Tabley Moat (NGR SJ 721774)

The fishing rights are let by Tabley Estate office
W and O Beck
Tabley Estate Office
Tabley
Knutsford
WA16 0HG

0565 722224 (work)

Angling Club
Lymm Angling Club
Mr David Cook (secretary)
PO Box 350
Warrington
WA4 5HX

0925 264893 (home)

Data Available
Lymm AC answered a questionnaire.

Fish community
The fish density is thought to comprise bream, eels, roach, perch, tench, carp and crucian carp, with the overall density being low.

Stocking
In 1993, an undocumented number of small cyprinids was stocked. Prior to this, pike had been stocked at various dates. In 1993 and 1994, 150 small pike were removed by Lymm AC.

Fishing practices
The coarse season applies and fishing is from 16 June to 14 march. Anglers mainly fish for bream, roach or carp. The fishing intensity can be quite high in summer with about forty person-days per. This decreases in autumn and winter.

Tatton Mere (NGR SJ 755802)

Angling Club
Day ticket from Tatton Country Estate
Head Ranger Mr Michael Greystone

0564 654822 (work)

Data Available
Volume of day-tickets sold in 1993 and published literature, see below.

Fish community
Fish species thought to be present are pike, perch, tench, roach and some carp.

Stocking
There is no recollection of stocking by the Estate.

Fishing practices
Season open from 16 June to 14 March. Only a small section of the west bank is used for fishing. About 500 day-tickets were sold in 1993.

Summary of scientific literature

Goldspink (1978) - roach and perch show year class instability. Carp, tench and bream between 1973 and 1976 failed to recruit. *Ligula intestinalis* was found to be absent.

Reynolds (1979) - fish species dominated by perch, roach and pike although other species stocked since it was opened to angling in 1962.

Goldspink and Goodwin (1979) - individual perch were found to reach up to 40cm in length.

Goldspink (1981) - bream were showing a decline in abundance.

Goldspink (1983) - tench up to 3 kg were regularly caught by anglers. Subjective estimate of stock density was 50 kg ha^{-1}.

White Mere (NGR SJ 415330)

Angling Club
Ellesmere Angling Association
Mr Paul Jones (secretary)
Avondale
Ellesmere
Shropshire
SY12 0BQ

0691 623297 (home)

Data Available
The angling club did not wish to complete the questionnaire. The NRA surveyed the mere using an echosounder on 27 January 1989 and some information is held in EN file notes.

Fish community
The NRA did not find many fish and correspondence between EN and the Angling Club show a low perceived biomass of fish in the mere. An angler, who fishes this mere, described the fishery as containing moderate numbers of pike, roach, perch and tench, with low numbers of bream and carp. The overall density is likely to be low.

Stocking
There is no documentation of stocking.

Fishing practices
Few anglers fish this mere and there are no competitions.

Berth Pool (NGR SJ 429234)

Angling Club
Berth Pool Anglers
Mr David Orrell (secretary)
Mill Farm
Petlow
Shropshire
TF9 3JS

0952 541678

Data Available
Returned questionnaire by Mr Orrell.

Fish community
The main fish species are roach, perch, carp and bream along with eels pike and tench. The angling club think that the fish density is likely to be moderate.

Stocking
In 1972, forty,1-2 kg, carp were stocked by local anglers. In 1972 and 1974, an undocumented number of small eels was stocked by Severn Trent Water Authority. Over the last four years, the lake has been annually netted by the angling club to remove roach on the basis that this will promote the growth of other species, especially carp.

Fishing practices
Coarse fish can be angled for between 16 June and 14 March. Eels can be sought all year round. In the spring and early summer (15 March to 15 June), the intensity of eel fishing is about two person-days per week. For the rest of the year, carp are sought, at about an intensity of two to four person-days per week. Carp are angled for by using boiled paste baits or particles such as hempseed, sweetcorn or maggot. Fishing is from the bank and no boats are allowed. There are no competitions held.

Ellesmere Mere (NGR SJ 405350)

Angling Club
Ellesmere Angling Association
Mr Paul Jones (secretary)
PO Box 3
Ellesmere
Shropshire
SY12 0ZZ
0691 623297 (home)

Data Available
Unpublished fish surveys by Goldspink and Barr carried out in late September 1993 and also by NRA in early October 1985.

Fish community
Roach and perch can be found in moderate numebrs. Bream, tench and pike occur, but at a low density (Goldspink and Barr 1993). The NRA survey revealed low fish stocks. The overall density of fish is likely to be low.

Stocking
No information was found concerning stocking.

Fishing practices
Few people fish Ellesmere.

Marton Pool (NGR SJ 448234)

Angling Club
Mr Tim Paisley (secretary)
1 Grosvenor Sq
Sheffield
S2 4MS

0742 580812 (work)

Data Available
Returned questionnaire by Mr Tim Paisley.

Fish community
Carp and eels can be found in moderate numbers in this fishery. Other fish species thought to be present, but in low numbers, include: bream, pike, roach and possibly perch. The overall biomass is thought to be low.

Stocking
Carp were stocked in the mid 1970s, but the size and number were not documented.

Fishing practices
Fishing is allowed between 16 June and 14 March. Angling pressure is about ten to fifteen person-days per week in the summer and autumn. In winter, the water level rises to such an extent that access is difficult and there is little fishing carried out. Almost all the fishing is with boiled paste baits for carp. No matches are held. Commercial eel netting took place in 1990 to reduce eel stocks.

Chapter 4 Discussion of biomass information in relation to limnology of the meres

The data offered by owners and anglers for the relative stock sizes of small, medium and large fish of the major species present are given in Table 1. Where such biomass perceptions are available, these values have been summarised by addition within each mere in Table 2. Data are given only for those meres for which detailed limnological data are also available (Moss et al (1992,1994)) in Table 2. In Tables 3 and 4, the results of correlation analyses among the relevant data are given

Table 1. Relative perceived abundance of each species size-group in each mere for the more abundant species. For each species (Br, bream; Cp, common carp; Cr, crucian carp; Pk, pike; Rch, roach; Rd, rudd and Tn, tench) there is a three digit code. The digits refer to the abundance, respectively, of small, medium and large fish on a 0-3 code of abundance. See Chapter 2 for details for more details. * denotes data not available.

Mere	Br	Cp	Cr	Eel	Pch	Pk	Rch	Rd	Tn
Aqualate Mere	223	001	000	230	222	333	333	000	000
Bar Mere	*								
Berrington	211	000	000	000	112	211	221	001	111
Betley Mere	212	311	000	000	112	132	121	111	111
Betton Mere	*								
Brown Moss	000	000	000	000	000	000	000	000	000
Bo Mere	222	011	000	110	110	321	321	100	111
Chapel Mere	*								
Colemere	001	001	000	021	311	221	331	000	001
Combermere	001	011	000	001	221	123	221	000	001
Copmere	112	000	000	112	321	123	111	000	112
Crosemere	111	011	000	000	111	221	111	000	022
Fenemere	221	112	011	111	222	103	333	332	113
Hatchmere	111	010	000	011	110	110	111	110	110
Little Mere	*								
Maer Pool	*								
Marton Pool	111	120	220	121	222	231	221	111	122
Mere Mere	*								
Norbury Pools	*								
Oak Mere	*								
Oss Mere	221	001	222	222	122	223	322	221	321
Petty Pool	*								
Quoisley Meres	*								
Rostherne Mere	*								
Shomere	222	000	100	000	100	120	211	221	100
Tabley Mere	013	011	000	010	110	010	111	000	011
Tabley Moat	103	003	010	011	322	131	111	110	001
Tatton Mere	*								
White Mere	011	011	000	000	111	310	112	000	112
Not SSSI									
Berth Pool	122	023	000	032	321	022	331	000	022
Ellesmere	*								
Marton Pool	*								

Table 2. Summary of perceived biomass data classified into the deep and shallow mere groups of Moss et al 1992. Br, bream; Cp,carp; Cr,crucian carp; Pch,perch; Pk,pike; Rch,roach; Rd,rudd; Tn,tench. Biomass values are the sums of the values for small, medium, and large fish.

	Br	Cp	Cr	Eel	Pch	Pk	Rch	Rd	Tn	Total
Deep Meres										
Berrington Pl	4	0	0	0	4	4	5	1	3	21
Bomere	6	2	0	2	2	6	6	1	3	28
Colemere	1	1	0	3	5	5	7	0	1	23
Crosemere	3	2	0	0	3	5	3	0	4	20
Hatchmere	3	1	0	2	2	2	3	2	2	17
Whitemere	2	2	0	0	3	4	4	0	4	19
Deep meres mean total = 21.7 ± 3.7 , n = 7										
Shallow Meres										
Betley Mere	5	5	0	0	4	6	4	3	3	30
Cop Mere	4	0	0	4	6	6	3	0	4	27
Fenemere	5	4	2	3	6	4	9	8	5	46
Oss Mere	5	1	6	6	5	7	7	5	6	48
Tabley Mere	4	2	0	1	2	1	3	0	2	15
Tabley Moat	4	3	1	2	7	5	3	2	1	28
Mean total for shallow meres = 30.2 ± 12.7, n = 7										

The general picture that has emerged from the species lists is that perch, pike, roach and tench are present in all of the meres (eighteen in all) for which we have semi-quantitative data. Bream is present in all but one, common carp in fourteen, eels in thirteen, whilst rudd and crucian carp are less widely distributed, with ten and five occurrences. This picture is unsurprising and is not altered when those meres for which we have species only lists are included. Common carp are perhaps more widely spread than anticipated for these fish are long-standing exotics which rarely breed successfully in Britain and can only be distributed as a result of deliberate introduction.

Table 3. Correlations among fish and other variables in the shallow meres. Total fish biomass and biomasses of common carp and bream are taken from Table 2. Predators include eel, pike and large perch; zooplanktivores include all fish bar carp and those listed as predators. Biomass values are taken from Table 1. Other data are from Moss et al (1992,1994). Tot, total fish; Cp/Br, common carp plus bream; Zoopl, zooplanktivorous fish; Pred, piscivorous fish; Graz, zooplankton grazing index (approximately the growth season mean total biomass per unit volume of filter feeding Cladocera); Plants, submerged and nymphaeid plant cover in %; cphyll, growth season mean phytoplankton chlorophyll a ($\mu g\ l^{-1}$). Values in the correlation matrix are those of r. Only those asterisked are significant at P<0.05.

	Tot	Carp	Cp/Br	Zoopl	Pred	Graz	Plant	Cphyll
Betley Mere	30	5	10	11	2	1.8	100	80.1
Cop Mere	27	0	4	12	10	8.6	75	55.2
Fenemere	46	4	9	18	9	19.3	15	52.8
Oss Mere	48	1	6	15	15	42.4	10	31.7
Tabley Mere	15	2	6	6	1	65.5	75	19.9
Tabley Moat	28	3	7	12	8	90.5	100	21.4
Quoisley Mrs	18	0	0	2	4	113	50	11.0

	Tot	Carp	Cp/Br	Zoopl	Pred	Graz	Plant	Cphyll
Tot	-	-	-	-	-	-0.49	-0.67	0.37
Carp	-	-	-	0.43	-0.31	-0.4	0.26	0.57
Cp/Br	-	-	-	-	-0.01	-0.64	0.13	0.66
Zoopl	-	-	-	-	0.67	-0.65	-0.38	0.52
Pred	-	-	-	-	-	-0.2	-0.62	-0.09
Graz	-	-	-	-	-	-	0.05	-0.92*
Plant	-	-	-	-	-	-	-	0.17

There was an apparently greater perceived biomass of fish in the shallow meres compared with the deeper ones (Table 2) though the difference was not statistically significant. Correlations revealed nothing of statistical significance that was not already established (the inverse relationship between grazing activity and chlorophyll a in the shallow meres (Moss et al 1992,1994). Sample sizes were small and inherent problems with perceived as opposed to measured values for fish biomass both mitigate against the establishment of reliable relationships. Of the correlations which, though not significant at P<0.05, are significant at P <0.1, the directions of the relationships suggest that valid measures of fish biomass are worth obtaining. Thus the negative relationships between fish biomass and plant cover, carp + bream or zooplanktivores and grazing index, and the positive relationship between carp plus bream and chlorophyll are all consistent with a strong effect of fish-induced top-down control on the chlorophyll a values and hence light climate for the submerged plants in the shallow meres. The lower perceived fish biomasses in the deep meres compared with the shallow ones is also consistent with the lower proportions of littoral zone (and hence breeding and feeding habitat) in the deeper lakes. On the other hand a similar analysis of relationships in the deeper meres (Table 4) produced rather more significant relationships, most of them counter-intuitive and in opposition to the generally accepted conclusions about lake relationships. Thus there were negative correlations significant at $P<0.05$ between carp plus bream and chlorophyll , and plant cover with zooplanktivore biomass and a significant positive correlation between chlorophyll and predator biomass. All of these are counter intuitive. Coversely there were significant correlations in the expected directions between total fish and plant cover (negative) and carp with chlorophyll (positive). Taken as a whole, the relationships revealed in Tables 3 and 4 are best regarded as spurious where fish data are concerned. The subjectiveness of angler perceptions is an insufficient basis from which to draw any valid conclusions on lake functioning.

Table 5 summarises the known stockings that have taken place in the meres concerned. All permissions given by the NRA and its predecessors under Section 30 of the Salmon and Freshwater Fisheries Act have been included plus a greater number that appear to have avoided such record.

Table 4. Correlations among fish and other variables in the deep meres. Total fish biomass and biomasses of common carp and bream are taken from Table 2. Predators include eel, pike and large perch; zooplanktivores include all fish bar carp and those listed as predators. Biomass values are taken from Table 1. Other data are from Moss et al (1992,1994). Tot, total fish; Cp/Br, common carp plus bream; Zoopl, zooplanktivorous fish; Pred, piscivorous fish; Graz, zooplankton grazing index (approximately the growth season mean total biomass per unit volume of filter feeding Cladocera); Plants, submerged and nymphaeid plant cover in %; cphyll, growth season mean phytoplankton chlorophyll a ($\mu g\ l^{-1}$). Values in the correlation matrix are those of r. Only those asterisked are significant at P<0.05.

	Tot	Carp	Cp/Br	Zoopl	Pred	Graz	Plant	Cphyll
Berrington Pl	21	0	4	6	10	0.1	5	20.4
Bomere	28	2	8	14	8	10	5	13.9
Colemere	23	1	2	12	9	48.6	5	29.7
Combermere	21	2	3	10	8	23.4	5	20.5
Crosemere	20	2	5	8	6	50.9	5	9.2
Hatchmere	17	1	3	6	10	0.44	20	30.5
Whitemere	19	2	4	5	8	14	15	16.7

	Tot	Carp	Cp/Br	Zoopl	Pred	Graz	Plant	Cphyll
Tot	-	-	-	-	-	0.1	-0.67*	-0.29
Carp	-	-	-	-0.27	0.40	-0.28	0.32	0.84*
Cp/Br	-	-	-	0.45	-0.26	-0.21	-0.25	-0.72*
Zoopl	-	-	-	-	0.1	0.14	-0.72*	-0.15
Pred	-	-	-	-	-	-0.05	0.21	0.73*
Graz	-	-	-	-	-	-	-0.48	-0.19
Plant	-	-	-	-	-	-	-	0.41

Table 5 Fish stockings in the Meres

Aqualate Mere	1970s unknown quantity of small (elver) eels
	1982, 800, 6-10cm, carp
	1985, 250kg, of elver eels
Bar Mere	No information
Berrington	No known stocking
Betley Mere	1960s unknown number and size of carp
	1979, 1000, 10-16cm, bream
	1979, 1500, 7-15cm, roach
Betton Mere	No known stocking
Bo Mere	No known stocking
Chapel Mere	No information
Colemere	1977, 500, 7-13cm, roach
	1977, 500, 7-13cm, tench
Combermere	No known stocking
Copmere	1984, undocumented number, 60-200g bream
	1984, undocumented number of 60g roach
Crosemere	No stocking
Fenemere	Late 1970s, 800, 0.8-1.6kg, carp
	1981, 2000, 5-10cm, roach
	1981, 1000, 5-10cm, rudd
	1982 "a large quantity" of elver eels
Hatchmere	Pre 1989, large number of pike
	1989, 300, 0.2-0.5kg, carp
	1989, 600, c0.4kg, bream
Little Mere	Around 1990, carp, roach and other small fish
Mear Pool	1978, 250, trout
	1981, 250, trout
	1982, 250, trout
Marton Pool	No stocking
Mere Mere	No information
Norbury Pools	No information
Oak Mere	No known stocking
Oss Mere	No known stocking
Petty Pool	No information
Quoisley Meres	No known stocking
Rostherne Mere	No known stocking
Shomere	1991, unknown number, c10cm crucian carp
	1991, unknown number, c10cm tench
Tabley Mere	1993, unkown number of small fish
Tabley Moat	Unrecorded stocking of pike
	1993, unkown number of small cyprinids
Tatton Mere	No known stocking
White Mere	No known stocking
NOT SSSI	
Berth Pool	1972, 40+, 1-2kg, carp
	1972/4, an unknown amount of elver eels
Ellesmere	No known stocking
Marton Pool	Mid 1970s an unknown number of 1-2 kg carp

Chapter 5 Natural history of the major species of angling fish in the meres

Bream (Abramis brama L.)

Distribution within UK

Bream are commonly found in weedy, muddy, eutrophic lakes, reservoirs, slowly flowing rivers and some canals across western and central Europe. In the British Isles, it is common in England, Channel Islands, Ireland and now can be found in parts of Wales and Scotland.

Life history

Bream often live for 10-15 years and sometimes over 20. They usually become mature in their third or fourth year. Spawning takes place when the water temperature rises above 15 C, usually in May or June and occurs in shallow, warm, weedy areas. Hybridisation with roach or rudd can be common. Recruitment is affected by temperature (Lammens 1982; Goldspink 1981) and in the north west of England, the production of strong year classes is often infrequent.

Feeding

Larval bream feed on small plankton for the first few weeks of life, but then adopt a more benthivorous nature. Bream obtain prey by making undirected snaps at the benthos (Uiblein, 1992). The swallowed sediment, is sorted and prey items are retained. This technique requires only movement of the protrusile mouth and combined with slow swimming makes feeding on low prey densities quite efficient (Diehl 1988). Fish may stay in one particular area and disturb large amounts of substratum to exploit a rich food source such as chironomids, Dreissena polymorpha or Sphaerium (Biro et al. 1991; Wright 1990; Giles et al.1990). Bream possess reflecting material (guanine) in their retina, which allow them to feed during the night (Diehl 1988). If benthic prey density is low, bream can switch their mode of feeding and utilise their gill filaments to act as biological sieves and become zooplanktivorous (Lammens et al. 1987). This feeding plasticity was demonstrated by Giles et al. (1990) who found that bream in a phytoplankton-dominated gravel pit ate only zooplankton (Daphnia hyalina) whilst in a nearby macrophyte-rich pit, benthic prey items (Sphaerium) were taken. The threshold for switching is dependent on the feeding effeiciency and availability of benthic and planktonic prey. Small bream, compared with large bream, are more efficient at feeding on zooplankton and less efficent at consuming large benthic macroinvertebrates (Lammens et al. 1985). Lammens (1982) demonstrated that growth and gonad development in a shallow, eutrophic lake was related to the amount and size of available zooplankton. Winfield et al. (1983) investigated the behavioural basis of prey selection by underyearling bream and found that copepods (Diaptomus gracilis and Cyclops spp.) and nonplanktonic cladocerans (e.g. Chydorus spp, Ilyocryptus spp.) were the main food items.

Interactions

Bream are generally benthivorous when compared with roach, which eat planktonic cladocerans (e.g. Daphnia hyalina and Bosmina longirostris). Bream can take copepods more efficiently than roach, due to a lower handling time (Winkler and Orella 1992), and this allows the smaller, less profitable, cladocerans to be ignored (Winfield et al. 1983). Size for size and in structurally simple habitats, bream are superior to perch and roach in feeding on both sediment-living invertebrates and planktonic microcrustacea (Diehl 1988; Lammens et al. 1992).

Angling methods and induced effects

Anglers fishing for bream tend to introduce large amounts of bait to one particular area. This often comprises cereal or bread-based "groundbait" laced with small food items such as sweetcorn, chopped worms, maggots, pupae of flies (e.g. Green bottle and Housefly) and hempseed. This strategy relies on the assumption that bream shoals move around the lake and stop at areas where the food density is high. The angler concentrates fishing effort, i.e. baited tackle, in these areas and relies on bream staying in these prebaited high food areas long enough to be caught. To catch large bream, 10-20kg of groundbait and up to 3 l of particle baits may be introduced.

Implications for water chemistry

Bream can potentially disturb sediment, generate turbidity and release nutrients. Scheffer (1989) states that bream do not feed in macrophyte beds, only in open water, and that local turbid conditions may develop around the feeding area. These effects implicitly will depend on the total numbers of bream, mean size, extent of benthic feeding, size of open area in relation to macrophyte beds, substratum type and water movement. Anglers appear to introduce large amounts of organic matter but this has little effect on nutrient levels or organic loading (Edwards and Fouracre 1983).

Implications for zooplankton

Bream may adopt a largely zooplanktivorous mode of feeding, consuming planktonic Cladocera and Copepoda. Due to body morphology, bream are unable to feed on zooplankton in structurally complex areas and thus macrophytes may provide refuges for zooplankton to escape predation by these fish. If the availability of large zooplankton is low, bream may become benthivorous.

Implications for phytoplankton

The cascading impact of reduced grazing by herbivorous zooplankton and an increase of nutrients may promote rapid increases of phytoplankton numbers.

Implications for macrophytes

In some cases, bream can be detrimental to the presence of submerged macrophytes. Bream resuspend sediment, increase turbidity and cause existing submerged macrophytes to be shaded out. An unstable sediment may be produced which might inhibit the establishment of young seedlings.
Wright and Phillips (1992) and Wright (1990) compared the macrophytes in two gravel pits and found that the intitial low biomass of macrophytes (<1% cover) in one of the gravel pits - Main Lake (area 17 ha and average depth 1.5m) - could be attributed to bream-induced resuspension of inorganic silt. Following fish removal (396 kg ha^{-1}, 48% bream), vegetation cover (Elodea canadensis and Potamogeton pectinatus) rose from <1% to 93%. Fish were reintroduced to enclosures and vegetation decreased from 43% to <1%. The other gravel pit, St Peter's Lake (area 2 ha and average depth 1.0 m) had a large standing crop of macrophytes (48% cover). Removal of fish (356 kg ha^{-1}, 18% bream), increased the vegetation from 48% cover to 95%, whilst enclosures with fish (250-300 kg ha^{-1}) kept the vegetation down to about 40%. Bream were considered to be causal of this reduction in macrophytes.

Carp (Cyprinus carpio L.)

Distribution within UK

From their natural abilities to reproduce and migrate, carp should show a very limited distribution in Europe. However, because they are valued for their eating qualities and angling sport, carp have been transported widely. Carp were introduced to the British Isles by monks as food sources about 600 years ago and can now be found in most parts of Britain, excluding cold northern areas or those of high altitude.

Life history

Carp mature in their third or fourth year and can live typically for 10-15 years. It is doubtful if many natural self-sustaining populations exist in this country as the climate is usually too cold for succesful recruitment (Michaels 1988).

Feeding

Carp are omnivorous and undergo ontogenetic changes in diet. Larvae eat plankton, then benthic items with the size range of available prey increasing as the fish grow older. Carp have a protrusile mouth, which is used to penetrate the benthos and may disturb sediment and increase turbidity.

Interactions

Large numbers of carp will reduce the food available for other species and this may induce diet shifts i.e. the density of benthic prey items may become low and cause other fish such as bream, perch and roach to become zooplanktivorous.

Angling methods and induced effects

In carp fishing there is a basic dichotomy in strategy with some anglers wanting to catch large numbers of small fish (up to 3 kg) and those wishing only to catch specimens (over 18 kg). The former group, called pleasure anglers, generally introduce large amounts of small particulate bait (such as maggots, sweetcorn, luncheon meat, bread and hempseed) and fish for periods up to six or seven hours. The other anglers, called specimen hunters, introduce larger amounts of bait, often over long periods of time. This may be of a larger size and more specialised e.g. high protein paste baits. Fishing sessions are typically 48-72 hours, though can be longer or shorter.

Implications for water chemistry

Carp generate turbidity and may release sediment-locked nutrients (Crowder and Painter 1991). Meijer et al. (1990) investigated the action of cyprinids (c80% carp) on turbidity, water chemistry, phytoplankton and zooplankton using ten drainable (0.1 ha) ponds. Fish sizes were large carp (>8.0cm @92 kg ha^{-1}), small carp (5.5-8.0cm @304 kg ha^{-1}), roach (6.5-8.0cm @22 kg ha^{-1}) and bream (5.5-7.0cm @52 kg ha^{-1}). Carp were found to increase turbidity by sediment resuspension. Ponds with fish contained significantly higher chlorophyll a concentrations, though the differences were small. In this study there was no change in phytoplankton composition, only biomass. Other studies have found a change in species composition but not biomasss (e.g. Lynch and Shapiro 1981). The densities of large zooplankton e.g. Daphnia hyalina and D. magna were significantly lower in the fish compartments, whilst smaller species such as Bosmina longirostris and cyclopoid copepods reached significantly higher numbers.

Implications for zooplankton

It is thought that carp may be zooplanktivorous, usually only when young. A high density of carp may cause other fish species to become zooplanktivorous, and this is probably the reason for the observed impact on large zooplankton by Meijer et al, (1990).

Implications for phytoplankton

Carp can promote phytoplankton dominance by removal of macrophytes and increasing availability of nutrients by internal loading from sediments, excretion and faeces production.

Implications for macrophytes

Cahn (1929) describes how an artificial dam in Wisconsin was a good sport fishery prior to the introduction of carp. After this, the luxuriant macrophyte stands were destroyed by the carp and the previously clear water became turbid.

Crivelli (1983) states that carp were introduced in the 1830s to the United States and proliferated. The impact of carp (0-726 kg ha^{-1}) on macrophyte (Potamogeton pectinatus, Ranunculus *baudotii* and *Chara canescens*) abundance in enclosures in a shallow (average depth 0.43m) lake in southern France was investigated. At end of the 71 day experiment, there was a strong negative correlation between macrophyte abundance and carp density. This was attributed to uprooting of macrophytes, as neither turbidity was affected nor were the plants eaten directly. The strength of the rooting system and the susceptibility to uprooting as well as other factors may lead to differential impacts of carp on macrophytes. However, this work was carried out using high carp density and in enclosures that were small relative to the size of fish. These dramatic results may not be readily applicable to any but the most intensely stocked UK carp fisheries.

Fletcher et al. (1985) introduced carp into a billabong and *Potamogeton* species, previously present did not develop.