The Effect of Watercress Farming on Fish Populations

This project set out to determine the impacts that discharges from watercress bed irrigation and salad wash effluent may have on fish populations. This was approached by examining sites upstream and downstream of discharges from three independent watercress farms, each farm with varying degrees of salad wash activity. The Bourne Rivulet site having a large salad washing facility which operates daily, discharging to some 5Ha of watercress beds whose combined run off forms the sampled Eastern channel; a farm on the River Crane which washes intermittently and a farm on the River Frome which does not wash salad. Firstly, habitat, water quality and macroinvertebrate composition of sites upstream and downstream of discharges were quantified. Secondly, using the same sites, fish densities were examined to see if there were changes to species composition, density and condition. Lastly, as PEITC may be released in discharges from watercress beds and salad washing processes, laboratory trials were conducted on fish embryos to understand the concentrations of PEITC that may cause mortality and sublethal effects.

Key findings:

Habitat

- Measured water quality determinands did not show watercress farm discharges to appreciably alter receiving chalk stream waters relative to upstream sites except for small increases in suspended solids.
- Fine sediments showed a slight increase below watercress farm discharges compared to upstream sites.

Invertebrates

- Gammarid abundances downstream of watercress discharges have improved over historic abundances, though abundances on the Bourne Rivulet East Channel were on average below the 500 per kick sample recommended. However, the Bourne Rivulet East Channel is best considered a discharge channel as it is fed purely from discharge from watercress growing and salad washing. Abundances just downstream of the East Channel at the Parallel were the highest found at any site indicating strong and rapid downstream recovery for the taxa.
- Biotic indices suggest that salad wash effluent discharges are having a measurable effect on invertebrate assemblages, with sites receiving salad wash having lower than expected scores indicating potential organic pollution. This was true for the Bourne Rivulet Parallel, which despite having the highest gammarid abundances, but was still depauperate in the most sensitive taxa.
- Total invertebrate abundances were higher downstream of salad wash effluent discharges, driven largely by higher abundances of pollution-tolerant taxa.

Fish

- There was a trend for decreased brown trout density and increased densities of non-salmonid species below salad wash effluent discharges.
- Young-of-year brown trout were below expected densities at sites below salad wash discharges.
- The relative weight, or condition, of adult brown trout was higher downstream of salad wash effluent discharges, which may be linked to the increased macroinvertebrate prey

abundance and/or lower densities of brown trout resulting in decreased competition for resources.
- Higher densities of non-salmonid species may also be driven by higher densities of favoured prey items in addition to reduced competition and exclusion by brown trout.

Laboratory

- There was a rapid and total mortality of all brown trout, carp and zebra danio embryos following exposure to PEITC concentrations of 1µg/L.
- Concentrations as low as 0.1µg/L resulted in significantly increased embryo mortality, and those that survived to hatch had an increase in the percentage of incidents of spinal malformations for all three species with brown trout most affected.
- Behaviour trials showed that embryonic exposure to PEITC concentrations as low as 0.1µg/L can reduce startle reactions in brown trout and carp, which may in a wild population leave them at greater predation risk.

Summary

There were reduced abundances of young-of-year brown trout in sites directly below salad wash discharge, though the effect did not extend far downstream. This may have been caused by PEITC exposure of embryos in nests, as prior estimates of PEITC concentrations in salad wash effluent are several orders of magnitude higher than levels that caused complete mortality in the laboratory trial. However, these estimates do not account for dilution in receiving watercourses, nor the extent to which PEITC may or may not infiltrate gravels to expose embryos. Further research is required to quantify actual concentrations of PEITC in gravel nests to assess if real world levels are capable of increasing embryo mortality. Total invertebrate abundances were higher below salad wash discharges, which may have led to the observed increased condition of adult brown trout. However, the invertebrate assemblages were characterised by fewer pollution-sensitive species and high abundances of pollution-tolerant species, potentially caused by PEITC in the discharge. In tandem with lower abundances of young-of-year brown trout, the longitudinal extent of the perturbation on invertebrates did not extend more than a few hundred metres downstream of the effluent discharge points.

Recommendations to mitigate effects of PEITC

- The use of artificial wetlands may increase degradation of volatile PEITC and decrease sediment loads in discharges.
- Filtering salad wash effluent through a bed of activated carbon may be a viable mechanism by which to strip PEITC from effluent prior to discharge.
- The use of UV to increase PEITC breakdown rates shows promise due to the high volatility of PEITC.

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