AGAINST MARINE FISH HATCHERIES: IRONIES OF FISHERY POLITICS IN THE TECHNOLOGICAL ERA

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ABSTRACT

Marine fish hatcheries have a long history of expensive operation with no demonstrable positive effect on the resource. It is exceedingly difficult to detect hatchery-produced fish. Although very expensive, full hatchery operation may be necessary to determine effectiveness. Modern techniques of genetic marking and fingerprinting provide new tools for determining hatchery success. Unfortunately, legislation to fund research on hatcheries is forestalling vitally needed legislation to stop further deterioration of fish stocks. Popular interest in marine fish hatcheries is having a deleterious rather than beneficial effect on the resources.

RESUMEN

Las piscifactorías marinas poseen una larga historia de costosas operaciones que no han demonstrado un efecto positivo sobre el recurso pesquero. Resulta excesivamente dificultoso detectar peces de criaderos. A pesar del alto costo, tal vez sea necesario mantener criaderos totalmente funcionales por un tiempo prolongado para determinar su eficacia. Las técnicas modernas de marcación genética e identificación individual (equivalente al uso de impresiones digitales) proveen nuevas herramientas para determinar el éxito de un determinado criadero. Nos urge la necesidad de una legislación que legisle la disponibilidad de fondos para la investigación de piscifactorías para evitar o frenar el deterioro de las poblaciones de peces.

INTRODUCTION

Several of California's marine fish stocks have declined severely over the past 70 years. Recreational and commercial fishermen have become increasingly vocal about rights to the dwindling supply of fish. In California, the concept of marine fish hatcheries was successfully promoted in the state legislature as a painless answer to this problem. A well-meaning California politician explained that instead of fighting over smaller and smaller slices of the pie, we now have the opportunity to increase the size of the pie itself. A modern technological solution to a politically difficult problem is hard to argue against. Yet I doubt that marine hatcheries are likely to solve the problem of declining fish stocks. Rather, consideration of artificial propagation is making fishery resource problems worse.

HISTORICAL PERSPECTIVE

The "hatchery solution" has a long history of attempted marine application, and from that history we should be able to learn a few lessons. Cod (*Gadus morhua*) larvae were released into the Atlantic Ocean for nearly a hundred years, beginning in the late nineteenth century. In the United States, some 50 billion cod larvae were released between 1890 and 1950, but it wasn't until 1952 that the operation was terminated due to lack of evidence that any worthwhile benefits had been obtained (Duncan and Meehan 1954).

The history of the Norwegian cod hatchery initiated by Captain Dannevig at Flødevigen (reviewed by Solemdal et al. 1984) provides further evidence that wishful thinking can postpone rational decisions almost indefinitely. The Norwegian hatchery operation was not closed until 1971, despite decades of research that failed to demonstrate any effect on the fish population. In 1911, Johan Hjort and a minority faction of a government committee issued an opinion that the question concerning the benefit from the Flødevigen hatchery was unsolvable, and that the hatchery should be discontinued. The majority of the committee advised against the hatchery's termination, but did point out that current methods needed to be replaced by unspecified "more complete" methods (cited in Solemdal et al. 1984). Ironically, the result was conversion of the Flødevigen hatchery from a privately funded operation to a government operation, which was to continue in virtually the same mode of operation for 60 more years.

It is interesting to read portions of Solemdal et al. (1984) in view of currently renewed hatchery interest in Norway. Whereas the former practice was to release early larvae, the new approach is to raise the fish to somewhat larger size and release them as juveniles; this is similar to the California plan.

The seemingly obtuse custom of introducing a practice prior to investigating its effect, as was the convention in Flødevigen in the 1880's may in fact have been a necessity

during those pioneer days of small scientific staff and little experience. With our knowledge, experience and well established research institutions the scientific investigations should precede the practice. We are specially thinking of the mass production of cod 0-group and the possibilities of restocking depleted populations.

Though the consistency of fry production still has to be demonstrated it is obvious that mass production will be a reality within some years. The fry produced can be used either in intense farming or released into the sea as a method for population restocking. Many people have a strong belief in the latter concept, while others are more skeptical. In fact, the situation is about the same as when Captain Dannevig was applying for support in the early 1880's.

The primary difference is that today the development is mostly an official task and therefore should be both under scientific and economic control. But the American hatcheries which were also developed within the official system, show that this is not a guarantee for the proper, logical and sound development of a project. The most obvious pitfalls today are lack of knowledge by the administration, too optimistic statements by scientists quoted by mass media, the general tendency of "fashion thinking" among administrators and scientists, and probably also critical funding from outside sources, e.g. the oil industry.

These statements apply equally to the marine fish hatchery program in California. To the credit of the California program, there is an explicit research component that is supposed to examine the effectiveness of such a program. However, determining the survival rate of hatchery-produced fish requires such a large output of those fish that a hatchery program must be fully implemented in order to determine its effectiveness! Thus the ideal of investigation preceding practice may not be achievable. Yet, as history has shown, the momentum generated is very hard to stop, despite lack of evidence that the program is effective. In fact, our technology for demonstrating positive effect in the open ocean is little better than it was at the turn of the century when Hjort deemed the question unsolvable.

SCIENCE AND HATCHERY EVALUATION

The fundamental requirements for evaluating stock enhancement by means of a hatchery operation are twofold: first, we must be able to identify hatchery-produced fish in subsequent catches, and second, we must be able to identify the genes of hatchery-produced fish in subsequent wild populations. The remaining information needed to evaluate a hatchery program is relatively trivial. If a sufficient fraction of hatchery fish live long enough to be harvested, it may be possible to justify a put-and-take operation, as is often done for inland recreational species. But without the second kind of evidence, there is no way of knowing whether the resource itself is being enhanced, which is the usual stated goal of these operations. There is no reason to believe a priori that the hatchery-reared fish is capable of natural reproduction in the wild; the fact is that we just don't know, and have little chance of finding out.

As a scientific problem, the null hypothesis is not clear. We could choose either H_0:hatchery fish are not reproductively viable, or H_0:hatchery fish are reproductively viable. The extreme difficulty of testing either hypothesis suggests that the null hypothesis, whichever it is, will not be rejected. Therefore, I submit that this either is bad science or it is not science at all. Moreover, without a substantial technological breakthrough, it is fraudulent to claim that a marine hatchery program can be evaluated "scientifically."

Fortunately, such a breakthrough may have occurred. About the only conclusive way to answer these questions is to mark and count the fish that are released from the hatchery, and monitor their recapture. Physical tags or markings can pose a handicap to survival in the wild, and could bias the results; they also provide no information on reproductive success. Only through genetic marking, a technology that recently has become practically feasible, can effective reproduction be tested. A genetic strain, as well as its offspring, should be detectable by genetic fingerprinting methods. Again, development of a genetic strain requires a long time and a large investment in hatchery facilities, before the program's potential effectiveness can be determined. Although evaluating a marine hatchery program may now be feasible, it remains extremely difficult and expensive. And that very expense bodes ill for an objective accounting of cost-effectiveness.

The few cases where marine hatcheries seem to have produced recoverable fish have been associated with estuarine rather than open-ocean fisheries (e.g., Rutledge 1989). Application to a slow-growing, late-maturing, long-lived oceanic fish such as white seabass (*Atractoscion nobilis*), as is being considered in California, strains biological and economic credibility. These fish will not become vulnerable to the commercial fishery for nearly ten years, which entails a substantial discount in economic value as well as attrition by natural mortality. The recreational fishery may encounter these fish somewhat younger, and values are undoubtedly higher to this segment of the fishery, but relative fishing pressures indicate that the bulk of the catch will be taken by the commercial fishery.

Also, the main body of the white seabass resource lies south of the Mexican border. We must further discount our hatchery production by the presently unknown but potentially large fraction that migrates south to join the main body of the population where it will be unavailable to California fisheries. Ironically, the more fish that display normal behavior and migrate south, the better is our chance of enhancing the population reproductively, but the poorer is our chance of catching those fish. Only the monitoring of genetic tags can address these difficult problems.

The critical question of whether a marine hatchery will be effective is not answerable before the attempt, and is exceedingly difficult to answer even after the attempt. Meanwhile, the operation is very expensive. Moreover, the program is prone to justification by wishful thinking: history has shown that a hatchery program can generate a broad base of public and political support in the total absence of any objective evidence that it actually works.

FINAL IRONIES

Effective management of fisheries on declining natural stocks has always been difficult to obtain. In California, effective management often has been legislated only after a resource has declined to a level so low that politicians no longer fear criticism for restricting catches (e.g., sardines, Pacific mackerel, Pacific bonito). The California fisheries for white seabass have declined severely (Vojkovich and Reed 1983), and in the 1980s we seemed to be nearing the historically proven conditions for effective fishery legislation. Now the "hatchery option" has changed this pattern: discussion of legislation to manage the white seabass fishery suddenly ceased with the creation of the marine hatchery program in California. Even though this program is only intended to be exploratory, the people responsible for enacting fishery management feel that they have effectively addressed the issue, and they appear to have little interest in taking action to conserve the remainder of the natural stock.

California's hatchery *research* program is now the main factor preventing rehabilitation of the white seabass resource. This is not the first time that a research program has forestalled effective fishery management in California: CalCOFI itself is a similar case, having contributed to the final collapse of the California sardine fishery (Radovich 1982). Of course, in the present case of white seabass hatchery research, the fishing industry is not intentionally forestalling management as it was in the sardine case cited by Radovich. Yet I believe that the late John Radovich, who was a strong proponent of research on marine fish hatcheries, would be dismayed to find that a legislated program of fishery research once again has postponed effective management, and is contributing actively to collapse of another fish resource.

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