ENGLISH NATURE

The role of fish in the management of freshwater Sites of Special Scientific Interest

No. 111 - English Nature Research Reports

working today
for nature tomorrow

The Role of Fish in the Management of Freshwater Sites of Special Scientific Interest

English Nature Contract Number

F72-06-38

Phillip Smith and Brian Moss

Department of Environmental and Evolutionary Biology
University of Liverpool

April 1994

Contents

Summary

1. Available information on the fish communities has been gathered for thirty-one meres, most of them SSSIs. Relatively little information was available from statutory sources (NRA and EN files) or from the published literature. Most information came from questionnaires sent to angling clubs or landowners. Although much information was obtained, only that on species present is likely to be absolutely reliable and even this will tend to overlook non-angled species such as bullheads, sticklebacks and stoneloach. Perceptions of stock size were given but cannot be compared between lakes or on any absolute basis. It is thus not possible to relate this information to measurements of chemical and biological variables made on the meres. A series of standard surveys are required for this.

2. Common carp, an introduced fish, is present in most of the meres and may cause eutrophication problems in at least one.

3. The natural history of the major species of angling fish has been reviewed and related to potential top-down effects in the meres and other shallow waters. A league table has been drawn up relating features of the fish and the manner of their angling to potentially deleterious effects in shallow waters. The league may be used to inform decisions about allowing restocking in SSSI sites and suggests that requests for predator removal should always be refused. The league, from least desirable to most favoured in this respect is: Common carp, bream, tench, roach, crucian carp, rudd, perch, dace, pike, eel, brown trout.

4. Discussion is made of the different aspirations of anglers and conservation interests and the role of the NRA Fisheries Strategy. It is recommended that EN and NRA officers agree a policy for fisheries management in SSSI sites. Conservation and angling interests are not always compatible in shallow, plant-dominated lakes. It is also suggested that EN and NRA officers establish a programme of angler education to disseminate new ideas of top-down influences.

5. A strategy is outlined for the obtaining of reliable data on the fish communities of the meres.

Chapter 1. Introduction

Many waterbodies have been designated SSSIs to a significant extent on the basis of their macrophyte communities. There are, however, a number of processes which may threaten macrophyte community stability. In many eutrophic waters, phytoplankton may become dominant at the expense of macrophytes. In eutrophicated water, the competitive ability of submerged macrophytes is reduced by shading (either via epiphytes or phytoplankton) or competition with phytoplankton for available dissolved nutrients, particularly carbon dioxide. Except in extreme circumstances, a eutrophic water may be dominated by either macrophytes or phytoplankton as alternative stable states (Scheffer et al 1993) and these states can exist over similar ranges of nutrients and once established, each is buffered from change.

Macrophytes can prevent phytoplankton dominance by utilisation of sediment nutrient sources, release of algal suppressants, shedding and replacement of leaves that are heavily shaded by epiphytes and providing a structural refuge within which filter-feeding zooplankton can escape from predation by fish. These refuges allow large herbivorous zooplankton to coexist with zooplanktivorous fish and hence to control phytoplankton in adjacent and overlying waters by grazing. The alternative dominant phytoplankton can begin growth earlier in the season and thereby shade macrophytes whilst it lacks structural refuges for zooplankton and enhances potential zooplankton predation by fish. The algal community may ultimately become dominated by largely inedible blue-green species and then zooplankton, even if present may have little effect on abundance.

The switching from one alternative state to another may involve mechanisms that directly destroy the plants (cutting, boat activity, herbicide run-off, grazing by exotic vertebrates, including fish, birds and mammals) or mechanisms that destroy the zooplankton grazing community (run-off of pesticides, (Stansfield et al 1989) or alteration of the fish community strongly favouring zooplanktivores (Bronmark and Weisner 1992)). The potential direct or indirect effects of alteration in the fish community are the particular concern of this report, which also focusses particularly on the possible importance of these mechanisms in the West Midland meres.

Fish have the potential to affect freshwater ecosystems through their ability to eat a wide range of animals, physically to alter the habitat through their feeding behaviour and to release nutrients via sediment disturbance and excretion of waste products. Sediment-, detritus- and macrophyte-eating fish mobilise phosphorus and may be significant if the external loading is low (Braband et al.1990; Richardson et al.1990). For example, 200 kg ha-1 of carp have been shown to release 0.52 mg P m^{-2} day^{-1} from sediment resuspension and excretion (Lammarra 1975). Post-spawning mortality of fish may lead to an increase in available nutrients in the benthos and water column (Kitchell et al.1975). Being able to move among the littoral, pelagial and benthic zones, the top-down (in the sense of direction of the food chain) effects of fish can occur over short time scales and affect large areas. Fish are now being increasingly incorporated into studies on nutrient cycling and energy flow (Braband et al. 1990).

In a eutrophic phytoplankton-dominated system, removal of fish usually results in decreased abundance of zooplanktivores and a resulting increase in predation upon phytoplankton and may allow macrophytes to redevelop. For example Leah et al.(1980) divided a eutrophic lake into two and in one half the fish population was fortuitously reduced. Many large-bodied cladocerans were found to be present in the fish-reduced half and associated with this was reduced turbidity and an abundance of macrophytes. Andersson et al. (1978) used enclosure experiments to detect the impact of fishes on water chemistry, phytoplankton, zooplankton and benthic invertebrates and found a reduction in the abundance of large Cladocera and an increase in numbers of small Rotifera where fish biomass was increased. The reduced grazing pressure on the phytoplankton made the water green and turbid and there were blue-green algal blooms. With a low density of fish, the cladoceran standing stock increased and the phytoplankton abundance decreased. Other examples illustrating similar effects include: Lynch and Shapiro (1998); Spencer and King (1984); Prost and McQueen (1987); Ozimek et al.(1990); Meijer et al. (1989); Christoffersen et al. (1993), though Lazzaro (1987) in a review of planktivorous fish noted that few studies were designed to allow statistical inference.

The West Midland Meres

The West Midland meres, located in Chesire, Shropshire, Staffordshire, and part of Wales comprise over 60 lakes lying in a lowland drift plain laid down on the retreat of the last glaciation. Within the group are some naturally eutrophic meres and also

others suffering from cultural eutrophication. Some are phytoplankton dominated whilst others have an abundance of macrophytes. A study of water chemistry, zooplankton, phytoplankton and macrophyte data, carried out for 22 SSSI meres (Moss et al., 1992, 1994) classified the meres into two ecologically distinct groups: either shallow (maximum depth <3m) and unstratified or deep (maximum depth >3m) and thermally stratified in summer.

The deep meres were fed largely by ground water and phytoplankton abundance was controlled by nitrogen availability (i.e. bottom up control). In the shallow meres, phytoplankton was controlled by zooplankton grazing. Within this group, however, there were some meres with relatively low zooplankton communities and high phytoplankton standing crops and others with high zooplankton and low phytoplankton. There was a general inverse relationship between phytoplankton and macrophyte communities but this was potentially consequential rather than causative (see above). The reasons for the variation in zooplankton stock could not be defined because of a lack of information on fish stocks. The function of the present contract was to see if sufficient information existed already to help resolve this matter.

Fish Communities in the Meres -Existing formally published information

Reported studies on the meres has been biased towards the larger ones e.g. Ellesmere, Colemere, Rostherne and Tatton (Banks1970; Okorie 1971; Ratcliffe1977; Goldspink 1978,1983; Goldspink and Goodwin,1979; Reynolds1979; Goldspink and Barr 1993). The National Rivers Authority does not routinely survey the meres.

Since the 1960s, there has apparently been a marked change in the fish populations of these deep meres. Perch have decreased due to the outbreak of perch disease in Rostherne in 1975 and Ellesmere in 1983. In both meres, the perch have recovered, but there has been an alteration in the population structure. Prior to the disease, perch lived up to eight years and became large (up to 1.3 kg ,Goldspink and Goodwin,1979), whilst by 1993, few fish survived beyond three or four years. Most perch had switched to feeding on zooplankton or littoral invertebrates. Cannibalism, previously common, was rarely recorded in 1993.

With eutrophication the fish communities of lakes usually undergo a change. With an increase in nutrients, a loss of structural habitat and an alteration in the light conditions, cyprinids such as roach and bream increase at the expense of perch. Reasons for this may be the ability of roach to feed on Cyanobacteria, detritus and macrophytes (Persson 1983a&b), shifts in zooplankton communities towards smaller individuals which cannot be taken by perch, and a reduction in macroinvertebrate prey, due to a loss of the most profitable macrophyte rich habitat (Leach et al.1977). Also, a reduction in light intensity due to phytoplankton abundance reduces the foraging efficiency of strongly visually hunting species (e.g. perch and pike), but favours bream and roach, which can feed efficiently at low light levels (Diehl 1988). With an increase in phytoplankton, the sedimentation of organic matter may increase to such a level as to cause a reduction in the dissolved oxygen in quiet waters, which may affect habitat utilisation by perch.

Pike do not grow to a large size in the meres and fish over 9 kg are quite rare. Pike feed mainly on perch aged 0+ or 1+. Roach are rarely taken because roach probably remain in the pelagic zone in deep lakes, whilst pike tend to remain in the littoral (Eklov 1992), though tend to spend more time in the pelagic with increasing turbidity (Asbjorn et al. 1986).

The main characteristics of the fish communities present in the deep meres seem to be: (i) fluctuations in year class strength (this, however, is a usual phenomenon in freshwater communities); (ii) generally low stock density ;(iii) in some cases, artificial stocking; (iv) dominance by roach, at least in 1993, with other species present including perch, bream, rudd, pike and in some meres, carp (both common and crucian) and trout.

There are no published data on the fish communities of the shallow meres, though it is in these that top-down effects are likely to be most significant and quantitative information on biomass in any of the meres is lacking.

Chapter 2. Methodology for the present survey

This report is based on the following thirty-one SSSI meres: Aqualate Mere; Bar Mere; Berrington Pool; Betley Mere; Betton Mere; Bomere; Brown Moss; Chapel Mere; Cole Mere; Comber Mere; Cop Mere; Crosemere; Fenemere; Hatchmere; Maer Pool; Marton Pool; Mere Mere; Little Mere; Norbury Pools (two lakes); Oak Mere; Oss Mere; Petty Pool; Quoisley Meres (two lakes); Rostherne Mere; Shomere; Tabley Mere; Tabley Moat; Tatton Mere and White Mere. It also considers the following 3 non SSSI meres: Berth Pool; Ellesmere and Marton Pool near Baschurch.

Information concerning fish community composition was obtained first from English Nature files at Attingham Park. The relevant National Rivers Authority Fishery Scientist was also contacted and details of surveys, stockings or fish kills were requested. Angling clubs that fish the meres were then identified and asked to complete a questionnaire about angling pressure, methods and the extent of stocking, occurrence of surveys and known fish kills (see Appendix). A request was made for the club to estimate abundance for three size categories of each fish species : small (up to 6 inches or 2oz); medium (6-12 inches or up to 160z) and large(more than 12inches or greater than one pound in weight) on a 0-3 scale. For this 0 indicated absent; 1, scarce but present; 2, present in moderate numbers and 3, present in large numbers. These values were subjective and gave relative abundances of fish within a mere, but are more difficult to use to make comparisons between meres. We suspect also that the clubs judged size classes on their own notions of size rather than those we asked for. Copies of the questionnaires used are appended.

To summarise the impact of different species of fish, relevant literature was reviewed and information about distribution, life-history, feeding, interactions, angling methods and implications for water chemistry, zooplankton, phytoplankton and macrophytes was compiled (Chapter 5).

SECTION I

MERE

NGR SJ

LANDOWNER FISHERY

work done so far

NRA Area
Fishery Scientist
Inspector

Angling Club
Address and secretary
Initial phone call
Sent questionaire
Received questionaire
Reminder

EN County

SECTION II

NATIONAL RIVERS AUTHORITY

NRA Fishery Officer

Surveys carried out

Any quantitative data on the fishery?

Angled
Coarse
Bream- Common
Bream- Silver
Carp- Common
Carp- Crucian
Eel
Gudgeon
Perch
Pike
Ruffe
Roach
Rudd
Tench

Game
Brown Trout
Rainbow Trout

Non Angled
Bullhead
Lamprey- Brook

Lamprey- River
Loach- Spined
Loach- Stone
Minnow
Stickleback- 10 spined
Stickleback- 3 spined

Other eg Dace

Any qualitative data?

SECTION III

ANGLING CLUB AND SECRETARY

tel.

Fishing lease dated from
Type of lease
Size of club (number of members)

SECTION IV

ENGLISH NATURE

County

Information held by English Nature

SECTION V

OTHER INFORMATION (eg (un) Published work)

PLEASE USE A DIFFERENT QUESTIONNAIRE FOR EACH MERE

If more space is needed for any section, please use an extra sheet or the back of this questionnaire.

ANGLING CLUB AND SECRETARY Fishing rights for

tel.

1 How long have this club been allowed to fish the mere? .....

What time of the year can the mere be fished? .....

Is fishing allowed from all the bank? .....

If not, how much of the lake is fishable? .....

How many boats are allowed? .....

Size of club (number of members) .....

2 Angling pressure on the mere (total number of people on an average week, including weekends). Please indicate the numbers of pleasure, match and specimen anglers.

	Pleasure	MatchSpecimen
Spring (March - June)	.....	....
Summer (June - August)	.....	....
Autumn(September - November)	.....	....
Winter (December - February)	.....	....

3 Estimated number and type of fish present in the mere.

please indicate abundance on a 0-3 scale
0 - absent
1 - scarce but present
2 - present in moderate numbers
3 - present in large numbers

Small fish include those up to about 2 ounces or 6 inches long.

Medium fish are those from 2 ounces up to a pound in weight (6- 12 inches).

Large fish are those above a pound in weight. Please indicate the presence of any specimen fish, giving their weight and number if possible.

Angled	small	medium	large
Coarse			
Bream- Common	.....	.....	.....
Bream- Silver	.....	.....	.....
Carp- Common	.....	.....	.....
Carp- Crucian	.....	.....	.....
Eel	.....	.....	.....
Gudgeon	.....	.....	.....
Perch	.....	.....	.....
Pike	.....	.....	.....
Ruffe	.....	.....	.....
Roach	.....	.....	.....
Rudd	.....	.....	.....
Tench	.....	.....	.....
Game			
Brown Trout	.....	.....	.....
Rainbow Trout	.....	.....	.....
Non Angled			
Bullhead	.....	.....	.....
Lamprey- Brook	.....	.....	.....
Lamprey- River	.....	.....	.....
Loach- Stone	.....	.....	.....
Minnow	.....	.....	.....
Stickleback- 10 spined	.....	.....	.....
Stickleback- 3 spined	.....	.....	.....
Other	.....	.....	.....
(eg Dace)	.....	.....	.....
	.....	.....	.....

4 Please give an indication of the methods used by pleasure and specimen anglers and the fish that they catch.

	methods and baits likely to be used including amounts of ground bait and loose feed.	Fish caught Species	Size
Spring (Mar - June, if no close season)			
Pleasure			
Specimen			
Summer (June - Aug)			
Pleasure			

	methods and baits likely to be used including amounts of ground bait and loose feed.	Fish caught Species	Size
Specimen			
Autumn (Sept - Nov)			
Pleasure			
Specimen			

	methods and baits likely to be used including amounts of ground bait and loose feed.	Fish caught Species	Size
Winter (Dec - Feb)			
Pleasure			
Specimen			

5 Please describe the typical number of matches that are held on the mere and what fish are usually caught.

Summer (Jun - Aug)

Number of matches (per month) .....

Number of anglers competing .....

Number of anglers catching fish .....

Species and size of fish caught that make up both the winning and back up weights.

Methods and baits likely to be used including amounts of ground bait and loose feed.

Autumn (Sept - Nov)

Number of matches (per month) .....

Number of anglers competing .....

Number of anglers catching fish .....

Species and size of fish caught that make up both the winning and back up weights.

Methods and baits likely to be used including amounts of ground bait and loose feed.

Winter (Dec - Feb)

Number of matches (per month) .....

Number of anglers competing .....

Number of anglers catching fish .....

Species and size of fish caught that make up both the winning and back up weights.

Methods and baits likely to be used including amounts of ground bait and loose feed.

6 Has the fishing changed over the last

i) 5 years ?

ii) 10 years ?

iii) 20 years?

iv) 30 years?

7 Any restocking ?

For each time include:
Date Species Size range of fish Reason for stocking

8 Netting or other surveys by the club ?

For each time include:
Date Species caught Size range of fish Reason for netting

9 Removal of fish (eg pike removal) ?

For each time include:
Date Species caught Size range of fish Reason for culling

10 Any known fish kills or sightings of dead fish ?

For each time include:
Date Species caught Size range of fish

If more space is needed for any section, please use an extra sheet or the back of this questionnaire

Thanks again for completing this questionaire and if you have any queries please contact me.

PHILLIP SMITH