Can watercress farming directly impact fish communities?

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Watercress (*Nasturtium officinale*)

- *N. officinale* produces chemical outputs thought to be toxic to macroinvertebrate species

- These can create an imbalance in invertebrate populations (Newman *et al*., 1992 & 1996; Dixon & Shaw, 2011)

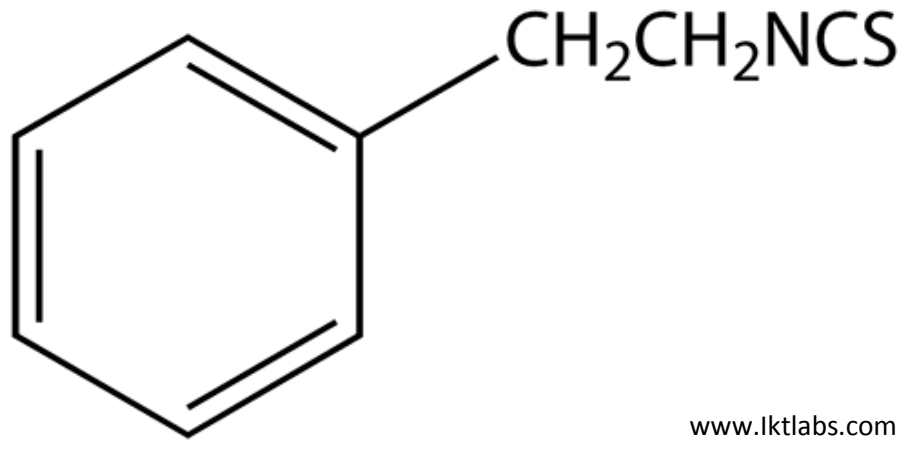
- This reduction in macroinvertebrate communities is thought to affect fish populations

Phenethyl isothiocyanate (PEITC)

- *N. officinale* possesses the glucosinolate-myrosinase system (Newman *et al*., 1992) (Mustard oil bomb!)

- Damage initiates myrosinase-mediated hydrolysis of PEITC

- This can be through:
  - Herbivory
  - Natural disruption
  - Harvest



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Soluble Reactive Phosphorus (SRP)

- Levels of SRP from watercress beds are small in relation to STP's and agricultural inputs (Cox, 2009)
- Elevated phosphorous levels from watercress beds could indirectly impact fish communities
- The eutrophication, algal bloom/plant growth and subsequent crash strip oxygen from the water
- Can it directly affect fish?

Literature

- The literature is limited and contradictory
- Longley (2007) found some trout populations to be stable
- Casey and Ladle (1988) found varying levels of trout habitation downstream of watercress beds, from healthy populations to channels devoid of trout

Literature

- Much of the literature has focussed on invertebrates
- Newman (1991). Herbivory and detritivory on freshwater macrophytes by invertebrates—a review
- Newman *et al.,* (1990). Watercress and amphipods—potential chemical defense in a spring stream macrophyte
- Newman *et al.,* (1996). Watercress allelochemical defends high-nitrogen foliage against consumption: effects on freshwater invertebrate herbivores.

Literature

- Cox, J. (2009). Watercress growing and its environmental impacts on chalk rivers in England. *Natural England Commissioned Report NECR027*

- Dixon and Shaw (2011). Watercress and water quality: the effect of phenethyl isothiocyanate on the mating behaviour of *gammarus pulex*

- To date, no research has been published on the direct effects of PEITC or SRP on fish

- Only medical papers appear to exist

Species

- The research to date has focused on trout as well as bullhead (*Cottus gobio*)

- What about the impacts of watercress beds on a range of fish species?
  - Salmonid
  - Cyprinid
  - Percid

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Approach

- Laboratory and Field based approach
- Laboratory research will use recorded PEICT and SRP levels
- Eggs will be fertilised and exposed using factory wash and spiked water


Courtesy of Dr. Lucy Crooks


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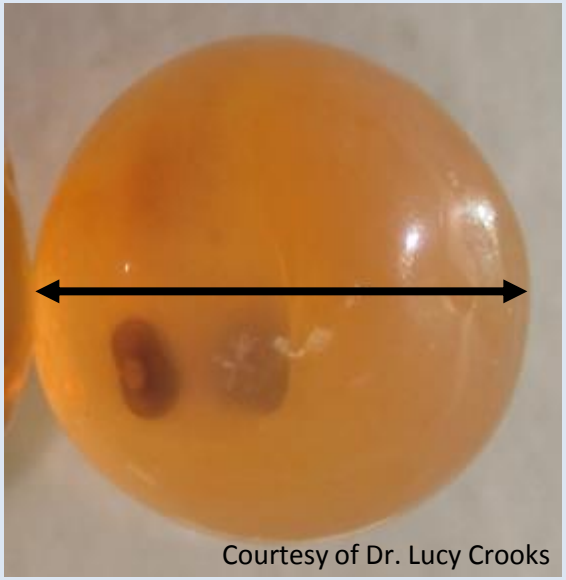
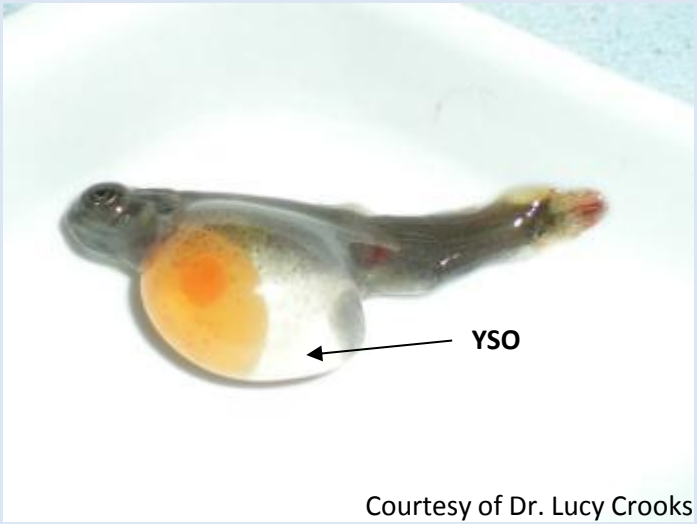
Embryonic Development

- During embryonic development eggs will be examined for developmental progress:
  - Volume
  - Weight
  - Diameter
  - Surface area:volume ratio
  - Hatch rate


Courtesy of Dr. Lucy Crooks

Hatching

- Upon hatching morphometric parameters will be examined for:
  - Fluctuating asymmetry
  - Length/weight relationship
  - Presence of lordosis
  - Yolk sac oedema
  - Percentage yolk sac to total weight



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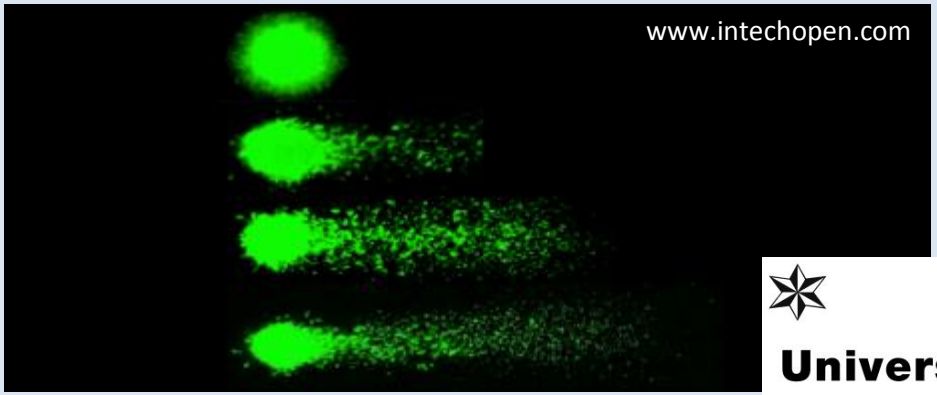
- Comet Assays



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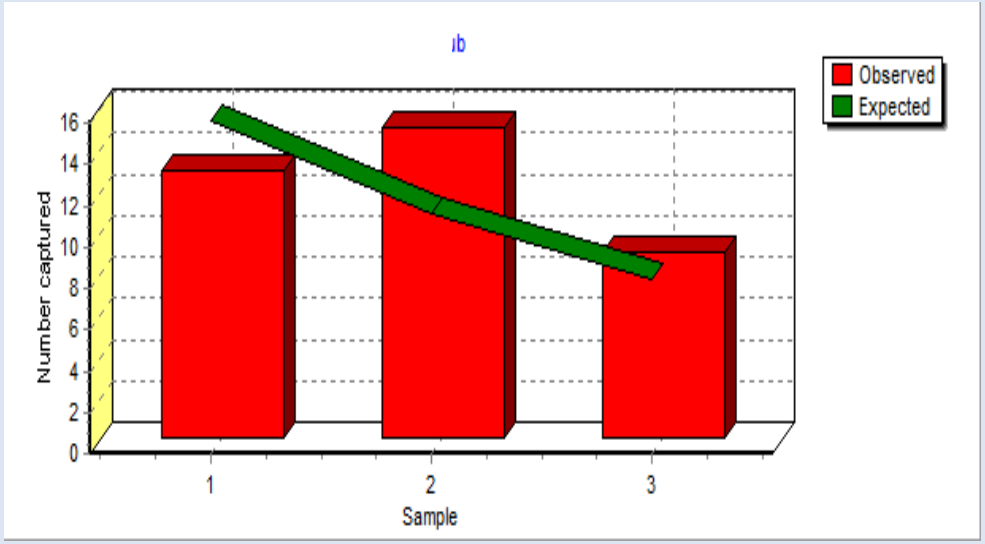
Field Surveys

- Electrofishing and habitat surveys semi-annually


Courtesy of Sven Verwiel

- Upstream and downstream
- of two/three sites

- 100m, three run depletion surveys will be performed



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Field Surveys

- Suspended solids
- Sediment fine fraction

Millimeters (mm)	Micrometers (μm)	Phi (ϕ)	Wentworth size class		Rock type
4096		-12.0	Boulder		
256		-8.0	Cobble	Gravel	Conglomerate/ Breccia
64		-6.0	Pebble		
4		-2.0	Granule		
2.00		-1.0	Very coarse sand		
1.00		0.0	Coarse sand		
1/2 0.50	500	1.0	Medium sand	Sand	Sandstone
1/4 0.25	250	2.0	Fine sand		
1/8 0.125	125	3.0	Very fine sand		
1/16 0.0625	63	4.0	Coarse silt		
1/32 0.031	31	5.0	Medium silt		
1/64 0.0156	15.6	6.0	Fine silt	Silt	Siltstone
1/128 0.0078	7.8	7.0	Very fine silt		
1/256 0.0039	3.9	8.0			
0.00006	0.06	14.0	Clay	Mud	Claystone

Sediment Particle Size Classification (Wentworth, 1922)

- Relationship between the invertebrate and plant communities and sediment structure

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Field Studies

- In-situ river monitoring may be possible in order to measure:
  - O_2
  - pH
  - Temperature

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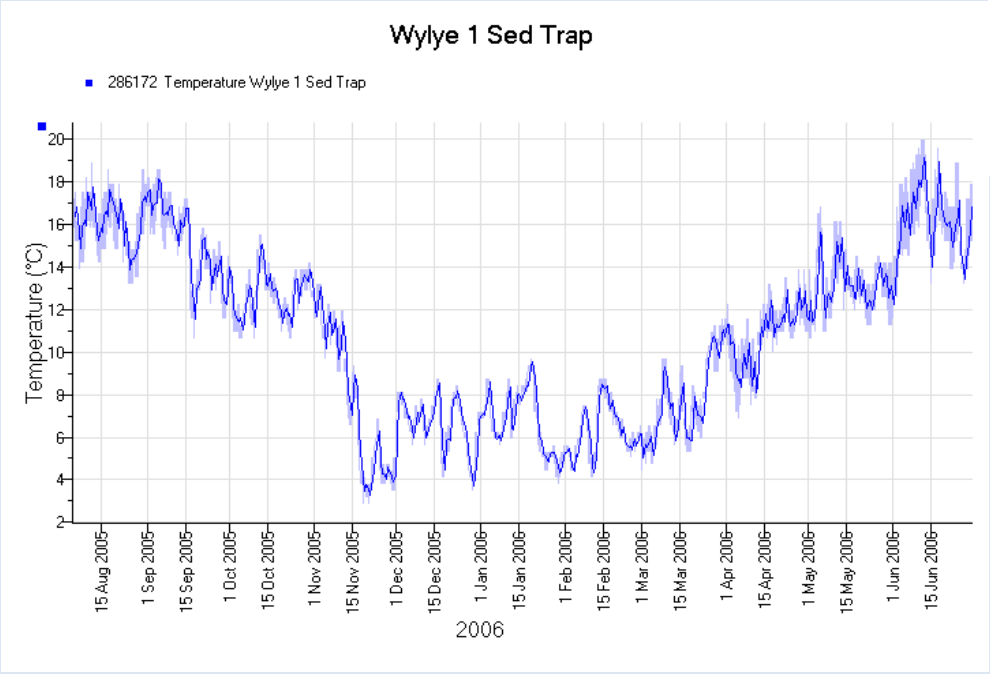
- Also:
  - Flow
  - NO_2-
  - NO_3-



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Outcomes

- The project will:

- Enable a better understanding of the impacts, if any, on fish populations

- Help to determine if fish communities are directly or indirectly affected by the farming of *N. officinale*