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Hatchery vs. wild fry

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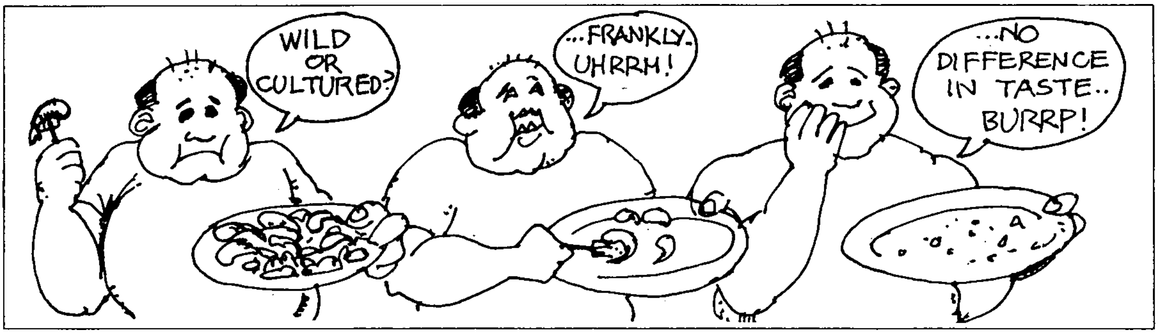

Hatchery vs. wild fry

Fisheries biologists and managers note that hatchery fish are perceived to be inferior to wild fish, and that hatchery fish degrade natural populations. These perceptions are not without foundation and these seem to be supported by studies on genetics and on the varying behavior between wild and hatchery fish. But it can be argued that the problems are the fault of how hatcheries are managed, and not with the potential hatcheries can offer.

The salmon: an example

Wild salmon populations are thought to be lost because of disproportionate harvest rates promoted by hatchery programs. It seems doubtful that hatcheries can actually supplement natural runs. Of over 300 hatchery supplementation projects in the U.S., only a few are successful. These failures may be caused by ignoring salmon life history, and by forgetting the compatibility between the fish and the environment. Perhaps, innocently, but nonetheless effectively, the management policy has been "existential disruption" where local species are eliminated or mixed with stocks that can be more conveniently bred in the hatchery.

It is imperative that the nature of the fish must be understood. The phenotype is shaped by the environmental features of the habitat, hence, genetic traits that evolve to accommodate those features are stock-specific.

The point that needs to be continually re-emphasized is that if a phenotype is to survive, the synchrony between the environment and genetics has to be maintained. Of course, environments are dynamic, and stocks are able to accommodate a certain amount of change either by the inherent structure of the population or by adaptation given sufficient time. However, when an environmental change is very severe, it is disruptive, and results either in reduced survival or the extinction of the phenotypic form.

This is the major problem with hatchery programs. Hatcheries tend to grow large numbers of fish, and those in excess of production (of donor streams) have often been released in natural waters. This practice imposes the most severe environmental changes possible for fish, and those adapted to given environmental limits are poorly equipped to handle new situations. From the fish culturist's perspective, however, as long as live healthy fish are released, there seems to be an immutable faith that they survive and return to perpetuate their form. There rests the dilemna. The expectations far exceed what is biologically realistic for the fish, and there is little continuity between the criteria used to judge fish quality and what the genetics of the fish will permit.

Some of the environmental features that influence population characteristics are very obvious (see tables). Temperature, for example, is probably the most important for salmonids; it affects nearly every phase of their life history and is certainly the major influence in stock separation and isolation. Other environmental influences are

Environmental factors that influence population traits	Population traits under some level of genetic control
• Geographical location	• Marine distribution
• Distance of freshwater migration	• Adult orientation
• Velocity of migratory pathway	• Adult return time
• Relative direction of migratory pathway	• Spawning time
• Migration temperatures	• Morphometrics
• Incubation temperatures	• Incubation rate
• Oxygen level during incubation	• Fry migration
• Productivity of the habitat	• Fingerling distribution
• Predator populations	• Smolt timing
	• Smolt orientation

more subtle, such as the effect of population size in altering patterns of distribution or migration.

Ethological patterns that involve substantial genetic control contribute to the fitness or the ability to pass on greater numbers of offspring. Certain traits are so important that they become fixed in the population to insure higher performance in subsequent generations. Disruption of the environment-genetic relationship lowers fitness proportional to the level of disruption, and the stock performance decreases.

Adult orientation and distribution in the marine environment is not random, but rather a characteristic pattern in time and space. These patterns are believed to follow ancestral pathways that provide the most efficient access to food resources based on historical distributions and sizes of fish populations sharing the marine habitat. Some populations distribute south, others north, some distribute over great distances, and others stay longer in local waters, but patterns within stocks tend to be consistent. Therefore, patterns that have evolved based on historical size and abundance constraints in natural populations may no longer be appropriate when the size or number of fish in the population has been substantially increased by artificial propagation. These differences constitute environmental changes to which the stock must respond to accommodate the new population boundaries.

Throughout the history of fisheries management, the fact that fish populations are an integral component in a complex environmental system has been ignored. The health of these populations is dependent on existing in synchrony with a given environment. If the requirements of fish populations are neglected, hatchery programs will continue to fail. Appropriate hatchery technology is a key to preparing hatchery fish for release to complete in the natural environment, but the seed stock used in such operations will always be the critical component that must be addressed first.

Reference: EL Brannon. 1993. *The perpetual oversight of hatchery programs.* **Fisheries Research** 18:19-27.

Lessons from Norway

The rapid development of farming and ocean ranching in Norway has led to an increased proportion of reared salmon in nature. Survival and migration of hatchery bred salmon appear to be strongly dependent on season. Adults escaping in summer seem to behave like homeless fish, and enter rivers at random for spawning. Salmon escaping at the smolt stage return to the area from which they escaped and enter rivers in the same area for spawning.

The fluke *Gyrodactylus salaris* has spread to 32 rivers, probably by stocking fish from infected hatcheries. The salmon lice, which normally are considered harmless to wild salmon, have been shown to affect salmon reared in net pens. Bacterial and fungal diseases are found among free-living as well as among cultured salmon; wild populations may act as reservoirs for these pathogens.

Escaped salmon may cause gene flow between cultured and wild populations, thus reducing the variation between natural populations.

Hybridization, with possible hybrid vigor and short-term adaptation, is another potential consequence, which may reduce the capacity of the population to adapt to local environments. Initiatives to protect natural gene pools include the technical improvement of farming facilities, the establishment of gene banks (now in operation), restrictions on the transfer of living material, and the use of indigenous fish for enhancement and establishment of areas protected from fish farming. Experiments to gain additional knowledge of the genetic resources are being conducted.

Reference: E Egidius, LP Hansen, B Jonsson, and G Naevdal. 1991. *Mutual impact of wild and cultured Atlantic salmon in Norway.* **J. Cons. Int. Explor. Mer.** 47:404-410.

On feeding, aggressive behavior, and distribution

Feeding, aggressive behavior, and spatial distribution of differently ranked individuals of hatchery and wild trout *Oncorhynchus clarki clarki* have been compared. Both hatchery and wild groups establish stable dominance hierarchies that seem to be based on size differences. Hatchery and wild fish within a hierarchical rank feed at similar rates. Hatchery fish are more aggressive than their wild conspecifics, irrespective of rank. Dominant hatchery fish are evenly distributed in pools and riffles, whereas dominant wild fish are three times more often in pools than in riffles. In both groups, socially intermediate fish are almost evenly distributed between pools and riffles, and subordinate fish spend most of their time in pools. On average, hatchery fish spend 57% of their time in pools and 43% in riffles, whereas wild fish spend 71% of their time in pools and 29% in riffles. These results support the hypothesis that excessive expenditure of energy for unnecessary aggression, use of fast-flowing water, or other purposes contributes to poor survival of hatchery fish after they are stocked in streams. Poor survival would reduce the efficacy of using hatchery stocks to supplement wild production.

Reference: MG Mesa. 1991. *Variation in feeding, aggression, and position choice between hatchery and wild cutthroat trout in an artificial stream.* **Transactions of the American Fisheries Society** 120: 723-727. pp. 723-727.

A final word

Role of hatcheries

For fisheries to recover, the natural patterns of genetic diversity between populations and within populations must be maintained. Many hatchery policies and guidelines do not recognize this basic premise.

A hatchery program should be only one component of a comprehensive rebuilding strategy for depressed populations. The best possible role for a hatchery is to temporarily rebuild a population while the causes of its decline are reversed, for example, while habitat is being repaired. This approach also reduces the long-term cost of running a hatchery program.

Hatcheries should not be used indefinitely to maintain fisheries. This does not address the real causes of the fisheries' decline, such as dams, habitat loss, water pollution, among others.

Instead, a more holistic approach to restoring fisheries is necessary. Solely focusing on a hatchery, no matter how well designed and managed, cannot compensate for the root causes of the species' decline. It will not result in sustainable restoration of naturally spawning populations.

Hatcheries alone do not solve the problems of dams or irrigation runoff or habitat loss. In fact, they create new problems, such as hatchery fish sometimes straying into other rivers and disrupting the genetic diversity of those fisheries. ***At best, hatcheries prevent the total extinction of depleted populations by allowing us to buy time to carry out restoration efforts.***

-- ***Seiche***, Winter 1994. University of Minnesota.