Sparsholt Fish Hatchery

Sparsholt is an ideal place for a cold water fish hatchery. The water, pumped up from the chalk rocks below, stays at a fairly constant temperature of 11ºC. The water is well oxygenated throughout the year and is also clear, clean and has a pH of 7.5. These stable conditions are ideal for breeding trout. Commercial trials for fish feed are also carried out on trout here. Atlantic salmon are reared here to restock the River Thames.

The Water System

The hatchery uses **borehole** water which is pumped up from the chalk aquifer at a rate of 50 cubic meters (cumecs) an hour. The borehole is 60m deep in order to keep the flow constant even in drought conditions. The water is 100% saturated with oxygen at this point. An emergency generator stands by to pump water from the borehole in the event of a mains power failure as fish would quickly use the oxygen in their tank and then start dying after 20 minutes in still water. The water passes through a degassing tower to remove nitrogen (which would otherwise cause the fish to suffer the "bends" and die) and is then fed down a system of pipes to the tanks.

The **tanks** contain various types of fish of different ages/ sizes and at various stocking densities. The fish breathe oxygen dissolved in the water and eat food. Their solid, liquid and gaseous waste products (excreta, urine, carbon dioxide etc) enter the water. The water is continually flowing through the tanks. When it leaves the tanks it then passes through a drum filter to remove the solids before being pumped to the second header tank at the top of the site. Then it flows down through the second set of tanks. The water is filtered again then passes through two deep sedimentation tanks

In the second **sedimentation tank** the reduction in flows encourages solids to settle downwards. (Solids are removed annually.)The clearer water above is piped off towards the reed bed.

The **reed bed** receives the water from the hatchery through a perforated pipe. The half hectare reed bed was planted in Spring 2002 with 14 mainly native species such as sedges, rushes and yellow iris. Other plants, such as water cress, are also now growing there. The primary aim of the reed bed is to increase the wild life conservation value of the area. Its secondary purpose is to "polish" the water (ie remove nitrates, phosphates and some sediment) from the hatchery water before it enters the lake.

The **lake** was constructed early in 2002. Some of the water from the reed bed passes through the gravel bank into the lake and soaks into the chalk below. The remaining waste water enters the aquifer through a soakaway in a corner of the reed bed. All of the water is recycled back into the aquifer.

The Fish

Rainbow trout, Brown trout and Atlantic salmon are hatched here from eggs and grown on to 'fry' and 'fingerlings'. Rainbow trout are sold commercially to fish farms to be grown on for the table. Native Brown trout are used to restock the River Itchen and the breeding adults are re-released here after the eggs have been produced.

Rainbow Trout are a greyish colour with a distinctive pink stripe along the sides of it's body. They also have 7-11 oval spots of greyish blue called 'par' marks along each side. The Rainbow trout grows well under farm conditions as it grows quickly and is less 'stressy' in the artificial conditions. Brown trout are overall a more brown colour, they have noticeable red spots on their sides and spots on their tails.

In the wild trout are carnivores, feeding on bugs, water insects and crustaceans when small. Bigger fish will predate on smaller fish and trout are known to be cannibalistic! At the hatchery trout are fed concentrated dry, rich, oily food pellets made from fish meal. This provides all they need to grow and the results are outstanding with 1kg of fish produced from each 0.68kg of food. However it is expensive. Food partially derived from plants is being trialled. Due to the good food supply at the hatchery, an adult fish will reach sexual maturity after 2 years.

In the wild trout would move up and down the river to search for food, hiding and waiting in shady spots for their prey. At the hatchery this habit is not possible although the tanks are covered in black netting to replicate the shade they prefer.

The Trout Life Cycle

In November/December wild trout migrate up to the shallow gravel areas of the river or tributary streams to spawn. Loose gravel is needed for the fish to dig a shallow hole called a 'redd' for the eggs. The ideal temperature for eggs is between 4-11ºC, hence winter spawning. After the female has laid the eggs the male fertilises them and covers up the hole. The trout then swim back down river in a very weakened state. Many die on the return journey.

Although many eggs get eaten by other fish, those that survive take approximately 30 days to hatch. Only 2-3% of the fertilised eggs will hatch. The shell dissolves and leaves the embryonic fish, called an 'alevin', which still has its yolk sac attached to feed from. At about 2-3 months old the fish is around 26mm in size and called a 'parr'.

After another month the fish will acquire a greyish blue colour and oval markings on each side. These "fry" grow quickly and reach 10cm at about 4 months old and 30cm at about 20 months. Between 1-3 years the fish are known as "fingerlings". At about 3-4 years old they begin to breed and return to the same spawning grounds where they were hatched. A Rainbow trout cannot breed in the UK in the wild, but if released into a river it may live for only 4-5 years.

Habits of Wild Trout

Most trout are solitary dwellers, except for the journey up river to spawn when they may travel as a shoal. Each fish usually keeps to it's own "lie", this is often in a hole under the river bank or large bolder. They chase away smaller trout or other fish. The largest trout always get the best "lies." They will wait and catch food as it passes on the current, such as insect nymphs, larvae, pupae that rise from the river bed and flies that have hatched on the surface. A trout can usually find all the food it needs in an area 1m by 3 m. If food is short the trout will grub in the weeds and gravel for freshwater shrimp and water hoglice.

In droughts they will become nocturnal and spend daylight hours lying motionless in cool pools under overhanging trees. Their eyes cannot adapt to changes in light as the pupil does not contract in brighter light so they stay in the shade. There is also less oxygen dissolved in warm water and as trout require high levels of oxygen they remain inactive until the sunsets.

The trout can sense other fish and potential food through water vibrations and acute eyesight. It has a line of nerve endings along it's lateral line which detects any water movement.

The chalk streams and rivers of the South of England are famous for trout fishing. The River Test in Hampshire is one of the most famous of all. Trout should continue to thrive in these rivers if they remain free from pollution and human interference, which will disturb the trout's natural way of life. Re-stocking programmes such as that aided by Sparsholt hatchery is helping to maintain trout populations.

Fish Farming

Fish farming is the intensive production of fish in a managed environment. About 16,000 tonnes of Rainbow Trout are produced each year in the UK. One quarter of these fish are used to restock rivers for anglers. The remaining three quarters are mostly farmed female Rainbow trout which produce food for people, either as whole fish from 350g to 500g in weight, or fillets. People much prefer to eat these female fish than male fish.

Reproduction is manipulated and growth is maximised to produce a high yield from a small area of land. For example a trout farm in the Test Valley produces about 250 tonnes of fish in water of less than one acre surface area. Rainbow trout are used for fish farming because:

- they are easier to feed when first hatched
- they grow fast
- they tolerate higher temperatures
- they tolerate lower dissolved oxygen levels
- they are relatively disease resistant

Adult fish spawn in winter. Females that have been "masculinised" (by feeding tiny amounts of male hormone when first hatched) are used to produce all female sperm. The eggs are stripped from the females and fertilised with "female" milt (sperm). The eggs are incubated in cool flowing water in the dark until the young all female alevin hatch.

Rainbow Trout Production Cycle

HATCHERY (optimum temperature of 8-12 degrees C)
Broodstock and fertilised eggs 4.5 months 4.5g "fingerlings"

FISH FARM (opt. Temp 15 C)
Fingerlings grow on for 7-9 months from 4.5g to 350g or more to "table" size

The Environmental Impacts of Fish Farming

Trout need flowing cool water with high level of oxygen. Ammonia is the main waste product from fish, although solid waste is also produced. Waste water from a fish farm or hatchery will have lower oxygen, a higher BOD (biological Oxygen Demand) due to the suspended solids and ammonia.

The hatchery at Sparsholt has consent from the Environment Agency for at least 10 years to discharge water back into the aquifer via the reed bed and lake. Visiting KS3/4 school pupils have measured water quality at the hatchery and in the reed bed and fishing lake since 2002. Appropriate equipment and techniques have been used to measure:

- **clarity**
- **temperature**
- **nitrates**
- **oxygen**
- **pH**

The Environmental Impacts of Fish Farming

Results so far have produced some interesting teaching points, especially in comparison with results from testing the water quality at Ower pond in the woods.

Temperature

Water emerges from the borehole at ~11 degrees Celcius all year round. It may change as it passes through the hatchery system, depending on the air temperature and weather conditions. Temperatures increase on a summer days, whereas the water may feel quite warm in mid winter! The lake has a large surface area and is exposed to the wind. Water warms up more slowly than land and takes longer to cool down.

Clarity

Clear water is not necessarily clean! The nitrate results must be considered together with the clarity. Dirty looking water can actually contain very little nitrate. The reed bed often has a low nitrate level yet has a lot of suspended solids. Pupils may consider Ower pond water looks "dirty" (ie not at all clear) yet be surprised that they have not measured any nitrates in it.

Nitrate

In general terms phosphates are the major pollutant in fresh water, usually derived from detergents used in washing. Phosphate, not nitrate, is the main limiting factor in plant growth. However it is much easier for pupils to measure nitrate – with a test strip- and link it with pollution.

Nitrate levels can be related to the excretion of ammonia by fish and the subsequent breakdown of ammonia to nitrate. (Remind pupils of the nitrate cycle.) Nitrate found in the lake and reed bed may also be related to fertilisers and manure applied to the fields around (and in particular field C above) the lake. Advanced groups of pupils may need to consider:

• if manure or fertiliser was recently applied (manure application on this farm is limited in quantity and timing in order to prevent water pollution by nitrates)

• if it has rained recently

• if there is any barrier of vegetation preventing run off from the field entering the lake/ reed bed. (there is a conservation area of trees and wild plants)

The recommended maximum level of nitrate in drinking water is 50mg/litre, which is the level found in the hatchery water! Therefore, any nitrate removal by the reed bed is a bonus as it improves water quality. The method of measuring nitrates used here is not sufficiently sensitive to detect the additional input of waste from the fish. Levels higher than 50 would indicate pollution.

Oxygen

Oxygen is dissolved in water. Oxygen meters are used to measure dissolved oxygen in the water. The higher the water temperature, the less oxygen will be dissolved in the water. Cooler water contains more oxygen. Water emerging from the borehole overflow pipe is often 95-100%.

Animals use oxygen in respiration. Plants produce oxygen as a waste product of photosynthesis. There are few plants in the hatchery tanks so oxygen levels will decrease as the fish in the tanks use the oxygen. Levels vary according to how densely stocked the tank is. Levels around 90%, sometimes lower, are usually recorded in the fish tanks. The sedimentation tank has, theoretically, no fish and some plant growth. Oxygen levels here are similar to those in the fish tanks.

Oxygen levels in the reed bed have been recorded, so far, as 75-85%. A wide variety of invertebrates are breathing oxygen in the water and underwater plants are producing oxygen by photosynthesis.

Levels in the lake are often recorded at 100%,and water is presumably super saturated due to diffusion at the water surface, plant photosynthesis and the mixing effect caused by the wind.

pH

Water at the hatchery is alkaline, usually with a pH of 7.5, as it has emerged from chalk rocks. However, rainfall is usually slightly acid, as some acids from the atmosphere have become dissolved in the rain (approx. pH of 6.5). Therefore, the pH of water indicates the impact of rain and surface run-off on the system. At the lake and reedbed, where rain has entered the system, the pH is often 7, ie neutral.