BIOTECHNOLOGY AND FISHERIES OCEANOGRAPHY

Dr Phillip S. Lobel
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts
USA

The question at hand is how human activities may affect the earth's environment and "bios". One special concern is the potential impact of long-term climatic change resulting from global warming (*see paper by G. Pontecorvo, this volume*). One projected result of global warming will be a rise in sea levels around the world. How coastal marine fishes may possibly respond to changing climates and how new technology may impact fisheries are the topics presented for discussion.

It is possible to only speculate about how fish populations, in general, may respond to changing climates. The climatic variable which will probably have the greatest effect is the open ocean circulation. Ocean currents, coupled with atmospheric storms (which affect the ocean's mixed layer), have a direct influence on the distribution and survivorship of many marine fish larvae. Knowledge of the life-cycles of fishes is fundamental to understanding the potential long-term implications of:

1. changes in coastal morphology that affect nearshore currents and,
2. global climatic changes that affect open ocean circulation.

A common theme has evolved in the life history patterns of a majority of coastal marine fishes. Adult fishes live near the protective shelters of corals and rocks. These species typically spawn at specific sites during particular times of the year. A majority of species produce offspring which are spawned as buoyant eggs that hatch within days. The newly hatched larvae live a specialised life in open ocean waters as part of the plankton. These larvae drift with the ocean currents for weeks to months before finding their way to coastal habitats. The fate of these larvae and how they find their way back to coastal habitats is a major determinant of the abundance of future fish stocks.

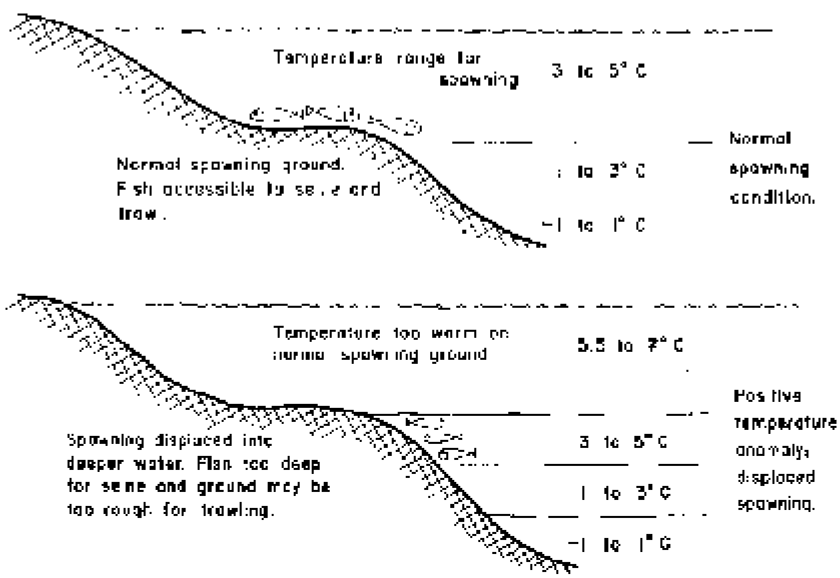

Figure 1: Schematic example of the effect of positive temperature anomaly on cod spawning and fishing (From Laevastu and Hayes 1982).

Survivorship of these planktonic fish larvae is partly a function of ocean currents, which transport the animals from spawning sites to nursery grounds, and the availability of food particles in the ocean's mixed layer (upper 100 m). Thus, changes in the pattern of oceanic circulation may significantly affect the future abundance of fishes found at various locations. The potential effect of warmer sea surface temperatures on larval fish survival is unknown. Climatic changes which modify atmospheric patterns may also be significant. Atmospheric storms stir surface waters and can dilute the concentration of food particles. Low food densities can result in larval starvation. Thus, the occurrence of storms can also have a profound impact of fish population dynamics. For recent discussions on this topic see Lasker (1981) and Lobel and Robinson (1986). Clearly, climatic changes which affect larval fish survivorship will have a long term impact on fisheries resources.

Another significant factor in the survivorship of young shore fishes is the availability of nursery grounds. Once the planktonic larvae have grown to an age at which they are physiologically competent to complete the metamorphosis from a pelagic to a benthic life, they must find suitable habitats along the coasts. Habitats which are important nursery areas and refugia for varieties of fishes include: coastal swamps, tidepools, estuaries, mangroves, shallow bays etc. Such habitats would be greatly altered or completely devastated by a rise in sea levels. Furthermore, such habitats are most vulnerable to sewage, industrial pollution, and destruction by development projects on the shorelines.

Climatic changes may have an effect on how fishes are caught. One result of the global warming of the oceans may be the displacement of fishes from their normal spawning grounds (Figure 1). This change will be first recognised by local fishermen who may no longer find fishes at traditional spots. The displacement of the fish populations into habitats of different topography may make certain species very hard to find and catch. However, this problem may be solved by another emerging technological development. This development is the new computer-driven electronic technology specialised for finding and tracking fishes in the ocean. This new technology includes:

1. satellite mapping of ocean currents and real-time data transmission to ships,
2. global navigation systems enabling continuos pinpoint accuracy,
3. acoustic systems for locating fishes underwater,
4. shipboard censors for measuring currents and seawater characteristics and,
5. improved ship design and more efficient fishing gear.

A saving grace for many fish populations to date has been that fishermen did not always know where to find them. The new electronic technology may create a situation wherein fishes can run but cannot hide.

The three biotechnology issues described for discussion regarding the potential effect on world fisheries are:

1. global warming and sea-level rise (changes in ocean circulation and possibly the patterns of fish recruitment),
2. industrial development of coastal habitats (increased sewage, pollution and destruction of feeding, spawning and nursery grounds) and,
3. electronic fishes technology (accurate methods for finding and catching fishes).

Each of these can have an effect on fish populations in addition to the natural variability of population cycles. A special concern is the synergistic impact of these multiple influences when they occur synoptically and especially when the natural population cycles are at low points.

References

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Dr. **Phillip S. Lobel**, received his B.A. in Zoology from the University of Hawaii and a Ph.D. in Biology from Harvard University. He is presently assistant scientist at the Woods Hole Oceanographic Institute and associate in oceanography, Center for Earth and Planetary Physics, Harvard University, co-chairman of the Biology Working Group and a Steering Committee member, he is involved in the Hawaiian Oceanographic Experiment and is author of numerous articles on the topics of oceanography and ichthyology. He is a recipient of many academic and research awards.