Stock Concept Related to Gulf Coast States Striped Bass Management

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Abstract: Gulf Coast striped bass *(Marone saxatilis)* represent a race of striped bass that differ phenotypically and probably genotypically, behave as a cohesive unit and were once spatially separated from other stocks. The significance of discrete spawning stocks of striped bass is discussed. Evidence for the stock concept is reviewed and discussed in relation to maintenance of genetic diversity in fish populations. Caution is urged that stocks, designated for release into foreign waters, be carefully evaluated with respect to their potential genetic impact on native populations.

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The Stock Concept was formally introduced by Ricker (1972) but the principle has long been realized by biologists and aquatic ecologists. The term stock refers to "fish spawning in a particular lake or stream (or portion of it) at a particular season, which to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season." Ricker (1972) states that most of the differences between local stocks can and usually do have both a genetic and environmental basis. Only direct investigations can show which type of influence predominates in a particular situation.

Discrete spawning populations have been recognized for several years as an important consideration in the management of west coast salmon (Lofteus 1976). This has led to the relatively new concepts of selective commercial harvesting, management based on size, and strength predictions. Progeny of discrete spawning populations of sockeye salmon *(Oncorhynchus nerka)* taken from parents spawning above and below lakes and reared under similar conditions exhibited significant differences in their response to water currents. In both cases the rheotactic responses resulted in a greater proportion of each finding its way into the same-nursery lake even though in one case the current response was upstream, the other downstream (Hammarstom and Nelson 1976).

Previous freshwater work may further serve to develop possible parallels of the stock concept for use in Gulf Coast states striped bass management. Martin (1957) described lake trout *(Salvelinus namaycush)* homing behavior that was very precise during spawning in Louisa Lake, Algonquin Park, Ontario, where spawning grounds were separated by only a few meters. Loftus (1958) described populations of river-spawning lake trout in Lake Superior. The horizontal distribution of these lake trout stocks overlapped in the open lake but continued to separate and move to "horne" rivers during spawning. Eschmeyer (1955), in discussing lake trout reproduction in southern Lake Superior, suggested that lake trout returned to the same spawning shoals. In many instances, the lake trout rehabilitation program in the Great Lakes, indirectly recognized the stock concept. Oliver and Lewis (1971) were able to find only a few examples of planted lake trout which successfully reproduced. Dorr et al. (1981) noted little evidence of natural recruitment beyond early fry stages of planted lake trout in Lake Michigan. This apparent reproductive failure has been attributed to possible genetically influenced stock- or strain-specific differences associated with egg development, behavior or reproduction that might adversely affect survival in the wild. Successful lake trout rehabilitation in the Great Lakes may be delayed by the lack of appropriate brood stock. This same problem may exist in Gulf Coast states if native striped bass gene pools are diluted.

Lake whitefish *(Coregonus clupeaformis)* in Lake Huron are comprised of apparently discrete stocks (Spangler 1974). Walleye *(Stizostedion vitreum)* literature also suggests strong parallels to the stock concept (Loftus 1976).

Biologists at Johns Hopkins University have recently discovered molecular differences in metabolic enzyme levels of adenosine triphosphate in erythrocytes in mummichog *(Fundulus heteroclitus)* stocks (DiMichele and Powers 1982). The form of the enzyme extracted from northern stocks of mummichog is more efficient at decreasing the affinity of hemoglobin for oxygen. This facilitates oxygen delivery to tissues at low temperatures (10 C) more efficiently than the same enzyme taken from southern stocks, while the southern stocks enzyme works better at higher temperatures (25 C). In laboratory tests, northern stocks of mummichog outswam the southern stocks in cold water, showing for mummichog at least that minor genetic variations can be significant. Since quickness is essential for a small mummichog, it appears that even minute genetic differences may aid the fish in its struggle for survival and that gene frequencies of specific populations could reflect adaptations to local environmental conditions.

From a theoretical consideration of the joint effect of various evolutionary processes, one can conclude that the most favorable condition for evolutionary advance would be a subdivision of a large population into numerous, partially isolated and locally adapted populations (Li 1955). Apparently

Gulf Coast states striped bass fishery biologists have failed to recognize the stock concept, effectively demonstrated by cold water fishery biologists, because of failure to utilize native striped bass in management programs.

It is now recognized in the southeastern United States that the native Gulf Coast race striped bass *(Morone saxatilis)* population is seriously depressed, and populations in numerous southeastern rivers have been lost. The only substantial population remaining is found in the Apalachicola River, Florida. The demise of this riverine race is the result of a number of causes; habitat loss, accumulation of agricultural pesticides in coastal rivers, impassable dams preventing passage to traditional spawning areas and summer cool water refuges, and possibly competition with Atlantic Ocean origin striped bass, introduced in 1966 (Crateau et al. 198I). Hatchery introductions of Atlantic Ocean origin striped bass may survive to maturity and mix with native stock during spawning thereby altering the original gene pool of a well-adapted stock. In the Apalachicola River, Florida, sexually mature native Gulf Coast and Atlantic race striped bass have been observed together in spawning areas at optimum spawning temperatures (Crateau et al. 198I).

Genotypic stock characterization work has not yet been attempted with native Gulf Coast striped bass. Phenotypic stock characteristics have been recognized, identified and used to separate Gulf Coast striped bass from introduced Atlantic race striped bass. Greater lateral line scale counts (Barku100 1970), greater growth, longevity, and higher average condition (K) factors have been observed (Crateau et al. 1980, 1981). Due in part to their suspected tolerance of wide temperature ranges (Crateau et al. 1981), Gulf Coast striped bass stocks are well adapted to the South's environment. Yet we are uncertain which of the differences in meristics, or behavior and life history characteristics represent genetic differences and which represent environmental effects.

To date little attention has been given to the significance of discrete, native striped bass spawning stocks in Gulf Coast waters. The question, "Why and how have native striped bass populations evolved and adapted to a certain river system?" is rarely asked. Why, in only a small area of the species range, does the population cease to be truly anadromous?

Care is needed to avoid overloading a river system through stocking with non-indigenous groups, races or strains of fish to the detriment of other stocks. Projects should require balance between native stocks, and careful evaluation of this management practice is needed. An excellent example of this would be hatchery plantings of stocks of fish foreign to a river which may survive to maturity and mix with native stocks during spawning. This practice could alter the original gene pool of a well-adapted stock, a race which has adapted to a certain river's chemical and physical parameters. Environmental changes may also force desegregation at spawning of formerly discrete but closely related stocks and interbreeding would result (Loftus 1976). An example would be a dam built below the confluence of 2 rivers that previously supported separate runs of fish.

Evaluation of striped bass stocking programs have typically focused on survival and harvest of the stocked fish and little attention has been directed towards impact on native striped bass populations. Genetic variation in striped bass populations constitutes a resource that must be properly managed so as not to reduce future opportunities for use. There is a general concern about man's impact on natural populations, and the present literature clearly indicate that currently practiced exploitation and management activities may easily reduce genetic variability among and within natural and hatchery populations.

The objective of the U.S. Fish and Wildlife Service Gulf Coast Striped Bass Project is to rebuild native Gulf Coast Striped Bass populations to acceptable abundance levels that will be self sustaining. A remnant of the original Gulf Coast striped bass gene pool still exists in limited numbers within the Apalachicola River system in Florida (Crateau et al. 1981). Since it is difficult to interpret the genetic importance of this remnant population, we believe the logical approach is to assume that it represents an important pool of genetic specificity and should receive high priority for preservation. We are currently using this remnant population as a brood stock source due to its native classification and preadapted genetic specificity.

A large problem faced by fishery biologists today is the uncertainty of knowing which striped bass genes or gene combinations should be preserved through specific management or enhancement programs. Recognition of the potential for stock formation is important for evaluating the impact of management actions and for planning the restoration of individual races in striped bass fishery management programs.

Genetic diversity at the species, population, and race level should be a fundamental consideration for all forms of management. Greater diversity at each of these levels should be protected. Regardless of how fishery management activities are performed, genetic diversity must be considered.

I conclude that the "stock concept" should be applied to the management of Gulf Coast striped bass and that this stock represents a group of fish that were historically spatially separated from other stocks and may be unique in its ability to survive in warm (32 C) water. Since Gulf Coast striped bass may have adapted in unique ways, they should be managed to insure their integrity until further research on striped bass genetics can be performed.

Gulf Coast striped bass have undergone subtle genetic changes over the centuries, but it is difficult to determine if the physical and behavioral differences represent different genotypes or are environmentally influenced. Gulf coastal rivers are physiographically similar, and because of the native classification of Gulf Coast striped bass and their genetic suitability, it is recommended that this race of fish be utilized to recolonize Gulf of Mexico river systems.

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