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# Important considerations in stock enhancement

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guidelines

# important considerations in stock enhancement

Blankenship[1] and Leber[2] presented guidelines for a responsible approach to marine stock enhancement in their article titled *A responsible approach to marine stock enhancement* published in the American Fisheries Society Symposium, American Fisheries Society 15:167-175 1995. The guidelines presented are essentially applicable to any species considered for stock enhancement.

1 **Prioritize and select target species.** Selecting the target species for stock enhancement can be a biased exercise. To avoid this, use of a semiquantified approach (developed in Hawaii) may be better. The approach has 4 phases: (1) an initial workshop where a selection criteria are defined and ranked in order of importance; (2) a community survey, which is used to solicit opinions on the selection criteria and generate a list of possible species for stock enhancement research, (3) interviews with local experts to rank each candidate species with regard to each selection criterion, and (4) a second workshop, in which the results of the quantitative species selection process are discussed and a consensus is sought.

An important step to remove bias from the species selection process lies in the type of numerical analysis used. The relative importance of the various criteria can be used in the analysis by factoring the degree to which each fish meets each criterion by the criterion weight. This produces a score for each species. A trained facilitator who is focused on achieving results can also greatly reduce bias in the exercise.

2. **Develop a species management plan that identifies harvest opportunity, stock rebuilding goals, and genetic objectives.** A management plan identifies the context into which enhancement fits into the total strategy for managing stocks. The goals and objectives of stock enhancement programs should be clearly defined and understood prior to implementation. The genetic structure of wild stocks targeted for enhancement should be identified and managed according to the objectives of the enhancement program.

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*NOTE*
*The parenthetical references have been purposely omitted. Please refer to the complete paper which may be requested from library@aqd.seafdec.org.ph*

3 **Define quantitative measures of success.** Explicit indicators of success are clearly needed to evaluate stock enhancement programs. The objectives of enhancement programs need to be stated in terms of testable hypotheses. Depending on enhancement objectives, multiple indicators of success may be needed. Numerous indicators should be identified to track progress over time. An example of such statement can be: *Hatchery releases will provide at least a 20% increase in annual landings of abalone in the area by the third year of the project.*

4 **Use genetic resource management to avoid deleterious genetic effects.** A genetic resource management plan should encompass genetic monitoring prior to, during, and after enhancement, as well as proper use of a sufficiently large and representative broodstock population and spawning protocols, to maintain adequate effective broodstock population size. Prior to enhancement, a comprehensive genetic baseline evaluation of the wild population should be developed to describe the level and distribution of genetic diversity.

5 **Include disease and health management guidelines.** Disease and health guidelines are important to both the survival of the fish being released and the wild populations of the same species or other species with which they interact. A stock enhancement program in the US requires that all groups of fish pass a certified inspection for bacterial and viral infections and parasites prior to release. Maximum acceptable levels of infection and parasites in the hatchery populations are established based on the results of screening healthy wild populations.

6 **Consider ecological, biological, and life history patterns when forming enhancement objectives and tactics.** Ecological factors that can contribute to success or failure of hatchery releases should be considered. Predators, food availability, environmental carrying capacity, temperature and salinity are all key variables that can affect survival, growth, dispersal and reproduction of cultured fish in the wild.

Preliminary, pilot-scale experimental releases with subsequent monitoring of culture fish can be a direct method to use in evaluating assumptions about the effects of uncontrolled environmental factors. For example, assumptions about carrying capacity in particular release habitats can and should be evaluated through pilot releases conducted prior to full scale enhancement in the sites.

7 **Identify released hatchery fish and assess stocking effects.**

# What is Stock Enhancement?

Stock enhancement can be defined as a process whereby the abundance of free living juveniles is supplemented by the release of juveniles reared in hatcheries or captured elsewhere (e.g., in offshore oceanic areas). Stock enhancement aims at increasing recruitments to a fishery by supplementing the number of juvenile fish or invertebrates that survive the planktonic phase.

The terms "sea ranching" and "marine farming" are often used as synonyms for stock enhancement. Likewise, the terms "reseeding" or "restocking" are often loosely used to imply stock rehabilitation through the release of juveniles from another source because natural reproduction is not enough to sustain local stock.

Other terms that crop up in stock enhancement are: "settlement", "recruitment", "settlement limitation", "culture-based fisheries" and "fisheries enhancement."

"Settlement" refers to the addition of postmetamorphic juveniles to the stock of demersal juveniles, whereas "recruitment" refers to the addition of new individuals into life stages or size range of a population. Most often, recruitment is referenced to sexual maturity (that is, recruitment into the spawning stock). "Settlement limitation" refers to a situation in which the number of juveniles that are added to a demersal stock periodically are insufficient for the stock to fully utilize the trophic resources or the habitats that are available in the environment. "Culture-based fisheries" are those fisheries in which recruitment to the exploited stock is entirely dependent upon the release of hatchery-reared juveniles. "Fisheries enhancement" is a general term covering all aspects of the manipulation of the physical or biotic environment of a fish or invertebrate stock in order to increase harvest, as well as supplementing natural recruitment by the introduction of new stock from an external source (Munro & Bell 1997).

Marine stock enhancement has a long history. In Japan, it dates back to 1762, when a samurai warrior named Aoto, established the Tanegawa (river of seeds) system. A fence was built in the middle of the Miomete River in northwest Honshu to prevent salmon from going upstream. During the spawning season all fisheries between the river mouth and the fence were closed to protect the breeding adults (Masuda & Tsukamoto 1998).

In the United States from the 1880s to the late 1890s, hatcheries from New England, to Gloucester and Woods Hole, Massachusetts and to Booth Bay Harbor, Maine, produced and released more than a billion fry of cod, flounder, tautog, shad and mackerel.

In Europe, the Norwegians led the way in stock enhancement in 1883. Other nations including Canada, United Kingdom, France, Australia and New Zealand also built marine hatcheries for stock enhancement during the late 1880s (Grimes 1998).

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Natural fluctuations in marine stock abundance can mask successes and failures. Maximization of benefits cannot be realized without the proper monitoring and evaluation system.

A few identification systems such as coded wire tags, passive integrated transponder tags, genetic markers, and otolith marks have been developed. These systems meet the requirements that identified fish are representative of the species with regard to behavior, biological functions, and mortality factors, and thus provide unbiased data. The widespread use of the coded wire tag is well known and it is safe to say that it has revolutionized the appproach to stock enhancement.

8 **Use an empirical process to define optimum release strategies.** As preliminary releases can be used to evaluate ecological assumptions, pilot release experiments give a means of quantifying and controlling the effects of release variables and their influence on the performance of cultured fish in coastal environments. Experiments to evaluate fish size at release, release season, release habitat, and release magnitude should always be conducted prior to launching full scale enhancement programs. These studies are a critical step in identifying enhancement capabilities and limitations and in determining release strategy. The lack of monitoring to assess survival of the fish release by marine enhancement programs early in the century through the 1940s was the single greatest reason for the failure of those programs to increase stock abundances and fishery yields.

9 **Identify economic and policy guidelines.** Initially, costs and benefits can be estimated and economic models developed to predict the value of enhancement. This information can be used for funding support through reprioritization, legislation, or user fees. It can also contribute to an explicit understanding with policy makers and the general public on the time frame that is needed for components such as adaptation of culture technology and pilot-release experiments before full-scale releases can begin.

10 **Use adaptive management.** Adaptive management is a continuing assessment process that allows for improvement over time. The key to the improvement lies in having a process for changing both production and management objectives (and

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strategies) to control the effects of enhancement. Essentially, adaptive management is the continued use of the above nine key components, to ensure an efficient and wise use of natural resource. ###

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The results suggest that (a) there was a significant genetic differentiation among the wild *P. monodon* populations in the Philippines, and (b) the cultured populations were significantly differentiated from the natural populations. More replicate samples from each of the geographic regions are needed to conclusively determine the possibility of an association between genetic differentiation and the status of mangroves and/or intensity of shrimp culture systems. ###

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**JAPAN AND TAIWAN ... FROM PAGE 21**

veloped monitoring and assessment techniques, especially the use of an effective tag for sub-adult and a coded microwire tag for juvenile prawns. It appears that the prospects for restocking with sub-adults to augment prawn broodstocks in nature are promising. Taiwan's prawns have joined a growing list of successful stock enhancement programs (Table 2).

In addition to prawns, TFRI has experimentally released fingerlings, sub-adults and adults of seven fishes, six crustaceans, and one mollusc from 1976 to 1995 (Table 3). Most released animals were fingerlings except for the Japanese eel (*Anguila japonica* Temminck and Schlegel) and grass prawn (*P. monodon* Fabricius).

Taiwan considers the provision of artificial reefs an effective approach to building a good habitat for fishery resources. Since 1973, both the central and prefectural governments have put more emphasis on constructing artificial reefs to provide fish habitats or substrates.

In addition, a total of 25 fisheries resource protective zones have been set up for fish (anchovy), crustaceans (lobster, kuruma prawn, redtail prawn, grass prawn), molluscs (small abalone, hard clam, *Tapes* spp., purple clam, blood cockle, top shell, pearl shell), echinoderm (sea urchin) and seaweeds (*Porphyra, Gelidium, Meristotheca*). **-- RIYA**

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