EFFECTS OF COARSE FISH IN SHALLOW LAKE ECOSYSTEMS: AN ECOLOGICAL AND SOCIOLOGICAL APPRAISAL

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Abstract

Macrophyte loss from Sites of Special Scientific Interest (SSSIs) in England has become widespread over the last 20 years. One reason for this may be changing trends in angling, a multi-billion pound industry that has an enormous impact on aquatic ecosystems. Stocking with cyprinid fish is a common practice, but fish species and the distribution of their biomass may be crucial to the ecosystem.

Carp (*Cyprinus carpio* L.), roach (*Rutilus rutilus* L.), bream (*Abramis brama* L.) and tench (*Tinca tinca* L.) at densities ranging from 0 to 800 kg ha^{-1} and at various sizes were placed into experimental mesocosms in Little Mere, a shallow, fertile lake in Cheshire, England. The effects these treatments had on the aquatic ecosystem were studied over two summers. I looked specifically at the effects of the treatments on benthic and macrophytic macro-invertebrate populations, macrophyte growth, lake water chemistry, epiphyton production and zooplankton / phytoplankton survival. The results from a variety of sampling and analysis techniques were collated and statistically analysed using general linear models and regression.

Carp had a greater detrimental effect on the macrophytes than bream, tench and in particular roach. A high density of fish (> 200 kg ha^{-1}) adversely affected the extent of macrophyte growth.

The decline in macrophyte growth seemed to be due to epiphyton, an algal mat that grows on macrophytes that probably reduced the amount of light and carbon dioxide available to the plant.

Macrophyte-associated macro-invertebrates rose in number and biomass with increasing epiphyton load. However they apparently had little impact on the extent of epiphytic growth. Shading from disturbed sediment or phytoplankton was also unimportant. The chemical data suggested that phosphorus concentrations increased even in the controls and substantial amounts were available. Phosphorus stimulation can therefore be discounted. However inorganic nitrogen levels were low and it is possible that release of nitrogen, from fish excreta, followed by immediate uptake could have been a factor stimulating epiphyton growth.

A questionnaire was compiled and sent to fifty nine angling clubs of SSSIs. In doing so the sociological and economic aspects of coarse fish angling were assessed and together with the mesocosm experiments gave a holistic overview of the state of angling and nature conservation in England today.

Despite the obvious conflicts of interest in some areas, angling and wildlife are not necessarily incompatible. Where due consideration is given to the effects of litter, habitat modification, disturbance, control of predators and stocking regimes, the two interests may be able to co-exist. However fisheries managers should realise the benefits to fish when the whole system improves through environmentally sensitive management and in this context habitat modification and site planning should be better governed by guidelines. In turn, conservationists need to work more closely with anglers.

To further understand the complex interactions occurring in lakes and to better comprehend the processes of eutrophication and restoration the continuation of a long term monitoring project of three linked lakes (Mere Mere, Little Mere and Rostherne Mere) was undertaken. This programme started in 1990 prior to nutrient rich sewage effluent being diverted from Little Mere and Rostherne Mere in 1991. Mere Mere acted as a control lake upstream of the discharges. I used data collected previously as well as data collected by myself over a two year period to assess the impact of this effluent diversion and consequent nutrient input reduction on this system of lakes.

Contrary to expectation, Little Mere responded quickly to effluent diversion in terms of available nutrients and increase of dissolved oxygen. However fundamental ecosystem structural changes have not occurred in Little Mere. This is because Little Mere was a macrophyte dominated clear water site prior to effluent diversion, perhaps owing to the abundance of *Daphnia magna* (Straus) and very few fish in the deoxygenated waters. It is still in a clear water state probably maintained by macrophytes acting as refugia for other smaller zooplankton when oxygen levels rose, fish returned and *D. magna* numbers were reduced. Nitrogen uptake by macrophytes, which limits phytoplankton growth, may also have been important.

Rostherne Mere has been slow to respond to effluent diversion. Chlorophyll *a* concentrations have not fallen despite a gradual decline in phosphorus and as such effluent diversion has failed in its ultimate aim. The efficient re-cycling of phosphorus within Rostherne Mere and slow phosphorus removal mechanisms are the most likely causes of the merely slight decrease in phosphorus concentration. Therefore nitrogen limitation is the mechanism most likely to control the phytoplankton crop. However whilst nitrogen reduction may reduce phytoplankton biomass in future, the presence of nitrogen-fixing algae may ultimately render this strategy unsuccessful.

Mere Mere acted as a control and has stayed relatively stable since 1990.