CHAPTER 28

Demersal Fishes - Life History Studies and Resource Assessment of fishes

AMBARISH P. GOP, MAHESH V. AND REKHA J. NAIR
ICAR-Central Marine Fisheries Research Institute

Demersal fishes are those, which are bottom dwelling fishes and fishes that are close to the sea bottom. Demersal fisheries have been a major source of human nutrition and commerce for thousands of years. Main objective of the demersal fishery is nothing but human consumption. Compared with pelagic resources like mackerel and sardine, the demersal fishes are relatively large and high value species. Since the fishes are mostly associated with sea bottom, these are also known as ground-fish fisheries. Deep-water fisheries are mostly featured by some of their major characteristics like slow growth, longevity, and low reproductive output that may be the reasons for the low sustainability towards the high level of fishing pressure. The intensity of fishing activity throughout the world, including demersal fisheries, has increased rapidly over the past century, with more fishing vessels, greater engine power, better fishing gear, and improved navigational aids. Many demersal fisheries are now overexploited and all are in need of careful assessment and management if they are to provide a sustainable harvest.

Studies revealed that the fishing pressure definitely leads to the fluctuation in the fish stocks and may leads to the changes in the life history of fishes. It has long been hypothesized that fishing can cause phenotypic changes in exploited fish populations. Targeted fish stocks may show some fluctuations in connection with their population and ecosystem. High level of fishing pressure on a fish stock may leads to the quickly maturing individuals which in turn leads to the population shift (young, small individuals maturing quickly).So fishing can increase fluctuations in fishes and their ecosystem, particularly when coupled with decreasing body sizes and advancing maturation characteristic of the life-history changes induced by fishing.

Since the fishing pressure and ecosystem differs for each stock, one fish stock may exhibit differences in life history parameters of other stocks of same species. Differences among these life history parameters among groups of fishes have long been used as a basis for identification of fish stocks. Age, Growth and mortality characteristics are the most frequently used life history parameters to identify the fish stocks. Like other life history parameters, age and size based parameters are strongly influenced by environmental factors, although the effects of these factors from exploitation is inherently difficult.

Fishing may drive life history changes via at least two different mechanisms.

(i) Fishing may induce plastic changes in life history traits. For example, heavy fishing pressure often leads to drastic declines in population size, which in turn can lead to the reduction of the intraspecific competition, and thus survivors may get a better individual growth rates.

(ii) Fishing may induce evolutionary (genetic) changes in fish stocks by selecting against particular life histories. Targeted fish stock may directly correlate with the fishing pressure by the removal of particular age and size group by the use of specifically selected fishing gears. Survivor may get genetic changes with respect to the life history traits like maximum length (small individuals mature early and so the maximum size will be reduced), Longevity (mature early and dies early). Age at first maturity (early matures).

However, many of the commercially exploited fish populations show not only demographic shifts in population structure but also trends in fish life-histories towards earlier maturation and declining adult body size. While such changes can be also induced by increasing water temperatures, most of the observed trends correlate positively with fishing pressure.

The morphological and reproductive characteristics, population sizes, and genetic frequencies of species are linked to their environments by natural selection. Different stocks of same species inhabiting different environments show different patterns of life history characteristics. The relationship among habitat, ecological strategies, and population parameters has been termed r and K selection (MacArthur and Wilson 1967) and/or optimal life histories (Gadgil and Bossert 1970). This body of theory is based on the assumption that natural selection operates on these characteristics in order to maximize the number of surviving offspring produced.

In fisheries biology, the value of comparative studies of life history parameters (fecundity, longevity, maturation age, maximum total length, parental care, and spawning season duration**)** has long been recognized (Holt 1962; Beverton 1963; Cushing 1971; Alverson and Carney 1975). These life history parameters should vary in a consistent pattern which can be predicted from the theory of r and K selection. This is not a particularly new or unique idea in fisheries biology. Beverton and Holt (1959) investigated a positive relationship between body size and life span and between mortality and growth rates. Cushing (197 1) suggested that there is a negative relationship between degree of density dependent regulation and fecundity. Alverson and Carney (1975) have suggested a positive relationship between body size and the time when a cohort maximizes its biomass. All these empirical observed trends in life history parameters are consistent with r and K selection.

The criterion for success in natural selection is the number of surviving offspring that a parent produces (Crow and Kimura 1970). Therefore, the best reproductive strategy is a compromise between two conflicting demands:

(i) production of the largest possible total number of offspring (r selection),

(ii) Production of offspring with the highest possible fitness (K selection).

The particular point of compromise for any species will be a function of the selection factors operating on that species and would be that species' position on the r and K continuum.

Life history traits

Life-history traits are often related through trade-offs that define the life-history strategy of a given organism (Winemiller et al. 2015). Such life-history strategies are used to shed light on the evolution of organisms, as well as the environment in which the species occur (Charnov et al. 2013).

Fisheries based on more r selected species:

- will be more productive. They can be fished at younger ages and at higher levels of fishing mortality. Given a minimum population size, these fisheries should also have a quicker recovery from overfishing.
- are likely to be strongly influenced by physical forces in the environment. Relationships of this type, e.g., between anchovies and upwelling, should be important considerations in management plans for these species.
- are likely to be of a boom and bust nature. Although in some years catches in these fisheries will be very large, they will be characterized by erratic production levels.
- are likely to have less range of variation towards growth rates, reduced age at first maturity, and greater fecundity at age.

Fisheries based on more K selected species

- will have a high maximum yield per recruit, but there will be fewer fish. These fisheries would be more susceptible to overfishing and stock depletion.
- are much more likely to have sophisticated life history mechanisms, which would have to be recognized in a management plan. (These mechanisms might include parental care systems such as nesting or live births, mating systems, or territoriality.)
- are much more likely to have strong interspecific relationships.
- in contrast to the boom and bust nature of **r** selected fisheries, will be characterized by relatively stable population sizes.

Conclusion

The r and K continuum is a model and as such occurs only in an idealized sense. The idealized r selected species occurs in an ecological vacuum with no density effects and no competition. The idealized K selected species occurs in a completely saturated ecosystem where densities are high compared with carrying capacities and competition for resources is intense. The problem of applying this model to any real situation is not a trivial one. Species are not simply subjected to a single selective pressure, or even to a single set of selective pressures. Because of this, r and K concepts should only be applied in a comparative sense between groups of species that have some degree of functional similarity. No species is r selected or K selected in an absolute sense; it is only relatively more r selected or K selected than some other reference species. This theory will only have value in a situation where the population dynamics of one member of a species group are fairly well understood. In short, r and K selection seems to have been an important evolutionary trend on marine fish populations. The result of patterns in population parameters which arise from r and K selection is that different management strategies would be appropriate. The value of this approach is likely to be in initial stages of development of a fishery. As a fishery becomes more developed and information that is more specific becomes available, a more refined management strategy would become possible.

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