CHAPTER 29

Life History Assessments of Fishery Resources as Applied in Biodiversity Valuation and Conservation

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In fisheries biology, life history parameters of fishes are routinely assessed as they can be employed to understand the dynamics of the resource and aid in fisheries management. Species inhabiting different environments will have the life history characteristics suitable for that particular ecosystem. In this, the principle of natural selection operates which ensures that maximum number of fittest individuals survive and flourish in that particular ecosystem. The relation between habitat, ecological strategies and population parameters give rise to an organism classified as either an *r* strategist or *K* strategist (Adams, 1979). The theory of *r* and *K* selection is based on two important assumptions. Firstly, the fitness of the offspring is positively related on the resources invested on it and secondly, there is only a fixed and limited amount of resources available. The best reproductive strategy is therefore a compromise between these two conflicting demands and determines the species position on the *r*-*k* continuum. The *r*- *k* continuum is a model and the *r* or *k* selection of any species is not in an absolute sense but only on a relative basis with reference to other species, and useful for comparison in an ecological context. Fisheries based on more *r* selected species will be more productive and can be fished at younger ages and higher levels of fishing mortality than *k* selected species. Also, provided there is a minimum population size and a spawning stock, their chances of recovery from overfishing are higher. Fisheries based on more *K* selected species will have a high maximum yield per recruit but fewer fish. Also, these fisheries will be more susceptible to overfishing and stock depletion. The *K* selected species will also have complex life history stages that require mating, live birth, territoriality and nesting (eg. sharks , rock fish, cichlids, catfish etc.).

Table1. Differentiation of species based on life history traits

Trait	*r* selected species	*K* selected species
Growth rate	high	low
Maturity	early	late
Fecundity	high	low
Body size	small	big
Maximum size	small	big
Maximum age/Life span	low	high
Age/Length at first maturity	low	high
Natural (pre-recruit) mortality	high	low

Fisheries based on *r* selected species are more likely to be influenced by the environment (eg currents, upwelling, rainfall, sea surface temperature) and typically show a 'boom and bust' nature with highly fluctuating catch trends. In contrast, the fisheries based on more *K* selected species have relatively stable populations and catch levels. Prediction of future catches from such fisheries is also possible with some degree of accuracy, if information can be gathered through larval surveys, prior to their recruitment into the fishery.

Overfishing and habitat loss are considered the two main threats to marine fish biodiversity.

The marine fish abundance and biodiversity trends can be assessed for quantitative (population size) and qualitative changes (species composition, age/size groups occurring). Within species, population size decline and related life history changes including that occurring at genetic level are being used in marine fish biodiversity assessments (Hutchings and Baum, 2005). Now there is increased awareness about the need for fisheries management using a holistic, ecosystem based approach. Fish biologists and fishery resource managers are increasingly depending on approaches that can identify those fish species or populations that are at greater risk for serious overfishing and population decline within the given ecosystem. Productivity Susceptibility Analysis (PSA) is one such approach that has been used in countries such as Australia and USA. In this procedure, the risk of overfishing is evaluated in a two dimensional context of 'productivity' and 'susceptibility' scores based on a suite of attributes for each stock/ species evaluated. The 'productivity' attributes are an indicator of the potential of the stocks for growth and recovery from perturbations. It can include 'r' (intrinsic rate of population increase), Maximum length/ age reached (L"), von Bertalannfy growth coefficient (K), estimated natural mortality (M), measured fecundity, breeding strategy, recruitment pattern, length/age at first maturity and mean trophic level among others. The 'susceptibility' attributes are related to fishing (catchability, geographic distribution, vulnerability to gears employed, economic value of the species caught etc) and management strategies (catch limits set or not, spawning stock biomass or proxies used for regulation of fishing mortality etc.) in place. Each attribute for the 'productivity' and 'susceptability' index is ranked on a score of one to three from low to high. Appropriate weightages can also be given. For consistent scoring and comparison of studies across regions, the ranges for the attributes have to be set taking into account the particular ecosystem studied and the species available therein. These results can then be appropriately used by fishery managers and policy makers to derive the maximum sustainable benefits from that particular ecosystem.