MARINE EDUCATION IN ALASKA: DEMAND AND SUPPLY CONSIDERATIONS*

Arlon R. Tussing

INTRODUCTION

This paper assesses the conditions of supply and demand for instruction and ocean-related knowledge, techniques, and skills in Alaska over the period in which it is meaningful to plan educational facilities. Fundamentally, the optimum package of such services is the largest one that the members of the community either are willing to purchase privately, or *ought to* be willing to purchase collectively because the benefits of each exceed its costs. In this essay I try to identify the principal variables but do not give numerical estimates of costs and benefits, nor make the rigorous distinctions among sectoral, state, and national views of the public welfare that are necessary in a benefit-cost evaluation.

The activities with which I am concerned here are those that take place under, in, on, or over the seas, and those that draw their chief raw materials directly and mainly from the sea, whose chief immediate markets are other marine activities as defined here, or that otherwise have a direct impact upon the marine environment. Examples of each are offshore petroleum production, fishing, water transportation, intercontinental air transport, fish processing, servicing of marine engines, and waste disposal. This definition also encompasses such activities as weather forecasting and oceanographic research, whose use of marine resources or impact upon the

*This paper was originally written as a report to the University of Alaska Sea Grant program. It does *not* include a description or evaluation of existing marine education programs in the University of Alaska, community colleges, and local school districts.

environment is not principally a material one, and it includes recreational as well as commercial activities.

The chief parameters of supply and demand for ocean-related educational services in Alaska are the size and structure of the state's economy, and the size and character of its population. Alaska's 1970 Census population was 302,173, or .15 per cent of the national population, and Alaska personal income originating in current production in 1970 was estimated by the U.S. Department of Commerce at $1,288 million or .18 per cent of the national total.[1] Within this economy, about $48 million in personal income could be attributed to fishing, fish and shellfish processing, and water transportation. A substantial amount of ocean-related economic activity took place in the government sector, which constitutes Alaska's largest industry (personal income originating $590 million). These include operations of the Navy, Coast Guard, National Marine Fisheries Service, Alaska Department of Fish and Game, and to a lesser extent, a large number of other agencies whose responsibilities extend to the sea as well as land (Federal Aeronautics Administration, Weather Service, Alaska Division of Oil and Gas, Bureau of Sport Fisheries and Wildlife, etc.). The state's second largest industry, crude petroleum and natural gas (personal income $49 million, value added $246 million),[2] is involved in offshore production in Cook Inlet, is engaged in or contemplating offshore exploration in several other parts of the state, and is involved with the sea in other ways. The activities of several other industries, such as mining and construction, are carried out on or impinge upon the ocean or the coastline. Altogether, depending on how maritime activities are defined, they account directly or indirectly for something on the order of $75 to $100 million a year, measured in personal income originating in those activities. This is about 6-to-8 per cent of the state total. Since 1959, the year of Alaska statehood, each of the industries mentioned, with the exception of non-fuel mining, has grown in absolute size; however, each of them except oil and gas has substantially declined as a proportion of total income.

Fishing and fish processing; offshore oil and gas exploration, development, and production; and water transportation, together with the onshore services (including those of government) that support each of them, constitute the overwhelming bulk of marine activity in Alaska. Together with the substantially less significant categories of undersea mining other than oil and gas and environmental observation and scientific research, they constitute the entire body of marine affairs in Alaska.

Alaska's maritime activities will not become large, from the standpoint of the national economy, in the near future. Notwithstanding the length of the state's coastline, the extent of its continental shelf, or the biomass and potential productivity of the nearby seas, the intensity of economic activity on and near the ocean is limited by the state's small population, environmental severity, remoteness from major markets, and high costs. So long as the population remains small and the unit costs of labor and material (including the implicit costs of transportation and waiting) remain high, significant economic activity on the sea, as on the land, will occur only where a resource stock of exceptional size or exceptional unit value is present.

All of the specific groups of marine activities listed previously are almost certain to grow in total economic contribution over the next decade, but they will grow at widely differing rates. The discussion that follows examines the near-term future of Alaska's fisheries, offshore oil and gas operations, marine transportation, undersea mining, ocean recreation and scientific research, and relates their respective prospects to the demand for ocean-related educational services in Alaska.

FISHERIES AND FISH PROCESSING

It is a mistake to focus upon "fishing" as a central element of fisheries industries; in a developed market economy, these activities normally account for no more than 10-to-25 per cent of the value of the final fisheries product. The fisheries industries or fisheries economy must be seen to include the system of processing and distribution; the production of boats, gear, fuel, and supplies; utilities; repair, port and business services; and the activities of government agencies responsible for regulation, management, and development of all other sections of the complex. The contribution of an existing or new fishery to Alaska's economy is not a simple function of the value of fish at some point in the production process, but is related more closely to the *value added* by the fishery, most broadly defined. The size of Alaska's fishery economy is limited by the potential volume of fish landed, but it is highly sensitive to changes in consumer tastes, costs, technology and government policies, which determine the form in which fish are finally sold, where the various stages of processing occur, where boats are built and serviced, and the like.

At their seasonal peak, the fisheries employ more persons than any industry in Alaska other than government. There is no satisfactory single index of labor input to fishing, but in 1969, 18,927 commercial fishing licenses were issued to individuals and 9,972 vessels were licensed (ADFG, No. 19, 1970) in July of that year, 6,995 persons were employed in 125 canning and preserving establishments, out of a total statewide employment of 111,900 (ADL, 1970). Adding the number of commercial fishing licenses to the monthly employment in processing gives a figure of 23.2 per cent of the employment total.[3] This figure exaggerates the proportional contribution of the fisheries to the state's total economy because of their extreme seasonality, the high transient component in the labor force, and the low wage levels in the processing industry compared to other industries in Alaska.[4] Open access to the fishery stock inflates the numbers of fishermen, which include many individuals who participate in the fisheries on a casual or recreational basis; it is possible that median net fishery earnings would be negative if proper account were taken of the opportunity cost of capital committed to boats and gear. Although it would seem that more than one-fifth of the state's employed labor force (including transients) were directly engaged in the fisheries either as fishermen or as workers in the processing plants, only 2.8 per cent of Alaska's 1970 personal income originated directly in fishing or seafood processing activities.

Projection of the future development of Alaska's fisheries requires separate formulations regarding catch volume, number of fishermen, employment in processing and auxiliary industries, and value added. Despite huge year-to-year fluctuations in some fisheries, particularly those for red and pink salmon, total Alaska landings by weight have shown an upward trend since the mid-1950's. The number of fishermen and vessels has also tended to increase. However, the average annual employment in fish processing does not show a clear trend; employment in 1970 was the highest in ten years but was still substantially below the levels of 1930 or 1950. Projecting these broad trends into the future, it is certain that physical volume of landings will continue to grow as new stocks are developed; there is also some latitude for increases in salmon harvests as knowledge of the resource stock and management techniques are improved.

The number of fishermen in the future cannot be projected on the basis of economic factors alone, but will be determined by government policy; these numbers will be largely unrelated to the volume of fish caught. There is a broad consensus among both

economists and agency officials that a large part of the effort—men, boats, and gear—devoted to the major fisheries, including Alaska salmon, are redundant.[5]

Rising prices for salmon, halibut, king crab, and eventually for tanner crab, dungeness crab, shrimp, and other species, can be expected to draw ever more fishermen and gear into the competition for an essentially fixed catch volume. Despite widespread sentiment in favor of legal limitations on fishing inputs, it is not clear now whether any politically and legally acceptable program of license limitation will be enacted in the foreseeable future. Depending on the measures taken by the state in this area, the number of fishermen and vessels operating in Alaska's waters and the adjacent seas might be twice the present numbers or fewer than half without substantially affecting the total volume of landings. It is worth pointing out, however, that the kind of manpower and equipment, and the economic structure of the fishing sector, would be radically different under a system of severe license limitation from what it will be if present trends and institutions are maintained.

It is noteworthy that Alaska fisheries currently concentrate upon a few species with very high unit value, for whose catch Alaska's high cost of labor, materials, and services are not a limiting factor, and in which the size of each year's catch is ultimately determined by the seasons, quotas, area restrictions, and other regulations of the state authorities. Large stocks of low-valued fish, both pelagic and bottom-dwelling, exist in the Gulf of Alaska and the Bering Sea; some of these stocks are heavily fished by foreign vessels but so far have been of almost no commercial interest to American fishermen based in Alaska. This situation is the result of cost factors that will probably not change soon; industrial fisheries, whether engaged in reduction or in producing blocks of white fish for human consumption, must process vast quantities of low value raw material on board or in nearby ports. Such an operation is highly sensitive to the costs of capital, labor, fuel, and other materials. Alaska's relative position in respect to all of these costs may improve somewhat over the next decade. Moreover, the extension of national jurisdiction over fisheries beyond the present 12 miles to as much as 200 miles is a possible outcome of the 1973 Law of the Sea conference. Such a change would favor the long-term outlook of the domestic industry and of Alaska bases with respect to the resources now harvested by foreign fishermen. Notwithstanding these improvements, it is not probable that Alaska will soon become the base of major industrial fisheries.

Expansion of the industry in the state will most likely proceed along the lines of the recent past, the more complete exploitation of those stocks which now bring high prices and for which demand is income-elastic: salmon, king crab, and halibut—in which there is little if any room for expansion; dungeness crab—whose landings might perhaps be doubled; tanner crab—where there is also substantial room for expansion; scallops—whose ultimate significance will not be so great as the foregoing—may be in a similar category. Other potentially high value species, as yet hardly exploited, are clams, flounder, and sablefish. Landings of shrimp have been the most rapidly growing component of Alaska's total catch. Landings, which averaged only about 3,000 tons per year in 1955-60, will probably be in the order of 50,000 tons in 1971. Shrimp command very high consumer prices; yet, because of high rates of spoilage, a very low recovery factor, and high processing costs, the total landed value to fishermen has been only about four cents a pound. Shrimp landings will continue to grow as new grounds are developed, providing serious overfishing is avoided in the presently exploited areas. In the absense of technical or organizational breakthroughs, however, the shrimp fishery is likely to be alone among Alaska's fisheries as one in which the total catch is limited by economic factors substantially before the theoretical maximum sustained yield can be achieved.

As noted earlier, fishing itself accounts for only a minor fraction of value added in the fisheries industries. Developments in marketing, processing, and transportation may actually have a greater significance for Alaska's seafood industries than changes in the volume of fish and shellfish harvested. The demand for fresh and frozen fillets, blocks, and fish products is substantially more sensitive to increases in consumer income than is that for traditional canned products. New technology in freezing, refrigeration, and transportation, and a shift toward more elaborate processing and packaging, point to a relative decline in canning compared to other processing operations. Federal and state sanitary and quality regulation is becoming more rigorous, as is consumer discrimination; also, the quality of frozen products is more sensitive to the condition of the raw fish or shellfish than are canned products. All these factors will combine to increase the value of processing compared to the value of raw fish; at the same time, processing will continue to be increasingly capital intensive, so that it is not clear whether the volume of products processed will increase more rapidly than the rate at which new technology reduces per unit labor input.

Moreover, ton-mile transport costs will continue to fall in relation to the prices of both raw fish and fishery products, so that the location of processing will be more sensitive to local cost factors than has been the case in the past. One result may be the shipping of a larger proportion of raw or semi-processed seafood to the Puget Sound area, Japan, or elsewhere for further processing and packaging. For these reasons, it is not possible to project with confidence a sustained growth of fish processing employment in Alaska. It is certain, however, that the same forces will cause the technical sophistication of food processing in the state to increase radically, and with it the proportion of technical and skilled labor in the total employed work force. With the industry's enhanced sensitivity to quality and to costs, the location of processing activities within the state, as well as the location of the economic margins for harvesting of shrimp and perhaps in other fisheries, will be determined by the availability and cost of the appropriate labor skills and of the kind of business and technical services required by a sophisticated industry.

The pattern of development described above will create demand for specialized instruction in three principal fields: (1) fishing boat operation, with an emphasis on navigation and safety; (2) food technology, particularly biological processes and sanitation; and (3) marine biology, with emphasis on resource management.

Fishing Boat Operations

The degree to which the sophistication of fishing vessels, gear, and operations will increase depends powerfully on the fate of proposals for entry limitation. If the open access regime is preserved in the salmon fisheries, for example, it is meaningless to speak of improved technical efficiency in harvesting. The rationale for the regulations that preserve the resource stock is the *reduction* of fishing efficiency to that point at which the fleet's catching power just permits the appropriate escapement in each management unit. Except in the areas of safety and product quality, there are no benefits either to the fishermen as a group or to society from improving gear or fishing skills in such an industry.

One proposed mode of entry limitation would restrict participation in the fishery to the safest, best-equipped vessels, and to highly trained skippers and crews. Even in the absence of such a program, the fisheries that are carried out in the open ocean and in all types of weather employ a relatively small number of larger boats

in which a variety of technical skills are critical. These vessels do require the equivalent of professional marine officers and seamen, and, in addition, the ability to use and service complicated and expensive gear and navigation and fish-finding equipment. The ability of Alaska-based fisheries to harvest the more remote stocks of crab, shrimp, and other species will depend in part upon the availability of these skills.

Safety standards in all of Alaska's fisheries are exceptionally low. Alaska's vital statistics indicate the highest proportional incidence of drowning of any state, and casualty losses to the Kodiak-based crab fleet are said in recent years to have exceeded that fleet's fishing earnings. Without taking a position on the controversial issue of certification for fishing boat crews, I estimate that there is a potential clientele of 300-to-500 fishermen who will be operating modern vessels in all weather on the open ocean from Alaska ports, and who ought to have formal training and/or apprenticeship comparable to that required for officers and seamen aboard merchant vessels, in addition to indoctrination in knowledge and skills peculiar to fishing in the North Pacific and the Bering Sea. Growth and replacement would provide openings for 25-to-65 graduates per year from a two-to-four year course of study. Both this segment of the industry and the several thousand small-scale fishermen, whether they are full- or part-time professionals or casual fishermen, constitute a permanent potential clientele for short courses and extension programs. Instruction in navigation and safety, marine radio, marine engine service and repair, refrigeration, and sanitation and quality control, ought to provide an audience of several hundred students each year in part-time and short-term courses.

Cost factors make it unlikely that large, modern fishing vessels will be built in Alaska, or even undergo rebuilding, overhaul, or major repairs in the state's ports. However, there is a continuing demand for routine engine and vessel service, maintenance, and repair. The majority of salmon fishermen apparently do much of their own boat and engine work, usually without any formal training in the associated skills, and there are probably 150-to-300 persons engaged in full- or part-time employment servicing commercial fishing vessels in Alaska.[6] Fishermen make up a numerous potential clientele for short courses in boat carpentry and diesel engine repair, and the demand for commercial vessel and engine work may be sufficient to support one or two high school or community college vocational education and apprenticeship programs.

Food Technology

Training in food technology essential to operation of modern seafood processing plants includes some knowledge of mechanical and chemical engineering, bacteriology, and biochemistry. Each operation can be expected to employ one or more food technology graduates. The total number of such persons within the industry is not likely to be sufficient to support a university curriculum in food technology within Alaska. However, the industry will employ several hundred semi-professional and technical workers, and skilled craftsmen in the service and operation of refrigeration and other specialized machinery, in quality control and sanitation, and in supervisory positions requiring a technical background. No manpower study has been done in the industry, so I am not able to give even broad projections of the occupational and skill composition of this section of the labor force. It is likely that growth and replacement demand for one or more of the technical skills associated with seafood processing would support an apprenticeship program coupled to a vocational curriculum at the high school or community college level.

There is a clear demand in the industry at present for short courses or extension programs in sanitation, quality control, and biological processes in food. The attempts in this direction at Kodiak have been exceptionally well received in the industry. Extension programs for both managers and skilled workers on refrigeration and other technical aspects of the industry will find a ready audience.

Fishery Science

Depending upon the narrowness of definition, there are presently two-to-three hundred scientists, principally marine biologists, associated with the fisheries in Alaska. Most of these are employed in positions of research management and administration in the Alaska Department of Fish and Game, the National Marine Fisheries Service, and the Bureau of Sport Fisheries and Wildlife. There is also a scattering in other agencies, at the University of Alaska, and perhaps in private industry. These are all "professional" positions requiring a university degree in a related science. I have found no solid ground for projecting whether the number of such positions will increase in the future, but there is evidently a statewide

turnover in the order of one or two dozen persons per year. Agency officials, both state and federal, express a preference for Alaska-trained scientists; if this preference were strictly expressed in recruitment policy, this manpower demand could clearly support a four-year university curriculum in marine biology in Alaska.

Offshore Oil and Gas Operations

Crude petroleum and natural gas is the largest private industry in Alaska in terms of gross value of product and value added. With very minor exceptions, all production so far has been from the Cook Inlet area in the southcentral part of the state. However, the biggest known petroleum deposit in North America was discovered on the Arctic Slope in 1968 and dominates both private and government planning in the industry. The general history and present status of the Prudhoe Bay development are well-known and need not be repeated here. Several other essentially unexplored provinces of Alaska are considered highly prospective, and it is unlikely that the Prudhoe Bay field will be the last giant field discovered in or near the state. The bulk of the presently producing Cook Inlet subprovince is under water, as are the vast bulk of the highly prospective Gulf of Alaska Tertiary subprovince and the slightly less attractive Bristol Bay Tertiary province. Other prospective areas, including the Arctic plain (which encompasses Prudhoe Bay) and the lower Yukon subprovince (Norton Sound), include an undetermined amount of offshore acreage. It is certain that each of these areas will be explored for oil and gas, and it is highly probable that some offshore drilling will take place in each of them.

The timing and amount of exploration effort depends powerfully on several factors that are now very uncertain, among them the fate and timing of the projected Alyeska pipeline; the legal determination of the boundary between state and federal jurisdiction in Cook Inlet, Bristol Bay and perhaps Norton Sound; federal and state leasing timetables and procedures; and the impact upon them of environmental policy and national energy policy. It is conceivable that there will be no new offshore drilling in Alaska in the 1970's, outside of Cook Inlet and some near-shore leases near Prudhoe Bay. It is more probable, however, that the Gulf of Alaska, lower Cook Inlet, and the Arctic Ocean will see major exploration within five years, and that oil will be discovered in commercial quantities in one or more of those areas. If this occurs, oil and gas industry investment

in platforms, terminal facilities, ocean transportation, and offshore drilling may amount to tens or even hundreds of million dollars, and employment by the operating companies and their contractors may average many hundreds of persons annually.

Offshore exploration development and production in the oil and gas industry employs professionals and craftsmen in several specifically marine specialties and trades, from engineers who design and supervise the construction and erection of drilling platforms to tugboat crews and divers. It is my assessment, however, that the induced demand for training in these specialties in Alaska will be very limited. First of all, the total number of persons engaged in the state in any one of these specialized trades will be extremely small. In the peak year of 1969, which saw the climax of activity on the Arctic Slope, the twelve months average employment by the petroleum industry in oil and gas production, well drilling, field exploration, and other field services was only 3,220. It is not likely that this total will again be exceeded in Alaska in the foreseeable future; assuming, however, that half this number is at some time employed in offshore operations, it is unlikely that more than one or two hundred persons will be employed in the marine specialties.

The foregoing employment total does not include construction personnel engaged in building and erecting platforms, transportation systems, and terminal facilities. These facilities will, however, invariably be designed and prefabricated outside of Alaska. The specialized professionals and craftsmen who are involved in this work, even at the site, are highly mobile participants in national or international labor markets, and would have no special propensity to go to or remain in Alaska for training in their specialties. Obversely, Alaskans who became, for example, platform engineers or underwater blasters would have a high propensity to leave the state. Industry perceptions regarding the field of ocean and ice engineering are similar to the foregoing view. Industry and contractor officials see no special role for a full university curriculum in ocean engineering; design of major structures such as platforms and pipelines will be carried out by specialized international firms that are not now and probably will not be headquartered in Alaska. Moreover, the principal professional training of those engaged is civil engineering, not oceanography or some related discipline. It is felt that the demand for professionals, both by design and fabrication contractors in the field, is for civil and mechanical engineers with an additional understanding of hydrology, wave and ice dynamics, electrolytic

processes in sea water, etc. In no case is an Alaska-trained graduate regarded as a superior recruitment prospect; a specialized marine-oriented engineering curriculum in Alaska would probably not change this situation. But there would be interest in short courses, institutes, and extension programs in the special knowledge and techniques relevant to operation in northern seas; industry would be willing to pay the full cost of these offerings.

WATER TRANSPORTATION

Water transportation, other than that conducted by government, accounted for about $9 million in Alaska personal income in 1970, 0.7 per cent of the state total. The annual average employment in water transportation, including fresh water and services incidental to water transportation, was about 1,000 persons, approximately 1.0 per cent of the state total. These figures rather understate the importance of water transportation in the state's economy. The state ferry system is not included, and because the interstate firms that handle the bulk of Alaska's waterborne commerce (and thereby the bulk of the state's imports and exports) are invariably based elsewhere, their wage and salary payments and contribution to personal incomes are overwhelmingly attributed to other places, principally Washington State and the Province of British Columbia. A substantial proportion of those employees recorded for Alaska are office and warehouse personnel, truck drivers, etc., employed by firms in the water transportation business. The bulk of the remainder, perhaps two or three hundred on the average, and five hundred at the seasonal peak, are engaged in charter and service operations to the fisheries, and the oil and gas industry; or in pilotage, tugboat, bunkering, or lightering operations for interstate transportation; or in freight and passenger service among smaller coastal communities.

Alaska is not about to become a major *entrepot* or a base for interstate or international merchant fleets. Deep sea water transportation in Alaska will continue to serve the state's imports of general merchandise and its exports of petroleum, timber, fish products, and other crude materials. The physical volume of imports will grow proportionally with the state's population, but some fluctuation from the trend will result from the uneveness of imports for industrial, government, and residential construction. Virtually all of Alaska's commodity production will be exported, and the volume

of ocean cargoes will be roughly proportional to the volume of production (less any petroleum that may be exported by overland pipeline). The growth of deep sea transportation touching the state may be very substantial, but this growth will have little impact on the demand for ocean-related education within Alaska. For cost and logistics reasons, these operations will invariably be equipped, headquartered, manned, serviced, and supplied from San Francisco, Seattle, Vancouver, Prince Rupert, or Yokohama, rather than Anchorage, Sitka, or Kodiak. The growth of ocean transportation may induce additional demand for local services of pilots, tugboats, etc. But new technology, both in navigation and in freight handling (containerization, bulk cargoes, etc.), are radically reducing the requirements for auxiliary services per ton of cargo handled, and it is improbable that there will be any major increase in the level of these activities even in the face of a large growth of cargo volume.

The small-scale port and coastwise shipping enterprises and their employees, however, may provide a clientele for, and receive benefits from the same vocational programs, short courses, and extension programs suggested above for the fisheries, particularly those related to navigation and safety, and marine engine service and repair.

OTHER MARINE ACTIVITIES

Aquaculture

Artificial rearing and controlled harvest of molluscs, fish, and marine animals, may be technically possible in Alaska waters but has not been shown to be commercially feasible.

Offshore Mining

Undersea extraction of non-fuel minerals has drawn some interest off the Seward Peninsula and will undoubtedly be attempted in other places. No meaningful projection can be made of value added or employment in this industry, and there is at present no basis for providing special university curricula or special vocational programs in the marine specialties associated with it. The foregoing conclusions about the requirements of offshore oil and gas activities will generally apply to any development of offshore mining.

Heavy Construction

Construction of piers, causeways, landfills, and the dredging of harbors and channels, etc., will become more frequent in coastal areas. Civil engineers designing and supervising the construction of these structures will require an understanding of wave and ice dynamics, littoral processes, etc. Acquisition of these skills on the part of undergraduate engineering students is best obtained within standard curricula. Short courses, institutes, and extension programs are in order for those already employed in the field.

Sanitation and Waste Disposal

Disposal of domestic and industrial wastes affects other uses of seas and estuaries; waste loads will increase along with local populations and industrialization. Fisheries are among the most economically sensitive industries to pollution, and in some localities are also the largest present source of water pollution in Alaska. Coastal communities have a variety of special problems in water quality management, and Alaska will provide perhaps two or three dozen engineering positions in federal, state, and local government requiring knowledge of the problems of marine waste disposal and pollution. The theory and technology treating these problems is not significantly different for Alaska (except perhaps in the High Arctic, where population and industrialization will continue to be sparse) from those in other states. The special knowledge required to deal with the marine environments is best introduced into the standard civil engineering curriculum, supplemented again by a variety of post-graduate programs for persons already in the field. Major waste disposal systems will generally be designed and prefabricated by outside firms.

A number of positions related to sanitation and water quality control comparable to the number of civil engineers in this field exists or will be created for chemists and biologists. These scientists will come from a variety of sources and will generally be recipients of a standard college program in the natural sciences.

Law

All the foregoing activities generate litigation, lobbying and legislation, and require professional inputs in the fields of admiralty law, fisheries law, and international law. The growth of marine activity in and around Alaska will increase the amount of legal work in these specialized areas; the growth of environmental concern also is giving rise to a new and complex body of regulations concerning safety and waste disposal, and is broadening both of the kinds of civil liability and the number of parties that have standing in civil litigation. There is at present no lawyer in Alaska who makes his principal business marine affairs; admiralty law and international law in particular are the province of highly specialized firms in New York, Washington, and San Francisco, and these firms will likely be engaged in any major litigation or administrative proceedings in Alaska. However, they will at times be associated with Alaska lawyers, and the latter will have a substantial and growing business touching at least incidentally upon admiralty, fisheries, and international matters. Moreover, there are substantial benefits to the state from having within its population even a handful of lawyers who are interested in, and can be consulted on, legislation, regulations, and state policy in the marine field.

Even for a major law school in the metropolis of a major maritime state, it is often doubtful that a specialized curriculum in law of the sea should be offered; there is clearly no place in Alaska, which has no law school, for a comprehensive program of this sort, but the state legal profession ought to provide substantial interest in courses in this area under the continuing legal education program.

Basic Science and Research

Despite the intimate logical and institutional association of basic and applied research and science education, the former is not a central concern of this paper. Except for marine biology with its application to fisheries resource management, there is no large constituency in the state to justify a formal university curriculum in marine sciences. Alaska, however, will continue to be proportionally more important as an arena for scientific investigation of the ocean than it is for ocean-based commercial activities or employment. Alaska's large share of the national coastline and Continental Shelf,

and its great variety of physical and ecological regimes are significant determinants of the level of scientific effort in marine disciplines. Proximity to this research arena decrees that Alaska will have a substantial establishment in marine affairs research, both at the university and in government, and that this establishment will tend to grow over time. Research within the state will itself provide some clientele for scientific education. The Institute of Marine Science at the University of Alaska now employs several persons who have received Bachelor's or advanced degrees at the University of Alaska. The decision to expand university programs in basic and applied sciences must on the whole be made on grounds other than in-state demands, and is related more to a philosophy of higher education and the conception of a national role for the University of Alaska.

CONSIDERATIONS IN THE SUPPLY OF EDUCATIONAL SERVICES WITHIN ALASKA

Alaska's high costs and small population pervade every aspect of educational policy in the state. Almost everything costs more in Alaska than elsewhere in the United States; Spring 1971 family budget costs in Anchorage were 49 per cent above the national average for a "lower" standard of living, 33 per cent above the national average for an "intermediate" standard of living, and 26 per cent above the national average for a "higher" standard of living (Tussing and Thomas, 1971). Costs in Ketchikan were similar to those of Anchorage, but those for Fairbanks and Juneau were substantially higher; those for other communities in Alaska probably tend to exceed those of Fairbanks and Juneau. In addition, because of the advantages of specialization and division of labor, the state's small population decrees a specialized economy and a specialized educational system. Serving principally the state's own population of only three hundred thousand persons, higher education in Alaska can do only a few things well. Another prominent consequence of the state's small population is the mobility of that population. The 1960 Census showed that 46.6 per cent of the 1960 population of Alaska had not resided in Alaska in 1955, and that 31.4 per cent of Alaska's 1955 population lived outside the state at the time of the 1960 census. This extreme rate of turnover probably has not continued to the present, but it is still true that most Alaska jobs requiring specialized skills are filled from out of state and that a very high proportion of Alaska youth leaves the state to seek their careers.

The consequences of the foregoing for the supply of the instructional services and for the optimum mix of educational activities within the state is complex. On the one hand, it is cheaper for Alaska to purchase most of its educational services elsewhere; this generalization applies both to filling skilled positions in Alaska industry and government, and to the task of educating Alaska's youth. It is generally cheaper to recruit educated and skilled personnel from outside—in effect to impose the training costs on other states—than to finance a broad range of educational and vocational training programs within the state, in the face of small student populations in most subjects, high money salaries for teachers and high cost levels for most materials and services. The disadvantage of conducting these programs within the state at Alaska cost levels is accentuated by the fact that a large proportion of graduates can be expected to leave the state within a short time after completing their training. On the other hand, the people of Alaska can, in general, purchase education for their own youth—at least those who would leave home anyway for a full-time undergraduate or graduate course of study—by paying tuition and/or out-of-state fees at institutions elsewhere. Again, the comparative benefit of doing this is accentuated by the fact that many Alaskans will immediately or ultimately make their careers outside the state.

Only limited resources can be devoted within the state to vocational instruction or higher education and it follows from the foregoing that these resources ought to be concentrated in those areas where comparative advantages can be identified. In general, these are instances of:

1. *Special subject matter.* Where training requires direct access to the resource or activity being studied and where that resource or activity is unique to the state, there is usually (but not always) an advantage in basing the educational program nearby. Some of the commercial fisheries in Alaska probably fall in this category. "Uniqueness" is not an absolute yes or no question, but one of more or less; there may be some peculiarly Alaskan resources or activities in which economies of scale in related fields may dictate that related training be conducted elsewhere. For example, food processing technology regarding Alaska king crab and tanner crab is conceivably better studied at Oregon State University than anywhere in Alaska.

2. *Special populations.* There may be populations with special characteristics or special requirements that are not likely to be met elsewhere. The cultural backgrounds and vocational orientations of many Alaska Natives may dictate the establishment of programs for them within the state, even where similar programs directed to non-Natives would be more economically or effectively provided elsewhere.

3. *Immobile populations.* Substantial proportions of the potential school population cannot or will not move their residence in order to attend school, for reasons of age or marital status, or for other social or economic considerations. The largest cost of higher education, both to the student and to society, has been found to be income forgone by not working. There are substantial benefits in providing continuing education programs locally for those already in the labor force.

4. *Economies of scale and joint products.* There are instances in which the unit cost and other disadvantages of an Alaska location might be overcome by a decision to start with a large enough scale of operation. This may be the case, for example, with undergraduate instruction in oceanography, or in some other ocean-related sciences; this is because of the prior existence of research facilities that can share their personnel, laboratories, and field stations with an instructional program. In each of the instances that come to mind, however, the establishment and operation of the existing plant has been overwhelmingly supported from federal funds, and serves a national or international constituency. It is to be expected that the same would be the case for undergraduate or graduate scientific instruction heavily dependent upon the existence of a research institute.

SUMMARY AND CONCLUSIONS

Additions of ocean-related courses to existing undergraduate and graduate curricula are justified in a number of fields, and there is a strong and growing demand for continuing education at the

university or post-graduate level in a broad spectrum of marine-related disciplines and professions. These include marine biology, food technology, law, and a large number of topics associated with engineering in marine and ice-stressed environments.

Local demand in coastal communities is probably sufficient to support vocational and apprenticeship programs at the high school and junior college level in navigation and fishing technology, diesel engine maintenance and repair, and perhaps refrigeration technology. There is substantial and growing demand for short courses and other forms of continuing education at the subprofessional level in navigation and ocean safety, sanitation and quality control, diesel engine maintenance and repair, refrigeration technology and boat carpentry, probably in that order.

The present status and development prospects of marine activities in Alaska generally do not, however, justify the establishment of new curricula or majors at the university level. The most prominent exception is probably the area of marine biology in which there is a substantial demand for graduates by resource management agencies of the state and federal government, which prefer some training in Alaska.

The incremental cost of providing instruction in other marine-related fields in Alaska will probably be very high compared to the benefits they yield to the state's economy or to the client groups; Alaska's industry and Alaska's people can obtain a better quality of instruction at a lower cost elsewhere. As part of a single nation and national economy, however, it is fitting that the state and its system of higher education establish and subsidize at least one and perhaps more educational programs serving a national and international constituency in the marine field.

Doing so can be regarded as partial compensation for the substantial educational subsidies Alaska receives in federal funds, and, more importantly, in the migration to Alaska of skilled workers and professional persons trained elsewhere. It must be kept in mind, however, that the small population and thin economy of Alaska, and the small size of the state's overall educational establishment preclude the support of quality programs in more than a very small number of fields. I would suggest that the state choose one and only one area of ocean-related activity in which to develop a major higher educational program of world stature, in addition to serving those

in-state demands that can be met well with in-state educational programs.

NOTES

[1]Total 1970 personal income for the state was estimated at $1,400 million, also .18 per cent of the comparable national total (U.S. Department of Commerce, August 1970). Sectoral estimates in this paper are from Tussing, *et al.* (1971:35-38).

[2]See Tussing, *et al.* (1971:31-38) for manner of estimating value added in petroleum and natural gas industries.

[3]The Alaska Department of Labor estimated average annual employment of commercial fishermen for 1969 and 1970, at 2,900, 2,700, and 3,100. This 1969 figure, plus an annual average of 2,710 in processing, gives a total average employment of 5,810, 5.9 per cent of employment in all industries (Alaska Department of Labor, May 3, 1971).

[4]Also, adding fishing licenses issued during the year to numbers of persons employed in processing in the peak month certainly involves some double-counting.

[5]Crutchfield and Pontecorvo (1969) regard 80 per cent as a conservative estimate of the proportion of surplus fishermen in the Bristol Bay red salmon industry; i.e., there were at least five times as many vessels and fishermen as were necessary.

[6]The same enterprises and persons usually service recreational craft as well.

REFERENCES

Alaska Department of Fish and Game, *Alaska Catch and Production, 1969: Commercial Fisheries Statistics*, Statistical Leaflet No. 19, Juneau, 1970.

Alaska Department of Labor, Employment Security Division, *Statistical Quarterly*, 1968, 1969, 1970, 1971.

———, Employment Security Division, Research and Analysis Section, *Commercial Fishermen Estimates*, Vol. 1, No. 3, May 3, 1971.

Crutchfield, J.A. and G. Pontecorvo, *The Pacific Salmon Fisheries: A Study in International Conservation*, Seattle, 1969.

Tussing, A.R., *et al.*, *Alaska Pipeline Report*, Institute of Social, Economic and Government Research, University of Alaska, Fairbanks, 1971.

Tussing, A.R. and M. Thomas, "Prices and Costs of Living in Urban Alaska," *Alaska Review of Business and Economic Conditions*, Vol. VIII, No. 3, September 1971.

U.S. Department of Commerce, *Survey of Current Business*, August 1971.