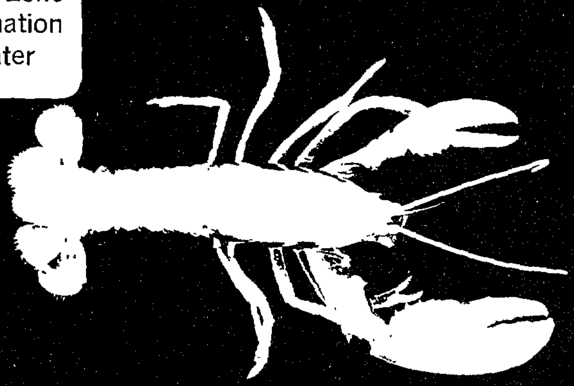
MAINE COASTAL RESOURCES RENEWAL



AQUACULTURE

RECREATION

PLANNING OFFICE
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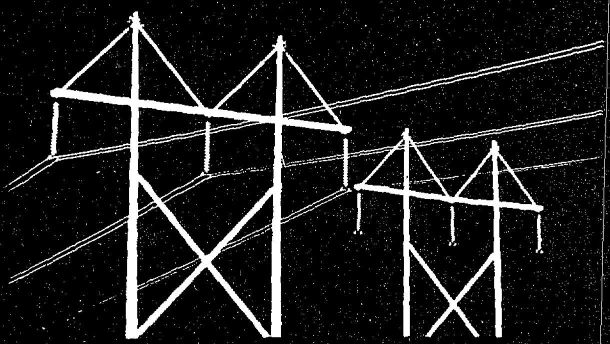
JULY 1971



ENERGY

MAINE COASTAL RESOURCES RENEWAL

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State of Maine
Executive Department
State Planning Office
189 State Street, Augusta, Maine 04330

KENNETH M. CURTIS
GOVERNOR

PHILIP M. SAVAGE
STATE PLANNING DIRECTOR

July 1, 1971

The Honorable Kenneth M. Curtis
Governor of Maine
State House
Augusta, Maine 04330

Dear Governor Curtis:

This is one of the first attempts to identify some of the major land and water uses of the Maine Coast—present and future. It is an attempt to deal in a more comprehensive and systematic way with the many and varied problems before us—to illustrate and illuminate the decisions to be made.

Public policy, in the past, contained no such process. We have dealt with problems singularly and in isolation, with no clear idea of relationships or total results.

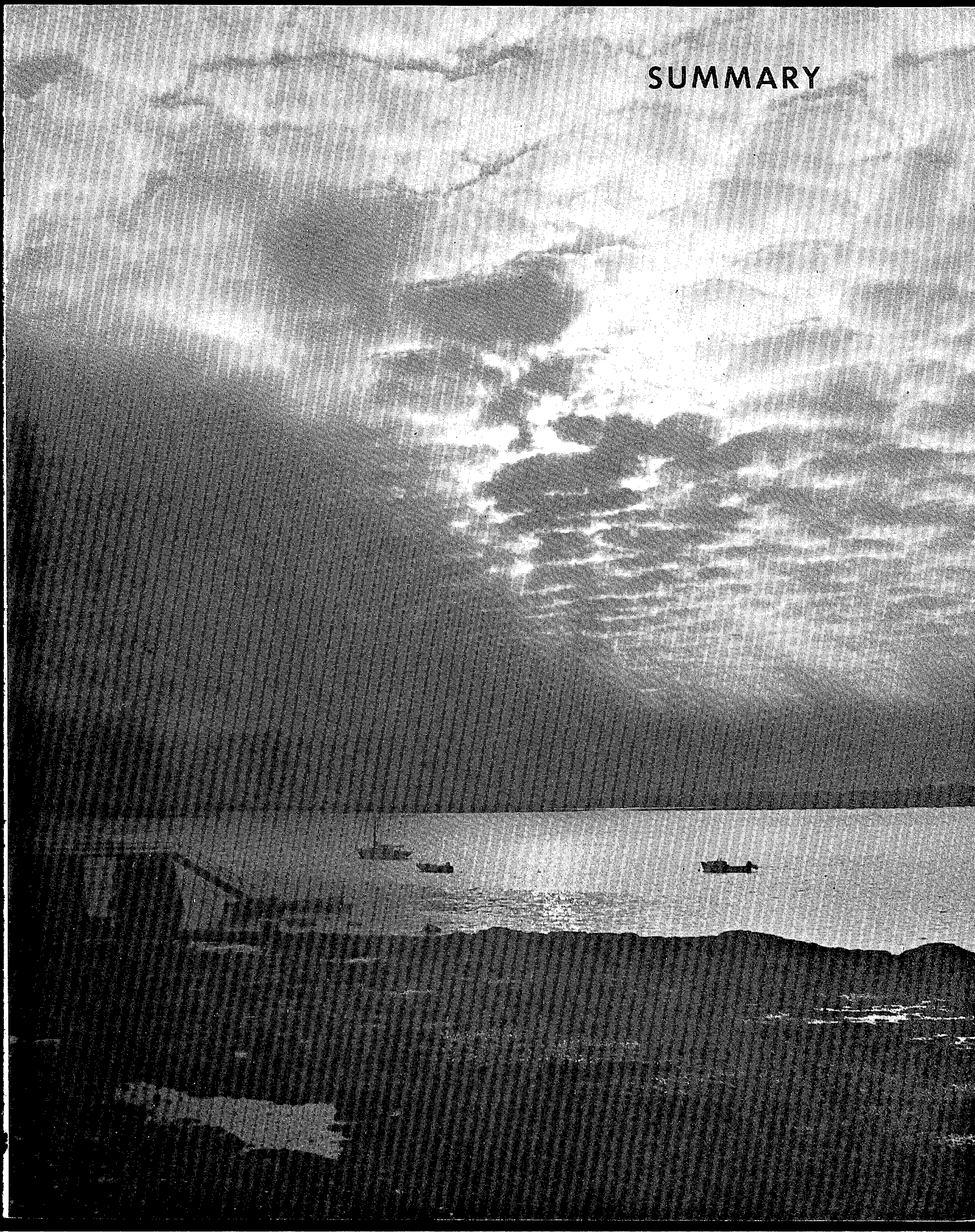
Perhaps this modest beginning, this one element of a comprehensive coastal planning effort, can show that there is no reason to take a piecemeal approach any longer, that, indeed, it is quite possible to maintain a good environment for everyone while, at the same time, providing the utmost opportunity for economic growth and fulfillment.

Sincerely,

Philip M. Savage
Philip M. Savage
State Planning Director

PMS:cs

SUMMARY



This study effort has been designed to strengthen the informational base for public and private investment decisions along with assisting Federal, State, regional and local coastal planning efforts in Maine.

Most of the pressing questions and demands concerning the utilization of Maine's coastal resources can only be realistically answered after the existing evidence is collected, analyzed, examined and projected in regard to possible future action. Even then the answers will not be answers in the traditional sense, but rather they will take the form of choosing that combination of alternatives that will provide the greatest long term well-being of all the people in the State of Maine.

Three principal topics have been singled out for examination by this study. The topics are:

1. Aquaculture

2. Energy

3. Recreation

The topics are referred to as study components. Each component has been reviewed and analyzed with the following considerations in mind: development potential, economic contribution, institutional relationships and planning implications. Our purpose is to define the degree of contribution that can be expected of these coastal uses and to define the extent and implications of their interrelationships.

In addition, two other segments are included as an integral part of this report. They are:

4. A proposed industrial recycling — Multiple-Use System

5. A recommended method for implementing Coastal Development Policies.

Part Four is devoted to the presentation of a proposal that would allow many coastal resource uses to be brought together in a way that would lead to mutual benefits for the participants. Part Five outlines the mechanisms needed to undertake a project of the type described.

Our traditional way of coping with problems of this nature has been to attack them separately with little consideration for the interrelationships between one problem and another. The result usually takes the form of continued aggrevation of the situation rather than a solution. The orientation of this report centers around finding the interrelationships that exist between the study components by identifying problems and their underlying causes. A method is proposed herein which outlines an integrated, direct approach for turning problems (often labeled wastes) into resources for industrial entities.

Four major problem areas were identified:

1. The current waste of physical resources along the coast.
2. The inadequacy of essential community services.
3. The severe lack of employment opportunities.
4. Lack of institutional flexibility and responsiveness to problems.

This study attempts to define those areas of public, possible private, investment which would be most beneficial for resolving these problem areas in Maine's Coastal Zone. Recognizing that the resources offered by the Maine Coast are experiencing urgent and growing pressures for utilization and development the following policy was established to guide our analysis:

> Uses should be encouraged that will optimize the intrinsic and real values of the zone and assure the greatest long-term social and economic benefits for the people of the State of Maine.

We have focused our attention on particular aspects of the situation which have significant impact with regard to the Coast: Aquaculture, Energy and Recreation.

The Aquaculture Component applies the major policy guideline to living marine resources. The aim is to protect and enhance these resources by promoting their safe and efficient harvesting and by encouraging the cultivation of new and existing forms of marine life. Maine's commercial fisheries are slowly declining and there is little public concern for their plight. Our goal is to improve the profitability of the existing fishing industry and assist in the advancement of aquaculture.

The Energy Component is concerned with industrial development and marine transportation. All efforts to expand employment are encouraged if industrial development will not degradate environmental and human resources. One task consists of identification and development of suitable locations for industrial expansion subject to public review and approval.

Coastal policy also encompasses the development of the marine transportation services necessary to provide support for existing and planned uses for the Maine coast. Maine's natural deep water harbors, unique to the East Coast, have made the area attractive to petroleum companies looking for ways to take advantage of the economies-of-scale that are inherent in the employment of the world's super tanker fleet.

In addition, the cold oceanic waters along the Maine coast have particular merits in regard to the power industry. Nuclear power stations, destined to provide much of our future electrical energy, require vast amounts of cooling water to condense steam used to drive huge generators. The Maine coast has been eyed as a possible answer to this cooling problem.

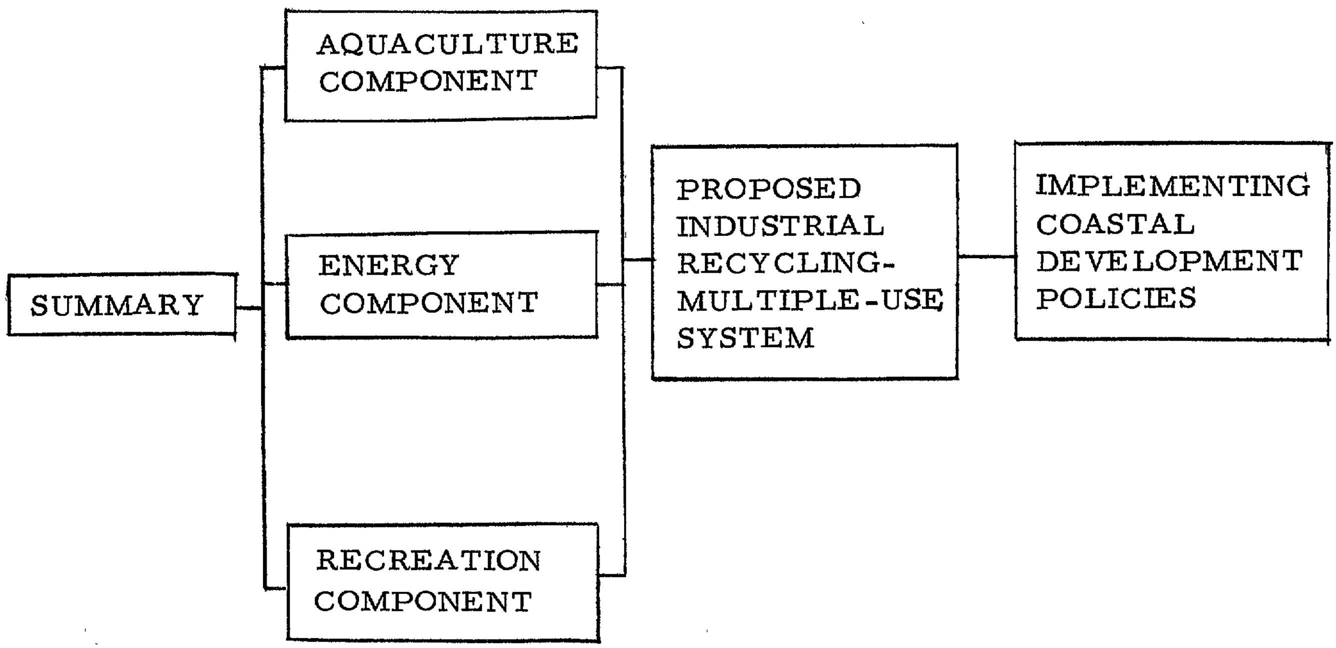
Our concern is also with reviewing the energy picture in Maine, specifically the petroleum industry and the power industry. We will highlight the advantages and disadvantages associated with coastal decisions that involve the energy industries.

Maine has long carried the label of vacation spot of Northeast; much of the attraction being the undisturbed beauty of the Maine coast. In recent years the recreational appeal of the coast has been jeopardized. Beaches are becoming crowded, considerable land has been purchased by large land developers for conversion to vacation home tracts, a boom in outdoor camping has caused overflows at our campsites, the demand for shoreline property by industry has lead to conflict with recreation interests.

The recreation component which deals with recreation-related activities along the coast looks toward ways to develop, operate and maintain recreation and tourist services throughout the coastal zone for the enjoyment of the State's citizens and the economic welfare of the State; also to restrain development which in fact, degrades recreational resources. Efforts should be directed toward developing a proper balance in recreational services as related to predicted demands and resource capabilities.

The following schematic shows the sequential framework around which this study has been built. The three components, Part One, Part Two and Part Three of the study are handled as independent subjects. Part Four, a multiple-use system is a logical extension of the initial work and, finally, Part Five is focused on the important task of determining how some of these proposals might take place.

Footnotes have been tabulated and placed after each study component. Reference is also made in this report to an appendix. The appendix contains the statistical data collected during the study and will be released as a separate document by the State Planning Office.



The State of Maine is faced with many divergent trends. Many of these trends revolve around the often conflicting demands for continued environmental quality and economic stability. How and when we deal with them will do much to shape the State's future. The how of this question is not easily answered. This study presents one alternative — the industrial recycling through multiple-use concept. We have focused on this concept because it provides a way of bringing together these seemingly conflicting demands; a concept that allows several industries to integrate their inputs and outputs to their better overall economic advantage than if they operate as separate entities and at the same time the concept maintains Maine's environmental integrity through recycling. It is also a means of correcting the present waste of our physical resources, which is proceeding at a frightening pace. Soils, water, fuels and many other resources are suffering ruinous depletion, pollution, or destruction from man's overuse.

The when of the question is far easier to answer — the time is now. We have continued to operate with approaches that rely on stop-gap measures for too long. We feel it is far more productive to take the initiative, outline our goals and how to achieve them, and then get down to the work of turning an idea into an operational reality.

PART ONE:
THE AQUACULTURE COMPONENT

PART ONE: AQUACULTURE

INTRODUCTION TO THE AQUACULTURE COMPONENT

Aquaculture can be broadly defined as:

> "Any directed effort by man to increase the yields of plants and animals in either fresh water or salt water."[1]

In essence, aquaculture is the farming of water as opposed to agriculture, the farming of land.

There has been a great deal of discussion concerning the potential significance of aquaculture as it relates to Maine's coastal areas. This interest has been generated partially as a result of successful projects elsewhere in this country and other parts of the world and partially as a result of the need for a viable new industry for Maine.

Maine aquaculture is still very much in its infancy. Considerable research and development has been initiated with every indication pointing toward an increased role in the future development of Maine's coastal resources; yet many problems must be resolved before aquacultural enterprises can be firmly established on a commercial basis.

The objective of this component is to identify and define the degree of contribution that can be expected from aquaculture as it develops and interacts with other coastal uses. This is undertaken within a planning context to provide the necessary information for meaningful public investment decisions and provide realistic input for the Maine Coastal Development Plan.

The critical factors associated with aquaculture — bio-technical, environmental, economic, legal, social and cultural — are analyzed in detail to determine the general characteristics of aquaculture. Then the specific assets and constraints to its development in Maine are examined and finally planning implications for the Maine coast are reviewed.

Scope and Methodology

Aquaculture, although old in concept, is relatively young and largely undeveloped in technique. Much of the specific technical information is not readily available nor is it easy to interpret for planning purposes. Yet if aquaculture is to be a major use of Maine's coastal resources, efforts must be made now to obtain the necessary information and preparations must be made to accommodate this potential use. As part of the State Planning Office's responsibility for coastal planning, this study effort is, therefore, oriented toward:

1. Outlining the known bio-technical and environmental requirements for potential types of aquaculture in Maine.
2. Outlining essential economic and institutional requirements for aquaculture development.
3. Delineating, whenever possible, the requirements associated with specific land and water locations for various types of aquaculture.
4. Defining priorities and compatibility criteria for different forms of culture as well as the possible interaction with other coastal uses.

Background

To provide a proper perspective regarding aquaculture in Maine this section will begin with a brief historical analysis of the Maine fishing industry.

The Gulf of Maine, bounded on four sides by the coast of Maine, Nova Scotia, Cape Cod and Georges Bank, has been a rich fishing ground since the colonization of the New World. Currents sweeping from the ocean floor rise along the Continental Shelf to surface at Georges Bank, carrying the volumes of food which attract great varieties of fish to feed on the food and each other. Less than 100 fathoms in depth, the Gulf waters warm as they circulate in a great counterclockwise manner toward Nova Scotia. The geographic location of Nova Scotia permits habitation of the Gulf by species requiring warmer water by deflecting the chilly Arctic surface currents, thus making the Gulf a haven for marine life on the edge of the harsh North Atlantic.[2]

America's earliest colonists quickly realized the wealth of the Georges Banks fishing grounds. Fishing increased steadily until the early 1800's when an extensive mackerel fishery flourished at Eastport. Herring catches grew from then until the turn of this century, when over two hundred smoke houses operated along the Maine coast.

As smoked herring faded in popularity, a process was devised to package sardines in hermetically sealed containers, giving birth to the sardine industry. By the early 1900's forty-five sardine canneries packed herring caught in the Gulf of Maine. Until only recently, when the industry has been forced to import sardines from Nova Scotia, the production of the sardine industry was greater than any other Maine fishery.

Technological innovations in canning and shipping methods greatly expanded markets accessible to the fishing industry. The processing and sale of several species such as menhaden flourished and then failed. The menhaden fishery, after growing to a multi-million dollar industry in fifteen short years, crumbled suddenly when the fish disappeared from coastal water in 1878.

Fishing emphasis shifted to the lobster after the disappearance of menhaden. To guarantee survival of the species, the State Legislature limited the ways lobster could be taken, and the lobster pot industry prospered. The landed value of the annual lobster catch has ballooned from half a million dollars in 1880 to nearly 16 million dollars in 1969.[3] In recent years, however, the catch has declined from a peak of 24 million pounds in 1957 to an average of 20 million pounds in 1968-1969.

Since the turn of the century, the extent of the harvesting of numerous finfish and shellfish has demonstrated the potential of becoming an important industry in Maine. Several such species are the clam, scallops, mussels, bloodworms, lobster, whiting, herring, and shrimp. However, due to either an inability to guarantee a constant supply to retailers because of technological problems associated with preservation, or to an inability to improve catches because of increased foreign competition, none of these species has assumed the economic importance experts had hoped.

Extreme fluctuations in yearly catches of a particular species can have devastating effects on an infant fishing industry. The heavy Northern shrimp catches of 1965 through 1969 instigated investment of considerable capital in boats, gear, and processing plants. Then in 1970 the catch fell by 20% and the poor fishing is apparently continuing. An official of Seafoods U.S.A., a Damariscotta based seafood distributor, estimates that the combined shrimp processing plants in Maine are capable of processing approximately one million pounds of shrimp per day. Applied to the record catch of 1969, this would mean twenty-five days of full production.[4] Unfortunately, it also means that invested capital lies idle for the remaining 340 days of the year.

The finfish industry also suffers from intensive foreign competition. Modern, efficient West German and Russian trawlers have so damaged fishing off our coast that the Federal government is currently negotiating regulation of Atlantic fishing activities with these governments. The Canadian government has recently strengthened its ground-fish fleet through vigorous subsidy programs. Each of these developments has diminished the effectiveness of Maine's fishing fleet and decreased production by related on-shore processing industries.

Consciousness of these problems has induced a slight pessimism in state officials and fishing industry representatives about the future of commercial fisheries in Maine. The myriad problems of labor and equipment costs, increased foreign competition and fluctuating catches appear to have no quick or simple solution. However, despite these obstacles, commercial implementation of the techniques of aquaculture looms as a distinct possibility.

Aquaculture is an established field in other parts of the world with many of the advanced nations presently engaged in culturing techniques. The leaders are those nations with a large dependence on seafoods such as: Japan, Norway, The Netherlands, Spain, Portugal and France. An example of one technique is the Norwegian method of overlaying a body of salt water with a layer of less saline water. This acts as a lens to increase temperature.[5]

Commercial aquaculture projects have only recently been established in this country. Many major firms such as Armour, Corn Products Co., Ralston Purina, Monsanto, United Fruit and others are engaged in efforts to establish commercially viable products. Trout farms have been operating in the midwest for some time; however, commercial efforts for salt water species is just becoming attractive.

A large effort is currently underway in the Puget Sound area of the Pacific Northwest. A consortium headed by the National Marine Fisheries Service is undertaking a Pilot Salmon Research Farm Project to raise 1½ pound pan salmon. These fish will be raised entirely in captivity and will require 14 to 16 months to reach marketable size.

There are no significant commercial projects in New England at this time; however, many research projects have been conducted with favorable results. Viable techniques appear to be available with the State of Maine having one of the highest potentials to reap these benefits.

An example of what can be done has been demonstrated in Lake Charlotte, Nova Scotia, by Sea Pool Fisheries, Ltd.[6] This firm is engaged in raising trout and salmon in a closed-cycle, temperature controlled rearing system. They expect a harvest of two million pounds by the end of 1972 with a long range estimate of 4 million pounds. Their facilities include pools which can be filled with any combinations of sea water and fresh water. The water is continuously recirculated through gravel and oyster shell filters and heat can be added from the waste heat of an oil-fired power plant. This provides the ability to regulate temperature, salinity, pH and recirculation to enhance the growth stages and control disease. The facilities currently use a 90% recirculation rate which provides for the conservation of water, lower heating costs, and easier control of the rearing environment.

The establishment of commercial aquaculture projects in Maine is just around the corner. Such efforts can supplement rather than extract from the ecology of the sea. They will capitalize on several unique properties of the sea. First, the sea is three dimensional in production capacity, while land is essentially two dimensional. Second, water's density lessens the effects of gravity on its inhabitants — thus less food energy is expended in building bones to resist gravity and in moving about to obtain food. Lastly, due to water circulation and the suspension effects of water, organisms usually do not need to search as far for food and seldom encounter food shortages.

These properties of the sea do not necessarily indicate that we must go to the sea for food that is already there. Rather, we must turn to the sea because, after sufficient research, we may perfect techniques which will allow us to realize the sea's potential to produce food more quickly and more economically than land.

Definition of Aquaculture

Over the years we have developed a highly sophisticated science of agriculture to maximize the production of foods on our lands. Yet, the development of aquaculture, producing aquatic food products, is relatively unknown in the western world. Recently, however, it has become apparent that land alone cannot supply our needs, so we have begun to turn to the sea. Yet we now fish the oceans so thoroughly that we may soon destroy a possible solution to the world food dilemma — the intricate chain of life in the sea.

If the sea holds the solution to improving the food situation, the quest for that solution will focus on aquaculture. Because we still hunt on the sea, and have not yet learned to farm it, our familiarity with aquaculture is considerably less than our familiarity with agriculture. A science of aquaculture is developing but its shape and content are as yet unclear. This uncertainty is reflected among aquaculturists at all levels. Definitions of aquaculture by noted experts vary considerably as demonstrated by the few provided below:

Aquaculture — Any directed effort by man to increase the yield of plants and animals in either fresh water or salt water.

T. A. Gaucher.

The cultivation or propagation of water dwelling organisms.

Our Nation and the Sea, Report of the Commission on Marine Science, Engineering and Resources.

Any increase in fish production, by whatever methods, above what can be produced naturally.

Dr. C. F. Hickling

The rearing of aquatic organisms under controlled conditions using the techniques of agriculture and animal husbandry.

John E. Bardach — The Status and Potential of Aquaculture — May 1968 — U.S. Dept. of Commerce

The complete control over a water dwelling organism in every phase of its life.

C. P. Idyll — *The Sea Against Hunger* — Crowell, 1970

Promoting or improving growth and hence production of marine brackish waters, plants and animals by labor and attention, at least at some stage of the life cycle, on areas leased or owned. Usually intended as a profit making venture.

E. S. Iverson — *Farming the Edge of the Sea*

Subjection of an organism to at least one manipulation before harvest or capture.

Ryther and Bardach — 1968

These definitions represent the different scientific conceptions of aquaculture. Their major point of differentiation is the degree to which man must interfere with the life cycle of an organism for the process to be known as aquaculture. Activities commonly known as fish management, such as the seeding of ponds with fish eggs, have been considered by some scientists to be aquaculture. With the advent of more intensive aquatic research, this opinion has diminished in popularity. Other opinions, as noted above, range from interference "at least at one stage of the life cycle" (Iversen) to the "controlled condition" required by Bardach, to Idyll's call for "complete control over a water dwelling organism in every phase of its life." In practical terms, releasing juvenile trout and salmon in their natural environment after raising them from eggs would conform to Iversen's definition. The growing of clams in a bacterially or thermally polluted flat is an example of cultivation under Bardach's "controlled conditions." Idyll's definition is met only by aquarium types of production and perhaps by recent attempts to raise lobster and trout in the cooling pools of nuclear power plants.

In an attempt to resolve this semantic jungle, two distinct types of aquaculture will be referred to herein. These are "intensive" and "extensive" aquaculture.

Intensive Aquaculture: This includes cultivation processes which have a significant degree of interference with the life cycle of the organism. Intensive aquaculture is characterized by small production units, intensive management, dense stocking, force feeding, stock selection and manipulation, high capital costs, high operating costs, and produces a high yield per unit area. It is furthest removed from the unpredictable forces of nature. An example would be the raising of organisms on unnatural foods, as trout or liver, in a controlled environment such as an aquarium.

Extensive Aquaculture: This includes cultivation processes which have a minimal degree of interference with the life cycle of the organism. Extensive aquaculture is characterized by large production areas, low management, low capital cost, low operating cost and low yield per unit area. Examples would include specie transplantation and improved harvesting as in the case of sedentary shellfish such as clams, quahogs, and mussels.

Thomas A. Gaucher, a Rhode Island natural resources consultant, has closely analyzed the internal principle of the more intensive aquaculture enterprises. Intensive aquaculture depends less upon market analysis and more upon "minimizing dependence on nature" to produce a profit. According to Gaucher, the major sub-systems of intensive aquaculture are:

1. The hatchery to support the spawning, hatching and larval culture requirements.
2. The nursery to support juvenile development.
3. The ranging sub-systems to support the post-juvenile development to market size.
4. The water sub-system including provisions for waste disposal and, in some cases, recycling of processed water.
5. A feed production and feeding sub-system.

The most widely known aquacultural enterprise which approximates the above model is the trout raising farm of Sea Pool Fisheries, Ltd., of Nova Scotia. A large and initially expensive operation, this farm employs the most recent feeding techniques, three types of water and numerous other technological innovations. The operation is not only economical but produces a product far superior to the foreign trout which previously dominated the market.

The basic advantage of this type of aquaculture is that it is self-perpetuating. Though the initial capital investment is large, no natural stock is depleted and minimal reliance is placed upon an unpredictable natural environment. It is a truly economical operation.

Aquaculture Activities in Maine

Basic aquacultural research has been performed by the Maine Department of Sea and Shore fisheries for many years. Only recently have the public and federal, state, and local governments shown an increased awareness of the potential for aquaculture in Maine. This interest has generated a much accelerated effort to establish a viable aquacultural industry. The institutions with aquaculture interests in Maine and the ongoing and planned projects are summarized in Table 1-1.

AQUACULTURE ACTIVITIES IN MAINE

ORGANIZATION	ACTIVITY	LOCATION	TIME FRAME
Department of Sea and Shore Fisheries	Raft Culture of Eastern Oysters	Spinney Creek	Ongoing
	Raft Culture of Eastern Oysters	Cousins Island	Ongoing
	Raft Culture of Eastern Oysters	New Meadows River	Ongoing
	Raft Culture of Eastern Oysters	Marsh River	Ongoing
	Lab Culture of European and Eastern Oysters, Hard and Soft Clams, and Blue Mussels	Wiscasset	Ongoing
	Lobster Culture	Spinney Creek	Planned for 1971
	Lobster Culture	Cousins Island	Ongoing
	Lobster Culture	Boothbay Harbor	Discontinued
	Feasibility of Air Curtain for Thermal Mixing	M.I.T. Cousins Island	Ongoing Resumed in 1971
	Environmental and Biological Research on Lobsters, Northern Shrimp, and Blood and Sand Worms	Boothbay Harbor Wiscasset	Ongoing Ongoing
	Pollution Studies—Thermal, Pesticidal, Heavy Metals, and Bacterial	Boothbay Harbor	Ongoing
	Irish Moss Studies	Casco Bay	Ongoing
Department of Inland Fisheries and Game	A Wetlands Inventory	State-wide	Near Completion
	A Natural Resources information retrieval and analysis system	State-wide	Operational in '71

TABLE 1-1

AQUACULTURE ACTIVITIES IN MAINE

ORGANIZATION	ACTIVITY	LOCATION	TIME FRAME
The Darling Research Center of the University of Maine.	A study of the effects of dredging in Belfast Harbor and spoil of Isle au Haut	Belfast	Ongoing
	Seagrant proposal to cover: Deep Sea Scallops, Oysters, Blue Mussels, Rock Crabs	Walpole	Ongoing
	Survey of the hydrography, sediments, Plankton, benthos and the commercially important plants and animals including finfish, in the Montsweag-Back River area, Maine Yankee Atomic Power Company	Wiscasset	Ongoing
	An environmental survey of the Damariscotta River estuary	Damariscotta	Ongoing
	Survey of the macroscopic algae of the Maine coast	State-wide	Ongoing
	A study of the food of **Pleuragramma** Antarcticum with comments on net feeding	Walpole	Ongoing
	Heavy minerals study of the St. George estuary, Coast of Maine	St. George River	Ongoing
	Small-scale distribution of estuarine phytoplankton	Walpole	Ongoing

AQUACULTURE ACTIVITIES IN MAINE

ORGANIZATION	ACTIVITY	LOCATION	TIME FRAME
NRC Project REASON	A demonstration Blue Mussel project	Not yet chosen	Contemplated
	An investigation of possible soft shell clam industrial expansion	Maine's polluted clam flats	Ongoing
Bureau of Commercial Fisheries	A lobster culture program	West Boothbay Harbor	Ongoing
Citizens Who Care	Raft culture of Blue Mussels	Long Island Casco Bay	Contemplated
Dept. of Economic Development	Compilation of non-biological data	State-wide	Ongoing
Malpec	Shrimp marketing and Trout culture	Boothbay	Ongoing
Harold Arndt & Larry Cole	Oyster culture	Woolwich	Contemplated
Dead River Company	Lobster Research & Marketing	Bangor	Ongoing
Salt Water Farms	Lobster Research & Marketing	York Harbor	Ongoing
The Research Institute of the Gulf of Maine (TRIGOM)	Formation of the TRIGOM Task force on Aquaculture	State-wide	Contemplated

ANALYSIS OF THE FACTORS OF AQUACULTURE

The suitability of various aquatic species for culture in Maine is dependent upon a wide variety of factors. These factors can be grouped into five general categories: bio-technical, environmental, economic, legal, social and cultural. Each category is analyzed in the following sections to determine current and foreseeable constraints, incentives, and planning implications for aquacultural enterprises.

Bio-Technical factors

The general bio-technical factors of concern to aquaculture are:

1. Problems relating to species biology such as control, supply, breeding, disease prevention, and nutrition of adult species and their progeny.
2. Problems of aquacultural ecology such as water and subsoil chemistry and fertilization as well as ecological manipulations permitting use of different areas of the water column.
3. Technological problems such as building and retaining of enclosures and the devising of harvesting machinery.

The extent of knowledge currently available on the above factors is severely limited. Marine biology is, for the most part, a young, although rapidly developing science and thus our understanding of the sea and its creatures is, at present, woefully deficient. Furthermore, much of the present aquacultural knowledge that does exist is for warm water species whose environmental requirements are more conducive to rapid growth and whose bio-technical factors are better known. Many of the behavior patterns, development stages, and nutritional requirements of the species that have been suggested for culture in Maine's cold water environment have yet to be determined through extensive research efforts. Species that have been suggested as possibly suitable to culture in Maine cover a wide range of marine species and the available knowledge on each varies enormously from specie to specie.

The marine experts consulted and literature reviewed about species most likely to be cultured usually based their selections on innumerable factors, both objective as well as personal. Generally, however, the selection factors and characteristics can be described within four basic categories: the characteristics of the specie, its environmental requirements, presently or possibly employed methods of culture, and limitations to culture. Information gathered concerning each specie suggested is presented according to these four basic categories. The following table summarizes this information.

No attempt at an exhaustive technical study has been made. A brief study of the following table will, however, afford the reader a general knowledge of a specie and its aquaculture possibilities in Maine.

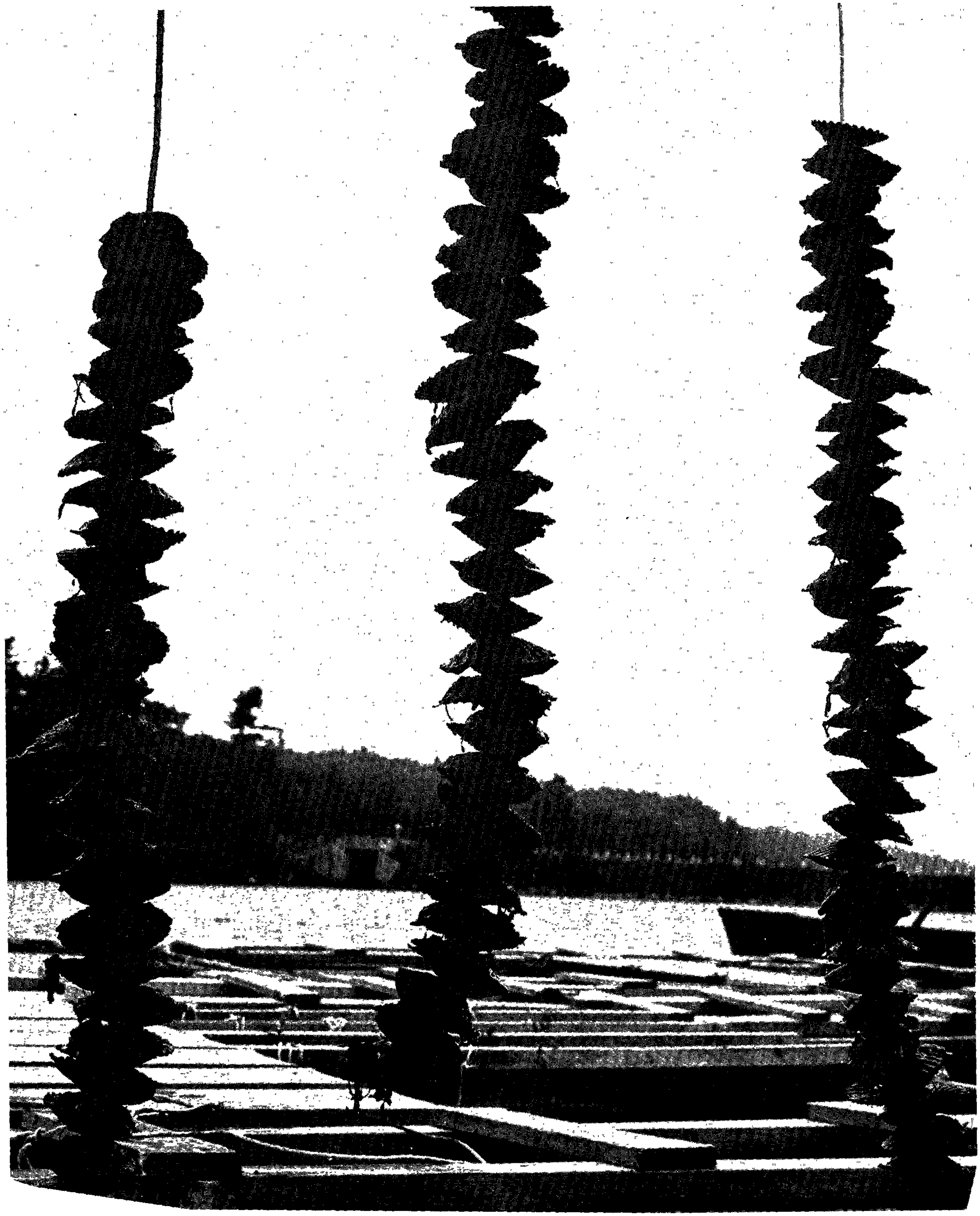


Table 1-2

CHARACTERISTICS OF POTENTIAL AQUACULTURE SPECIES FOR MAINE

	IDENTIFYING FEATURES	SOME IMPORTANT ENVIRONMENTAL REQUIREMENTS	METHODS OF CULTURE	LIMITATIONS TO CULTURE
BLOODWORM (Glycera dibranchiata)	A pink marine worm up to 13" in length with a proboscis with prongs that can be extended for procurement of food, and a tapered tail. Sexes are separate. In captivity it swims in corkscrew fashion except during spawning, when it swims with lateral undulations of the body. Emits steady stream of sperm, and female explodes with all eggs emitted at once.	Better survival rate correlated with temperature in the range of 46.6° to 48.8° F. Upper water temperature tolerance of 89° F. Occurs in intertidal and shallow subaqueous areas.	Not presently cultured. Efforts generally concentrate on improvement and retrieval of natural yields. Hardy and matures to size quickly. Very prolific. Research now directed to increase growth rate by increasing temperature in larval and adult stages.	Larvae difficult to raise. Specie die after spawning. Larvae culture studies now in progress.
SANDWORM (Nereis virens)	One of the most common marine worms, reaching a length of 18 inches. Nocturnally active and is typically both carnivor and herbivor. Non-spawning sandworms are characteristically reddish-brown. Male is cream colored just before spawning, strong steel blue during spawning, and female dark green, usually, during spawning. Visibly spawning worms are males while females are hidden from sight.	Burrows in deep sand or mud. Occurs under stones. Close correlation between sea water temperature at spawning and supply three years later. Most abundant at mean low water mark.	Not presently cultured. Efforts concentrated on harvesting of subtidal sources by mechanical methods could expand yield of both marine worm species.	Experimental development of eggs to date unsuccessful. Species dies after spawning.
ROCK CRAB (Cancer Irrozatus)	A decaped crustacean with a hardened outer shell and five pairs of jointed legs; a crawler, carnivorous.	Prefers mud with vide variations in temperature and salinity.	Seeded but not cultured in captivity.	Small meat yield per organism compared to lobster. Passes through several moultings before maturity. Must be shucked by hand which is uneconomical. If pressure continues on lobster stock and mechanical shucking can be developed there is considerable potential for this species.
JONAH CRAB (Cancer borealis)	A decaped crustacean, larger than the Rock Crab, also carnivorous and a crawler.	Prefers rock bottoms with wide variations in temperature and salinity.	Seeded but not cultured in capitivity.	Same as above.
LOBSTER (Homerus americanus)	A long decaped crustacean. Crawls and swims short distances. Eats many forms of marine organisms and vegetation, such as mussels, wheeks, clams and crabs, are scavengers. Desirable market size 10"-12" in length, 1½ to 2 lbs., female has 3,000-100,000 eggs.	Optimum temperature in relation to greatest catch 46.°-46.5° F. Boulders and small rock bottoms for hiding places. Shallow water sought in spring, deeper water in winter.	Cultured, but not yet at competitive prices. Three dimensional shelters and cages used. Breeding techniques can be employed. Shedding peaks at highest water temperatures, usually in Sept. Natural areas seeded with food sources to increase catch. Thermal effluent from power plants shows lobster can be raised in some promise. Under controlled conditions, 3 years to market size.	Five to six years to market size. Canabalistic in close quarters. Easy prey for finfish predators unless cages used. Only one quarter of weight is meat.
SEA SCALLOP (Pectin magellanicus)	A bivalve mollusk which resembles a Shell Oil Company Symbol. Large (5-6 inches across) radially ribbed shell. Swims in a jumping fashion by opening and closing its shell. Very hardy, feeds on phytoplankton.	Maximum catch related to water temperature 45.3° to 47.1° F. Thrives in deep water, especially in summer months. Especially abundant in waters 20-50 fathoms.	Harvested naturally by dragging. Research underway to develop scallop hatchery and locate juveniles on experimental scallop area. Slight temperature increase increases spawning and fertilization.	Will spawn in hatcheries, but larvae die. Low meat yield. Slow growth even at high temperature. Seed is susceptible to large current variations. With large cyclical variations in natural supply about every ten years.
BLUE MUSSEL (Mytilus edulis)	Extremely prolific bivalve mollusk having elongated narrow shell and cylindrical foot. Dark blue exterior and pearly interior. Sexually mature at first year. Hardy, siphons plankton for food. Develops bisus threads which adhere to solid objects on the surface.	Prospers in very saline water and low temperatures. Also requires high light intensity. Prospers on solid objects in the intertidal zone and at all depths. Optimum survival associated with temperatures between 59° and 68° F. Many mussel attaching areas in intertidal areas are destroyed by scouring ice in winter.	Presently cultured in Europe on rafts and poles in shallow beds. Large numbers form in clusters. Easily cultured without artificial propagation. Extensive marketing needed to dispose of existing supply.	Susceptible to disease, predators, and parasites. Meat easily poisoned by siphoned pollution or germs. Often develops pearls. Low consumer acceptance.

	IDENTIFYING FEATURES	SOME IMPORTANT ENVIRONMENTAL REQUIREMENTS	METHODS OF CULTURE	LIMITATIONS OF CULTURE
SOFT CLAM (Mya arenaris)	A bivalve mollusk with a thin shell and long siphon. Reaches 4-5 inches in diameter. Burrows to depth of approximately 2½ times its length. Found in marine sediments, inter and sub-tidal areas.	Tolerates a wide range of salinity and temperature. Prefers stable sediments with high permeability. Optimum survival temperature is 45.3° to 46.6° F.	Major predator, the green crab and survival rates closely keyed with abundance of this specie. Rotation of naturally occuring population based on size, distribution and growth will generally increase crop. Growth rates increase with moderate increases in temperature. Significant increases in yields through mechanical dredging, protecting and transplating of small clams. Bacteriologically polluted soft shell clams can be purified through ultra-violet light or through self-purification by pure water. Proper management of existing resource precludes need now of artificial propagation.	Difficult currently to propagate under controlled conditions. Highly susceptible to pollution and predation.
HARD CLAM (Micronaria mercenaria)	A heart shaped bivalve mollusk, called little necks when small, a Cherrystone when medium sized, and a Quahog when large. A round ovate, thick hard shell. Short siphons, lives in a shallow burrow. Quahog can reach size of up to 6 inches in length.	Prospers on shallow bottoms with little tidal scouring, but good water movement. Usually found between tides and on shallow gravel, sand or muddy bottoms.	Cultured by removing seeds from exposed coastal areas and redistributing them to reduce density and prevent winter exposure. Can be dredged. Easy to artificially propagate. Potential in selected areas of Casco Bay. To improve yields is being successfully cultured intensively in commercial laboratories.	Cannot tolerate tidal scouring. Susceptible to predators and pollution. Susceptible to disease when cultured intensively.
EUROPEAN OYSTER (Ostrea edulis)	A round, flat bivalve mollusk of 3-4 inches. A filter feeder. Alternatively male or female. Reaches sexual maturity in winter months.	Prefers deep water with no tidal exposure.	Cultured in floating trap at 100 square yards. Conventional hatchery techniques employed successfully. Spawn with rising temperature in the spring.	Cannot tolerate low temperatures. Reproduction sporadic. Laboratory induced spawning is difficult and costly. Four years to market size.
NORTHERN SHRIMP (Pandalus borealis)	A long bodied decaped crustacean which during three years is male, turning to female and egg-bearing in fourth year.	Favors water temperature of 44.6° to 46.9° F. Migrates to live in cold bottoms of soft mud and sand, and found in greatest numbers in western areas of Gulf of Maine.	Better management holds best promise for increased yields. Not presently cultured commercially. Temperature increases both growth rates and fertility of adults. Successful techniques in culture of warm water.	Eggs survive best in cold water. Sensitive to very warm water. Extremely vague life cycle.
FRESHWATER SHRIMP (Machrobrachium cercinas)	A long decaped crustacean larger than Northern Shrimp and nearly the size of the lobster. Frequently reaches 9 inches in length. 250,000 eggs per female. It is an exotic specie.	Freshwater wet lands or brackish coastal wet lands. Requires warm water.	Presently cultured in Asia and Florida in warm water ponds. Larval stages require seawater and laboratory care. Basic research continues on temperature and salinity tolerances.	Very sensitive to oil or chemical pollution. Requires warm water. Cannot survive at temperatures below 23.° C.
SALMON (Salmo salar)	Small head, graceful body one fourth as deep as long. Blunt nose, gaping mouth, forked tail. Bluish-brown back, silvery belly, 10 lbs. average. Spawn in Oct.-Nov., 8-10,000 eggs.	Differential temperatures for egg incubation, fry development, and growth of young fish. Pure fresh water with gravel stream bed for spawning. Ocean sea water for adult growth.	Cultured in holding water and raceways. Fed high protein diet. Smolting pan held under controlled light conditions.	Requires large volumes of cold high quality water in which to grow. Susceptible to a variety of diseases and parasites. Sensitive to low levels of oxygen and high concentrations of nitrogen. Requires specialized diet.
TROUT (Salmo qairdeneri)	Smaller than the salmon, but of the same build. Bluish on back, speckled sides and belly. Sides marked with a long pinkish streak. Feeds on small organisms.	Same requirements as for the Atlantic Salmon except *sea water not required.*	Cultured in intensively controlled growing pools. Fed a special high nutrient, low waste producing diet. Market size in eight months. Presently cultured in Japan.	Requires a large volume of cold high quality water in which to grow. Susceptible to water borne diseases. Water conditioning systems are extremely expensive.
EEL (Anquilla nostrata)	A voracious, elongate, snakelike fish having smooth slimy skin. Brown above, yellow sides, white bottom. Large pelvic fins, median fins confluent about tail. At maturity 2′ long, 9 lbs. in weight, nocturnal.	Fresh or brackish water until sexually mature. Sea water in which to spawn. Adapts well to varying ranges of temperature of dissolved oxygen.	Limited culture in Japan. Wide range in diet and tolerant of wide range in temperature and dissolved oxygen concentration. Highly prolific, 10,000,000 eggs. High market demand in Europe and Asia.	Slow growing, taking minimum of five years to maturity. Spawns in Atlantic, near Bermuda. Dies after spawning. Little market demand in U. S.
ALEWIFE (Alosa pseudoharegus)	Similar to herring, with slightly heavier and deeper body. Projecting lower jaw, saw toothed belly. 10″-15″, 14 ounces at maturity. Plankton feeder — with some small fish.	Prefers shoreline areas of lakes and ponds for spawning, although will spawn in deadwater pool & riffle areas of streams. Egg development best at 55°-60° F. Spawns in fresh and brackish water areas.	Not presently cultured. Caught returning to parent streams in late April through early June.	Three to four years to maturity. Requires fresh and salt water during different phases of its life cycle. Primarily a plankton feeder. Market demand fluctuates with availability of large volumes of fish.
SEAWEED Irish Moss (Chondrus cripus)	A red algae, a small seaweed growing attached to rocks, 2″ to 10″ in height, sturdy perennials, short, repeatedly branching near tips, multiple branching giving a crisp tufted appearance somewhat resembling parsley.	Located just above water level to a depth of about 20 feet.	Not presently cultured. Mechanical harvesting being pursued as major current costs of developing products is hand-raking harvesting limiting individual raking to 400-500 pounds during 4-5 hour low tides.	Care in harvesting needed to protect, holdfast or naturally occuring fields can be depleted in a few years.

Environmental Factors

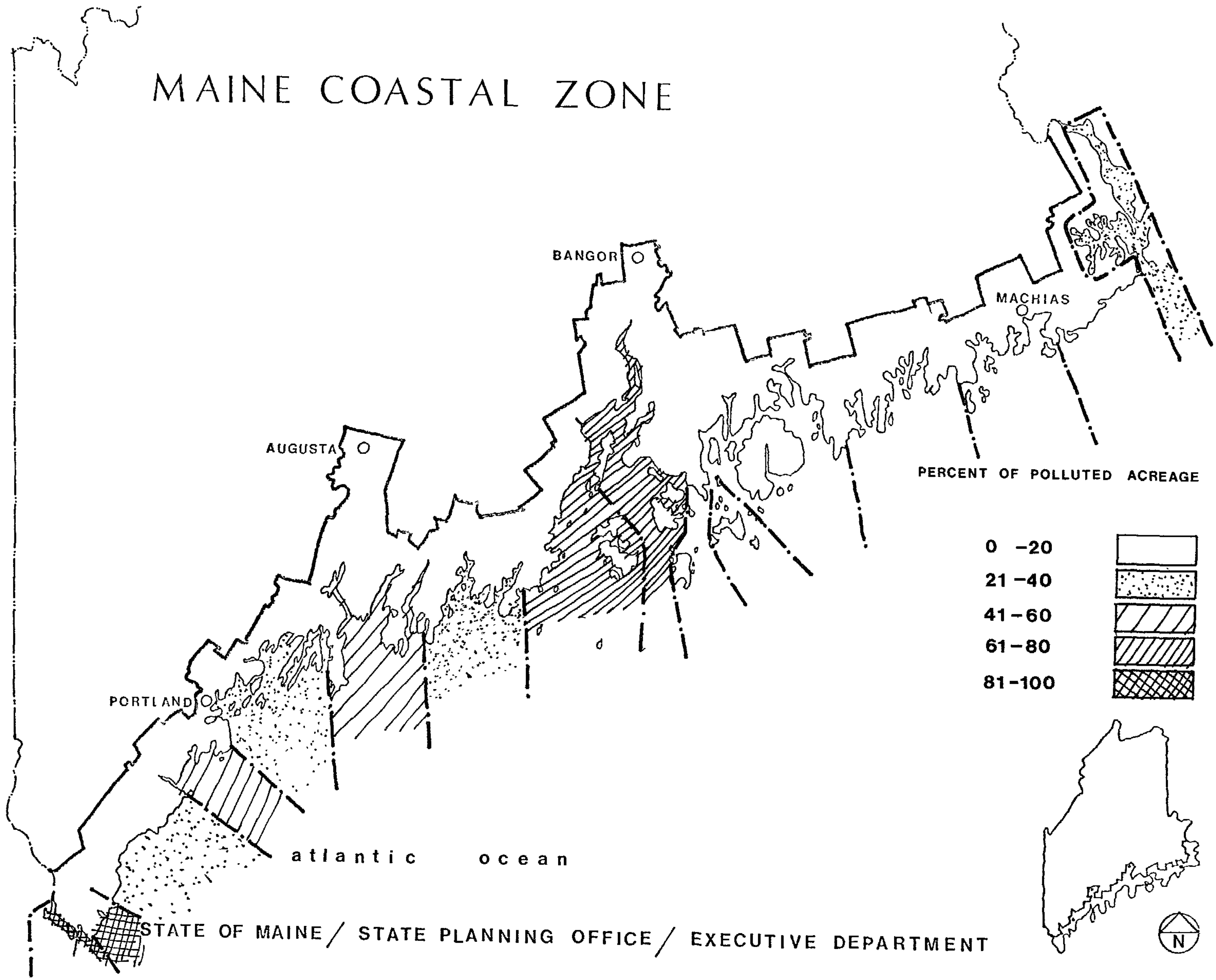
The Maine coastal environment has long been praised for its unique variety and breathtaking beauty. Recently, Maine's unique environmental features such as its undersea topography, its indented and varying coastal orientation with a southern exposure and its relatively unspoiled ecological configuration have received increasing attention as valuable assets for aquaculture development.

Other aspects of the Maine coast, however, are of dubious and, in some cases, detrimental value to aquaculture. Such features as extreme tidal shifts and resultant currents in eastern portions of the Maine coast make the introduction and survival of marine life in this area difficult. The flocculent nature of this portion of the coast along with extreme tidal heights (18 feet in Eastport, Maine) have the ancillary effect of virtually scouring the sea bottom in many unprotected coastal areas and thus eliminating chances for marine growth. Such tidal variations could also adversely affect maneuverability and harvesting operations of many potential surface aquacultural enterprises. However, for most of the coast (Kittery to Machias) the tide is less severe (8 to 12 feet) and can be an asset by providing good circulation systems for food and nutrient distribution.

Another critical requirement for growth of marine species is favorable temperatures. Maine's coastal waters are not only cold but experience extreme seasonal fluctuations in temperature with the effect of inhibiting continuous specie growth. In winter, marine organisms must expend considerable amounts of energy simply adjusting and maintaining metabolic rates in response to temperature changes. With more energy being expended for metabolic functions, less energy is available for food hunting and fish growth. Energy requirements of fish in capturing and consuming prey, in defending territory, and in operating energy (metabolism) can be large. Maximum production of fish will occur where minimum extraneous energy efforts are involved. By reducing these extraneous energy costs to a minimum, food conversion and growth rates are increased. As stressed by Brett, because fish have a low maintenance metabolism (provided temperature control is optimum for the species) they form one of nature's best food converters.[8] There is, however, evidence to suggest that highly favorable nutrition requirements can possibly offset the slowed growth experienced during cold water periods. Oysters, for example, can apparently be grown in Maine almost as quickly as they can be grown in warmer waters. This is more than likely a result of the quality feed and nutrient available for oysters in Maine waters.

Salinity is also an important environmental factor to the development of many species. Salinity shifts are caused by increased fresh water runoff during the spring thaws. Such rapid seasonal changes can be disastrous to extensive sea farmers of salinity sensitive species.

Another environmental factor in aquacultural development is the issue of water quality. Not only is water quality essential to most types of aquaculture, but that quality is threatened by the very activity which demands it. Intensive forms of aquaculture pose as severe a threat of water pollution as any other large-scale industry. The effect on water of raising 50,000 lbs. of salmon, for example, is equivalent to the pollution load of a city of 10,000 people. Recycling of waste water from aquaculture enterprises will be a necessity.


MAINE COASTAL ZONE
BANGOR
MACHIAS
AUGUSTA
PORTLAND
PERCENT OF POLLUTED ACREAGE
0 -20
21 -40
41-60
61-80
81-100
atlantic ocean
N
STATE OF MAINE / STATE PLANNING OFFICE / EXECUTIVE DEPARTMENT

In another section of this report, consideration is being given to the feasibility of having a closed recycled food-producing system.

Improving existing water quality in Maine is now well underway. However, severe and toxic pollutants such as mercury remain in river bottoms and food chains. These will have continuing detrimental effects. The extent of pollution has been thoroughly documented by the Department of Sea and Shore Fisheries. The pollution patterns of Maine's clam flats is graphically shown in Figure 1-1. This demonstrates the severity of the problem. As expected, the heaviest pollution occurs near the more densely populated areas. A new and major salmon culture industry has recently begun production in Nova Scotia. The promoter of this five million dollar enterprise, when questioned as to reasons for the choice of the Canadian site over a Maine one, said, "We looked at Maine's water quality data and eliminated the State because of its lack of adequate quality water."[9] Such sentiment does not augur well now, or in the immediate future, for the large scale development of a viable aquaculture industry.

Despite drawbacks, Maine's coastal environmental characteristics appear favorable to many types of potential extensive aquaculture. There is some evidence to indicate, also, that the long-range trend in development of aquaculture appears to be in the direction of highly intensive aquaculture, which would depend less on the natural environment and more on a controlled pool or embayment for fish culture. "An intensive cultivation approach employing modern processing techniques can minimize the dependence on nature and increase the system's reliability, output and profit potential.[10] Natural environmental requirements may, therefore, consist essentially of a constant water supply of a good quality at a desired operating temperature.

Economic Factors

To provide the proper perspective for aquaculture in Maine, this section will deal with economic considerations. The preceding discussion of aquaculture has centered upon some of the basic bio-technical and environmental factors associated with increasing the natural supply of various marine organisms. Discussions of the supply of fish are irrelevant if there is no demand. In few cases, however, has an actual demand for a marine product been adequately demonstrated. Numerous experts base their cultivation contentions for a species on a presently high market price, such as that of lobster, without considering the possible effects of increased supply on that price. Few businessmen would invest the substantial capital necessary for intensive aquaculture on such few facts or on unsubstantiated opinions. More information is needed.

General Patterns of Seafood Consumption

This section will discuss several aspects of national finfish and shellfish consumption.[11] The relationship of consumption to income, region, type of work and age will be analyzed. Also discussed will be national consumption patterns for meat and other protein suppliers. These patterns are significant because the consumer must be willing to buy the products of an aquaculture industry if that industry is to succeed.

Per capita consumption of fish and shellfish in the United States is growing steadily. Generally this may be attributed to inflation of meat prices, technological advances in preserving, packaging and transporting of ocean products, and the introduction of products easily prepared at home, such as fish sticks.

The greatest per capita consumption of fish and shellfish occurs in ethnic and religious groups. Negroes consume twice as much per capita as do whites, and Jewish families consume more than twice the amount consumed by Protestant families.

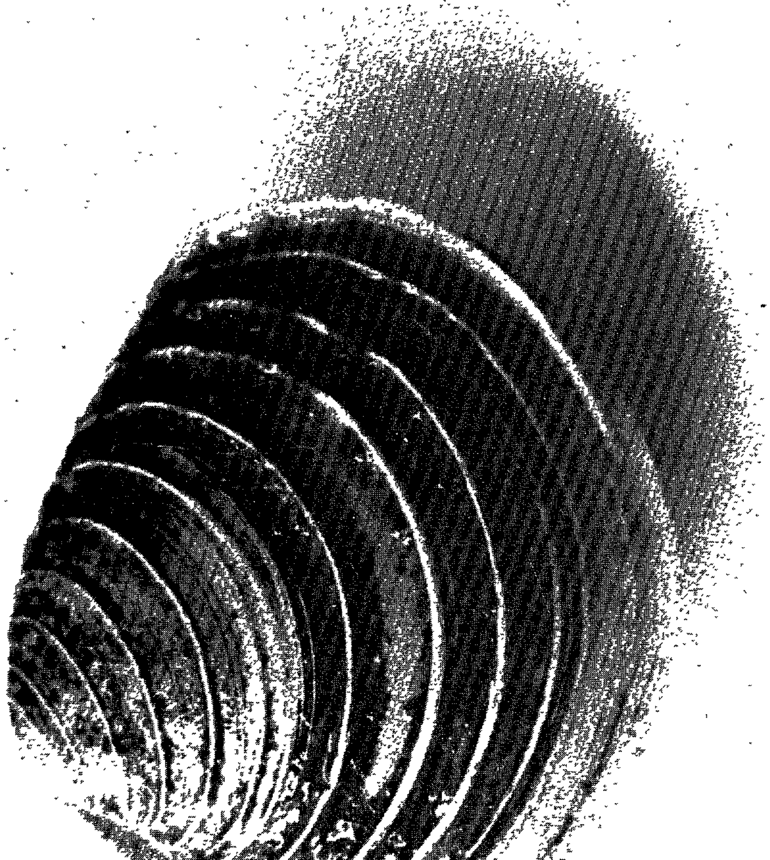
These consumption patterns are built upon low priced stable replacement foods such as whiting and shellfish, and not upon the luxury foods this report considers for aquaculture. Shrimp appear to be the only major exception to this rule, due to the large volumes of fresh shrimp consumed in the Southeast United States. As income increases, consumption of the luxury varieties increases. Groups at the end of the income scale consume almost completely different species, rather than differing amounts of the same species. Consumption peaks at the middle of the socio-economic scale of clerical or sales workers, who consume a mixture of staple and luxury ocean products. The largest amount of fish eaten away from home peaks at the high income levels of $15,000 per year. Types of meals affected by income level are shrimp, lobster, crabs and seafood platters, while oysters, haddock, and fish sandwiches appear relatively unaffected. As might be expected, consumption patterns follow the seasonal availability of species.

General shellfish consumption patterns differ slightly from the consumption patterns of finfish, primarily because of the effects of tradition and slow technological progress in product distribution. Most shellfish are consumed fresh, which limits the marketing area. Also, as with fresh clams in New England, tradition is the major factor in the creation of a market. Although a strong demand for clams in New England makes the area consume one-half of the nation's clam production, the recent pollution of many flats has forced the region the import eighty percent of the clams it consumes.

Oyster consumption deviates from the pattern of shellfish consumption previously described as increasing with income. Oysters are regional, produced in great numbers in short seasons and not easily marketed as a luxury food. Generally, however, shellfish patterns follow finfish patterns, with clerical and sales workers of the middle income group consuming the greatest amount per capita.

Proximity to the specie landing point is the major factor influencing regional consumption of finfish and shellfish. Thus the Eastern and Southern coastal regions account for most U.S. consumption. Beyond this faction, areas with fast modes of transportation, such as the North Central area, consume the next highest amount. These patterns again reflect the public preference for fresh seafoods and the problems of processing and transporting popular species.

Since World War II, the per capita consumption of protein by Americans has increased with their per capita income. The major part of this protein is supplied by meat, poultry and fish products. Fish consumption, unlike that of meat and poultry, has hardly increased at all. Since 1954, yearly per capita meat consumption has increased 150 pounds to 161.0, fish 12.5 pounds to 14.0, while



poultry consumption has skyrocketed from 28.5 pounds to 45.4 pounds. A stable demand is evident for fish, with only population expansion producing a demand for larger fish catches. This is graphically illustrated in Figure 1-2.

Because many of these figures are national in scope, it would be erroneous to base industry projections for Maine on national marketing statistics. The immediate regional markets for Maine products are New England, the Middle Atlantic states and the Eastern North Central states. Growth figures, unlike consumption figures, are available by region. Respective growth rates for the three regions over the past ten years were 8.6, 8.3 and 9.1 percent. Although these are slightly less than the national growth rate of 11.4 percent, these areas are the most densely populated in the nation. Thus the burgeoning population will increase aggregate demand even if per capita demand remains stable.

Market and Industry Analyses

As this study progressed, the paucity of public information on the various economies of individual fishing industries and the characteristics of both their actual and potential markets became apparent. As previously noted, few profit making industries have been based on hopes or opinions. Detailed information on current industries and their markets is badly needed to assess the potential of aquaculture in Maine. Some of this necessary information appears in a series of papers published in April of 1970 by the Division of Economic Research of the Bureau of Commercial Fisheries. In addition, the University of Maryland published a paper on "Demand for Shellfish in the U.S." in 1969. These interdisciplinary approaches to solving the many problems of the U.S. fishing industry comprise the backbone of this section.

Lobster:

The lobster industry, the best known of Maine fisheries, has experienced decreased catches in recent years. This may be the result of excessive fishing effort or of slowly declining water temperatures. Also, there have been indications that this decrease is partly related to heavy offshore trawling for the larger, more prolific lobsters. While illegal in Maine, this practice can be employed beyond the twelve-mile limit. Research to determine the causal relationship for these declining lobster catches is badly needed.

Although the total lobster catch has fallen recently, the price per landed pound has continued to rise. The average 1960 price was $.45/lb., while the average 1970 price was $.95/lb. Despite inflation, this is a significant increase and reflects the luxury nature of the food. It also indicates a growing demand despite shrinking production. This demand has resulted partly from market expansion through the use of air freight, which has given new life to several Maine seafood distributors. However, the costs of air freighting lobsters reinforces their position as a luxury food item.

Consumption of frozen lobster, particularly lobster tails, is increasing, but most Maine lobsters are still marketed fresh. The New England markets absorb almost all lobsters produced in New England because of strong regional eating traditions and the high cost of air freight. An intensive culturing of lobster, therefore, might compete with, rather than supplement, the present lobster crop. How-

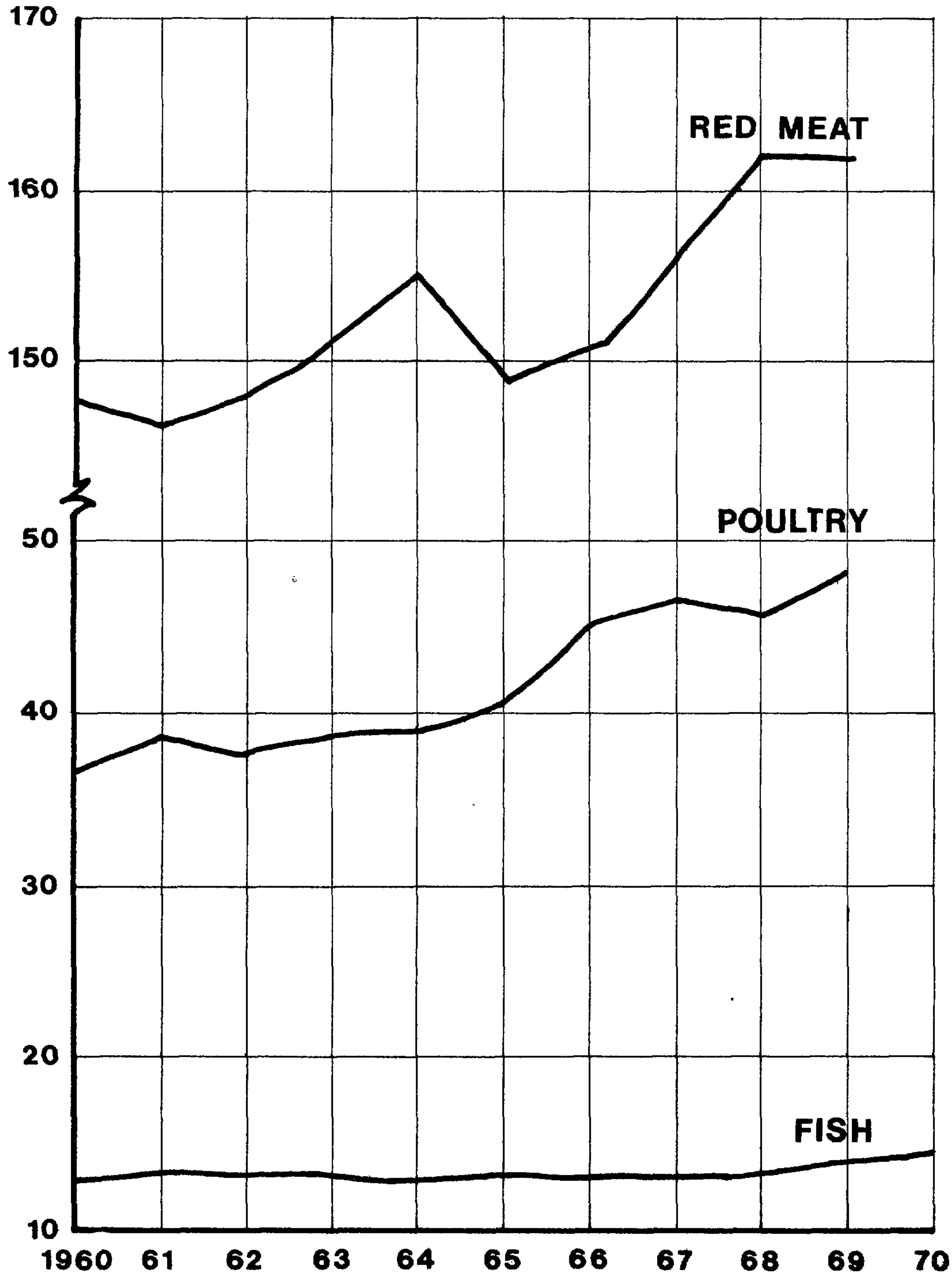


FIGURE 1-2

PER CAPITA CONSUMPTION (Pounds/year)

Source:

Department of Agriculture, U.S. Government Printing Office
Washington, D.C. 1970

ever, given the distinct and growing demand for live lobster, and the new and developing market for frozen lobster meat, an increase in lobster catch is not likely to compete with the present crop. It should be possible for the industry to develop the canned and frozen food lobster markets since the United States imports nearly as much lobster as is caught in Maine, and at a comparable price. For example, imports of canned lobster meat are valued at over six million dollars annually.

In 1967, a base year for the Bureau of Commercial Fisheries statistics on consumption, national per capita consumption of lobster was .82 lbs. This consumption is expected to increase to 1.02 lbs. of lobster meat per person by the year 2000. That figure, when multiplied by projected population estimates for that year, suggests an aggregate demand of twice the 1967 catch.[12]

The Maine lobster pot industry employs less than four thousand men full time, and an equal number on a part-time basis. The Bureau of Commercial Fisheries estimates the average income of all full-time lobstermen to be under five thousand dollars annually. While higher than the national average, this income is a poor return on the fisherman's investments in his boat and gear. This low level, considered in light of the number of part-time lobstermen, may indicate that a high percentage of lobstermen are underemployed or not utilized to their fullest working capability.

The size and extremely local nature of a lobsterman's investment makes the cycle of under-employment difficult to break. Because his equipment requires a proportionately high investment, constant attention, and is not easily marketed, the lobsterman cannot respond quickly to job opportunities elsewhere. Since aquaculture typically exhibits a fairly low labor to capital ratio, it cannot be assumed that intensive lobster culture will significantly overcome the economic problems of the lobstermen by providing alternative employment. Nor can lobstering equipment, such as boats and gear, be directly transferred into an intensive culturing operation. Increased productivity through aquaculture might, therefore, benefit only the processing segment of the industry.

Oysters:

Due to the cultivation of large beds along the Middle Atlantic coast, the American oyster industry is currently experiencing a resurgence. Prior to this resurgence, landings had fallen by two million pounds in the last twenty years.[13] The value of oyster production in Maine is minimal because the species will not survive through the larval stage in Maine's cold waters. However, since adults thrive in Maine's cold waters, if problems of the larval stages can be mastered, an oyster industry may be possible.

It is likely that the oyster larval problem can be overcome. One hatchery facility is presently being constructed adjacent to an electric plant's effluent in Long Island Sound, where the water temperature is raised from 7° to 10° C., as water passes through the hatchery cooling system. Juvenile oysters have already been cultured successfully in the vicinity of a power plant's thermal discharge, and it would appear that the use of this heated water for hatchery purposes would greatly improve the economics of a hatchery operation.[14]

Although the United States trails France, Japan and China in per capita consumption of most fish, it leads these nations in the consumption of oysters. This has been true for years, despite the fact that per capita consumption has fallen from .502 lbs in 1950 to .358 lbs in 1968. Surprisingly, New Englanders consume a smaller amount per capita than any other section of the nation. The Middle Atlantic states consume more oysters than other areas but due to the popularity of canned oysters, the demand potential is generally nation-wide. This general demand indicates a lack of traditional or cultural barriers to potential domestic markets. The Bureau of Commercial Fisheries predicts no change in per capita consumption of oysters from 1970 to 2000, but, due to population increases, predicts aggregate demand for oysters to increase by one-third by the year 2000.[15]

Currently successful oyster industries, such as those on Long Island, New York plant rafts of infant oysters and harvest mature oysters on the bottom with dredges. While no information is available on the economies of these operations, it is apparent from the magnitude of capital investment needed and the highly mechanized plant and harvesting operations that the industry employs fewer people per landed ton than does the lobster pot industry. More extensive research into these industries is needed.

It should also be noted that the convoluted Maine coastline may not be as well suited to harvesting operations as are the flat, shallow coastlines of Long Island and the Middle Atlantic States.

With the uncertainty over the demand for oysters, and the comparative advantage of the Middle Atlantic states in natural oyster production and oyster culture resources, it seems likely that investments in oyster culture operations in Maine may be less economically efficient than investments in other aquaculture projects.

Clams:

Maine's production of hard clams (quahogs) has fallen from a peak of 590,000 pounds in 1949 to a yearly average of less than three thousand pounds over the past decade. This discussion will, therefore concentrate on soft shell clams because of their greater impact on the Maine economy. Like the national oyster industry, the Maine soft shell clam industry has experienced a recent resurgence. In the past ten years the landed catch has risen from a low of 1,450,000 pounds in 1959 to a peak of 5,300,000 pounds in 1970. Yet, this poundage is less than one-half of the landing of either of the peak years of 1948 and 1949.[16]

New England consumes far more clams per capita than any other region, and accounts for much of the total national demand. National consumption has grown from .267 pounds per capita in 1947 to .341 pounds per capita in 1968, and is expected to increase to .440 pounds per capita by the year 2000.[17] Applied to that years' projected population, the increase will double the present aggregate demand for clams.

The New England demand for clams is an excellent example of the dependence placed on a traditional market. Local clam beds, fouled by pollution and ravaged by inefficient harvesting, can no longer meet New England demands. Eighty percent of the clams consumed in New England are imported from the Middle Atlantic states.[18]

Maine's clam production has been significantly impaired by the bacterial pollution of many excellent clam flats. Seventy-eight percent of the flats in York County and fifty-seven percent of the flats in Cumberland County are closed, with the remainder on the verge of being closed. Depuration plants are used to purify polluted clams by ultra-violet light treatments, but only on a limited scale. If society can eliminate pollution of rivers and reclaim the clam flats, an important source of revenue will be reopened.

Maine clams are usually harvested by hoe, while those in the Middle Atlantic states are dredged. Greater application of dredging operations in Maine would be a cost reducing technological innovation. Such an innovation in harvesting would however result in the reduction in the level of employment, thus increasing unemployment problems in the fishery industry even further. In the absence of appropriate programs to facilitate labor mobility and to control harvesting efforts, the long run costs of such a technology improvement might outweigh the short term benefits unless careful plans are made to avoid this possibility. It appears likely that dredging for clams will most likely be introduced in Maine polluted flats first, in conjunction with regional depuration facilities.

It has been estimated that hand digging of clams destroys between 50 and 70 percent of the clams left behind. If so, use of dredges in harvesting would increase productivity of beds by about fifty percent. In addition, presently unharvestable beds might be brought into production as a result of the ability of dredges to harvest clams in water deeper than that where hand harvesters are able to operate.

Given the traditionally strong consumption patterns in New England for clams and the generally more favorable flavor of New England clams over those produced in southern areas, it seems likely that any increase in New England clam production over the next 10-15 years will find a ready market in New England, and any foreseeable significant increases in productivity will probably not cause a reduction in prices.

Shrimp:

The development of the Maine shrimp industry is a recent development. The industry did not exist five years ago, and now is a relatively stable factor in overall Maine fisheries with considerable research and marketing activity now proceeding to secure new markets and develop new products.

The industry got into full swing about three years ago with landings of, in 1969, 24½ million pounds with a value of $6 million.

The Sea and Shore Fisheries is attempting to encourage the European market that already is familiar with the cold water shrimp, particularly in Scandinavia. About 50 percent of the Maine harvest has gone to Europe in the past with the percentage expected to top 60 percent this year.

Like all marine harvesting, there has been a problem of wide ranging fluctuating supply. Thus, the shrimp catch topped 24½ million pounds in 1969, the peak year, and dropped to a figure of 17 million pounds in 1970, a figure expected to be indicative of the 1971 crop.

Salmonoids:

This term covers both trout and salmon, neither of which is currently the basis for an industry in Maine. However, both are prime prospects for intensive aquaculture and the development of support industries. MALPEQUE of Boothbay, an international fisheries firm, has begun a project to raise great numbers of trout in cages suspended in the effluent of Maine Yankee's Wiscasset nuclear power plant. If this project succeeds, it will help satisfy the hotel market demand which is only partially met by Sea Pool Fisheries Ltd. of Nova Scotia. The demand for trout is so great that hotels will accept smaller trout rather than wait for the large, mature trout. While no figures were available on trout consumption, it can be inferred that, except for those caught by sportsmen, trout is a luxury food. Careful control over intensive trout culturing enterprises is necessary because trout are very susceptible to disease. These intensive enterprises often employ numerous biologists and engineers, but few semi-skilled personnel. Regional impact of such enterprises is likely to be small due to these employment patterns.

Domestically produced trout compete with frozen imports. In 1965, 4 million pounds of frozen trout were imported into the United States. In New England and New York, imported trout usually serves the retail foodstore market, while domestically produced trout from Idaho and Washington State serve the institution-restaurant market.

According to the records of the receipts at the New York City Fulton Fish Market, imports exceeded domestically produced trout by a factor of about 5 for each year the records are available. In 1968, New York prices of domestic trout were 30¢ to 35¢ higher than imports.

Fish brokerages handling trout and salmon at the headquarters of large chain stores were interviewed in a recent study to determine the marketing characteristics of trout and salmon. More than 10 firms in New York and Boston were included. All informants indicated that a new trout product would be accepted if it were promoted by the producer and the quality were at least equal to the products already available. All expressed interest in buying and selling a locally produced product but they needed relatively large amounts of the product on a weekly basis. One informant said he could use between 10,000 to 13,000 pounds per week while one broker bought between 70 to 80,000 pounds of imported frozen trout per month from one supplier at one time.

To break into this market, a supplier must guarantee a minimum supply on a weekly or monthly basis and be able to produce fish at a unit cost at least equivalent to that incurred in the large trout farm complexes in the west. Production costs of state operated trout hatcheries clearly show that food and labor accounts for 70 to 80 percent of total variable costs of hatchery production (they use about one man working twenty minutes to produce one pound of trout). This implies that 16 men working 40 hours per week for 50 weeks would be employed

in an operation which produces 100,000 lbs. of trout a year. Thus the regional employment impact of such an enterprise would most likely be small. Although the market for this industry may exist, its contribution to local employment is questionable. Also critical is whether or not water supply requirements, in terms of quantity, quality, and temperature would be available in Maine.

Salmon, once plentiful in Maine, are among the many victims of our polluted rivers. It may be possible, however, to culture salmon in a manner similar to trout. If so, an excellent market exists for a good product. Demand for salmon has remained constant in the United States for the past twenty years. The supply in that time has diminished by forty percent, probably because of river and estuarine pollution. In 1947 the nation consumed 391.5 million pounds. In 1967 the nation consumed only 245.7 million pounds. This drop in supply, coupled with the constant per capita demand, has boosted the real price from $.81 per pound in 1947 to $1.09 per pound in 1967, an increase of over forty percent.

Demand for salmon is spread equally over all income classes. Negro families consume more than white families while Jewish families top other religious groups. The West Coast leads all other regions in consumption, but demand is also high in other areas. Most salmon is consumed at home and is not fresh, but canned.

A recent study by the Bureau of Commercial Fisheries provides a rather optimistic demand projection for certain anadromous species, including salmon.[19] This study projected a 180% increase in sport fishing demand for these species by 1980 and 248% increase by the year 2000. It is doubtful that present salmon sources will be able to keep pace with this tremendous increase in demand. If these estimates can be considered accurate, then a rise in price for salmon to $1.90 per pound by the year 2000 is possible. If such a trend is valid, then the potential for aquaculture of salmon is great.

The river herring or alewife is also being examined for its commercial potential for consumer consumption. The fish now brings about 5 cents a pound as bait and about a cent a pound (delivered to a rendering plant) for use as fish meal. This fish depends on its growth, to a considerable extent, and its development upon the salmon restoration program.

Economics of Aquaculture Enterprises

To date no large scale attempts have been made to establish a commercial aquaculture facility along the Maine Coast. However, the soundness of the concept is, as we have pointed out earlier, being demonstrated elsewhere in the world. In this section, some general economic considerations that would be necessary to make the industry a success are reviewed.

An excellent example of an aquaculture industry model based on the present market is the "million dollar" model discussed by Professors Gates and Matthiessen of the University of Rhode Island.[20] These scientists assert that for an aquaculture industry to be of regional importance in northern New England it must gross at least one million dollars annually. Attainment of this figure will provide a significant increase in regional income and employment.

Three factors influence attainment of the one million dollar figure: cost of production, market volume and price. Cost of production, embodying the economies of scale, is the key factor. Major factors in this cost are minimizing the numbers of indivisible inputs, such as food milling facilities, maximizing the possibilities for joint production of species, such as in joint marketing and advertising, minimizing the maturity time of the species and maximizing the feed conversion efficiency of the species.

The remaining factors of market volume and price are considered only as they relate to each other. This type of market analysis depends upon the per capita demand for a product to determine the volume purchased at a certain price. Since the relationship between price and volume sold is not constant, there is an opportunity to make an additional profit. Market volume may be increased by advertising campaigns, improved packaging or marketing a better quality product. The possible effect of such methods is usually determined by market survey techniques and the results of such efforts are described by the change in the coefficients of demand which are a result of altering consumer tastes and preferences.

In practical terms, the factors of cost of production, market volume and price may combine in three basic ways to produce the "million dollar" gross demand necessary, by Gates, for New England aquaculture. They are: high volume and high price, high volume and low price, and low volume and high price. Gates and Matthiessen consider oysters, salmonoids and soft clams examples of the first combination; flounder, haddock and cod examples of the second; and bloodworms, an example of the third. With these criteria, Gates and Matthiessen selected oysters, lobsters, salmonoids, scallops and the hard clam as the species most likely to guarantee commercial success if cultured.

Dr. Robert Dow, Director of Research for the Maine Department of Sea and Shore Fisheries, has considered the economic of potential aquaculture enterprises in great detail. His findings have been published in numerous articles and indicate a very favorable economic potential for aquaculture. Basically, per acre yields with their associated economic values have been determined. This information was extrapolated to indicate the potential economic value from additional acreage and yield which could be obtained by management and culture techniques. Although the high level of some estimates might be impossible to achieve, since price would be affected by very large increases in supply and some projections were made using the highest yield areas as a base, the overall indication is very favorable.

Dr. Dow has stated,[21] "There is no valid reason why the production of food and pharmacologicals from the sea cannot become Maine's primary industry, employing more personnel at higher salaries than any other industrial activity." A structural outline of this industry was given and is reproduced here as Table 1-4.

An aquaculture enterprise can overcome the horizontal integration which currently restricts profits in the Maine fisheries. The Maine fisherman can expect to receive a landed price which is less than half of the final retail price. There is a cost of about 1½ cents per pound to move the catch from the dock to the processor who then adds an amount approximately equivalent to the landed price for processing. The cost of the product is further increased as it moves through the wholesale-retail chain to the final consumer. An aquaculture enterprise can be vertically integrated by growing, harvesting, processing and distributing the final product. This would provide a more efficient and economical operation. The value added by a vertically integrated operation will significantly add to the economy of the Maine coastal area.

The economic potential for aquacultural enterprises in Maine exists; it only needs to be exploited.

ORGANIZATION AND RENEWABLE MARINE RESOURCE ECONOMY

I. Unprocessed Products:

A. Live seafoods: eastern and European oysters, shrimp, soft and hard clams, crabs and lobster, gastropods, sea urchins, slipper shells, and selected finfish.

B. Live sport fishing baits: green crabs, mummichogs, mussels, shrimp, clams, gastropods, bloodworms, sandworms, and other annelids.

C. Seed stock of selected species for export.

II. Processed Foods:

A. Canned seafoods: oysters, clams, lobsters, crabs, shrimp, snails, mussels, roe, specialty products.

B. Frozen seafoods: same as above plus steaks, fillets, and individual meals.

C. Fresh seafoods: all species listed in MAINE LANDINGS, plus gourmet specialties.

III. Processed Products other than Foods:

A. Food additives: stabilizers, desiccants, clarifiers, fortifiers, and coagulants.

B. Drugs, antibiotics, laboratory and medical supplies, and pharmacologicals.

C. Stabilizers and spreaders for paints, hand and face lotions and leather treatments.

D. Culture media, industrial additives, biological and botanical specimens.

IV. Infrastructure:

A. Processing and manufacturing plants.

B. Research facilities.

C. Academic and training institutions.

D. Other service facilities.

E. Supportive goods manufacturing.

TABLE 1-4

Legal Factors

Present Maine law is a definite hinderance to the development of large scale aquacultural enterprise. If aquaculture is to achieve significance in Maine, certain revisions must be made in Maine laws. These revisions must embody the two guarantees essential to successful aquacultural enterprises; a guarantee that the investment in aquaculture will be protected and a guarantee that the cultivator may harvest what he has planted. The following sections will be a general discussion of the lack of laws, the inappropriate or inadequate laws and the legal uncertainties which cloud the future of aquaculture in Maine. The specific statutory language drafted to implement necessary changes in Maine law may be found in the appendix.

Protection for Aquaculture

One of the glaring deficiencies in Maine's legal structure is the absence of legislative guidance or administrative machinery to arbitrate among the various uses and users of the Maine coast. This institutional vacuum will be discussed further under the section entitled **Institutional Constraints.**

The absence of any mechanism or administrative machinery to regulate competing uses in the marine environment emphasizes the fact that protection of the investment in aquaculture involves a compatible environment and legal safeguards for the site as well as legal considerations pertaining strictly to fish culture. Direct compensation or recourse to a cultivator for destruction of his endeavor is limited to restitution for damage from an oil spill, as provided by the Coastal Conveyance of Petroleum Act, and civil liability for harm resulting from trespassing on an oyster cultivation area or the unauthorized taking of shellfish from a clam cultivation area. In some instances there is criminal liability for molesting the project or directly discharging a deleterious substance on the cultivation area. /See 12 M.R.S.A. 4253, 12 M. R. S. A. 4351, 38 M. R. S. A. 551 (1970 Supp.)/

The ideal location for an aquaculture enterprise would be an isolated area protected by zoning laws from the encroachment and deleterious effects of domestic or industrial activity. Similar restrictions in the utilization of the adjacent water areas for commercial or recreational crafts and curtailment of the public right of fishery in the area would also be necessary. The enterprise would be allowed to dam tidal creeks and estuaries and to divert tidal waters. The cultivation site should be assured of a continuous supply of fresh water and unpolluted sea water. Waste generated by the enterprise that could not be recycled, would be conveniently disposed of in the sea. The extensive facilities at Sea Pool Fisheries Ltd. in Nova Scotia approach this ideally. This corporation has the distinct advantage of owning large acreages of uplands and tidal flats; it selected a non-populated isolated spot for its enterprise and the Provincial Government has assured that the environment would remain that way by strict zoning ordinances and restrictions on navigation and fishing in the vicinity.

Few Maine communities are so sparsely settled that they are able to give such environmental protection and neither the state nor any municipality can provide similar legal protection under the present legal framework or any political feasible future framework.

Diversion of Tidal and Fresh Waters

Provision should be made to encourage aquaculture by allowing diversion of tidal waters which could provide nutrients in a closed system and allow the enclosed area to benefit from the cleansing action of the tide. Such a diversion would be possible under the suggested legislation found in the appendix.

On the other hand, aquaculture in such a closed system may, of itself, constitute a source of pollution. The legal framework must provide not only for protection **for** but also **from** aquaculture enterprises.

The degree of environmental degredation in marine waters from both industrial and domestic sewage is a detriment to aquaculture in an extensive open aquaculture system. A refinement of water classification standards is necessary because of the extreme susceptibility of shellfish to certain toxic elements and the characteristic ability of shellfish to concentrate substances not ordinarily harmful for human consumption to lethel levels. Merely establishing proper criteria, however, will be ineffective until present standards are met.

Another addition to Maine law which might increase the possibility of more extensive aquaculture would be statory authority to dam or enclose tidal creeks or inlets subject to proper restraints as to interference with navigation. This provision is also provided for in the suggested enabling legislation. Also deficient in Maine law is the legal inability of the State to control and regulate the flow of water in streams that flow into tidal estuaries. Often the depth of the water and the salinity are important factors in the growing process of either artificially or naturally occurring marine species. Legal resolution of this inadequacy may involve repurchase or taking of flowage rights that have previously been given or sold by the State.

Cultivation in Polluted Areas

State health regulations prohibit harvesting of shellfish from polluted areas. Any area which fails to meet minimum standards is closed by the Department of Sea and Shore Fisheries. One exception has been made to this strict rule. Shellfish may be taken from mildly polluted areas, under Department of Sea and Shore Fisheries Supervision, and sold commercially provided that they come up to standard health requirements after processing through a depuration plant. /12 M. LR. S. A. 3452, 12 M. R. S. A. 3503/

The upgrading of Maine's coastal waters is a Legislative perogative. The conformity to classification is under the surveillance of the Environmental Improvement Commission. Provisions should be made to allow the Department of Sea and Shore Fisheries, or other persons or agencies working under Departmental authorization and scrutiny, to use presently polluted areas for research and the experimental cultivation of shellfish. Similarly, it should be made legal to recycle domestic and industrial pollutants as nutrients for marine species that can thrive on such enrichment of the food chain without becoming unfit for consumption in the process. Aquaculture has even been mentioned as a means of minimizing pollution by such recycling.

The advantages of allowing cultivation in polluted areas is that such cultivation would not compete with subsistence fishing or commercial harvesting because the flats and areas so taken are already closed to exploitation. A draft of a law which would authorize cultivation in polluted waters may be found in the appendix.

Research Statutes

The suggestion for utilization of polluted areas in the last section highlights the inadequacy of statutory authorization for research activity needed to encourage the cultivation of fishery resources. Even the Department of Sea and Shore Fisheries is handicapped by provisions that a riparian owner's consent is necessary for using tidal flats for research. In the absence of eminent domain, the Department's research plans may be thwarted. More startling is the paucity of provisions for activity conducted by other state agencies, academic institutions, or for private research. The most glaring deficiencies in research provisions are the meager areas that may be used and the relatively short time that an investigator may be assured of retaining the experimental site.

Not only must provisions for research for both the Department of Sea and Shore Fisheries and other private or public entities be liberalized but there must be statutory authorization to proceed from the table-model pilot project to cultivation on a commercial scale. Research must provide the data necessary to gain political acceptability for curtailing the public right of fishing by documenting projections of the overall profitability of aquaculture and its multiplier effects on the economy of a community.

Present research provisions may be found in 12 M. R. S. A. 3701-3705. Suggestions for revision of these sections may be found in the appendix.

Inflexible Laws

By Maine law, the Commissioner of Sea and Shore Fisheries is directed to enforce the fishery laws as enacted. Statutory exceptions to the strict adherence to these laws have been provided for Departmental personnel and certain federal counterparts but do not apply to other state agencies, educational institutions, or private individuals or corporations. Whatever justification there may be for such strict adherence for commercial fishing in general, the rationale seems very thin when applied to research activity, especially to private or semi-private institutions whose sole concern is enhancing the species or increasing the total of knowledge about such species. It is unfortunate that there are no provisions for the use of modern equipment and techniques or that, in some cases, their use is forbidden.

The same frustration felt by persons engaged in research on marine species is undoubtedly shared by persons involved in the commercial aspects of fisheries who are precluded from economic management of fishery resources. Aquaculture has sometimes been defined as farming rather than hunting but in the case of sedentary shellfish such as clams, quahogs, and mussels, the distinction is largely a matter of semantics. Projection of tremendous increases in the yield and in the economic return from these mollusks have been made by Departmental research personnel. These projections have been predicated on scientific management and mechanical harvesting facilitated by granting of exclusive leases for clam cultivation. The present law, with its insistence on inefficiency and waste in harvesting clams by the clam hoe, is based on historic socio-economic conditions.

As in the past, pressure may be brought to bear on the Legislature to retain such crippling provisions in the law. However, the State should at least experiment with modern methods to determine possible increases in productivity.

A special research license would overcome a presently formidable obstacle to aquaculture. The research license could cover both scientific research and research on a scale that would make it possible to appraise the results of scientific management. It would not be unreasonable for the Commissioner of Sea and Shore Fisheries to attach whatever conditions and regulations that he thought appropriate in the issuance of such a license. It is recommended that the Commissioner have this tool to advance the economic and biological potential of Maine's marine resources.

A draft of provisions for such a license has been included in the appendix.

The Leasing of Extensive Areas

One of the deterrents to commercial aquaculture in Maine is the inability of a cultivator to obtain sufficient acreage with exclusive rights to the cultivated species to make the project economically feasible.

The Commissioner of Sea and Shore Fisheries may lease only one acre on the flats to a person interested in scientific research or the commercial development of fish or shellfish. Below low water mark the same modest acreage is allowed for fish or shellfish with only slightly more ample areas allowed for seaweed cultivation and harvesting.

Legislation should be enacted to authorize retention of larger areas for aquaculture. A combination of a limitation on total acreage that any one person or corporation could lease for cultivation coupled with provisions for competitive bids on prime areas would minimize possibility of abuse from such liberalized laws. [A suggested amendment to the present law is included in the appendix. Present law may be found in 12 M. R. S. A. 4304, 12 M. R. S. A. 3703.]

Long Term Leases

While total amounts of subaqueous land, water area, or flats vary from species to species, on almost universal requirement for any aquaculture endeavor is a long term renewable lease which gives the cultivator a property interest which he may assign, convey, or devise. In some states submerged land has been sold, but the better policy would be the long term lease.

The renewable twenty year leases granted by the Maine Mining Bureau, a competitor in the marine environment, stand in sharp contrast to the six year maximum term for which the Department of Sea and Shore Fisheries is authorized to execute a lease. Municipal shellfish authorities may grant leases up to ten years for cultivation on flats and tidal creeks. There is no guaranteed right of renewal for either of these types of leases. [Present law may be found in 12 M. R. S. A. 3703, 12 M. R. S. A. 4304. Suggested amendments to present law are included in the appendix.]

Free Floating Devices

Cultivation of marine species takes place not only in closed systems, on flats, and on subaqueous land, but also in free floating equipment. Maine has not statutory provision for the authorization of oyster rafts, cultivation cages, or other floating devices. Although they may be of any size, 20′ x 20′ x 5′ would correspond to approximate dimensions that have been contemplated by one cultivator for culture in Maine. These devices would be anchored in navigable waters and would require sanction by the United States Army Corps of Engineers and adherence to any applicable Coast Guard Regulations. The federal interest would be primarily directed towards the needs of navigation while the state interest would be more encompassing and could be exercised better by licensing and supervising the utilization of such equipment. An authorizing statute has been suggested in the appendix.

Riparian Rights

Although the riparian owner has been rightly accorded certain preferences and perogative, his preferential treatment should be limited to his right to free coming and going and the opportunity to use the marine area immediately adjacent to his property. There seems very little justification for his ability to tie up the area if he is not going to make use of it himself. The inordinately large vo˙ce of the riparian owner is contained in the oyster cultivation statute, 12 M. R. S. A. 4253, the research statutes 12 M. R. S. A. 3701-3, and the clam cultivation statute 12 M. R. S. A. 4304. Suggested amendments to these laws have been included in the appendix.

The Residency Requirement

Although a residency requirement, either of the state or the municipality, has not been written into cultivation leases for research activity granted by the Department of Sea and Shore Fisheries, the prerequisite is still retained in cultivation leases for oysters and clams. This requirement does not seem in the best interest of the State if the State wishes to encourage aquaculture investment and development. The availability of capital and inclination probably has little correlation with residency in a suitable locality or the State. Preference could be given to residents, the Department or the Municipality, who could decline to grant a lease to a non-resident if it seemed in the best interest of the granting authority. Any prohibition against non-residents seems unwarranted. Amendments to present law to remove this requirement have been made in the appendix.

Jointly Allocated Areas

Despite the fact that appropriate areas for aquaculture on tidal flats do not always correspond to political boundaries, there is no law which authorizes more than one municipality to join together to issue cultivation leases. Precedent for such an arrangement may be found in the authorization for municipalities to enter into an agreement for joint allocation might be possible under present law by a strained interpretation of that provision, a clear cut authorization would be more desirable. Recommended amendments to present law have been made in the appendix.

Rights in the Intertidal Zone

A more extensive cultivation of flats in the intertidal zone presents a complex legal, social and political problem. The legislature has delegated to municipalities the authority to regulate shellfish harvesting and cultivation on municipal flats if they care to exercise the authority. The municipalities may lease up to one fourth of the total area of flats in a municipality for exclusive cultivation, but this provision has not been extensively used. Local fishermen's reluctance to see flats taken for exclusive cultivation is understandable. The large areas of clam flats closed because of pollution compound the problem and increase the intensity of potential conflict between the cultivators and the diggers.

Although the legislation enabling a municipality or the state to grant exclusive rights on tidal flats has been judicially sanctioned, a real question remains as to whether these flats can be tied up by long term leases. The Maine Supreme Judicial Court must further clarify the riparian versus public rights in the intertidal zone before any large scale aquaculture will take place in this area. If the Court should rule more heavily in favor of private rights, obtaining a riparian's permission might have to be considered a necessary expense of any aquaculture investment. The ruling in the recent litigation in which the State Wetlands Control Board's denial of a petition to fill in tidal lands was not upheld by the Maine Supreme Judicial Court makes this problem a very appropriate and timely one for aquaculturists. Persons who obtain a lease under present law may question the validity of a municipal or state grant against the wishes of a riparian owner.

Because of legal uncertainty in the intricate interrelationship between private property, riparian rights, public rights, and the livelihood of local inhabitants, it is recommended that responsibility for cultivation of clams, quahogs, and mussels be left with municipalities. Consideration should be given to allowing the state to grant cultivation leases if the municipaltiy was not exercising its option to regulate these fisheries. A clarification of property rights in the intertidal zone is imperative for any extensive investment in this area. Until the Maine Supreme Judicial Court rules on this important question, state or municipal jurisdiction is unimportant.

A possible solution for the reconciliation of scientific management of these flats and the historical use of these areas by clam diggers might be authorization for the formation of fishermen co-operatives composed only of resident licensed diggers. Land suitable for aquaculture could be allocated to these associations which in turn could conduct cultivation on the land as an association, could sub-let the land to one of its members, or could sub-let the flats to the State or even an individual or corporation who was not a resident of the municipality. Although no more than one fourth of the tidal area of flats in a municipality may now be leased, there should be no limitation on the amount of land that could be leased by the municipality to such an association except that such land was certified as suitable for aquaculture by the Department of Sea and Shore Fisheries or a coastal management authority. Such an arrangement would retain local control of land usage and give persons (who might be denied subsistence because of the granting of exclusive franchises) a voice in the granting process and possible tangible economic benefits from the cultivation effort. This type of association is referred to in the planning implications sections.

Social and Cultural Constraints

A formidable obstacle inhibiting the development of an aquaculture industry in Maine is the individualism of Maine's coastal inhabitants. Although the independent manner of these taciturn citizens enthralls tourists, it has also dislodged many attempts to gain a foothold for even minimal aquaculture development on the Maine coast.

Efforts to introduce aquaculture have often failed because aquaculture requires the cooperation of large numbers of people. State and local governments must solve legal problems as well as problems of attitude, and local men must either labor for "outside" organizers or attempt to work together in an equally uncomfortable hierarchy of responsibility. Although ignored by public relations men, the individual's preference for self-reliance is usually tightly interwoven with a keen distrust of organization. The changes in laws, traditions and personal hierarchies requisite for aquaculture do not come easily in this environment. Many coastal organization failures can be attributed to this problem, and each failure increases the individual's conviction that he is wise to labor alone.

The Maine native also considers the ocean to be his, not the property of all Maine people. Like his ancestors, he braves the sea's worst weather to make his living. He feels that his work, as well as his ancestors, has made him a trustee of the sea, with the right to determine its use. This attitude is incompatible with the concept that the sea is a public resource to be used for the public good.

A major reason for developing aquaculture in Maine is to provide a more stable economy and employment for coastal residents without disrupting their lives. Many who glorify the Maine resident in summer never see him in winter, never visit his homes or schools and do not fully understand the strain of raising a family on the offerings of the unpredictable sea. In many cases, the Maine people could change their own laws to help themselves immediately. The scientific evidence to provide the direction is already available. It is clear that the tradition of limiting the use of the sea to individuals and limited pressure groups hurts the people of Maine as a whole.

The attitudes and problems of the coastal fisherman are well understood by Ivan W. Fly, President of Seafoods U.S.A. of Damariscotta. His firm exports lobster, shrimp and bloodworms to all parts of the United States and Europe and depends entirely upon individual fishermen for products. Mr. Fly estimates that he could have marketed at least fifty percent more of his products in 1970 if that amount had been available. Mr. Fly: "We cannot indefinitely continue to operate in the 1970's as we did in the 1930's. Petty jealousies and a lack of willingness to help anyone but yourself is what is killing the infant marine industries of Maine."

Water pollution is another area where the public attitude inhibits the development of aquaculture. Until recently the public has been uninformed and unconcerned about the pollution of rivers, bays and estuaries by industries and municipalities. Recent legislation, particularly on the Federal level, recognized the problem and set deadlines for cleanup. However, due to shortage of Federal matching funds and weak enforcement policies, the timetable may not be met.

Although some exceptions exist, aquaculture is not feasible in the large coastal areas of Maine which are polluted by land based industries and population centers. Each year more valuable acres of clam flats in Penobscot Bay are closed because of pollution. The heated debate over Machiasport made the public so sensitive to oil pollution that a spill of fifty gallons in Casco Bay makes news, but little is written of the six million gallons of raw sewage dumped into that bay daily. The effect of this sewage on marine life is tragic. And the problem is growing.

The dilemma is that aquaculture is only a potential industry, while the polluters are actually providing a living for many Maine people. The practical wisdom in closing down these polluters for the sake of a clean environment for a long-range aquaculture industry would be severely questioned by State and local officials. If tough enforcement of present statutes is demanded by the public, and if industry can solve its technological cleanup problems, a long-range solution may be possible.

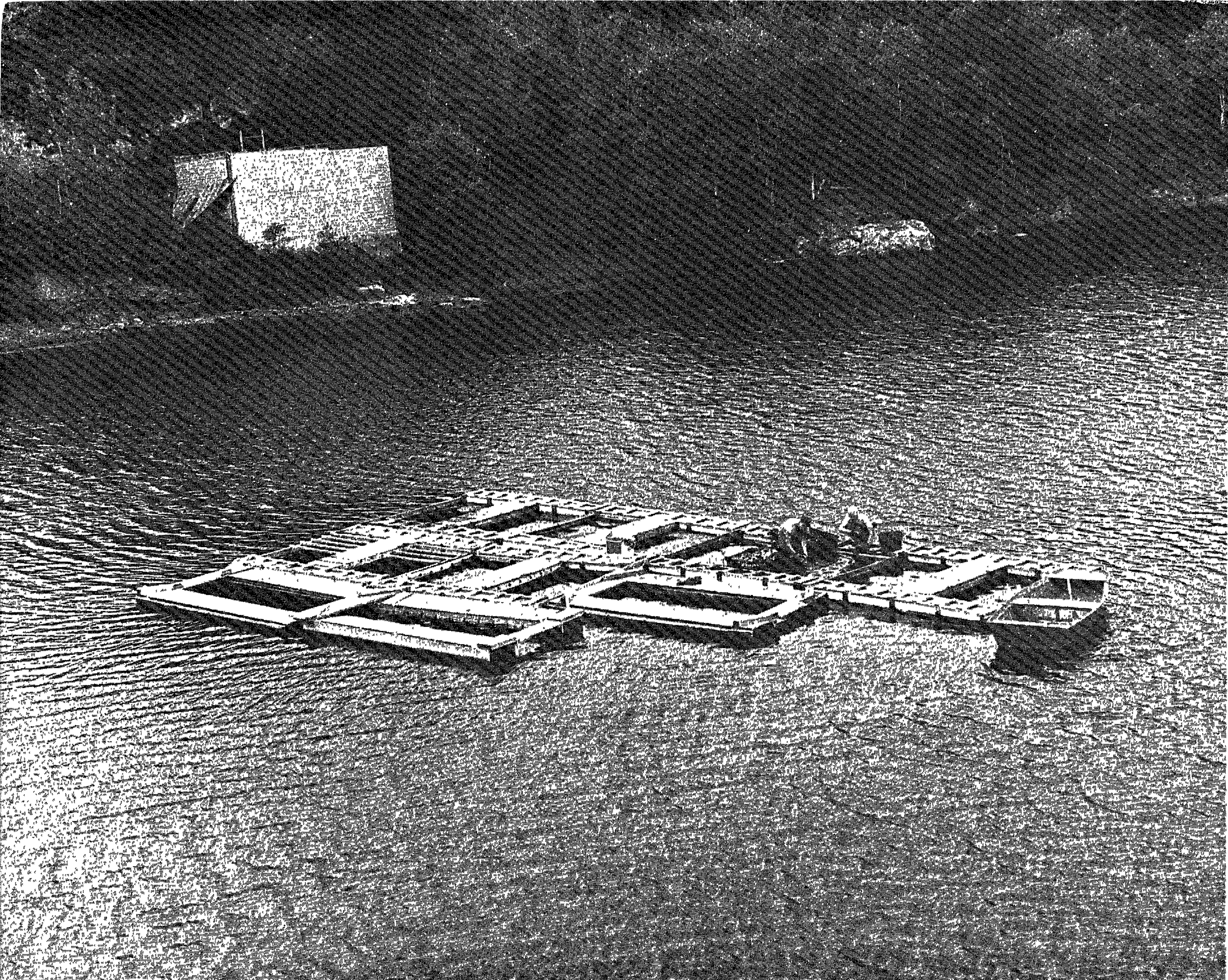
Aquacultural research is currently being conducted in bacterially and thermally polluted waters. Even now, clams raised in bacterially, polluted flats are marketed after treatment in water sterilized by ultra-violet light. Maine Yankee, operators of the Wiscasset nuclear power plant, have underwritten numerous attempts to raise trout, lobsters, and bloodworms in the thermal effluent of the plant. However, even if this research is successful, the public may not be particularly eager to buy foods raised in an environment actually polluted by bacteria or potentially polluted by radioactivity. While there is no scientific evidence of significant radioacivity around nuclear plants, careful control and surveillance of power plant effluents to reduce the dangers to life and environment will be essential and is no doubt technically possible once mutual relationships and benefits are more clearly understood by aquaculturalists and power suppliers. The ecology or whole earth movement, once considered a fad is an influencing factor in the commercial success of a product, as officials of the tuna and swordfish industry have noted.

Cultural impediments may exist for the types of food produced through aquaculture. The initial problem, as discussed in the economic section of this report, is that unlike Japan, China and parts of Europe (land shortage areas), ours is a meat eating nation. Meat, though expensive, is easily available and our transition to a greater dependence on fish foods may be lengthy.

PLANNING IMPLICATIONS

The essence of planning in any realm is anticipation and accommodation. Planning for aquaculture in Maine, therefore, requires some technique for anticipating its impact and for accommodating its use within a framework of other competing resource demands. Typically, planning projections for future use are based upon an extension of past trends. This is difficult for aquaculture because of its novelty to Maine, its lack of clear identifiable technology elsewhere, and its threat to local ingrained fishing methods.

Planning projections should be derived not only from past trends but also in accord with future objectives. Due to the relative newness of aquaculture in



Maine, opportunity exists for satisfying such future objectives. A major goal toward which public programs for the development and use of marine resources can be appropriately directed is to maximize the present value of expected net social benefits to be derived from Maine's marine environment. This goal can provide the direction for planning decisions in the field of aquaculture. The interrelationships between aquaculture and other coastal uses have a significant impact on the achievement of the above goal. The planning implications associated with these interrelationships are discussed in the next section. A more complete discussion of the benefits which can be derived from the total interaction of all the component industries is given in the section "Proposed Industrial Recycling — Multiple Use System."

Multiple Use Concept

Providing for the accommodation of aquaculture will require a careful consideration of the multiple use possibilities of aquaculture, or, simply, a look at the ability of aquaculture to get along with other existing and potential coastal uses. There have been many multiple use possibilities advanced for aquaculture.

One method is using thermal effluents or other types of pollutants to enhance growth of various species. Electric power-producing industries are anxious to prove the compatibility of thermal effluents with fishery resources, thereby improving their environmental balance sheets. A large number of environmental studies, funded through Maine Yankee Atomic Power Company, is being conducted by various research organizations. The Ira C. Darling Center of the University of Maine is collecting basic information on the ecology of the power plant site area, while the Department of Sea and Shore Fisheries is evaluating the potential of heated sea water as a medium for the aquaculture of eastern and European oysters, quahogs, bloodworms and edible mussels.

Some of the major problems faced with the use of thermal effluents to enhance growth of marine species are:

1. Often cyclical nature of temperature of thermal effluents and the possibility of complete shutdown as a result of malfunction or performance of normal repairs.
2. Although heated water is a definite stimulus to growth during winter months, particularly in Maine's cold water environment, heated water can be lethal to many fish species during other times of the year.
3. Various waste products are occasionally discharged into the effluent, including acid waste, domestic waste, low level radio-active waste, and chlorine used to minimize fouling in heat exchange coils.

Most of these drawbacks to the use of thermal effluents for the increased stimulation of specie growth can be alleviated through the promotion of a high degree of cooperation between the two industries. Arrangements can be devised to divert excess thermal waters and other waste products, possibly through separate piping systems. Cooperative planning between aquaculture enterprises and power plant operations is needed to minimize the effect of plant shutdowns. Dual reactor plants are designed to run continuously with either one or both reactors operating, and are particularly well suited to aquaculture. Due to the possibility of a power plant shutdown, native species have a distinct advantage since they will survive in the cold water environment.

Another example of a multiple use possibility is an aquaculture operation which will utilize certain types of pollution. Maine's Department of Sea and Shore Fisheries has for many years used polluted flats and tidal areas for aquacultural research purposes. Studies on the utilization of wastes and by-products for the production of fish indicate that domestic sewage can serve as nutrient sources for the growth of algae which in turn can be used as a source of food for culturable species. The utilization of sewage in a combined algae and fish culture system produces a useful product while at the same time substantially reducing the polluting effects of waters.

The multiple use concept provides some distinct opportunities for aquaculture enterprises in Maine. This concept is explored further in the final section of this report.

Public Corporation

A recently advocated economic incentive for aquaculture is the concept of a public corporation. Many potential aquaculture operations are at present only marginal as an economically viable enterprise. Yet such activities might be profitable individually to fishermen who are now making a marginal living from the sea. Many of these fishermen do not have the large amounts of capital required to underwrite even an initial investment in such an undertaking. Some form of a public corporation or cooperative for such a venture would assure that while the public at large might be deprived of the common right of fishing by the leasing of an exclusive cultivation area, those most dependent on fishing would be benefitted. This would make particular sense for clam cultivation in the intertidal zone — an area historically available for subsistence fishing.

Another possibility for the utilization of a public corporation would be to raise lobsters, a specie uniquely qualified to be cultured in Maine. The extent of control necessary to supervise the growing, harvesting, marketing and selling of a greatly increased yield might more properly fall under a public rather than a private corporation. The possibility of public investment in such an undertaking would allow those who have traditionally pulled lobster traps an opportunity to benefit from a venture that otherwise would basically be in competition with their efforts. Care must be taken in such a venture, however, that strict scientific management and fiscal accounting are not victims of a non-competitive bureaucracy.

There are many other possibilities for fishing cooperatives or public corporations and each situation would require different legal implementation. A bill which will provide the basic mechanisms for facilitating the leasing of large areas for commercial aquaculture has been submitted to the legislature.

We recommend this bill be adopted and positive steps be taken to benefit from the provisions that will be established. This can be implemented by establishing a public institution to facilitate the initiation and operation of multiple-use aquaculture facilities. Such an institution would be available in the proposed Maine Land Development Corporation.

Specie Forecast

It is not the purpose of this report to predict which, if any, of Maine's fisheries will line the pockets of our coastal citizens. There are no dream or miracle species upon which aquaculture efforts should concentrate. However, due to archaic laws and to the inadequate funding of state promotional, research and management efforts, Maine's fisheries are at a low ebb. A determined program of governmental stimulation of the fishing industry, like that begun in Canada, would result in a healthy expansion of virtually all segments of the industry. Government leadership in developing a viable aquaculture industry can be one form of support. The following provides an evaluation of the most promising species for aquaculture in Maine.

Species identified as having a high probability for aquaculture in northern New England were screened and ranked in accordance with several factors thought to influence the introduction of aquaculture enterprises in Maine. It is recognized that the evaluation method used is somewhat subjective and based on general considerations. Given more specific, definitive information, other choices might have been made. However, in viewing the prospects for aquaculture in Maine, it is felt that the selections made below offer the best possibilities at this time. Success with those species evaluated as highest, i.e., clams, lobsters, salmonoids, would provide a broad spectrum capability and a sound basis for adding other desirable species at a later stage.

The general factors used to evaluate each specie are weighed to reflect their relative importance. The specie evaluation table along with the weights used for the evaluation factors are shown in Table 1-5.

The time has come to benefit from past research. We recommend the initiation of a publicly sponsored demonstration project to investigate large-scale lobster culture possibilities in Maine due to the lobster's high market price, high demand, and strong consumer recognition. In addition, efforts should be initiated to investigate salmonoids, clams, and sea worms. Once a successful aquaculture industry is operating, with the species mentioned, other attempts to initiate programs with other species will be greatly facilitated. What is needed is a simple, direct commitment to place aquaculture high on Maine's list of industrial development priorities.

With this commitment, the Maine Coastal Plan can begin to devise a rational management scheme for the coast that will form the basis for allocation of areas for aquaculture purposes.

GENERALIZED SPECIES EVALUATION FOR AQUACULTURE IN MAINE

	Price Range (refers to its high or low range or its flexibility with varying supply)	*Market Size* (refers to its geographic range, volume and package acceptability)	*Ease of Culture* (refers to its hardiness, responsiveness to manipulation as well as current knowledgeability as to culture techniques)	*Growth Rate* (refers to specie maturation time to market size as well as its conversion efficiency-food to flesh ratio)	*Environmental Adaptability* (refers to specie's suitability to Maine's cold water environment)	*Institutional Compatability* (refers to specie's degree of interference with other uses & other interests)	*Resultant*
Marine Worms	6	3	0	3	3	1	16
Crabs	4	5	2	0	1	3	15
Lobster	6	5	5	1	3	1	19
Shrimp	5	4	2	1	3	1	16
Mussels	2	1	4	3	3	1	14
Clams	5	3	4	3	3	0	18
Scallops	5	3	3	1	1	3	16
Oysters	4	3	4	1	1	3	16
Salmonoids	5	4	3	2	3	0	17

Priority Weighting Assigned To Evaluative Factors

	Favorable	Limited	Unfavorable
Price Range	6	4	2
Market Size	5	3	1
Ease of Culture	4	2	0
Growth Rate	3	1	0
Environmental Adapt.	3	1	0
Institutional Compatability	3	1	0

TABLE 1-5

FOOTNOTES — AQUACULTURE COMPONENT

1 T. A. Gaucher, "Potential for Aquaculture," TRIGOM Conference on Aquaculture in Northern New England, Oct. 21-23, 1970.

2 State of Maine, Dept. of Sea and Shore Fisheries — 26th Biennial Report for Period July 1, 1968 to June 30, 1970, State House, Augusta, Maine.

3 *Maine Landings*, Annual Summary, State of Maine, Dept. of Sea and Shore Fisheries and Department of Fish & Wildlife Service, 1955-1970.

4 Interview — Ivan W. Fly, January 1971.

5 Robert L. Dow, *Renewable Marine Resource Industry Potential in Maine*, State of Maine, Dept. of Sea & Shore Fisheries, November 1970.

6 Gary K. Gunstrom, "Sea Farming in the Canadian Maritimes," Sea Pool Fisheries, Ltd., Lake Charlotte, Nova Scotia, May 1971.

7 Op. Cit., T. A. Gaucher.

8 J. R. Brett, "The Energy Cost of Living," Marine Aquaculture, Oregon State University Press, Corvallis, Oregon, 1970, p. 51.

9 P. E. Cavanaugh, President of Sea Pool Fisheries, speaking at TRIGOM Conference on Aquaculture, Durham, N. H., Oct. 21-23, 1970.

10 T. A. Gaucher, "Technological Aspects of Aquaculture," TRIGOM Conference Background Material, Oct. 21-23, 1970, p. 15.

11 M. Miller, D. Nash, "Regional and Other Related Aspects of Shellfish Consumption, Paper #74," Bureau of Commercial Fisheries, Sept. 1970.

12 "Northern Lobsters Basic Economic Indicators," Bureau of Commercial Fisheries, Paper No. 53, April 1970, p. 15.

13 Op. Cit., *Maine Landings.*

14 Op. Cit., T. A. Gaucher, "Potential for Aquaculture."

15 "Oysters: Basic Economic Indicators," Bureau of Commercial Fisheries, Paper No. 56, May 1970, p. 18.

16 Op. Cit., *Maine Landings.*

17 Op. Cit., "Oysters: Basic Economic Indicators."

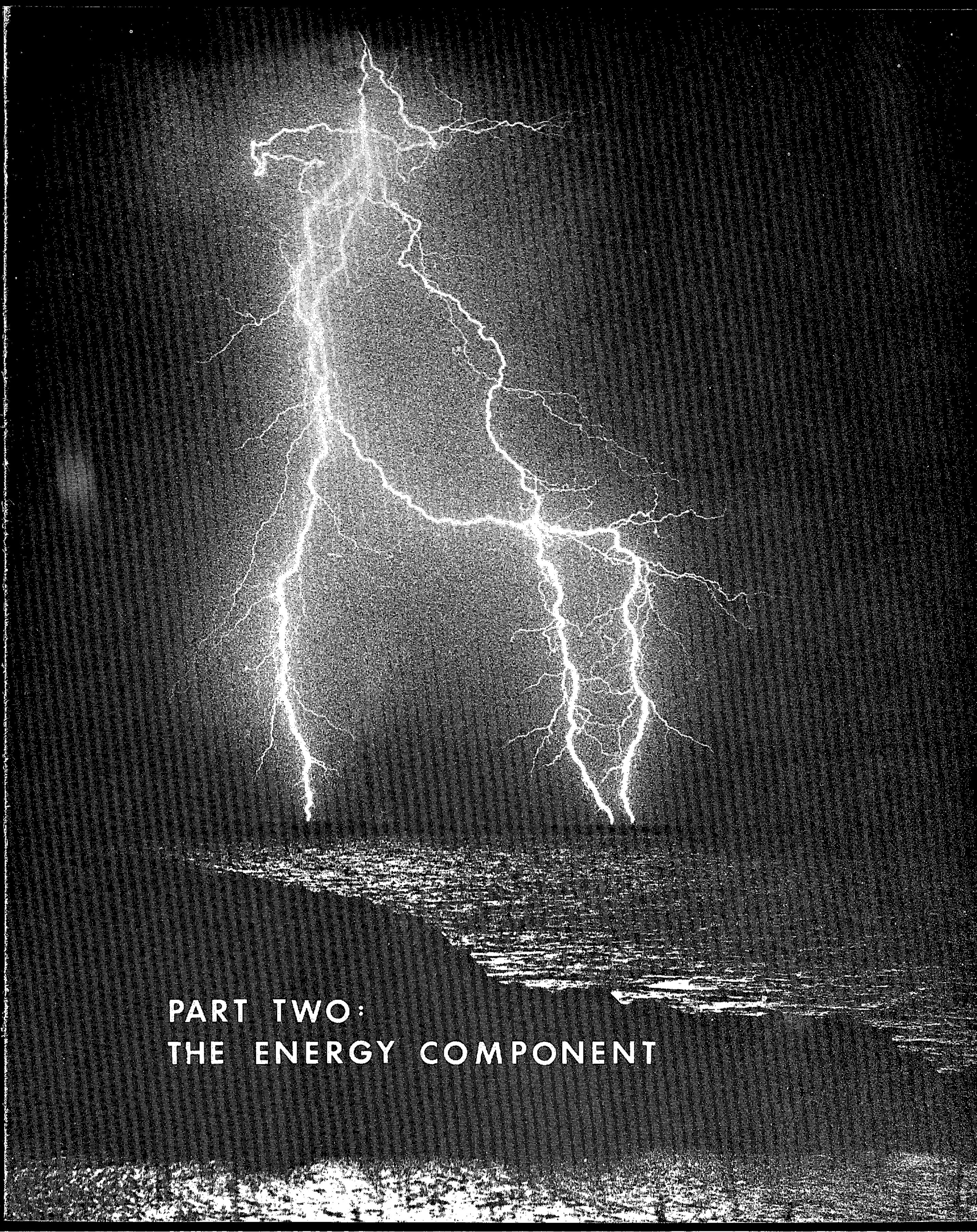
18 Morton M. Miller, Darrel A. Nash, "Regional and Other Related Aspects of Shellfish Consumption, Bureau of Commercial Fisheries, Paper No. 24, 1970, p. 12.

19 "Salmon: Basic Economic Indicators," Bureau of Commercial Fisheries, May 1970, p. 26.

20 J. M. Gates, G. C. Matthiessen, "Determinants of Success in Aquaculture," TRIGOM Conference on Aquaculture in Northern New England, Oct. 21-23, 1970.

21 Op. Cit., Robert L. Dow.

22 T. A. Gaucher, "Thermal Enrichment and Marine Aquaculture," Marine Aquaculture, Oregon State University Press, Corvallis, Oregon, 1970.



PART TWO: THE ENERGY COMPONENT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INTRODUCTION TO THE PETROLEUM STUDY

Petroleum and the Coastal Zone

The goal of the Maine Coastal Plan has been stated as follows: "To develop a comprehensive plan providing for compatible and multiple uses of the coastal zone, optimizing those intrinsic and real values assuring the greatest long term social and economic benefits for the people of the State of Maine." One challenge facing the plan is to develop workable guidelines with regard to the expansion of the petroleum industry as it relates to the Maine coast.

The controversy surrounding the proposed oil refining complex at Machiasport has continued for nearly three years; the proposed oil storage depot in Casco Bay, seemingly ended by governmental order, is still shrouded by a legal question; geophysical surveys of the east coast ocean floor (a prelude to off-shore oil and gas exploration) have been financed by a number of major oil companies, and the constitutionality of the recent legislation pertaining to the coastal conveyance of petroleum is being contested in the Maine courts. More recently, an oil desulfurization refinery as part of a marine-industrial park at Sears Island has been proposed. All of these actions have focused widespread attention on those facets of the petroleum industry operating within the coastal zone. This investigation of the oil industry centers its attention on the factors that most directly affect the coastal zone. For example, the impact of petroleum trade on harbor activity, the ability of existing harbor facilities to meet future demands of the industry, and the ability of the coastal waters to meet the navigational requirements of future oil tanker transportation. In addition, an economic analysis of the industry in the state has been conducted to include the situation at present and estimates of economic changes over the long term.

The basis for workable guidelines for the coastal plan must be accurate, objective data coupled with the best available estimates of future trends. It is the overall goal of the Petroleum Study of this public investment plan to provide this information.

Before examining the status of the petroleum industry in the State, a few general facts about the coastal zone should be reviewed. The number of miles of Maine coastline is the greatest of any state north of Florida. Portland Harbor handles more tonnage than any New England port and is the second largest crude oil port in the nation. In recent years about 98% of the tonnage handled at Portland has consisted of some form of petroleum. The harbor accommodates tankers of approximately 110,000 dwt. with a maximum draft of 45 feet. (The much talked about super tanker fleet of the future is focusing on 200,000 dwt. vessels, although Gulf Oil Corporation has 326,000 dwt. tankers in operation.) Further up the coast, Searsport, capable of handling ocean going vessels with a draft restriction of 38 feet, is very active in petroleum trade. Approximately 85% of the tonnage handled at Searsport consists of petroleum products. Close to Searsport, on the Penobscot River, is Bucksport. Bucksport and river traffic to Bangor are heavy in the trade of petroleum, with over 90% of the volume handled attributable to oil.

It is obvious, after reviewing these facts, that the actions and plans of the petroleum industry are a primary input to the Maine Coastal Plan. The integration of the social and economic aims of both the people of Maine and private business must be accomplished. To allow either the citizenry or industry unfair advantage is creating an unhealthy situation. Each is dependent on the other and the healthy advancement of one is the healthy advancement of the other.

SUMMARY OF EXISTING SITUATION IN THE MAINE PETROLEUM INDUSTRY

An Overview of the Industry

The purpose of this initial section of the study is twofold: (1) to provide an overview of the petroleum industry with respect to its structure, its functions, and its importance as a supplier of raw energy; and (2) to establish a base level of information from which projections of economic activity can be made.

The petroleum industry in the United States is comprised of a number of large integrated international corporations. For 1969, Fortune's listing of the 500 largest industrial corporations by sales noted seven oil companies in the top twenty with combined sales of $48 billion. The industry is highly capitalized, leading all industries in assets per employee and sales per employee while ranking near the bottom in terms of sales per dollar of invested capital. It is important to identify the capital nature of the industry.[1]

Turning to the State of Maine, the value of petroleum products crossing Maine boundaries each year is estimated to be $541,000,000.[2] The product mix of petroleum entering Maine and the structure of the industry are unique. The industry can actually be divided into two distinct segments, one concerned with transporting crude petroleum, the other with marketing refined products. Explanation of these two functions follows:

1. **Transporting crude petroleum** — International tankers off-load crude oil at Portland Harbor; a major pipeline system then carries the oil to Canadian refineries near Montreal. This function accounts for approximately 80% by volume of all the petroleum products crossing Maine boundaries.

   Crude petroleum is oil in its natural form as it flows from the well head. The crude petroleum arriving at Portland Harbor originates from Venezuela. All the crude oil is handled by one firm, the Portland Pipe Line Corporation, at Portland Harbor. We will discuss the transporting of crude oil in a later section.

2. **Marketing refined petroleum products** — Approximately 90-95% of the total energy requirements of the people of Maine are supplied either directly or indirectly by petroleum products which originate from sources outside Maine. The receipt, storage, distribution and sale of refined products are carried out by an extensive marketing network comprised of major oil companies and numerous independent dealers.

   With regard to refined products, it is necessary to explain the major items in this category. The following list contains the products that account for almost 100% of the market in refined products, both in terms of physical volume and level of sales. This study will make reference to these product categories rather than selecting particular products, of which there are many, some known by more than one name.

TABLE 2-1

MAJOR REFINED PETROLEUM PRODUCTS

Product Category	Principal Use and Related Notes
● Gasoline	Internal combustion engines — includes all octaine ratings — Retail sales carry a $0.08 State tax and a $0.04 Federal tax per gallon.
● Jet Fuel	Turbojet Aircraft Engines
● Kerosene	Heating — Maine's per capita consumption of kerosene for heating is the highest in New England.
● Distillate type / Heating Oil	Heating — Households and small establishments, close to 90% of sales are No. 2 oil.
● Distillate type / Fuel Oil	Internal combustion engines (diesel type), several grades of diesel fuels for specific uses.
● Residual type / Heating Oil	Heating, large establishments, residuals must be heated for handling.
● Residual type / Fuel Oil	Utility companies, for generation of electrical energy, also large vessels.
● LPG	Cooking and heating — Liquid petroleum gas, also known as bottled gas.

Estimate of Dollar Value of Petroleum Products

Any attempt to establish the dollar value of petroleum products entering the State of Maine is faced with the problem of price changes. At present the petroleum industry is plagued by a worldwide shortage of tanker transportation. Oil industry spokesmen claim that the continued closure of the Suez Canal, forcing tankers from the Persian Gulf to travel around Africa, the shutdown of the Tapline across Syria, and cutbacks in Libyan oil production by government directive, have all contributed to this situation. As a result chartered tanker rates have approximately tripled. This action has particularly affected the price of residual oil in New England, much of which is imported. In addition, recent legislation requiring the use of low-sulfur fuel has increased the demand for this type of fuel in excess of supply capability. The heavy upward pressure on the pricing schedule is considered to be a short term phenomenon and will equilibrate over the long term. Therefore, for the purpose of this study, we have attempted to discount the short term situation.

Our analysis uses the year 1968 as base data partially because of the price structure problem just cited (during 1968 oil prices were reasonably stable and consistent with general trends) and partially because the types of information needed for this study were last reported in detail for that year. Another associated problem is that not all users pay the same price for certain types of oil. Large volume users obtain their oil through negotiated contracts and the price per barrel can vary significantly. Our estimates are the average price paid for the year 1968. Table 2-2 gives the dollar value of each major product category. In Table 2-2(A), similar information is given for the crude oil handled at Portland Harbor as well as other details pertaining to that operation.

TABLE 2-2

CONSUMPTION PICTURE — 1968 — STATE OF MAINE
(Refined Products)

Product	Volume*	$/Bbl.	Total $ Value
● Gasoline	10,300,000 bbls.	$10.30**	$106,000,000
● Jet Fuel	941,500 "	6.30	5,940,000
● Kerosene	2,285,000 "	6.30	14,400,000
● Distillate type/Heating Oil	8,540,000 "	6.30	53,200,000
● Distillate type/Fuel Oil	1,232,000 "	6.30	7,750,000
● Residual type/Heating Oil	2,280,000 "	2.00	4,560,000
● Residual type/Fuel Oil	12,370,000 "	2.00	24,740,000
● LPG	590,000 "	11.00	6,500,000
	38,538,500 bbls.		$223,090,000

* Source of Volume Data — Yankee Oilman,
Fuel Trades Fact Book — March 1970
Residual Oil Calculated from Tonnage Handled at Ports

** Gasoline price does not include Federal and State Tax

1 barrel (bbl.) = 42 gallons
See Table 2-1 for Product Definitions

TABLE 2-2(A)

CRUDE OIL — ESTIMATED VALUE (1968)			
Crude Oil	140,000,000 bbls.	$2.27	$318,000,000

* Venezuelan crude — price quote Fortune September 1, 1967

PORTLAND PIPELINE INFORMATION

Year	Volume	Bbl/day	No. of Cargoes
1970	156,220,000	428,000	445
1969	142,928,000	392,000	438

Pipelines	3 to Montreal 24″-18″-12″
Design Capacity	Present capacity 528,000 B/D to be increased in 1971 to 550,000 B/D with further increases up to 627,000 B/D possible with existing lines.
Storage Capacity	3,560,000 bbls. (max.) 3,120,000 bbls. working capacity
Payroll	$1,300,000 — $1,200,000 annually
Operating Cost (direct)	$4,000,000 — $3,500,000 annually
Property Tax	$524,000 annually
Secondary Benefits	Estimate of $10,000/ship spent at Portland Harbor facilities — approximately $4,400,000 on an annual basis.

Source: Portland Pipeline Corporation

It should be noted that this estimate shows only the dollar value of the products consumed or transported in the State of Maine. It does not attempt to measure the value added by Maine concerns.

Personal Income and Petroleum

To establish an economic perspective, it is necessary to look at the entire Maine economy. Table 2-3 presents information pertaining to personal income for the State of Maine. Personal income is the sum of all payments received for participation in current production. The transfer payments referred to are payments for other than productive services, i.e., relief payments, veterans' benefits, etc.

TABLE 2-3

PERSONAL INCOME — STATE OF MAINE
(in millions of dollars)

	1968	1969
Wage and Salary Disbursement	1,785	1,911
Farms	21	22
Contract Construction	89	108
Manufacturing	651	674
Wholesale/Retail trade	283	309
Finance, Insurance and Real Estate	66	72
Transportation, Communications, and public utilities	107	117
Services	178	199
Government	382	402
Other industries	7	7
Other Labor Income	98	106
Proprietor's Income	271	305
Property Income	401	431
Transfer Payments		
Less: Personal contribution for social insurance	(94)	(107)
Total Personal Income	2,768	2,987

Source: **Survey of Current Business,** August 1970

This income was generated by a labor force of approximately 380,000. The oil industry employs on the order of 6,000 persons or 1½% of the labor force. It is difficult to make an accurate estimate of the contribution that the oil industry makes to total personal income. However, wages and salaries are on the order of $30,000,000 which represent about 6% of all wage and salary disbursements in Maine. Many retail establishments in the oil industry are proprietorships; therefore, considerable income accrues to owner/operators. In addition, a sizeable portion of property income can be attributed to the industry.

Primary and Secondary Benefits of the Maine Petroleum Industry

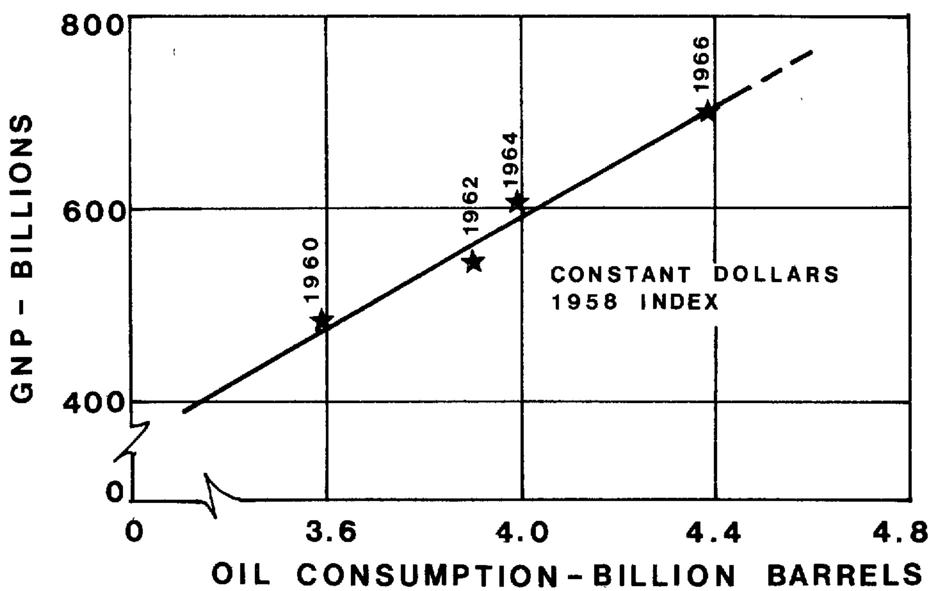
As we have already pointed out, the petroleum industry does not play a dominant role in the employment picture in Maine nor does its contribution to personal income appear to be a significant factor. Certainly those individuals relying on the petroleum industry for their livelihood will be quick to differ with this opinion but in the overall context the statement is an accurate one. What is it then that does make the industry such a dominant force? **It supplies raw energy.**

A key indicator of an area's standard of living is the amount of energy each individual has available for his use. Twentieth century life styles of the industrialized nations, as well as future economic growth, are directly dependent on the availability of energy and the ability to transform that energy into productive uses. The simple fact that the petroleum industry is the main supplier of raw energy goes a long way toward explaining its importance to modern economic life. For example, in the State of Maine 98% of all households are heated by oil.[3] (This compares with a national average of 36%.) Virtually all forms of transportation in the State utilize a petroleum product as fuel. Of the electrical generating plants in the State using fossil fuels as a source of raw energy (approximately 60% use fossil fuels, the balance using water power), the fossil fuel is a petroleum product.[4] Industrial, commercial and institutional heating requirements, as well as industrial process requirements appear to use a high percentage of petroleum products.

What does this heavy dependence on petroleum products mean? It means that one of the inputs required to sustain the present level of economic life and to foster future economic growth is petroleum. Why doesn't Maine use alternative forms of raw energy? Basically because other forms are either in short supply or hindered by technical difficulties. The relatively low population density of the State of Maine and the distance from supply sources contribute to the high distribution costs associated with energy marketing in the State. These factors account partially for the lack of competitive forms of energy. Perhaps the most graphic way to show the relationship between the productive output of an area and its consumption of energy is to present the historical data available for the United States. Figure 2-1 presents this information.

GRAPH FIGURE 2-1

GROSS NATIONAL PRODUCT AND OIL CONSUMPTION



Consumption of Petroleum Products

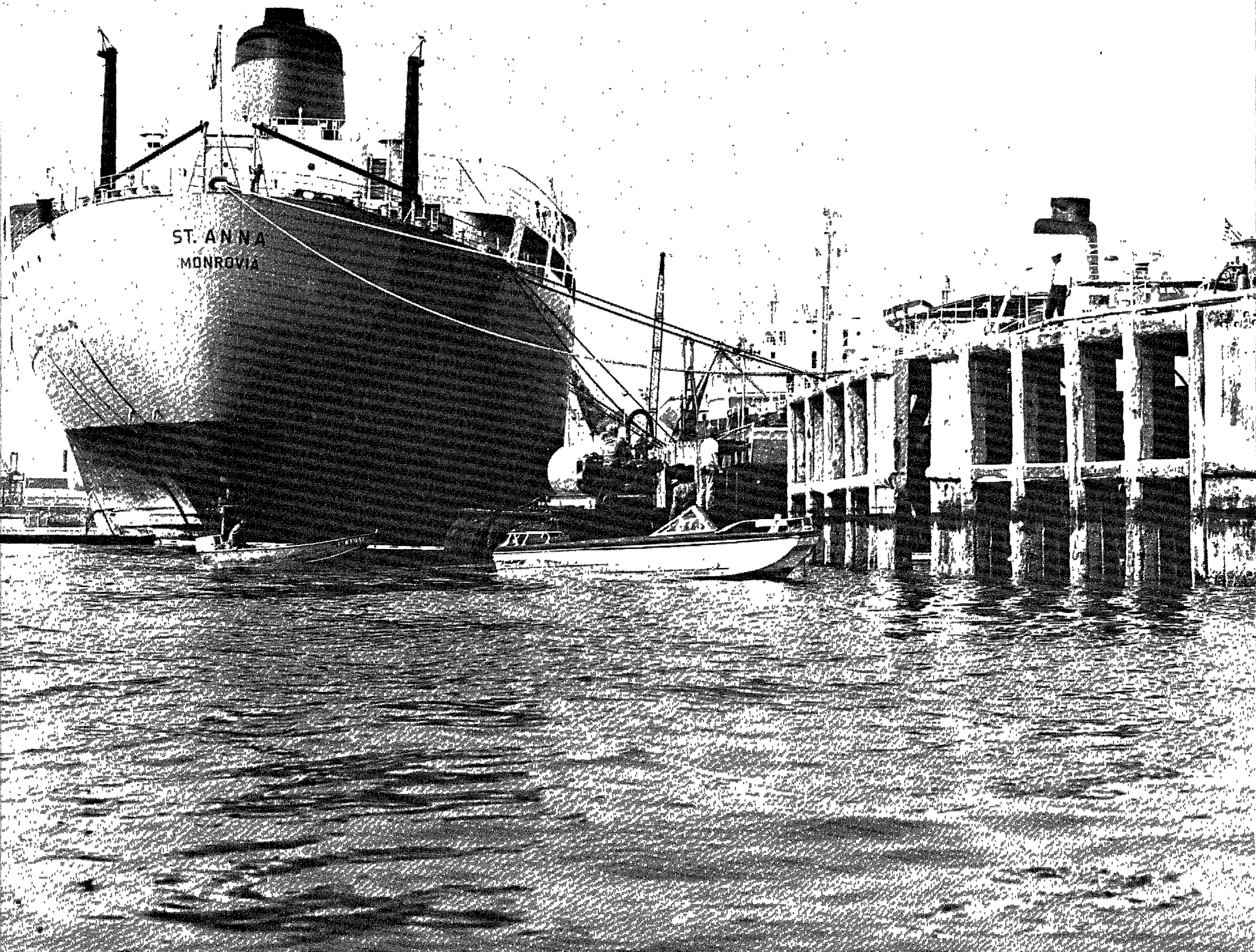
A general study of energy economics by the Chase Manhattan Bank in 1968 suggests that the major uses of petroleum can be broken down into four major categories: (1) Transportation, (2) Residential Heating, (3) Electrical Utilities — conversion of thermal energy into electrical energy, (4) Industrial/Commercial — use as an energy source in production processes. Carrying this breakdown one step further we have determined the various products consumed by each major use. These data will be particularly useful in the forecasting phase as the growth rates of the major uses are more easily estimated than the growth rates of the individual products. The close correlation between major use and the amount of petroleum products consumed by each use increases the level of confidence associated with parameter estimates. Table 2-4 presents the breakdown of petroleum products by major uses of energy and is a general indication of the importance of particular petroleum products with respect to type of final consumer.

TABLE 2-4

BREAKDOWN OF PETROLEUM PRODUCTS BY MAJOR USE OF ENERGY (1968) IN MAINE

1. **Transportation**		
Motor Gasoline	10,300,000	
Jet Fuel	941,500	
Kerosene	49,000	
Distillate Fuel Oil	737,000	
Residual Fuel Oil	1,750,000	
LPG	53,300	
		13,830,800 bbls.
2. **Heating — Residential**		
Kerosene	2,236,000	
Distillate Heating Oil	7,685,000	
LPG	538,000	
		10,459,000 "
3. **Electrical Utilities**		
Distillate Fuel Oil	115,000	
Residual Fuel Oil	8,450,000	
		8,565,000 "
4. **Industrial-Commercial**		
Distillate Fuel Oil	1,227,000	
Residual Fuel Oil	4,350,000	
LPG	44,000	
		5,621,000 "
TOTAL		38,475,800 bbls.

Notes: Volumes are in barrels
Source: **Yankee Oilman**, March 1970
Residual oil figures calculated from tonnage handled at ports.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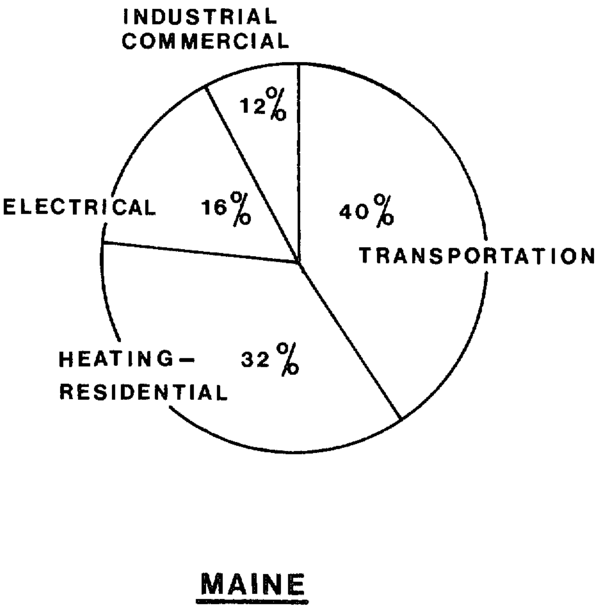
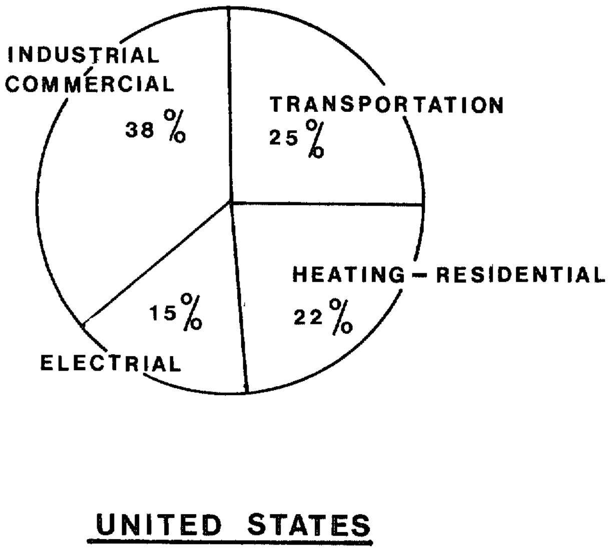
CONSUMPTION BY MAJOR USE IN PERCENT





Notes: United States data are for total energy supplied by all sources.

Reference: **Outlook for Energy in the United States,** Winger et al. Chase Manhattan Bank 1968. State of Maine data are derived from Table 2-4 and include energy supplied by petroleum products. Since only 5-10% of Maine's energy is attributable to non-petroleum sources the two pie charts are comparable.

The State's relatively low industrial output is consistent with the level of energy used by the industrial/commercial sector. Also the low population per square mile is reflected in the transportation sector.

Port Activity in Petroleum

Petroleum is brought to Maine by water transportation. For the purposes of this study, we examined port activity along the coast and determined the relative importance of each facility with regard to refined petroleum products. Table 2-5 presents the results of this investigation. Portland Harbor, the Penobscot area (Bucksport to Bangor) and Searsport Harbor account for 99% of the refined products activity in the State. The table includes three lesser ports for comparison.

Other coastal towns receive some petroleum products but in even smaller amounts than the last port on the list. The three major ports are capable of handling ocean going tankers. The lesser ports are serviced by smaller coastal vessels and oil barges that load at the major ports and deliver to the many small coastal facilities. This study assumes that all petroleum products coming into Maine enter at one of the three major ports. This assumption is supported by Table 2-5.

TABLE 2-5

RELATIVE IMPORTANCE OF PORTS HANDLING REFINED PETROLEUM PRODUCTS ALONG THE MAINE COAST

	Port	Volume	Percent of Total
(1)	Portland	30,000,000 bbls.	67
(2)	Penobscot (Bucksport to Bangor)	9,050,000 "	20
(3)	Searsport	5,450,000 "	12
(4)	Cobscook Bay/Lubec (Eastport)	210,000 "	.5
(5)	Rockland	140,000 "	.3
(6)	Moosabec Bar (Jonesport)	120,000 "	.2

Note: Estimates based on tonnage handled as reported by Corps of Engineers — data is for 1968.

Further breakdown of the product mix handled at each of the three major ports is tabulated in Appendix

The Tanker Situation

As we pointed out earlier, most of the activity at Maine seaports is concentrated in tanker traffic. This section will take a closer look at the tankers that carry the oil with special note of the trends developing in this segment of the shipping business. Tankers are classified in dead-weight tonnage (dwt) which expresses a ship's total carrying capacity, including crew, provisions, and bunker fuel. Actual cargo carrying capacity is slightly less than the dwt. figure. In other words, a 50,000 deadweight-capacity is slightly less than the dwt. figure, for example, a 50,000-deadweight-ton tanker can lift about 47,000 tons of crude. Reference is sometimes made when speaking of tanker size to those built during World War II known as T-2's. These ships were 16,600 dwt. and about 500 feet long. At the present time most of the vessels in normal coastwise service are limited to 70,000 - 90,000 dwt. range due to draft restrictions.

Despite the lack of deep water harbor facilities in the United States, the world tanker fleet has been rapidly expandiing its average cargo carrying capacity. In 1956 the lowly T-2 had been dwarfed by the then largest 45,000 dwt. tanker. Ten years later, the total carrying capacity of the free world fleet had doubled and the size of the largest ship was 210,000 dwt. Now the largest ships in operation are the 326,000 dwt. Japanese built "super mammoth" tankers, chartered by Gulf Oil. However, the "super tanker fleet" as the really big ones are known, appears to have settled on 200,000 ton vessels as being the optimum economic size. The draft on a vessel this size is about 60 feet.

What about trends in the size of oil tankers operating in the coastal waters of Maine? The following chart constructed from data kept by the Corps of Engineers will serve as an example. For a three year period, the number of tankers entering Portland Harbor are related to their approximate draft requirements. With regard to the smaller draft vessel (36 feet and less) no trend is evident; however, in the over 36 feet categories, a definite trend toward the deeper draft vessels is evident over this same period. It should be noted that the maximum draft allowable in Portland Harbor is approximately 45 feet, which suggests that the port is close to operational capacity.

With the growing demand for petroleum and the advent of the super tanker fleet, it is little wonder the oil industry is concerned about getting the oil ashore. There are very few ports in the world and none in the United States that can handle a ship much larger than 100,000 tons. (Draft requirements of about 50 feet.) The 326,000 ton super mammoths of the Gulf fleet are serviced by an oil transfer facility at Bantry Bay in Ireland. From Bantry Bay the crude oil is taken to European refineries in smaller shuttle tankers.

Storage and Transportation Facilities

Each of the three major coastal facilities have significant storage capacity which is the initial link in the distribution chain. From these points petroleum products are transported to the final consumer by pipelines, railroad tank car, or over-the-highway tank truck. The following table indicates the storage capacity available.

TABLE 2-6

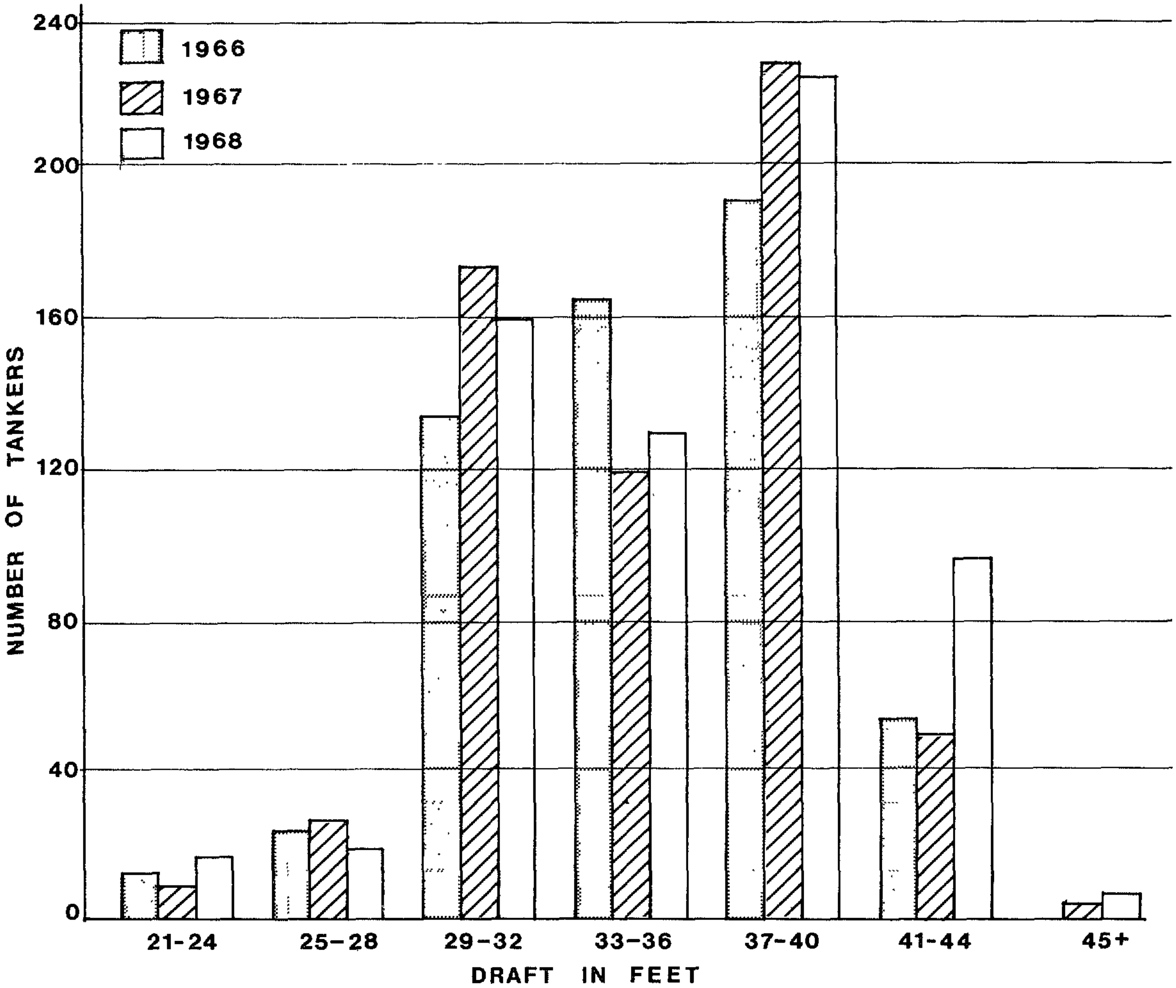
STORAGE CAPACITIES

Location	Storage (bbls.)	Principal Operators
Portland/S. Portland	10—9,000,000	All major oil companies
Searsport	8— 600,000	C. H. Sprague & Son Shell Oil Company
Bucksport	10— 800,000	C. H. Sprague & Son Webber Tank Inc.

Other major storage areas are located at Hallowell (near Augusta) and at Bangor. A 6-inch diameter pipeline designed to carry refined products links Portland, Hallowell and Bangor, a distance of 135 miles.

FIGURE 2-2

NUMBER OF TANKERS ENTERING PORTLAND HARBOR BY DRAFT CLASSIFICATION



Description of Principal Harbors

The Coast of Maine has numerous harbors, several of which play a leading role in the marketing and distribution of petroleum products. These are described briefly in this section of the report.

Portland Harbor

Portland Harbor is located between Portland and South Portland, fifty miles northeast of the Maine-New Hampshire border and about one hundred miles from Boston. The channel entrance at the end of Casco Bay is marked by Portland Head Light. The entering channel is one thousand feet wide, and dredged to a forty-five foot depth at mean low water. Off South Portland is a large forty-five foot anchorage basin. Adjacent to this, at the head of Front Harbor channel is another anchorage basin about thirty feet deep. Proceeding up Fore River, which divides Portland and South Portland, the thirty-five foot deep channel narrows to one hundred feet at the Portland drawbridge. Fore River Channel, dredged to thirty-five feet at mean low water, includes a turning basin. Piers and facilities for off-loading of petroleum tanks are situated on the South Portland side of the channel, and piers for handling dry cargo and for ferry service are located on the Portland side.

Searsport Harbor

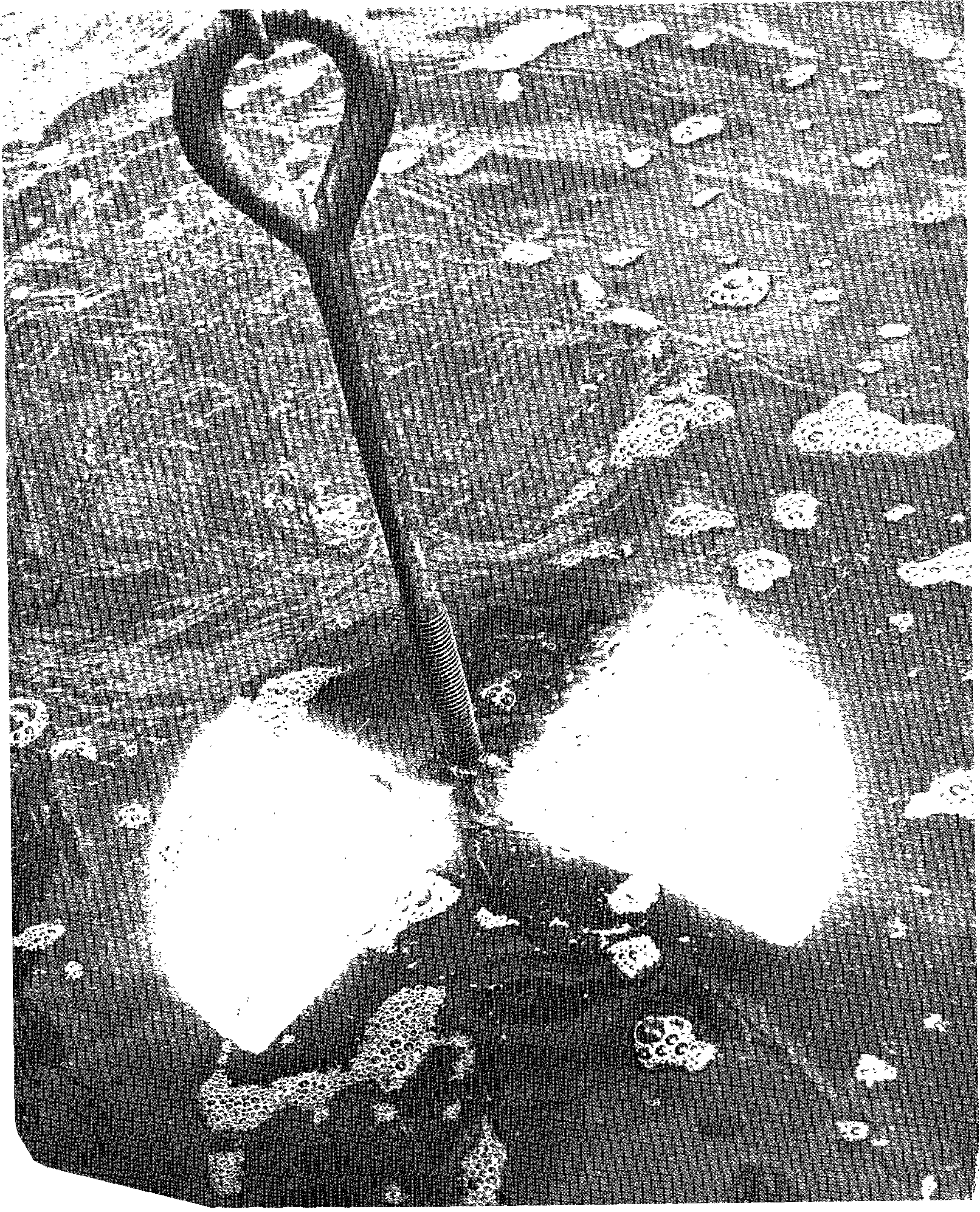
Penobscot Bay cuts deeply in the main land at the midpoint of the Maine Coast. About thirty miles from the open ocean is Searsport Harbor. Freighter and tanker traffic tie-up at the docks located at Mack Point. The approach is open and almost due north. The channel (five hundred feet at the narrowest point) and the turning basin, 1,500 feet, are dredged to a depth of thirty-five feet at mean low water. Berths for two piers are dredged to thirty-two feet. One of these piers is owned by the Bangor and Aroostook Railroad. Searsport is the southern loading point for the railroad which serves the northern counties of Maine.

Bucksport Harbor

Leaving Searsport and travelling northward on the Penobscot River, one proceeds through the Bucksport Narrows, under the Waldo-Hancock Bridge, where the water depth is fifty-eight feet, to Bucksport seven and one-half miles from the mouth of the river. The berths at Bucksport can accommodate any vessel capable of navigating the Narrows. However, at the start of the Narrows, near the southern end of Verona Island, the water depth is twenty-three feet at mean low water, thus limiting the size vessel that can reach Bucksport.

Penobscot River

Bucksport to Bangor, on the Penobscot River, is a distance of twenty miles. Small coastal tankers can navigate the river. From Bucksport to Winterport (four miles north of Bucksport) there is a three hundred fifty foot wide, twenty-two foot deep channel. The river winds northerly through Crosby Narrows, Sterns Mill and South Brewer, where the controlling depth is fifteen feet. The harbor at Bangor-Brewer is fourteen feet deep.



Rockland Harbor

Near the entrance to Penobscot Bay is Rockland Harbor about seventy-five miles northeast of Portland. The waterfront activity at Rockland is centered around the fishing industry. It is the nation's leading lobster port and in commercial fishing is second only to Boston and New Bedford. There are several branch channels in Rockland Harbor — the main approach is two hundred feet wide and eighteen feet deep. Fourteen foot channels then branch out to form five separate channels to the various docking facilities.

Eastport Harbor

At Eastport, near the United States - Canadian border, lies Eastport Harbor. A combination "L" shaped breakwater and pier has twenty-one feet of water alongside at mean low water. Eastport is at the entrance to Passamaquoddy Bay and has a mean range of tide of eighteen feet.

FORECASTS OF SUPPLY AND DEMAND FOR ENERGY

Major Markets

Demand forecasts with regard to the consumption of petroleum products for the United States are available; however, no forecast explicitly for the State of Maine is known. Therefore, it is the intent of this section to make a projection based on available information and our knowledge of basic trends in the economy and industry. Most petroleum forecasts are expressed in barrels per day or in units of energy. In this section, barrels per day will be used.

In 1968, our base year, the United States required thirteen million barrels of petroleum products per day, and Maine required approximately 90,000 barrels per day or about .07% of national consumption. On an annual per capita basis, that reduces to 32.5 barrels for Maine compared to 24.3 barrels for the entire country. With this basic data for past consumption established judgments must be made for supply and demand, in addition to capital expansion, for the next few decades.

The four major uses or markets for primary energy, as noted earlier, are:

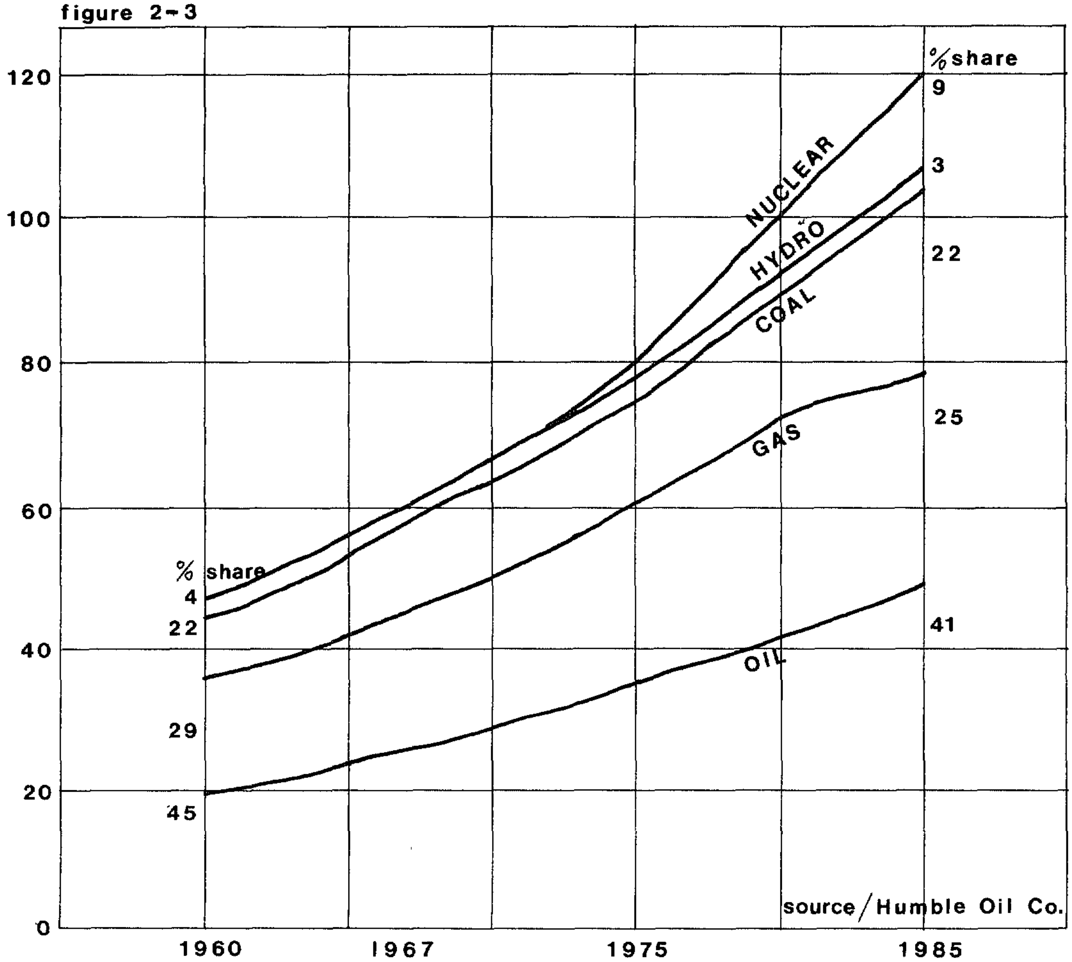
1. Transportation
2. Heating — Residential
3. Electric Utilities
4. Industrial — Commercial

These markets consume and will continue to consume vast amounts of energy. The energy is supplied by a variety of sources — in Maine, the principal source is petroleum products.

For decades ahead, there will be little change in the relative standing of each energy source. The lone exception appears to be the growth of nuclear energy. By 1985, nuclear energy will supply 9% of the nation's requirements (presently it supplies less than 1%) slightly reducing the percentages currently supplied by oil and gas. Figure 2-3 indicates the projected relative position of energy sources.

UNITED STATES ENERGY SUPPLY BY FUEL SOURCE
quadrillion BTU

figure 2-3



In the State of Maine, gas and coal are not significant factors in energy supply; in the past, oil has filled approximately 90-95% of the requirements.

The major markets were examined with respect to United States requirements and the regional requirements of the State of Maine. The individual analysis including a discussion of the necessary assumptions and the projection techniques employed are presented in the Appendix.

It is necessary to combine the information on these principal markets to arrive at an overall forecast of future demand. The weighted average approach was utilized as follows:

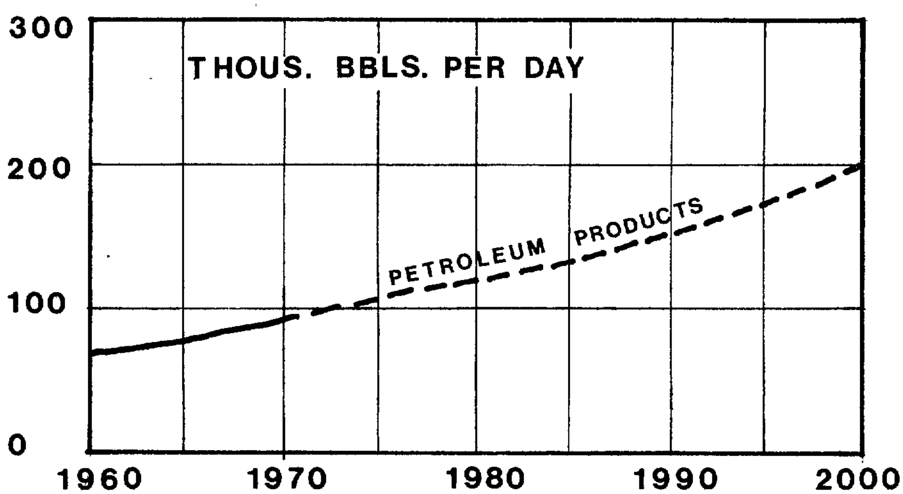
Market	Weighting	Growth Rate	Weighted Rate
Transportation	.40	3.0%	1.20%
Heating — Residential	.32	1.0%	.32%
Electric Utilities	.16	3.2%	.51%
Industrial — Commercial	.12	3.0%	.36%
			2.39%

Average Overall Growth Rate = 2.4% Per Year

Our analyses of the major markets and their growth rates are consolidated and displayed graphically below. Assuming this growth rate for the long term, we can extend the forecast to the year 2000.

FIGURE 2-4

ENERGY DEMAND IN MAINE



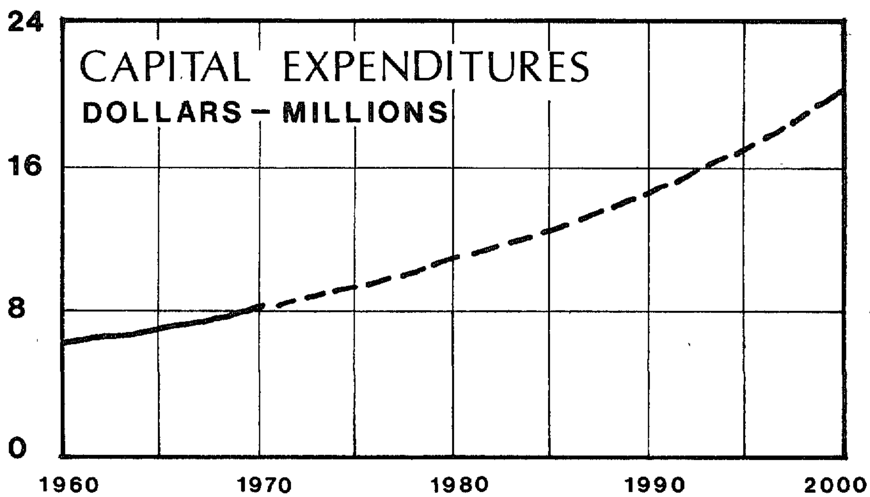
GRAPH 2-4

Capital Expenditures

Capital expenditures can be viewed as falling into one of two categories; the first includes normal expenditures necessary to expand facilities to meet future demand. (We have estimated the overall growth rate of future demand to be 2.4% per year.) The second category includes possible expenditures that might be required should certain events, such as construction of an oil refining complex, materialize. This second category will be discussed under a separate heading.

Information relating to capital expenditures is sparse. Therefore, in order to make a projection several major assumptions concerning capital outlays have been made. We assume capital outlays will grow at a rate paralleling the growth rate of sales, and be slightly higher. We also assume that the portion of the total capital outlays of the petroleum industry which will be allocated to Maine will be in proportion to expected sales. Using these assumptions, we can construct the following picture of future capital expenditures for the State of Maine.

GRAPH 2-5



PLANNING IMPLICATIONS OF THE PETROLEUM STUDY

This concluding section is a synopsis of planning implications drawn from the study of the oil industry in the State of Maine. A portion of our input was derived from published sources; the remainder of the information is based on opinions of individuals in the field. Organizations contacted during the study are named in the Appendix.

Review of Important Factors

One factor for consideration in future planning, highlighted by this study, is Maine's dependence on the petroleum industry. Of all energy consumed in the State, 90-95% can be traced to petroleum products. Maine must rely on external sources of supply for petroleum products. The study also delineates the relationship between economic growth and oil consumption, further underlining the importance of this energy source.

Another factor having a significant effect on future coastal plans is environmental management. The Environmental Improvement Commission is charged with the responsibility of protecting the State's interests in this area. The Commission has had in effect for some years a system for classifying the coastal waters with regard to pollution level. The current trend is toward upgrading the classification of the coastal waters, meaning the reduction of existing levels of water pollution and the discouragement of activities leading to increased pollution. This limits the locations along the coast that can be considered for future development by the oil industry to those areas already industrialized, with a relatively high pollution level.

Petroleum development must also contend with the site selection law. This law enables the EIC to deny a proposal on the basis of environmental danger. The most publicized example of the conflicts arising among special interest groups in the State is the proposed oil refining complex at Machiasport. A review of the Machiasport case will highlight points for consideration in future planning.

During the summer of 1968, Occidental Petroleum Company announced plans to build an oil terminal and refinery at Machiasport, Maine. The project had the support of the State's top officials and legislators at the time. The refinery was to bring prosperity to an economically depressed region, and lower fuel oil costs for all New England. The attraction of Machiasport was deep inshore waters, deep enough to accommodate super tankers. So attractive was the proposal that several other corporations began to show interest in developing the area.

Soon, however, the voices of dissent were raised. The Natural Resources Council of Maine and then the Sierra Club challenged the accuracy of the promises, and generated public concern over the effect of possible pollution on existing marine industry and tourism. In addition, the suitability of the area for safe navigation by super tankers was highly criticized.

Citizens from all over the State began to show concern and then doubts with regard to the venture. As a result, public resistance to the project was high when the legislature met for a special session in January of 1970. Two bills, known as the siting bill and the conveyance bill, quickly became law and the Environmental Improvement Commission had new regulatory powers over coastal developments. Plans for the Machiasport refinery complex, as originally perceived, were soon abandoned.

The series of events that surrounded the Machiasport proposal point out the potential pitfall of uncontrolled development. The need for objective information, as opposed to the biased arguments raised during the controversy, is also pointed out.

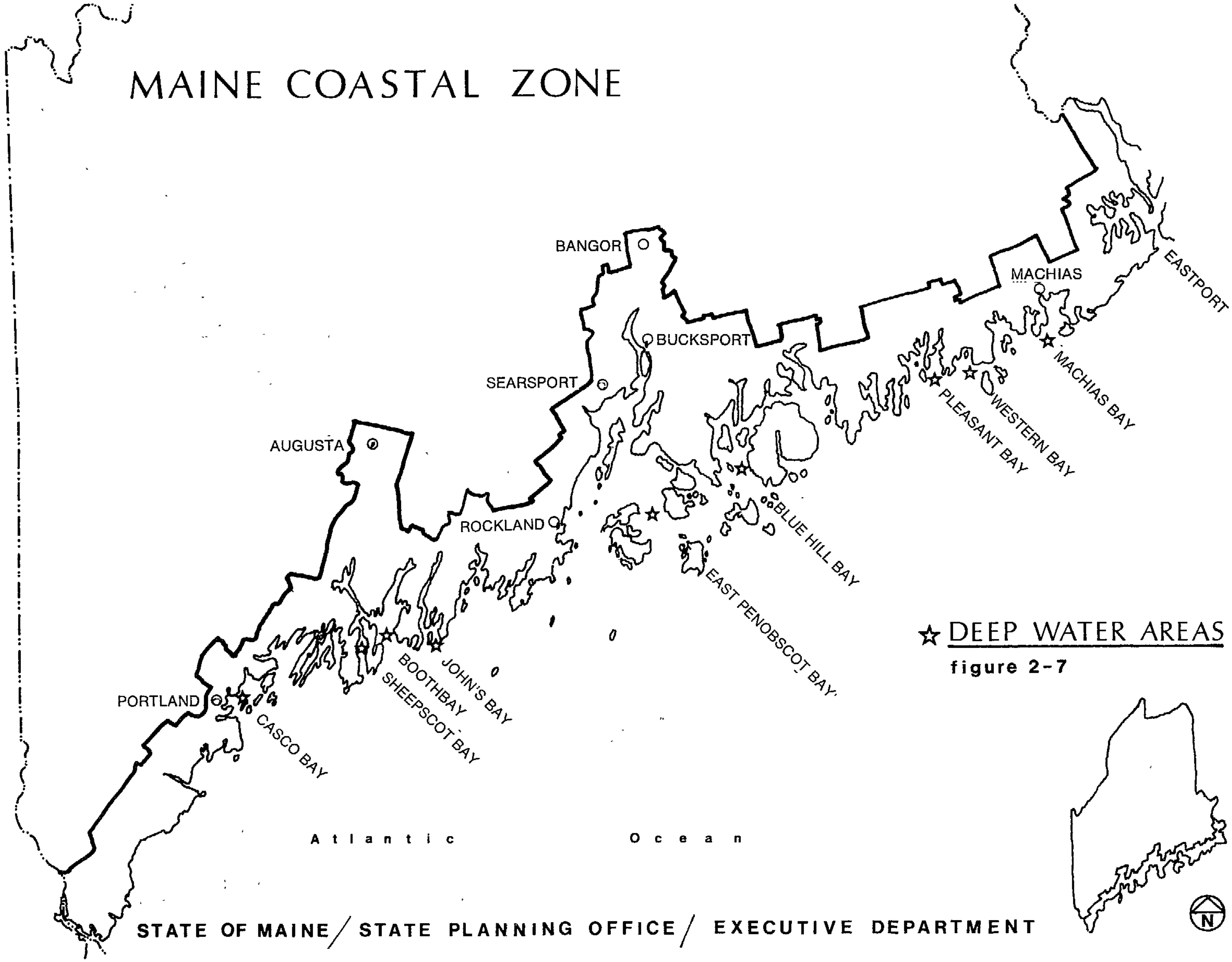
An answer to the question relating to where, along the coast, development will occur was also sought by this study. An answer to this question is merely a guess; however, certain indicators can be helpful in formulating future plans. Future developments relating to the oil industry can be categorized as follows: (1) supplying the future consumption needs of the people of Maine; or (2) bringing new petroleum operations to the State.

New Petroleum Ventures

Consumption demands have been forecast in previous sections. We believe normal replacement and modernization of existing facilities can meet the anticipated internal demands. This means that the major coastal facilities at Portland, Searsport, and Bucksport could be modified gradually to meet Maine's requirements. However, with regard to where and what form new petroleum operations will develop, we can, as noted earlier, speak only of the indicators.

One possibility is the construction of an oil refinery, the major attraction being water depths that can handle super tankers. Studies conducted for representative refining facilities indicate that a 100,000 B/D plant would involve an investment of $100-$150 million and employ 350-400 workers. The economics of such an operation were presented during the Machiasport controversy; however, the most volatile issue is environmental concern. The Maine coast has harbors that could be developed into deep water ports; the coast also presents difficult avenues of approach and dangerous weather conditions. Despite the availability of electronic navigational equipment for vessel guidance the possibility of an oil spill disaster still remains regardless of how remote that possibility is. Deep water facilities, whether for refining, storage, or transfer, are faced with this reality. The level of concern for the environmental health of the Maine coast displayed by the citizenry has demonstrated that the people do not take the trade off between economic benefits and environmental risk lightly. The lack of deep water facilities on the East Coast may mean continued pressure for a complex along the Maine coast. An indication of this is the promotion of the Sears Island/ Maine Clean Fuels, Inc. proposal closely following the Machiasport proposals.

Two maps were developed during the study to point out areas of possible expansion. One map (Figure 2-6) indicates the locations of existing facilities; gradual expansion of these facilities can meet the future consumption demands for the State. The second map (Figure 2-7) indicates possible deep water ports. The locations indicated have water depths of 60-90 feet or more and approach channels of approximately 3000 feet in width. The constraint of environmental


MAINE COASTAL ZONE
BANGOR
MACHIAS
EASTPORT
BUCKSPORT
SEARSPORT
AUGUSTA
ROCKLAND
MACHIAS BAY
PLEASANT BAY
WESTERN BAY
BLUE HILL BAY
EAST PENOBSCOT BAY
PORTLAND
CASCO BAY
BOOTHBAY
JOHN'S BAY
SHEEPSCOT BAY
DEEP WATER AREAS
figure 2-7
Atlantic Ocean
STATE OF MAINE / STATE PLANNING OFFICE / EXECUTIVE DEPARTMENT
N

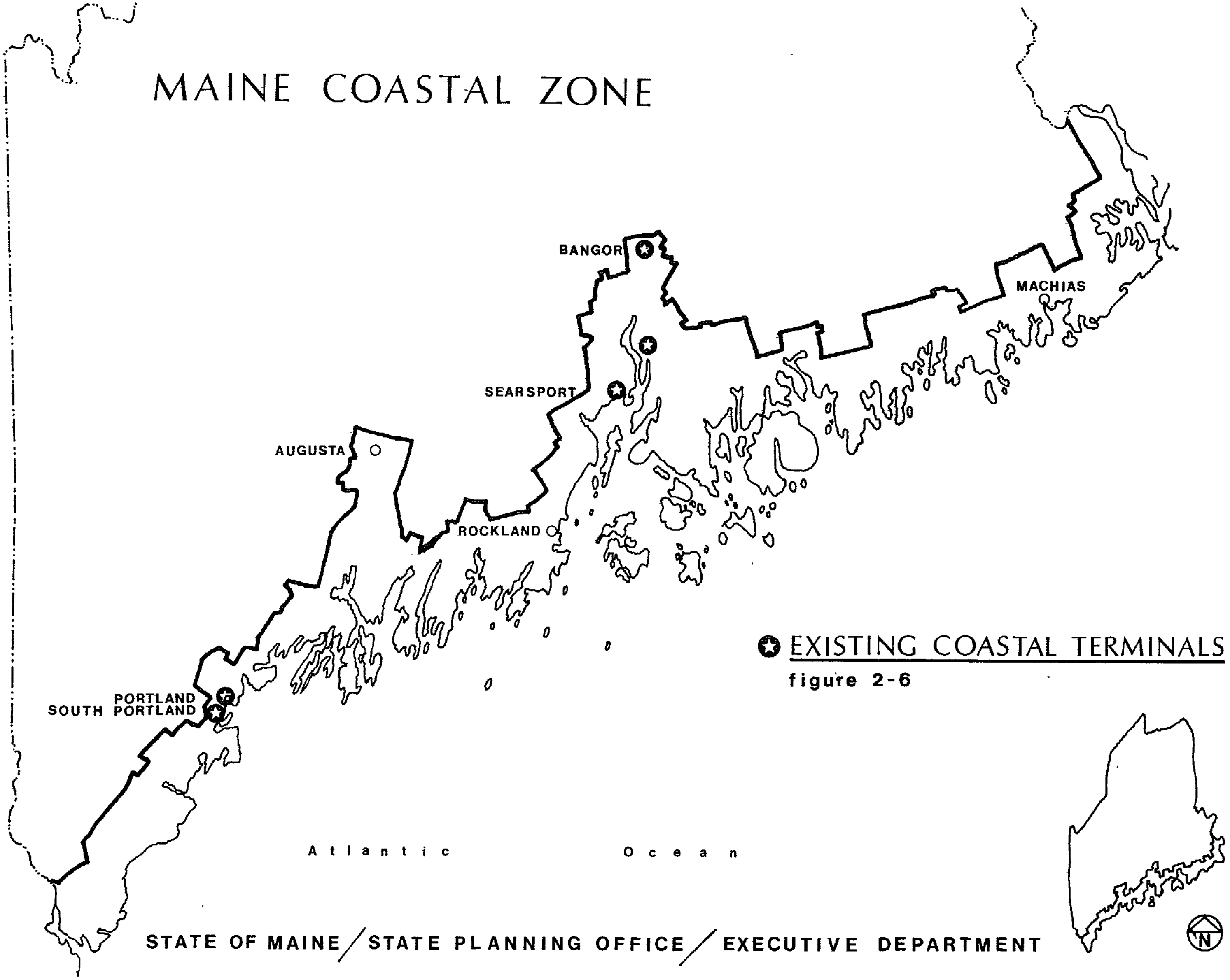

MAINE COASTAL ZONE
BANGOR
MACHIAS
SEARSPORT
AUGUSTA
ROCKLAND
PORTLAND
SOUTH PORTLAND
EXISTING COASTAL TERMINALS
Atlantic Ocean
STATE OF MAINE / STATE PLANNING OFFICE / EXECUTIVE DEPARTMENT
N

figure 2-6

management indicates that site selection may be limited to areas with relatively high levels of water pollution, as determined by the EIC classification procedures.

The planning implications surrounding offshore drilling can be broken into two parts: first, planning associated with exploratory drilling. Exploratory drilling is expected to take place sometime in the seventies. Restrictions relating to this activity could be minimal, providing proper regulations evolve during the exploratory phase. Second is the planning required if actual production takes place. Since the existence of oil fields off the Maine coast is unknown, we believe that a planning effort relating to oil production is not warranted at this time.

The Energy Crisis and Maine

Several factors relating to the production and distribution of petroleum products and other energy sources have caused an imbalance of the supply and demand picture, more commonly known as the energy crisis. In this section we shall comment on this subject and the implications for Maine.

The causes of this situation are many and opinions differ widely over the relative causal effect of any one factor, however, the factors most frequently mentioned by oil industry spokesmen are:

- A worldwide shortage of tankers
- Delays in nuclear energy facilities
- Air pollution regulations relating to sulfur content of fuel oils
- Refinery trends toward the more profitable lighter fuels

The shortages involving petroleum products relate to the heavy fuels. The import quota does not affect the heavy fuels. However, crude oil is subject to the quota thus heavy oils refined in this country are indirectly influenced by the quota system. The trend at the refinery towards the lighter, more profitable, fuels appears to have a bigger impact on the industrial fuel market than the quota system.

Notice that mention is not made to any worldwide shortage of energy sources. In fact, a recent study conducted for the Associated Industries of Massachusetts stated the following:

The rise in fuel oil prices is also by and large not the result of a fundamental long lasting scarcity for this product. At the end of 1969 worldwide crude oil reserves were sufficient to cover 35 years of consumption at 1969 levels. Refiners generally have the flexibility to increase their crude runs and fuel oil yields to accommodate a reasonable increase in demand for this product.

What about future prices and shortages? The shortages that exist are due to the complexities of production and distribution and not to fundamental shortages of the raw product. If these problems can be handled efficiently (the Federal Administration has taken several steps in this direction and the New England governors are pressing hard for further changes) there is good reason to believe that a market balance can be restored. Oil companies are currently adjusting their production to produce increased quantities of low sulfur content fuel oil to meet air pollution regulations, however, there will be an increased cost associated with this change that is already manifesting itself in higher electrical rates and higher manufacturing costs. Consumer prices of all petroleum products can be expected to reflect at least a portion of the current inflationary trend.

FOOTNOTES — PETROLEUM STUDY

1 This information, taken from the June 15, 1970, issue of *Fortune* magazine, indicates that the petroleum industry is one that requires very large amounts of capital on a continuing basis. The cost of such capital should be recognized when analyzing the industry.

2 See Table 2-2.

3 *1970 National Petroleum New Factbook Issue.* Estimate of home heating fuels for 1968.

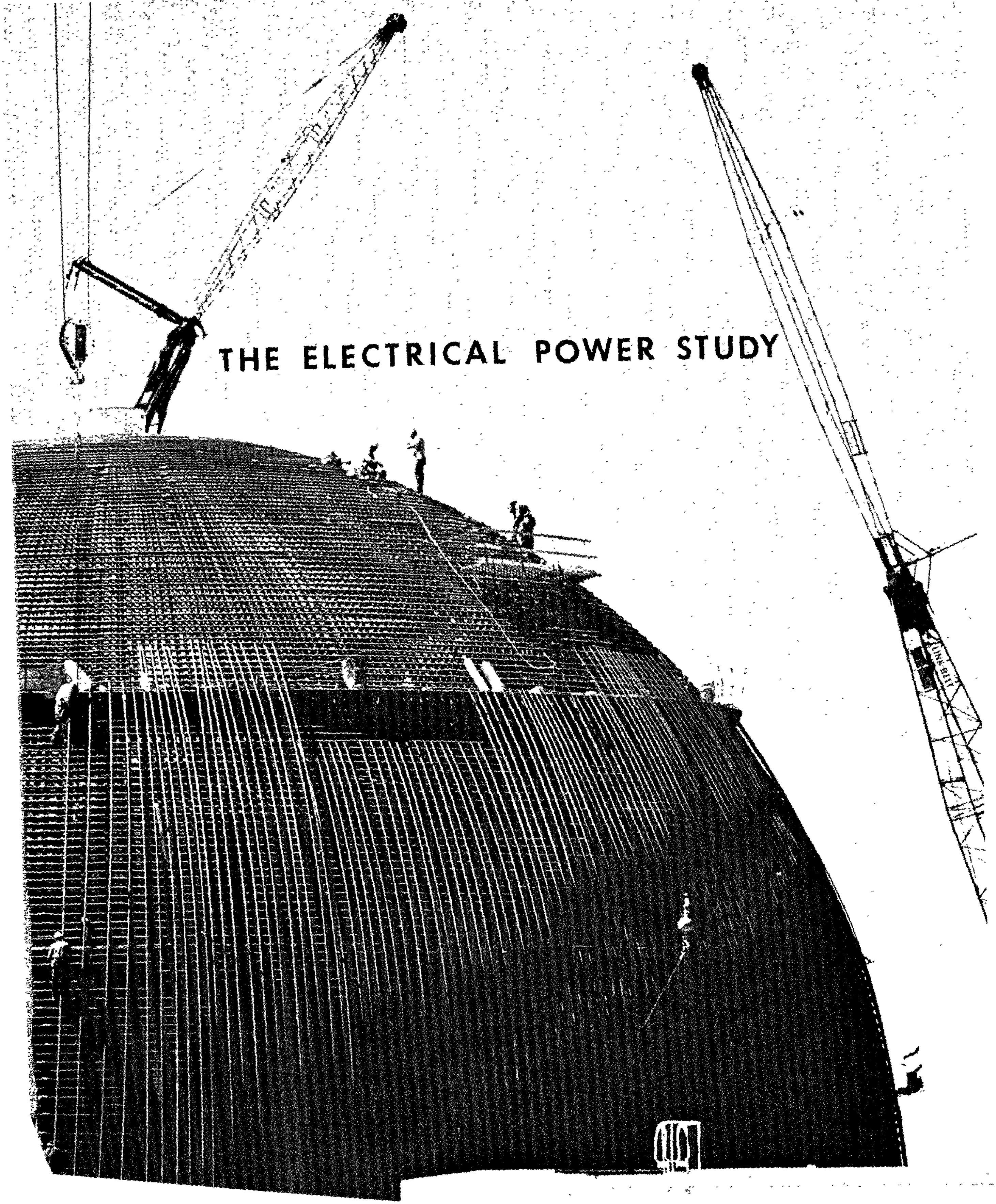
4 Percentages calculated from data found in Power section of *The Maine Handbook – Statistical Abstract – 1968,* Department of Economic Development.

5 The data relating to expected growth rates for the United States were extracted from *Outlook for Energy in the United States,* The Chase Manhattan Bank 1968 New York.

6 This estimate is based on the slope of the energy use curve shown in Figure 7.

7 We have assumed that the use of electrical energy will follow the general population trend. Maine's population growth rate is expected to be about ½ of the national rate.

THE ELECTRICAL POWER STUDY



INTRODUCTION TO THE ELECTRICAL POWER STUDY

Of all the energy markets, none has experienced a more dramatic growth rate in demand for its output than the electrical energy sector. By 1980 the electrical energy sector is expected to account for as much as one-third of the total nation-wide energy utilization. One question that looms large in the planning efforts of both public and prviate interests is where will new power plant facilities and distribution lines be located. The level of concern for this matter is implied by President Nixon's environmental message for Congress presented February 6, 1971. In that message the President pointed specifically to the area of power plant siting. One of his recommendations would require states or regions to establish power plant siting agencies to which utilities would be required to submit their major construction plans for approval. The agencies would hold public hearings and certify specific sites, facilities and transmission routes well in advance of construction. It is interesting to note that the State of Maine passed legislation in 1970 that is based on a very similar framework.

The President's message went on to encourage states to assume control of land-use planning within their borders as well as regulation in areas of critical environmental concern such as coastal zones and scenic and historic areas. The importance of the proposed federal siting bill (which is part of the same Presidential package) for public and private power companies is the precedence it grants the siting authorities over existing state or local laws. The proposed new authorities would consider state and local interests, but their rulings would be final, subject only to judicial review. Moreover, a utility having a certificate of approval from an authority and any necessary Federal licenses then would be authorized to use Federal powers of eminent domain, if necessary, to obtain land. The proposals, in allowing the individual states to form the authorities, have implied that future siting will be administered at the state level. As an additional incentive to get things moving, those states that fail to act by 1974 would lose their share of $100 million proposed in federal land-planning assistance.

The State of Maine has a particular interest in what is expected of the electrical power industry for a number of reasons. First, compared to the rest of the country, Maine's cost of electricity is high; as much as 30% higher in certain rate categories. Second, our overall consumption of electricity is lower than the national average, an effect that may be linked to the rate structure, our industrial output, and the problems associated with making the entire energy market a truly competitive one. Third is the fact that Maine offers some of the advantages that have been cited as prerequisites for future power plant sites such as abundant cooling water and large tracts of land. As a result, Maine could become a major exporter of electrical energy.

The electric power study of the Cycle IV — Public Investment Plan ties the emerging trends that will influence the power industry in the future together with the existing situation. The study begins with an analysis of the Maine power industry as it is today. Then proceeds a discussion of what can be expected in the decades ahead, and finally the planning implications that evolved from the study as they relate to overall coastal planning.

THE PRESENT STATUS OF THE MAINE ELECTRICAL POWER INDUSTRY

An Overview of the Industry

The electrical power industry sells secondary energy. Electrical energy is produced commercially by converting other forms of energy known as primary energy which includes such fuels as fuel oil or coal (fossil fuels), water, gas or nuclear. A generator is necessary to produce electrical energy which is then distributed to various users. These generators in turn are driven by a device that uses primary energy.

The power industry is characterized by its economies of scale. Users can generally obtain electrical energy most economically when the supply originates from one large generator rather than from a number of scattered small ones. Electricity can be transported very efficiently over long distances because of the unique advantage of being able to step-up and step-down the voltage level by means of transformers. At extremely high voltages the line losses are very small. (A line loss is the energy that is transformed into thermal energy when current flows in a wire; this energy cannot be recovered.) Once electrical energy is transported to an area where many users are located the energy is distributed at lower voltage levels.

Power generating plants are classified in two main ways; the total amount of power the plant is capable of producing and the type of prime mover (i.e. the device that drives the generator, which in turn is readily identified by the primary energy used). The table below indicates the prime mover classifications.

TABLE 2-7

CLASSIFICATION OF POWER PLANTS

Type	Description
Steam-Electric Plant	Most common type — steam turbine drives generator — the thermal energy required to manufacture steam is supplied by fossil fuels or nuclear fuels.
Hydro Electric Plant	Moving water is primary energy source.
Pumped Storage Hydro Electric Plant	Water is pumped to a storage reservoir then released to drive generators. Plants are used for supplemental power to an existing distribution system in most cases.
Internal Combustion Plant	Generator driven by engine. Fossil fuels utilized.
Gas Turbine Plant	Generator driven by fossil fuel turbine.

Some of the terms associated with the power industry need further explanation. In this section common ones will be outlined. The measure of electric power is watts. It is an indication of the rate at which work is being done. Consumers pay for electrical energy by the watt-hour or more commonly by the 1000 watt-hour known as the kilowatt-hour. One watt-hour is as one would expect — the use of one watt for a time period of one hour. In a sense, the power companies sell work (or its equivalent). The consumer pays for the amount of work delivered in electrical form. A given job can be done at a very high rate of doing work per unit of time and be accomplished quickly or the rate of doing work per unit of time can be low and the amount of time required to finish the job can be long. In either case, the total work supplied is the same and the cost to the user is the same. On the other hand, for a given facility there is a maximum rate at which work can be supplied to a user; if users want the facility to work faster it simply can't be done.

Electrical power companies have to concern themselves with meeting peak demand, that is, supplying the maximum number of watts they will be asked to produce at any given time. If the connected load for a given power system exceeds the generators maximum output then each user gets a little less energy per unit time than he wants. This situation leads to the well publicized "brown outs" and "black outs". Since most utility companies are faced with a level of demand high enough to result in a brown out only as a rare occurrence, it becomes uneconomical to build the extra capacity needed to meet that demand. Thus one of the principle trade-offs the utility industry is faced with is designing a plant that will meet maximum demand yet can be operated efficiently over the long run. Reserve generators and interconnecting grid systems are approaches to this paradox. There is more than enough generating capacity in this country to meet maximum demands (Federal Power Commission Chairman John N. Nassikas released estimates of net dependable capacity of 327,000 megawatts and an estimated peak demand of 254,000 megawatts for the Continental United States) however, utilities cannot always get the energy to the user the moment he flips the switch.

Maine Electric Power

In the State of Maine there are three principle firms that generate most of the electricity supplemented by a number of minor firms that utilize small internal combustion engine/generators or buy their power from the larger firms. Several of the engine driven generators are located on remote coastal islands. The following table presents a picture of the relative importance of the power producers in Maine.

To assist future planning it is necessary to know what the sphere of influence for an individual company is. Coastal zone electrical power is about equally split on a geographical basis between the Central Maine Power Company and Bangor Hydro-Electric Company. In terms of sales however, Central Maine Power Company which operates in the heavily populated southwestern counties, has a decided sales advantage in sheer numbers alone.

TABLE 2-8

RELATIVE RANKING OF MAINE UTILITY COMPANIES — 1970

Utility	Power Generation Megawatt Hours	Net Power Purchased Megawatt Hours
Central Maine Power Co.	3,670,158	869,225
Bangor Hydro-Electric Co.	547,218	388,881
Maine Public Service Co.	20,921	0
Aggregate of Other Co.'s	9,706	238,813
Total	4,248,003	1,496,919

Megawatts = 1000 Kilowatts

The following map points the service areas for the utility companies operating in the coastal zone.

TABLES 2-8 through 2-12 compiled from company annual reports

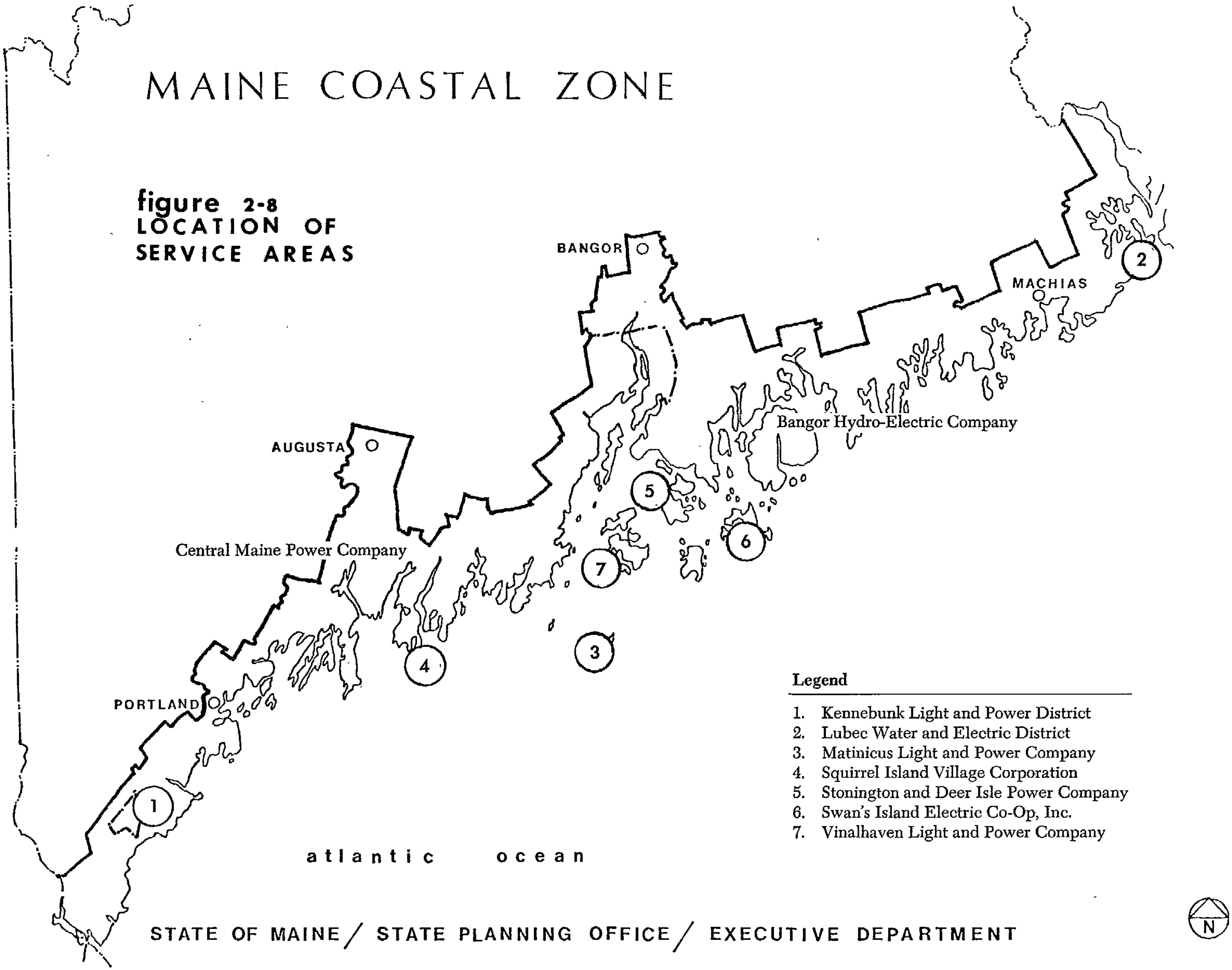
According to figures for 1970, approximately 65% of the power capacity in the State of Maine is attributable to a fossil fuel primary energy source. The remaining 35% is water power. A breakdown of the power generating capabilities of the major Maine utilities is shown in Table 2-9. While many of the fossil fueled plants around the country use coal, Maine utilities needing thermal energy for the manufacturer of steam to run their turbines use petroleum products almost exclusively.

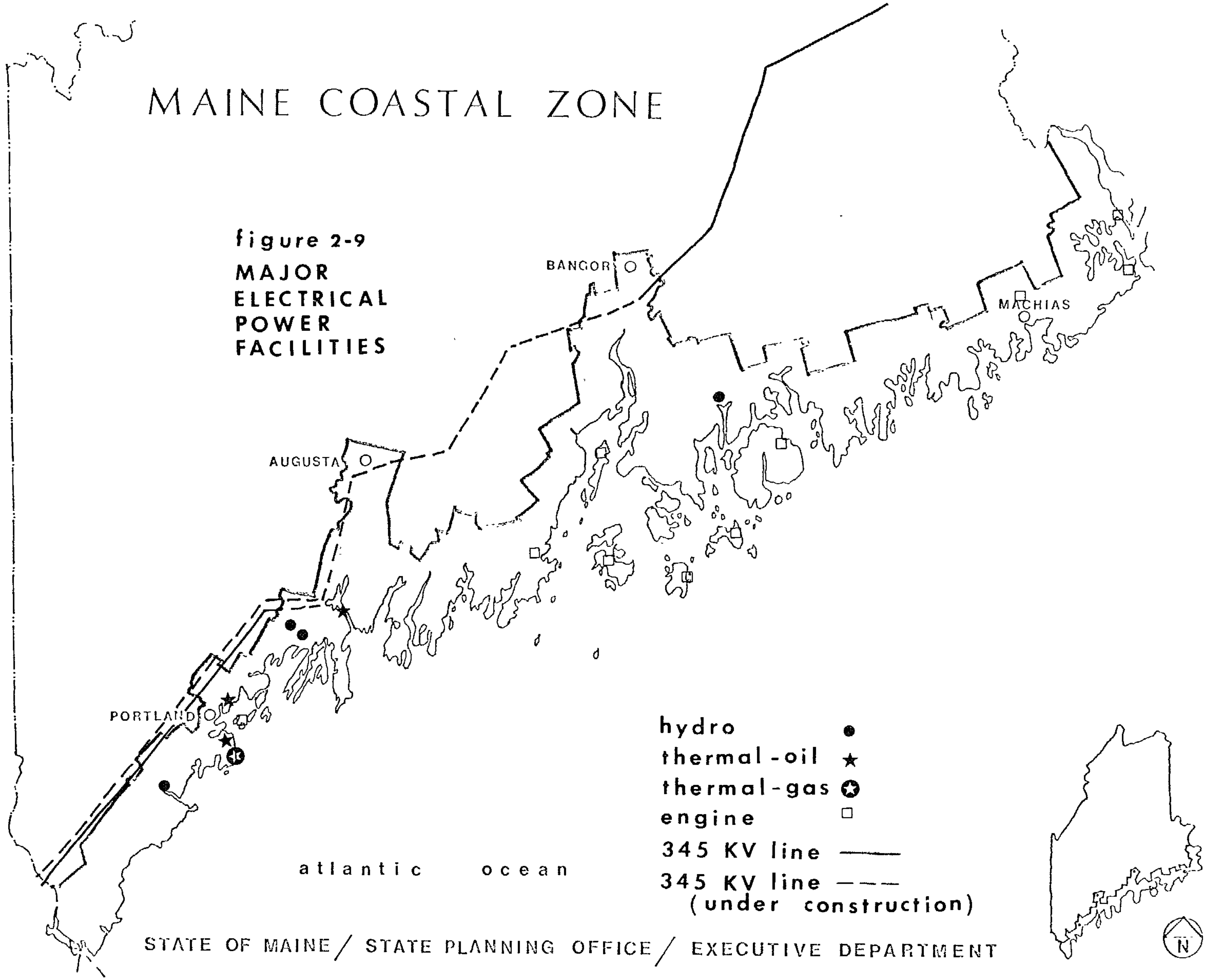
TABLE 2-9

POWER GENERATION BY PRIME MOVER TYPE: MAINE UTILITY COMPANIES — 1970

Company	Power Generation K. V. A. - - - - - -			
	Thermal	Hydro	Engine	Total
Central Maine Power Company	454,756	310,327	51,308	816,391
Bangor Hydro-Electric Co.	63,236	48,336	35,000	146,572
Maine Public Service Co.	22,904	2,875	17,212	42,991
Aggregate of Other Co.'s	0	0	3,661	3,661
	540,896	361,538	107,181	1,009,615

Also of importance to the coastal zone planning effort is the location of existing facilities and the nature of those operations. Figure 2-9 is a map showing this information as well as the route of the 345 kv regional transmission line that will span the State and export power when the 855,000 kw Maine Yankee Nuclear Power Plant comes on line in 1972.


MAINE COASTAL ZONE
figure 2-8
LOCATION OF
SERVICE AREAS
BANGOR
MACHIAS
AUGUSTA
Bangor Hydro-Electric Company
Central Maine Power Company
PORTLAND
atlantic ocean
Legend
1. Kennebunk Light and Power District
2. Lubec Water and Electric District
3. Matinicus Light and Power Company
4. Squirrel Island Village Corporation
5. Stonington and Deer Isle Power Company
6. Swan's Island Electric Co-Op, Inc.
7. Vinalhaven Light and Power Company
STATE OF MAINE / STATE PLANNING OFFICE / EXECUTIVE DEPARTMENT
N


MAINE COASTAL ZONE
figure 2-9
MAJOR
ELECTRICAL
POWER
FACILITIES
BANGOR
AUGUSTA
MACHIAS
PORTLAND
atlantic ocean
hydro
thermal-oil
thermal-gas
engine
345 KV line
345 KV line
(under construction)
STATE OF MAINE / STATE PLANNING OFFICE / EXECUTIVE DEPARTMENT
N

Personal Income and the Utility Companies

Plans regarding coastal development and public investment are necessarily linked with their expected economic impact. It will be necessary, as proposals evolve, to weigh the value of proposed changes against existing economic patterns. To provide a point of reference the employment picture in the electrical power industry is put in prospective with the overall state economy.

An indication of the contribution of the electric power industry to Maine's economy can be obtained by comparing recent economic data. The most recent data for personal income for the entire State is for the year 1969. Data relating to the specific companies is for 1970, however, broad comparison can be made. Table 2-10 presents the personal income picture for the State. The work force during this time period was about 380,000 persons.

TABLE 2-10

PERSONAL INCOME STATE OF MAINE

	1968	1969
	(Figure in Millions)	
Wage and Salary disbursement	1,785	1,911
Farms	21	22
Contract Construction	89	108
Manufacturing	651	674
Wholesale/Retail trade	283	309
Finance, Insurance and Real Estate	66	72
Transportation, communications, and public utilities	107	117
Services	178	199
Government	382	402
Other industries	7	7
Other Labor Income	98	106
Proprietor's Income	271	305
Property Income	401	431
Transfer Payments		
Less: Personal contribution for social insurance	(94)	(107)
Total Personal Income	2,768	2,987

Source: **Survey of Current Business**, August 1970

The wage and salary story for the utility companies is depicted by Table 2-11.

TABLE 2-11

EMPLOYMENT AND WAGES: MAINE UTILITY COMPANIES — 1970

Company	No. of Employees	Payroll
Central Maine Power Co.	1,859	15,842,000
Bangor Hydro-Electric Co.	341	2,941,000
Maine Public Service Co.	231	1,880,000
Aggregate of other Co.'s	111	515,000
	2,542	21,178,000

Because the utility industry is highly capitalized, the number of employees as a percentage of the total work force is small, however, its secondary impact on the economy cannot be overlooked. As a supplier of energy, this industry is an important factor of production to other industries. Over one-half of all sales are to commercial and industrial users. In addition, continued construction by utility companies provide construction jobs. An indication of the activity in these two areas can be obtained from the following table.

TABLE 2-12

SALES AND CAPITAL INVESTMENT: MAINE UTILITY COMPANIES — 1970

Company	Plant Investment	Gross Revenue
Central Maine Power Co.	$350,000,000	$ 76,497,000
Bangor Hydro-Electric Co.	55,500,000	14,998,000
Maine Public Service Co.	31,000,000	8,162,000
Aggregate of Other Co.'s	3,200,000	1,231,000
	$420,700,000	$100,888,000

The $200 million Maine Yankee Nuclear Power Plant at Wiscasset is an example of jobs being credited to utility construction. At the end of 1970, $42.5 million had been injected into the Maine economy as a result of the Maine Yankee project. Approximately 1000 construction workers are involved in the project.

Utility Rates

One disturbing factor relating to electrical power in the State of Maine is the fact that its cost is high in relation to the rest of the country. A survey by the Federal Power Commission in 1969 showed that the typical electrical bill for residential service put Maine in the forty-sixth slot among all states. In fact, for some residential service the revenue per kilowatt-hour for all New England was 30% higher than the rest of the nation. The reasons for this differential are not altogether clear however many have been presented. The average annual usage of electricity by residents of Maine is lower than the national average; also of concern is the fact that rate structure, as presently designed, charges the highest per unit cost for low levels of use. As usage goes up the consumer's per unit cost for electrical power goes down. The economies-of-scale associated with electrical power distribution may preempt any arguments against this pricing structure, however it would seem that the highest unit cost is directed toward the user with the least ability to pay. Residential fuel oil, which powers many of Maine's generators, is a higher cost fuel than some of the fuels used in other parts of the country. (It is still cheaper to use fuel oil than coal however unless the power plant is within a reasonable distance of the coal fields.) The regulation of utility rates tends to encourage the use of equipment for as long as possible, thus equipment that could be replaced by more efficient versions may be staying on line longer than necessary and contributing to the higher costs. The network systems needed to channel power from areas experiencing low demand to one that is faced with excess demand have not been fully developed. None of these reasons above can fully explain why Maine's power costs are at their present levels, however, since energy is directly linked with economic development it is necessary to make Maine competitive with regard to the energy spectrum. There is considerable disagreement about just how to do this but general agreement regarding its overall desirability.

ELECTRICAL POWER FORECASTS

Annual and Peak Demands

The electric power industry is a regulated industry, that is the rates it charges for its product are administered by law. As a result, a large amount of data relating to the operation of utility companies is available to the public. This section presents a review of the forecasts relating to future electrical energy levels. The forecasts are the result of extensive industry studies by various groups.

The projected energy requirements in millions of kilowatt-hours for the State of Maine and the other New England States is presented in Table 2-13. The average annual growth rate is estimated at 6.56% for the period 1970-1990 based on historical trends.

TABLE 2-13

ELECTRICAL ENERGY REQUIREMENTS STATE OF MAINE 1970-1990

State	Average Annual Growth Rate	Projected Energy Requirements (Millions of Kilowatt-Hours) 1970	1980	1990
Maine	6.56%	5,385	10,165	19,177
New Hampshire	7.98	3,614	7,837	16,781
Vermont	10.26	2,648	7,077	18,672
Massachusetts	7.58	25,858	54,024	111,431
Rhode Island	7.57	4,159	8,686	17,906
Connecticut	8.28	17,170	38,279	84,252
Total	8.00	53,449	115,903	249,042
New England	7.88%	58,834	126,068	268,219

Source: A Study of the Electric Power Situation in New England 1970-1990 H. Zinder et al Sept. 1970

It should be noted that the average annual growth rate shown here is a compounded rate (i.e. in calculating the energy level of a given year the level of the just previous year is expanded by 6.56%). This also means that the absolute increase each year is accelerating.

Along with the overall electrical energy requirements it is important to look at the projected peak demand for the coming decades. The following table presents the estimates that have been generated relative to peak demand.

TABLE 2-14

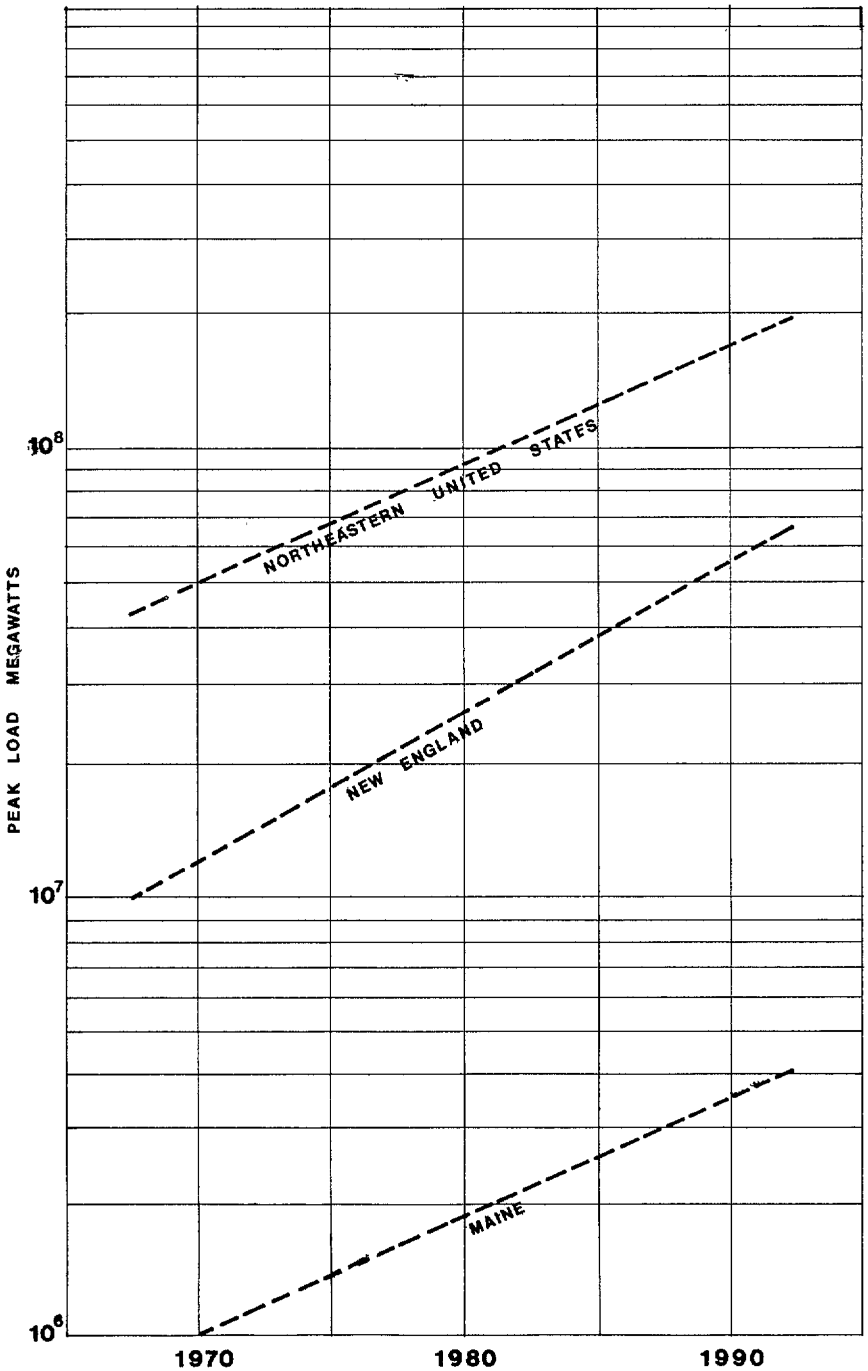
PROJECTED PEAK DEMAND: STATE OF MAINE

State	Projected Peak Demand (Thousands of Kilowatts) 1970	1980	1990
Maine	1,003	1,879	3,529
New Hampshire	737	1,570	3,320
Vermont	540	1,418	3,694
Massachusetts	5,271	10,824	22,046
Rhode Island	848	1,740	3,542
Connecticut	3,501	7,669	16,669
Total	10,897	23,221	49,271
New England	11,900	25,100	52,800

Source: A Study of the Electric Power Situation In New England 1970-1990 H. Zinder et al. Sept. 1970

PROJECTED PEAK ELECTRICAL LOADS IN THE NORTHEAST

figure 2-10



Similar data is shown graphically in Figure 2-10 to indicate the relative magnitude of the **projected peak electrical loads** for the northeastern United States, New England and the **State of Maine.** Note that since the loads are increasing by a given percentage of each previous year's level, the projections are straight lines on a semi-logarithmic plot.

We can expect that the utility companies will be scheduling their construction plans approximately in accordance with the expected gains in peak demand. For Maine during the 1970's this means the start up of the Maine Yankee Atomic power power rated at 855 megawatts and the construction in 1977 of a conventional fossil-fueled steam plant at Cousins Island near the existing Wyman fossil-fuel plant. The Cousins Island plans call for a 700 megawatt facility. An additional unit or two at Cousins Island or the addition of another nuclear unit at Maine Yankee could provide for Maine's electrical power needs through the 1970-1990 era.[2]

With regional and possibly even national electric power grids, the location of power plants may not necessarily follow the classic rule of locating near sources of demand. Maine's advantages for power generation of cold water and available space may dictate more consideration of the location of such facilities here in Maine.

Of further interest is the breakdown of energy requirements by class of service. While data has not been compiled for the State of Maine, estimates have been made for New England and this data can serve as a guide for future planning. The energy requirements by class of services for all of New England are shown in Table 2-15. The relative importance of each category can be implied by this table. Electrified transportation is not a factor in the Maine power situation.

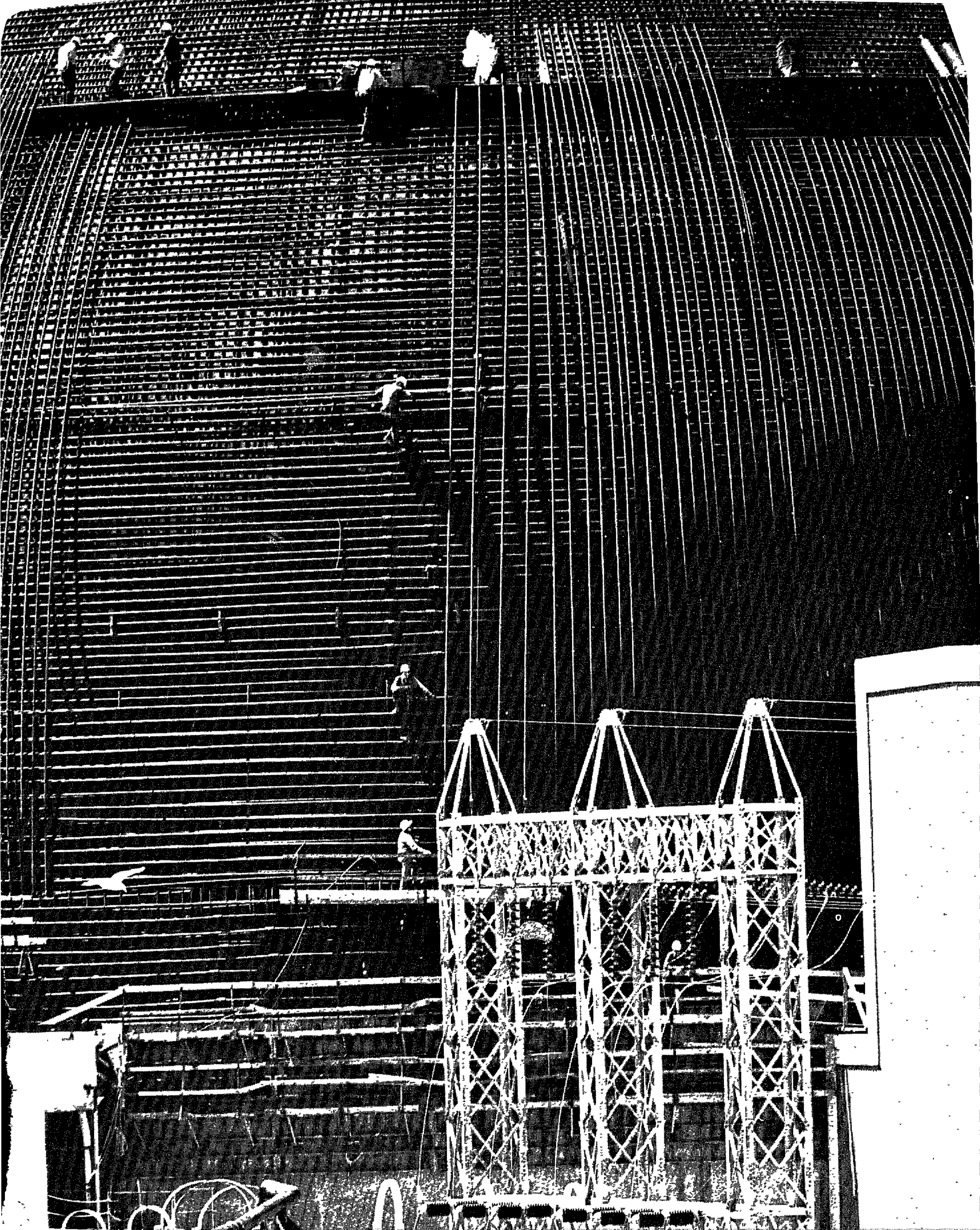
TABLE 2-15

ENERGY REQUIREMENT BY CLASS OF SERVICE IN NEW ENGLAND

	Millions of Kilowatt-Hours		
	1970	**1980**	**1990**
Rural and Residential	18,375	39,717	85,797
Commercial and Industrial	32,653	69,604	148,070
Street & Highway Lighting	756	1,323	2,544
Electrified Transportation	131	124	128
All Other	1,392	3,009	6,520
Total Ultimate Consumption	53,307	113,777	243,059
Losses	5,527	12,291	25,160
Total Requirements — Energy for Load	58,834	126,068	268,219

Source: A Study of the Electric Power Situation In New England H. Zinder et al Sept. 1970

[2] Interview with Professor William Shipman, Bowdoin College, June 2, 1971



Maine's Yankee Atomic Power Company

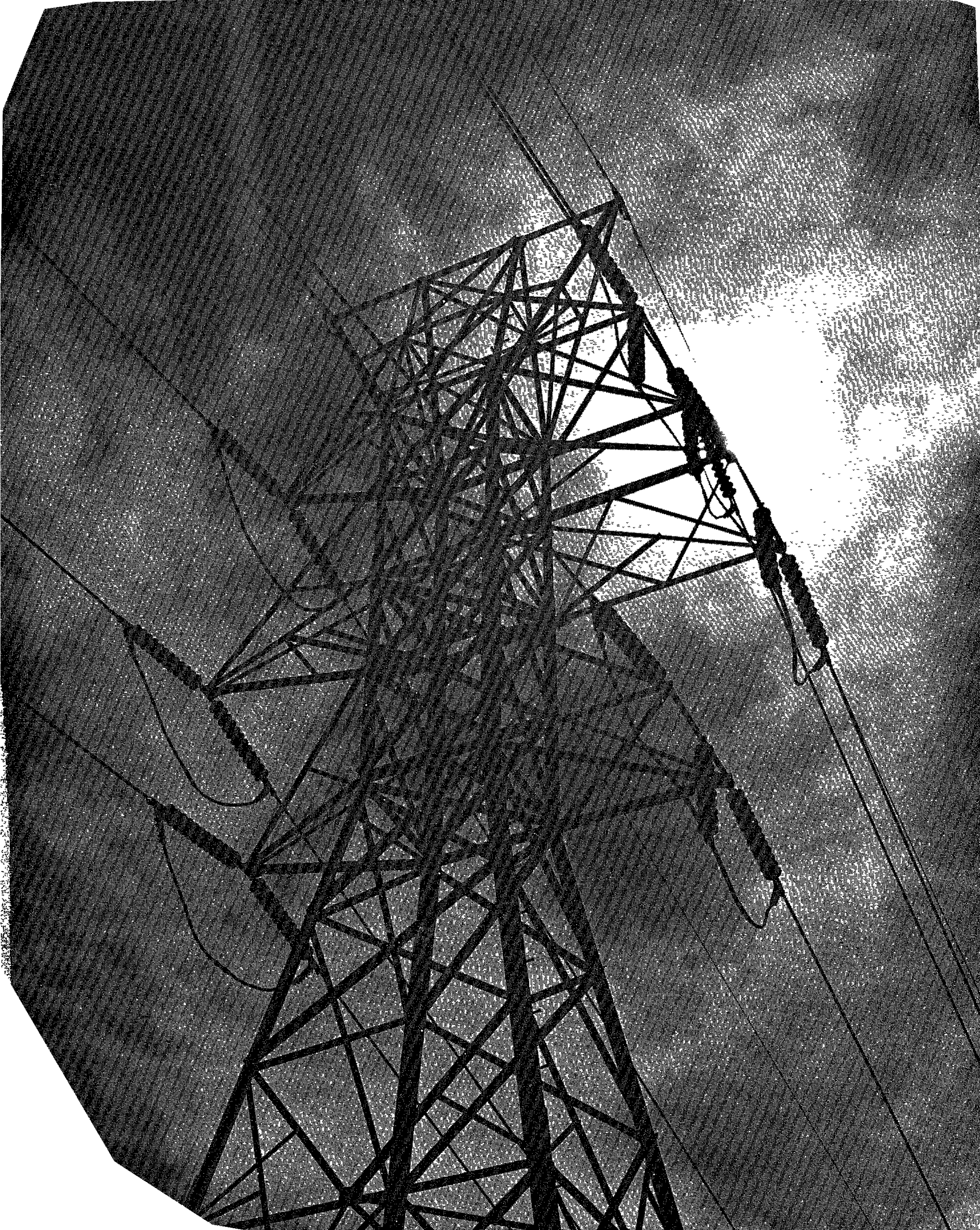
In September of 1967, the Maine Yankee Atomic Power Company announced plans to build a 855 megawatt nuclear-fueled steam electric generating plant at Bailey Cove in Wiscasset, Maine. Construction is well along now and the facility is to be operational in the middle of 1972. The Maine Yankee Atomic Power Company, which will own and operate the facility, is made up of eleven New England utility companies. The ownership is divided in accordance with the amount of electrical energy that will be supplied to each owner for distribution. The Central Maine Power Company owns 38% of the nuclear facility and when the new plant is operational, Central Maine's capacity will increase by 325 megawatts. The Maine Electric Power Company, Inc., is another firm with similar participation rules as those for the nuclear plant. Maine Electric Power Company is constructing the 345 kv transmission and distribution network that is spanning the State.

Past Projections

Future planning depends on the ability to predict, with a certain degree of accuracy, what lies ahead. In hopes of lending a cautionary note to this section it is worthwhile examining what has happened in recent years regarding power forecasts. Power companies serving the major urban areas of the northeast have underestimated their peak future loads since about 1965. The conventional yardstick was the Federal Power Commission's 1964 National Power Survey. This survey forecasts a declining rate of peak demand growth. Just the opposite has occurred. As a result some power companies have experienced brown outs and, on occasion, black outs. The utilities have had to scramble to get extra generating power on line. Delays in getting nuclear fueled plants constructed compounded the forecast errors. High cost, low power gas turbine units have been installed as a stop-gap measure. (The gas turbine units can be brought on line quickly). During the same time period, planners placed a heavy emphasis on inter-connections (grid systems designed to ship power from areas of excess capacity to one with a shortage) consequently plant reserve power capabilities were trimmed. One consideration, seemingly overlooked, was that all the pooled systems contributors might need to tap the system at the same time. About the only way out is increased nuclear capacity. Consolidated Edison of New York expects 35% of its capacity to be nuclear units in five years, however, in 1965 the same company expected 24% of its capacity to be nuclear units by 1970, the actual total turned out to be closer to 1%.

All of this is not to say that poor planning is totally to blame, but certainly the state of affairs would be different if demand had been predicted to accelerate.

What is suggested is that projections be continually monitored to spot deviations between them and actual demand. Also since power plants need lead times of approximately ten years, every effort should be made to use the most sophisticated forecast techniques available even to the extent of making several independent forecasts of the same variables then comparing the predictions. The additional expense can be justified.



PLANNING IMPLICATIONS OF THE ELECTRICAL POWER STUDY

The Areas of Conflict

The public controversy that continues between the utility companies and public interest groups today can be traced to two general areas:

1. The environmental problems associated with nuclear and fossil fueled powered generating stations such as air and radioactive pollutants as well as siting problems.

   and . . .

2. The proper balance between public or private power institutional arrangements.

In this section we shall review some of the current thinking in these areas and make suggestions that will help the future coastal plan effort.

With regard to the problems associated with nuclear fuel several general statements can be made. Steps have been taken to guard against the possibility of releasing radioactivity to the surroundings. Structure walls are designed to withstand earthquakes and hurricanes. A vaporproof steel liner is also installed to trap any leakage, however entire underground complexes have been proposed to further reduce the possibility of such a radioactive exposure.

Another allied factor is the problem of disposing of atomic fuel once its usefulness in the reactor has ended. Proposals to date call for the burying of radwastes, as these radioactive materials are called, well beneath the earth's surface. The long range effects of such a practice are still not entirely known.

Nuclear power plants need large amounts of water to condense the steam used to operate the turbines. Cold water is generally taken from a natural source, pumped through the condensers, and returned to the source at a higher temperature than when it left. If the water temperature is altered significantly aquatic life is upset — possibly destroyed. Present plans call for limiting the allowable temperature rise and using cooling towers when necessary. Interestingly enough the field of aquaculture (increasing the yield of marine life) has shown that some temperature rise may be beneficial for certain species. The concept of a multiple-use resource is pointed out by this possible dual use of sea water.

The second major area where conflict has arisen is in the area of air pollution. Next to automobiles, smoke stacks are the chief polluters of the nation's air. The principal contaminants are sulfur oxides. Power plants in the United States account for about 50% of the man-made sulfur dioxide that pours into the atmosphere. As regulations become stricter, industry has tried turning to low-sulfur fuel, but what is classified as low-sulfur fuel one year may not be classified so the next. For instance, New York City's Consolidated Edison Company, the oil burning utility that now operates with a 1% sulfur limit on fuel will be restricted to 0.3% by the end of the year. Also, there is still considerable public and scientific debate about the impact on persons of A.E.C. approved radioactivity emissions particularly within range of 20-30 miles from a given plant site.

To combat this problem, the oil companies are beginning to refine low-sulfur fuels. At present, however, it is difficult to obtain low-sulfur fuel oil in the quantities required. Another alternative is the installation of a scrubber in the smoke stack. A scrubber is a kind of shower bath in which a liquid absorbs the sulfur dioxide and reacts with it. Most scrubbers (a variety of these devices are being marketed) are somewhat experimental in nature and their effectiveness has not been fully assessed.

In early February of 1971, air pollution control regulations were made more strict at the national level. The Air Pollution Control Office of the Environmental Protection Agency released its new national limit on sulfur dioxide. The new limit, which for sulfur dioxide would be an annual average concentration of 80 micrograms per cubic meter of air, will have significant impact on the individual states. States will be required to have approved plans for implementing the new national standards by the summer of 1972.

Planning Power Plant Sites

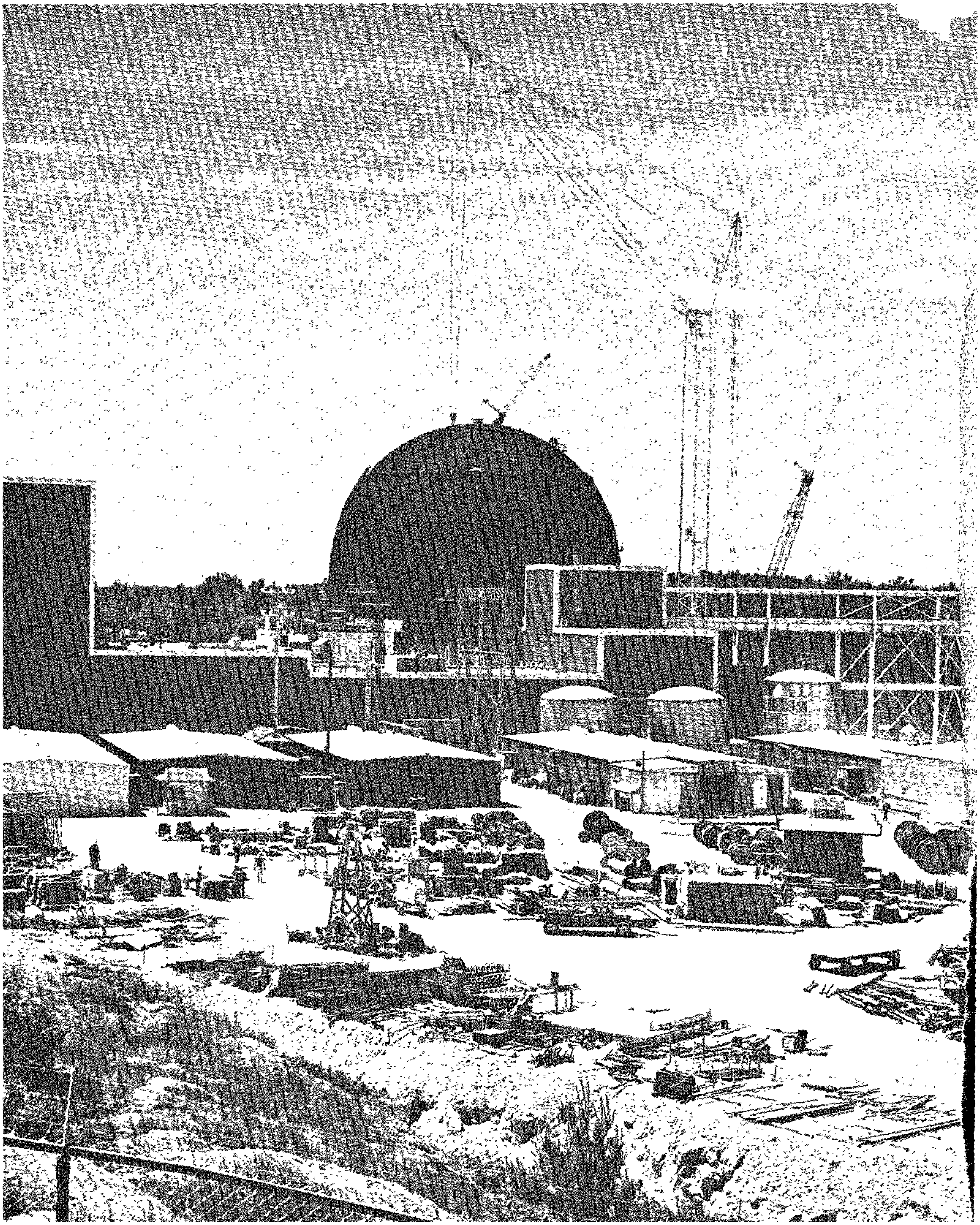
The utility companies will continue to expand capacity to meet the rapidly growing demand; that much is known, the next question is where will the new plant be placed. All power companies are faced with the problem of choosing and acquiring new sites. The Maine Coast offers both advantages and disadvantages with regard to meeting acceptable site criteria. Four of the principle factors considered in power plant siting are listed below.

- Availability of large amounts of cooling water for stream condensers.
- Access to transportation during construction phase and for employees when plant is operational.
- Foundation conditions.
- Location relative to load centers and transmission networks.

Seldom can all these factors be satisfied completely by one site therefore a compromise is usually necessary and the cost of sacrificing one factor must generally be offset by an advantage in another.

The Energy Policy Staff of the Office of Science and Technology has published guidelines for power plant siting. Below is an outline of those guidelines and comments that will update the original statements.

1. The design of nuclear fueled power plants must meet the safety requirements of the Atomic Energy Commission.
2. The design must meet air pollution criteria and standards as established by the individual states and the National Air Pollution Control Administration of the Department of Health, Education and Welfare. The Environmental Protection Agency established in July 1970 now administers the national standards.
3. Water quality standards for thermal effects must be met as outlined by the individual states and the Federal Water Pollution Control Administration of the Department of the Interior. The Environmental Protection Agency now handles this responsibility at the Federal level.



The first three guidelines are regulated as noted by the Environmental Protection Agency. The remaining guidelines are mainly subjective in nature and are applicable to general planning.

4. Develop the opportunities for public recreation at plant sites and avoid impairing and existing recreational areas.
5. Consider aesthetic values in the overall design and give attention to the appearance of power plant facilities and transmission lines.
6. Recognize the rural development considerations in plant siting.
7. Consider the siting requirements and the lead time requirements necessary to provide reliable service.
8. The nation's defense preparedness is to be considered in determining location and capacity.
9. Attention must be given to the routing of transmission lines and the problems of transmission line right-of-way for alternative plant locations.
10. Plant capacity should be large enough to meet regional load demands, including mutually agreeable arrangements for meeting the bulk power requirements of the small utility companies.
11. Consideration should be given to the prospects of combining the power plant with other commercial ventures, such as aquaculture, recreational facilities, industrial centers, and even new cities. An example of this type of integration is provided in another section of this report.

At the State level much of the responsibility associated with power plant siting lies with the Maine Environmental Improvement Commission (EIC). The siting law passed by the First Special Session of the 104th Legislature in 1970 requires public hearings prior to most large construction to insure that the intended use of the site does not endanger the ecological balance. This law is one of the most far reaching laws relating to environmental control ever passed by any state. The results of the initial test cases should form the basis for any modifications to the law that might be required to insure that the legislature can achieve its desired objectives.

With regard to thermal effects of discharged condenser water (specifically the allowable temperature rise) several utility companies located on Lake Michigan in the Chicago Area have been wrestling with this problem recently. Environmental administrators from Indiana, Michigan and Wisconsin voted for thermal pollution standards that limits warming surface water to 3° F. or less within 1000 feet of a discharge pipe. The outcome of this confrontation should be followed closely by planners as a precedent may be set regarding thermal standards.

Alternative Power Supplies

The concern over brown outs, air pollution and nuclear fueled power plants has created renewed interest in looking at possible alternatives or modifications to the existing approach. In this section several of the methods are reviewed.

One suggestion is the establishment of a national grid. A transmission system linking the major power stations for the entire country. The net dependable capacity of the nation's generating equipment comfortably exceeds the estimated peak demand; thus if the energy could be distributed effectively by a national grid some of the pressure for new facilities could be relieved. Regional grids already exist as do a few interregional grids, however power industry critics feel that utilities are deliberately dragging their feet with regard to further extensions.

Also on the horizons of nuclear technology is the breeder reactor. Breeder technology is actually a means of improving the primary fuel situation for the power industry. Theoretically a nuclear power reactor can be built that will create, via the fission process, more nuclear fuel than it consumes. The Atomic Energy Commission and private industry are involved now in a program that is aimed at developing a practical breeder reactor by 1990.

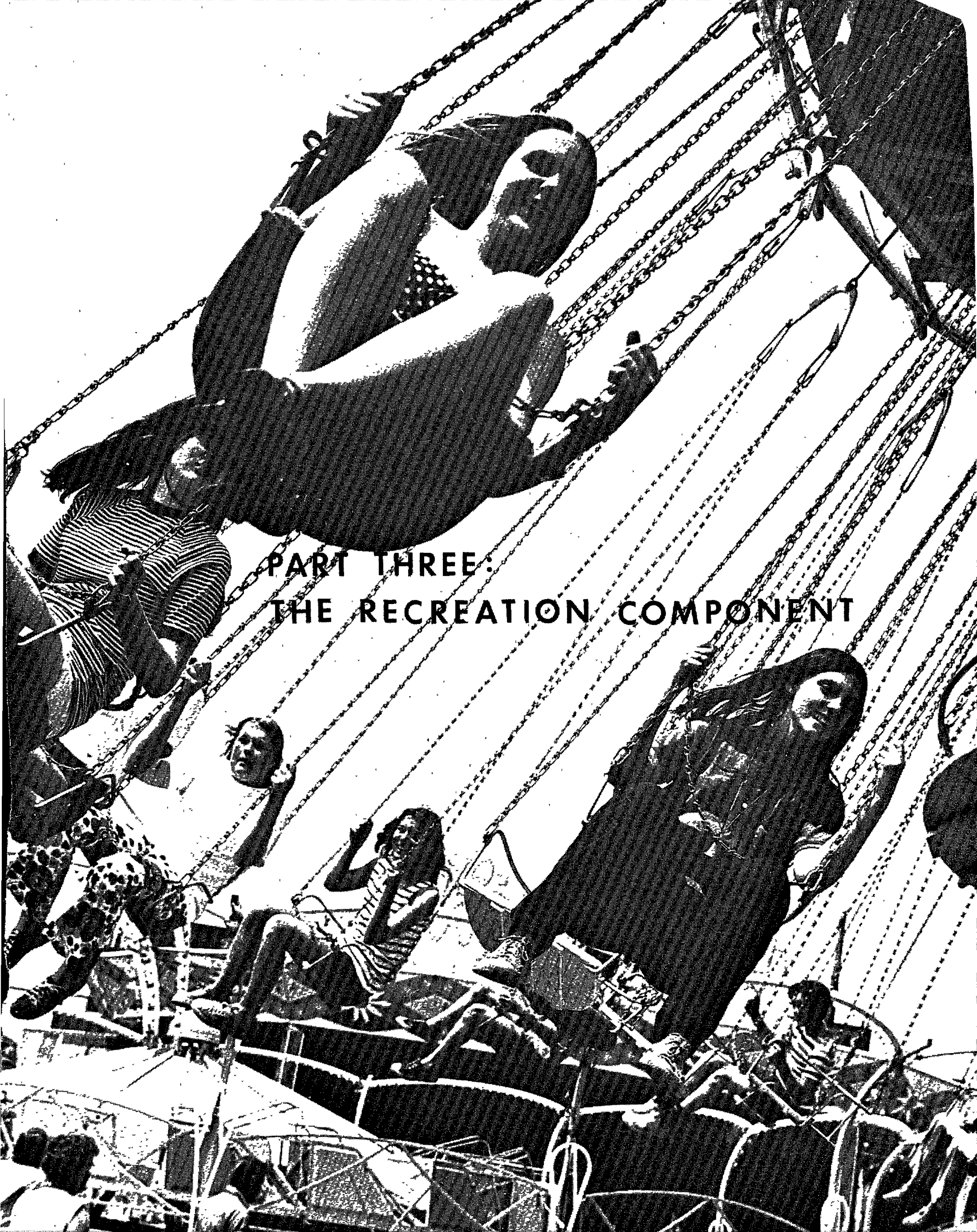
The Dickey-Lincoln School Project, a proposed hydroelectric system located on the Upper St. John River, received considerable study by the U. S. Army Corps of Engineers and a number of other State and Federal agencies during 1966 and 1967. However, since that time requests for funds to proceed with planning of the project have been turned down by the U. S. Congress and no work is being done at this time. The plans called for the construction of two dams. At one, the Dickey Dam near the junction of the St. John and Allagash Rivers, would be eight generating units of 95,000 kw each, totalling 760,000 kw. At the other, the Lincoln School Dam, would be two power facilities rated at 35,000 kw each. The estimated cost for the project would be $230 million.

The Passamaquoddy tidal power project, a concept first explored in the 1930's for harnessing the potential energy of rising and falling tides, has been renewed life recently. Senator Edmund S. Muskie (D. Maine) and other public officials have requested a review of the project in light of present economies and technologies as well as the present environmental demands that enhance the attractiveness of this project.

Other tidal power projects are being investigated for the Bay of Fundy between the Canadian provinces of New Brunswick and Nova Scotia. If successful, the possibility of importing surplus electrical power from Canada would take on new meaning. Each of these possibilities just discussed could have a definite impact on the shape of Maine's power spectrum in the years ahead.

In summary then there are a number of considerations that could have a bearing on the extent to which the Maine Coast will be used for additional electrical power generation:

- the public's perception of the health and safety factors associated with nuclear and fossil fuel generating plants.
- the feasibility of alternate beneficial uses of thermal effluents and other cost-benefits to the State.
- the disposition of the Dickey-Lincoln School hydro-electric power project.
- the possibility of a national power grid.
- energy exchange arrangements with Canadian electrical power suppliers.
- the realization of tidal power as a primary energy source for electrical generators.
- technological breakthroughs relative to electrical power production (i.e., fusion, solar energy, etc.).



PART THREE:
THE RECREATION COMPONENT

CASH FLOW GENERATED FROM AQUACULTURE

NEW INDUSTRIES

		Annual Gross	Employment
Algae Farm		2.8 M	25
Oyster Farms		5.0 M	85
Lobster Farms		12.0 M	230
Trout Farms		6.0 M	75
	TOTAL	25.8 M	415

COMMERCE WITH EXISTING INDUSTRIES

	Conventional Commerce	New Income to Industries
Chicken Farms		
Sell feed	1.1 M	
Buy manure		.3 M
Processing Plants		
Sell fish	6.0 M	
Buy curry	1.8 M	
Electric Power Plant		
Buy hot water		3.75 M
Town		
Taxes		1.4 M
	8.9 M	5.45 M

CONCLUSION — A BEGINNING

Rather than concluding this segment, it is hoped that a beginning will have been made toward a new, positive direction for coastal Maine. It is impossible to be complete in delineation or solution of any one of the component areas. But the orientation here has been to present a scheme for attacking the most serious problems in each area by generally utilizing its problematical aspect, usually its noxious output, as a beneficial requirement for the solution of problems in another area: i.e., to close as many waste-requirement loops as possible. By demonstrating the immediate feasibility of a familiar environmental principle —recycling, as applied in an economic situation, it is possible to preserve and enhance the priceless qualitative aspects of the Maine Coast.

The recycling concept can be applied in other instances and should become a very important consideration when weighing future coastal resource planning decisions.

The following section of this report will outline some institutional and organizational arrangements which will be needed to implement coastal development proposals.

Most generating stations are very large by their nature — they are also usually isolated and hence, by today's standards, they tend to be visually obtrusive. One way of diminishing the mass problem would be to build into the ground, or half into the ground. The structure would then become a land form sculpture: built in some old quarry, for instance, it would:

— blend into the surrounding landscape
— become a major tourist attraction (unique)
— by being buried (partially) in solid rock, it would be safer
— would make it less vulnerable to natural or man-made attack
— would not endanger valuable land if it were built in a quarry which has been abandoned
— power lines are on tower above trees with only roads for access and maintenance.

Golf course	18 hole @ 25,000/hole	450,000	150 A
Tennis, handball, etc.		120,000	30 A
Multi-Units			
Motel	350 units @ 12,000/unit (includes convention complex)	4,200,000	15 A
Multi-Units	100 units @ 35,000/unit	3,500,000	80 A
Housing	250 units @ 45,000/unit	11,250,000	300 A
Yacht Basin for 200 boats & repair	200 boats	1,750,000	10 A
Open Space			300 A
		29,070,000	945 A

Land Cost: 945 @ 1000/acre = $945,000

Total Capital Cost, excluding financing: $30,615,000*

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* includes power and sewer

SUBSYSTEM: POWER PLANT (NEW OR EXISTING) BASE LOAD STATION

Function/ Product: To generate electrical energy: 1,700,000 kilowatts of electricity and heated water or super-heated steam

Raw Materials Needed: Large amounts (1,200,000,000 gals) of coolant sea water for reactor cooling energy source.

Market: Local and possible wholesale electricity for major metropolitan areas (Boston and New York City).

Site Criteria: The facility must meet all AEC requirements and possibly exceed some of these requirements. They are:

- — 3000 ft radius of non-habitation
- — one mile from major population areas
- — suitable for large shipping of reactor components
- — ease of shipping out radioactive gases and solid waste
- — not located on major seismic belt or lines
- — rock foundations preferred
- — coolant waters are taken from deep water 40-60′ to reduce killing pythoplankton, the beginnings of the food chain.

Services:	a) Beach: 5 month ocean bathing through heated beach complex b) Choice of individual houses, cabins, motel rooms c) Direct service to airport d) Restaurants specializing in seafood, poultry, organic vegetation e) Ship repair for aquafarmers; charter and rental services f) 18-hole competition golf course
Raw Materials:	a) Nuclear power for heat and electricity b) Sufficient adjacent lands to reap the benefit of increased land value (thus internalization of profit, and promotion of planned development of outlying areas if owned by few whose interests are not in areas of land speculating). c) Sufficient initial investments to defer excessive interest rates (possible sources of revenue are the power company coupled with a large investment capability of a private entrepreneur and Federal and State assistance). d) Coastal frontage for aesthetic livability.
Waste/ Byproducts:	a) Human excrement and organic garbage for fertilizer manufacture, promotion of algae growth and organic farming. b) Inorganic garbage utilized to create a mound for a possible open-air theater or ski area.
Site Criteria:	Beach area required. Coastal visibility for tourist housing and golf course. Forest and farm land open spaces required. Slope should be greater than 8% and less than 15% with some parts 20% for maximum residential visibility of coast and ocean. Orientation of land to sun — sunrise and sunset. Develop the field/forest edge relationships which will act as natural dividers for increased privacy and rural environmental effect.

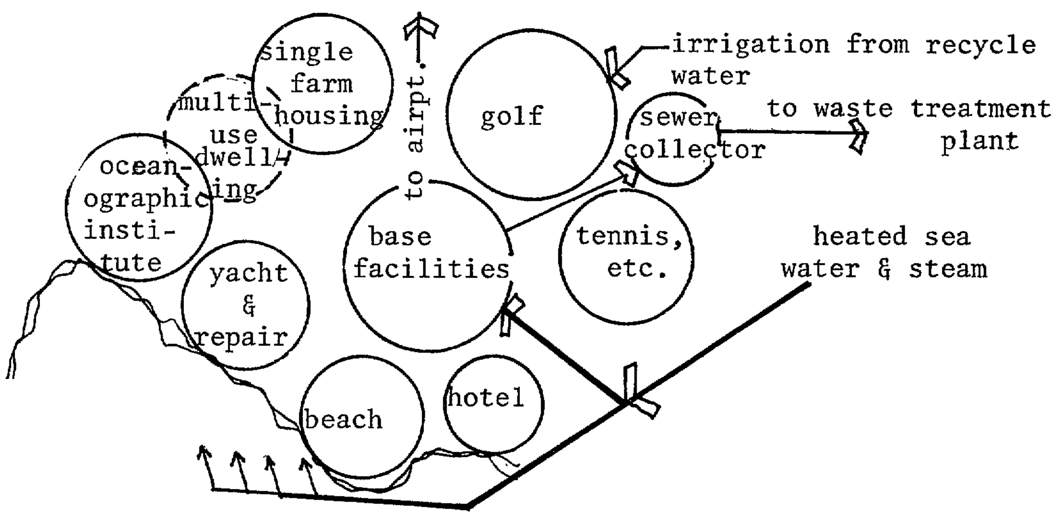
Base Facilities	Number	Avg. Sq. ft.	Total	Capital Costs	Area
Bank	1	1000	1,000		
Restaurants	4	1500	6,000		
Novelties	6	1000	6,000		
Drugstore	2	600	1,200		
Antique	4	800	3,200		
Bookshop	2	800	1,600		
Museum	1	1500	1,500		
Craft shop	6	400	2,400		
Art gallery	4	800	3,200		
Town hall/meeting house	1	2500	2,500		
			286,000		
Misc. & maint. @ 10%			28,600		
			314,600		
			@ 27 =	8,400,000	60 A

Complex building forms and masses should blend naturally with the environment of the area. Major open spaces will depend on the man-made building pattern. The shape, size and edge relationships of that pattern will govern its quality. This will reflect and enhance the nature of the institution and its relationship with the community at large and, most importantly, with each individual user. We are building for ourselves and our future, hence the requirements, both physical and spiritual, are most important criteria.

Size: the facility would grow with the progression in development of industrial components and their continuing research needs.
Employees: 10 service, 20 science and technical people.
Cost: $400,000 for initial facility which could be part of an existing oceanographic research facility or a new coastal research laboratory for Maine.

SUBSYSTEM: SMALL TOWN-CITY COMPLEX (11,000 PERMANENT, 20,000 SEASONAL AND CONVENTIONAL)

Function: To house in a livable environment the employees and private entrepreneurs associated with the aquaculture-agriculture-electrical system; and to accommodate and promote tourism as a non-pollutant form of industry.



Sewage - Algae Plant

10 million gal sewage/day — 200,000 lb algae/day

Expenses

Capital & operating cost for sewage	$ .4 M
Capital & operating cost for algae products	.7 M
Capital & operating cost for algae harvesting	.9 M
Hot water from power station	.5 M
Chicken Manure ($10/ton)	.3 M
	$2.8 M

Income

Algae broth fish and oyster feed (23,000 tons/yr @ $60/ton)	$ 1.4 M
Dried algae chicken feed (13,000 tons/yr @ $100/ton)	1.1 M
Organic fertilizer (4,500 tons @ $30/ton)	.1 M
Recycled water	.2 M
	$ 2.8 M

SUBSYSTEM: COASTAL RESEARCH LABORATORY

Function/ Service: To supply the research and technical staff needed to sustain the various components within the system. It would serve as a training institute for college and pre-college students interested in ocean-related studies as well as serving as a major applied research facility. Developing this with a major college or university might be desirable.

Site Criteria: The facility would be close to the town for services and use of the resort area. One of the major problems with a resort results from lack of year-round use. One of the problems with university housing is that for four months in the summer it is not used intensively. Combining both these conflicts might be to the mutual advantage of both. Proximity to the recreational environment would be an improvement upon the typical institution housing. The units would then have a higher use factor and more attention and money could therefore be allocated for such housing. Soil should be suitable for underground piping and foundations, with a gravel source in proximity.

Site Criteria: An area of 150 acres of fairly flat land. Soil suitability is important: should be clay type, not located in flood plain, and prevailing winds away from populated areas. Facility should also be screened with trees, evergreen type, and securely fenced.

Cost of Waste Treatment Complex

Capital Cost

Land: 100 A @ $300/A	$ 30,000
Bioligical oxidation towers	900,000
Communitors	100,000
Pumps & lift stations*	350,000
Settling tanks	100,000
Storage & tertiary lagoons	200,000
Ozone injection/recovery	300,000
Maintenance & control bldg	50,000
	$2,030,000

Yearly Cost

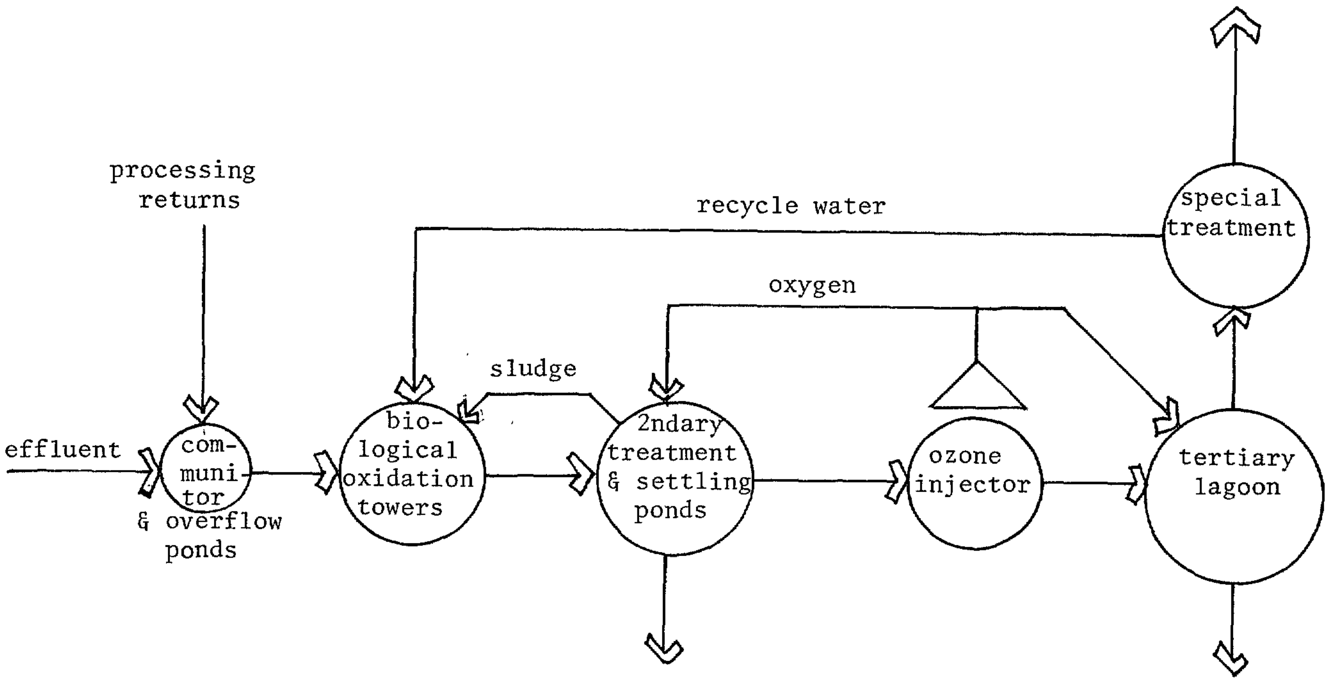
Labor & tech	$ 50,000
Repairs	50,000
Depreciation	200,000
Interest	140,000
	$ 440,000 / 3,650,000,000 gal/yr

Cost per million gallons = 120/Mg

* does not include external piping

SUBSYSTEM: WASTE TREATMENT COMPLEX

Function/ Product :	To treat sewage and make it safe for use in algae pond; to purify water
Market:	Utilized in algae pond and land farming
Waste/ Byproducts:	Solid organic fertilizer from cleaning of pond bottoms, recycling of potable water



Process: Communitors are first located at the major collector components: town, recreation complex, chicken farm/processing plant. The solids are finely ground in the communitor and carried to the multi-stage treatment in an effluent solution. The first stage of the process is an aerated lagoon (a series of suspended perforated pipes which inject air). The secondary treatment is also aerated. The solution then passes to an ozone injector. This will kill most of the pathogenic virus. Ozone will break down into oxygen (a great deal of it escaping into the air), and a collector-compressor device will capture escaping oxygen and compress it, pumping it back into the aeration system. At this point, controls and monitors would analyze the solution's suitability for pumping and mixing with sea water for the algae ponds.

Site Criteria: Should be near fishing fleet, waste treatment center and located near a major transportation line. Soil should be adequate for medium foundations and extensive underground piping.

A large building complex with heavy traffic demands should be effectively screened to reduce the impact of its mass. Tree screens can be used to blend parking area with surrounding areas. Large settling tanks will contrast with the mass of the building.

	INPUT		OUTPUT					
	Fresh Water gal/day	Stream lbs/hr	Bird/ Fish/ Algae	Produce lbs	Rendered lbs/day	Effluent	Capital Invest.	Employ
chicken	500,000	10,000	70,000	245,000	69,000	500,000	4½ M	300
fish	150,000	10,000	120,000	36,000	84,000	150,000	1½ M	160
algae	unknown	10,000	20,000	20,000		red/ steam	1½ M	15
	650,000	30,000			153,000		6½ M	475±

SUBSYSTEM: FOOD PROCESSING PLANT

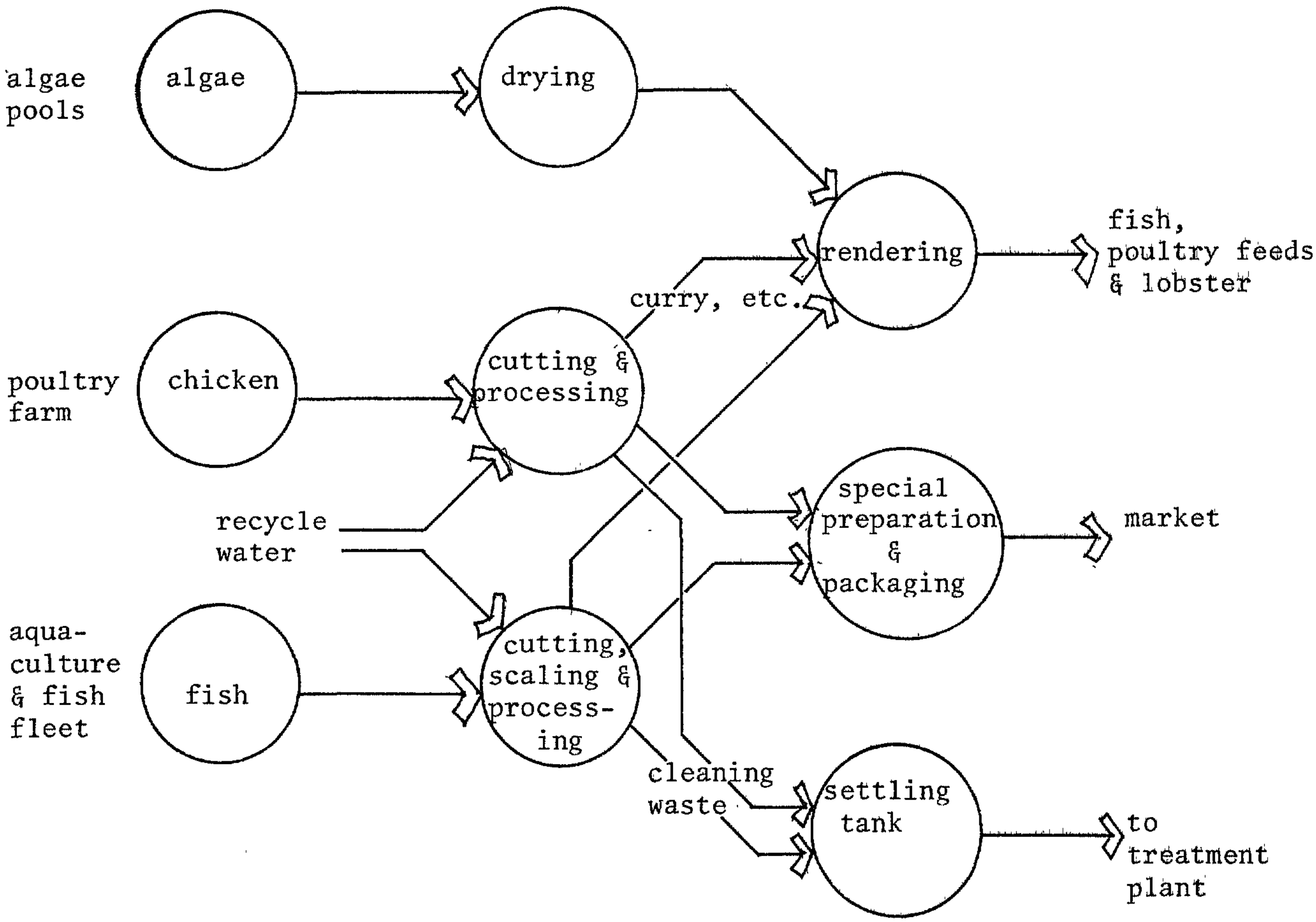
Function/ Products: To prepare poultry and seafood for various markets:
a) poultry products
b) sea foods:

aquaculture	offshore catch
lobster	halibut
oyster	sardines
trout	herring
	pollock
	cod

c) fish and chicken feeds for local purposes as well as outside demands

d) algae drying and rendering

Market: U.S. and Europe; domestic feeds



Site Criteria:	Ponds would average 1 acre in size and about 1 foot in depth. Flat areas make pond construction easiest but require pumping. Slope sites would be more difficult for pond construction, but could make use of gravity for water flow. Ponds should be near salt water and heated water source. Use of low-yield land possible — i.e., land which has been stripped of its timber or of otherwise marginal suitability.
Yield:	One acre could produce 200,000 lb of algae. 50 acres of algae could feed & produce 1 M lb. oysters. 1000 acres of algae production would produce 200 M lb. of algae.

Cost of Algae Ponds and Production

Capital Cost

Land: 800 A @ $400/A	$ 320,000
Construction: 700 A of pools @ $3000/A	2,100,000
Piping & buildings & pumps	1,000,000
	$3,420,000

Yearly Cost

Maintenance & operation @ $100/A	$ 70,000
Interest @ 7%	240,000
Depreciation @ 10 years	342,000
Taxes @ 30/1000	100,000
	$ 752,000

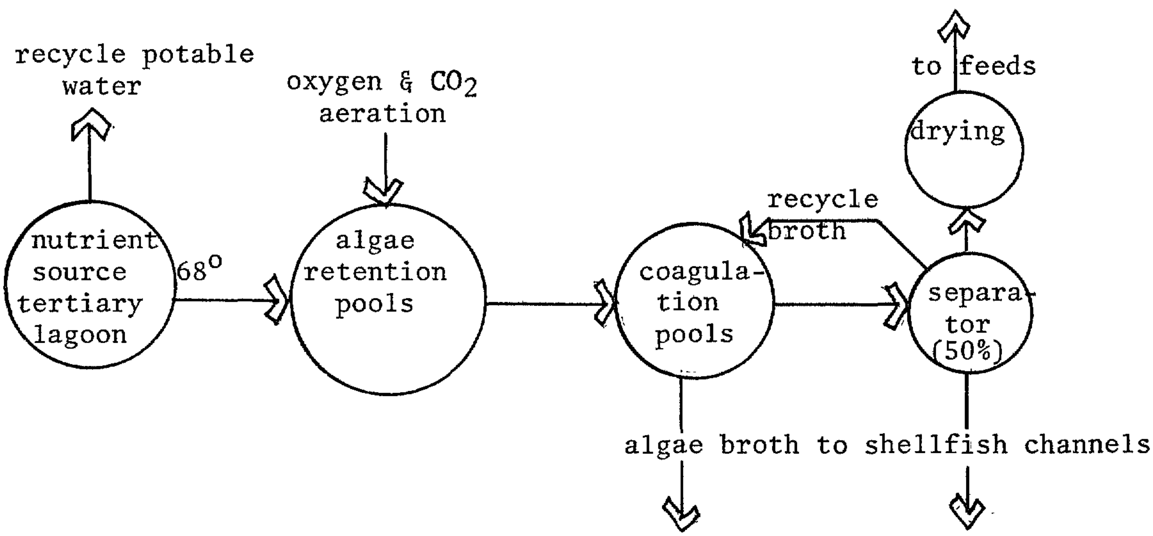
Production Cost/Year

200,000 lb/day = 36,000 tons/year

COSTS	TOTAL Million $	COST PER TON Dry	COST PER TON Wet
Operation	.7	20	20
Heat	.3	8	8
Harvesting & Drying (13,000 tons/year)	.7	50	
Handling & piping to oyster & fish farms (23,000 tons/yr)	.2		10
Effluent	.6	15	15
		93	53

SUBSYSTEM: ALGAE PONDS

Function/ Product :	To provide the best possible environment for the growth of algae (unicellular) and algae broth as a primary food source
Market:	Major protein for a) feeding first stages of lobster larvae, shellfish, oysters, clams, other mollusks b) combining with fish curry and chicken curry in pellet form to feed mature lobster, sea trout, salmon, other fin fish and as poultry feed
Waste/ Byproducts:	Organic solids settling to bottom would periodically be cleaned out as fertilizer for land farming or land fill. Algae broth would be mostly free of pollutants and after coagulation the algae solution would pass over oyster and shellfish beds as feed.



Process:	65°F sea water from power plant mixed with waste treatment effluent in a 10 to 1 ratio in algae culture ponds.

Annual Cost

Fixed Cost:		
Depreciation	$ 4,500	
Interest	3,000	
Taxes	1,500	
	$ 9,000	$ 9,000

Operating Cost:

Feed	$47,000	
Labor	10,000	
Maintenance & operation	5,000	
Heat & electricity	2,000	
	$63,000	$63,000
	Expenses	$72,000

Income

Broilers	$40,000	
Eggs	35,000	
	$75,000	Income $75,000

* volume: indicated possible increase in New England market, retaining positive advantage and existing chicken farms — **The Maine Poultry Industry**, July 1970.

** overall costs of a contract farm are similar, except that the moneys are divided between the farmer and the large-scale producer.

Process:	Chicken cage farming techniques are well-established. Use deep-pit manure collection, empty 2-3 years.
Site Criteria	Use of cage farming techniques requires very little acreage for the raising of poultry. Other land needs — garden, fields and area to dry chicken manure (danger of nutrient run-off). Size 10 to 25 acres. Soil should be suitable for buildings and gardens. Within 50 miles of processing plant for delivery and chicken feed. Slope can be up to 10%

Development of indoor open space and building masses will constitute major land patterns. The shape, arrangement of open space and buildings will determine quality of the rural environment. Major spaces and farms delineated by visual screens: pines, spruces, etc.

Size: 10 - 15 acres — 25,000 birds/farm

Volume* and Waste Products

Bird Type	No.	Feed	Manure	Solids @ 29%
Hen: Layers	6,000	100 lb/yr	270 tons	80 tons
Broilers	76,000/yr.	8 lbs/9 wks	300 tons	90 tons

Average farm size — 25,000 birds for one-man operation

Operational Cost of an Independent Chicken Farm**

one man — 25,000 birds
6,000 laying hens
19,000 boilers x 4 crops/year

Capital Cost

Land, buildings and equipment	$34,000
Stock	11,000
	$45,000

Income:	25,000 8-lb baskets of Grade A Tomatoes @ $2.00-$2.50/basket		
	TOTAL INCOME		$50,000
		to	$62,500
	profit (labor costs) for 2,		$20,400
		to	$32,900

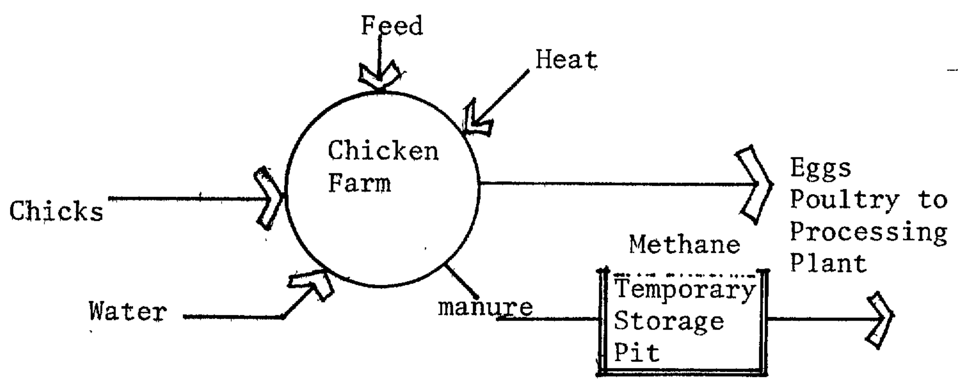
* taxes @ $500/year
** low-cost heat and fertilizer

SUBSYSTEM: POULTRY FARMING

Function: To raise poultry and poultry products

Market: Poultry market is well established. Chicken curry can be rendered for chicken and fish feed. Chicken manure is a major nutrient supply for algae.

Raw Materials: Farm and chicken feed. 10-acre average



temperature and climate conditions. Greenhouses can protect plants from the elements, but would require large amounts of heat. Low-cost heat can be supplied to greenhouses located in proximity to an electric generating plant. This source of low-cost heat provides greenhouse growers a more competitive situation. (Current farming methods rely on large scale, high technology and product specialization. Adverse climate and ecological conditions are dealt with artificially. Organic farms rely on natural solutions to adverse conditions and are typically smaller in scale with high product diversification.

These small-scale farms would obtain low-cost natural fertilizer from the various settling plants of the waste treatment plants and metabolic waste settling tanks. The greenhouse structures would be permanent glass greenhouses with heating and watering systems. Harvested goods would be shipped according to market demands and economies of transportation.

Site Criteria: Soil should be suitable for agriculture, permitting light foundations and underground piping. Orientation to sun is important. Should be in proximity to power plants (steam) and waste treatment center (fertilizer) within short driving time of major transportation facility.

Development of open spaces is a powerful land pattern. The shape, size and edge relationships will govern the quality of these spaces. In operating new space the quality aspects are as important as the farming criteria. In large part, these farms will be occurring in rural areas, making the nature and composition of open spaces and building complexes a most important facet in developing the character of the community.

Cost Aspects of a Typical Greenhouse Production:

heated to 65° year round
2 crops per year
2 worker tomato greenhouse

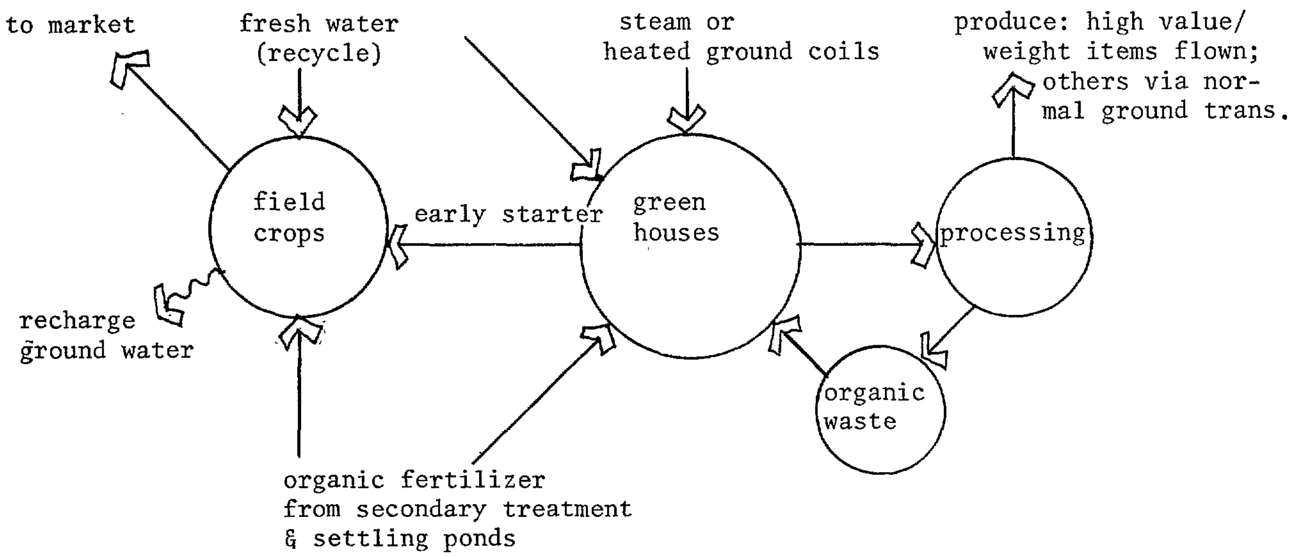
Typical Cost Aspect of a 1-Acre Greenhouse Tomato Production Farm

Expenses:	40,000 sq ft greenhouse @ $4.50/sq ft		
	= 180,000 @ 7%	=	$12,000
	Depreciation for 20 years	=	9,000
	Expenses, taxes*, fertilizers** and heat**	=	8,000
	Labor (see profit, below)		
	TOTAL		$29,600

SUBSYSTEM: ORGANIC LAND FARMING

Function/ Product : To grow wholesome foods year-round without use of chemicals or pesticides.

Market: People are becoming more and more concerned about the quality of their food as industry-induced additives are found to be harmful. Recent trends toward eating organic foods (naturally grown, without chemicals or pesticides) indicate 10% growth per month of this market in the last 16 months in the U.S.* Presently, much of the organic food comes from the west and the mid-west. A major limiting factor in growing of these foods in Maine and New England is temperature control and ease and speed of delivery of the product to market.



Process: Care and attention and small-scale efforts are needed to grow wholesome organic foods. Producing a year-round abundance of these foods has been limited in the past because of the

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* Time Magazine article

Oyster Channel Farm

10 channels/farm   7 rafts/channel

Capital Cost

10 channels 90′x12′x14′ @ $3000	$30,000
Pumps @ 5000	5,000
7x10 = 70 rafts x 150, 10,500 @ $1/sq ft	10,500
	$45,500

Fixed Cost/Year

Interest	$ 3,100
Depreciation	2,300
Taxes	1,300
	$ 6,700

Operating Cost/Year

Fixed	$ 6,700
Maintenance	2,000
Algae food	10,500
Heat	4,500
Labor	10,000
Starting larvae	1,000
	$34,700

Income

35,000 lb @ $1.00/lb =	$35,000

Process: Establish a larvae hatchery where conditions are completely controlled. Larvae are raised 14-21 days in heated sea water and then placed in another tank where they will attach themselves to raft systems or oyster shells on the bottom. From there they are placed in either oyster channels (rafts) or into the estuary (rafts and bottom) where the channels empty into them.

Oyster channels are intensive farming units designed to give maximum food exposure and dissolved oxygen to oysters suspended from rafts placed within the channels. Warmed sea water at 65-70° from the algae pools will comprise part of the water supply and constitute the food supply. Water flow could be either gravity or pumped. After passing through the channels the sea water would go into a settling tank where solid metabolic waste would settle out to the bottom. This area would be excellent for raising bait worms both as a commercial product or for fish food (if production were great enough, it might bring down the market price — thus it could become a food source for aquaculture). The settled metabolic waste would also (properly dried) make good organic fertilizer.

The water would then run over a series of baffles to eliminate or reduce concentrations of toxic elements. At this point the sea water could either flow into the estuary or be recycled back through the oyster channels.

The estuary could provide a less controlled and lower density situation for cultivation of shellfish. The sea water will still be warmer than normal because of water inflow from fish, lobster and shellfish farms. The estuary will depend on tidal action for flushing of metabolic waste. Nets will provide protection from possible fish predators.

Site Criteria: Oyster channels have to be near algae ponds and near the estuary to facilitate large water volumes. Gravity systems would depend on slope: the estuary would depend on normal protection from coastal storms and waves. The shape and current would determine the amount of flushing.

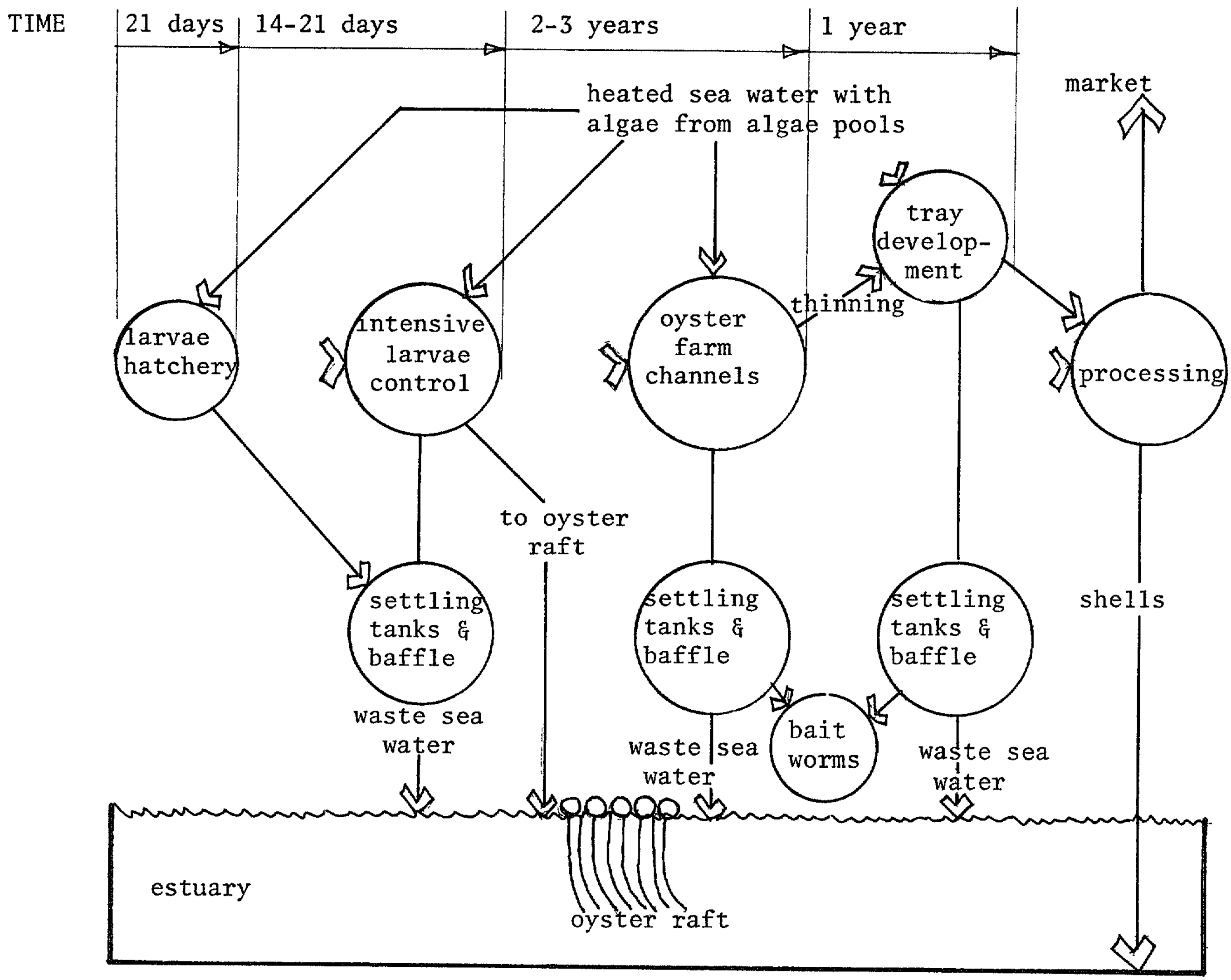
Use of an estuary necessitates having water frontage, but with proper screening and design, it would not detract from surrounding area. Use of estuary by power boats would have to be closely controlled.

SUBSYSTEM: AQUACULTURE / OYSTER FARMING

Function/ Product : To facilitate the use of algae; and, to raise commercially marketable oysters.

Market: Undeveloped markets in large areas of U.S. (other than middle Atlantic states) and Europe.

Waste/ Byproducts: Metabolic waste collected in settling tanks may provide breeding grounds for bait worms and a source of organic fertilizer. Processed shells are redistributed in proper locations to provide natural breeding grounds for shellfish. May in time also provide a possible primary food source to other fish farmers.



INTRODUCTION TO THE RECREATION COMPONENT

Recreation is an activity, not an industry. However, the past few decades have fostered a dramatic growth in those industries often linked with recreation. As a result, sometimes these businesses are grouped together and referred to by one of several pseudonyms: leisure time industry, leisure group, vacation travel, recreation services group, and others. We shall refer to all of these in this report as recreation-related industries.

These recreation-related industries involve many sectors of Maine's economy, therefore, it is necessary to establish an overall prospective for this study. The following few paragraphs and the accompanying tables summarize those aspects of recreation that are examined in detail in the remainder of the recreation component and provide an overview.

The term recreation very quickly brings to mind the various activities that individuals pursue in their leisure time. The list below contains those activities that relate to the Maine Coast. Next to each activity is a measure that indicates the level of participation with regard to that particular category, also the percentage of the total State activity that is attributable to the coastal zone.

RECREATIONAL ACTIVITY	ESTIMATED LEVEL IN 1970	PERCENT OF STATE TOTAL
Swimming, Picnicking, Hiking	3,030,000	
Day Use of State Parks	visitor-days	91
Motor Boating & Sailing		
Motor boats registered	16,000 boats	36
Sight-Seeing		
Day use of State Memorials	244,000	
	visitor-days	94
Peak daily highway traffic	140,000 vehicles	60
Nature-Study		
(No available indicators)		
Outdoor Sports		
Registered guides	185 persons	48
Registered deer kill	17,000 deer	41
Ski area attendance	53,000 skier-days	11

Due to this recreational activity, many companies have been established to provide the products and services demanded by the recreationalists. Many of the firms can trace all of their revenue to recreational activities. Below are the major types of business in recreation-related industries and their gross revenues for 1967. In addition, the percentage that the revenues represent of the State total which can be attributed to coastal firms is shown.

BUSINESS DESCRIPTION	REVENUE: 1967	PERCENT OF STATE TOTAL
All Recreation-Related Firms:	$262.4 million	62
Hotel & Motels	42.0 million	84
Boatbuilding & Repair	7.6 million	100
Amusements	13.2 million	70
Eating & Drinking Places	50.7 million	68
Tourist-Oriented Stores	148.9 million	53

Of particular importance are the indicators that give insight into the overall economic impact recreation has on the coastal zone. These include the number of jobs provided by recreation-related industries, level of wages received, investment in real property and others. Below is a summary of this information including percentage breakdowns for each variable. The data represents estimates for the year 1970.

		Recreation-Related Industries	
	Amount on Coast	% of all Coastal Industries	% of Statewide Recreation-Related Industries
Employment	**21,000 persons**	9	77
Year-round	13,000 persons	8	72
Summer peak	8,000 persons	5	90
Payrolls	**$27 million**	3	51
Summer	$17 million	2	79
Other seasons	$10 million	1	12
Personal Income	**$75 million**	4	69
Retail Trade	$48 million	2	67
Services	$21 million	1	75
Real Property			
Valuation	$800 million	25	49
Taxes	$ 22 million	25	50

The recreation component looks closely at the existing situation in the recreation-related industries. Following that examination is a forecast of how various sectors will behave in the years ahead, and finally a discussion of the planning implications that recreation places on Maine's coastal zone.

THE EXISTING SITUATION IN THE RECREATION-RELATED INDUSTRIES

General Economic Measures

The Maine coastline is one of the nation's greatest natural resources. The general outline of the coast is only 228 miles in length, however, when the shore along all bays, estuaries, and the 1,149 islands of 10 acres or more is measured, the coastline totals 3,500 miles. The 139 coastal towns contain 13% of the State's entire area and 45% of its current population. One half of the 1970 coastal population of 444,000 persons is concentrated in towns within the two southwestern counties. Although the total population of the coast has increased only 2% since 1960, fifteen coastal towns have gained over 25% and seventy-nine coastal towns rose from 0% to 25%. Forty-five communities (including most of the large industrial cities) lost population.

Employment along the coast totals approximately 150,000 persons of which about 13,000 permanent jobs and an additional 8,000 summer jobs are in recreation-related industries. For the purposes of this study recreation-related industries include: commercial lodgings, public and private campgrounds, commercial amusements, eating and drinking places, stores selling to tourists, and transportation carriers. Payrolls in the coastal towns during 1967 totalled $616 million, which was 57% of the State total. The recreation-related industry payrolls accounted for about $27 million of the coastal total. An additional $23 million was earned by proprietors and their families from these enterprises. Average wages in the State's recreation-related industries in 1969 amounted to about $1,000 less than the average of $5,688 for all industries. Total personal income of employees and proprietors in the recreation-related industries during 1969 approximated $108 million throughout the State, or about 5% of the total for all industries. It is estimated that the recreation-related industries of the coastal counties generated about $75 million in personal income, only part of which came from out-of-state tourists.

TABLE 3-1

ESTIMATED PERSONAL INCOME DERIVED FROM RECREATION-RELATED INDUSTRIES IN MAINE, 1969
(Millions of Dollars)

Source of Income	Total	Retail Trade (1)	Services (2)
State Total:	108	72	36
Wages & Salaries	53	32	21
Proprietors' Income	55	40	15
Coastal Economic Areas:	75	48	27
Wages & Salaries	40	25	16
Proprietors' Income	35	23	11

(1) Gasoline service stations, eating & drinking places, misc. stores
(2) Motels and hotels, commercial amusements and recreation

Although income generated in the recreation-related industries has secondary effects on other industries which either sell to them or to persons employed by them, the lack of data on these relationships renders hazardous the employment of such multipliers developed for other states. More precise measures of employment and income due to tourism are needed, particularly for individual towns.

Real property valuations in the coastal towns rose 57% from 1960 to 1970, when the total amounted to $3.2 billion (at 100% of estimated market value). The greatest relative increases occurred in the prime tourist area.

The valuation of recreation property along the coast comprised about 20% of the total property valuation in that area in 1959. Local property taxes of $89 million were collected in 1970 in those towns of which perhaps $22 million was derived from recreation property.

Coastal Homes — Permanent and Seasonal

The number of homes utilized as permanent residences in the coastal towns rose from 137,000 units in 1960 to 146,000 in 1970 — an increase of 6.3%.[1] The largest relative rises occurred in Lincoln, York and Cumberland Counties, while Washington and Penobscot Counties experienced declines.

The coastal towns now contain 23,000 seasonal housing units which comprise 39% of the statewide total.[2] A direct comparison between the number of seasonal homes in these towns in 1960 and 1970 is not available; however, it is estimated that seasonal homes declined by 3.1%.[3] A substantial drop took place in York County, particularly in the resort areas of Old Orchard Beach, Wells, and York. We expect that these decreases resulted from the conversion of seasonal homes to year-round use. Substantial increases in seasonal units took place in Hancock and Washington Counties, with smaller rises in Lincoln and Knox. Of the 139 coastal towns, 66 sustained losses in the number of seasonal homes, 55 had increases of between 0-49%, and 18 experienced gains of 50% or more.

Seasonal homes in the coastal towns now comprise a somewhat smaller share (13.1%) of all housing units in that area than do the seasonal units in the inland towns (16.8%). However, seasonal dwellings comprise over 50% of all housing units in 16 towns, 25%-50% in 36 towns, and lesser shares in the remaining 87 municipalities. Lincoln and Hancock Counties have the greatest number of communities with large shares of seasonal homes. (Figure 3-1 indicates the towns that were above and below the 25% level).

The estimated median value of year-round homes in the coastal towns rose 63% (from $9,200. to $15,000.) during the last decade.[4] The highest values in 1970 were recorded in Cumberland, York, and Kennebec Counties, however, the greatest relative increases took place in Hancock, Lincoln, Sagadahoc, Knox and Waldo Counties. With regard to seasonal homes in the coastal towns valuation data has not been compiled. Some insight is provided by a survey conducted by the Maine Department of Economic Development dating back to 1959.[5] That study revealed that the estimated market value of all seasonal residences in the coastal towns was $102 million or 63% of the statewide total for seasonal homes at that time. The same study shows Hancock, York, Lincoln, Cumberland, and Knox Counties has the highest total valuations of seasonal homes.

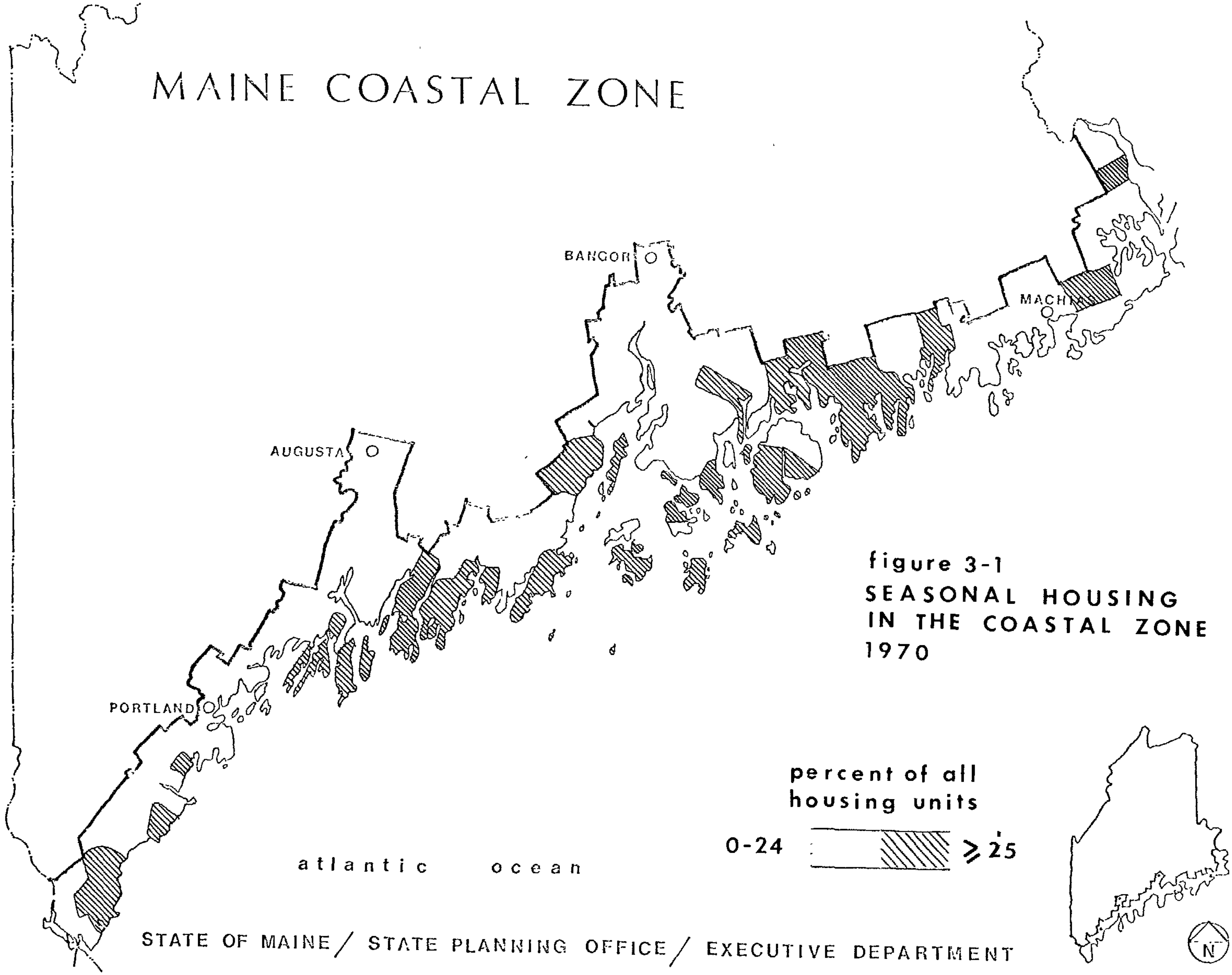
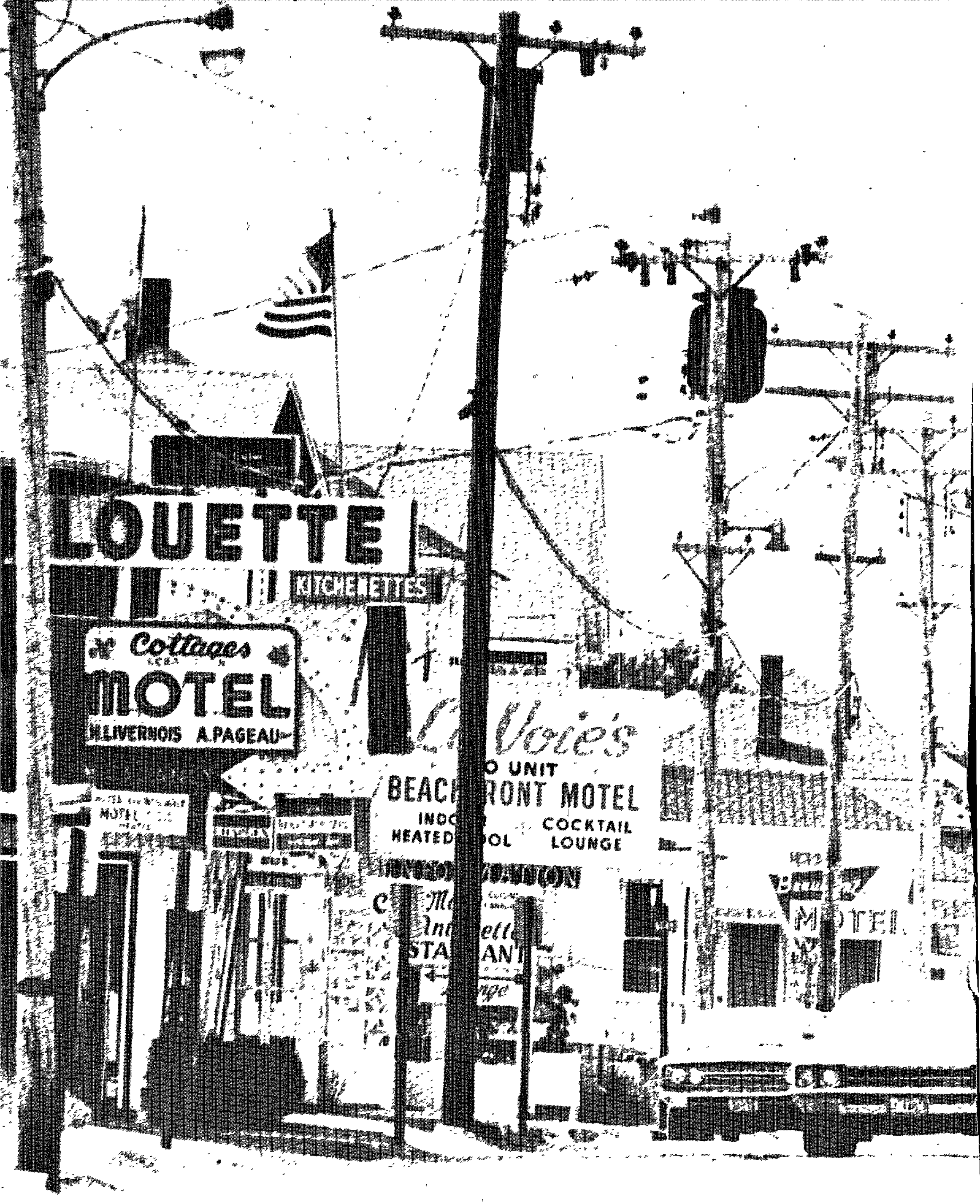


figure 3-1
SEASONAL HOUSING IN THE COASTAL ZONE 1970


LOUETTE
KITCHENETTES
Cottages
MOTEL
H.LIVERNOIS A.PAGEAU
O UNIT
BEACH RONT MOTEL
INDO
HEATED OOL
COCKTAIL
LOUNGE
MOTEL

Commercial Lodging

In 1967 there were 743 commercial lodging places (hotels, motels, tourist courts, camps) with a capacity of almost 31,000 rooms in the coastal towns.[6] This capacity, which constitutes 36% of the State's total is concentrated largely (75%) in York, Cumberland, and Hancock Counties. Eight towns (five in York County, plus Portland, Augusta, and Bar Harbor) have over 1,000 rooms each, with a total capacity of 19,000. In 1959, commercial lodgings on the coast had an estimated market value of $47 million.[7] A new survey of both capacity and valuation of commercial lodgings is needed.

Approximately 84% of Maine's hotel-motel business, as measured by payrolls and receipts, is located in the coastal counties.[8] (The data does not reflect the proportion of these county totals that is allocable to the 139 coastal towns). Annual payrolls, which amounted to $11.6 million in 1967 in the coastal counties, provide an important measure of the economic importance of the lodging industry. A substantial portion or receipts or transient rentals is paid to out-of-state suppliers making them less reliable as indicators. However, taxable transient rentals, which totaled $27 million in the coastal counties during 1969, are growing faster in Penobscot, Kennebec, and Sagadahoc Counties.

Estimates prepared by the Public Affairs Research Center for the Maine Park and Recreation Commission indicate that commercial lodging places provided about 2.4 million visitor days' occupancy to patrons in the coastal counties in 1968.[9] The leading counties were Cumberland, Penobscot, and York. Nearly one-half (45%) of the estimated visitor-days occurred during the summer months of July and August, 35% in the spring and fall, and 21% during winter. In York, Lincoln, and Hancock Counties more than 50% of the annual visitor-days took place during the two summer months. The inland counties experienced a more even distribution throughout the year. Assuming that each hotel-motel occupant spends twenty dollars per day, the total receipts for the entire State is calculated to have been $48 million for 1968. A survey of hotel-motel occupancy, receipts, and payrolls by town is needed to provide a more accurate picture of the economic importance and location of tourism in Maine. It appears likely that tourism will expand roughly in proportion to expected increases in the northeast "origin population base", as discussed in a later section.[10]

Turning now to look at the seasonal residents and some of their spending habits. Information in this area was obtained from the **Northern New England Vacation Home Study — 1966** published by the Bureau of Outdoor Recreation of the U. S. Department of the Interior. The investigation indicated that the average number of seasonal dwelling occupants in Maine was 4.2 persons, who used their dwelling an average of 255 visitors days (60.7 days per person, mostly in the summer), and who spent an annual average of $1,873. per household. The latter figure includes $777. for local expenditures (groceries, meals, transportation, etc.), $193. for local real estate taxes, $484. for household maintenance, $156. for major sports equipment, $125. for major household equipment, and $140. for regional travel and purchases. Applying these figures to the 23,461 seasonal homes on the Maine coast, we estimate that Maine's seasonal homes are used by about 100,000 persons who spend 6 million visitor-days and $44 million per year. (Comparable estimates for the entire State are 250,000 seasonal residents who spend 16 million visitor-days and $113 million per year).

The table below indicates the percentage participation in the various forms of outdoor recreation that were sought by vacation household members in Maine as determined by the study.

OUTDOOR RECREATION

Vacation household members	
Golf	18%
Horseback riding	13%
Bicycling	10%
Tennis	7%
Water Activities:	
Swimming	56%
Motor Boating	53%
Fishing	50%
Water Skiing	23%
Sailing	17%
Canoeing	13%

Camping and the Coast

Although the number of campsites available at Maine's coastal state and national parks grew 24% during the last decade, usage of those facilities increased 118%.[11] Over one-half (312,000 camper-days) of statewide public camping now occurs along the coastline. Two-thirds of the coastal usage takes place in Acadia National Park, with the remaining one-third concentrated primarily at Camden Hills, Cobscook Bay, and Lamoine State Parks. Campers at coastal parks spent an estimated $1.5 million during 1969.

According to the 1969 Maine State Park Camper Survey undertaken by the State Park and Recreation Commission. 90% of all campers at state parks that year were residents of the northeastern United States and eastern Canada. (26% came from Maine, 33% from other New England states, 22% from the Middle Atlantic states, and 8% from Canada).

In 1967 the coastal area possessed 471 private campgrounds (including trailer camps, recreational camps, tenting areas, and boys' and girls' camps) that were licensed by the Maine Department of Health and Welfare.[12] Approximately 38% of the capacity of the trailer camps, recreation camps, and tenting areas, (which totalled over 8,900 sites or cabins), was located in only one county — York.[13] Other leading counties were Hancock, Sagadahoc, and Lincoln. While the coastal counties contained only 38% of total statewide camps of this type, 75% of the 26,000 person capacity of boys' and girls' camps was located in these areas. If these campers spent the same amount per day as those at public parks the total dollars spent in 1967 would have been $10.4 million.

Estimates of occupancy of private campgrounds in 1968 were made by PARC from the data cited above.[14] These estimates reveal that nearly one-half of the statewide total occurred within the coastal counties, and that three-fourths of the use of private campgrounds took place in the western portion (York through Lincoln Counties). We estimate private campgrounds occupancy will grow at a rate similar to that of public campgrounds occupancy.


STRAFFORD FARMS
• DAIRY •
OPEN AGAIN

Looking at the activities pursued by state park campers once they arrive at the parks, the 1969 Maine State Park Camper Survey mentioned previously indicates that 68% participated in swimming, 43% in hiking, 40% in picnicking, 40% in touring, 27% in boating, 24% in fishing, 21% in nature study, 4% in water skiing, and 7% in other activities.

Sight-seeing

One indicator of activity in this category is the volume of highway traffic passing selected stations throughout the State. The State Highway Department's automatic recorder stations in the coastal towns showed a 24% increase in annual traffic between 1961 and 1969, and a 51% rise during the peak months (usually August or July).[17] About one-half of the recorded traffic occured in York and Cumberland Counties. The greatest incidence of tourism occurs in the coastal towns of Lincoln and York Counties, where traffic in the peak month is almost twice the respective annual averages. Hancock County's peak is 61% above its annual average and Cumberland's is 27% above, while Penobscot and Kennebec have lesser differences.

The State Highway Department's study of U.S. Route 1 traffic during the summer of 1965 revealed that at eight selected stations on the Maine coast, about 40% of the out-of-state origins or destinations were other New England states, 22% were Middle Atlantic states, 12% all other states, and 26% were in Canada. However, the easternmost stations in Washington County had a much higher proportion of traffic with Canada than did the southwestern stations, which had a greater share with the northeastern states.

Attendance at the various state forts and memorials is another important indicator of the volume of sight-seeing. The number of visitor-days at these facilities on the Maine coast rose 135%, or from 104,000 in 1960 to 244,000 in 1970.[18] The latter figure represented 94% of the statewide total. The greatest concentration of visitors occurs at forts and memorials in Waldo, Lincoln, and York Counties. Fort Knox and Fort McClary have by far the greatest attendance. Four additional facilities have been acquired during the last year, but are not yet open to the public.

Other attractions are the numerous historic landmarks, of which 83% are located on the coast. Of the 159 coastal landmarks (mostly homes or public buildings) designated or recommended by the State Advisory Committee, the largest numbers are in Lincoln, Cumberland, and York Counties.[19]

Some of the landmarks, as well as additional structures, are open to the public as museums.[20] The greatest concentration of museums is in York, Cumberland, Lincoln, and Knox Counties.

PARTICIPATION ACTIVITIES ASSOCIATED WITH MAINE RECREATION

This section presents an overview of principle activities that individuals pursue in their leisure time as they relate to the Maine coast. Many of the activities are directly related to the water, however, several utilize the natural setting of undeveloped areas.

Swimming, Picnicking & Hiking

Statistics pertaining to the category of swimming, picnicking and hiking are not published, however, state and national parks provide many of the facilities required of this activity. The statistics relating to state and national parks can be considered a reasonable indicator of the level of participation in this activity and are presented here.

The parks along the Maine coast have a total of 41,000 acres and 2,400 picnic sites or parking spaces. Day use of these facilities rose 126%, or from 1.7 million visitor days in 1960 to 3.7 million in 1970.[15] The latter figure represents 19% of the state total. Three-fourths of all day use of the coastal parks takes place at Acadia National Park, which is followed in importance by Reid, Camden Hills, Crescent Beach, Two Lights, Moose Point, Popham Beach, and Quoddy Head State Parks. Attendance at all of these parks has grown tremendously, but is now being slowed at several of the older facilities by lack of capacity.

Boating

Although boating appears to have increased considerably in both coastal and inland waters, there are few figures to document this increase. The registration of motorboats of more than 10 horsepower has risen from 36,431 in 1964 to 44,249 in 1970 throughout Maine. The State Bureau of Watercraft Registration and Safety has estimated that 36% (approximately 16,000) of these craft are used principally in coastal waters. Registration is not required of sailboats or motorboats with less than 10 horsepower.

There are 440 boating facilities of four specific types open to yachtsmen and fishermen along the Maine coast.[16] These include 197 piers, 31 boat and yacht clubs, 96 boat yards and marinas, and 116 boat launching ramps. The bulk of these facilities is located in Hancock, Cumberland, Knox, and Lincoln Counties, although York, Washington, and Sagadahoc Counties also have sizable numbers.

Nature Study

Much of the activity takes place in the state and national parks, as well as in Federal and State wildlife refuges and private nature conservation areas. The two national wildlife refuges on the coast are Moosehorn, in Washington County, and the newly created Rachel Carson seashore area in York and Cumberland Counties. In addition to the 7,700 acres in Federal lands, 8,060 acres are maintained as game management areas and small marshes (leased areas) by the State Department of Inland Fisheries and Game.[21] These State areas are open to the public for hunting, fishing, and boating, as well as nature study. The greatest acreages are located in Washington, Hancock, Sagadahoc, Cumberland, and York Counties.

Several private conservation groups, principally the Audubon Societies and the Nature Conservancy, also own and maintain areas for nature study and outdoor recreation for their own members, with limited access to the public. Of the 4,500 acres in such private conservation areas on the Maine coast, the largest concentration occurs in Lincoln, Hancock, Sagadahoc, and Cumberland Counties.[22]

Fishing and Hunting

Fishing and hunting are among the most extensive outdoor sports taking place along the Maine coast. One indication of their popularity is the number of registered guides who lead parties engaging in fishing, deer and bear hunting, waterfowl and upland bird hunting, Atlantic salmon fishing, and white water canoeing.[23] Atlantic salmon fishing is concentrated on the Dennys, Machias, and Narraguagus Rivers in Washington County which are stocked by the Atlantic Sea Run Salmon Commission. The future growth of salmon in these rivers, as well as the Penobscot and others, is dependent primarily on the reduction of pollutants which kill the fingerlings. The availability of 15 species of saltwater game fish in Maine's numerous streams and harbors has been tabulated by the State Department of Sea and Shore Fisheries.[24]

An indication of the volume of hunting near the Maine coast is the tabulation of game kill prepared annually by the State Department of Inland Fisheries and Game. Two-thirds of all deer killed in the coastal counties were shot in York, Washington, Hancock, and Waldo in 1968.[25] The highest average kill of partridge, ducks, woodcock, bear, fox and bobcat per successful hunter took place in Hancock and Washington Counties. We expect however that most of these animals, except for waterfowl, probably were shot in upland areas rather than along the coast.

COMMERCIAL ASPECTS OF RECREATION

This section discusses spectator sporting events and amusements in addition to retail sales by restaurants, gasoline stations, stores, and the use of public transportation.

The 1967 Census of Business indicates that there were 39 motion picture and 308 other amusement establishments (bands and orchestras, theaters, bowling alleys, dance halls, sports clubs, amusement parks, fairs, carnivals, scenic railroads and coin-operated amusement devices) along the Maine coast. The Census estimated that establishments in the coastal counties had receipts of $13.2 million and payrolls of $3.5 million. Receipts and payrolls for the coastal counties were more than 70% of respective statewide totals for that year.[26] Over one-half of the coastal amusement business was concentrated in the two southwestern counties of Cumberland and York.

Horse racing on the coast takes place at Scarboro Downs in Scarborough. In addition, harness races are held there and at fairgrounds in Cumberland, Topsham, and Bangor. Automobile racing also occurs at the Beech Ridge, Wiscasset, and Winterport Speedways.

Winter Sports

Snow skiing, ice skating, and snowmobiling are the principal outdoor sports taking place along the coast during the winter months. The only available attendance figures are for skiing, which totalled about 53,000 skier-days (1969-1970) at the four coastal ski-areas — Big A in York, Sky-Hy in Topsham, the Camden Snow Bowl in Camden, and Snow Mountain in Winterport. Skiing is rising rapidly in popularity, the statewide increase exceeding 700% since 1960.

Snowmobile races are held at the Big Oval in Brunswick. There are no organized iceboat races along the coastline.

Retail Sales

Annual taxable sales for all products rose 73% in the coastal counties between 1960 and 1969.[27] During the summer tourist season (May-September), total taxable sales in this area increased slightly more — 76%. The greatest rise took place in Hancock County (96%) and the lowest in Washington (32%). Summer sales generally represent about one-half of the annual total in 1969, although York and Hancock Counties experienced somewhat greater shares (59% and 55%, respectively) during the tourist season.

The 1959 Recreation Property Inventory of the Maine Department of Economic Development revealed that all restaurants, recreational shops and amusements had a total market value of $36 million that year. Of that amount $19 million was attributable to property in the coastal towns, three-fourths of which was within the Counties of York, Cumberland, and Hancock. This property inventory should be updated as a part of the ongoing coastal planning effort to identify market value trends.

Retail sales of recreation-related goods (gasoline, food and drink, antiques, sporting goods, etc.) increased 31% in the coastal area between 1958 and 1967. Sales of these items totalled $200 million for the latter year.[28] The greatest in-


PEPSI
FRANKS
Hot pastrami
CORN
ON THE COB
BOSTON
Pizza
MEAT BALL
HOT SAUSAGE
PEPSI

creases occurred in York, Knox, Kennebec, and Penobscot Counties; however, two-thirds of all 1967 sales took place in Cumberland, York and Penobscot. The coastal area accounted for 57% of statewide sales of recreation-related products during that year.

There were 742 restaurants and other eating and drinking places within the coastal area in 1967. These establishments had a capacity of 75,434 seats and sales of about $51 million, 55% of which took place in two counties — York and Cumberland.[29] This level of sales generated by the coastal establishments represented two-thirds of statewide sales during 1967. The increase in sales for the coastal establishments was 87% between 1958 and 1967; the greatest relative rises occurred in Knox, Hancock, Cumberland, Penobscot, and Lincoln Counties.

Transportation

Between 1962 and 1969, the number of air carrier passengers rose 122% at Portland, Augusta, Rockland, Bar Harbor and Bangor combined. Since 1969, trunk carrier summer service at Rockland and Bar Harbor (serviced by Northeast Airlines) has been supplanted by Downeast Airlines and Executive Airlines, respectively. Northeast continues to serve Portland and Bangor, both cities having experienced substantial air traffic increases in recent years.

Water passenger carrier traffic along the Maine coast has increased steadily since 1960. During the past decade this category saw its summer business grow twice as fast as it did in the off-season.[30] The greatest increase in summer traffic took place in Casco Bay where the Casco Bay Line Company operates special excursions for tourists. In addition, service is offered to the Casco Bay Island for the benefit of seasonal and year round residents. About one-half of the annual traffic in Casco Bay now occurs between June and September. Over 60% of the Penobscot Bay passenger traffic handled by the State Ferries takes place during the summer, while 90% of the passengers on the Bar Harbor-Yarmouth service of the Canadian National Railway travel during those months. The Lion Ferry connecting Portland and Yarmouth, Nova Scotia, transported more passengers and automobiles during 1970 than the Bar Harbor ferry.

Eastern Greyhound Lines operates two daily round-trips by bus between Boston and Bar Harbor, and three daily round-trips between Boston and Calais during the summer months.

Published figures on the number of passengers carried by the buses are not available.

Marine Facilities

The Census of Maine Manufacturers reports that employment in boat building and repairing establishments, most of which are located on the Maine coast, rose from 439 in 1960 to 613 in 1969. During the same period, the value of product at these establishments doubled — from $3.8 million to $7.6 million.

The coastal counties also lay claim to 195 marinas; 112 sell fuel, 56 have storage facilities, 63 carry out repairs, and 44 sell marine hardware.[31] These marinas also have more than 1,700 moorings and additional anchorages. The largest concentration of marinas is in Knox, Hancock, Lincoln, York, and Cumberland Counties.

FORECASTS OF RECREATION DEMANDS

Coastal planning relies on an ability to foresee future needs and demands. Obviously this is an area of great uncertainty, however, certain trends are evident and can prove useful for planning purposes. In this section projections of recreational demands are reviewed by examining several indicators that measure the variables of interest.

Camper Attendance

A model developed by the Public Affairs Research Center for the State Park and Recreation Commission related past camper attendance at state parks to socio-economic variables and projected future attendance at state parks based on assumed future changes in the variables. The base population for the study was basically that of the Northeast region. Figure 3-2 indicates the area utilized. The population of this area is labelled the "origin population base" for future tourism in Maine. Other base information includes: auto registrations, leisure time, and personal income. For example, the population of the northeastern states and the eastern provinces is projected to increase from 64 million in 1970 to 71 million in 1980 and 79 million in 1990. A large portion of the increase will take place in the Boston-Washington megalopolis. This population belt is creeping northward from Boston extending now into southern New Hampshire. It is likely that southwestern Maine will be affected during the next decade, consequently Maine's population is projected to grow to 1.1 million by 1980 and 1.2 million by 1990.

The model also distributed future attendance to specific parks (both existing and projected) based on their relative distance from State border crossings and major urban centers. (Attendance at Acadia and Baxter Parks was projected independently.) The model predicts that summer camping at the coastal parks will rise about 130-140% by 1980 and 250-260% by 1990, as shown in Table 3-2. This assumes that sufficient facilities will be provided, particularly at Acadia, which now has a policy of building no additional campsites. If not enough public campsites are provided, the incremental attendance will resort to private campgrounds, as is presently taking place.

ORIGIN POPULATION BASE FOR RECREATION IN MAINE

FIG. 3-2

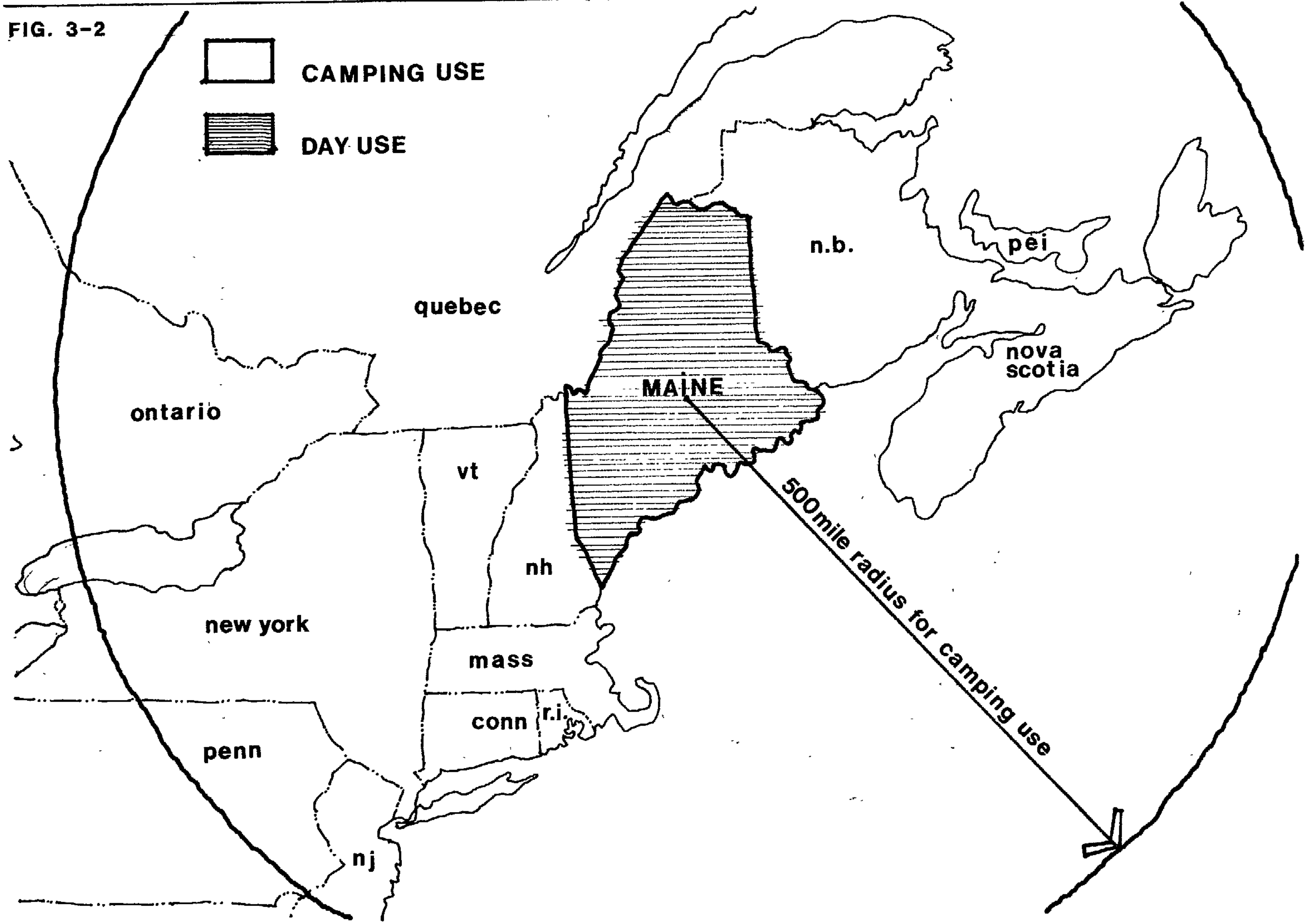


TABLE 3-2

PROJECTIONS OF SUMMER CAMPING AT NATIONAL AND STATE PARKS ON MAINE COAST 1969-1990
(Thousands of Person-Days)

County	1969 Actual	1980 No Change	1980 Park Added	1990 No Change	1990 Park Added
State Total:	526	1,007	1,016	1,422	1,432
Coastal Parks:	282	656	672	994	1,012
York	—	—	—	—	—
Cumberland	—	—	—	—	—
Sagadahoc	—	—	—	—	—
Kennebec	—	—	—	—	—
Lincoln	—	—	—	—	—
Knox	45	44	41	55	50
Waldo	3	17	15	21	18
Penobscot	—	—	26*	—	32*
Hancock	225	565	561	881	877
Washington	9	30	29	37	35
Inland Parks**:	244	351	344	428	420

* Brewer Lake in Orrington

** Including those in counties listed above

Source: PARC, Demand Analysis of State Park Utilization and Other Outdoor Recreation Activities in Maine

The summer day use and camping at state and national parks on the Maine coast is shown graphically on Figure 3-3 showing the expected increases to 1990.

Tourism

The following table summarizes the current estimates and projections of tourism along the coast, as measured by visitor days and total expenditures. The projections are based largely on expected changes in population and income in the northeastern states. It must be emphasized that these figures are only rough approximations which may be in considerable error. Detailed studies are needed to measure tourism far more Precisely.

TABLE 3-3

ESTIMATED VISITOR-DAYS AND EXPENDITURES BY TOURISTS ON MAINE COAST, 1970-2000

	Millions of Visitor-Days				Millions of Dollars			
Type of Lodging	1970	1980	1990	2000	1970	1980	1990	2000
All Lodgings:	10.8	20.2	28.9	37.7	104	200	292	376
Summer residences	6.0	9.0	12.0	15.0	44	60	80	100
Hotels and motels	2.4	5.6	8.5	11.5	48	112	170	220
Public campgrounds	0.3	0.7	1.0	1.2	2	4	5	6
Private campgrounds	2.1	4.9	7.4	10.0	10	25	37	50

This data has been summarized on the following graphs. Figure 3-4 indicates the projected number of tourist visits along the Maine coast and Figure 3-5 shows the projected expenditures that tourists will make in the coastal zone.

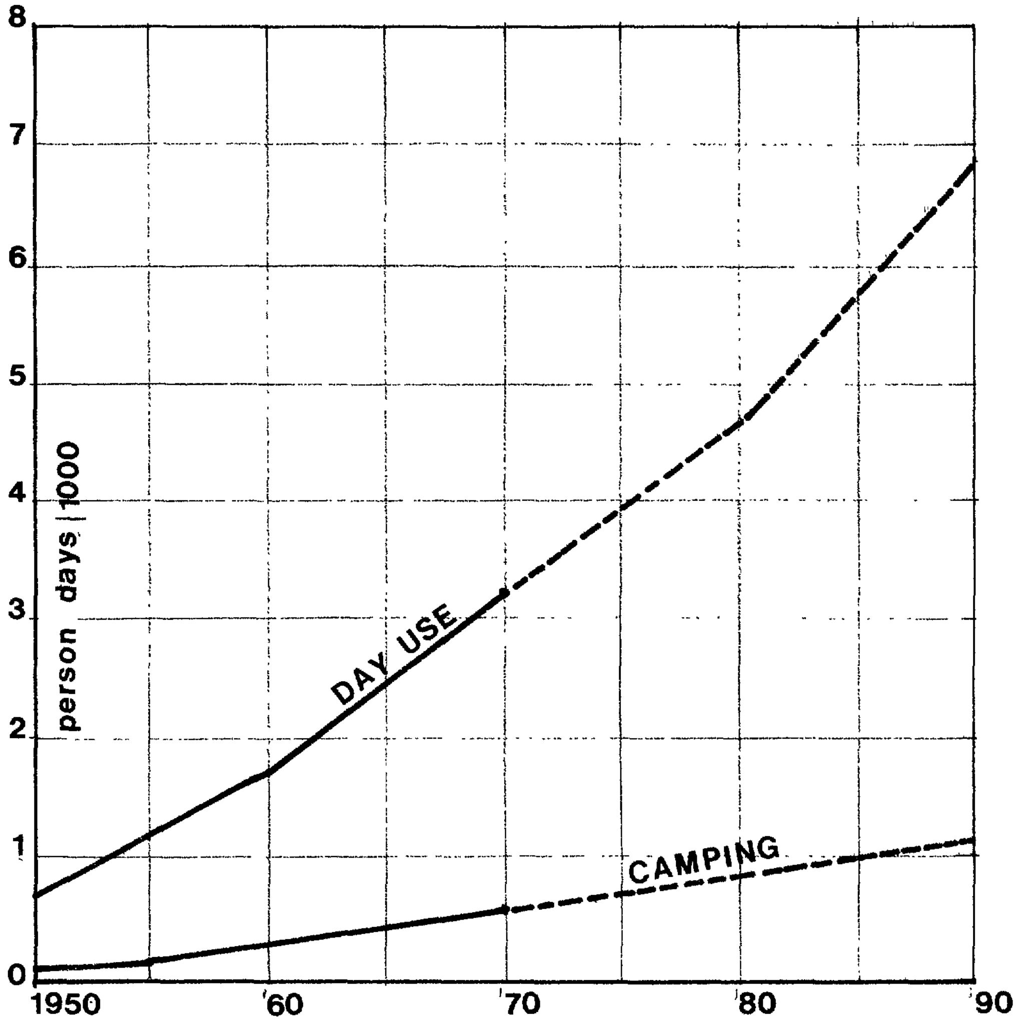
Seasonal Homes

An indication of the activity relating to seasonal homes can be found by making a judgment about the number of this type home that will be built in the future. On the assumptions that the number of seasonal units on the coast will rise to 30,000 by 1980 and 40,000 by 1990, and that the number of persons per household will drop to 4.0 and they will spend an average of 300 visitor-days (with more time in the spring and fall) and $2,000. annually per household, then there will be about 120,000 seasonal residents who spend 9 million visitor-days and $60 million per year in 1980. Extending this trend to 1990 would mean the figures will be 160,000 seasonal residents who spend $12 million per year by that time. The above figures appear reasonable, although there is at present no basis on which to project the number of seasonal homes. A thorough land-use study (particularly of vacant land) would be essential to provide part of the necessary information.

SUMMER DAY USE & CAMPING

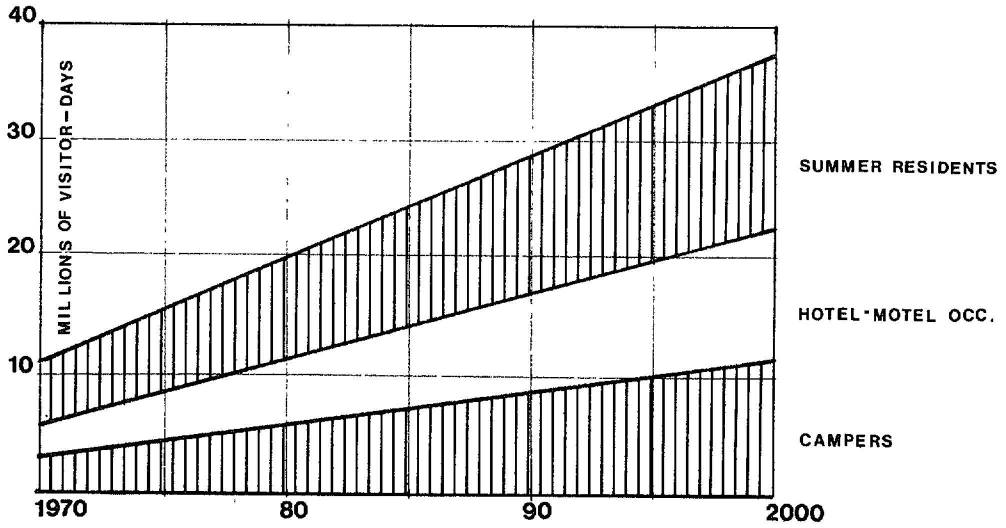
at State & National Parks on the Maine Coast

FIGURE 3-3



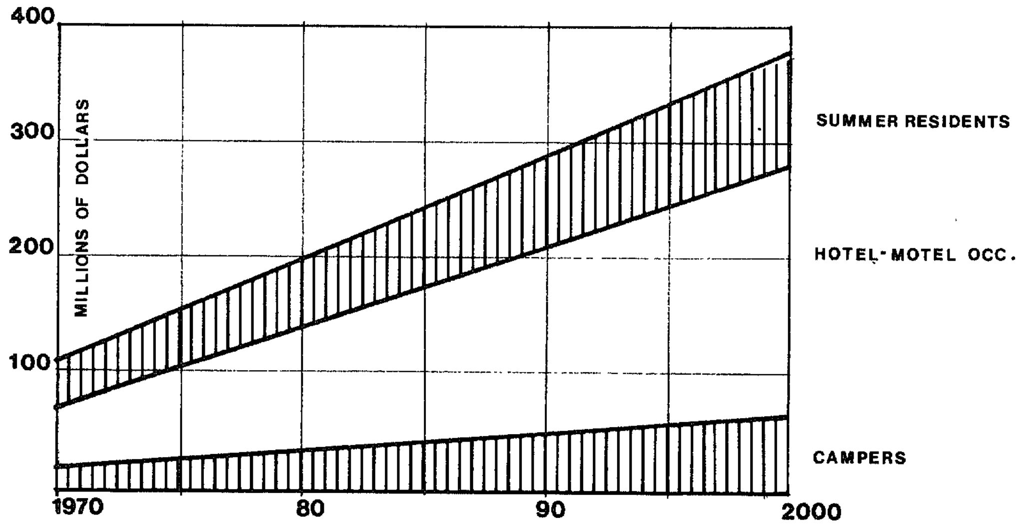
TOURIST VISITS ON MAINE COAST

FIGURE 3-4



TOURIST EXPENDITURES ON MAINE COAST

FIGURE 3-5



PLANNING IMPLICATIONS OF THE RECREATION STUDY

At this stage of the investigation of the coastline, few policy generalizations regarding recreation are possible. One that can be made now, however, is that Maine's coast can have increased economic development (including tourism and other carefully selected industries) without destroying its visual charm, but only if the State and towns act quickly enough to establish controls sufficiently to ration carefully the development of presently vacant land.

A corollary generalization that can be added is that more stringent land-use controls must be instituted if tourism is to flourish. It is doubtful if increasing numbers of tourists will want to come to Maine if the coastline becomes an urban slum, or if public access to shore and lakes is so limited or congested that enjoyment of the area's remaining attractions becomes difficult. Examples of recreational slums abound already in York County, as well as in lower New England, Long Island and New Jersey.

Before further generalization regarding potential conflicts in land use can be made, specific studies would be needed. For example, detailed analysis of relative economic and esthetic benefits of industrial versus recreational or commercial development of Sears Island, Trenton, or Machias should be undertaken before approval is granted for specific projects at those locations. Likewise, studies of the economic and environmental effects of possible improvements of U. S. Route 1 or a new East-West Expressway should be undertaken before the decision is made to build, and, if so, where. However, there are several functional areas in which planning implications have been highlighted by this study. These will be discussed under individual subheadings in the following paragraphs.

The recreation-related industries are important to overall planning efforts along the coast because so much coastal activity is linked to this sector. Related revenues are estimated to be over 60% of the statewide total of about $300 million. Employment and personal income that are attributable to coastal recreation-related industries approximate 75% of the statewide total. Projections for the number of visitors we can expect in the future and their expenditures indicate that demands will double in 25 years. The fact that recreation does play an important role in our economy must be weighed in the decision-making process.

The Promotion of Tourism

One question for consideration relates to whether out-of-state tourists should be encouraged or discouraged from coming to Maine. There are organized movements in at least three states — Vermont, New Hampshire and Oregon — to discourage either the establishment of more summer residences or a great influx of transient tourists. Advocates of this course would oppose the addition of expressways and extension of roads into wildlands, the proliferation of billboards and strip commercial developments along highways, and the preempting of shorefront property by wealthy outsiders.

Opposed to this point of view are those who would attempt to strengthen the state's weak economy (in respect to wages and lack of diversification) by encouraging tourism, particularly of transients. For example, farmers or others owning attractive rural property might be able to develop various facilities for tourists which cannot be provided by state parks. (The U. S. Department of Agriculture reports that a sample of farmers in New England invested the following average amounts in various recreational enterprises during 1961: $21,000. for fish bait sales, boat rental and guide service; $35,000. for vacation farms; $12,000. for pony rides; $28,000. for hunting and fishing equipment; $34,000 for picnicking and swimming facilities; $87,000. for riding schools; $133,000. for golf courses and bowling alleys; $250,000. for summer camps; and $322,000. for resort and amusement centers).

Public Campgrounds and Beaches

The demand for recreational facilities is expected to accelerate in the years to come. In the past, little has been done in the way of setting standards, such as the most desirable number of persons per acre, for use of recreational facilities. Since choice recreational land is limited, attention must be given to finding methods of preserving what we have and yet, at the same time, allowing citizens to enjoy the recreational aspects of the coast; an enjoyment to which they unquestionably have a right.

A report prepared by the Public Affairs Research Center for the State Park and Recreation Commission entitled **Supply of Outdoor Recreation Facilities in Maine** contains a chapter on facility user standards. There is a discussion of the functions of state, regional, and municipal parks, as well as desirable space standards, e.g., park acres per 1,000 population or percent of total area in parks, as modified by natural characteristics. Density standards also were tabulated for selected outdoor recreation activities (swimming, camping, picnicking, playing games on open fields or playgrounds, hiking, nature study, horseback riding, boating, canoeing, snow-skiing, snowmobiling, and ice skating) in which the State has a particular interest. In addition, certain policy questions concerning the acquisition and development of state parks were provided:

1. Should state parks and their facilities for camping and day use be developed primarily for state residents or also for out-of-state tourists?
2. How should state park development be related to the establishment of similar facilities by the private sector?
3. Should new state parks be established generally near urban centers, or in remote areas with outstanding natural characteristics? Subsidiary considerations include the relative travel time for prospective users and comparative cost of acquisition of land at different locations.
4. Should intensively used areas of state parks be rotated and rejuvinated periodically? For example, campsites might be rotated every five years, and entire campgrounds or picnic areas every twenty years, in order to renew deteriorating site conditions.
5. Could camps in cut-over timber lands be utilized for public camping use?
6. Should over-used beaches and adjacent areas of state parks and privately-owned land such as Old Orchard Beach be rotated or redeveloped?
7. Should uniform standards for construction and maintenance of state-owned camping and day use facilities be established for all agencies, i.e., Park and

Recreation Commission, Baxter Park Authority, Forest Service, Inland Fish & Game Department, and the Highway Commission? Should one agency build and operate all such facilities?

8. Should uniform site-location standards regarding water supply, sewerage, drainage, etc., be established for all state parks in conformance with Environmental Improvement Commission guidelines?

9. Should the State expand technical and financial assistance to municipalities for outdoor recreation facility planning and operation? Should regional parks be created?

10. Should certain recreational activities be limited to particular state parks?

Finding answers to these questions should form the basis for an expanded study of Tourism & Recreation in Maine. Also, the Maine State Planning Office is currently involved in a natural areas inventory study designed to identify specific areas by their important aesthetic and other recreational aspects as well as indicate ways of assuring their quality is preserved. This study due for completion in November, 1971, will form the basis for further acquisition of recreational areas along the Maine coast.

Improving Controls for Recreational Resources

Part Five of this report is devoted to methods of implementing coastal policies; however, controls and new institutional arrangements that would relate directly to recreation have been proposed and will be reviewed here.

The Federal Commission on Marine Science, Engineering and Resources, in its 1969 report, **Our Nation and the Sea,** recommended that each seacoast state be empowered to establish a Coastal Zone Authority. The following powers would be available to each Authority:

1. Planning — Conducting necessary studies for comprehensive coastal planning;

2. Regulation — Establishing zoning and granting easements or permits to ensure conformance with the land use plan;

3. Acquisition — By eminent domain or negotiation; and,

4. Development — Construction of beaches, marinas, and other facilities, and leasing of lands for development by private enterprise.

Although no state coastal zone authorities have yet been established, bills for coastal management have been introduced in several states (Washington, California, and Rhode Island). None of these bills have been enacted at this writing. They are described in **State Coastal Management Legislation** issued in December, 1970, by the New England River Basins Commission.

The Bureau of Outdoor Recreation of the U. S. Department of the Interior, in its 1970 report, **Islands of America,** has proposed the creation of five Maine Island Trusts, the initial one comprising the islands in Casco Bay and the others being Sheepscot Bay, Muscongus Bay, Penobscot Bay and Downeast. It is recommended that 30,000 acres (about 15% of the total island area) eventually be placed in public ownership (one-third in fee) under State or local Management.

Six state actions are recommended:

1. Including analysis of islands in comprehensive plans;
2. Clearing title to state-owned lands and assuring public access;
3. Providing statewide zoning for island conservation;
4. Adopting regulations to control dredging and filling;
5. Including island protection in State pollution regulations; and,
6. Acquiring or otherwise obtaining public access to suitable lands.

The Bureau also recommends that local governments adopt long-range plans and effective zoning, acquire island property for public use, and assure public access to shore lines by acquisition, easements and tax incentives. In addition, the Bureau advocates that private groups support Island Trusts, purchase desirable islands and control public use, provide limited public recreation on private land, and donate islands to public or quasi-public bodies for recreation and conservation purposes.

In a report entitled **Protection and Development for Recreation Resources** submitted to the New England Regional Commission in November, 1968, there is a proposal for establishment of The New England Trust. It would be a private, non-profit organization administered by a Council composed of representatives from public and private agencies with interests or responsibilities in the use and conservation of open space and in the preservation of historic buildings. The Trust's functions would include: planning regional recreation resource development, acquiring and managing natural areas, improving existing recreation areas, improving and protecting New England's open land, acquiring and maintaining historic buildings, giving technical assistance and legal advice in conservation and preservation to private and public agencies, supporting education and publishing information on conservation and preservation.

Practically all decisions regarding land use in coastal Maine relate directly or indirectly to some facet of recreation. New methods for looking at the overall effects of land use are needed as well as workable means for implementing land use projects that utilize the multiple use through recycling concept. Recreation must be recognized as a necessary ingredient in the development process. Future land use planning must reflect this fact if mistakes of the past are to be prevented from recurring.

The scope of what lie ahead for planning efforts is strongly suggested by what is presently taking place to change the recreational resources of Maine. Such alterations as:

> The filling of salt marshes for beaches, marinas, resorts, or industries will destroy fish, shellfish and birds.
>
> The construction of factories producing high volumes of air or water pollutants will impair a wide area for most recreational purposes.

Contamination of ocean or lake water by sewage from residences or industry may preclude its use for boating and swimming.

The occupation of large shore-front tracts by resorts or summer residences may prevent access to the public (both residents and transient tourists).

The urbanization of the shoreline and lake-frontage, particularly along highways, may result in such ugliness that the area loses its charm for both residents and tourists.

Should Maine become, in effect, a national park to provide for the recreational needs of the nation, as has been suggested, or should it put primary emphasis on raising the income level of its poorer citizens and effecting a more stable economy? Can both goals be met concurrently?

If the projections of visitor-days and expenditures by tourists which were shown earlier in this report are realized, would the resulting economic benefits be sufficient to justify the probable deterioration in the environment which might result? Or, can tourist expansion be realized in Maine without severe environmental alteration?

The far reaching implications of these concerns point out the shortcomings of the fragmented attempts at solutions that have been used in the past. Tomorrow's solutions must be based on an integration of the combined leisure needs of man with the vital needs of nature.

FOOTNOTES — RECREATION COMPONENT

1 Recreation Appendix — Year Round Homes on the Maine Coast 1960-1970 — Table 7

2 Recreation Appendix — Seasonal Homes on the Maine Coast — 1960-1970 — Table 8

3 This estimate is based on the decline experienced between 1960 and 1970 in a similar Census category.

4 Recreation Appendix — Market Value of Homes on the Maine Coast 1960 and 1970 — Table 9

5 Maine Department of Economic Development, Recreation Property Inventory 1959

6 Recreation Appendix — Number, Capacity, and Market Value of Commercial Lodgings on the Maine Coast — Table 10

7 Maine Department of Economic Development Recreation Property Inventory 1959

8 Recreation Appendix — Payrolls, Receipts and Transient Rentals of Commercial Lodgings on Maine Coast — Table 11

9 Recreation Appendix — Estimated Occupancy of Commercial Lodgings on Maine Coast 1968 — Table 12

10 See explanation under Forecasts of Recreation Demand — Recreation Component

11 Recreation Appendix — Camping Facilities and Usage of National and State Parks on the Maine Coast — Table 13

12 Recreation Appendix – Number of Private Campgrounds on Maine Coast 1967 – Table 16

13 Recreation Appendix – Capacity of Private Campgrounds on Maine Coast 1967 – Table 17

14 Recreation Appendix – Estimated Occupancy of Private Campgrounds on Maine Coast 1967 – Table 18

15 Recreation Appendix – Capacity and Day Use of National and State Parks on Maine Coast – Table 19

16 Recreation Appendix – Piers, Clubs, Boat Yards, Marinas, and Launching Ramps on Maine Coast 1970 – Table 24

17 Recreation Appendix – Average Daily Highway Traffic at Automatic Recorder Stations on Maine Coast – Table 27

18 Recreation Appendix – Area and Day Use of State Forts and Memorials on Maine Coast – Table 28

19 Recreation Appendix – National Historic Landmarks on Maine Coast 1970 – Table 30

20 Recreation Appendix – Museums Open to Public on Maine Coast 1969 – Table 31

21 Recreation Appendix – Federal and State Wild Life Refuges on Maine Coast 1970 – Table 33

22 Recreation Appendix – Private Nature Conservation Areas on Maine Coast 1970 – Table 34

23 Recreation Appendix – Activities of Registered Guides on Maine Coast 1970 – Table 35

24 *Outdoor Recreation in Maine,* Outdoor Recreation Study Team, University of Maine 1966

25 Recreation Appendix – Game Kill on Maine Coast 1968 – Table 36

26 Recreation Appendix – Number, Receipts, and Payrolls of Commercial Amusement Establishments on Maine Coast 1967 – Table 37

27 Recreation Appendix – Taxable Sales on Maine Coast 1960 and 1969 – Table 40

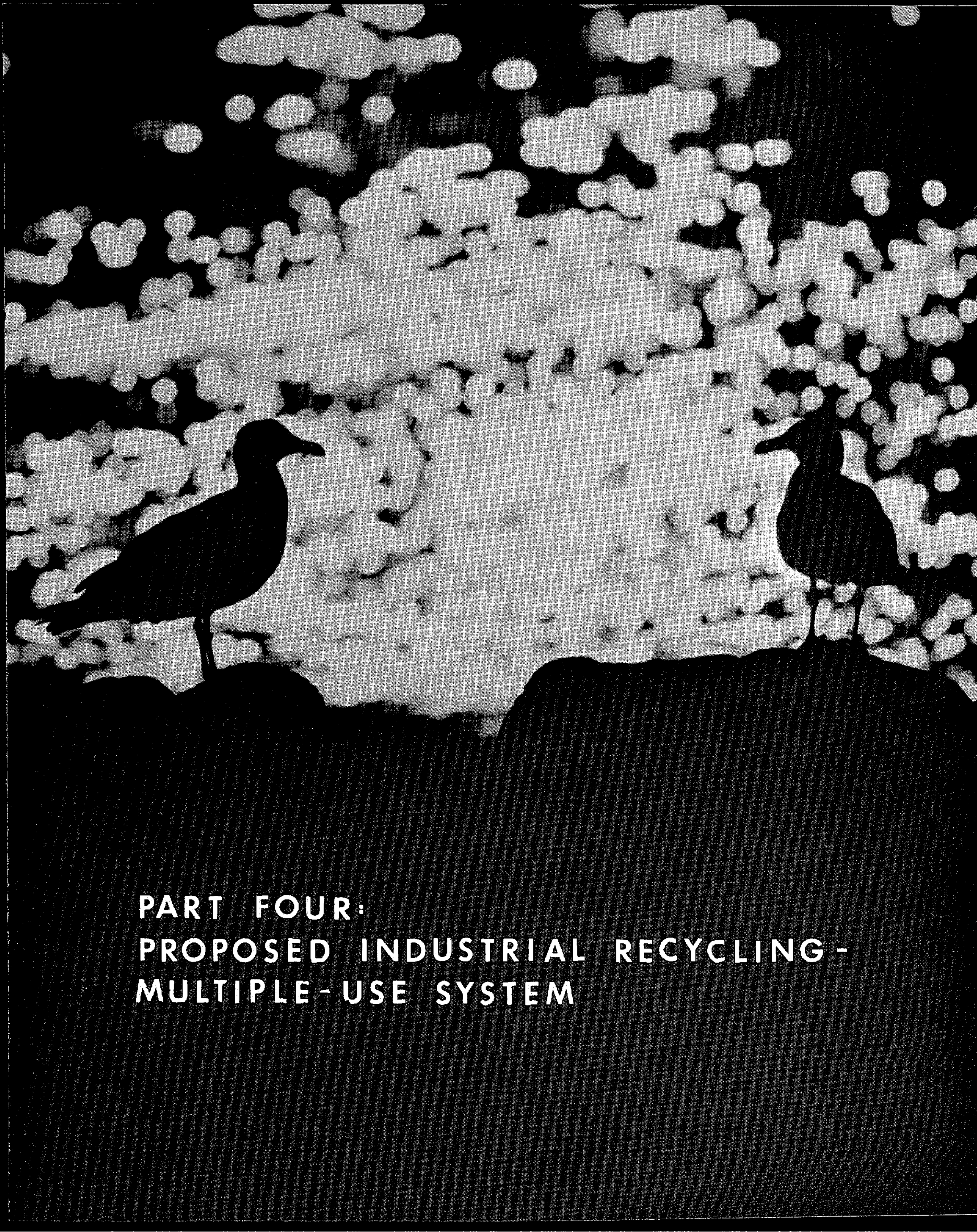
28 Recreation Appendix – Retail Sales of Recreation – Related Stores on Maine Coast 1958 and 1967 – Table 44

29 Recreation Appendix – Number, Capacity and Sales of Eating and Drinking Places on Maine Coast 1967 – Table 42

30 Recreation Appendix – Air and Water Passenger Carrier Traffic on Maine Coast 1960 and 1970 – Table 43

31 Recreation Appendix – Marina Facilities on Maine Coast 1970 – Table 25

32 *Rural Recreation Enterprises in New England,* Agricultural Economic Research Report No. 56, Resource Development Economics Division, Economic Research Service, U. S. Department of Agriculture.



PART FOUR:
PROPOSED INDUSTRIAL RECYCLING-MULTIPLE-USE SYSTEM

INTRODUCTION TO INDUSTRIAL INTEGRATION

Previous sections of Cycle IV of Maine's Public Investment Plan have thoroughly traced development patterns, present trends and planning implications of three major coastal uses in Maine. Prescriptions for improvement were suggested. In this section, a workable proposal is made for a comprehensive solution to those specific problem areas identified as well as others which were only alluded to. Implementation of this proposal would require a major redirection in current efforts but could easily result in a vast improvement in the quality of lives of many of Maine's citizens.

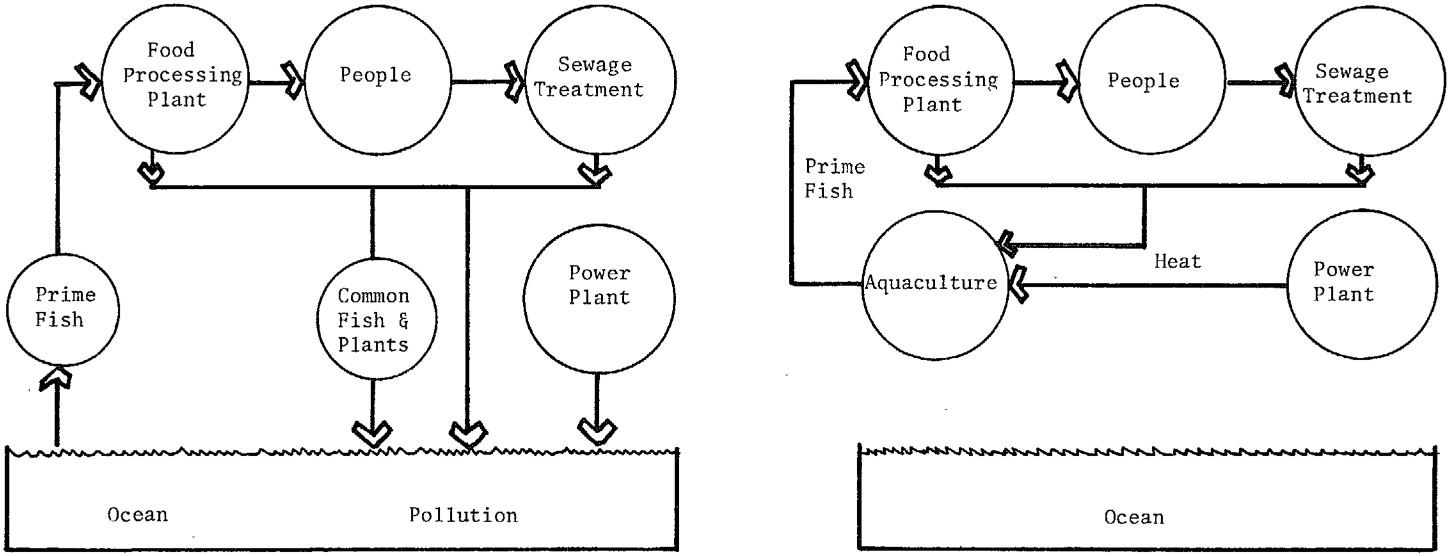
It is increasingly clear that drastic changes are rapidly taking place in many basic, traditional American values and pursuits. Growth, for example, as a driving motive and as a measure of continued progress, is now being openly questioned. The reawakening of man's intimate concern for his environment has dramatically indicated the folly of unlimited growth on what is clearly a resource-limited planet.

Such changes and the trends they imply can, however, be beneficial to Maine, provided the State begins the process of re-evaluating its characteristics in the light of these new directions and reorienting its priorities accordingly. Certain professed economic disadvantages in Maine can now easily be considered as assets. Such features as inaccessibility, low industrial development, few people over a large area, all work to place Maine significantly ahead of other areas in terms of this new, emerging environmental-consciousness. In fact, Maine's economic stability is now based directly upon the quality of its social and natural environment.

It is also recognized, however, that many persons in Maine have not shared in the economic bounty that most enjoy. This proposal seeks to correct some of these basic economic inequities, yet incorporates this with an essential concern for the continued quality of Maine's environment. Thus, the first aim of this proposal is to provide jobs for many of Maine's disadvantaged people. Second, through a symbiotic industrial integration, a system is proposed which is not heavily taxing to the environment. Finally, by focusing on Maine's abundant natural resources and its newly recognized assets, a unique, highly profitable and stable activity can be easily initiated.

Generally, the intention of this proposal is to present a rational development proposal for the coastal zone of the State of Maine — one which would provide a high standard of living for its population. Specifically, the assignment is to confront certain problem areas covered in other sections of this report, and then in this section to explore totally new ways in which these problems might be made to contribute to viable solutions. The problem areas covered are recreation, land and sea farming, power generation and recreational growth centers.

The scope of the proposal contained within these pages is necessarily broad. It is meant to suggest many possibilities for improving Maine's economic status. The proposal is based on the environmentally sound concept of recycling which facilitates the development of otherwise marginal industries which, when brought together, can attain a clear economic justification.



CONVENTIONAL SYSTEM

Reduces supply of fish from the ocean and contributes to the deterioration of diverse ecological system.

PROPOSED SYSTEM

Provides prime products for the human cycle without adversely affecting the ocean environment.

ENVIRONMENTAL ALTERNATIVES

figure 4-1

The recycling concept operates between a town, an electric power plant, and aquaculture industry, and expanded existing agriculture and fishing industries. The basis for cooperation between these components are those economic and ecological advantages to each member derived by exploiting the natural dependence of each on the others in a manner more efficient than is currently employed. Specifically, the wasted byproduct of one industry is often useable as a raw material for another industry. Both industries become more profitable if one industry can buy the other's waste at a lower price than he otherwise pays for raw materials and the other sells his waste rather than paying to dispose of it.

Coastal Maine possesses several opportunities for land use integration of this nature which will make new industries feasible, revitalize existing industries, provide local towns and the State with additional tax revenue while lowering some of their operating costs, provide coastal residents with employment and recreation and lower living costs, and provide lucrative investment opportunities for many investors.

Figure 4-1 is a schematic representation of the concept of industrial integration as it relates to the more conventional system.

ESSENTIAL CHARACTERISTICS OF PROPOSED SYSTEM

The recycling concept involves a food supply chain and a waste disposal/ pollution control scheme. The components of the recycling system are a town, an aquaculture industry, agricultural expansion and an electric power plant. The major flows in the system are:

1. Food from agriculture and aquaculture to people;
2. Sewage and wastes from agriculture, food processing industries, and cities flowing to the algae culture;
3. Animal feed from algae culture to poultry and other aguaculture farms which then raise products for human consumption; and,
4. Heat and energy from the power station to the aquaculture complex and other components.

The concept is presently undeveloped in the United States and Maine because the combination of motivating forces has matured only recently. These motivating forces are:

— critical need for new industries in Maine which would create a wide range of job opportunities for a large resident population of sea-oriented people

— increasing concern for the abatement of coastal pollution, thus restricting many industrial development prospects

— the need for the reduction of power-generated thermal pollution from the expansion of power generating facilities on the Maine coast

— the slowly declining state of Maine's commercial fishing industry combined with the increasing discovery of harmfully polluted natural stocks of ocean fish

— the impending food-population pinch requiring large new high-protein sources.

The development of an aquaculture industry in Maine is thus a natural solution to these motivating forces. Constraints faced in developing aquaculture are largely alleviated through the integration of other industries which would provide the initial support required to make sea farming viable for the Maine coast.

The following flow diagram indicates the many interrelationships of industrial integration.

Aquaculture

The first phase of aquaculture development is promoting natural ocean production by seeding, protecting and feeding desirable species. This phase has been practiced by the Chinese for 4000 years, by the Romans 2000 years ago, and is widely employed today in China, Japan, Europe and in some parts of the United States, particularly in the lobster and oyster industries.

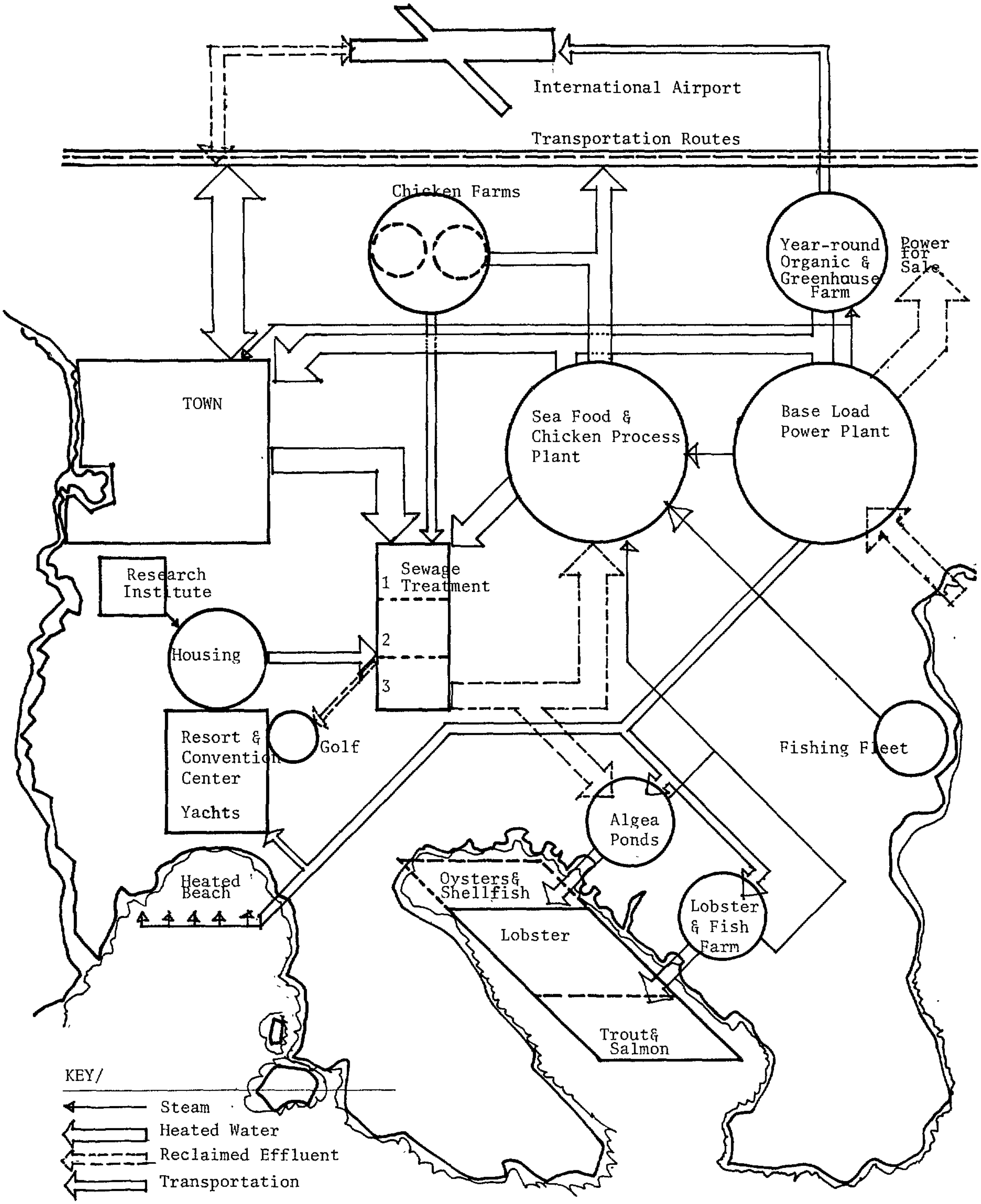
The second phase of aquaculture is raising products in closed tanks, ponds or pens. In the United States, fish farming is already well established and commercial oyster ponds are beginning to prosper. In Europe, fish, oysters and clams are all raised in large quantities. Fish ponds are a food source second only to rice in China. Several countries notably Scotland, England and Russia, are developing complete aquaculture systems involving the production of algae, shellfish and fish.

A promising new development in aquaculture is the use of heated water from electric power plants to raise the growth rate and extend the growing season of marine cultures. The resulting increase in productivity greatly enhances the competitive position of aquaculture. Fish are presently being raised commercially in heated water in Russia, England, Scotland and Germany. In the United States, oysters are raised commercially in heated pools on Long Island. Pilot projects involving heated water, sewage and food production from algae are underway in England, Scotland and Germany. Several dozen universities and other research stations have contributed to the development of aquaculture by researching the food, environmental and health requirements of promising aquaculture species. Considerable progress is being made in breeding and selecting new strains of fish which have high growth rates and other features desirable for cultivation.

Maine's cold waters are reputed to be one of the most nutrient-rich areas in the world. Many of its estuaries have large tidal flushing rates facilitating the introduction of food and nutrients and dissipating low levels of fish wastes. Although some of Maine's largest estuary complexes are polluted, the source of

INDUSTRIAL INTEGRATION IN COASTAL MAINE

figure 4-2



pollutants are in many cases in a few localized points, facilitating clean-up of the Maine coast. The coast also has a highly varied configuration providing a wide range of natural ocean environmental conditions.

Finally, the geographic location of the coast on the fringes of both arctic and temperate sea environments permits the development of species common to both areas. Thus Maine is admirably suited to a wide range of aquaculture development possibilities.

Recreation

Recreation in Maine faces numerous problems. Last year (1970) more than one million people drove by automobile up the coast of Maine to visit Acadia National Park. Tens, perhaps hundreds of thousands of others visited Maine to enjoy its lakes and streams (fishing, boating and swimming), mountains (skiing, hiking, climbing), forests and fields (nature study, exploration, collecting). As the large urban areas to the south increasingly become untenable as wholesome environments, there is a proportionate recreational pressure placed on Maine, much of it on Maine's 3,500-mile coastline. Of this enormous coastal area, only 25 miles is open to public access. The rest of it is under private control of one form or another, some of it commercially open to the public.

Much of the coastal pattern of recreation in Maine is geared almost exclusivly to the automobile. This means that recreation on the coast is mostly visual and tends to concentrate in those relatively few areas where road construction and the sea happened to meet, usually at the heads of bays and estuaries. Uncontrolled land bordering heavily traveled highway almost always results in sub-standard development. The participating establishments must be readily visible and accessible to auto travelers. Contrary to the skiing, hiking and canoeing recreational public, the usual coastal recreationist is a passive non-participant, and the exploitation or servicing of his needs intensifies a pattern or uncoordinated and unattractive development. Last, the seasonal nature of this coastal recreational industry may send a relatively large portion of the income it generates out of state, where the owners themselves spend the winter months. And, even at that, relatively few types of business really benefit from this passive tourist population, since the owner of the camper or tour trailer often stocks his larder at home, before leaving for Maine.

Our major consideration of coastal recreation, then, is to establish an integrated way of controlling its location, guaranteeing its quality and providing some sort of real engagement with the environment for those who utilize it.

As part of this proposal, therefore, a small recreational resort town-city complex of approximately 11,000 permanent residents is suggested as part of the total complex. This community, which could easily be an expansion of an existing Maine town, would provide an intensive recreational experience for many visitors to the coast and would, at the same time, minimize the tourist impact on ecologically sensitive coastal areas.

Energy

The projected need for electrical power in the United States has increased substantially. Within two decades, it is estimated that 250 new power plants will be needed across the country. In Maine, the Maine Yankee Atomic Power plant now under construction will become operational in 1972. Another major power generating plant near Cousins Island in Yarmouth is scheduled for completion by 1977. In terms of longer-range projections for the Maine coast, studies indicate a possibility of an additional 15 to 30 power generating plants by the end of this century.

Site problems in connection with new power generating plants are increasingly becoming the subject of concern. The consequent discharge of large quantities of heated condenser water may cause deterioration of the ecology of receiving waters unless careful controls are imposed.

Because of Maine's cool waters, sites along its coast are becoming increasingly desirable as a coolant for power plant effluents at potentially minimal environmental destruction.

It is anticipated, however, that cooling waters from nuclear plants can be economically utilized in the form of heating waters for aquaculture, algae, fish and poultry food production, and as a source of low-cost heat for recreation, greenhouses and a small community. Electric power plants convert only 30 to 40% of their fuel energy into electricity. The remaining 60 to 70% is wasted as heated coolant water. A typical power station wastes as much heat as can be produced by $500,000 worth of fuel per day. This heat is difficult to utilize because it is available only at low temperatures (70-100° F.). This temperature is, however, ideal particularly for aquaculture.

Although considerable controversy surrounds the safety and health aspects of both site and actual operation of power plants, a great deal of research is being undertaken to alleviate these fears. The Power Component, another segment of this investigation, considers in greater detail some of these concerns. Technological solutions can be discovered to ameliorate potential environmental threats from thermal effluents provided that cooperative, open working relationships are developed between private and public power interests. This source of inexpensive energy for Maine's use could mean a new era of economic well-being for the State if it can be utilized as described herein.

SPECIFIC ASPECTS OF MAJOR SUBSYSTEMS

The following pages outline known characteristics and features of the various subsystems included in the industrial integration proposal. Functional relationships are diagrammed, production processes outlined and site criteria provided.

These descriptions are then followed by tabulations listing products, markets, raw materials needed and values attributable. Also tabulated is land and location requirements and financial aspects of each major component.

The concluding section provides a summarization of land and site characteristics and financial returns expected.

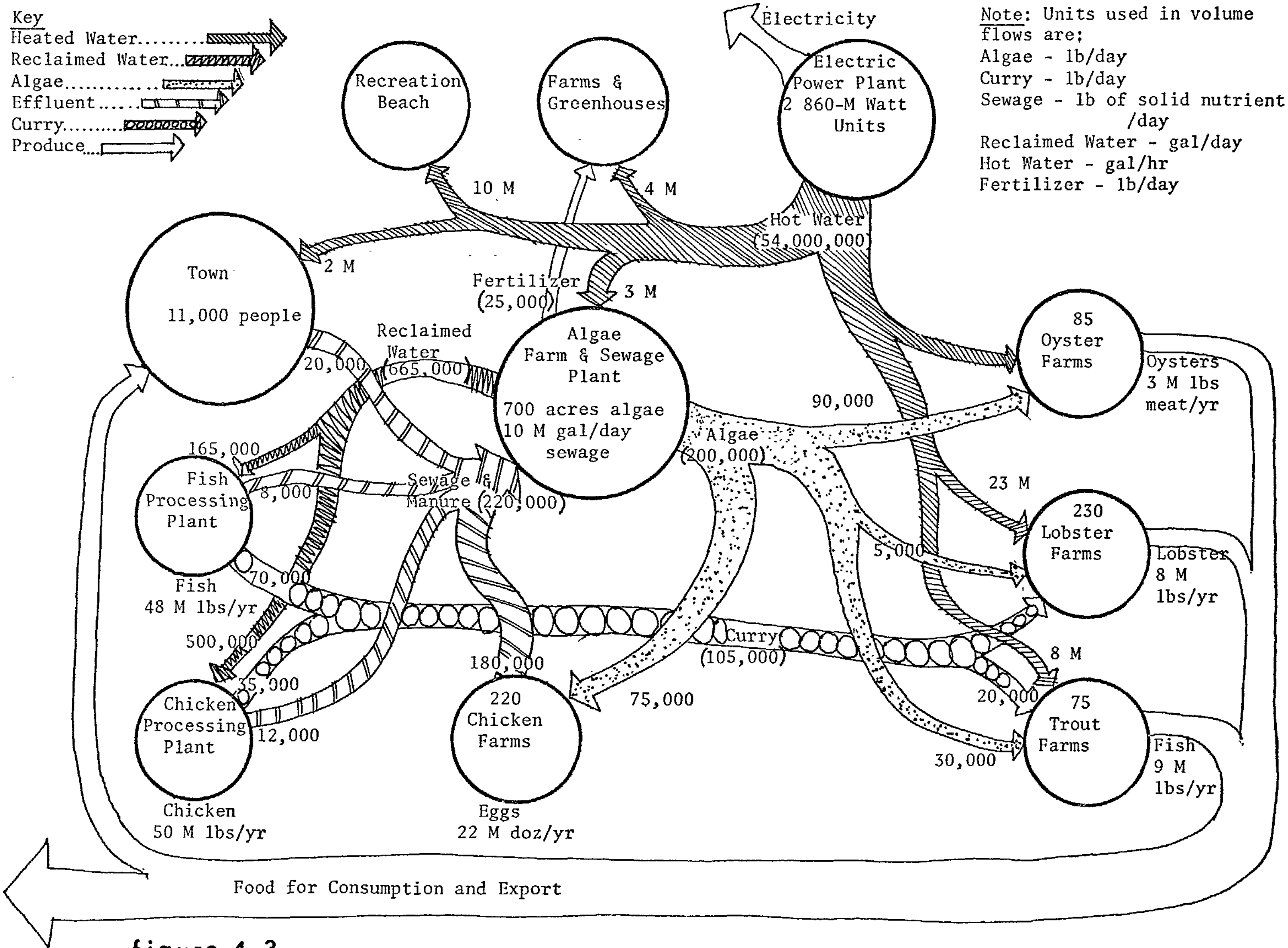
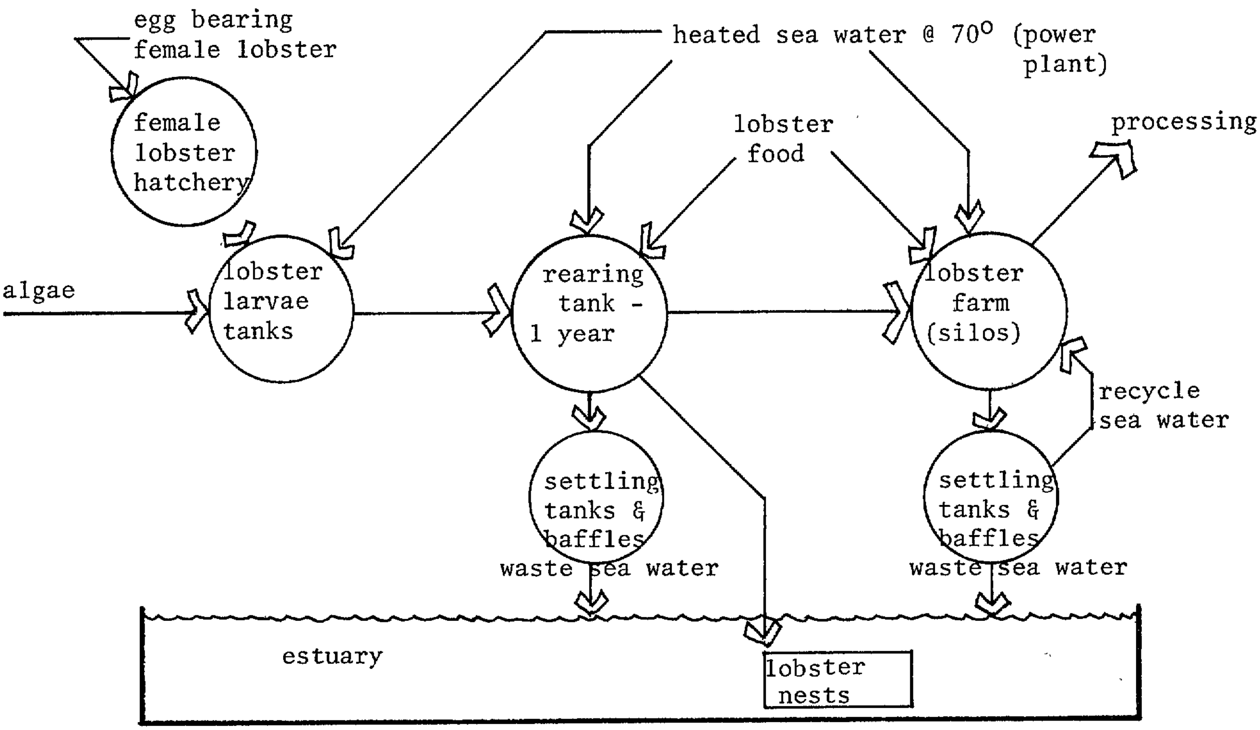


figure 4-3 FLOW DIAGRAM FOR RECYCLING SYSTEM

SUBSYSTEM: AQUACULTURE / LOBSTER FARMING

Function/ Product :	To raise commercially marketable lobster
Market:	The U.S. is currently importing large amounts of frozen lobster; New England currently absorbs most of the fresh supply.
Waste/ Byproducts:	Metabolic waste from settling tank is used as fertilizer.



Process: Female lobster, bearing brown eggs, are brought in by lobstermen and placed in hatching tanks. They are kept in circulating sea water at ± 65 to 70° and fed as normal (once a day). The hatched larvae are screened into "rearing" tanks and fed a diet of ground clams and algae. After reaching the fourth molting stage (two weeks), the lobsters are transferred to individual cages in larger tanks. Flowing sea water heated at ± 65° is constantly circulated through the tanks.

At the end of one year, the lobsters are transferred to larger cages. These cages are roughly twice as large as the lobster will be at market size. Market size is expected to be attained in 3 to 4 years.

Two forms of farming might be employed here — silos (inland) or lobster nests (estuary). **Silos** have the advantage of permitting "intensive" care. These vertical silos are structurally very inexpensive. Sea water at 65° is pumped to the top and circulates to the bottom of the structure. The sea water after treatment flows to the estuary. Food is introduced at the top of the structure and is carried naturally down by the flow of sea water. Alternative method of production in **estuaries.** The use of closed-type estuaries with little or no outside pollution could be ideal for extensive lobster farming. Large cages or nests with individual compartments would be placed on the floor of the estuaries (some could also be floated). A float would serve to hold the feeding line and hoisting cable. Feed would be introduced via a feed line into a core distributor. The food, some pellet form* of food, would be carried via the tidal flow through the nest. Any food not consumed by the lobsters would be carried by the tidal flow and consumed by the fin fish being raised in the same area; they would be contained by nets across portions of the estuary.

Site Criteria: Located close to but not on estuary for sea water disposal: close to warmed sea water supply line.

Silo farms need only 3 acres of land to accommodate the 7 silos. Slope of 8-15% could employ gravity flow: less than 8% would need a pump system. Soil suitable for medium foundations and extensive underground piping. Silos will have strong visual impact. Small clusters should be screened with trees to preserve scale and establish rural land pattern.

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* combination of fish curry and algae

Lobster Farming / Silo and Estuary

4,000,000 2-lb. lobsters/year
half produced in estuary cages = 2M/year
other half produced in silo farms = 2M/year

assume cage size is 2′x1′x6″ 1 cubic foot
1 cubic foot lobster

30 x 12 x 15
10,500 = lobster/silo

Capital Cost

Land: 3 A @ 500/A	$ 1,500
7 silos @ 3000 apiece	21,000
cage system @ 1500	10,500
pump and food feeds = 2000	12,000
	$45,000

Fixed Cost

Interest	$ 3,150		
Depreciation, 20 years	2,250		
Taxes @ 30/1000	1,800		
	$ 7,200		
Fixed cost	$ 7,200		
Maintenance	2,000		
Heated water	10,000		
Food: 120,000 lbs @ .08/lb	9,600		
Labor	10,000		
	$38,800	Expenses	$38,800

Income

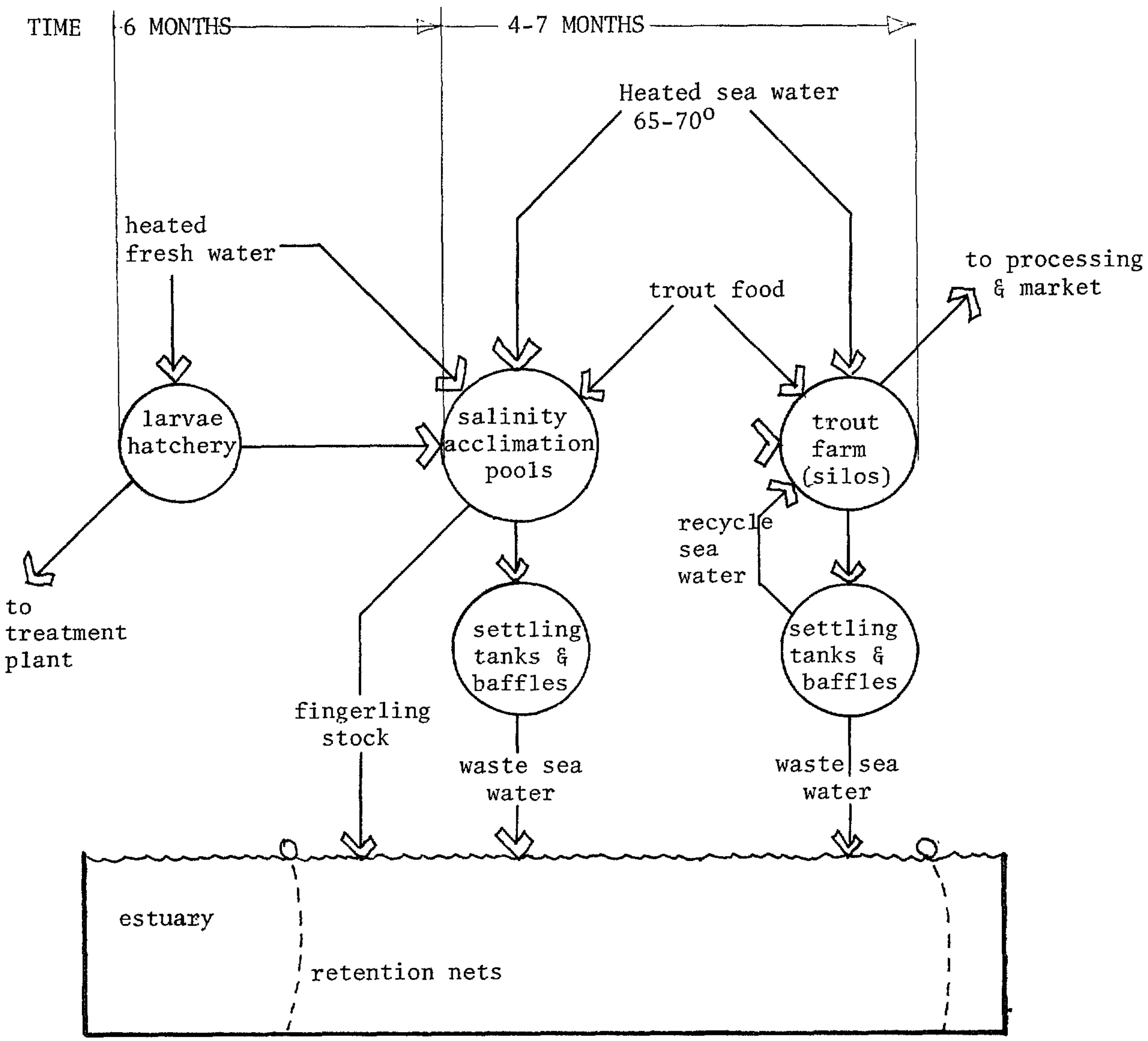
$$72{,}500 - 10\%\ \text{mortality} = \frac{65{,}000}{4\ \text{years}}$$

= 16,300 lobsters/year x 2

+ 32,600 x $1.40/lb. = $45,600 — Income $45,600

SUBSYSTEM: AQUACULTURE / RAINBOW, BROOK TROUT

Function/ Product :	To raise commercially marketable rainbow and brook trout
Market:	Large U.S. market: currently large amounts of frozen trout are imported for commercial and restaurant trade (particularly New York and Boston markets).
Waste/ Byproducts:	a) Metabolic waste from settling tank used as organic fertilizer and for raising bait worms
	b) Unused portion of fish is processed into fish meal



Process: Fish larvae are hatched at either the on-site hatchery or purchased in the fall as fingerlings (3-6″). They are raised to about 3-6″ and then put in salinity tanks for adjusting to seawater salinity (30 to 31/1000). The next stage has two possibilities: inland trout farming and estuary trout farming.

The inland fish farming would be more intensive in nature and thereby allow a greater density of fish per cubic foot (lbs/cubic ft). This could take place in **silos.** Via a controlled inlet at the top, warmed sea water at 65 to 75° is introduced and exists through an outlet at the bottom. Food in pellet form would be introduced at the top and drift down with the current.

The warm sea water would then drain out and be collected along with that of other sea-water silos to be passed through a clarifying tank where the solid metabolic waste would settle out. The solution would then pass over a series of baffles to remove some of the gases (ammonia, etc.) and then passes to the estuary (some might be recirculated through the tanks if the clarifying system were large enough).

The fish would be graded between 4 and 7 months, the market-size ones being sent to the processing plant and the undersized sent either to the silos or into the estuary for further growth.

The alternative is **estuary** trout farming, where fingerlings or undersized fish could be raised in heated-water estuaries. These would be enclosed estuaries with neated areas to keep fish confined and separated as per grade. They might also be kept in with lobster nests, since they are basically top feeders and would not interfere with lobster feeding. Flounder or some bottom fish could provide clean-up for all unconsumed settled food, perhaps. Metabolic waste could be carried out by the tide and diluted.

Site Criteria: Fish farming with the use of silos could be accomplished on a slope, using gravity, and on the flat using pumping systems. Both need soil suitable for medium-weight foundations and extensive underground piping. The silo farming has the advantage of using back land rather than valuable coastline (which can then be used for recreational areas or other land use).

Protection from sea storms and large waves is necessary. Allowances would have to be made for tidal fluctuations and 50-year storm tide.

Silos are a dominent land pattern and would blend well with proper edge pattern development.

Fish Farming with Silos and/or Estuaries

6,000,000 lb production silos
3,000,000 lb production estuaries

9,000,000 lb total

Operational Cost of 30′ x 60′ silo = 42,000 cu ft

2 cycles/year 2 silos/man — 40,000 lb trout

Capital Cost

Land	$ 500	
Silo	10,000	
Pumps	4,000	
Mechanical	4,000	
	$18,500	/ silo

Operational Cost — Fixed Cost

Interest @ 7%	$ 1,300	
Taxes @ 30/1000	540	
Depreciation @ 20 yrs	900	
	$ 2,740	$ 2,740

Material Cost

Food	21,600		
Labor	6,000		
Heated Water	10,000		
	$37,600		$37,600
		Expense	$40,340

Income

40,000 per crop
72% maturity — 35,000 x 64% = 22,500 lb x 2
= 45,000 lb x $1.00/lb — Income $45,000

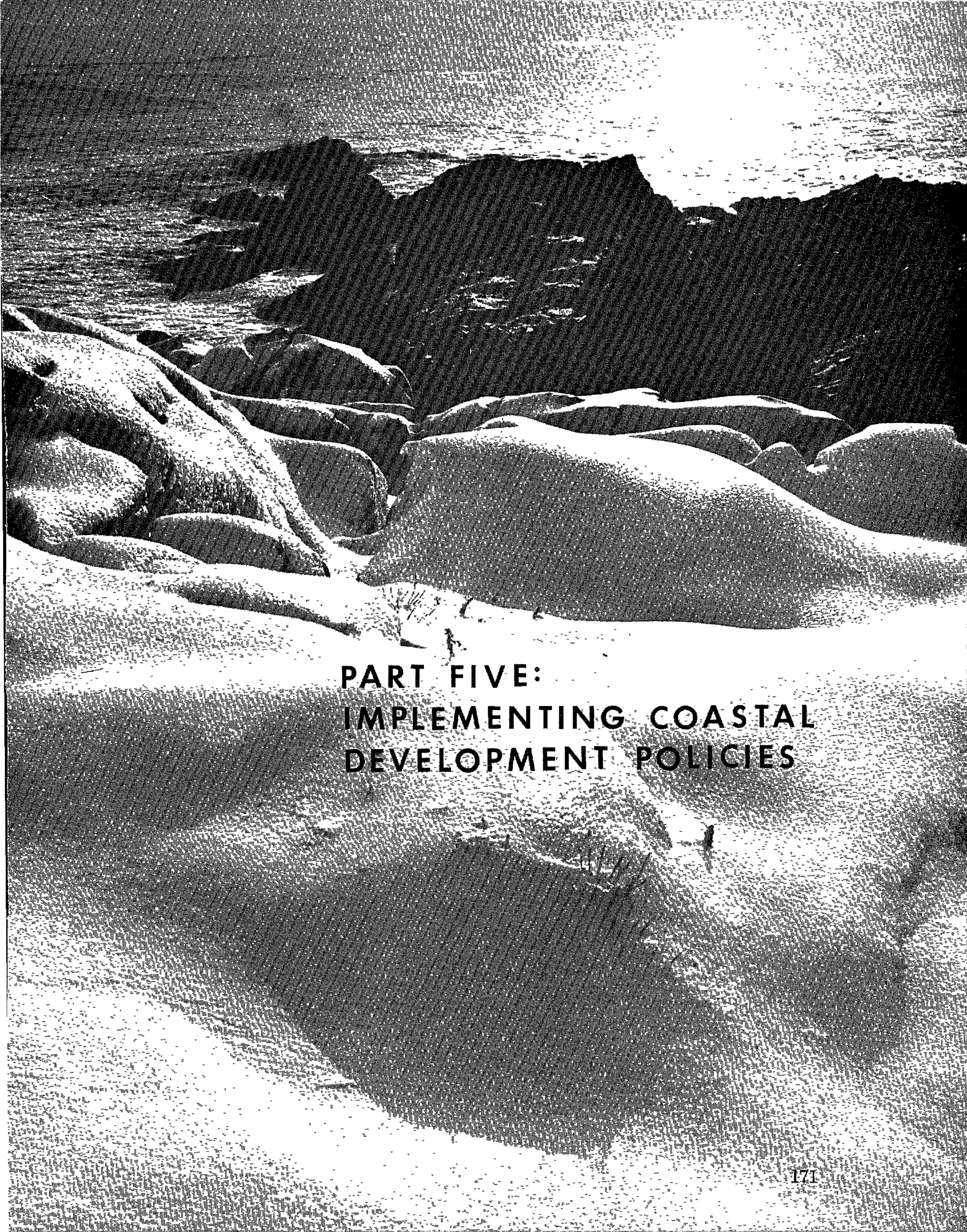
FUNCTION		INPUT	OUTPUT	BYPRODUCT	LAND USE		FINANCIAL					
Components	Market				Locational Factors	Site Requirements and Considerations	Land Area	Capital Costs	Operational Costs	Employment	Local Tax Pay	Components
Power Generation Plant°°	Local & Eastern Seaboard	Nuclear material Coolant water 54,000,000 gal/hr	Electricity 1,700,000 KW	Heated sea water 54,000,000 gal./hr. Radioactive wastes	Availability of coolant water, preferably within 8,000 ft of salt water 30 to 60 feet deep.	AEC regulations: 1) 3000′ radius of nonhabitation; 2) one mile from major population center; 3) able to ship 300-ton pieces by barge; 4) foundation & seismic stability.	800 Acres	$200 M to $350 M		75-100	$ 6 M to $10.5 M	Power Generation Plant
Resort Town° 11,000 people	Eastern Seaboard	Land, building materials and design concepts. Main idea is to maintain rural character. Multi-use with tech. *institute for year-round use.*	Services and living space. Reci *tion area for 800-1500* peo Services: 5-month ocean sw *ming, yacht* basin, golf cou dwellings, restaurants. Some fac ties and units to serve tech. in tute.	Sewage 800,000 gal./day	Near salt water and major traffic route; near airport. Location near major institute desirable.	Individual protection and careful blending with the natural surroundings. Visual contact with water frontage, land form and some slope to maximize visual contact with water. Existing pattern to have as few visual liabilities as possible. High quality water, orientation to sun, few pollution liabilities.	3000 A. °°°	$30 M to $40 M		100-250	$.240 M to $.360 M	Resort Town 11,000 people
Coastal Research°° Laboratory		Land *facilities for* research, reference and habitation	Services and technical help for tire recycle complex	Sewage	Small frontage requirement on ocean. Proximity to town is desirable.	Development of major open spaces and building masses. Shape and composition of building and open spaces *will* reflect quality of spaces and nature of environment.	200 A	$ 4 M to $10 M		60-100	$.12 M to $ .3 M	Coastal Research Laboratory
Waste Treatment Complex	Local Effluent Collection	Human effluent (20,000 lb./day) Chicken manure (180,000 lb./day) Food processing plant effluent (18,000 lb./day)	Treated effluent for algae fa (200,000 lb./day) Organic fertilizer from sludge (25,000 lb./day) Reclaimed water (650,000 gal./day)	Ozone from ozone injector is recycled. Methane is generated by decomposition, possibly used for heat and power	To reduce piping cost, facility should be located near population center and algae pools; also within easy transportation distance of chicken farms and food processing plants. Some thought to prevailing winds. Retention ponds for overflow during malfunction.	Level land (less than 4% slope), not in flood plain, security fencing. Visual screening of pools: offensive odor only if system malfunctions.	100 A.	$ 2 M to $ 3 M	$ .440 M/year $120/M gal.	3-5	0 to $.09 M	Waste Treatment Complex
Algae Pools	Local Aquaculture & Agriculture	Aerated & ozone injected effluent waters — 220,000 lb./day. Sunlight-heated sea water — 100 M gal./day	Dried algae for chicken feed (75,000 lb./day) Algae broth for oyster and fish forms (125,000 lb./day)	Salt water containing unharvested algae	Close to waste treatment complex and oyster and fish farms.	Large flat area. Terrain suitable for gravity flow of algae broth to oyster and fish farms and to estuary.	800 A.	$3.3 M to $ 5 M	$.730 M	10-30	$.1 M	Algae Pools

° existing
°° new or existing

°°° includes 945-acre recreation complex

FUNCTION		INPUT	OUTPUT	BYPRODUCT	LAND USE				FINANCIAL			
Component	Market				Locational Factors	Site Requirements and Considerations	Land Area	Capital Costs	Operational Costs	Employment	Local Tax Payments	Component
Lobster Farms	U.S. & Europe	Heated sea water (23 M gal/ hour) Lobster food (85,000 lb./day)	Lobster (4,000,000 2-lb. lobsters/year) $12 M		Farms can be inland or on estuary for disposal and reuse of sea water.	Silos dominate land pattern. Soil and terrain suitable for medium foundations and high-volume pipe lines. Estuary suitable for lobster growth.	100 A 5 A/farm	$9,900,000 (230 farms @ $45,000/farm)	$9,000,000 (230 farms @ $39,300/farm	230	$.297 M	Lobster Farms
Oyster Farms	U.S. & Europe	Heated sea water (4 M gal/ hour) Algae broth (90,000 lb./ day)	Oysters (3,000,000 lb./ year) $ 3 M		Near or on estuary. Near algae pond.	*Channel System* terrain & soil suitable for channels and for high-volume pipe system. *Estuary System:* raft pattern dominates site character. Incompatible with recreation. Storm protection, tide & current for flushing.	100 A	$3,900,000 (85 farms @ $45,500/farm)	$2,950,000 (85 farms @ $34,700/farm)	85	$.117 M	Oyster Farms
Trout Farms	U.S.	Heated sea water (8 M gal/ hour) Fish & chicken curry (25,000 lb./day) Algae broth (35,000 lb./day)	Trout (9,000,000 lb./ year) $ 6 M		Slope channeled ponds used to agitate water. Estuaries: warm water and protected from coastal storms & tides.	Silos dominate land pattern. Soil for medium foundations. Estuary: tide and currents for flushing, protection. Incompatible with recreation.	100 A	$2,800,000 (75 farms @ $37,000/farm)	$3,000,000 (75 farms @ $40,340/farm)	75	$ .84 M	Trout Farms
Estuary		Cool coolant water from aquaculture. Natural ocean water and food.	Part of the fish and shellfish culture is raised in the estuary.		Close to algae ponds and power plant.	Tidal fluctuation & currents, protection from hurricanes, flood plain contamination siltation. Shape for tidal flushing, net reten'n. No industry pollution.	100 A					Estuary
Chicken Farming**	Local & New England	Imported grain (120,000 tons/year) Algae feed (12,000 tons/ year)	Broilers (17,000 birds/ year) Eggs (22,000,000 doz./ year) Manure (180,000 lb./day) $16 M		Farms can be located inland. System for delivery of manure to waste treatment plant required. Proximity (25 miles) to processing plant and feed sources.	10-25 acres in size. Poultry buildings are large masses and present screening and scale problems. Edge & screen elements to determine quality and rural character.	1000 A	$5,650,000 (100 farms @ $56,500/farm)	$16,000,000 (220 farms @ $72,000 farm)	220	$ .15 M	Chicken Farming
Organic & Greenhouse Farming	Eastern Seaboard	Sunlight, fresh water, fertilizer, heat	Vegetables and flowers $ 2 M	Organic waste	10 mile radius of power plant 40 mile radius of airport As close to town as "rurally" possible.	Good soil for agriculture (0-10% slope). 5-15 acres in size. Plastic greenhouse gives unique land pattern. Low building form makes screening easy. Shape of buildings and open space will determine quality of rural spaces.	1000 A	$18,300,000 (100 farms @ $180,000/1-A. greenhouse & land @ $300/A	$3,000,000 (100 farms @ $30,000/farm)	200-300	$ .6 M	Organic & Greenhouse Farming
Seafood & Chicken** Processing Plant	New England	Whole fish (12,000,000 lb./ year) Whole chicken (17,000,000 birds/year) Fresh water (650,000 gal/ day)	Fish (50,000,000 lb./ year) Chicken Meat (50,000,000 lb./year) Curry (110,000 lb./day) $34 M	Effluent	Located near (5 miles) fishing village-aquaculture facilities. Close to highway. Close to airport. Requires large amounts of fresh water and super heated steam.	Flat area. Visually screened with land form or land pattern (trees). Soil suitable for medium foundations and extensive underground piping.	25 A	$6,500,000	$34,000,000	400-500	$ .2 M	Seafood & Chicken Processing Plant
International Jetport*	World	Flat land, fuel	Transportation	Noise & Atmosph. Pollu.	Near town, technical institute, resort. Proximity to processing plant.	Large flat area. No vertical obstructions (mountains, towers).	2000 A					International Jetport

* existing
** new or existing



PART FIVE: IMPLEMENTING COASTAL DEVELOPMENT POLICIES

IMPLEMENTING COASTAL DEVELOPMENT POLICIES

Introduction

The development of proposals such as suggested in the previous section requires careful consideration of implementation alternatives. Until now coastal development has been almost entirely the province of private enterprise. Public involvement has been restricted to single purpose projects with a restricted scope such as Acadia National Park, or Kittery Naval shipyard. The integration of several major industrial prospects for the Maine coast will require new techniques of organization and administration. This section reviews, briefly, some alternative institutional arrangements that will be needed for such socially-responsible coastal development projects.

The institutional innovations discussed represent types of public organizations capable of implementing unique, large-scale projects that can only be accomplished through public-private cooperation. Another requirement needed is the ability for land and marine resources acquisition for the comprehensive development of a particular site. Such an institutional mechanism has evolved at the state level as the result of the pressing urban crisis in other parts of the country. It is referred to by two names, an "urban development corporation" (U.D.C.) or an "area land development authority (L.D.A.)" The U.D.C. or L.D.A. allows project implementation through both state and regional public organizations on a comprehensive institutional basis.

The functional need for such institutions has been generated by the expansion of influence of many development activities across municipal geographical borders and the parallel requirement for quick and easy assembly of the resources necessary to carry out projects that involve multiple land-use developments. Motivating the multi-interest institution is the enticing hope that the maximum benefit can be obtained at the lowest cost and much more rapidly. Finally, the immediate need for lending impetus to such prospective industries as aquaculture, multi-use of power projects, and controlled port and recreational development, mandates the presence of powerful fiscal and administrative tools to undertake the required research, and planning to get such projects underway. Further complicating the matter are existing demands to husband our natural resources while at the same time tremendous pressures exist for utilization of these same resources. A governmental hands-off attitude is increasingly viewed as potentially self-destructive, an approach that does not allow for long term views of development and conservation but only for short term private gain.

There is little question that the Maine coast is a limited resource in terms of physical size and in its ability to support particular uses. Beneficial employment of these resources is an absolute necessity. It is this necessity for the wise use of Maine's coastal resources that require careful integration of competing land uses, and the need for new approaches to wisely developing the natural capabilities of the coast. Public experience with organizational structures designed to combine public and private interest where a number of potential competing uses are involved, is limited. However successful examples do exist. Urban renewal, airports and private-public developments of parks and recreational areas, to name three examples — have set precedents for this type of activity.

The acquisition and development of resources could occur through a type of Urban Development Corporation or Land Development Authority which have similar capabilities and powers regarding acquisition and development.

Each of these institutional approaches offers a common set of powers and capabilities:

(1) The acquisition of land using, if necessary, the power of eminent domain.

(2) The general powers of a corporation, to sell, lease, contract, bond, and manager projects. The power to operate business enterprises that can be operated on a profitable basis by private enterprises is not included.

(3) The establishment of local area development corporation with powers similar to the parent agency.

(4) The ability to over-ride local ordinances and zoning codes where necessary to allow the agency to operate quickly and effectively in its developmental projects.

(5) The availability or required presence of advisory citizens committees to provide guidance on both projects and programs.

(6) The ability to work with all public and private non-profit firms on specific projects or programs.

(7) The capacity to create any type of multiple-use development unit.

The urban development corporation concept permits the self-financing approach of projects through sale, lease, or capital management and by selling revenue bonds. It is expected that seed money will be required to begin the corporation and to fund initial administrative costs.

The development corporation would be a valuable tool for the type of multiple development previously discussed. The British experience with coastal planning indicates the need for undeveloped coastal estuary areas to be developed as "planned unit development" using the authority and resources of the government to insure wise and coordinated development of potential uses on a comprehensive basis.

In Maine such an approach could be accomplished through the employment of the development corporation with actions coordinated with other public and private agencies. As an example, the recently defeated Aquaculture Act (An Act to Encourage Aquaculture in Maine's Marine Waters, L.D. 1242, 1971) would have permitted leasing of both shore and tidal lands as well as subacqueous areas for private research and commercial aquaculture activities. The Aquaculture Act did not however assign the power of eminent domain to the Sea and Shore Fisheries Department, nor did it grant administrative powers to develop or contract for facilities not directly related to aquaculture activities.

With additional research it may be found feasible to utilize thermal effluent from an atomic power plant to control water temperature of a aqua-farm such that year-round culture of shellfish and growth of farm land products can be commercially successful. A Maine urban development corporation could easily act as the coordinating and development agency that would give this diverse project the direction and unity it needs. The urban development corporation can acquire the necessary land and sub-acqueous terrain then, in turn, allow the Sea and Shore Fisheries Department to lease this property to a private operator for commercial aquaculture purposes. The urban development corporation could contract for construction of a nuclear power plant with a public power authority on condition that certain "effluent services" be provided to the commercial land and sea farm operators. The entire package would be reviewed by the Environmental Improvement Commission (E.I.C.), for consistency with site and pollution regulations as well as for consistency with the comprehensive Coastal Plan.

This discussion has presumed the completion of state governmental reform measures, such as those outlined for the proposed Natural Resources Department presently before the 105th Maine Legislature. The reorganization problem is summarized in the following excerpts from an extensive study report covering governmental agencies as they relate to marine resource management:

"There is no long range over-all direction or supervision of the management of natural resources or marine resources in this State. The State Planning Office, when it becomes fully operative, by statutes should be the possessor of a comprehensive plan for natural resources and the overseer of the execution of such a plan. This, however, is hardly a substitute for a working line agency. . . A consolidation of State agencies would allow for more orderly planning in carrying out this task. . . If all the agencies were in the same boat, this might make a more interesting voyage"[1]

The consolidation of approximately twelve existing agencies into a natural resources department, the addition of clarifying legislation and new mechanisms such as a U.D.C. would be a logical governmental extension to meet the needs of effective governmental action. These improvements are within the scope of legislative delegation of power and responsibility and would aid in the carrying out of projects long contemplated but thwarted due to institutional weakness and inflexibility. Conceptually Governmental reorganization was accepted and passed in the closing hours of the Maine 105th Legislature.

The U.D.C. could work jointly in the field of multi-use projects with other departments in addition to a Natural Resources Department. However, if as expected primary program responsibility for coastal resource management falls to a Natural Resources Department, the greatest impact of the U.D.C. on coastal development would be in relation to projects coordinated within and by this agency.

Maine Land Development Authority

Placed before the 105th Maine Legislature was a proposed Maine Land Development Authority (M.L.D.A.) which combined elements of both the New York Urban Development Corporation and the Advisory Commission on Intergovernmental Relations L.D.A. The M.L.D.A. proposal created a body politic similar to New York's Urban Development Corporation with board of directors of nine members to include the Commissioner of the Department of Economic

Development with the balance chosen by the Governor with the advice and consent of the Governor's Executive Council. The eight-at-large members have four year terms. The bill stated the need to cope with problems of both rural and urban development. Commercial, industrial and residential development were mentioned in the statement of intent but not the term recreation. The initial biennium appropriation for the M.L.D.A. called for $184,000 and The Department of Economic Development planned to utilize the law to further the idea of its area industrial parks. The M.L.D.A. also mentioned explicitly the concept of implementation of new towns — a highly feasible component of the multiple-use proposal made as part of this report. The M.L.D.A. was however defeated by the 105th legislature.

The proposed M.L.D.A. also allowed the forming of subsidiaries (with the approval of the Governor) made up of a town, county, or city or a combination thereof.

Implementation And The Planning Process

Pragmatic approaches to planning and implementation are aimed at welding plans and performance, promises and real policies, and proposed rules and actual execution. For example, if housing goals are suggested by an accepted plan, if a fixed amount of money is appropriated, if definite policy is set down by a governing body; then if objectives can be met via such action of the governing body, then — and only then — can results that are measurable be expected to occur. What we are speaking of here is the concept that government cannot be held responsible for idealistic goals, but it can be held accountable for failing to attain stated objectives or specific program accomplishment if appropriate resources are allocated. More important, stated objectives can be measurable thus providing a significant improvement over governmental accountability.

There is, however, as yet no state comprehensive policies plan. Few if any local and regional plans include measurable accountable goals and objectives. The future of Maine's economy has been implicitly, closely tied to recreational development primarily within coastal and mountain land areas. Yet none of these development directions have been openly and carefully evaluated in terms of other development possibilities which might be more beneficial. It is thus difficult to assess the actual nature and capability of the implementing agencies that currently affect the coast.

Implementation and coordination mechanisms as part of new institutions such as a U.D.C. as well as proper accountability are all factors of importance which would be available and are needed for defining and strengthening a rational course for Maine's coastal economic and social structure.

Summary And Conclusions

The development corporation proposed has the power to assemble land and diverse interests for integrated development of multi-use facilities. This factor is not present in the authorization of any existing State agency.

As a practical matter the broad grant of power to a development corporation would be balanced through the mechanisms of public opinion, local public attitudes and reactions, as well as the ability of the State government itself to exert its authority and influence over the agency.

It is quite clear that many of the tasks facing a development corporation would be far beyond its initial capability (whether Maine, New York, or any other state) for some time to come in terms of the State's needs and the resources that could be reasonably developed by the corporation to meet those needs.

A clear advantage of the Urban Development Corporation approach is the ease of devising working arrangements with public and private agencies for land aggregation and development. The development corporation can act as a development tool for other departments of the government thus, further centralizing functions and cutting down on the need for duplicating the eminent domain process among state departments and bureaus.

While discussion has centered on the State level impact of the U.D.C., it has considerable potential for spurring local areas into action as well as providing the mechanism for local participation within regional Urban Development Corporations (U.D.C.). Local U.D.C.'s should at least allow minority membership on its governing board plus the opportunity for advisory citizen group involvement. Ownership or profit sharing in the Corporation by area residents should also be an integral part of such an institution. Further, the availability of a powerful local tool for development could well spur greater local development activity, and possibly the desirable shift of some state projects to the regional level. In the past, local implementary structures have been weak or non-existent. The U.D.C. at the regional level could alleviate this lack of flexibility of local institutions. One of the first areas of operation of a local U.D.C. could be in existing or planned industrial parks and recreation areas. The U.D.C. presents a potentially effective organization for the initiation of local and regional, as well as State, development.

This discussion has emphasized the importance of the U.D.C. because it has those characteristics needed to coordinate sometimes incompatible and often diverse multiple uses and to simplify public-private cooperative developments. In addition, the U.D.C. would also aid greatly in bridging the gap between promises and action (i.e., accountability) that often occurs in state government. Both these aspects are considered essential for coastal development of a necessarily high quality.

FOOTNOTES — IMPLEMENTING COASTAL DEVELOPMENT POLICIES

1 *Maine Law Affecting Marine Resources*, Vol. 1, "State Government Organization: Agencies Dealing with Marine Resources," Harriet P. Henry et. al., (Portland: 1969) pp. 140-141.

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