75-7

NOTES ON BIOLOGICAL COMPONENTS REQUIRED FOR DEVELOPMENT OF A MANAGEMENT SYSTEM IN THE NORTHWEST ATLANTIC

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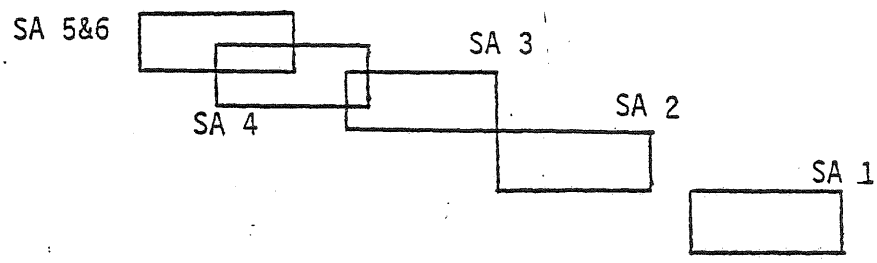
An ecosystem in the ocean is never a completely closed entity; however, boundaries have to be defined in order for man to intellectually deal with its compartments. Definitions of such boundaries are influenced by the primary focus of interest in each particular case. In this case I am basing my definition on the biological interactions of the primary fisheries components (obviously man's activities are part of this ecosystem also, although not considered here).

The following schematic illustrates areal overlaps based on ICNAF Subareas and Statistical Areas (SA).



There are four species with large biomasses which according to the best scientific advice available have to be considered as a biological unit between SA 5+6 and SA 4. They are *Illex* squid, mackerel, argentine, and pollock. With the first two a significant percentage of the winter concentrations in SA 5+6 move to SA 4 and back again (50% or larger). For argentine and pollock, the entire stock moves freely between SA 5+6 and 4. The potential yield from these stocks combined approaches one-third of the total from SA 5+6.

In addition to the above stocks, interchanges of other species also take place. Although data is just beginning to be available, the interchange between herring stocks in SA 4 and wintering concentrations in SA 5+6 may well prove to be most significant (several returns from tagging in SA 4 have been made in the southern part of SA 5). Herring alone may well produce in excess of 30 percent of the total potential yields on SA 4-6. In addition to herring, there are complex problems of intermixture of other fish and shellfish along the SA 4-5 boundary, and it is pertinent to note that species which move between SA 4 and SA 5+6 interact with those that are resident in each area.

The biological structure of the ecosystem can basically be expressed in terms of a trophodynamic web involving plankton, benthos, and fish. The basis of the food supply is the energy of the sun harnessed by the phytoplankton through the process of photosynthesis. This energy reaches the top-level predator (man) through a very complex system of interactions, and a fish species may occupy several different trophic levels during differing stages of its life history. Such a web implies a plethora of biological stock interactions. Data is not available at this time to be specific on this issue; however, let it suffice to mention that recent stomach-analysis studies conducted at the Northeast Fisheries Center indicated that pollock, alewife, redfish, mackerel, and herring all had fed to a large degree on the same invertebrate organisms.

To maintain a fishable biomass at equilibrium requires two assumptions: the environment must maintain a consistency, and fishing must remove fish more or less in proportion to the relative productive capacities of the various stocks. At our current level of understanding, this requires that the total catch of all species be less than the sum of the estimated catches calculated from individual species assessments.

By-catch of species other than the main object in a directed fishery or the catch of more than one species together when both are equally desired, also creates problems for the attainment of the desired relative biological yield from each species. Until fishing can be made more species specific, catches which give a specific goal of, say, maximum sustainable yield of one species, may cause fishing mortality on another species in excess of that which that species can sustain. Finally, in addition to the problem by-catch may cause in terms of overfishing, it is also important in terms of allocation between user groups when one group wishes a directed fishery on a species which is taken as by-catch by another fishery.

Given an ecosystem in equilibrium, it may appear desirable to man to move to an alternative equilibrium state. Effects of large-scale disequilibria are not predictable. Small, slow changes (10-year scale) have been observed and new equilibrium reached. However, not enough information is available to assess the relative changes in total productivity from differing states of equilibrium. One may well have to sacrifice catch as a result of changes which degrade productivity.

It is pertinent to realize that with the current state of knowledge it is critical that two principles be kept in mind. The first is that all models should recognize that there is a great deal

of uncertainty in the data and in the models that are being used. Second, the question of reversibility of change recognizes that alternative choices have a socioeconomic base and that such conditions can change far more rapidly than biological changes. Thus it is necessary to consider the time required, and probabilities for reversibility, in any proposed change in equilibria. Reversibility values at present are only qualitative (e.g. 10 years to recover in general) but they must be a component in any conceptual model.

In summary, it should be noted that there is no "biological" objective for fisheries management but that the understanding of the biological basis of the ecosystem will lead to the ability to predict what the potential effects on productivity are of various "manipulations" of the ecosystem.