NRA Fisheries 40

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NRA

National Rivers Authority
Anglian Region

A REPORT ON FISH PRODUCTION IN THE NATIONAL RIVERS AUTHORITY

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APRIL-SEPTEMBER 1990.

C O N T E N T S

SECTION 1 : INTRODUCTION

1.1 The National Rivers Authority

The N.R.A. was created in 1989 when the ten water authorities were each split into a public and a private body. The N.R.A remained in the public sector with the responsibilities of water resource planning and control, land drainage and flood protection, the protection of the water environment and the improvement and development of fisheries.

The Anglian region of the N.R.A is geographically the largest, covering 27000 km^2 from the Humber down to the Thames. It is divided into five divisions (Cambridge, Lincoln, Oundle, Colchester and Norwich) with headquarters at huntingdon in Cambridgeshire.

The fisheries section of the Anglian N.R.A carries out many duties including population studies, pathological analysis, law enforcement and fish production. These all serve to acheive the remit of the N.R.A to 'maintain, improve and develop fisheries'

During this industrial placement I was based at Costessey fish farm near Norwich.I was involved in both fish production and fish population studies.

Costessey fish farm is a medium sized farm of approximately 11 hectares. It has 16 earth lagoons giving a total lagoon area of 1.58 hectares. Many of these ponds are used for larval rearing of fish produced on site, whilst the

Traditionally fisheries have been improved soley for the benifit of Anglers. Whilst this is still an important reason for improving fisheries, more recently the philosophy has shifted towards improving rivers for their conservation value, which includes ensuring the river has a wide diversity and biomass of fish.

1.3 Methods of Improving Fisheries

The tradditional method of increasing fish stocks is to boost biomass levels by restocking from high to low stock areas. This method has however proved largely unsuccessful (demonstrated by stock surveys). It is thought this is due to the stress of capture and transport in addition to the change in water chemisty, flow and habitat structure of the new water.

A more favorable method is that of stock supplementation. This involves the creation of new water bodies, or the use of existing bodies adjacent to rivers. These bodies are then managed as rearing ponds and stocked with larvae. A direct connection with the river alllows the release of the larvae after one or two growing seasons. Thus many of the problems of traditional restocking are overcome. This is now increasingly practised within the Anglian region. The fist stage of this process is to produce the fry.

1.4 The Reproduction of Cyprinids

The methods used for cyprinid reproduction can be divided into natural and artificial spawning. Traditionaly natural spawning has been favoured because of its simplicity and the lack of reliable protocols for artificial spawning.

More recntly reliable protocols have been developed for all the important cyprinid species. To the extent that in many cyprinid fish farms artificial spawning is used to the exclusion of other methods.

NATURAL SPAWNING

This can be acheived in a variety of ways in more or less controlled conditions. The broodstock can simply be left in the rearing ponds, or alternatively they can be spawned in spawning ponds or tanks.

If the broodstock are left in the rearing ponds they can destroy both eggs and fry. This method also allows no control over the number of fry remaining in the pond.

Natural spawning in tanks or ponds provides greater control. In many many warmer countries with more predictable weather spawning ponds are relatively common, the Dubisch type being the most popular. This consists of a shallow square pond with a deeper peripheral ditch. The centre of the pond is planted with grass (usually rye grass) over which the broodfish spawn. They are then removed from the peripheral ditch. After hatching the fry are then collected from the peripheral ditch for stocking into nursery ponds.

In the U.K. spawning ponds are not generally used due to the unpredictable weather (a cold spell could lead to high mortalities). Thus natural spawning is usually carried out in tanks with artificial substrates provided onto which the eggs are laid. The substrates are then transfered to rearing ponds.

This method allows some control over the number of eggs placed into the rearing ponds however fertilisation rates and egg survival are still generally low.

ARTIFICIAL SPAWNING

The artificial spawning of Salmonids has been well researched and is widely practised. Artificial spawning of cyprinids has however, until recently been difficult and unpredictable.

The main difficulties encountered with cyprinids derive from their different genital structure, particularly of the female. In general the eggs are much more difficult to strip from the female and greater pressure on the abdomen and ovaries is required. The males also release milt much less freely. Most cyprinid eggs are sticky and this must be eliminated to make mass incubation possible.

SECTION 2 : METHODS USED AT COSTESSEY FISH FARM

2.1 Artificial Spawning at Costessey Fish Farm

Since most cyprinids can be treated in roughly the same manner I will give a general account of the methodologies used, highlighting the differences between species.

2.2 Obtaining Broodstock

Many broodstock fish are obtained from the wild. This ensures a wide gene pool is maintained, the gametes are from fish which have survived in a wild environment and more farm space is availiable to rear on fish.

Electrofishing is the usual method of capture, broodfish often coming from known hotspots year after year.
There is usually no assesssment for broodfish quality, largely due to the difficulty involved in making such an assessment. If however the spawning of a particular population has a low success rate in consecutive years, then a different population may be tried the following year. This was performed with Bream this year and the reproductive success rate was considerably improved (however other factors may well be involved).

Some Broodfish are kept at the farm, namely those which do well in the farm ponds i.e. Carp, Tench, Roach and Rudd. This saves time in finding broodstock and gaurantees enough fish will be found. The fish are electrofished or netted from the ponds.

The timing of broodstock capture is crucial. Levels of gonadotrophin in the fish should be rising, causing sexual characteristics to develop. These are usually spawning turbercules on the males and an increase in body weight by the females. If the fish are caught too early then the stress of capture, possible change of water temperature and photoperiod can disrupt hormone levels in the fish and prevent the fish coming into spawning condition. Susceptibility to such stress is largely species dependant and some species, notably Carp will come into condition in the tanks (with such species the male and females are kept separate). Prolonged tank holding however is generally avoided since it often leads to fish mortality and low numbers of poor quality eggs.

If however the fish are captured too late they may have already spawned. To prevent this the rivers and ponds are monitored to see when fish are spawning.

2.3 Hypophysation

Hypophysation is the technique by which ovulation and spermiation are induced in fish. So called because extract of fish hypose (pituitary) is used. For cyprinids Carp pituitary extract (CPE) is generally used and for salmonids

Salmon pituitary extract (SPE) is used. This ensures the gonadotrophin in the extract is phylogenetically close enough to mimic the fishes own.

The CPE and SPE are obtained commmercialy in a powder form or as whole pituitaries. This is then made up in an isotonic (to the fish) salt solution. Injections are either intraperitoneal or intramuscular, intraperitoneal tend to be perferered because less precision is required. Large difficult to handle fish are aneathetised before injection (e.g. Chub, Carp, and Bream), whilst smaller fish can be injected whilst concious.

Males which spermeate freely may not require any inducement (usually Chub). Otherwise a one off injection of 2.5 mg kg^{-1} CPE 24 hours berfore spawning is used for all cyprinid species.

Females can be given a similar one off injection however experience has proved this to be unreliable. Two injections 12 hours apart tend to produce much better results. A priming dose of usually 1 mg kg^{-1} starts germinal vesicle migration (GVM) , a resolving dose of usually 5 mg kg^{-1} carries on GVM causes germinal vesicle breakdown (GVMD) and finally ovulation. Ovulation may occur between 10 and 30 hours after resolving depending upon temperature and species. The females are checked periodically near the expected time of ovulation. This is done by applying pressure to the fishes abdominal cavity, the production of any eggs from the vent shows ovulation has occurred. If the fish do not ovulate when expected a biopsy of the ovary can be taken using a biopsy needle. Microspial analysis can then identify the state of the ovary. Depending upon this information it may be necessary to wait longer, reject the fish , or give a third injection, however these are rarely successful.

2.4 Hand Stripping

All fish are aneathetised before stripping, this makes the fish easier to handle and relaxes their muscles allowing the eggs to be stripped more easily.

Males are checked for viability by microscopy. The abdomen is squeezed and the milt collects just below the vent, from where it is pipetted out. A drop of milt is placed on a microscope slide with a drop of water to activate the sperm*, a slide cover is placed on top and the sperm activity can be observed under the microscope.

*Tench and Dace sperm are active on release so no water is required.

Both males and females are thoroughly dried before stripping to prevent premature sperm activation and the eggs `hardening off' before fertilisation. Hardening off occurs when the eggs take up water and calcium, thus the eggs swell up and the membrane becomes tough and impenetrable to sperm.

The female is stripped by holding the fish almost vertically above the bowl. Pressure is applied to the ovaries at their ends near the pelvic fins, the eggs then start to move down the ovaries and the hand moves down with them. This may have to be repeated several times until all the eggs are removed. This is impotant as eggs remaining will decay and can lead to peritonitis which is usually fatal.

Depending upon egg numbers several females may be stripped into the same bowl before fertilisation. Milt is added to the bowl either via pipette or by holding the male above the bowl. A fertilisation solution is then imediately added to prolong sperm activity and ensure thorough mixing. The eggs are intermittently stirred over several minutes (sperm activity varies between species, but after 4 minutes most species sperms are inactive). The eggs are then washed repeatedly with fertilisation solution and finally borehole water to remove the milt and other excess organic matter which could be a source of infection.

2.5 Degumming the Eggs

If the eggs are sticky and are to be mass incubated e.g. in zoug jars their natural stickyness must be removed to prevent them clumping together. This must be done imediately after fertilisation; as they take on water they become more sticky and will begin to clump.

There are a variety of methods of degummming, the sophistication of which ranges from using flour to stick to the adehesive and then removing both adhesive and flour to using a bacterial protease to breakdown the adhesive. One of the most popular methods however is to use tannic acid this effectively breaks down the adhesive.

2.6 Incubation

Incubation may be performed in zoug jars or on artificial substrates in trays. Zoug jars enable large numbers of eggs to be incubated in a small space, however they tend to be more labor intensive and the risk of infection (by bacteria or fungus) is greater. At Costessey trays have always been used until this year when zoug jars have been used for the first time with success.

Incubation time depends upon temperature and species. During incubation eggs are monitored to ensure development is proceeding and to check survival rates.

The fungus **Saprolegnia** tends to grow on dead egggs and then spreads to live eggs smothering them and starving them of oxygen. In zoug jars this can cause mass mortality, thus all dead eggs must be removed. This is easily done using a pipette since the yolk proteins become insoluble once the egg dies and the egg turns white.

In trays the substrates can be removed once all the eggs have hatched, this removes all the egg cases which would otherwise rot increasing the biological oxygen demand of the water and creating a source of bacterial and fungal infection. In zoug jars hatching can occur in the jar and the water current then carries the larvae over the edge and into a tray below. At Costessey however not enough trays were availiable for this, so the eggs had to be syphoned out of the jars just before hatching and placed on substrates in trays.

2.7 Larval Rearing

The larvae live off their yolk sac for the first few days (or weeks depending upon species), once this is absorbed they begin to swim to the surface looking for food. The larvae are then fed with either egg yolk suspension or a proprietory dry food. It is at this point the larvae are usually stocked out since further rearing is difficult and the trays are required for other species. If however there are no ponds ready for the larvae they must be reared until there are. The larvae are fed at least four times daily, preferably hourly, in addition fresh water must be run through either continously or regularly to maintain water quality.

Larvae are transported in strong plastic bags inflated with oxygen. The bags are floated in the water before release to equilibrate temperature.

2.8 Pond Managment

During the winter the ponds should remain dry to eliminate parasites (flukes, leeches), predators and competitors (other fish, invertebrates) and macrophytes which compete with algae for nutrients. All these factors reduce the production of the pond.

A few weeks before stocking the ponds are filled and fertilised. Fertilisation is with manure, triple super phosphate, and an NPK mix (nitrogen, phosphate and potassium). If temperatures are high enough and there is sufficient irradiance a phytoplankton bloom should develop within a few days. At this time the pond must be carefully monitored to detect the prescence of the first zooplankton. These will be initially small zooplankton, mainly rotifers which are an ideal food source for first feeding larvae.

Stocking densities are dependent upon the production value of the pond. The Costessey ponds cannot be completely drained and thus have a low production value. The normal stocking density is 10 fish per m^2. At Snailwell the ponds can be drained and the stocking density is usually between 10 and 20 per m^2. The installation of an automatic feeding system and aeration (dissolved oxygen content drops markedly with feeding) at Snailwell will however allow stocking densities of over 40 per m^2.

During pond rearing the ponds are monitored to determine the point at which there is insufficient natural food to feed the fish. This depends upon the growth of the fish. At this point supplementary food must be given.

2.9 Fish Capture and Release

The fish are ready for release into the rivers by September\October. The ponds are partially drained down until there is a concentration of fish in the deep end of the pond and they are then netted out. They are then transported in oxygenated containers to the river. The pond can then be totally drained and left overwinter.

At Costessey some fish are kept overwinter inside in a warm water rearing unit, this enables high production values and makes efficient use of the facilities. Carp and Tench are the best fish for this since they can tolerate high stocking densities and a low oxygen content.

SECTION 3 : DISCUSSION

3.1 Review of Production at Costessey in 1990

This years fish production in the Anglian region has been highly sucessful. The numbers of larvae produced are significantly higher than in previous years with over two million larvae produced at Costessey and Brampton.

This is largely the result of the development of reliable protocols for all species produced. In addition broodfish quality and quantity has improved.

For the fist time this year Dace have been produced (at both Costessey and Brampton). Since Dace are the first coarse fish to spawn, this makes efficient use of the facilities at this time of year. This however creates an additional problem, since temperatures and irradiance levels are low at this time a phytoplankton bloom is unlikely to develop. Thus this year the Dace had to be reared on for nearly two months before a pond was ready for them. During rearing mortality was high.

A solution to this problem would be to use polytunnels (which create a greenhouse effect) over small ponds to raise water temperatures. There is a possibility of this being implemented at Snailwell next year.

The production of Grayling fingerlings in significant numbers has been a first this year. The eggs were incubated mostly in zoug jars with very low mortality rates. Larval rearing however caused very high mortalities, high levels of pathogenic bacteria were found in dead and dying fish, however treatment with an antibiotic yeilded no improvement. This suggested there may be another problem which was predisposing the fish to infection. It was noted that many of the dead fish had eaten artemia cysts, these are indigestable and can cause starvation in fry. A technique for decapsulating the cysts has since been found and this may be used next year.

Bream continued to be a problem this year with high mortalities in both zoug jars and on trays. Fertilisation rates were high but many eggs died during development. These were very difficult to remove from the zoug jars due to their small size. When the eggs were placed in the troughs these eggs then rotted and caused a drop in dissolved oxygen content. Many larvae were lost in this way. We tried placing the eggs on substrates in the trays and then removing these just after hatching, however since the eggs had been degummed many of them washed off the substrates and ended up in the troughs anyway. Thus trays were overall more sucessful than zoug jars.

Previous to this year Woynarovich fertilising solution has been used for all cyprinid species. This year Bream sperm viability was compared in both half strength and full strength Woynarovich. It was found that the sperm were viable for almost twice as long in half strength Woynarovich, however sperm activity was lower. This was performed after a personal communication (Henshaw 1990) revealed the same results with Dace. Following this half strength solution was used for all fertilisations with good fertilisation rates. This finding requires further investigation to look at sperm viability in a range of fertilisation solutions for all cyprinid species and to correlate this with fertilisation rates.

The use of Tetramin E, a proprietry dry food for first feeding larvae has been highly successful this year for all larvae. This has been used in preference to egg yolk suspension as this sinks rapidly leaving wasted food on the bottom which reduces water quality.

Degumming of eggs was performed for the first time this year using tannic acid. This was generally very effective although degumming had to take place immediately after fertilisation otherwise the uptake of water caused the eggs to become too adhesive to be degummed effectively. Some very sticky eggs (notably Bream) required two washes of the tannic acid dilutions before they were fully degummed. Remaining clumps had to be either physically broken up or removed. The main problem with the degumming procedure is that it is very labor intensive. Another degumming technique such as using a bacterial protease (as already mentioned) may be much easier, however it is likely to be expensive.

Overall zoug jars were very successful this year, enabling the incubation of many more eggs than would be possible with trays. The main dissadvantges of them are that they are more labor intensive and more eggs are lost from engulfing with fungus.

Conclusion

Fish production in the N.R.A is a useful tool for the managment of fisheries. Developments in cyprinid spawning techniques now mean that almost any coarse species can be produced. There is however still much research required to improve the reliablity of spawning particularly with certain species. To this end the N.R.A should remain committed to research in this area, and I feel that this should be coordinated at a National level. Last year Anglian region held a fish production workshop, which was attended by delegates from all regions. This was a positive step towards a National R and D program.

The success of fish production from an environmentalists viewpoint, can only be measured by the numbers of restocked fish which survive and reproduce successfully. The Angler however only requires that the fish attain a size at which they provide good sport. To maintain fish stocks the environmentalists viewpoint must be taken, since restocking levels can never be sufficient to maintain a non reproducing population. Thus it is important that restocking is only considered where the fishes niche requirements will be fullfilled to enable the fish to both survive and thrive. There are people who argue that restocking is superflous, since if a river is improved and then left for a sufficient period it will naturaly reach its carrying capacity of fish. While this is to some extent true it takes many years for this to happen and restocking accelerates this process. In addition pollution incidents can happen at any time after which restocking is necessary to reduce the impact on the fish population. It shoud also be remembered that some species notably Barbel consist of very small populations with low natural recruitment levels, thus to maintain the stock and to maintain a heathly gene pool, stock supplementation is necessary.

In conclusion restocking is an important part of fisheries management within the N.R.A. It is however an expensive tool and it must be used wisely. At present there is a dearth of information relating to the success of stocked fish. For restocking to be efficient research is required in this area.

References

This has been in the main a personal account taken from a diary kept throughout the spawning period.

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ACKNOWLEDGEMENTS

I would like to thank Geoff Brighty for giving me an enjoyable and rewarding placement in Fish production. I would also like to thank Dave Jordan for his help and cooperation. Nick Bromidge and Andy Wood for their assistance throughout the placement and everybody else at Costessey Fish Farm for their help and friendship.