Contents

Abstract

This paper explores for probably the first time, the effect of canoeing activity on the catch rate of anglers. The findings are based on three experiments on a fishing lake in Norfolk were the catch rate of anglers was recorded before, during and after canoeing activity. A second set of experiments made use of a hydrophone to record the noise of a canoeist passing over the surface of the water.

The study concludes that the canoeing produced no effect to the catch rate of the anglers. The sound of a canoe passing over is not significantly louder than background noise and therefore does not scare the fish away.
In short the canoeing activity had no conflict with the anglers and in one case the canoeing aided the anglers.

Acknowledgements

The Author is very grateful too:

Harleston and District fishing club for the use of the site and providing the fishermen. Especially Nigel Poll, Secretary for all is help in setting up the experiments.

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Introduction

> *For centuries the ancient sport of angling has been practised on our rivers and streams. ...These same waters are attractive to canoeists whose sport needs access and freedom of passage if it is to maintain a healthy growth. Inevitably, there has been a conflict of interest between the sports involved. Davies, E. In Sports Council (n.d.)*

The statement above helps to highlight the problem of water usage between the many recreational users of water. Since approximately the 1950's the growth of canoeing has been rapid, this has been accentuated by the development of new construction materials like plastic (polyethylene) and the boom in car ownership making it possible to easily move the craft to alternate locations.

The term 'canoeing' has been used throughout this paper as a generic term for all forms of canoe sport including kayaking and open canoeing.

Access to the water for canoeists is a large problem both in rivers and lakes. One of the largest problems is the access to "white water" river like those in North Wales, the Lake District, the Yorkshire Dales etc. Here the conflict between canoeists and game fishermen is often great. The chosen area for this study is still waters (lakes), the access to such waters is an increasing problem due to the increase in recreational course angling. Still water was chosen for the study as is was felt that it would be easier to manage than white water. The study is therefore limited to the specific area of the experiments and wider discussion is difficult.

This study proves that there is no effect to the catch rate of roach during canoeing activity on a deep water (3.7m) lake.

Background Information

This section of the paper will study the historical problems of conflict between angler and canoeist, then go on to present background material for the main study. This will be given under the following sub headings:

- Historical conflicts. General recreation disturbance problems between anglers and canoeists
- other surveys examining effects of canoeing
- Characteristics of Roach *(Rutilus rutilus)*
- Basic over view of fish auditory system
- Synopsis of the physical properties of sound in water

Historical conflicts.

According to English and Welsh law there is no right of access to inland (non-tidal) waters which do not have a right of navigation. The right to grant access is that of the owner of the land on either side of the river / lake, which are often farmers or estate owners. These riparian owners can take a lot of money from selling fishing licenses for coarse or game fishing, the cost of such licenses can be up to £25.00 a day in Suffolk.(Wilson 1995)

Owners do make considerable efforts to maintain access for angler and often stock the waters especially, therefore the taking from licenses is not all profit.

Canoeists therefore are required to make arrangements for access to the water. Some of this work is conducted by the British Canoe Union (BCU) using its large group of volunteer access officers. A list of people over seeing access on each river is found in the BCU members year book. Some of these agreements involve the paying of remuneration either centrally by the BCU or by individuals as they paddle the water. For example all BCU members are entitled to paddle on the navigable areas of the Norfolk Broads, there is a license for this activity, but the BCU pays this centrally on behalf of its members. Example of other practices include the Afon Llugwy (North Wales) from Pont Cyfyng to the Ugly House, here the farmer who's land is crossed to access the river is to be paid 50p per head, the Dee (North Wales) is only paddlable a few times each year during pre-arranged tours, the funds from which are partly used by

the land owners to manage the access sites. An exception to the Dee is the 'nomads' site at Llangollen. The site is owned and run as an canoeing and rafting centre, part of its revenue is that canoeists can pay (£4.00) to paddle on this short but exciting piece of water.

Despite all this work, access to the water for canoeists is still very limited "Out of a total of 19,144 kilometres on 656 rivers listed by Edwards in his book *Inland Waterways*, there were agreements covering 519 kilometres on 31 rivers. In other words anglers had agreed to share 2.7% of the available length of rivers in England and Wales" Storry (1989 p.39)

There are many cases of conflict between canoeist and fisherman, several reports of these are noted in Canoeist and Canoe Focus magazines and include such articles as:

Seiont Demonstration. Canoeist May 88 pp 15-19
Moynihan backs status quo. Canoeist July 1989 p9
do you care enough? Canoe focus April 91
NRA research programme. Canoeist Sept 91 p8
sports council conservation. Canoe focus June- Sept? 91 p31
Access. Canoe focus April 92 pp16-17
Tay access in danger. Canoeist June 92 p8
NRA about face- frightening fish. Canoeist Oct 92
Access. Canoe focus April 93 p47
Does canoeing disturb fish - call for help. Canoeist June 93 p 8
Access. Canoe focus August 93 p33
River Teme. Canoe focus Oct 94 p42

Most notable of which is the Seiont demonstration in March 1988, fishermen blocked bridges with gates and fencing when 60-70 canoeists tried to paddle the river. During the day most paddlers succeeded in getting through, there were several arrests of both anglers and canoeists, but importantly talks regarding access were promised.

Thankfully access has come along way in nine years, but there is still a large amount of water that is not available to canoeists and areas of the country were there is great animosity between anglers and canoeists.

The research for this study was conducted on the Norfolk / Suffolk border, here most lakes are privately own by fishing clubs who guard their access very carefully. There is 289 different still water (lakes and ponds) locations used for angling in Norfolk and Suffolk (Wilson).

Other surveys

There is very little previous research in this field, one study is that of Chester Weir and the possible effect that canoeing and bathing had on the migration of salmon up river. This was commissioned by the NRA (now Environment Agency).

The introduction from this report is quiet useful in summing up the feelings of anglers. "Historically there has been a perception, amongst the angling fraternity within the Dee catchment, that canoeing activity and bathing at Chester Weir has restricted the numbers of salmon successfully migrating into the Dee, although there has been no objective evidence to either support or reject this claim. An investigation was therefore advanced to establish the true position with regards to any influences canoeists or bathers may have on migratory fish movement at Chester Weir." Environment Agency (n.d.) p2

The weir at Chester is a popular canoeing spot offering moving white water in an otherwise flat water area. At times the canoeing can be quite intensive and there are some organised 'rodeo' events now taking place at the weir. The study made use of the latest technology by radio tagging salmon to monitor their progress up the weir. Counters were set up on the weir and the time and duration of canoeing and bathing activity was logged. The report concludes:

7.0 Conclusions

7.1 Canoeing impact on salmon migration past Chester Weir

The behaviour of adult, wild salmon is naturally influenced by a wide range of environmental factors and conditions such as river flow, light intensity, water temperature and quality. Sufficient radio-tagged individuals reached the weir and to within the limited area of the fish pass. In general the impact of canoeing was of insufficient magnitude to differentiate it from the variability in behaviours recorded through the interaction of a number of extrinsic environmental and physical factors operating in the vicinity of Chester Weir. Environment Agency (n.d.) p18

As already stated the amount of canoeing taking place at the weir can often be considerable. The canoeist are usually 'playing' in the rough water, it is this playing in

water that is often stated as having a serious effect on the fish, and yet, any effect was of 'insufficient magnitude' to make it stand out form other factors. The Environment Agency are at present compiling the information in a more readable format, it is hoped that they do not take too long over this and that the study will get the press coverage in canoeing and fishing journals alike.

Angling v Canoeing

It is the authors opinion that it is not a case of canoeists or anglers winning the argument, but rather, it is about a closer working relationship so that all can enjoy the water. Part of the problem is possibly the image that the two sports portray; angling is more often regarded as a relaxing noble sport of gentlemen, whilst canoeing is portrayed as an all action adventure for the young. It is obvious to the author that there is a lot more to each sport than a simple statement can outline.

Angling has as greater number of participants than canoeing, this combined with it's different image may aid the exclusion of paddlers from private waters.

Estimated number of people participating in watersports	6,800,00/year
Estimated number of canoeists	800,000/year
Approximate number of Angling Licences sold	1,000,000/year

from NRA Recreation Strategy (1993)

However, if the number of licenses sold is a measure of the number of anglers they are less than a sixth of the total water sports users, and yet, they appear to have control over a far greater than a sixth of the available water.

Characteristics of Roach *(Rutilus rutilus)*

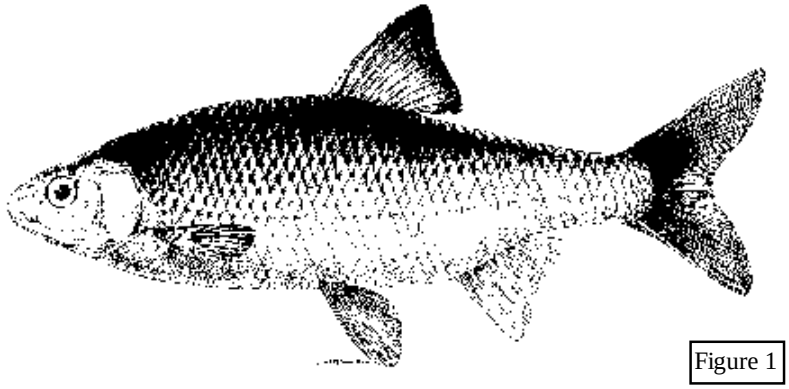


Figure 1

The fish used for this study were Roach *Rutilus rutilus* they are part of the Cyprinidae family which also includes all the Carps. This is the largest fish family with some 175 genera and approximately 2000 species. (Maitland)

They are a shoaling species, tolerant of wide range of species and some mild pollution lowland lakes and rivers, as such they are a very successful species that can be found extensively all over Europe and Asia.

Part of why the Roach is such a successful fish in Europe is the fact that it can survive on a variety of diets, table (1) below helps to demonstrate this.

Food of Roach in the river Stour and the river Frome, as percentage numbers (except* = percentage occurrence)

Stomach Contents	*River Stour*	*River Frome*
Algae	11*	18*
Macrophytes	8*	-
Molluscs	20	39
Crustaceans	1	1
Insects		
Mayfly larvae, pupae & adults	4	24
Caddis larvae	25	1
Midge larvae	19	15
Blackfly larvae	12	-
Other invertebrates	7	21
Number of fish Examined	347	22

Table 1. After Mann 1973 in Maitland & Campbell (1992 p.218)

"Being largely mud swallowers and therefore having to ingest and process large amounts of indigestible material. Roach typically do not have a stomach (or pyloric caecae) but the intestine is very long - around 15 times the length of the fish. With their well-adapted mouths, Roach are able to penetrate some 5cm into the bottom mud…" Maitland & Campbell (1992 p.216)

Perception of sound in fish

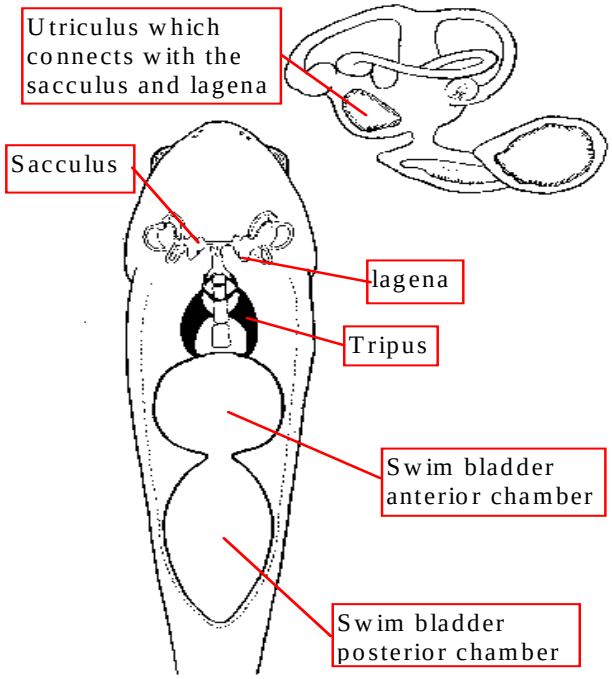


Figure 2

Figure (2) Linkage of ears and swim bladder in carp like (*Ostariophysi*) fishes. After Marshall (1965) and Fisch (1963) in Bone (1995)

Not all fish receive sounds in the same way, most freshwater fish including characins carp like fishes use the swim bladder. The swim bladder is gas filled and used by the fish as a buoyancy tank to regulate floatation. Sound travels through the water as vibrations, it is these vibrations that cause the wall of the swim bladder to vibrate. Figure (2) shows the swim bladder and its links to the inner ear. Vibrations in the swim bladder are transmitted to the inner ear (sacculus) via bones of the skull. The sacculus is filled with fluid and cells which each have a hair protruding into fluid, these are connected to nerves. Solid particle(s) -Otoliths float in the fluid, vibrations cause movement of the otoliths this bends the hairs and thus setting off an impulse through nerves to the brain. Different frequencies trigger different hairs, loudness triggers more or less more or less hairs.

Sound

Sound is propagated through mechanical longitudinal wave motion in a medium (gas, liquid, solid) without this medium the waves cannot spread, this is not the case with electromagnetic waves which do not need a medium through which to transmit.

Sound is described in terms of frequency, wavelength, amplitude, speed and intensity. When looking at the meaning of each of these terms it is helpful to consider the sound in terms of a trace that would be received from an oscilloscope (figure 3).

Frequency - the number of complete oscillations made in one second.

Wavelength - the distance between two successive wave crests.

Amplitude - maximum displacement from the point of rest or the central position (height of wave)

Speed - the speed of sound in air is 330 m/s in water this is considerably increased to 1500m/s.(Avison 1991)

Intensity - the rate at which the wave carries energy away from the source. This is at right angles to the direction of travel of the wave.

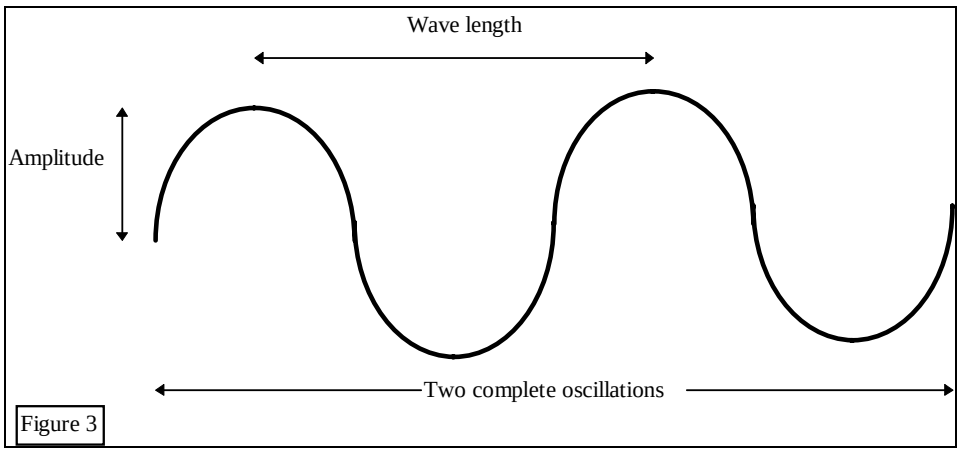


Figure 3

Sound in fluids

As in air sound is transmitted as longitudinal waves, molecules move back and forth in the direction of propagation

Velocity of sound in water is about 4 times faster, it is dependant on the temperature of the water and the amount of impurities present. In freshwater at 20^{o}C the velocity of

sound is 1482.3ms^{-1} compared with 1521.9ms^{-1} in sea water at 20^{o}C (Kaye & Labey 1975)

Dissipation of sound energy in water

As the sound proceeds through the water its energy is reduced by a number of factors.

1. viscous loss - the relative movement of the adjacent particles. Resulting in energy loss similar to that of friction.
2. transfer into heat energy.
3. kinetic energy of molecules converted into potential energy.

After Kinsler 1982

The absorption is dependant upon the frequency of sound and the type or purity of the water. This is summarised in figure 4 below.

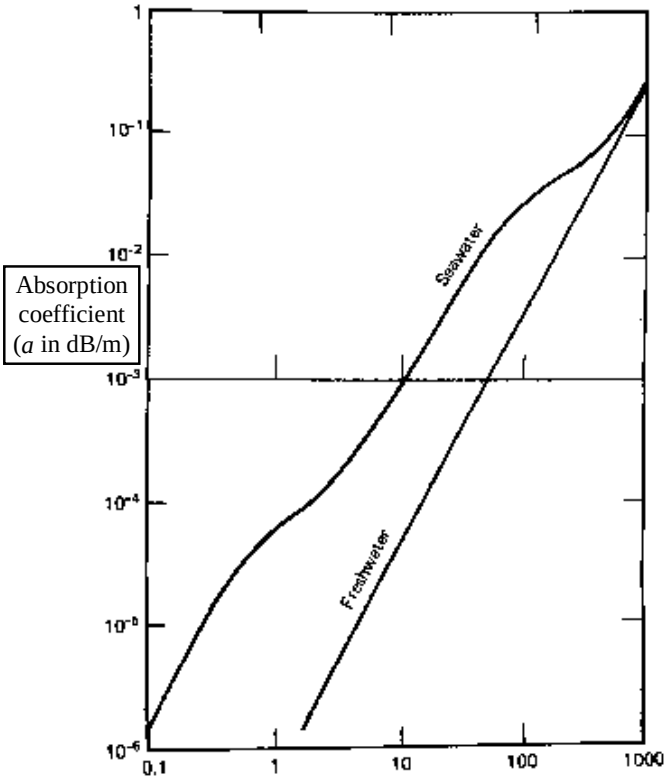


Figure 4 sound absorption in freshwater and in seawater at 5^{o}C and 1atm.
Kinsler (1982 p.159)

The more dissolved salts the greater the absorption of sound.

Methodology

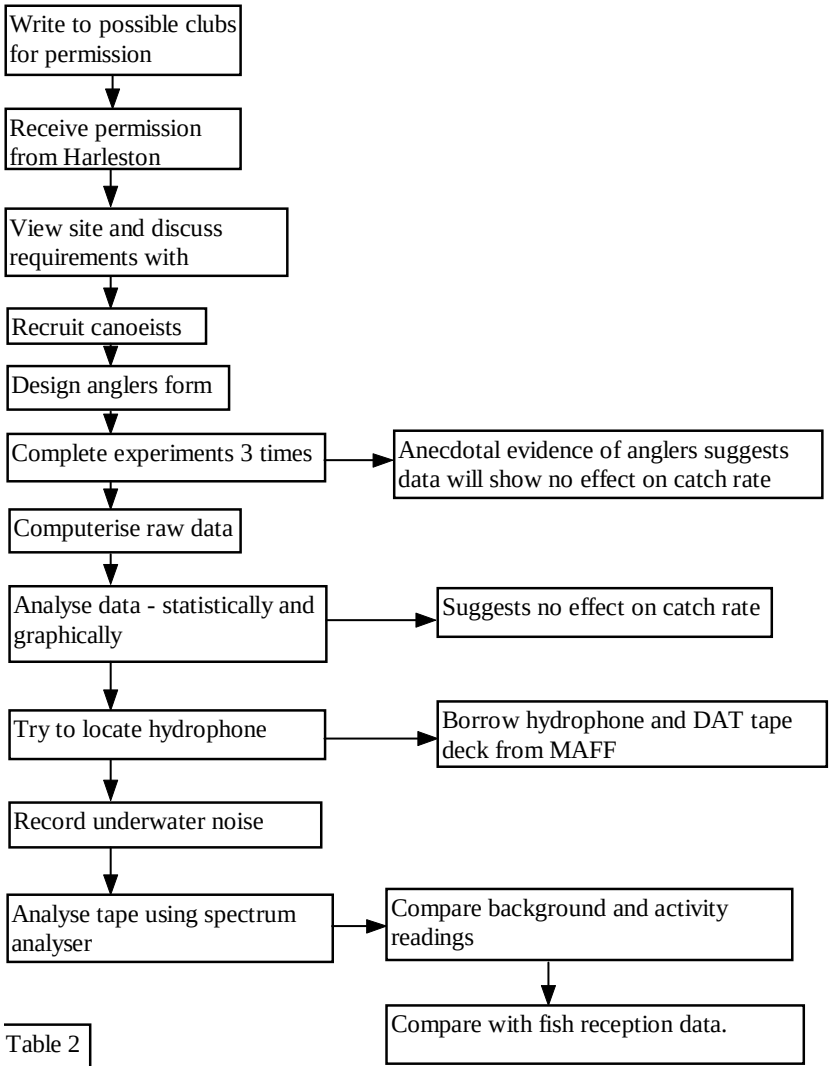


Table 2

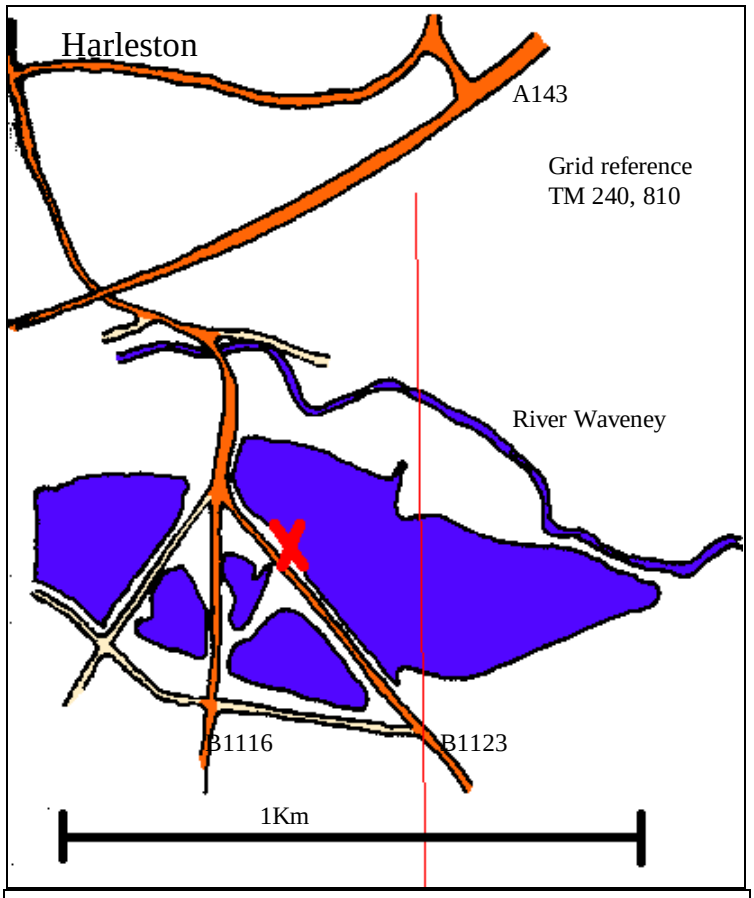
Table 2, opposite shows the order of steps taken for this study, these are now described in more detail.

Approximately 20 fishing clubs in the Norfolk / Suffolk area were contacted by letter about the possibility of help with the collection of data. Most of the clubs chose not to reply, one or two did reply in a short negative manner.

The author is very grateful to Harleston and District Angling club for their agreement and help to use their largest fishing lake at Weybread Pits.

The club runs a series of six old gravel pits for the use of it's members. The 'Ocean' pit is the largest of these and can be seen in the figure below. There is a small amount of sailing allowed on this lake, it is in a very restricted area to keep the anglers and sailors apart.

"The largest pit, aptly called the Ocean Pit, is an immense sheet of water over 100 acres and is easily the largest gravel pit in Norfolk. It holds a fine head of specimen bream, quality roach in profusion plus tench, pike to over 25lb and a small stock of wily, but large carp" Wilson (1995 p.112)



Map of area used. After Ordnance Survey (1987)
Figure 5

The data collect was organised by arranging for approximately 10 canoeists and 10 fishermen. The experiments were conducted on three consecutive Tuesday evenings in August 1996.

The fishermen set up and fished for at least one hour before the canoes arrived. The experiments took place on the south west shore of the lake (point X figure 5). The canoes launched from the east end of the lake and paddled down to the experiment site.

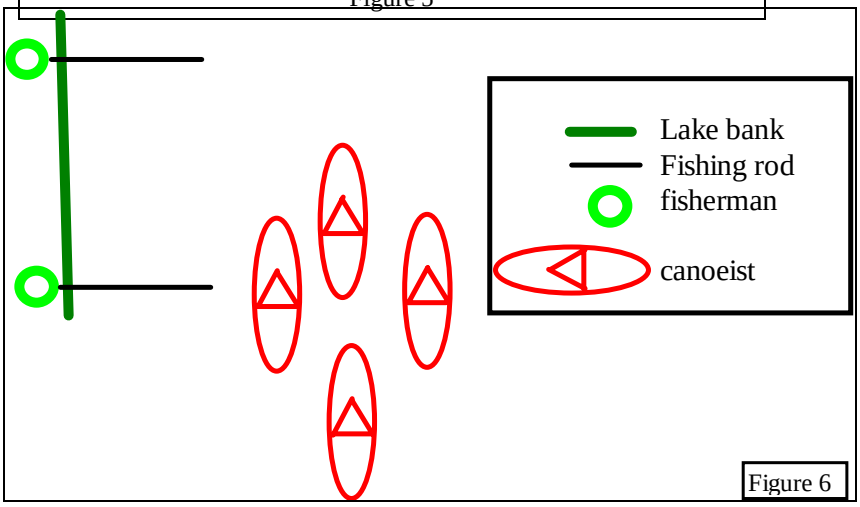


Figure 6

The logistics of trying to get enough volunteers and then get them in the right place at the right time was considerable. Signs were required on the road side to direct the canoeists and arrangements for refreshments after the activity were made.

The fishermen were lined along the bank of the lake with approximately 5metres between them. After an hour had elapsed the canoeists arrived and continued to paddle for an hour. Figure 6, above is a diagram of this. During the hour the canoeists paddled

back and forth along the experiment zone, the canoes passed very close to the floats of the anglers. Every effort was made to keep up the activity during the whole hour.

The anglers continued to fish for as long as was possible up to 1hour after the canoeists had gone. Often the weather was a limiting factor as the anglers had had enough.

The anglers recorded their catch and any comments on a half hourly basis on the form provided (see appendix one).

The site was returned to in early December. The depth of the water every metre from the shore was measured and used to draw a profile of the lake bed.

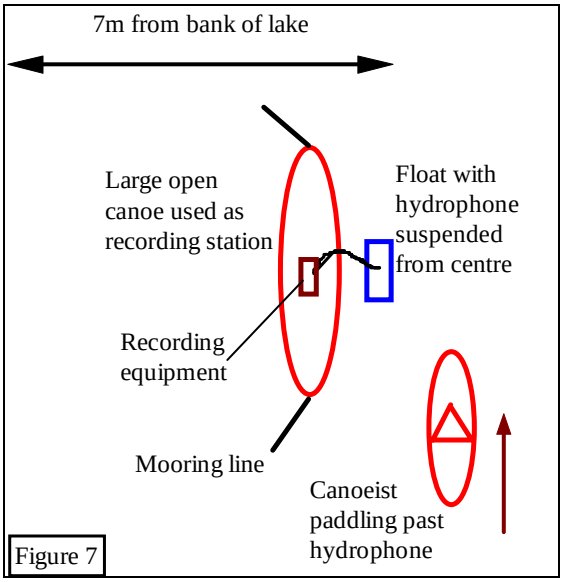


Figure 7

The sound of a kayak passing over the top of the water was recorded using a hydrophone. Set up shown in figure (7) opposite, recording equipment in large open canoe moored 7m from the bank, hydrophone suspended from a float in a manner that allows it to be suspended at different depths.

The specification of the hydrophone and recording deck can be found in appendix two.

Using a stereo recording deck allowed the hydrophone to be recording on one channel and a commentary on the other channel see figure (8) opposite. This was very helpful as it allowed easy recognition of which depth the hydrophone was at.

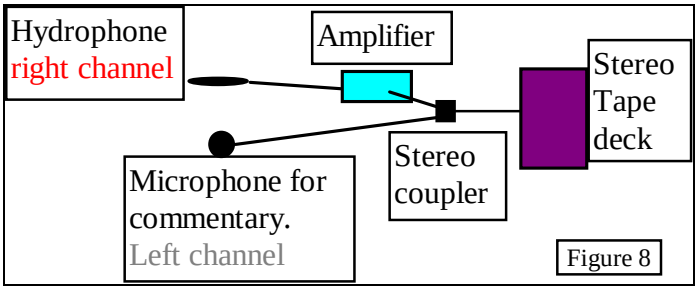


Figure 8

The tape was played to a spectrum analyser which was paused at specific points. The trace of frequencies could then be plotted on an X-Y plotter.

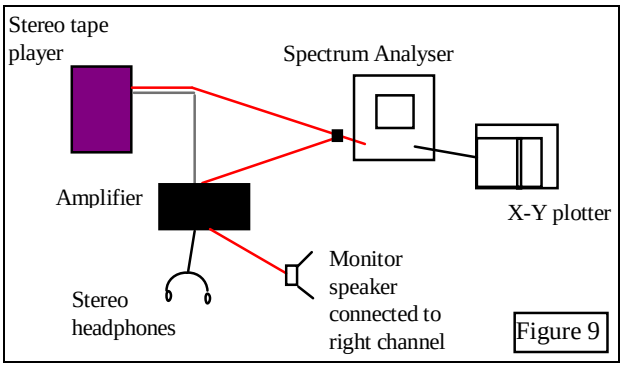


Figure 9

Figure 9 opposite shows the set up used to analyse the tape. A monitor speaker played the amplified right channel to make detection of patterns easier. Stereo headphones allowed the commentary to be listened too which facilitated the correct labelling of the charts from the plotter in terms of hydrophone depth. The tape deck also had a counter which enabled the tape to be partitioned into the areas of each depth recording.

Graphs were obtained for each depth (surface, 1m, 2m, 3m, bottom 3.7m) for a background reading and at a point when the kayak was passing over. These graphs could then be compared with each other and against information for the audibility capabilities of fish and Roach in particular. The presentation of this data follows.

Results

The raw data is shown presented here in a week by week format.

First Wk										
	N.Poll	Mears	Brand	Knights	Baldwin	Moye	Mean wk1	Range		
17:30								Min	Max	Stdev
18:00								1	1	0
18:30	1	1		1			1	1	9	3.4
19:00	7	6	2	9		1	5	1	7	2.3
19:30	7	4	5	7	1	3	5	2	8	2.7
20:00	3	4	3	8	2	8	5	2	7	1.9
20:30	3	4	5		2	7	4			

Second wk				Range		
	N. Poll	J.Gre	Mean wk2	Min	Max	Stdev
17:30						
18:00						
18:30	15		15	15	15	0
19:00	14	3	9	3	14	7.8
19:30	10	4	7	4	10	4.2
20:00	11	11	11			0
20:30		8	8			0

Third week						Range		
	N.Poll	M.Taylor	W.Taylor	W.Baldwin	Mean Wk3	Min	Max	Stdev
17:30	10		1		6	1	10	6.4
18:00	6		1		4	1	6	3.5
18:30	4	2	2	3	3	2	4	1.0
19:00	11	15	2	1	7	1	15	6.8
19:30	10	3	4	5	6	3	10	3.1
20:00	5	6	4	1	4	1	6	2.2
20:30		6			6	6		0

	Mean wk1	Mean wk2	Mean Wk3	Mean (total)
17:30			6	6
18:00			4	4
18:30	1	15	3	5
19:00	5	9	7	7
19:30	5	7	6	6
20:00	5	11	4	7
20:30	4	8	6	6

The fourth table shows the totals for the experiments and the fifth table gives the data in terms of the activity taking place. This information is displayed in graphical terms on the subsequent page.

	Before Canoeing	During Canoeing	After Canoeing
17:30 to19:00	6.25		
19:00 to 20:00		6.33	
20:00 to 20:30			6

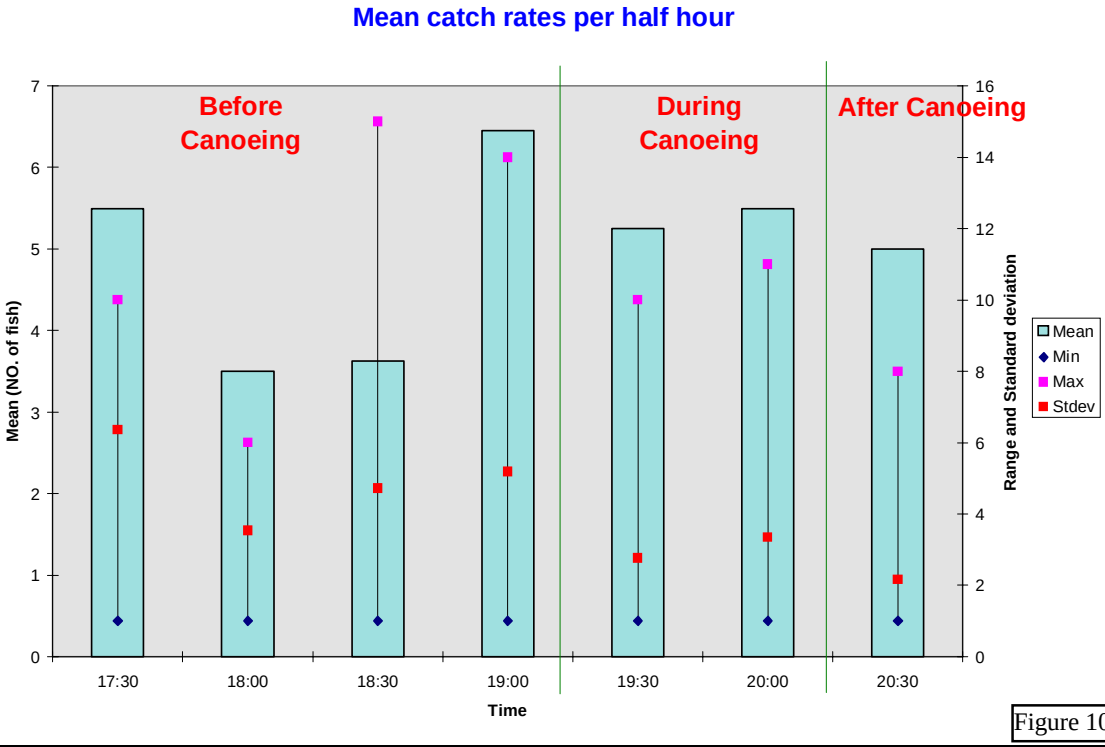


Figure 10

The figure 10 above shows the combined data from all three experiments, the mean, range and standard deviation have been plotted.

The initial low catch rate is probably due to the time taken for the swim to become active. The 'swim' is a term anglers use to describe the area of water they are fishing in. Anglers cast a lot of ground bait into the area as soon as they start fishing, to attract fish into the area. This process can take up to half an hour usually and could therefore explain the initial drop in catch rate.

The gradual catch rate from 19.00 could be due to the drop in light. Roach are not night feeders and as such fishing in the twilight is often poor. By the end of the canoeing session it was often fairly dark.

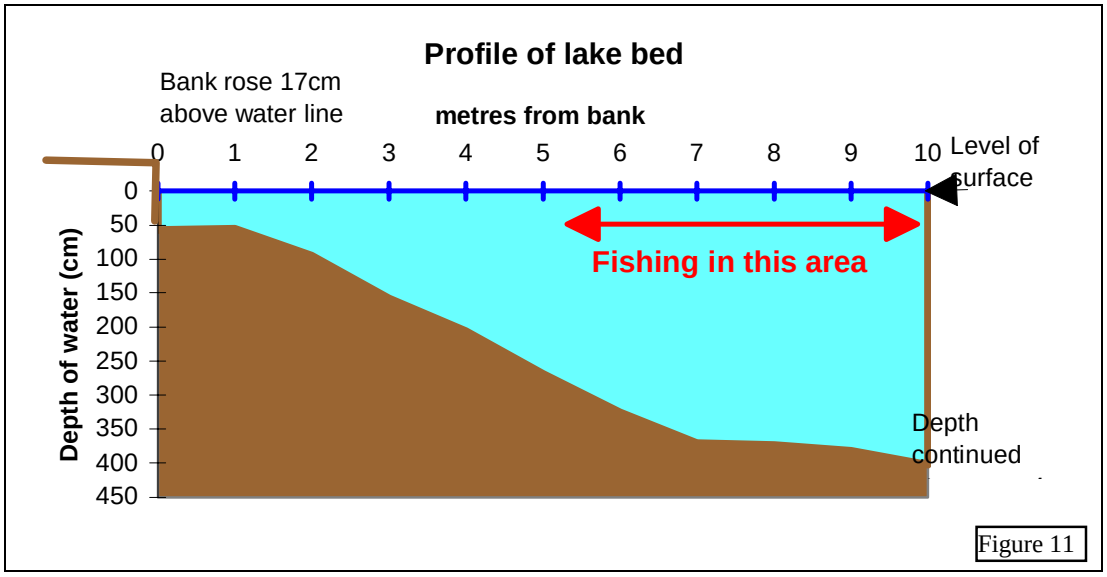


Figure 11

Figure 11 above indicates the profile of the area of the lake being used. The depth continued at approx. 4m up to at least 20m from the bank, depth in middle of lake measured as 5.3m (approx 60m from shore).

Audiogram results

Traces of frequencies have been recorded from the spectrum analyser, these have then been scanned into the computer and the kayak recording has been superimposed over the background trace for each level.

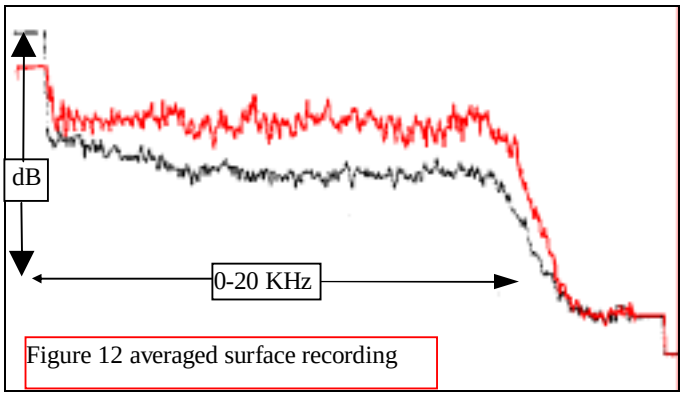


Figure 12 averaged surface recording

Graphs for the five recording levels are shown, in each case the lower line is the background level and the upper (red) representing the level with the kayak passing over. The X axis shows frequency (KHz) whilst the Y axis displays intensity (dB). The details for figure 12 shown here are averaged, this is a facility on the spectrum analyser which greatly enhances the quality of the figure. The remainder of the traces are shown on the subsequent page, they are not averaged.

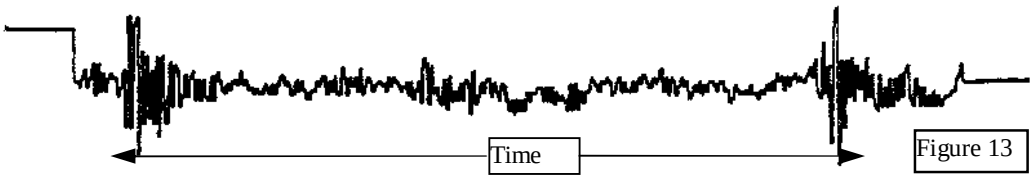


Figure 13

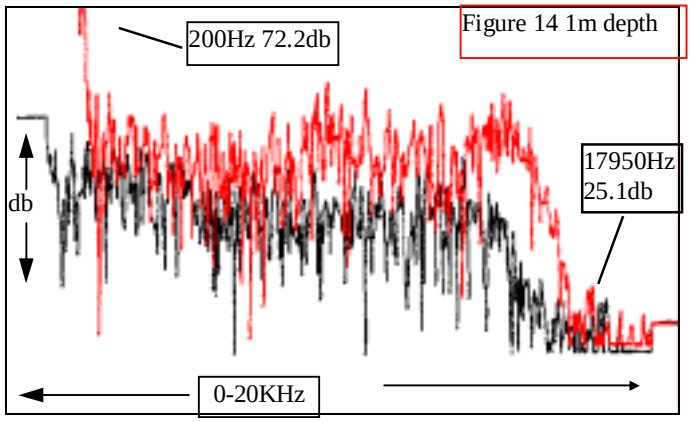


Figure 14 1m depth

Figure 13 above shows the wave pattern that the surface reading is taken from, the two large areas of peaks represent paddle strokes. Once such a display was captured on the spectrum analyser the display was altered to show the range of frequencies in that segment the resultant graphs are displayed here.

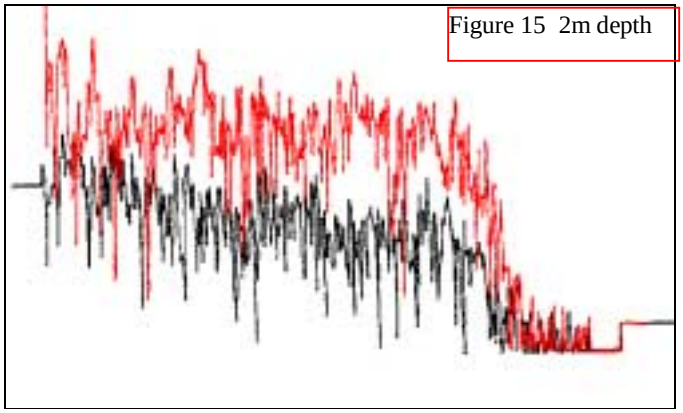


Figure 15 2m depth

The most significant factor is that there is little difference between the trace lines, on the non averaged graphs there is a lot of cross over of lines. As both signals were amplified the decibel readings are insignificant without measuring the amplification, but the height of the background trace lines demonstrates that:

- considerable amplification was required to detect the noise of a kayak,
- the noise was across a similar range to the background noise.
- the closeness and considerable overlap of the trace lines indicates that the

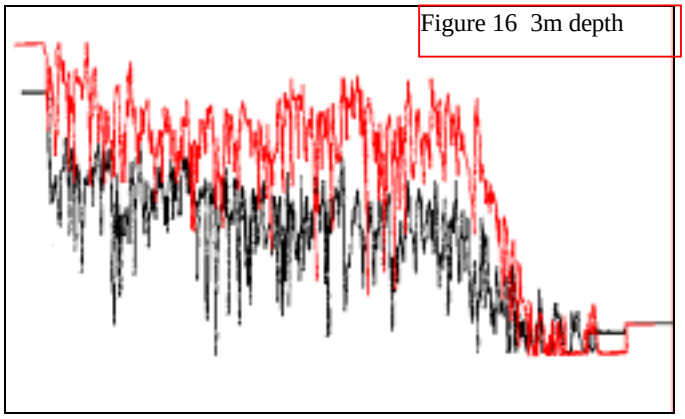
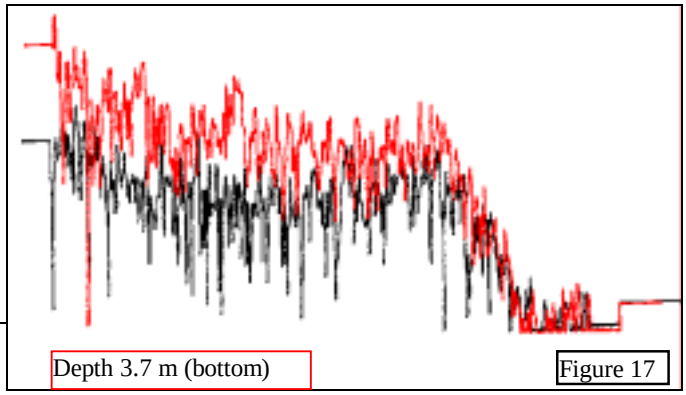


Figure 16 3m depth



Depth 3.7 m (bottom)

Figure 17

noise caused by kayaks and canoes is very small.

Discussion

The results shown in the previous section indicate two specific points. Firstly there is no significant impact to the catch rates of Roach during canoeing activity. Secondly there is no apparent disturbance to the fish from the noise produced during canoeing. This is supported by all the evidence of the study, the previous works of the NRA and anecdotal evidence of some anglers and canoeists.

Importance of study

This research is limited to a narrow field which is discussed later, but it is probably the first such study of its kind. There is a lot of research looking at the effect of angling on waterfowl and wildlife (Pierce 1993, Cooke 1976, Cooke 1987, Edawrds 1985 etc.) there are studies on the effects of recreation and canoeing on waterfowl and wildlife (Grice 1993, O'Brien 1987, Tuite 1982, Ward 1990 etc).

The author has been unable to locate any other such studies regarding the catch rate and canoeing. There are some statements regarding the lack of scientific evidence in some of the canoeing press for example; "Anglers continue to allege that we (canoeists) do cause disturbance and bodies such as the NRA (now called Environment Agency) continue not to do any research into the project" Fisher[1] (1993 p.8) "The NRA have issued their latest batch of research projects. Still there is nothing on the effects or otherwise of canoeists on fish appetites." Fisher[2] (1993 p.8).

The editor of Canoeist Magazine (Stuart Fisher) was contacted, but he was still unaware of any research in this field (appendix three). Reference was made to a study at a university in north east England. After further searching this was in fact a study on recreational impacts on water fowl conducted by Dr. Anne Westerburge.

The environment agency study at Chester weir (page 7) make no reference anglers trying to catch fish, only fish migration up the river. Although this is obviously pertinent to game fishing.

From the lack of available literature it is possible to state that this study is a far as is known unique and the first of its kind.

Fish catching experiments.

The combined results from all the experiments shows that there was no effect to the catch rate during the canoeing activity. Figure 10 (page 18) clearly shows this point. It is shown later on that the experiments were conducted at the best time of day for catching roach (page 25).

During the second experiment the wind was blowing a strong north westerly, the anglers stated that strong winds makes the bait lie in an unfavourable position, which does not encourage the fish. As the canoeists made their first pass of the fishermen paddling into the winds enticing the fish. However, as the water was very deep (up to 3.7m) the effect of the wind on the bait may be called into question.

During this study the author has acquired other anecdotal evidence that activity does not always cause fish scaring. On the canal fish are often caught just after a canal boat passes, this is thought to be due to the stirring of the sediments that can occur as the boat passes.

Importance of sound

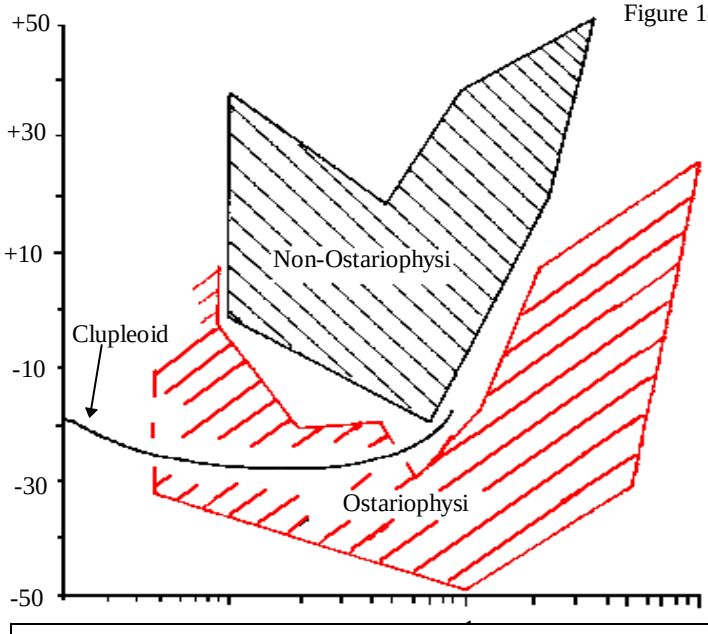
Having found that the canoeing activity had no effect on the catch rate it was important to produce a statement as to why this was the case, when most people would have expected the canoeing to scare the fish.

The audiograms (figures 12 & 14-17) clearly show:

- there is little difference in the background noise and the kayak noise.
- the range of sound produced is across the 0-20Khz frequencies.

Figure 18 opposite is useful for discussing the audiogram results. Roach are Ostariophysi

Figure 18



Audiograms of fish. The shaded areas enclose a number of audiograms of different species in each group. The x axis shows threshold sound pressure in decibels re 1µ bar. Threshold scale is logarithmic.
Bone, Marshall & Blaxter (1995 p.228)

(hear with bones) their range of hearing is more acute than other fish and is across the range 0.035 - 9 KHz. The range of frequencies produced by the canoeing activity should have been heard by the fish. As the lines on the audiograms (figures 12 & 14-17) are close together it is likely that whilst the frequencies are within the range for fish detection there magnitude is not large enough to make them detectable or is detectable by the fish but not significant enough to scare them away or stop them feeding.

The noise produced by the canoe is not a sharp quick noise but one that is continuous and builds. Wrangles (1985) describes the importance of sound when fishing;

> *One thing which is most important when boat fishing - noise. Equipment dropped on the bottom boards will make a great booming sound which will be carried to the fish, I have known a feeding shoal to be put to flight by the clatter of a landing net as it was laid down in the boat.*
> Wrangles (1985 p.172)

This suggests that sudden noises that are more likely to scare the fish, than a gradual build up of a canoe passing over.

Roach are shoaling fish that are described by some as 'freshwater sheep' because of their actions, if one moves they all move. Yet they were not disturbed by the canoeing.

The author was unable to locate audiograms relating to just roach, these would have been interesting to study in terms of better understanding, but would not change the basic facts that have been described above.

Sound recording traces

Although the traces of the recording can not at this time be used to make specific statements relating to the acoustic capabilities of fish, the fact that the two trace lines on each figure are so close together does indicate that there is little difference in the rise of noise level when canoeing activity is taking place. The difference allowing for the considerable amplification is probably just a few decibels. This rise of a few decibels may not be detectable by the fish or may just not be of any significance to it and therefore does not cause anxiety. The rise in amplitude of the signal as a canoe passes is not sudden, but a gradual rise and drop off across the whole spectrum of frequencies 0-20KHz which may therefore not induce fright in the fishes.

Anglers

There were considerable problems associated with obtaining permission from a fishing club to carry out the experiments. Further problems were associated with having enough anglers attend, on one occasion it was down to two anglers. The weather was variable and anglers were giving up there time freely. On reflection it may have been useful to set a competition with for example £50.00 prize for the most catches over all the experiments, this may have encouraged wider participation from the anglers.

It was originally expected that the anglers would log on the recording sheet after every catch, however it quickly became the case that they total their catch every half hour. This was basically due to there being a large number of catches that would have resulted in time consuming recording. For more accurate recording of times, species and weights of fish it would have been useful to have an independent record keeper for each angler.

The fact that anglers had to record their own catch did leave the system open to abuse, it is the authors opinion that this has not taken place. During informal discussions with the anglers most seemed confident that the canoeing activity would destroy their fishing not just for the period of disturbance but for the whole evening. It very quickly became apparent that this was not the case, fish were still being caught during all the canoeing activity. The anglers were surprised at this, but there is no evidence to suggest that their record keeping was less than honest so as to show a conflict. In other words if the data had shown that there was a significant drop in the catch rate this could have linked to the anglers wanting to convey that message.

Catch rate after canoeing

By the time the canoeists had finished their session it was starting to get dark, most anglers were prepared to stay for half an hour longer but it was difficult to encourage a longer stay (up to an hour had been hoped) especially on evening when the weather was less than favourable.

Time of day

Is it possible that the time of day had any effect? All the experiments were conducted at the same time of day (evening), it would be useful to examine other sessions at different times of the day. The problem is really one of logistics of getting everyone needed at total of 20 plus people in the right place at the right time. The evening as the best time to catch roach is supported by many angling authors.

> *The time of year and light intensity are two more factors (as well as bait) that have a great bearing upon your success as a roach fisherman… The best time under these conditions (summer, bright and sunny) would be early morning or the cool of the evening when the sun has left the water, and my experience has been that it is the latter time when the roach feed best of all*." Wheat in Wrangles (1985 p.171)

"they (Roach) feed most aggressively during low light values at dawn and particularly dusk falls." Wilson (1993 p.90)

"Probably the process of evolution has selected fish whose instincts are to move and feed freely as soon as they notice this sharp drop in underwater illumination; at that time they are much safer from predators like herons…" Walker (1981 p.16)

It therefore seems that the experiments were conducted during the best possible time to catch Roach. It is possible that time of day may alter the effect, but as all the experiments were conducted at the same time of day it is not possible to comment on this.

Analysing the recordings

After discussions with the Ministry of Farming, Fisheries and Food (MAFF) about the recording of underwater sound the author was advised of the equipment that would be needed to record and that a spectrum analyser would be required for the assessment of the recordings. The system used as described in the methodology was not how the physics department normally uses this piece of equipment. The capture of relevant pieces of information was slightly random, especially at the start. The equipment was set up, when the tape was playing the analyser displayed a continually changing trace like that shown in figure 13. Whilst listening to the recording it was necessary to anticipate the desired trace and push the freeze button on the analyser. Initially this was

a bit hit and miss, but after practice became quite precise. The results shown are taken form later attempts when this process had been perfected. This area is still a cause of slight concern, some way of displaying a trace over a longer period of time would have been useful to check that the reading taken was of the maximum level as the canoe passed over head.

It is not possible at present to use the information about the amplitude (dB) of the sound produced in quantitative terms against information about the responses of fish and Roach specifically. This is because of two reasons, firstly the signal from the hydrophone was amplified before it was recorded. The amplifier was set at '6' but at this time there is no information as to how to calculate the actual reading from such an amplification.

Secondly the information at present available regarding the auditory perception of fish is very general and no information specific to Roach has been identified.

trace from spectrum analyser not at correct level as signal was amplified

Limitations

It is important to state here that the findings are limited to the very narrow area of study and indeed a study like this probably poses more questions than it answers, for example:-

- how significant is the type of fish? Roach are mainly bottom feeders in what is relatively deep water. If other types of fish were being studied the results might be different.
- If the lake had been shallower would more disturbance have been caused by the canoeists?
- If more wet activities had been pursued ie. capsizing and rescues, would this have caused disturbance that was more significant?

As the study has been conducted on flat water it has no bearing on the wider issue of fish being scared away on moving and white water, where game fishing is taking place. How ever the results would suggest that the disturbance caused even by continuos canoeing activity is negligible especially when compared to the amount of disturbance in a moving river anyway. The extract given below are the comments of a more liberal

angler, but it does emphasise that there is some confusion about the possible effects of canoeing.

"The Perth local newspaper reporter sent to cover the Scottish Canoe Exhibition was a Tay angler… He claimed that one or two paddlers passing straight down river have no adverse effect on angling and can actually make the fish more likely to respond."

The report went on to say "However a group playing in rapids, and particularly, rolling can have an adverse effect on angling" Fisher, S. (1996)

Further research in this area would be interesting, a long similar lines to the study conducted. The fishing experiments would be possible although there may be a slight logistics problem of supplying a constant stream of canoeists, as they can not usually paddle up hill! The problem could be overcome with careful planning.

It would also be perfectly possible to record the acoustic levels, although logistically it would be more complicated arranging for the hydrophone to be fixed a various levels.

Further experiments

At the present time the author has no intention of pursue the research much further, however there are some interesting area that needed to be followed up for a fuller answer to the problem. This is a summary of further research that would in the authors opinion be of use.

1. Redo experiments on flat water. Set up a series of competitions that would encourage the same fishermen to attend all the experiments. Increase the number of experiments from 3 to at least 6 to give more sample data. Make use of an independent recorder for each angler make more precise notes of times and weights of fish.
2. Redo recording of underwater sound levels, identify a way of calculating the actual amplitude of the signal, try to find a more specific way of using the spectrum analyser. Locate more specific information about auditory capabilities that can be compared to the traces of the recordings.
3. Set up large tank as a lake environment stocked with fish (Roach). The effects of surface disturbance to the fish could be studied, if a large enough tank could be found the fish could be monitored during canoeing and fishing activity. Whilst it is unlikely to be practical to have a tank large enough for canoeing in, it would be interesting to play recording of the kayaking and use simulated disturbance.

4. The above would still only make the study applicable to flat water, it would be necessary to conduct steps one and two on moving water to gain a fuller understanding.

Summary

The study shows that canoeing activity on the lake used had little effect on the catch rate of anglers. Further, that the noise created by a passing canoe was minimal and was therefore unlikely to scare the fish. Factors that are limiting to the wider application of these findings are; the type of water used (flatwater), depth of water, time of day (evening), target catch (roach) and other factors that were not studied for example the importance of light and shadows.

Executive Summary for publication in the canoeing press

Does canoeing activity disturb fish and therefore angling? This was the initial question that I started with for my degree dissertation. From here it was necessary to define the area of study in a more limited way and through discussion with my tutor it was decided that a study on flatwater would be more easily managed.

During the summer of ’96 I organised an experiment involving anglers and canoeists. I am very grateful to Harleston and District Angling Club and especially Nigel Poll for their assistance in completing this study. Approximately 20 clubs in the Norfolk / Suffolk area were contacted, but Harleston was the only one who showed any interest and would allow the experiments to be conducted on their fishing lake.

Angling experiments

The catch rate of anglers was monitored, in order to maintain an experimental control the anglers fished for 1 hour before the canoeists arrived, the hour during canoeing activity and for an hour after canoeing activity. The anglers recorded their catch every half-hour during this time.

The experiments were repeated a total of three times on three consecutive Tuesday evenings in August. During the canoeing activity approximately 10 canoeists paddled back and forth in front of the anglers, often passing within centimetres of their floats.

The results of these experiments have been combined and are summarised in figure 1 below.

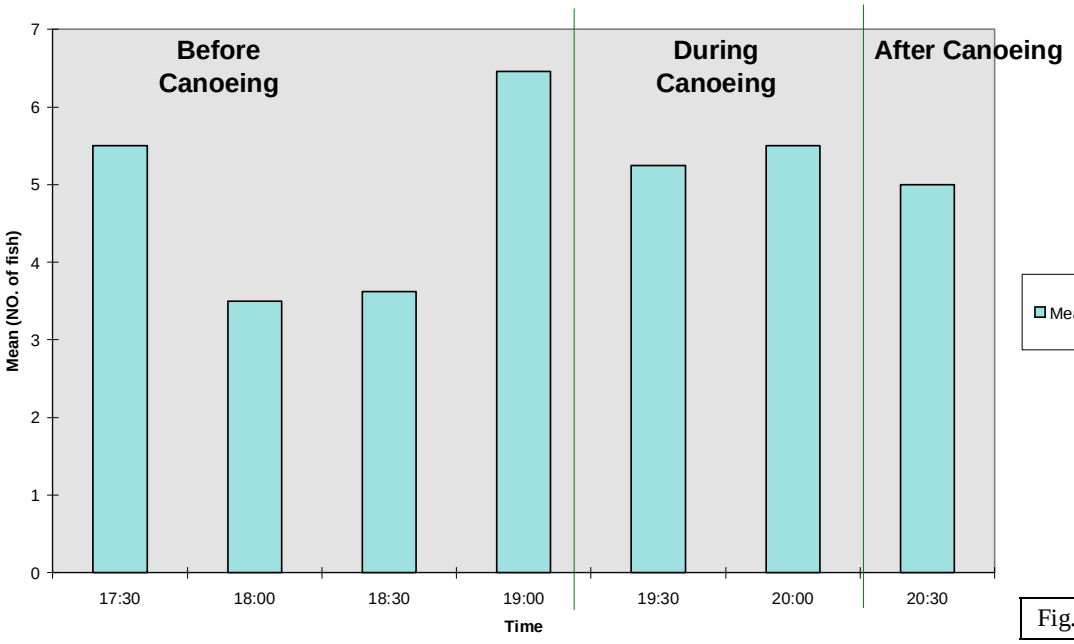


Fig.1.

The results displayed in figure 1 suggest that there was very little effect to the catch rate during the canoeing activity. This is supported by the anecdotal evidence of the anglers. When the anglers arrived they seemed determined that the canoeing would scare the fish away for the whole evening, they were very shocked that they were still catching fish during close and prolonged canoeing activity.

As far as is known there are no studies that have looked exactly at this subject. The NRA studied the possible harmful effects of canoeing activity at Chester Weir. Their report concludes:

7.1 Canoeing impact on salmon migration past Chester Weir

The behaviour of adult, wild salmon is naturally influenced by a wide range of environmental factors and conditions such as river flow, light intensity, water temperature and quality. Sufficient radio-tagged individuals reached the weir and to within the limited area of the fish pass. In general the impact of canoeing was of insufficient magnitude to differentiate it from the variability in behaviours recorded through the interaction of a number of extrinsic environmental and physical factors operating in the vicinity of Chester Weir. Environment Agency (n.d.) p18

Is the sound of canoeing activity an important factor in scaring the fish?

Having suggested that there was little effect to the anglers it was required that some explanation was suggested.

The noise and the disturbance of the water seemed the most likely action to scare fish away, therefor underwater recordings of canoeing activity were made at the target site.

I am very grateful to the Ministry of Agriculture, Fisheries (Lowestoft) and Food and especially to Bill Meadows for lending the hydrophone and recording equipment.

The noise of a kayak passing over was recorded at 1m intervals from the surface to the lake bed (3.7m). Background recordings were also made. These recordings were then studied using a spectrum analyser. From this traces of the range of frequencies present at each level were obtained. By scanning these into the computer it was possible to superimpose the canoeing sound over the background for each level.

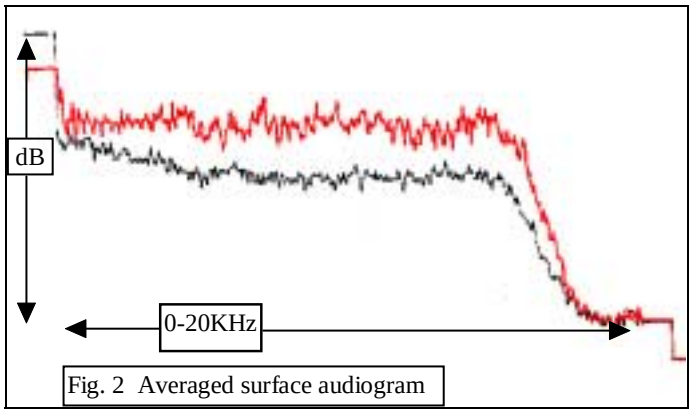


Fig. 2 Averaged surface audiogram

Figure 2. Shows the traces for the surface readings. In this case the traces have been averaged to make the easier to see. The red trace is the canoeing sound.

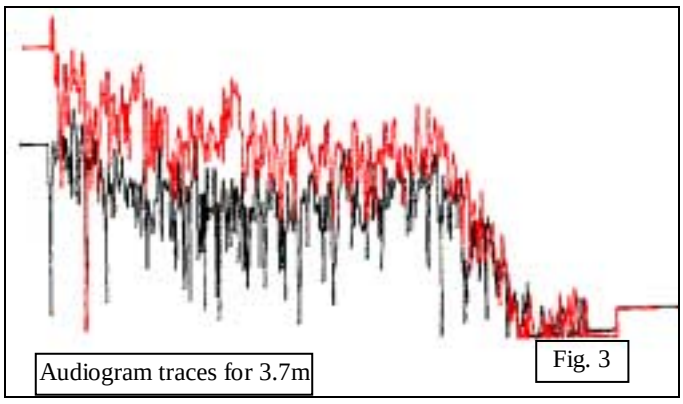
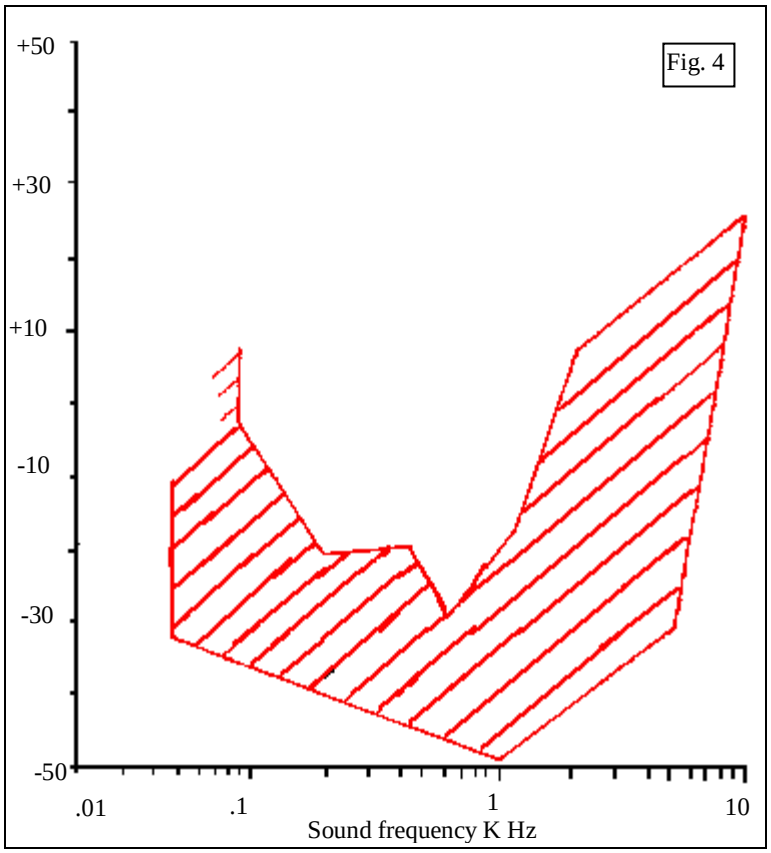


Figure 3 shows the traces for the bottom of the lake (3.7) these have not been averaged. Note the considerable overlap in the traces.

The difference between the traces is very small, especially when it is considered the amount of amplification that was required to get a recording.



Audiograms of fish. The shaded areas enclose a number of audiograms of different species in each group. The x axis shows threshold sound pressure in decibels re 1µ bar. Threshold scale is logarithmic.
Bone, Q., Marshall, N. & Blaxter, J. (1995)

Figure 4 opposite, suggests the range of frequencies that fish like Roach (fish used for this study) can hear is across the range 0.035 - 9 KHz. The sound of the canoeists encompasses this range.

The sound of canoeists are within the range of frequencies for fish to hear, it therefore seems likely that the difference between the background noise and the canoeing is so small that either the fish do not pick sense it or more likely it is not of sufficient magnitude to scare them away.

Summary

1. in the study site fishing catches were did not appear to be altered by canoeing activity.
2. the sound of the canoeing activity would appear to be minimal and therefore not disturbing the fish.

As keen as we all must be for the wider discussion of access to the water it is important to remember the limitations of this work.

- all the experiments were based on flatwater at the same time of day.
- the target catch was limited to Roach (*Rutilus rutilus*)
- the canoeing activity did not involve capsizing and other wet activities
- the study confines itself to the importance of sound, light may be a completely different issue.

There are many different ideas about access, for my part I would be pleased to share the resources with other water users and I don't wish to give the feeling that I have an immediate right to paddle on all fishing lakes, but lets start talking about greater access.

If you would like to know more please contact me via Canoeist.

Many thanks to:
Bruce Wayman for the use of canoes and clients.
Geoff Griffiths my tutor at Liverpool John Moores University
John Redshaw for paddling in the rain for the recordings.
to all those who helped in any way, paddling or fishing.

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Appendix One

Catch record sheet

Thank you for agreeing to help me with this project. I am grateful for your time and the expertise that you bring. It would be useful if you could complete this form, keep it updated during the match and return it to me at the end of the evening. As I am not an angler some of the questions I ask may seem odd or irrelevant to you, please bear with me. Once again many thanks for your help.

Lawrence Chapman

Name..... Contact NO.
.....
Fishing Pitch NO. .....
Please give a brief description of your line set up. e.g. are you fishing deep or shallow? Type of bait used? Type of float ? type of hook? and any other relevant information.

Please complete grid for each catch during the evening. The timing is very important so please try to be as accurate as possible.

Time	type of fish	size of fish (weight)	other details

Appendix Two

Specifications

Appendix Three

Correspondence

Appendix Four

Canoeist Magazine report