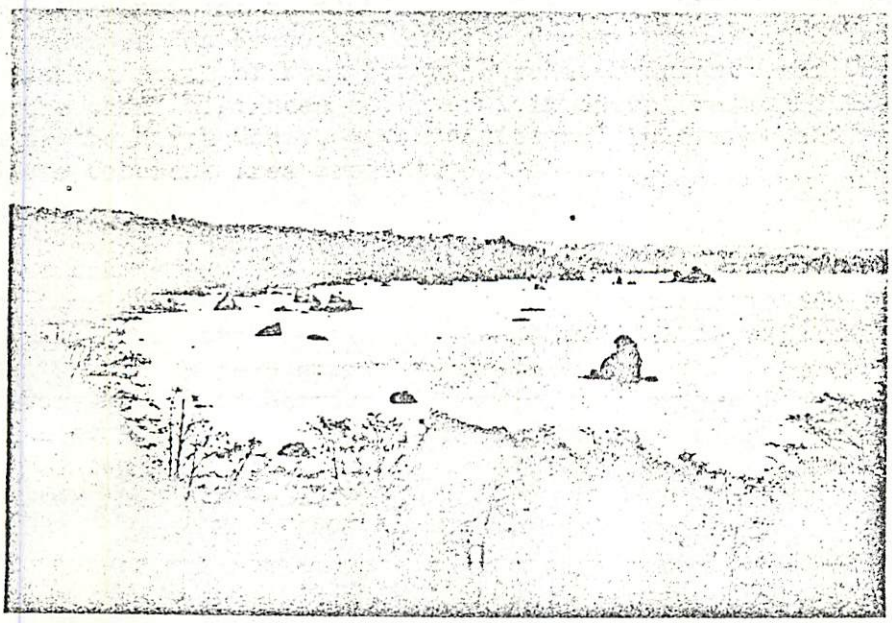
A Report on the
Humboldt State University
Sea Grant Program
Sept. 1973 - Sept. 1974

ANNUAL REPORT



Submitted by
HUMBOLDT STATE UNIVERSITY

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REPORT ON THE HUMBOLDT STATE UNIVERSITY SEA GRANT PROGRAM 1973 - 74

INTRODUCTION

Humboldt State University has held a Coherent Area Project under the National Sea Grant Act since 1969. The program is best described by its title, "Development of Living Marine Resources of Northern California." The strong natural resources programs of the university -- especially fisheries science, oceanography, marine biology, and wildlife management -- provide a pool of talent (both faculty and student) particularly suited for such a program. Humboldt is also the only 4-year institution on the California coast between San Francisco and the Oregon border; proximity to the important fishing ports of Fort Bragg, Eureka, Trinidad, and Crescent City, as well as the short distances to several important salmonid spawning streams along the North Coast, gives additional relevance and value to the Humboldt State Coherent Area Project.

Individual Sea Grant projects in the past 6 years have focused on subjects such as crustacean and salmonid mariculture; the development of management information on herring, anchovy, and salmon; abalone and sport clam fisheries; artificial crab baits; and the bacterial detoxification of pulp mill effluent. The 1973-74 grant supported 4 research projects and the Marine Advisory-Extension Service. Three of the projects were directly involved with economically important marine animals of the Pacific Coast. The fourth related indirectly to marine life -- it focused on the disposal of toxic wastes into marine waters.

To help ensure maximum utility of Humboldt's Sea Grant efforts, project leaders make strong efforts to establish and maintain contact with state and local government agencies and with the industries which will ultimately benefit from their work. Two of the projects which we report on here are products of close cooperation with governmental agencies. The wastewater rearing of juvenile salmonids uses facilities and equipment contributed by the City of Arcata; the investigation of the ecology and reproduction of the red abalone is a joint venture with the California Department of Fish and Game. A third project, investigating methods and conditions for detoxification of pulp mill effluent, is financed in part by the pulp industry and relies on local mills for effluent supplies and expert consultation.

Humboldt's Marine Advisory Program is headquartered on the waterfront in the busiest of the region's fishing ports, Eureka. From there, maximum contact with fishermen, seafood processors, and recreational boaters is achieved. The director and his assistant, working out of the Eureka office, serve the fishing industry in Fort Bragg, Eureka, and Crescent City. They have succeeded in making Sea Grant a useful and visible service to the regional seafood industry; in turn, the industry is one of Sea Grant's strongest advocates in northern California.

The Sea Grant Coordinator at Humboldt State is Dr. Theodore Kerstetter, director of the university's marine laboratory. He is responsible for preparation of proposals, budget management, and the coordination of the Humboldt State program with those of the University of California and the University of Southern California. Guidance to the program is provided by an advisory committee which includes individuals who represent the commercial fishing industry, the fish processing industry, marine-oriented recreation, California Department of Fish and Game, the Bureau of Sport Fisheries and Wildlife, and local educational institutions.

FUND ALLOCATION BY CATEGORY
1973 - 74

	Sea Grant	Matching
Program Management	8,200	9,400
Research	53,100	67,800
Advisory Services	59,100	4,200
Totals	120,400	81,400

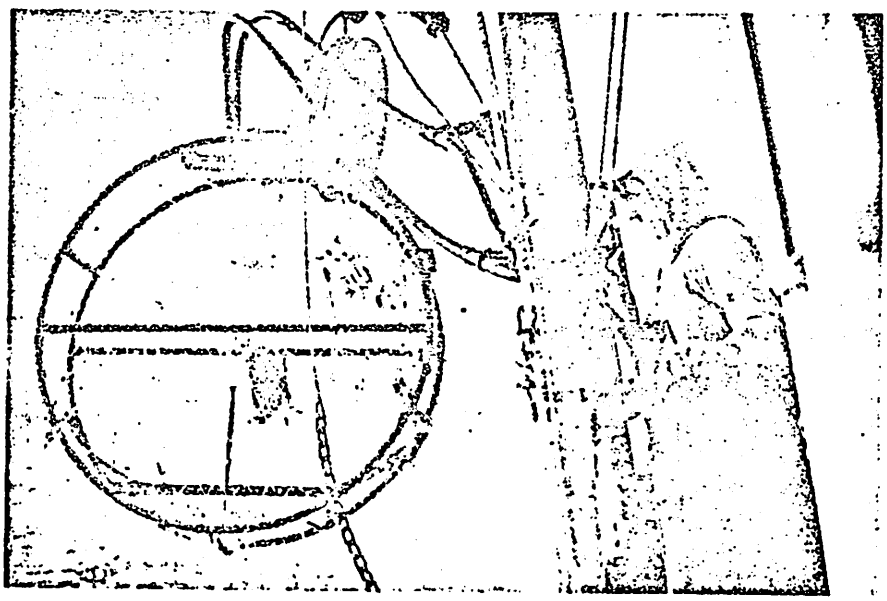
RESEARCH ACTIVITIES

Essential Amino Acids

The dietary amino acid requirements of 2 molluscs and 1 crustacean, all potential candidates for mariculture, were worked out by Dr. William Allen during the 1973-74 grant year. He fed ^{14}C-labeled precursors to red abalones, California mussels, and Dungeness crabs, then extracted and identified amino acids which had incorporated the carbon-14 label. Those were the non-essential types. Amino acids which did not incorporate the label are those which must be supplied in the diet, thus they are essential. Dr. Allen concluded that the requirements of the 3 species he studied appear to be similar to most metazoan animals, although some peculiarities in the synthetic pathway of proline in the Dungeness crab became apparent. One technical paper describing his results in detail is in press, and two more are in preparation.

Artificial Crab Baits

Field tests of artificial crab bait (another of Dr. William Allen's projects) were conducted by the California Department of Fish and Game in the Fall of 1974. The bait is a polyacrylamide gel made up with natural or artificial attractants. The gel serves as a binder, releasing the odoriferous attractants slowly over an extended period. The natural attractant employed was homogenized razor clam; the amino acid, glycine, was the most successful of the artificial flavors. Overall the gel baits were about 50% as effective as the natural bait, chopped razor clams. But in some locations, Fish and Game Biologists reported that the gel made up with razor clam homogenate was just as effective as the natural bait. One advantage of the gel bait is that a given amount of razor clam can be used to bait many more crab pots than if used only in the chopped form. A final technical report is in preparation, although field tests will continue to be conducted.



Dungeness crab trap comes aboard

Abalone Ecology

A two-year study on reproduction of two populations of red abalone, Haliotis rufescens, was concluded in the summer of 1974. This was part of a continuing investigation of the ecology of the red abalone in Northern California, undertaken as a joint project by Dr. John DeMartini of Humboldt State and Mr. Richard Burge of the California Department of Fish and Game. Estimates of fecundity and of the size when sexual maturity occurs were made. Spawning in the study areas occurred in late spring and early summer, although not all mature abalone spawned each year.

John DeMartini and student at study area

Food habits of abalone were noted, and the kelp, Alaria marginata, continued to be the major food, although other kelps are also eaten. An interesting behavioral observation was that a major cue for feeding is surge. When surge commences, abalone extend up to 2/3 of their foot from the substrate to more efficiently catch the drifting kelp that comes in with the surging waters. Where abalone occur close inshore, large amounts of drift kelp also occur.

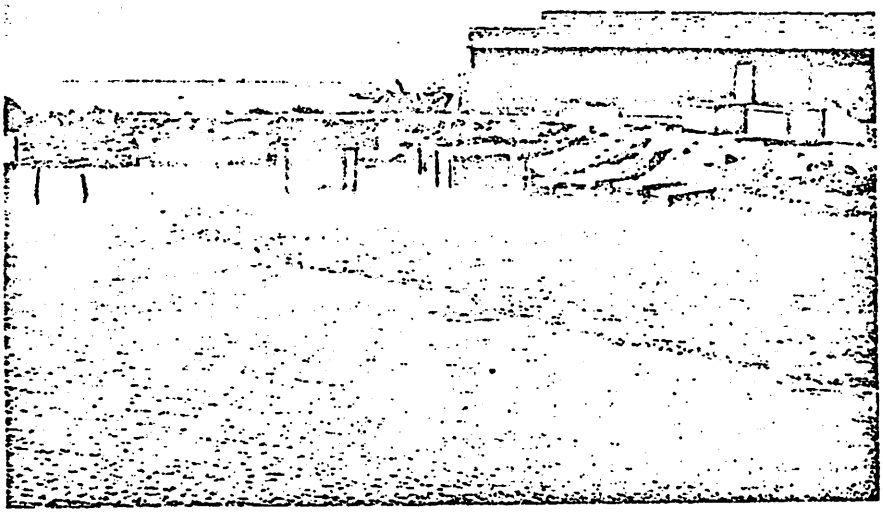
The major thrust of the study has been on growth; during the past year, several hundred abalone were remeasured for annual growth, and several hundred were retagged. It appears that growth becomes very slow upon reaching a length of 6½ inches, at least in the study area. The present lower size limit, 7 inches, may be unrealistically high, but a definite decision will be delayed until the completion of growth studies on abalone populations further to the south.

A knowledge of abalone movement patterns is needed for proper management because of the possible movement into depleted populations of abalone from deeper waters. The study of tagged animals has shown that movement is erratic and individualistic; some stay in the same spot for months, while others may move often. Movements of several hundred feet in 2 to 3 years have been noted.

Wastewater Salmon Rearing

Six thousand chinook salmon smolts, reared entirely in a brackish water ecosystem fertilized by treated sewage, were released into the waters of Humboldt Bay in April and May of 1974. Their entire diet during their time in the two wastewater ponds was furnished by a food chain based on sunlight and the nutrients added by the treated sewage effluent.

Survival for the 4-month rearing period in one of the ponds approached 30%, considered by project leader Dr. George Allen to be a level which will economically justify the operation. An 80 day period the previous fall yielded 8,300 fingerling coho salmon; for the two ponds, that represented survival rates of 56% and 85%. Another noteworthy result came from summer rearing experiments, when water temperatures ranged from 20 to 26 degrees C. Survival rates for yearling coho and fingerling chinook were 64% and 58% respectively. Nor was there any demonstrable evidence of disease. (Losses in the two ponds are almost certainly a result of predation by herons, egrets, and other piscivorous birds.) Fish pathologist Dr. Robert Busch has isolated several potential pathogens, but none has been a problem yet in the wastewater fertilized ponds. In fact, coliform bacteria counts from the fish pond waters are always lower than those from adjacent bay water samples!



Part of wastewater culture facilities

An interesting and potentially valuable result came from the studies of graduate student Barry Collins. He monitored the development of the Na^+, K^+-activated ATPase, a salt regulating enzyme in the gills of fish. In anadromous species, the level of this enzyme rises dramatically coincidentally to smolting, thus it can be an indicator of readiness to migrate to sea. Collins' work showed that the physiological peak for smolting came in late April for the chinook fingerlings in the wastewater ponds. But, in a similar group of chinook kept in 1/2 strength sea water, the enzyme levels fell to pre-smolt levels later in May, indicating that (1) young salmonids should not be kept too long after smolting, and (2) that not even half-strength sea water is sufficient to maintain high enzyme levels. A similar group in full strength sea water maintained high enzyme levels.

Toxic nitrogenous compounds are a potential hazard in many intensive aquaculture operations. Graduate student Richard Crawford took the problem of nitrite (NO_2^-) toxicity into the laboratory and emerged, months later, with a fascinating conclusion. Calcium ions in the water protect against nitrite poisoning! At 100 ppm nitrite and 10 ppm Ca^{++}, mortality of juvenile chinook salmon was 90% in 48 hours. At 100 ppm Ca^{++} and the same concentration of nitrite, mortality was almost absent. For the aquaculturist, a practical conclusion is that a brackish water system, which would have a high Ca^{++} content, would be much less sensitive to the toxic effects of nitrite ion.

Pulp Mill Effluent Breakdown

The microbial breakdown of pulp mill effluent, and the reduction in toxicity which results from that breakdown, continued to be a prime concern of the Humboldt Sea Grant Program. Dr. William Lester terminated the first phase of the project at the end of the grant year, and is currently writing the technical reports. His successful work to date has shown that an anaerobic system, followed by an aerobic one, is decidedly more effective in permanently eliminating the toxic effects of the wastes than is aerobic treatment alone.

The chief source of toxicity in Kraft pulp mill effluent is the chlorinated lignin fraction. Aerobic bacterial degradation apparently affects primarily side chains of the lignins, leaving the polymeric molecular skeleton intact. Although toxicity is initially lost under aerobic attack, it subsequently returns, probably as a result of regeneration of ring structures. In contrast, the anaerobic process (requiring at least 2 bacterial populations) degrades the polymeric molecular structure and continues to breakdown the subunits, at least to the ring structures. If aerobic breakdown is then allowed, toxicity does not return, presumably because the polymeric skeleton with its complex side chains no longer exists.

Dr. Lester's group has established optimum physical conditions for both anaerobic and aerobic processes. By using both systems (in the sequence anaerobic to aerobic) under optimum conditions, the time necessary for a 70% reduction in toxicity has been reduced from two weeks to six hours! Pilot

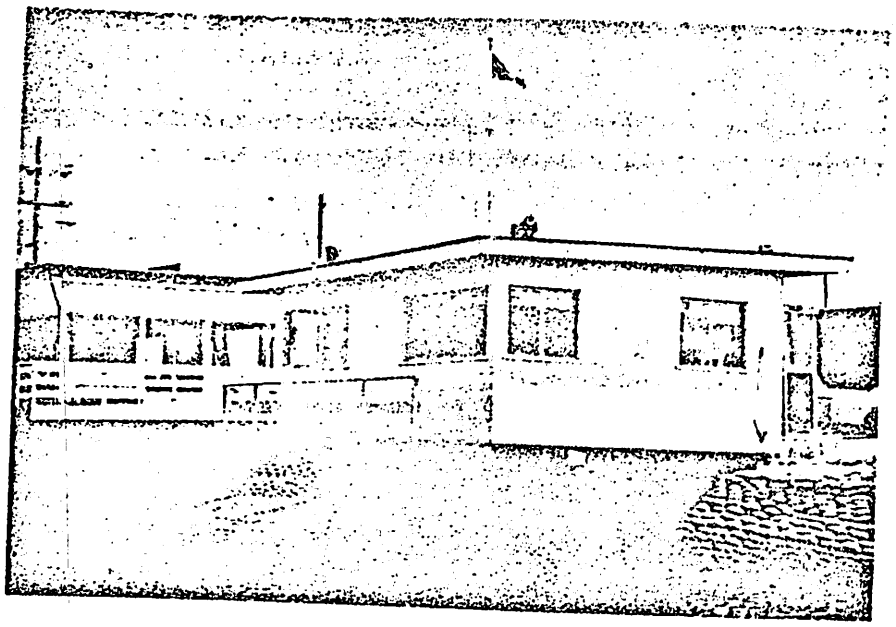
tests of a continuous flow system were also performed during the grant year, with effluent breakdown approaching 50%.

To test for effluent toxicity, the 24-hour development of embryos of Urechis caupo, a large marine invertebrate, was monitored. The well-known sensitivity of embryos to toxic pollutants made this a sensitive and appropriate bioassay. Parameters for the test were worked out by Dr. Lester's group as a subproject on the grant.

Gross isolates of both the anaerobic and aerobic bacterial populations have been made. At a minimum, five different genera are involved. Characterization of the anaerobic population is well underway at present; as identification proceeds, the breakdown of the different lignin subunits, and the byproducts produced, are being assigned to the appropriate bacterial species. Dr. Lester states that while bacterial isolates are not yet available for distribution, mixed cultures can be sent to interested investigators.

ADVISORY SERVICES

The Humboldt State University Marine Advisory-Extension Service (MAES) serves the three major northern California fishing ports of Fort Bragg, Eureka, and Crescent City from the centrally located port of Eureka. The annual fish and shellfish landings for this area is approximately 50 million pounds which makes it the most productive area in California, if the tuna landings in southern California are excluded. Because of the high degree of fishing effort in this area (800+ vessels, 3600 fishermen), the primary effort of the MAES has been directed towards serving as the information link between the university and those people involved with the commercial fishing industry. To a lesser degree, we have worked with coastal zone planners, youth groups and recreational users.



The MAES office is "on the waterfront"

The MAES program is directed by Mr. Stan Ludwig, who assumes primary responsibility for providing coverage to Eureka and Crescent City. He is assisted by Mr. Fred Jurick, who has primary responsibility for services to Fort Bragg.

The MAES has a close working relationship with State and Federal agencies, as well as associations such as the Humboldt Bay Fisheries Association (which pays the rent for our office), California Seafood Institute, and are members of PASGAP (Pacific Sea Grant Advisory Programs).

Many hours are spent in personal contact situations; but we use meetings, workshops, demonstrations, the media, and a newsletter to disseminate information with wide-spread interest. Accomplishments during the 73-74 year include:

-- Conducted a "Citizen's Input Conference" to identify problems as seen by those who use the marine environment.

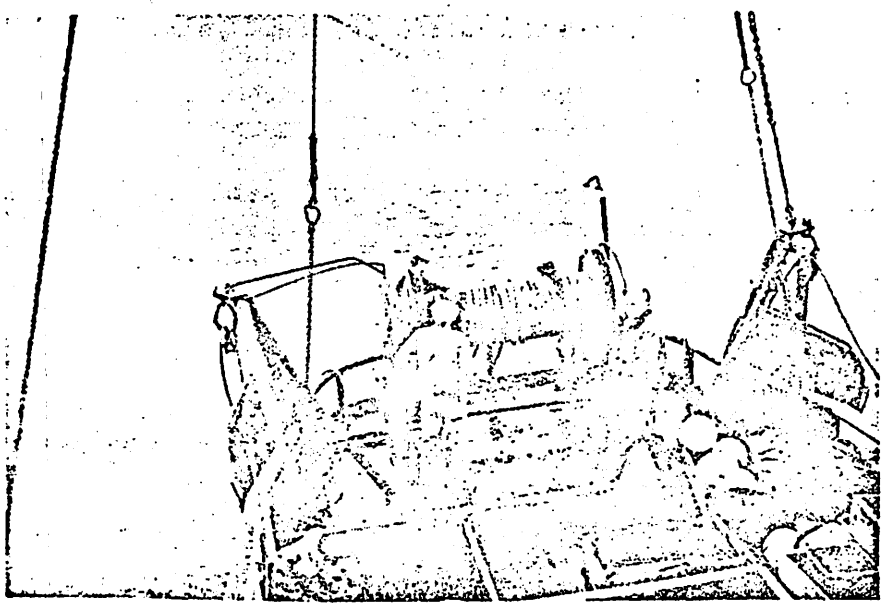
-- Worked with fishermen interested in developing a Herring fishery in Humboldt Bay and Crescent City. This resulted in a nominal fishery and a Sea Grant funded project to assess the Herring population in Humboldt Bay.

-- Conducted a fishing vessel safety meeting in Eureka; we are participants in a coast-wide effort to improve safety on vessels.

-- Participated in meetings to develop a National Fisheries Plan.

-- Coordinated a program with NMFS to demonstrate the use of trawl mensuration equipment.

-- Worked with representatives of the fishing industry and National Weather Service to provide improved weather forecasting.



Net is recovered during trawl mensuration trials

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