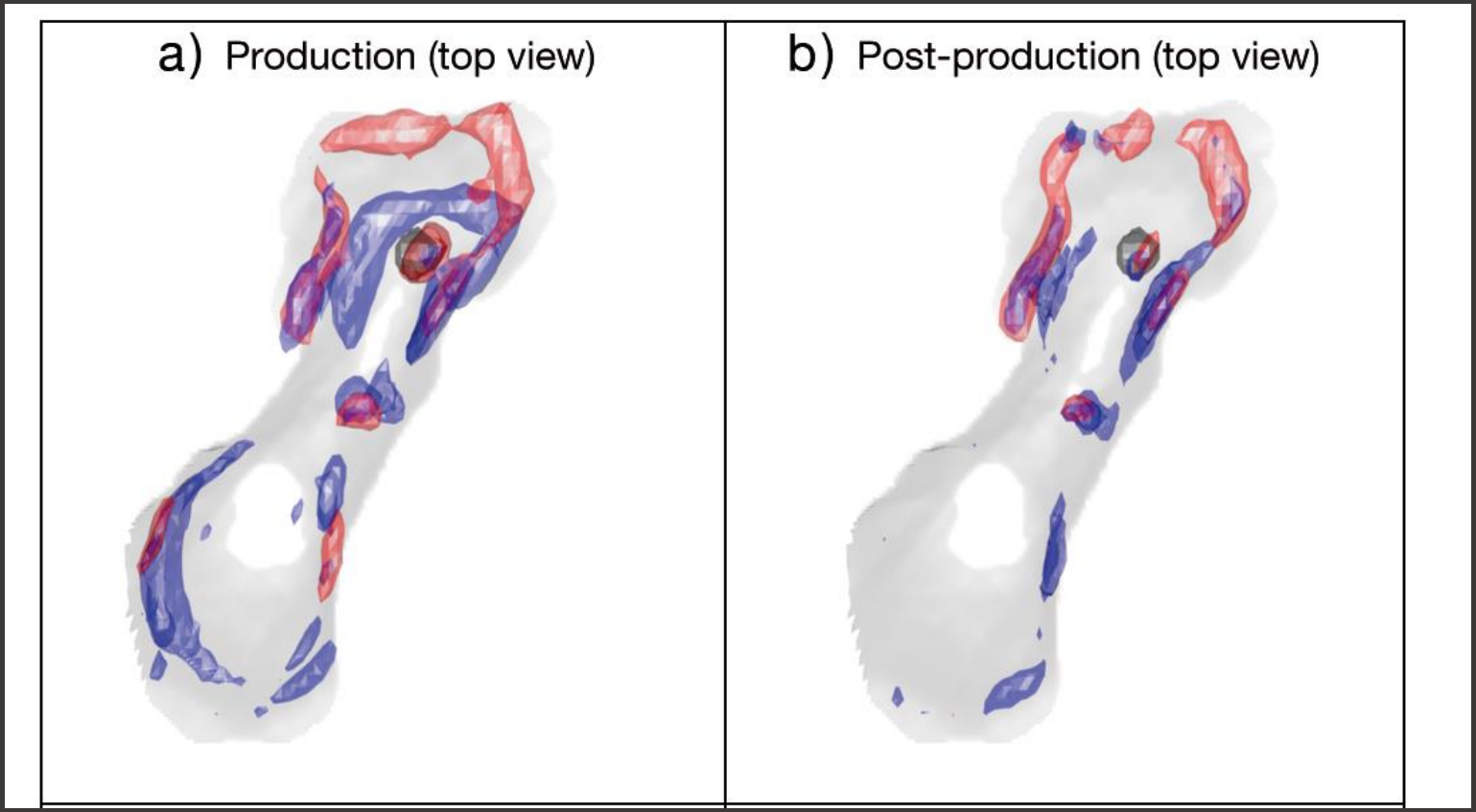
Aquaculture experiment

Aquaculture experiment

- Adult trout abundance doubled, but then declined once aquaculture ceased
- Maturation age declined (females, age 10 to age 5), size at maturation increased (380 mm to 405



Rennie et al. in review



Charles et al. 2017, Aquaculture Environment Interactions 9:415-428

- Escaped rainbow trout remained near the cage during production, but moved nearshore once operations ceased
- Lake trout showed no affinity for the cage

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Where are we going?

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- Greater integration of the food web using tracers
- Link longterm data sets fish, zooplankton, benthos, phytoplankton, etc
- Estimates of 2^{O} production
- Modelling
- Integrating data sets from multiple lakes at ELA and around the world – generalized responses to climate change, stress etc.


Thanks!
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