RESOURCE ENHANCEMENT STRATEGIES AND STOCK ENHANCEMENT PRINCIPLES

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■ RESOURCE ENHANCEMENT STRATEGIES

1. Regulation or control of fishing activities through legislation

- Regulation of fishing season
- Prohibition on the use of specific fishing gears
- Regulation of harvestable size
- Prohibition of specific fishing areas

2. Establishment of marine sanctuaries or protected areas

- Likely to be the only effective means of replenishing a fishery where there are no resources to establish hatchery infrastructure
- Provides a base population whose excess recruits will spill out to colonize fished areas

3. Prevention of degradation of the environment

- Pollution control
- Mangrove reforestation

4. Modification or rehabilitation of habitats

- Deployment of artificial reefs
- Seaweed reforestation or afforestation

5. Transplantation of stocks

- Preferably of breeding adults from unprotected to protected areas
- A means of establishing a breeding population in an area whose native population is scarce such that gamete fertilization is almost nil

Release of hatchery-produced seeds (stock enhancement)

- A means of artificial recruitment to supplement or enhance existing stocks; potentially much more rapid than natural stock recovery and could be self-sustaining if the seed reproduce before harvest

■ DEFINITIONS OF STOCK ENHANCEMENT

- Activities aimed at maintaining or sustaining the productivity of marine and freshwater bodies through the production and stocking of seeds and the maintenance and development of fishing grounds (Regionalization of the Code of Conduct for Responsible Fisheries – Aquaculture Development, 2001).
- 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 (Munro and Bell, 1997).
- Stocking of hatchery-produced seed for the public good without the intention of benefiting an exclusive user group (Bannister et al., 1991)
- Replenishment of wild stocks (Leber, 1999)

Propagation of resource organisms and/or modification of natural habitat and environmental conditions for recovery of depleted stocks and also for increased production from the natural grounds (Shokita et al., 1991).

■ MAJOR ISSUES IN STOCK ENHANCEMENT

1. Risk of disease introduction or increase in the wild fishery
2. Risk to the genetic integrity of the wild fishery
3. Consequences to aquaculture of genetic risk minimization
4. Resource sharing (stock and water)
5. Compliance issues

■ IMPORTANT CONSIDERATION IN STOCK ENHANCEMENT

1. Ecological – availability of food and niches; biodiversity conservation (no displacement of wild individuals); no introduction of pathogens
2. Genetic – preservation of genetic diversity of natural stocks
3. Social – resource-use conflicts, property rights, harvesting regulation, etc.
4. Economic – costs and benefits

■ PRINCIPLES OF STOCK ENHANCEMENT

1. Prioritize and select target species

- Define and rank criteria
- Consult community and local experts
- Get consensus

The choice of species depends on a combination of economic and social factors and biological characteristics. The most obvious choices are:

1. Highly desirable and valuable species
2. Early life stages should be amenable to being caught from the wild or reared in hatcheries, en masse, at viable cost

Important biological attributes

A. Hatchery production

1. Ability to spawn in captivity
2. Ease of larval rearing (e.g. non-cannibalistic behavior)

B. Release into the wild

1. Rapid adoption of behavior promoting survival in the wild
2. Fast growth
3. Relatively low natural mortality
4. Narrow habitat preferences
5. Minimal propensity to migrate (low mobility)
6. High fecundity

Protocol for species selection involving the community (Leber, 1994)

1. Initial workshop – to define and rank selection criteria in order of importance
2. Community survey – to solicit opinions on the selection criteria and generate a list of possible species for stock enhancement
3. Interviews with local experts – to rank each candidate species with regard to each selection criterion
4. Second workshop – to discuss the results of the quantitative species selection process and to seek consensus.

2. Develop a management plan for the species

- Goals and objectives should be clearly defined and understood prior to implementation (What is the population being enhanced? Can it be geographically defined?)
- Genetic structure of wild stocks should be identified and managed according to the objectives of the enhancement
- The following assumptions and expectations should be considered:
  - Post-release survival
  - Interactions with wild stocks
  - Long-term fitness
  - Disease

3. Use genetic resource management to avoid deleterious genetic effects

- Genetic monitoring prior to, during and after enhancement
- Collection of broodstock from the population into which hatchery-produced juveniles will be released

• Proper use of a sufficiently large and representative broodstock population and spawning protocols

• Regular replacement of broodstock

4. Practice disease and health managment

• Determine maximum acceptable levels of infection and parasites in the hatchery populations based on healthy wild population levels

• Screening for viral/bacterial infection and parasites prior to release

• No release of unhealthy seeds

5. Consider ecological, biological & life-history patterns when forming bjectives & tactics

• Ecological factors affect survival, growth, dispersal and reproduction:

- Biotic factors: predators, food availability, accessibility of critical habitat, environmental carrying capacity
- Abiotic factors: temperature, salinity

• Physiological and behavioral deficits in hatchery-reared fish can strongly reduce survival in the wild

- Swimming ability
- Feeding behavior
- Predator avoidance
- Schooling
- Habitat selection

6. Identify released hatchery fish and assess stocking impacts

• Tagging and marking systems should be reliable

• Evaluate if released hatchery fish increased abundance without displacing wild individuals

Tags appropriate for stock enhancement

1. Able to mark small individuals
2. Detectable in all subsequent life-history stages, especially the adult
3. Unique to the local population,
4. Suitable for identification of individuals or cohorts from multiple releases
5. Inexpensive to apply and detect
6. Transmitted to subsequent generations (or in other instances not transmitted)
7. Harmless to the tagged organism and subsequent consumer
8. Acceptable to the public

7. Use an empirical process to define optimum release strategies

• Conduct experimental releases to determine optimum

- Size at release
- Release season
- Release habitat
- Release magnitude

8. Define quantitative measurements of success

Example: Hatchery release will provide at least 20% increase in annual landings of top shells

Factors affecting the success of stock enhancement

A. Fitness of hatchery-reared juveniles
   1. Reduced tolerance to stress
   2. Increased vulnerability to predation

B. Release strategies
   1. Size at release
   2. Release season
   3. Release habitat
   4. Stocking density

Reasons for stocking failures

1. Failure to anticipate the impact of planted species on the native species
2. Failure to consider the suitability of the stocking material to the receiving aquatic systems
3. Failure to include habitat protection and/or enhancement as a consistent management technique
4. Failure to consider the quality of the stocking material

5. Faulty stocking techniques

Three basic information needed to measure the success of stock enhancement programs:

1. Rate of recovery of the released individuals
2. Cost of producing the additional juveniles
3. Unit value of the harvested animal

Four ways to assess the contribution of cultured juveniles to wild stocks:

1. The proportion of released animals in the commercial catch
2. The survival rate of released individuals at the time of first harvest
3. The ratio of cultured juveniles to the estimated recruitment from the wild stock
4. Increases in total catch following enhancement

Factors that determine the economic viability of stock-enhancement systems:

1. Cost of producing the additional juveniles
2. Magnitude of the increased production resulting from enhancement
3. Value of the additional production

9. Identify economic and policy objectives

- Estimate costs and benefits
- Develop economic models to predict the value of enhancement
- Educate the public and policy makers on the need and benefits of a responsible approach of stock enhancement
- Use co-management approach wherein there is sharing of responsibilities or management functions among government agencies, community, and other sectors

10. Use adaptive management

- Continuing assessment process that allows improvement overtime
- Continued use of the nine principles to ensure an efficient and wise use of a natural resource

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