CALIFORNIA DEPARTMENT OF FISH AND GAME ARTIFICIAL REEF PROGRAM, WORK IN PROGRESS

Dennis Bedford[1], Jerry Kashiwada[2], and Juan Hernandez[3]

[1]California Dept. of Fish and Game, Marine Resources Division, 330 Golden Shore, Suite 50, Long Beach, CA 90802
(562) 590-5171, E-mail: dwbedford@compuserve.com
[2]California Dept. of Fish and Game, 19160 S. Harbor Dr., Fort Bragg, CA 95437
(707) 964-9078, E-mail: jkashiwada@compuserve.com
[3]California Dept. of Fish and Game, 4775 Bird Farm Rd., Chino Hills, CA 91708
(909) 597-9823, E-mail: 110124,542@compuserve.com.

The California Department of Fish and Game has been building artificial reefs off southern California since the late 1950s. Early work was aimed at determining what materials were best suited for building artificial reefs that would both attract and hold marine organisms, particularly popular sport fish species.

During the early to mid-1980s our attention was focused primarily on determining if an artificial reef could function in a very similar way to a natural reef. The construction and multi-year study of Pendleton Artificial Reef, off northern San Diego County proved that, in time, a well constructed artificial reef can develop the same community structure as similarly configured natural reefs (Aseltine, In press). As a bi-product of this work the qualitative and quantitative production of attached shellfish and other invertebrate species was well documented (Aseltine, In press; Palmer-Zwalen, In press).

Finfish species have remained problematic, since many species come and go freely from any particular reef complex. As elsewhere, resolving the finfish "attraction vs. productivity" question has played an important role in the planning and installation of new reefs, whether for fisheries management purposes or mitigation. Work during the late 1980s and into the present has focused on trying to quantify the productivity of artificial reefs for finfish species, and to develop reefs directed at producing more of certain species.

Central to the problem of establishing productivity for fish is knowing when and for how long different species are resident on a reef. Further, since small individuals of a given species are likely to use a reef in a different manner than larger individuals, residency as well as territoriality must be accounted for separately for each size class of fish.

Beginning in 1993 a three phase program was initiated aimed at quantifying fish productivity on artificial reefs. Phase one addressed the interaction, or use of an artificial reef by a selected group of fish species. Phase two, currently in progress, seeks to model minimal productivity as a function of duration of residency and growth of different species and multiple age classes. This phase involves extensive tagging and year round re-sighting of individuals. Phase three will assess the functionality of a series of previously established experimental reefs, configured at differing locations, depths and reliefs, at producing desirable target species. Phase three will begin when the experimental reefs have been established for at least 10 to 15 years, or approximately the year 2000.

During Phase two, we have concentrated our tagging efforts on garibaldi (*Hypsypops rubicundus*), California sheephead (*Semicossyphus pulcher*), señorita wrasse (*Oxyjulis californica*), and rock wrasse (*Halichoeres semicinctus*) at Pendleton Artificial Reef (PAR). We have chosen to focus tagging efforts on these four species due to their presence in large numbers, visibility, ease of capture, and low tagging mortality. During our initial tagging effort, we had included kelp bass (*Paralabrax clathratus*), but decided to abandon this species, due to high fishing mortality which interfered with our ability to estimate residency.

Diver deployed gill nets, cast nets, and baited traps are used to capture fish. The gill net is a 10 mm-mesh monofilament net, approximately 10 m in length and 3 m in height. The net is weighted at the bottom by a lead core line and suspended at the top by cork floats. During netting divers actively herd fish into the net. After removing fish from the net they were placed in mesh bags and later brought to the surface where they were measured, tagged, and then brought back to the capture site on the bottom for release.

The cast net consists of a 2.5 m diameter, 18 mm-mesh monofilament net with weights on the perimeter. Fish were attracted to a baited station with either red or purple sea urchins (*Stronglyocentrotus franciscanus*, *S. purpuratus*) collected off site, or California mussels (*Mytilus edulis*). Three divers then suspended the net above the baited station and dropped it upon the fish which had gathered in a feeding frenzy.

Fish traps consist of wire cages, approximately 1 m by 0.75 m in dimension. Each cage has two funnel shaped entry ports. The traps are baited with urchins placed inside a mesh bag. The traps are typically placed at the base of a reef module. These are particularly effective at capturing sheephead, and form the basis of a commercial live fish fishery.

For two of the four species, we are using conventional monofilament tags (1 and 3 cm long) of two colors: red and yellow. Each tag has a unique number and a phone number that can be dialed to report a tag recovery. We attached multicolor bands of shrink tubing to make each tagged fish distinguishable to divers who often cannot approach close enough to the fish to read the tag number. In addition, each fish is injected with one or more colors of biocompatible plastic elastomer (Northwest Marine Technologies, Inc.) In unique combinations. This provides backup identification for the conventionally tagged species, but also provides the only method of identification for señorita wrasse.

Since this study is designed to monitor and model residency of certain fish species, it is desireable to avoid monitoring behaviors associated with any initial tagging trauma or tagging mortality. To avoid this, individual fish become part of the study group only when they are first observed, a minimum of two days after tagging. To date there have been 79 fish regularly re-sighted as part of the study group. Tagging will continue until approximately 200 fish are in the study group.

A survival analysis will be applied to the observed residency times for each individual fish. The results of this analysis will provide a statistical probability of a fish of species (x), of age class (y), of surviving to time (t). Once established, these parameters can be utilized with total fish counts and growth information to calculate a minimum quantifiable fish productivity for an artificial reef.

The first year of re-sighting has produced some interesting preliminary results. Spawning adult garibaldi, as expected, do not leave the territory immediately around their nests. They have always been found at the same module where they were initially tagged. However, garibaldi not establishing nest sites have demonstrated variable affinities to one or more modules. Tagged sheephead of various sizes have been observed on several of the surrounding modules in addition to small rock piles between modules. They appear to move more freely between modules than other species. Rock wrasse and señoritas appear to remain on one module, however both have a tendency to follow divers, necessitating a revised sampling protocol, in which divers can never swim from the initial tagging module to one of the neighboring modules. Even while observing this new protocol, several señoritas seem to sense a diver's presence on a neighboring module and will come across to investigate. This occurs even when the visibility is poor. These fish must either hear us or feel other vibrations transmitted through water. In such cases we must swim back to the initial tagging module to draw these fish with us. Under such circumstances we must use a compass to find our way. The fish apparently do not share our limitations. Both rock wrasse and señorita populations appear to have a high natural mortality, each showing a substantial reduction in numbers over the course of a single season.