FUNCTIONAL STRUCTURE OF DEMERSAL FISH COMMUNITIES

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The gross effects of pollution on demersal fish communities can be discerned by describing the communities in a way that allows one to predict what species should be found where. If this can be done, anomalous situations (i.e., the absence of a species in an area where it "normally" should be found) can be identified and investigated to determine the cause. The objective of the study described here, which was supported in part by a grant from the Environmental Protection Agency, is to define the structure of southern California demersal fish communities in this manner.

The coastal and island waters of southern California are considered to be a faunal unit. This means that samples of organisms taken from a particular habitat at a particular depth within the Bight should have approximately the same species composition. Preliminary examination of demersal fish communities indicates that the species found living together usually fill different feeding roles (a feeding role is defined here as a manner of foraging for food). Species that fill the same feeding role are usually found at different depths or in different habitats. However, in certain instances, two species can fill the same feeding role and coexist if, for example, one species is larger than the other and thus feeds on larger food particles, if one feeds during the day and the other feeds at night, or if one is specialized for selecting a particular type of food.

Using a cluster analysis, such as recurrent group analysis, we have identified groups of species that commonly occur together in local bottom waters. According to Gause's hypothesis, each species within such a group would fill a different role. By plotting the distribution of the groups over the study area, we have found that they break down (by losing some but not all species) near certain outfall areas. Further investigation showed that, in some cases, one species is replaced by another species that fills the same role, while in other cases, no replacement occurs. This suggests that the species in the different roles may be affected by pollution to different degrees and that each feeding role should be investigated independently to determine pollution effects.

By defining sets of species that fill the same role and describing the relationships (size, spatial distribution, etc.) of the species within each role, we can create a model of the demersal fish communities that allows us to predict which species should be found at a particular depth in the same habitat throughout the Bight.

METHODS

Some 130 species of fish commonly collected by otter trawl at depths of less than 200 m in southern California were sorted into feeding roles. We accomplished this by:

- Noting the most obvious morphological differences among coexisting species found in recurrent groups. Making feeding behavior inferences from the morphology of the fishes.

- Reviewing feeding behavior and stomach content literature on each species.

- Determining fish stomach contents in the field and laboratory.

- Observing fish feeding behavior in laboratory aquariums or in baited camera films and television tapes. To determine the relative abundance of species within a feeding role relative to depth, we had to examine a large number of samples collected in a uniform manner over a large area, with respect to both geography and depth. The data used for this study represent 350 otter trawl samples collected off the coast from Santa Monica Bay to San Clemente and off Santa Barbara Island and Santa Catalina Island at depths ranging from 10 to 200 m. The samples were collected by 25 ft. wide otter trawls towed for 10 minutes at 2.5 knots. Samples were collected over a 2 year period in all seasons of the year, and the fish species collected were identified and measured in a standard manner.

Species comprising a role can coexist if they are of different sizes and thus eat different sized food particles. Therefore, species within a role were sorted into classes, each containing an equal range of jaw sizes since size of jaws among fish is usually related to food particle size and is more relevant to the coexistence of similar species than the length of the fish. The relative abundances of species within a jaw size class were then plotted versus depth to show depth separation of species.

RESULTS

The general types of demersal fish foraging behavior are shown in Figure 1. All of the samples were collected by otter trawl, which can be used only on soft bottom habitat.

Since the soft bottom is a very simple habitat in that it has almost no relief, the differences in foraging behavior among the species that we are considering are rather basic. (This would not necessarily be the case in rocky bottom areas, which supply many microhabitats.) Soft bottom fishes can be divided into two major groups: (1) bottom fishes, which usually lack swim bladders (Group 1 on Figure 1) and (2) water column fishes, which usually possess swim bladders (Group II on Figure 1). Water column fishes such as those in Role IIB on Figure 1, which feed on the same range of food particles as some bottom fishes, such as those in Roles IB and IC, might be more mobile than the bottom fishes and therefore capable of foraging over a larger area (although less thoroughly) than the bottom fishes. Fishes that feed on the bottom often have structures such as barbels that may allow them to locate their prey by chemical sensors or means other than sight; hence, we divided Roles 1C and IIB into two sensory categories

The classification system shown in Figure 1 assumes that most species are somewhat opportunistic in that they will eat almost anything that crosses their path. However, as the species in each feeding role focus on a different part of the environment, there are still

differences in the food the members of each role will encounter. Nevertheless, ists do exist. For example. some species have teeth for crushing species that special adapted hard items and are able to eat food that other forage in a similar manner cannot eat.

An example of the depth separation of species within a feeding role is shown in Figure 2. role (Role IA on Figure 1, which we after the most abundant member) are bottom fish feeding primarily on food items in the water column. The food of the smaller members of the role includes active shrimp like microcrustacea such as mysids; larger members may feed on shrimp, squid, and active fishes such as anchovies.

The species included in this role are flatfish with medium to large mouths equally developed on both sides of the head, little lip development, and medium to large eyes. Four jaw size groups were analyzed for depth separation of species: Class A represents the smallest mouth size, and Class D represents the largest. The graphs in Figure 2 indicate the species within a size group that would most probably be found at a particular depth.

It should be noted that while species that replace each other are generally living at different depths, an overlap zone does exist. Within this zone, both species may be found together. Similar overlap zones will usually occur between species that replace each other geographically or by habitat.

Other roles that we have analyzed for depth relationships show similar patterns, although most do not show as many size

The species filling this call the sanddab role groups nor do the overlap zones between species occur at the same depths. From this classification system (which applies only to a depth range of 10 to 200 m), anomalous species distribution patterns can be identified and investigated. If a species is not present in an area where we would expect to find it, at least two possible situations may exist: The role is still present (the species has been replaced by another similar species that fills the same role). This would indicate that there is still food in the area for members of this feeding role, although something has shifted the advantage from one species to another. The role is rare or absent (no replacement by other role members has occurred). This indicates that the food utilized by this role is gone or that some other factor is affecting the role members (e.g. something has interferred with their foraging behavior or there is heavy mortality by fishing, etc.).

The first situation may be relatively unimportant from a community standpoint as the role still exists, while the second would represent a breakdown or change of the natural community. Unless commercial or sport species are affected in the first situation, studies to determine causes would first be aimed at situations in which a role is entirely

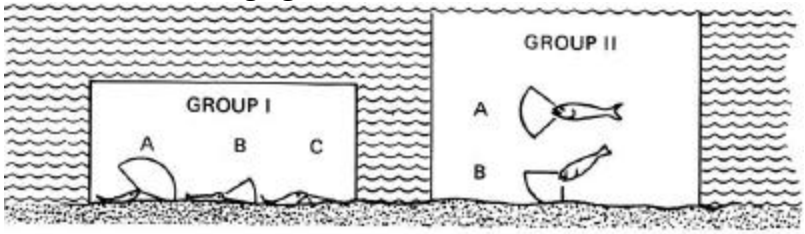
absent.

We have completed about 75 percent of the work involved in classifying the trawl caught nearshore demersal fishes. Most of our work in the future will be focused on identifying

anomalous distribution patterns and determining possible causes for each. The results of this study will be submitted to a scientific journal for publication.

FIGURES

Figure 1.
General types of demersal fish foraging behavior



I. FORAGE FROM BOTTOM
  A. ABOVE BOTTOM
  B. ABOVE AND ON BOTTOM
  C. ON BOTTOM
    1. BY SIGHT
    2. BY OTHER SENSES

II. FORAGE FROM WATER COLUMN
  A. IN WATER COLUMN ONLY
  B. IN WATER COLUMN AND ON BOTTOM
    1. BY SIGHT
    2. BY OTHER SENSES

Figure 2.
Depth distribution of species filling the sanddab feeding role in Southern California coastal waters