THE CALIFORNIA DEPARTMENT OF FISH AND GAME'S MARINE CULTURE LABORATORY

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Abstract. One of the more recent developments within the California Department of Fish and Game has been the establishment of a marine culture laboratory. The laboratory is situated on the central California coast immediately south of Monterey.

A complete water system that provides for filtered, ultraviolet treated, heated, chilled, and raw (unaltered seawater, has been installed.

The main water supply system consists of dual submersible pumps, housed on the seafloor, in 15- to 20-ft. depths, that push water to an elevation of 120-ft. to a 20,000-gal. storage reservoir. All seawater lines and equipment in contact with seawater consist of plastic or other inert substances to eliminate toxic metallic ions and inhibit corrosion within the system.

The principal objective of the culture laboratory is to explore the feasibility for mass culture of selected marine species such as abalones, scallops, crabs, prawns, lobster, and clams to provide basic information for mariculture and augment existing fisheries through "seeding" programs.

One of the more recent developments within the California Department of Fish and Game has been the establishment of a marine culture laboratory. Financed in part by funds under the Bartlett Commercial Fisheries Act (P.L. 88-309), the laboratory is situated on the central California coast immediately south of Monterey, at Granite Canyon.

The main seawater supply system consists of dual 10-hp., submersible pumps, each rated at 150-gal. per minute and housed in a collector structure on the seafloor in 15- to 20-ft. depths.

The collector itself weighs approximately 10 tons. It is constructed of two 20-inch diameter transite pipes, of 1-inch thick material, each 10 ft. long. Inside of each 20-inch diameter transite pipe is a 10-inch diameter transite pipe also 10 ft. long and one inch thick.

The annular space between the two pipes is filled with 3/8-inch diameter gravel. The submersible pumps are sleeved inside the 10-inch diameter pipes. Both the 10-inch and 20-inch and 20-inch diameter pipes are slotted, allowing water passage. The gravel pack provides filtering of larger particles and debris that could clog or damage the pump impellers, but allows smaller plankton organisms to pass through. The transite pipes, gravel pack, and pumps are all contained within a framework of 4-inch tubular steel pipes and steel plates. The collector base is anchored to the seafloor with 12 cubic yards of concrete.

Seawater is pushed from the submersible pumps through dual 4-inch diameter polyvinyl chloride (P.V.C.) supply lines to the main 20,000-gal. storage reservoir located 120 ft. above sea level, and 20 ft. above the laboratory level.

The submersible pumps are alternately operated on a monthly basis since one pump can supply the current laboratory usage of about 80 gal. per minute. Thus, the growth of fouling organisms such as mussels and barnacles is inhibited by having one line of the dual system evacuated bimonthly.

Dual 4-inch diameter P.V.C. lines supply water from the main storage reservoir to the laboratory under gravity flow. These supply lines are also used on an alternate basis as described above.

At the laboratory, the supply lines bifurcate. One line enters the laboratory as "raw" seawater and provides plankton to filter feeding organisms. The other line passes through a high transport sand filtration system. This filtered water may then be stored in a 5,000-gal. reservoir or supplied directly to the laboratory. The filtered-water storage reservoir allows for a continuous filtered-water supply to the laboratory when the sand filters are being backwashed, and filtered-water cannot pass directly into the laboratory.

Filtered seawater in the laboratory first passes through an ultraviolet (UV) unit for removal of bacteria. This provides for relatively sterile seawater, highly desirable in specific laboratory operations.

Part of the filtered, UV treated seawater then passes into a heated seawater system. This system consists of a glass heat exchanger, a freshwater boiler, and a pump that continuously moves heated seawater through the system. A control panel serves to regulate the heated seawater system via a pneumatic valve and temperature recorder. The control panel also monitors ambient temperature and salinity of seawater being supplied to the laboratory.

Heated seawater is used in a variety of applications, such as conditioning animals for spawning, actual spawning by thermal shock, establishing parameters for optimal growth and survival, and determining lethal limits.

Seawater is chilled below ambient temperatures by means of portable refrigerating units that can be mounted above reservoirs. Several hundred gallons of seawater can be chilled 5 to 6 degrees C. below ambient temperatures in a relatively short time.

All seawater lines and equipment in contact with seawater consist of P.V.C. or other inert materials to eliminate toxic metallic ions and inhibit corrosion within the system. Additionally, the water lines are arranged in a loop system, minimizing dead ends which would allow hydrogen sulfide to accumulate.

The main laboratory building, containing 3,000 ft.^{2} of floor space, was developed from an existing structure designed for military use. A conditioning and spawning room, a larvae culture room, and a forage culture room occupy the bulk of the floor space in this facility.

Another structure with 700 ft.^{2} of floor space, serves as a holding facility for shellfish prior to their use in the laboratory, and also provides facilities for rearing juvenile shellfish, hatched in the laboratory, to adult sizes on a pilot scale basis.

Rounding out the marine culture laboratory complex is a greenhouse for growing unicellular algae, and a small food preparation facility which provides for particulate feeding juvenile shellfish and adult shellfish brood stock.

The principal objective of the culture laboratory is to explore the feasibility of mass culture of selected marine species, to provide basic information for mariculture.

Research is in progress on the market crab, (Cancer magister), the spot prawn (Pandalus platyceros), the Pacific oyster (Crassostrea gigas), and the red abalone (Haliotis rufescens).

We have succeeded in rearing market crabs through the five zoeal larval stages to the megalopa stage, but extensive mortalities have occurred at each stage. Difficulties encountered in maintaining good water quality through the 3- to 4-month larval period were largely responsible for the high mortalities.

We have had good success in mass culturing the spot prawn. This prawn is endemic to many of the submarine canyons occurring along our coastline, and supports a modest commercial fishery in the Monterey region.

In the laboratory, we have achieved 80 to 90 percent survival through early larval stages. Each adult female yields 3,000 to 4,000 larvae. Juvenile stock hatched in the spring of 1971 now exceed 3 inches in length, excluding antennae.

Present research on the spot prawn is directed towards determining temperature and salinity parameters, and finding optimal food formulations for best growth.

Research on the Pacific oyster is concerned with developing a resistant strain. Pacific oysters periodically suffer from high mortalities on beds, causing economic problems within the industry. We have available in the laboratory 16-year-old stock that has survived through several high mortality periods in Humboldt Bay. Presumably these oysters have developed an environmental resistance to disease and other mortality factors. We plan to spawn them and eventually their progeny through successive generations and, hopefully, develop a resistant strain.

The red abalone was successfully spawned in the laboratory in November 1971. Larger progeny from this hatch now are almost 2 mm long. Growth is relatively slow, one-year-old red abalones are only 1 to 1½ inches long. Under optimum growing conditions they may attain lengths of 7 inches in 4 to 5 years.

The abalone does show considerable promise for mariculture, despite its slow growth. Its food chain is short -- phytoplankton to larger kelps -- and it commands a premium market value.

While the Japanese and some private hatcheries in California have been able to hatch relatively large numbers of abalones, efficient mass culture techniques remain to be developed.

Mariculture operations in the United States are principally centered in the well-established oyster industry. However, in the past decade there has been an increased interest in farming other species, such as the Pompano, shrimp, and lobster, and in California the abalone. Private enterprise in California is developing into a multimillion dollar operation.

I believe that the majority of fishery scientists today are of the opinion that the mass culture of selected marine species to supplement diminished native stocks, or to provide an additional protein source through mariculture, is not feasible. I do not share this view.

It is my opinion that yields from shellfish species, such as the abalone, can be increased manyfold, in a fraction of the space now supporting a commercial fishery, by implementing simple farming practices such as predator-competitor control, and habitat improvement. However, legal constraints and institutional problems in our country represent a formidable barrier to a viable mariculture program.