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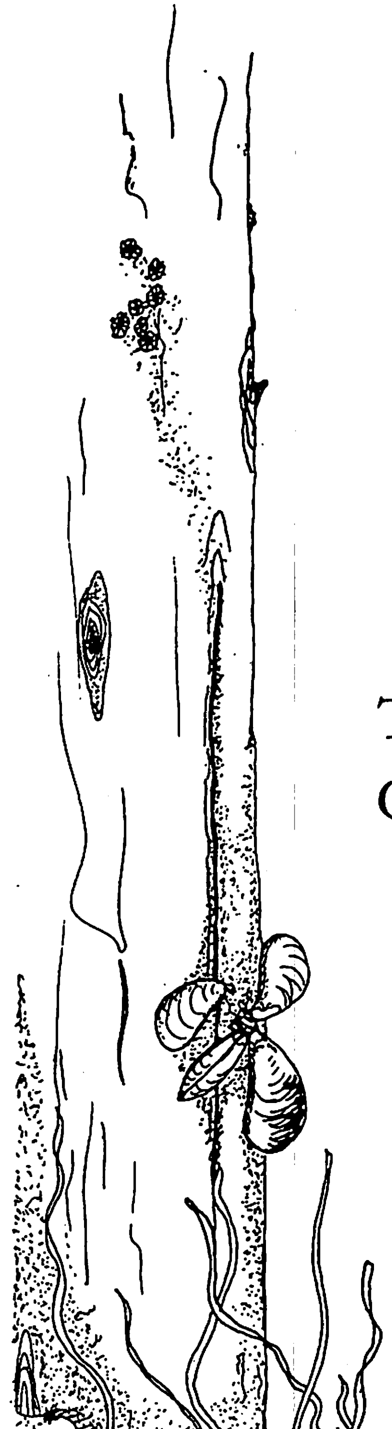
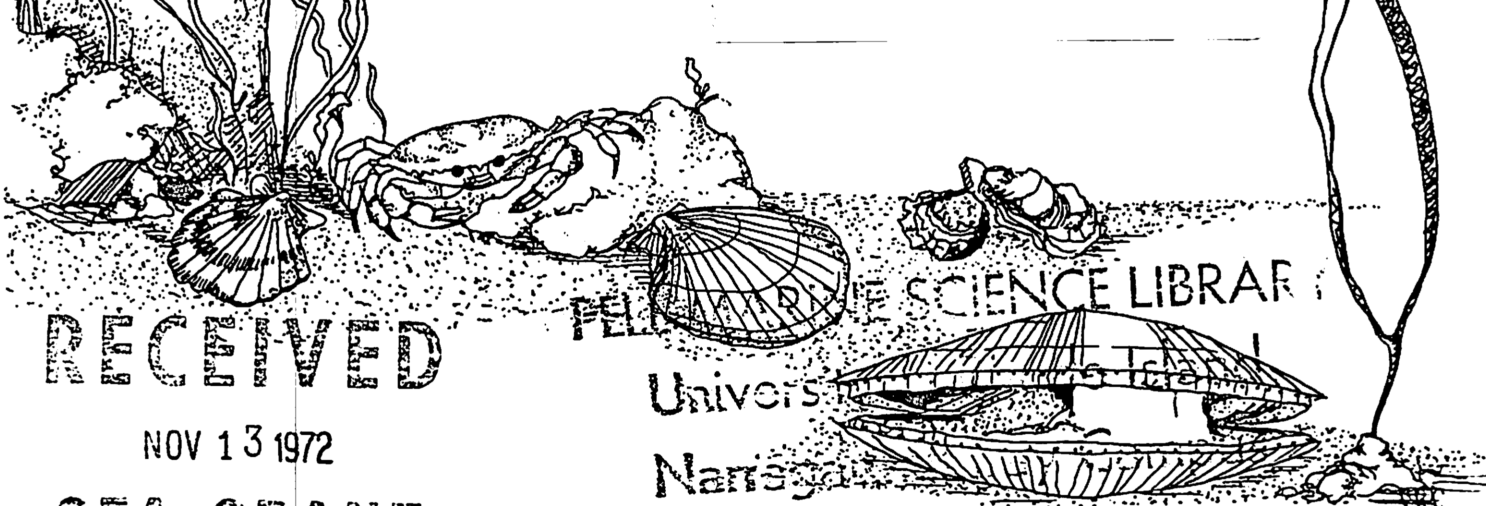


The University of Maine's Coherent Project Sea Grant Program

A report on the
University of Maine's Sea Grant Program
for 1 May 1971 to 30 April 1972

University of Maine at Orono October, 1972



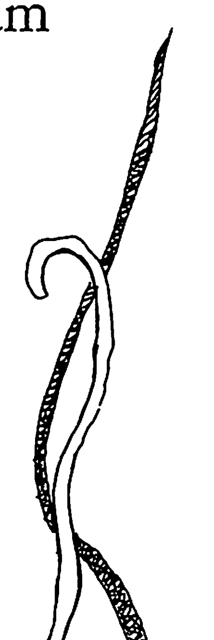


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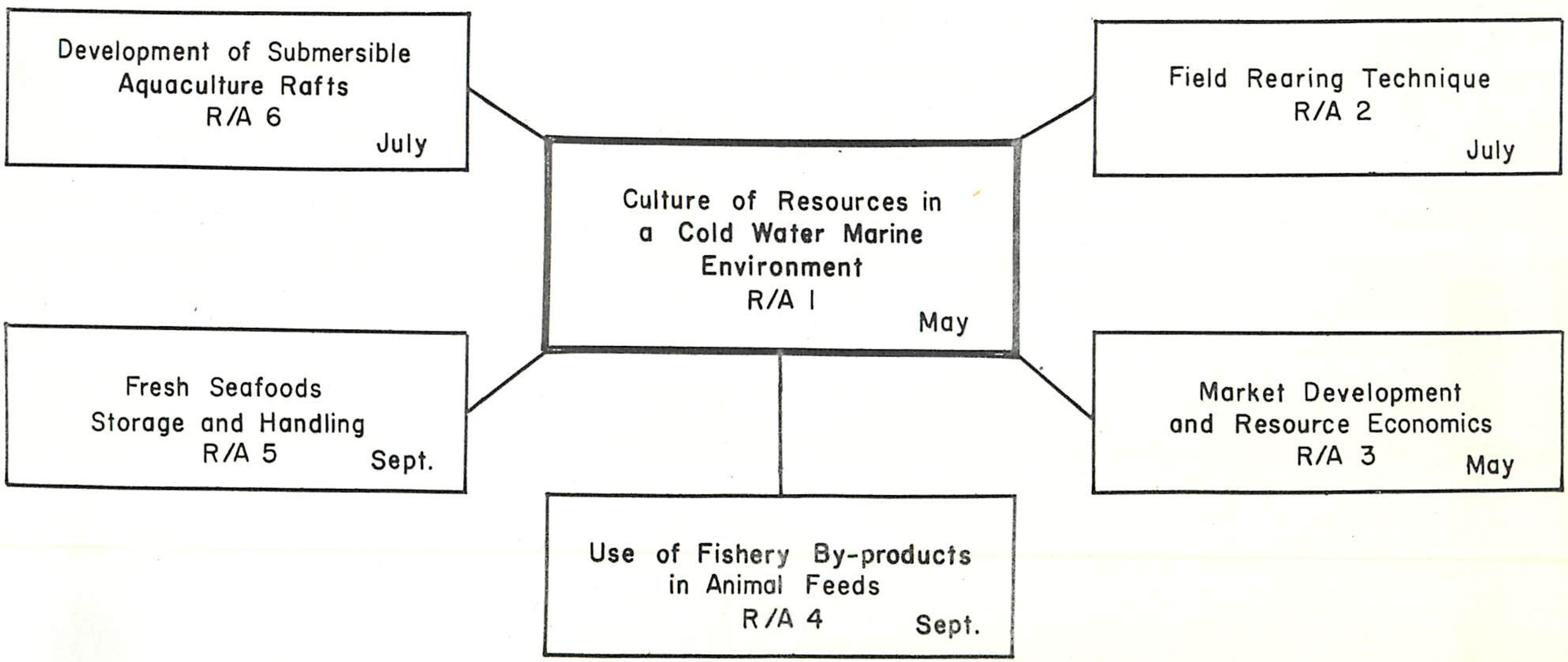
Fig. I

University of Maine Sea Grant Coherent Project Program 1971-72

Interaction of Projects and Month of Activation



Project R/A-1

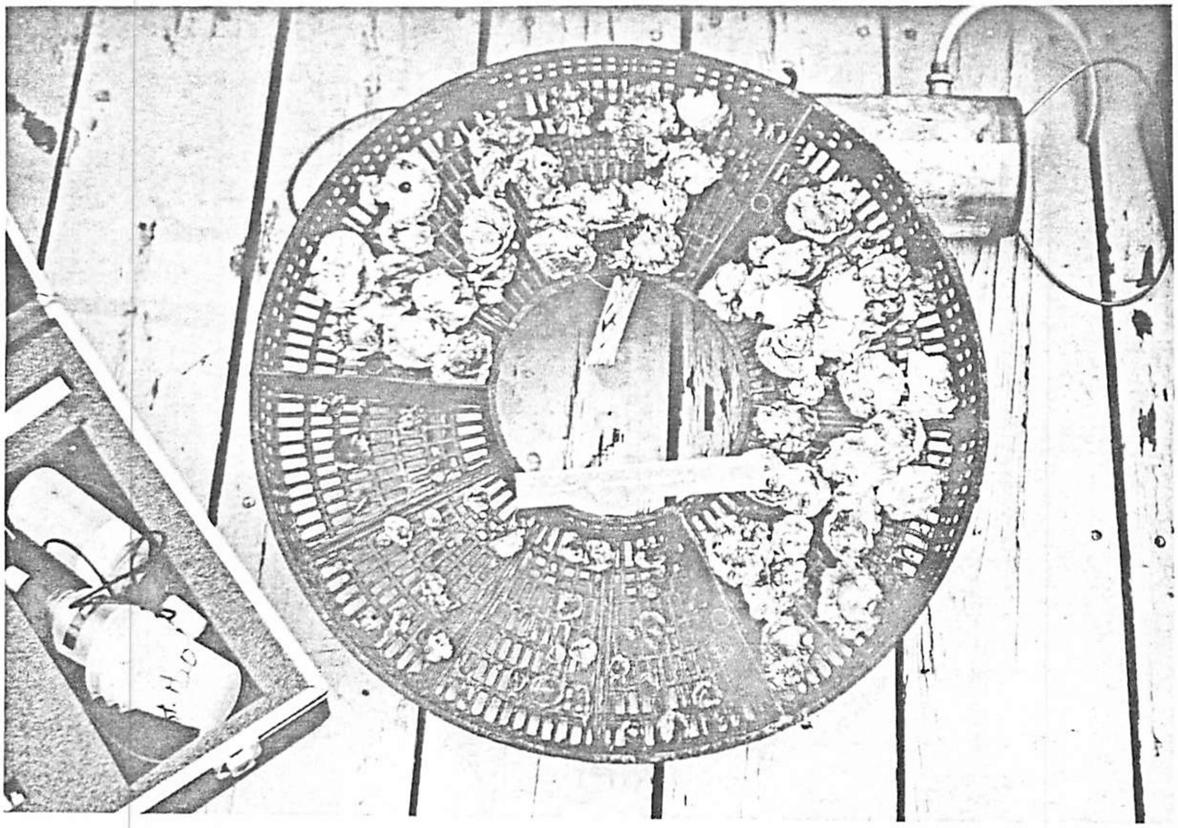
Culture of Resources in a Cold Water Marine Environment

Project R/A-1 is biologically oriented and based at the Darling Center marine laboratory. By interacting with the other sub-projects at Orono, it has as its goal the increase of Maine's marine harvest. Progress derives from the gathering and applying of knowledge on several commercially valuable marine species.

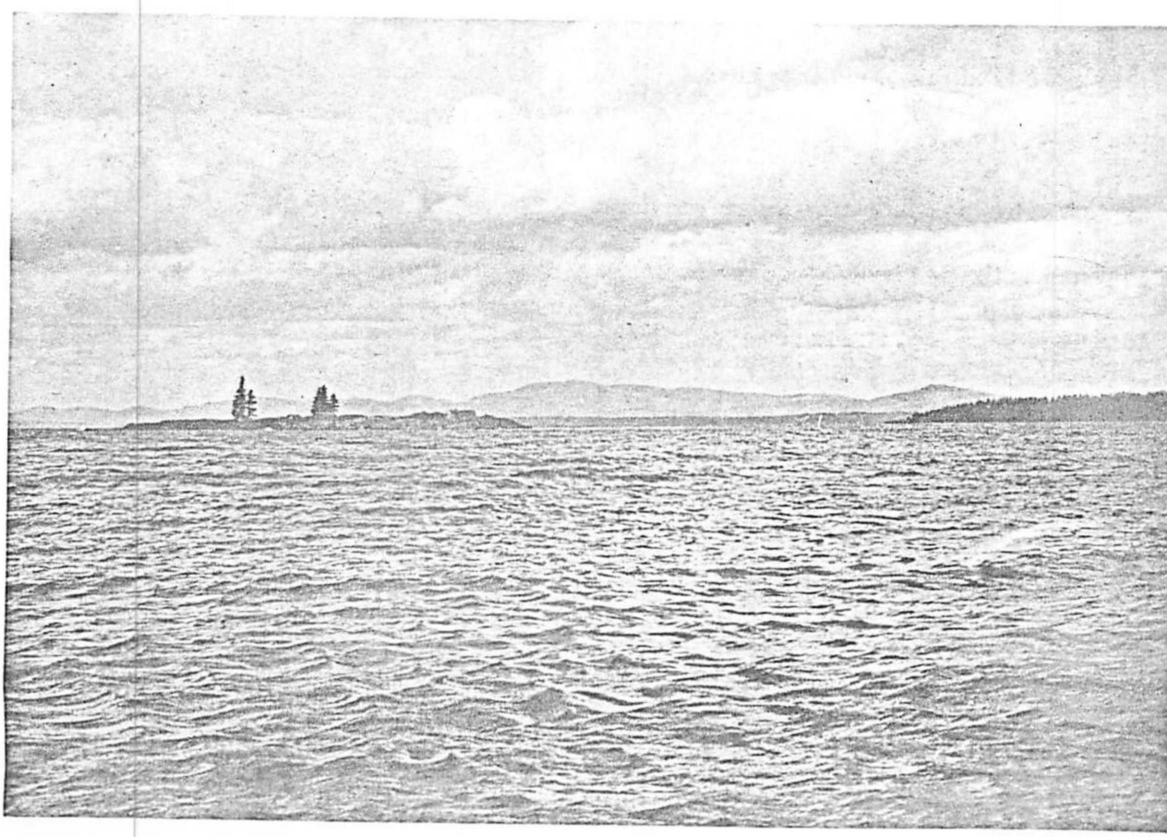
The subject is conveniently divided into two areas. First is the stimulation of commercial use of marine species which are of high economic value but now unavailable in sufficient quantities. In this category are American, European, and Japanese oysters. With 3.5 thousand miles of coastline where in Maine's past American oysters were extremely abundant, especially in the upper reaches of her "arms of the sea" estuaries, Maine now harvests no oysters. Scallops are also in this category: The sea scallop, although still harvested, does not approach its former abundance in Maine; the bay scallop, possibly adaptable to Maine waters, has never been present.

The second area comprises species ubiquitous in Maine and potentially desirable commercially, but for one reason or another not utilized to their fullest potential. Two groups are paramount. The blue mussel, which paves the bottom in some Maine waters, is a gourmet item in continental Europe, but utilized in only a token fashion by ethnic food outlets in metropolitan regions of the United States. The second group contains the rock and Jonah crabs. Abundant in Maine's waters, these delicious crabs have been largely overlooked by local commercial fishermen.

This narrative will discuss our research emphasis and



Comparative oyster growth: Europeans occupy from "10 to 4 o'clock" in the circular tray; Americans in other tray section grew more slowly. (Below) Penobscot Bay is a typical open environment representative of high salinities and low temperatures.



progress with each of these species, together with a short rationale of the work for the first grant year.

Oysters

This group of species holds immense economic promise for Maine. Several items of research were emphasized during the first year: Can Maine waters grow oysters economically? Since Maine's environmental conditions are so diverse, which oyster species would be most suitable for culture here?

Our study related several environmental parameters to American and European oyster performance in Maine waters. Young-of-the-year oysters were rafted in several diverse Maine marine environments; growth and mortality were measured periodically. Mortality was negligible and growth was excellent at most stations (Fig. 2). Fouling was light except at two warmer up-estuary locations. At three sites in the Damariscotta River, oyster response was correlated with primary productivity, phytoplankton standing crop, salinity, temperature, and nutrient levels. From the latter study it is hoped that a mathematical model can be derived that can be used to predict the success of oyster performance in any of Maine's waters.

Several important findings are already apparent. The American oyster grows well in Maine's upper estuaries, while the European oysters have shown excellent performance at nearly all experimental sites, including those in the most exposed coastal zones. A two-inch size was achieved in the first growing season; if these growth rates continue, it should be possible to produce a market half-shell oyster in two years by rafting techniques in Maine. Thus this area compares very favorably with established more southerly areas for

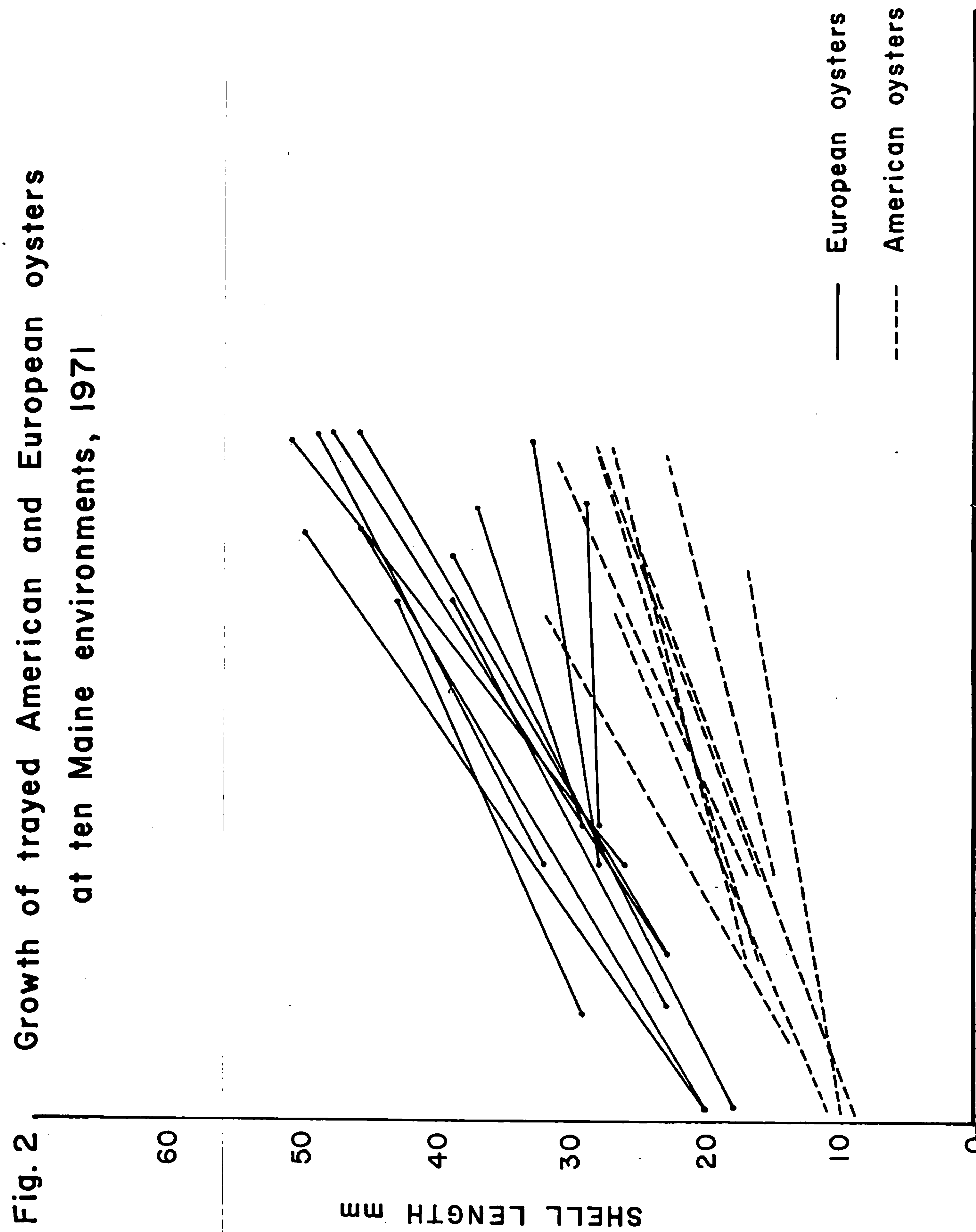


Figure 2 from the Second Annual Sea Grant Report "Culture of

Resources in a Cold Water Marine Environment" oyster production.

From the standpoint of raft culture, European oysters at all sites exhibited growth characteristics superior to those of American oysters; they grew separately and maintained a good shell-configuration even when crowded.

Data reduction on this project has only begun, but from the study we expect an excellent evaluation of Maine's potential for economically competitive oyster culture.

-- European oysters stocked in Maine waters in the late 1940's have apparently maintained marginal populations. These may represent a Maine-adapted brood stock valuable to future mariculture efforts here. What is the present status of these populations? Can their natural reproduction be enhanced by more intensive management?

Several sites of original introduction were SCUBA-surveyed in cooperation with biologists from the Maine Department of Sea and Shore Fisheries. European oysters were still present at several sites in the Linekin Bay and Boothbay Harbor regions, but numbers were greatly reduced from a 1961 survey. There were many year classes present, however, and shell bags placed in inner Boothbay Harbor revealed some set (26/bag) in August and September 1971. The limiting factor in population expansion appears to be a lack of suitable subtidal setting substrate. During the next growing season, a truckload of oyster shells will be planted in Boothbay Harbor and the level of set will be monitored.

-- Since natural reproduction of oysters is marginal in Maine, where can large numbers of seed oysters be obtained? Can established hatchery techniques be adapted for northern conditions? What new techniques do we need to make hatcheries a success in Maine?

Our first year's hatchery effort was designed to determine if the known techniques of conditioning, spawning, larval rearing, and later nursery culture for American and European oysters could be applied to the boreal Maine environment. Two aspects were of especial interest to us: 1) Whether the 20-year-old Boothbay introductions have moved genetically from their Dutch parent stock with respect to temperatures necessary for gonad production and spawning; 2) Whether the Maine coastal waters could be utilized for feeding shellfish larvae by the inexpensive natural algal techniques so successful in the mid-Atlantic region.

We were successful in 1971 in conditioning and spawning Maine-adapted European oysters from February to October. A 20°C temperature regime for a 20-30-day period in either closed or open aquarium systems resulted in gonad maturation. We anticipate continued success with this aspect in the future; it appears that published information from other areas will be valid for European oysters in Maine.

With larval feeding, we were not successful in rearing larvae by natural algal techniques at our down-estuary Damariscotta River site. We were successful, however, at our upper-estuary Marsh River field station. In Maine waters there appear to be gross qualitative and quantitative differences in phytoplankton; therefore the sites for future commercial hatcheries should be selected on the basis of the phytoplankton available in adjacent waters.

We have advanced hatchery techniques on other fronts. A major problem has been the proper handling of cultchless or free single hatchery oysters to a market size. Together with the Agricultural Engineering Department we have developed a method of reattaching cultchless oysters to a substrate. Several adhesives were tested; Portland Cement's "Quik-Plug" performed best in all respects and is inexpensive. This method permits the mass handling of cultchless oysters in the hatchery and then permits optimal growth and shell shape in later field stages.

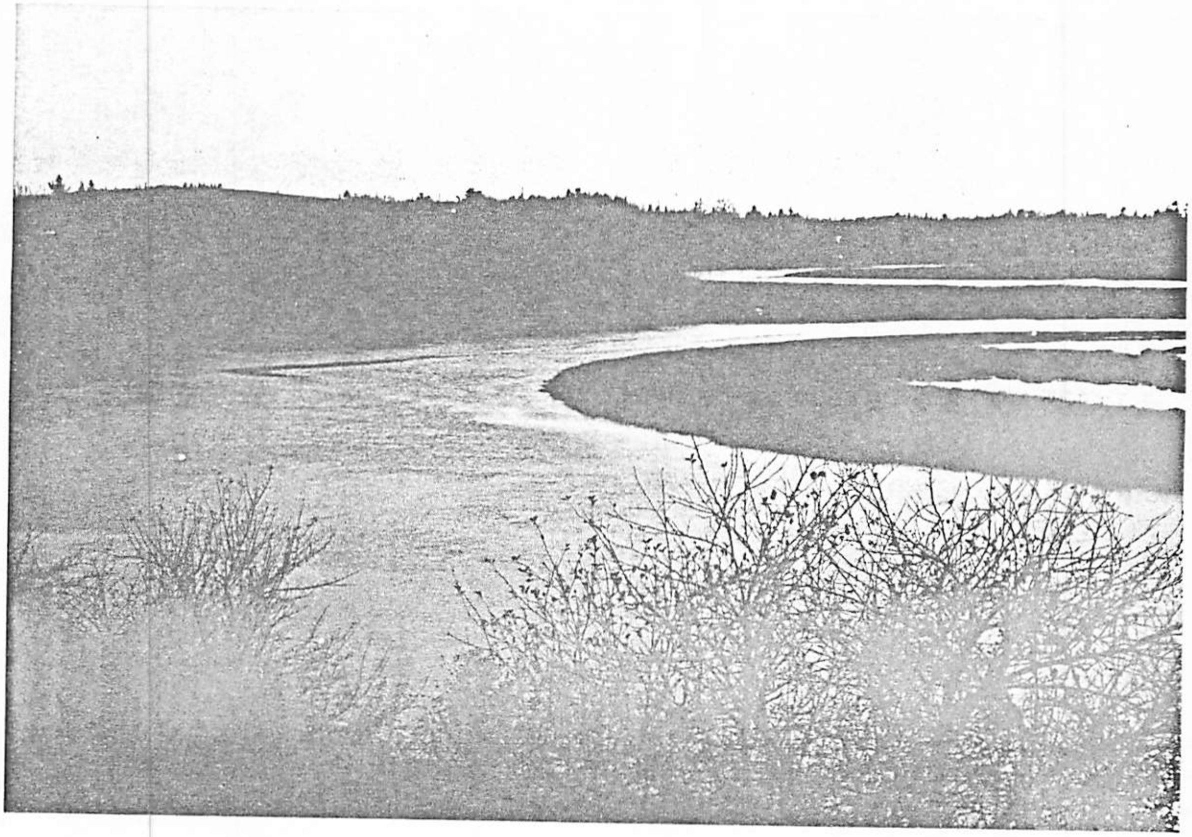
Advances were also made in increasing efficiency of oyster setting in the hatchery. With assistance provided by an NSF grant, it was found that adult European oysters emit a biochemical compound or pheromone which stimulates setting in mature oyster larvae. Thus far, it appears that a high molecular-weight protein is involved with iodine at the active site. Work continues to purify and identify the compound. A successful discovery of the precise substance could have tremendous potential for controlling the larval setting process, particularly.

Sea and Bay Scallops

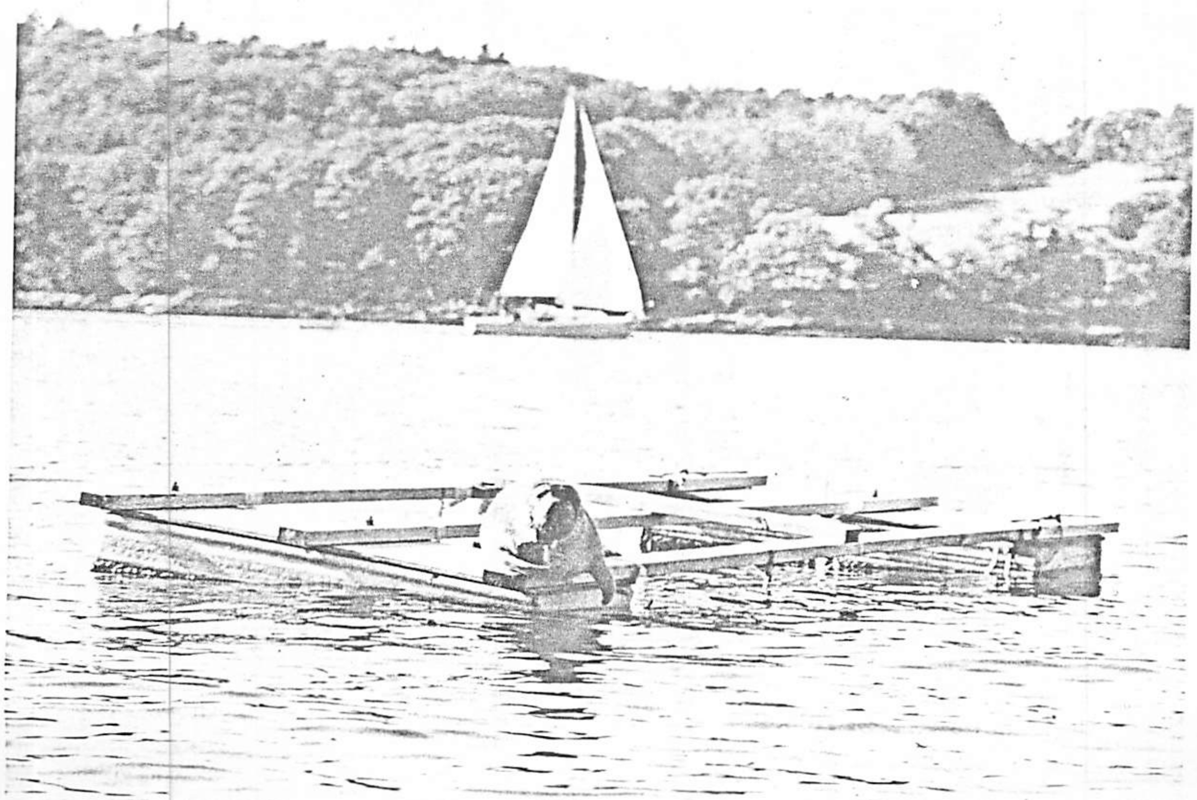
Toward offsetting the decline in Maine landings of the sea scallop and the depletion of many formerly productive inshore beds, several aspects were investigated during the first year.

-- Can methodology be developed to produce seed sea scallops in hatcheries? Could this be a way to enhance field populations with genetically superior hatchery-produced stocks?

In 1971 we were able to spawn sea scallops from May to September without subjecting them to modified temperatures. Standard cultural algal techniques were not successful, however, in rearing the larval phase beyond an early straight-hinge stage. Additional



The Pleasant River, about two miles above the bridge at Addison, a Down East estuary suitable for experiments with oysters. (Below) Rope-suspension of mussels on a raft in the Damariscotta River, with interested visitor.



experimental work is needed to define conditions which will allow sea scallop culture in the hatchery.

-- For a given size of scallop it has been found that the weight of the eye (adductor muscle) may vary up to threefold. Is this variation genetically controlled? If so, can superior animals be selected for brood stock?

As an initial step in the genetics of sea scallops, we began a cooperative project with the University of Maine's Zoology Department to karyotype the species. The chromosomes are comparatively large and few in number (less than 20). The sea scallop would appear to be a likely candidate for genetic manipulation.

Our work with the bay scallop has only begun. By all economic and biological analyses the bay scallop heads the list as a species adapted for intensive aquaculture. While the hatchery technology for bay scallops is well-known, (Castagna, NSA, 1971), it remains to be demonstrated how well this species grows and survives in Maine's waters. Growth of a handful of bay scallops tested during 1971 was promising. Sufficient brood stock from Long Island has just been obtained; a hatchery effort will begin in 1972.

<u>Mussels</u>

The blue mussel represents a potentially valuable resource in Maine, but presently harvested in only a limited fashion. While it is primarily an ethnic food item at present, there are other barriers to its widespread use. Many Maine mussels contain pearls, which detract from their palatibility.

Mussels from certain areas have a high incidence of pearls while mussels from other areas have few or none. What environmental factors are associated with pearl formation? What are the causative mechanisms involved? In comparing shorebound versus rafted mussels, it was found that for mussels of a similar size the rafted populations contained markedly fewer pearls. Moreover, the rafted populations exhibited thinner shells and a superior growth rate. These results are presently being substantiated and the causative mechanisms determined. Assuming the marketing problems can also be solved, it would seem that rafted mussel-culture in Maine has significant commercial potential.

Crabs

Cancer irroratus, known to Maine fishermen by nine common names, is the third most important marine crustacean harvested in the state. Eighty to 90% of New England crab landings come from Maine. One hundred fifty people and businesses were identified as active members of the crab fishery during the last six years. During this time annual landings have fluctuated greatly, declining on the average of 12%/year. Much of this decline is due to unpredictable markets, weather, and the competitive value of lobsters. A decline in the number of crabs caught per trap has also been noted.

The following statistics come from our resource and market surveys conducted during 1971: Average marketable crabs are males 4-inches or more across the carapace. These crabs wholesale for $10/crate (200 to 250 crabs/crate), $.10/lb. or $.05 each. It takes 10 to 12 such crabs to give a pound of meat depending on the season. A picker may average 1-½ pounds/hour and sell the meat wholesale for $2.30 to $3.20/lb. Retail meat prices range from $2.50 to $3.86/lb.

Extremely harsh weather during the 1970-71 winter season cut the crabbing effort and the resulting catch by 50%.

Average whole-crab wholesale prices 1970 to 1971 rose from \$.057 to \$.067 while average lobster wholesale prices for the same period rose from \$.95 to \$1.00/lb.

Recorded crab landings for the past 10 years indicate that annual landings of 1.5 million pounds are attainable. Resource investigations indicate that recorded landings may represent only 50% of the actual total landings. Most crab processing is done within a fishing-family unit and the crabmeat sold at a local stand or general store. These landings are not recorded and may raise total crab landings to three million pounds annually. It is hypothesized that a statewide maximum sustainable yield of (3 million pounds less 12%) 2,640,000 pounds is possible with proper management. Management principles could include the construction of an escape vent in the crab trap to allow smaller crabs to escape, a closed season during the last productive months and a minimum size (± 95-100 mm).

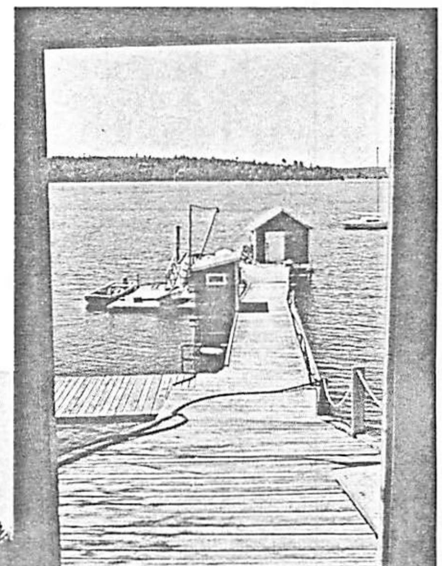
Estimating geographical and seasonal crab abundances from data provided by commercial lobster-trap fishermen was difficult. Individual trap design varied widely. The spacing of trap laths varied from 1/4 inch to 1-3/4 inches thus affecting the size and number of crabs caught. Average trapping of large (± 4 inch) male crabs throughout the state appeared fairly constant. Half-round lobster pots averaged 8 crabs/pot in the spring, fewer in summer. New, half-round crab pots constructed with two plastic funnels in the top outfished half-round lobster pots 5:1. Two year old crab pots were only 50% as effective.

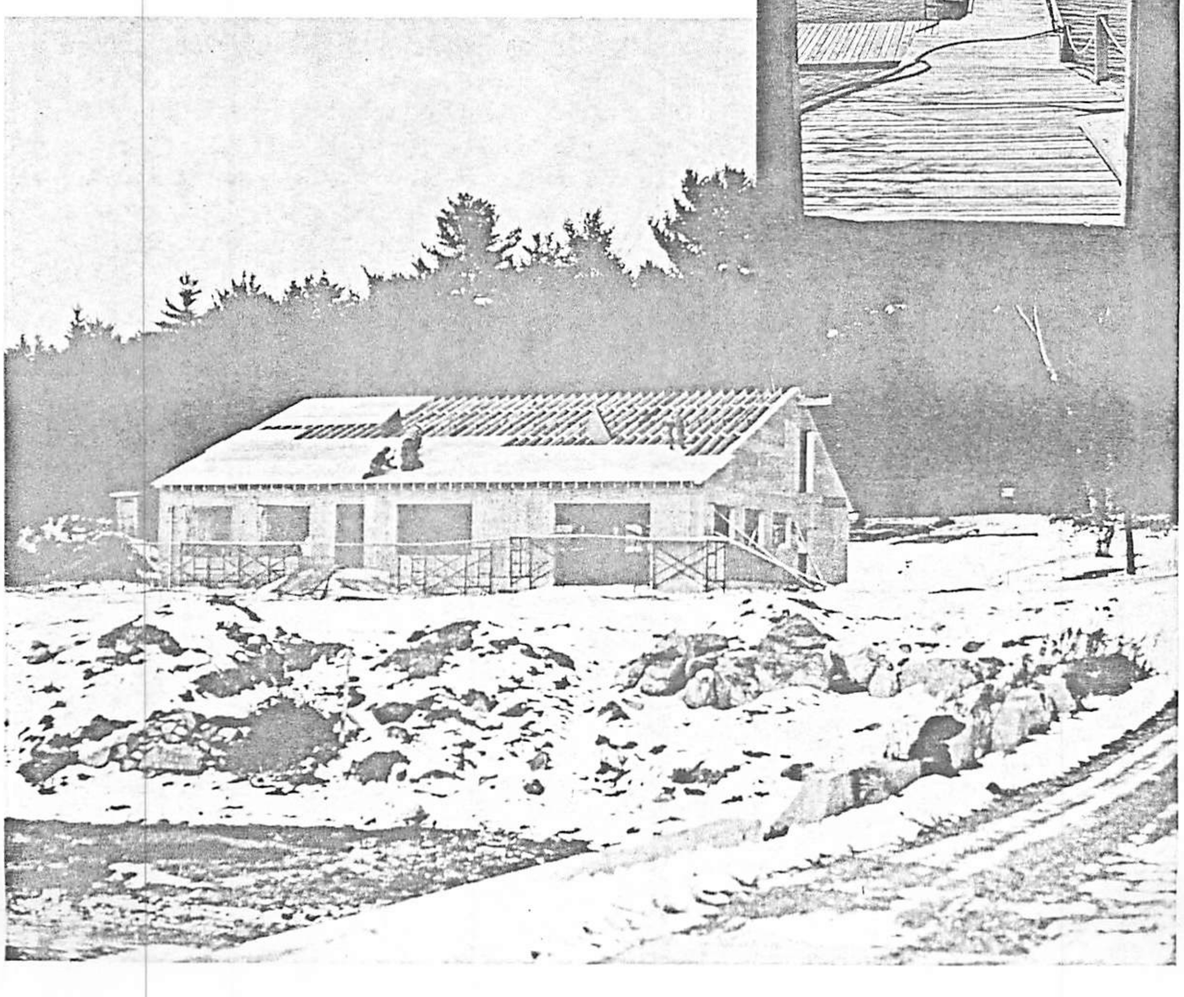
Cancer borealis lives in rocky areas where C. irroratus is not found as commonly. These areas have been mapped out. Population levels of C. borealis appear less than 1/10 those of C. irroratus. Shedding (molting) of female C. irroratus occurs in November-December and males in January-February. Shedding may occur in southern Maine waters two to four weeks in advance of "Downeastern" waters.

Many more factors, including the type of bait used, affect trapping. A standardized trapping experiment or plane-board SCUBA survey is needed to assess geographical and seasonal abundances throughout the state. This study would provide better understanding of our crab resources and establish guidelines for optimum resource utilization.

During a crab study on a related, but non-Sea Grant project, the male:female ratios in trap catches were found to be extremely erratic, ranging from about 100:1 in some months to about 4:6 in others. Since only the males are harvested in the commercial fishery, a better understanding of crab behavior and catchability was necessary.

Such studies were initiated in October, 1971. The preliminary results are most interesting. Cancer irroratus undergoes very little seasonal estuarine migration and catchability appears to be largely determined by the molt cycle. The female crab activity patterns seem to be governed by water temperatures. The male molts in mid-winter and retains its feeding activity throughout the coldest periods, probably to fill out the body mass within the new post-molt shell. Traps fished in January yielded 90% and those fished in February 85% of recently molted males. This information on basic crab biology and behavior will aid us in devising optimal trapping procedures.





In the initial grant year, our laboratory aquacultural work was conducted in a former lobster-holding building nearby (right). During this period our pilot-experimental hatchery at the Darling Center was designed, funded, constructed, and ready for occupancy in May 1972. This new building provides an excellent laboratory-headquarters for continuing and expanding our Sea Grant aquacultural program. (Photo taken December 23)

Project R/A-2

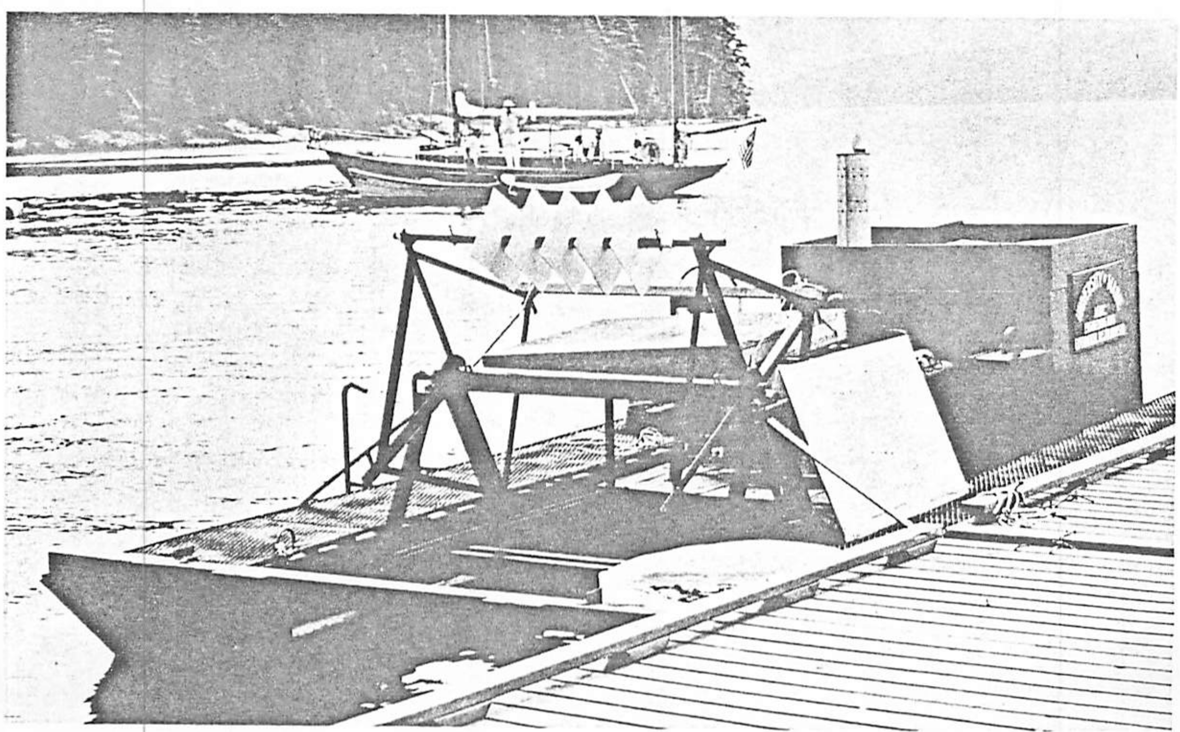
Optimization of Field Rearing Techniques for Hatchery Cultured Shellfish in Maine Waters

The Agricultural Engineering Department has been working on the development of mechanizable field-rearing techniques for free oysters. The success of cultchless hatchery techniques presents the problem of economically raising these oysters to harvest size in the field. Placing small juveniles on the bottom is impractical, and the only feasible alternatives seem to be traying or reattachment.

The Agricultural Engineering Department began studies in June 1971 to evaluate reattachment as a practical system. Free juveniles were reattached, with different adhesives, to asbestos cement panels. These panels were supported in wooden frames and suspended in different locations along the coast. After six months they were taken out. The reattached oysters responded to the substrate by depositing new shell in close proximity to the surface. The result was a permanent new adhesion which would probably support the oyster in position to a harvestable size. The growth rate was superior to that of tray-reared stock, and shell morphology was more symmetrical--this has bearing on the ultimate sale price of the oysters. Quick-drying portland cement was identified as the best gluing agent.

The success of these experiments led to the proposal of a complete rearing system based on reattachment, but also suitable for trayed oysters. For reattached oysters the basic units of the system are one-foot square panels of ¼-inch asbestos-cement board to which the juveniles are glued. Six of these panels are spaced in parallel on a five foot long plastic pipe. The pipes are themselves connected in parallel by polypropylene rope to form a long rope-ladder-like line. These lines will be deployed in the growing areas in long loops suspended from styrofoam floats. These are anchored to the sea bed by concrete blocks so that they are at least eight feet below low water mark. To deploy, service and retrieve these lines, an oyster harvester was proposed. This consists essentially of a pontoon-type styrofoam raft with facilities for winching up the lines. On the raft the oysters would undergo the appropriate operation: sowing, harvesting, culling, or fouling-removal before returning the lines to the water.

A 1/10 model of the long-line system has been constructed, together with a model of the proposed harvester. These components will be used as an evaluation load for design of the full-scale prototype at a later date. These components have been used to present the concept and have served as a basis for evaluation of the conceptual design. Design work on a full-scale prototype of this oyster rearing system is planned for the immediate future.



Project R/A-3

Market Development Studies on the European Oyster, Rock Crab and Jonah Crab in the Northeast

The objective of this project is to determine the market potential as well as the competitive supply sources for European oysters.

An extensive review of the literature dealing with the economic and marketing considerations for oysters has been made. In addition numerous sources of information have been compiled from a variety of public and private agencies and individuals to provide a backlog of data on which to proceed with an analysis of market potential. Limitations of the available data have been noted, in aid of narrowing down the number of study design objectives.

A preliminary econometric analysis has also been made in an attempt to isolate the variables that influence oyster consumption and to develop, through a multiple regression technique, a predictive equation that may be of some use in estimating future consumption.

The results obtained to date are highly tentative due primarily to the lack of refined data on some of the data needed in the equations. Further work is needed in an attempt to overcome this problem. Further research is also progressing to delineate the importance of variables other than those in the equation which may be of importance in explaining variations in demand. With further refinement, the model will be a useful tool in predicting demand.

Project R/A-4

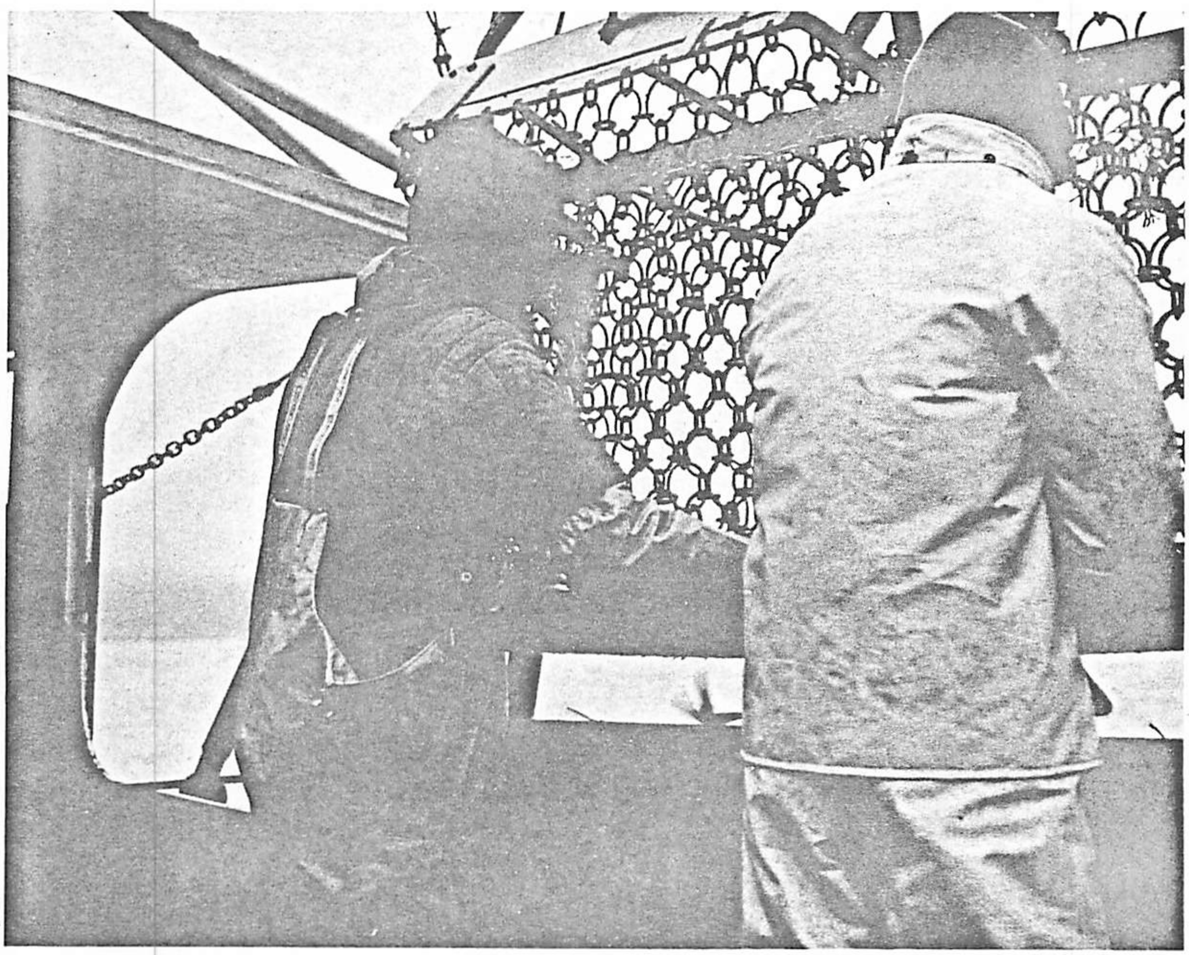
Animal Food Additives from Maine's Fishery By-products and Under-utilized Species

The commercial scalloper needs to find a way to dispose of the waste products (viscera) without polluting. The commercial poultryman needs more economical sources of protein to feed his birds. The latter is especially true in the Northeast where transportation costs are high. Over 50% of the weight of the soft parts of scallops are either discarded at sea or disposed of in some other way. This waste material is a potential source of protein and energy although its initial moisture content is very high. The objectives of this sub-project in which the Department of Animal and Veterinary Sciences is involved are to (1) prepare a dry feed ingredient from the waste product and (2) to determine its value by both chemical and biological means.

Over one ton of sea scallop viscera has been obtained and frozen in the fresh condition for analyses and experimentation. A pilot plant facility was designed and constructed to process thawed samples. The latter are homogenized, air-dried at 38 $\pm$ 1°C and ground up again. Since the moisture content of the final product is less than 10%, there should be no deterioration.

Chemical analyses of the dehydrated product can be summarized as follows. The protein level (approximately 50%) is typical of protein supplements. The high salt content (9.7%) would eliminate the need for salt addition to poultry rations containing 5% of the dried scallop viscera. The amino acid pattern of the product closely resembles those of poultry by-products meal and meat-and-bone meal, two widely used protein supplements. The ether extract (oil) content of about 16% is quite high relative to typical protein supplements including Menhaden fish meal, which normally contains approximately 10% ether extract.

Further studies, including chick bioassays, will be required to determine whether or not dehydrated scallop viscera could compete with other ingredients in the market place.



Project R/A-5

The Potential of the Blue Mussel and Other Marine Resources as Foods in the United States

Review of literature to date has revealed no information on the effect of handling and storage conditions on the sensory quality, nutritive value, and associated microbiology of the mussel, *Mytilus edulis*.

In the United States live mussels are generally packed in barrels or wooden crates and shipped in refrigerated trucks or trains. In some instances sea water ice is placed on top of the shipping container (Nowak, 1). Marketing and distribution time is estimated to be 2-4 days.

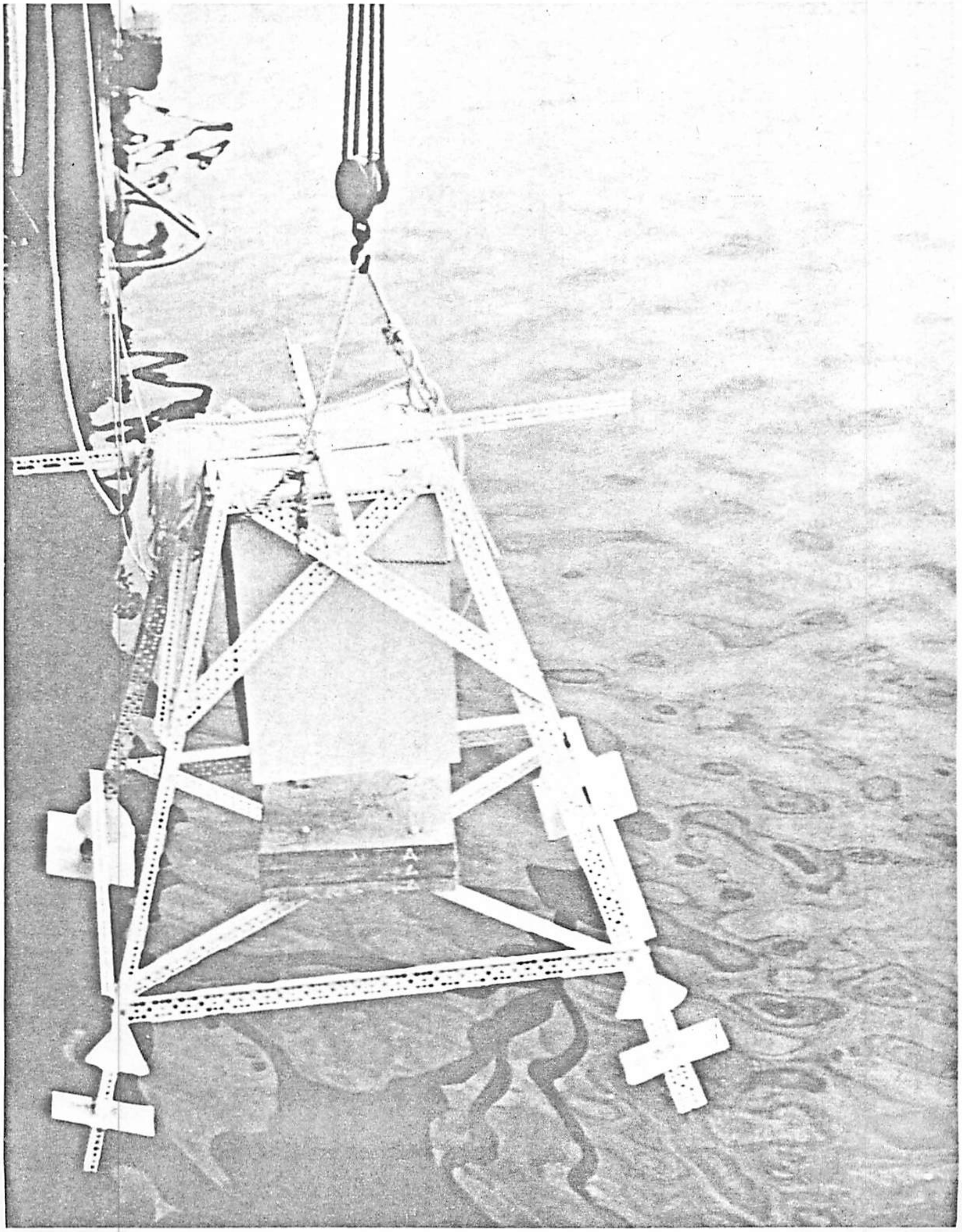
Initial studies have been carried out to evaluate the effect of storage at temperatures of 32°F and below (14° and 20°) on the quality and associated microbiology of *Mytilus edulis*.

Mussels deteriorated in quality relatively rapidly when stored at 14°F and 20°F (off color texture and odor at 4 days) as compared to those stored at 32°F (color and texture essentially unchanged and slight off odor at 8 days).

There appeared to be no significant effect of treatment on the Standard Plate Count of the samples. Although a small number of coliforms were detected in two samples, there were no fecal coliforms found in any of the samples.

(1). Nowak, W. S. W. 1970. The Marketing of Shellfish. Fishing News (Books) Ltd., London, pp. 263.

Further investigations are being carried out on the relation of packaging conditions at 32°F (iced, brined, crates, drums, burlap bags and plastic bags) to associated microbiology, sensory quality and nutritional composition.



Prototype underwater raft, described on Page 23

Project R/A-6

Design of Submersible Rafts for Aquaculture and Systems Analysis of Hatchery Procedures

During the first year the primary effort was directed toward the design and construction of an underwater raft for mollusca aquaculture and the study of a mechanized environment for mollusca rearing in the marine laboratory at the Ira C. Darling Center.

An underwater rafting system is being evaluated since it has certain advantages over a surface-floating rafting system: (1) it allows for multiple use of the water by placing the raft at a depth which will not interfere with commercial or recreational boats, (2) it is less susceptible to damage by rough water, (3) it eliminates ice damage, and (4) it reduces aesthetic pollution.

The first prototype of an underwater raft has been completed and is now ready to be placed in-situ. The prototype was designed to examine the feasibility of this type of system and to experimentally determine any unpredicted problems. The design was not optimized to carry the maximum mollusca load nor the most effective use of a square unit of water surface area. Rather, the primary consideration was convenience in experimental evaluation. This raft is raised to the surface by supplying air (from a SCUBA diving tank) through plastic tubing. The air displaces water in the raft's chamber which gives the raft positive buoyancy to bring it to the surface. After the desired servicing is performed, it can be submerged merely by allowing the air to escape through the tubing. This type of system is convenient since it can be serviced from the smallest boat.

Other types of submersible rafts are being considered to determine the most effective way to utilize a square unit of water surface area.. Convenience of servicing the raft while providing the highest ratio of mollusca volume per raft dollar is another criteria being given strong consideration.

Roger Morin, the graduate student on this project, will examine certain phases of raft design for his master's thesis.

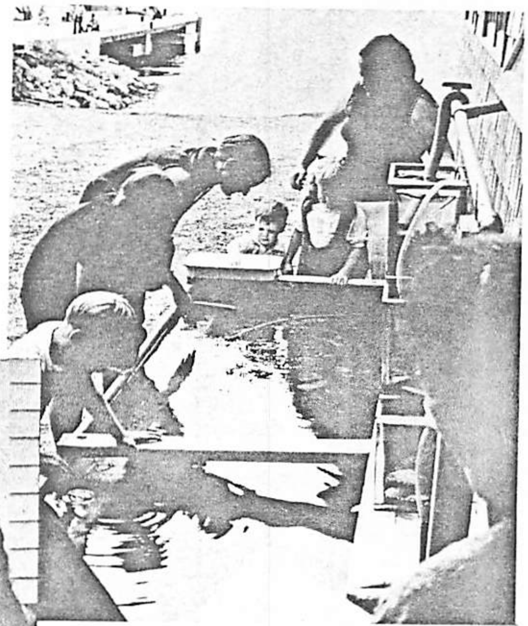
Any rafting system must be either fixed to the bottom or rest on the bottom. This allows a path for crawling predators such as starfish and oyster drills. One barrier system to block these paths has been fabricated and tested at the Darling Center and appears to hold promise. Other approaches to this problem are being considered.

To utilize indoor marine laboratory space efficiently and to reduce manual handling of mollusca grown for sea seeding, it is highly desirable that some degree of mechanization be developed. The design of such systems are being examined. The same type effort will be undertaken for growing food for mollusca.

In raft designs and the mechanization of sea laboratories, consideration for the eventual users of perfected systems must always be considered. Certain special configurations considered will be compatible with presently used equipment (for example, fishermen and lobstermen and their gear). After economic feasibility of rafting has been demonstrated, more sophisticated systems may become commercially attractive.

The end goal of this effort is to develop the state-of-the-art so that interested persons may use rafting as supplemental or sole source of income.

In addition to our efforts in research, we also strived to inform the public about the Sea Grant program and the potential aquaculture has for Maine. Illustrated talks about the aquaculture projects were given before eight school groups, seven civic organizations, one regional scientific society, and one national scientific meeting. An open house was held in October of 1971 during which approximately 700 citizens viewed aquaculture in progress. Public awareness of the program also has been promoted by television and several articles in local, regional and national newspapers. Public reaction to the Sea Grant program has been most encouraging.



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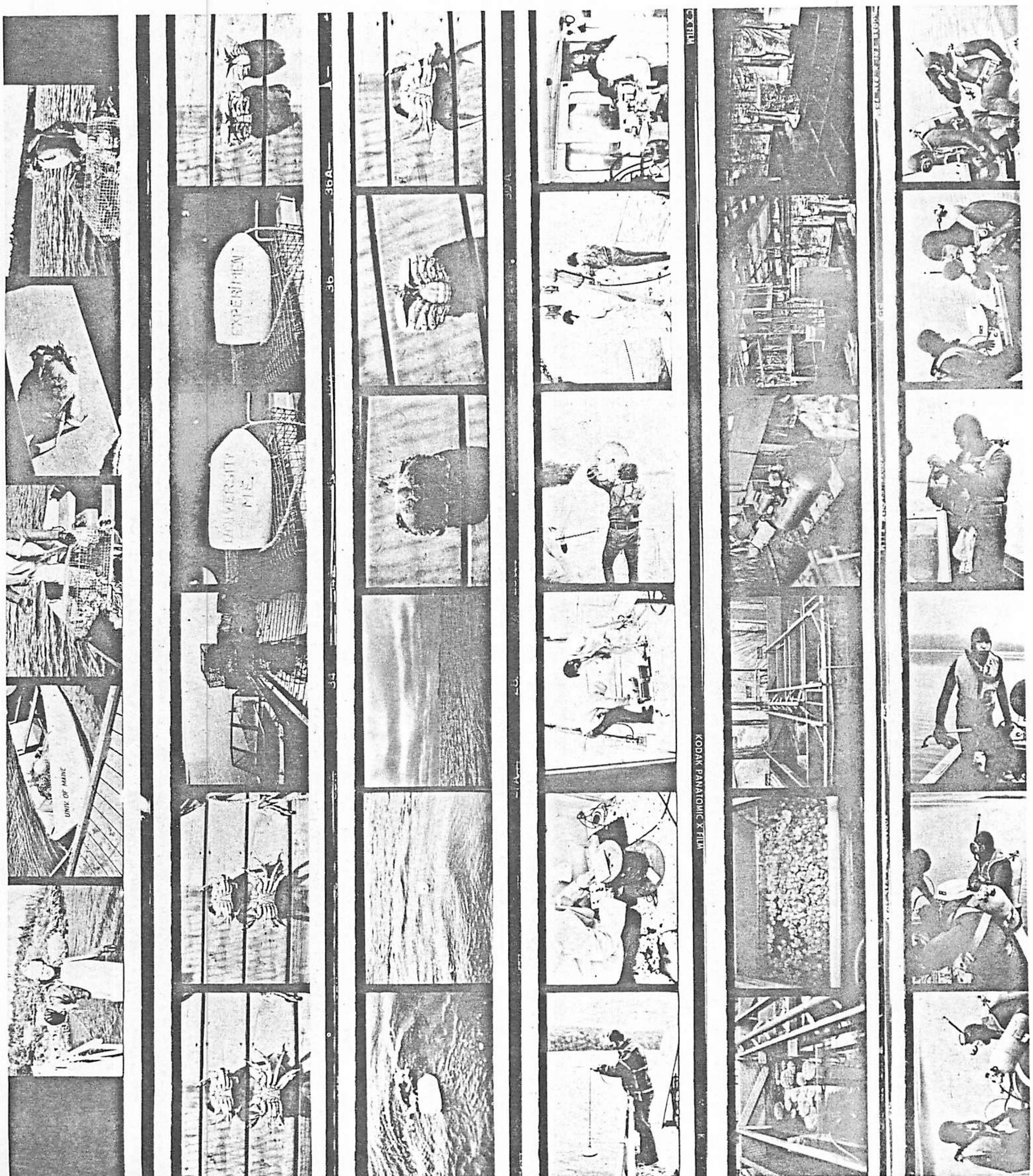

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