EDUCATIONAL NEEDS OF THE U.S. COMMERCIAL FISHING INDUSTRY

A REPORT TO THE UNITED STATES SENATE

BY THE NATIONAL SEA GRANT COLLEGE PROGRAM, NOAA

BY

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February 1980

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Rockville, Maryland 20852

National Sea Grant College Program

March 24, 1980

Honorable Ted Stevens
United States Senate
Washington, D.C. 20510

Honorable Claiborne Pell
United States Senate
Washington, D.C. 20510

Dear Senators Stevens and Pell:

I am herewith submitting the National Sea Grant College Program report on Educational Needs of the U.S. Commercial Fishing Industry requested during the Sea Grant Authorization Hearings held by the U.S. Senate in 1978. The report is based on the views of those interested in the educational needs of the commercial fishing industry, including college and extension educators, commercial fishermen, industry managers, and representatives of the National Marine Fisheries Service and the National Sea Grant College Program. Such views have been supplemented and documented by reference to both published and unpublished literature. This is a staff report prepared by the Office of Sea Grant and, as such, its contents should not be construed as representing Departmental or Administration positions.

In conducting the research and personal surveys for this study, we found, on the one hand, a paucity of factual data and documentation and, in the other hand, a disparity of opinion as to what the commercial fishing industry educational needs are. Accordingly, this report cannot be considered a consensus but, rather, an attempt to reflect reasonable interpretations of available data and experiences, and the middle ground of expert opinion. This dearth of data, and strongly held but divergent views, has dictated that the study proceed with caution and thoroughness. As a result, this report has taken much longer to complete than we anticipated.

I hope and trust that this report will serve as a solid foundation for building needed educational infrastructure in support of a newly vitalized U.S. commercial fishing industry.

Respectfully,

Ned A. Ostenso
Director

Enclosure

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EXECUTIVE SUMMARY

Recent legislation has provided the U.S. commercial fishing industry with a unique opportunity to capture a larger part of the sustainable wealth of living resources within our Fishery Conservation Zone. Reduced imports and increased exports of fish and fish products is an attainable national goal.

During the study the educational needs and opportunities of the commercial fishing industry, at this time of expanding activity, were examined. The results indicate that a modest expansion of existing educational programs is warranted.

New or upgraded fishery educational programs needed by the U.S. commercial fishing industry to meet this opportunity are of three kinds:

- Vocational-technical programs primarily to improve the practical knowledge and skills of those already in the industry.

- Associate degree programs to educate and train new entrants into the industry and give them a background for further education to the bachelor level and beyond, if they desire it in the future.

- Bachelor through doctoral degree programs to produce fishery industry specialists to be the new wave of teachers, researchers and industry representatives.

An educational infrastructure needs to be created in the United States to achieve these goals. The infrastructure should include programs at all educational levels and should give first priority to the vocational-technical training of adults already in the industry and to associate and higher degree programs for new entrants into the industry.

At present there are a relatively few associate degree programs closely related to the real needs of commercial fishermen. Bachelor and post-bachelor programs do exist in some of the specializations such as marine economics, law fisheries biology, aquaculture and seafood technology. Both the strengthening of and creation of new programs and facilities should be considered.

A new emphasis on fishery educational programs will not solve all of the multifaceted problems of the industry. However, without an adequate educational infrastructure the U.S. fishing industry will not be able to employ increasingly sophisticated ships and equipment in the internationally competitive struggle for the food resources of the seas. Most importantly, we believe that such an educational infrastructure will help promote badly needed vertical integration in education and training programs for the industry.

Therefore, in addition to educating the public about the industry and its products, and an expanded emphasis on vocational-technical programs for adults already in the industry, additional funding must be provided:

- to create or upgrade at least one associate degree program on each of the three coasts -- Atlantic, Pacific and Gulf.

- to create or upgrade at least two departments or schools of commercial fisheries, one on the Atlantic and one on the Pacific coast, which will offer bachelor and higher degree programs.

- to provide an integrated, three-tiered educational system (vocational-technical, associate degree and bachelor or higher degree) which facilitate re-entry at any time.

- to build a flume for fishing-net demonstration and research purposes at one of the advanced-level fisheries departments or schools and to establish a fishery electronics research and demonstration facility at the other.

Sea Grant alone can not attempt to answer all of the questions listed in the U.S. Senate request for the study. For example, if a decision is made to assist in creating or upgrading the program and facilities of only one associate degree institution on each of the three coasts then the choice of institutions should not be made by Federal fiat. The public, state legislatures, faculty members and fishery interests should be represented in an intense discussion and competition for designation of any of the associate degree institutions to be upgraded. Such discussions and competition should result in programs with a better benefit-cost ratio than if only the Federal Government undertook the task.

However, it is clear that the educational efforts called for in this report are beyond the interest and funding capability of a single state. This is due in part to the fact that a high percentage of the students enrolled in these programs will come from states other than the one in which the institution is located. Federal funds will be needed on a continuing basis to provide a significant base for new or upgraded programs.

The Senate request also raised the issue of a suggested curriculum for each educational program determined to be necessary. General curriculum recommendations are discussed in the report. However, specific curriculum elements for each type of program are not specified. These decisions have been made traditionally by local faculty: such a faculty planning function is recommended for new or upgraded fishery educational programs. Ideally, the resulting programs should allow students to reenter as their need for additional formal education develops and provide a good working relationship between the vocational-technical or associate degree programs and the higher degree programs.

We recommend that only state and private institutions be considered as the location for new or upgraded fishery education programs. Federal institutions and Federal faculty were considered unnecessary and undesirable.

The attached report is presented in six chapters plus appendixes. Chapter One discusses the current status of the U.S. commercial fishing industry in terms of numbers of fishermen, craft and vessels, import/export ratios and published comments on educational needs of the industry. Educational efforts of some of the successful foreign fishing nations are discussed in Chapter Two. Chapter Three provides a description of existing associate degree programs, their strengths and limitations, as a basis for discussion of the higher education programs needed to ensure the long-term health of the industry. Chapter Four contains a discussion of educational programs as they relate to projections for technological innovation and employment potential of a strengthened commercial fishing industry. Specific recommendations for instituting or upgrading associate and higher degree programs are made in Chapter Five. A summary of the report and its conclusions are found in Chapter Six.

PREFACE

In recent years the United States commercial fishing industry has undergone dramatic change both in technological sophistication and in its political, economic and regulatory environment. Accordingly, there has been increasing concern about the adequacy of the essentially laissez-faire education and training structure of the industry. The need for a more coherent and substantive national approach to fishing industry education and training has been addressed in proposed Federal legislation and by the U.S. Senate request for a study of the needs for new programs to educate and train domestic commercial fishermen.

In response to this request from the Senate, the Office of Sea Grant formed a study group to consider the educational needs of the U.S. commercial fishing industry. Members of the Study Group and Conferees, listed in Appendix A, were drawn from all levels of post-secondary education, all parts of the industry, Marine Advisory Services and national offices of the National Marine Fisheries Service and the National Sea Grant College Program.

The charge for the study Group was explicitly expressed in the conference report of the National Sea Grant Authorization Hearing, 1978:

> "<u>Fishery Revitalization Study</u>
>
> During the course of the hearing, discussion was held on which topics should be studied under Sea Grant's national projects research program. One issue received particular attention: the need to modernize the skills of U.S. commercial fishermen. The committees made the point that as commercial fishing technology becomes more sophisticated, U.S. fishermen need advanced training similar to that provided to the fishermen of other nations.
>
> As a result, the committees wish the National Sea Grant Office to conduct a comprehensive study of the need for and options regarding new programs to train domestic commercial fishermen. The study is to be submitted to the Committees by January 1, 1979. The study is to analyze and make recommendations regarding all aspects of this issue, including but not limited to the following:
>
> National, regional, and state costs and benefits that accrue as a result of establishing programs and centers responsive to this need;
>
> The substantive content and curriculum for such programs;

Alternative institutional arrangements at Federal, State, and local levels to administer such programs and centers; and

The most desirable geographic distribution of such programs and centers throughout the United States.

The committees believe that this effort is important and that the Sea Grant program is uniquely qualified to undertake a study of this kind."

Because of the magnitude of this assignment and the timetable for reporting, the Study Group concentrated on the broad spectrum of undergraduate and graduate educational needs of the U.S. commercial fishing industry. In addition, there was some discussion of how a new or improved educational structure to serve the needs of entrants into the industry might also benefit those already working in the industry. Group members were well aware that fishermen represent only one segment of a complex and important industry which has diverse educational needs at many levels and were acutely sensitive to the sad fact that few solid data exist upon which to build a quantitative foundation for this study. Accordingly, extrapolation had to be made for limited data, anecdotal reports and foreign examples. Validity of the study is most related to the massive accumulated experience and diverse background of the many people who generously volunteered their time to its development.

ACKNOWLEDGEMENTS

The National Sea Grant College Program appreciates the cooperation of those who accepted the invitation to participate in the meetings of the Study Group or in subsequent discussions with the author of this report. These individuals gave freely of their time and effort in the hope of benefitting the U.S. commercial fishing industry.

In addition, Dr. Roland Smith and Mr. William Hannum, National Marine Fisheries Service (NMFS) and Dr. Virgil Norton, University of Maryland, discussed the nature of the study with National Sea Grant College Program representatives. During the Study Group's second meeting, Captain Roger Motte, Head of Ocean Science, Plymouth Polytechnic, Plymouth, England, and Captain David B. Thomson, Senior Fisheries Extension and Training Officer, U.N. Food and Agriculture Organization (South China Sea Program), presented information on overseas fishery education programs and also participated in some of the subsequent discussion. Svernir Cunnlaugsson, Counselor, Embassy of Iceland translated printed materials and discussed Icelandic fishery education programs with the author.

This report of the Study Group, supplemented by references to the published literature and solicited personal communications, was written by Dr. Warren E. Yasso on special assignment to the National Sea Grant College Program from Teachers College, Columbia University. A few paragraphs of the text were edited from contributions of Study Group members. Other contributions are included in the appendixes.

The cooperation of those who read and commented on this report is also hereby acknowledged with gratitude. Such comments have led, through a series of revisions, to an improvement in the final text. However, the author has mainly attempted to reflect attitudes and opinions of a majority of members of the Study Group and the conferees listed in Appendix A. Many knowledgeable persons from outside the Study Group, who read a late draft of this report, have expressed opinions ranging from substantial agreement to substantial disagreement with the conclusions and recommendations of the Study Group. It is not surprising that there should be diversity of opinion on an issue as complex as the educational needs of the U.S. commercial fishing industry, especially in view of the dearth of solid supporting data. Therefore, it was gratifying to find wide, albeit non-universal, support for conclusions contained herein.

Chapter I

INTRODUCTION

In 1975 there were 260,323 persons employed domestically as fishermen, processors or wholesalers. In the same year, 103,194 craft and vessels were used in the domestic commercial fishing industry of which only 16,211 were vessels over five net tons (National Marine Fisheries Service, 1979). Processing and wholesaling were carried out at 3,606 shore establishments, three-fouths of which were in Atlantic Coast and Gulf states.

Between 1968 and 1978 exports of domestic edible fishery products increased to reach a record weight of 203,778 metric tons (448 million pounds) and a record value of $831.7 million in 1978. When nonedible fishery products are added, the total export value increases to $905.5 million also representing a record. Over 35 percent, or 71,947 metric tons (158 million pounds), of the record export of edible fishery products is accounted for by various forms of salmon. These represent about 39 percent of the export dollar value of edible fishery products.

United States imports of edible fishery products in 1978 totaled 1,100,348 metric tons (2,421 million pounds). This was a record import weight of such products and its $2.275 billion value also set a record. Adding import of nonedible fishery products also establishes a record total value of $3.099 billion. Tuna represent the largest weight of any single fish product import amounting to almost 36 percent, 390,919 metric tons (860 million pounds), of the edible import total. However, shrimp represent the largest value of any single fish product import amounting to 18.5 percent, $421.7 million, of the edible import total.

Commercial landings by U.S. fishermen amounted to about 2.74 million metric tons (6.1 billion pounds) live weight in 1977. Landing weights are roughly equally distributed among the Atlantic, Gulf and Pacific Ocean regions. Great Lakes and other inland landings total only about 7 percent of the average for the larger regions. However, the foreign catch within the U.S. Fishery Conservation Zone (F.C.Z.) amounts to an additional 1.754 million metric tons.

It is generaly assumed that 9 to 18 million metric tons (20-40 billion pounds) of fish are available, on a sustained basis, from the U.S. F.C.Z. (U.S. Department of Commerce, 1976). The U.S. F.C.Z. is the largest of any nation. Within it are an estimated one-fifth of the world's living marine resources (U.S. Department of Commerce, 1976). Thus, improvement of the U.S. capability in commercial fishing is needed not only to reverse the trend of U.S. fish product imports but also to tap the potential wealth within the U.S. F.C.Z. The situation is in the U.S. Department of Commerce report cited above:

> "The U.S. commercial fishing industry has before it opportunities to reach new levels of production and to expand further its already significnt contributions to the Nation's food supplies and economy. For the nation as well as for the industry, the prospects deserve urgent attention."

Many reports have dealt with the complex scientific, political, economic and sociological interaction needed to improve the U.S. commercial fishing industry. A report to the Congress by the Comptroller General of the United States (1976) suggests four basic actions to strengthen the industry:

"a. Restoring fish stocks through effective management and improvement of the environment;

b. Developing underutilized species;

c. Displacing foreign fishing in the U.S. F.C.Z.;

d. Increasing the efficiency of harvesting operations and overcoming barriers to processing, marketing and distribution."

In addition, the Atlantic States, Gulf States and Pacific Marine Fisheries Commissions (1977) recommended an improvement in information quality and flow to industry, and public and education programs. The first four educational needs identified were:

"a. preparing retailers and merchandisers to properly handle and display products;

b. consumer education programs to promote use of all types of seafood;

c. education of commercial fishermen about finance, taxes, loans and establishment of cooperatives;

d. on-the-job training programs for entrants into commercial fishing, in supporting fields such as: welding, refrigeration, navigation and hydraulics."

The importance of these suggestions is illustrated by the following excerpt from a U.S. Department of Commerce report (1976):

> "Food products must be wholesome, safe for consumption, and

of a quality that encourages consumer interest and confidence. Because fresh fish spoil more rapidly than most other foods, the quality of fisheries products, and consequently their acceptance in the market place, is often highly variable and should be improved. The growing variety of species available and of processes for converting them to products for retail consumption, calls for improved labelling to better inform consumers."

While not denying the need for the educational efforts listed above, the Study Group recognized the need for fishery education programs at all academic levels. Included in such programs would be public education about fish, fishing, seafood processing, marketing, seafood nutrition and preparation of meals containing seafood products, as well as vocational-technical and workshop training for those already in the industry. For the long-range health of the U.S. fishing industry, the educational system should provide more extensive formal training for fishermen and seafood processors and also should produce a new breed of commercial fishery specialist. A consensus of the Study Group was that the U.S. system of higher education is not now capable of turning out such a coherent spectrum of talent. The new term, "commercial fishery specialist," is an umbrella designation covering many fields of expertise within the commercial fishing industry: education, management, technology, law and so forth. These specialists would be most useful to an industry which is increasingly becoming more vertically integrated. The Study Group does not denigrate existing undergraduate and graduate programs in such fields as ocean law, economics and fishery biology. Rather, the desire is to state that considerable innovation in staffing, structuring or restructuring of degree programs and building of new facilities is needed before the U.S. commercial fishing enterprise can be best served by an integrated educational system that addresses commercial fishing in its entirety as a complex industry.

Chapter II

INTERNATIONAL PERSPECTIVE ON FISHERIES SCHOOLS AND PROGRAMS

This section contains a brief survey of the literature on foreign schools and programs. The appendixes contain more detailed reports on foreign programs prepared by, or at the urging of, members of the Study Group.

The basic question is whether foreign nations, with demonstrable success in fishing, have developed unique programs that might serve as models for adaptation to the U.S. system of education. From the information in reports discussed in this section and in associated appendixes it appears that the foreign programs rely on the type of formal educational system familiar to all Americans. However, the age at which students are sensitized to the fishery industry, types of training programs by student age and degree/certificate expectation and upward mobility through schooling are all related to the obvious political, social and economic environment of each nation.

U.S.S.R.

An overview of the Soviet fishing industry is provided by Kravanja (1976). From a dominantly coastal marine fishery prior to the early 1950's, the Soviet Union now has the world's largest distant-water fishing fleet. From 1950 to 1975 the total catch increased from 1.7 million to 10.3 million metric tons. During that time the estimated number of Soviet fishermen has remained constant at about 250,000 as the fishing industry shifted from a labor-intensive to capital-intensive development. Capital investment grew from a yearly average of $2.9 million in 1940 to $1 billion in 1975.

Expansion of Soviet fishing has required a highly skilled labor force provided through government recognition of fisheries workers as professionals and development of an effective system of fishery secondary schools and universities specializing in fisheries education and training. Sensitization to fisheries development and occupations begins in primary schools where some field trips and other programs emphasize the fishing industry and fisheries biology. In addition Soviet fishermen are relatively well paid, enjoy long vacations, live a comfortable life aboard ship and enjoy other special privileges such as foreign travel.

There are basically four types of fishery schools which provide education and training:

1. Fishery Trade School (non-diploma) - seven schools accept eighth grade graduates who become skilled, low-paid workers after one, two or three years of training.

2. Specialized Secondary Schools - called the mainstay of Soviet fisheries education, 25 schools train captains, navigators and other officers for either high seas or coastal and inland fleets.

3. Higher technical and engineering institutes - equivalent to U.S. colleges, these six institutions accept a relatively few secondary school graduates to become top-level economists, gear designers, planners, managers or engineers.

4. Schools for improving the qualifications of fisheries personnel - these are actually education programs, to upgrade and update skills of medium to upper echelon personnel, given in enterprise training centers for the secondary and higher-level institutions.

Approximately 61,000 were enrolled in 31 Soviet secondary and higher level fisheries schools in 1975. About half of these were enrolled in correspondence courses while working full time in the fishing industry. About 10,000 students graduate from the system each year. All but three of the schools are located in proximity to lake or ocean waters.

An estimated 2,500 to 3,000 full time faculty members serve the needs of students. Therefore, student/faculty ratio appears to be about 20 or 25 to 1 on an overall basis. However, if only full time students are considered then the ratio drops to a number more in line with that discussed later in this report. Average annual per capita student cost to the Soviet government is $1,050.

JAPAN

Japan is considered one of the countries where "institutionalized vocational training has reached the highest level of development" (Cole and Hall, 1973). Colleges for fishermen have existed in Japan since the 1890s. The Japanese system is used as a model for nations desiring to make fishing of major economic importance. Educational alternatives are available at all levels of instruction but early specialization is required of students.

Senior fishery high schools accept students at about age 15 for courses lasting about three years. Seven specializations are offered:

Fishing operations

General fisheries

Fisheries management

Fish processing

Fish culture

Marine engineering

Radio and electronics

Those completing such basic specialization enter the industry at the deck-hand level or equivalent. However, the schools also offer postgraduate work of professional level which involves students in an additional academic year of classroom instruction followed by one year on a training vessel and six months on a commercial vessel. Those who complete the postgraduate course qualify as first-class second navigator or engineer.

There are 60 senior fishery high schools in Japan, ten of which offer evening classes. In the early 1970s, total student enrollment was 60,000 of which about 750 were postgraduate trainees. Most of the schools operate their own trainig vessels.

At the next higher educational level are the two fishery colleges which continue a tradition begun in 1890s. About 1,500 students are enrolled in all programs which are dominantly of a practical nature: one-third of the courses are general; the remaining two-thirds are specialized. A one-year postgraduate course leads to a Certificate of Competency in seamanship. A two-year course in advanced fisheries subjects leads to an M.S. degree. Fish culture training stations, field biology laboratories and training vessels are operated by the colleges.

Those who wish to pursue a career in fisheries research complete an academic training available at about 16 other universities. A more detailed account of Japanese fisheries high schools and the two universities of fisheries is given in a report by J. Doyle (Appendix C).

In addition to reseach facilities at the academic institutions, there are "Nine national fisheries research laboratories and a network of 80 prefectural experimental and branch research stations (which) conduct extensive research programs on fishing, marine biology and other oceanography areas" (Comptroller General, 1976).

In recent years the Japanese fishing industry has declined in importance. In 1971 Japan became a net importer of fish products. Because of an absolute decrease in its productivity growth rate and decrease relative to other industrial sectors, the gross value of fishing industry output represented only about one percent of Japan's 1973 gross domestic output. However, the fishing industry remains a major economic factor in that it provided about 50 percent of the animal protein consumed in Japan in 1973 (Comptroller General, 1976). In contrast, fish products account for only about 5 percent of animal protein consumption in many western nations.

Support for the Japanese fishing industry comes from its government through the Fisheries Agency of the Ministry of Agriculture, Forestry and Fisheries. In 1976 the Fisheries Agency had an operating budget of $472 million with an additional $637 million earmarked for insurance programs, loans, and investments (Comptroller General, 1976).

Among the recent programs designed to aid the fishing industry are long-term, low-interest loans to:

-- reduce debt of fishing companies

-- reduce overcapacity of the tuna fleet

-- help with higher fuel costs

A similar loan program to stabilize domestic fish prices began in 1976.

GREAT BRITAIN

Prior to 1973 no bachelor's degree program for fishery science existed in Great Britain. However, in that year the Council for National Academic Awards approved a four-year course at Plymouth Polytechnic, Department of Maritime studies, leading to a B.S. in Fishery Science. Entrants must have high academic qualifications and extensive maritime experience as evidenced by a Certificate of Competency as Master, Skipper, or Mate.

The curriculum at Plymouth Polytechnic is a three-part academic program interrupted by two 26-week (average) work experiences in the fishing industry. Main objective of the program is to turn out graduates who can assume duties such as:

-- development officers with research teams

-- operations managers of fishing fleets

-- command of trawlers

-- management posts in trawler companies

-- advisors to operations and design criteria

-- management posts in fish farming

-- advisors to overseas governments, particularly those with development programs

-- processing, marketing and distribution

-- research and development posts

A full time equivalent faculty of eight professors service the program which has about 150 students.

In 1971 the Grimsby College of Technology instituted a diploma course in Fisheries Management within its Department of Maritime Studies and Fisheries. The program was built around head-of-department and six subject tutors. It is designed to train well-qualified entrants for posts as senior administrative and management officers of a fishery.

A recent innovation which combines research capability and fisherman training is the flume tank at the Fisheries Training Center at Hull, England. The Center was constructed with funds from the White Fish Authority, a government agency samller than, but somewhat like, the U.S. National Marine Fisheries Service.

Cost of the Training Center and flume was about $700,000, not including the land, which was donated. It should be noted that most of the classroom instruction takes place nearby at the Nautical College in Hull where the Fisheries Training Center offers a range of short, practical, but highly specialized courses for fishermen. Two courses, each of five days duration, make use of the flume tank which is the largest of its kind in the world. The flume is a reinforced concrete tank 31 meters long, 5 meters wide and 5 meters deep with a water recirculating system that can simulate trawling at speeds up to 2.25 meters per second (4.5 knots). In it, scale models of trawls and other fishing gear are demonstrated. The courses are free to British fishermen but also available to foreign nationals on a fee basis. One American skipper-owner who took the five-day course, titled "Fishing Gear Technology for Distant Water Fishermen," was reported to have said"...I think I have learned more here in five days than in 20 years at sea." (Wray, 1978)

NORWAY

From an emphasis on vocational schools closely oriented to preparing students for specific fisheries occupations the focus is now toward an open ended system that allows progress toward a university degree.

In mid-1978 a fifth government-supported training school for fishermen was opened. The school, located south of Bergen, has a faculty of eight and a maximum student enrollment of 70. Any

Norwegian who has completed the nine-year primary education program is eligible to apply for the two-year training program to receive a fishermen's ticket. While at school the candidates receive free board and lodging as well as travel expense for holiday trips back home (Fishing News International, 1978a).

The first year of the program centers on such courses as basic science, fishing gear, nautical subjects and fish finding equipment, catch techniques and fish handling. A candidate spends the second year aboard a fishing boat doing supervised work. As an alternative to the two-year formal training program a fisherman's ticket is available to those who have successfully completed three years as a working fisherman.

Those desiring a fishing boat skipper's certificate must pass an examination after completing a second year of supervised practice and an additional year of course work.

A more detailed overview of Norwegian fishing education programs in primary and secondary schools, special vocational schools, universities, technical schools and adult education programs, prepared for this study by P. Heggelund, can be found in Appendix D.

TAIWAN

Taiwan has one university and two colleges that offer four-year education programs in commercial fisheries. Such programs graduate about 120 student annually. There are four commercial fisheries programs at the junior-college level which graduate about 500 students annually. An additional 500 students graduate annually from the five vocational schools which offer pre-college training for commercial fisheries. Most schools at all levels offer separate programs for fisheries technology, marine engineering, aquaculture and seafood technology. Schools at the pre-college and junior-college level also train skippers for inshore work boats whereas schools at university and college levels also train merchant marine officers.

Costs of the educational programs are difficult to assess because of government subsidization and relatively low wages of faculty (approximately $100 to $200 a month). Taiwanese students for associate and bachelors' degrees pay tuition of about $1,000 a year; vocational school students pay tuition of about $30 a year (David Kan, personal communication).

In addition to the formal education programs, there is also an upgrading program for fishery workers. A pre-college graduate can reach the same level of accomplishment as a two-year or four-year college graduate by credited work experience on fishing vessels and by taking correspondence courses or by passing examinations. The National Oceanic University has five research centers, four colleges and fifteen departments in fisheries and related maritime sciences. New fishing technology is introduced to the fleet through the fisheries services and research centers.

For captains of fishing vessels under 30 meters (100 feet) licenses are not required; most of the captains are fishermen without formal training. The fisheries program in Taiwan is strong because most of the schools offer several choices of major study thereby allowing more efficient use of faculty members. The success of the programs also benefits from easy access to employment for pre-college and junior college graduates.

Experience with fisheries training in Taiwan indicates that the grass roots of commercial fisheries training is at the pre-college and junior college levels. The four-year college program graduates tend to take shore jobs or merchant marine jobs rather than employment on fishing vessels.

ICELAND

Fishing and fish processing combine to form Iceland's major industry. In recent years there has been an increase in the stern trawler fleet. The new, European built ships are more efficient than the side trawlers they replaced. They can be worked by crews of 16 rather than the 25 or 30 needed previously. Boatbuilders have also developed combination trawler/purse seiners and trawler/long liners that are of interest to Icelandic fishermen (Fishing News International, 1978b). Three 45 meter (225 ft.) trawler/purse seiners were added to the Icelandic fleet in late 1977. They have the most modern electronic and hydraulic equipment including bow and stern thrusters of 400 horsepower each (Fishing News International, 1978c).

Because it is so widespread and vital there is a pervasive national interest in all aspects of the industry. A majority of Icelanders have friends or relatives whose incomes derive from the industry. Therefore, Icelandic youth have a continually reinforced sensitization to the industry. Fish processing plants offer summer employment to school and college youth. Girls somewhat under 16 years of age can work in the processing plants. They are restricted, however, to jobs that do not require the high productivity for which older workers are paid bonuses (Glen, 1975).

Iceland has compulsory education for youths age seven to 16. During the past few years significant changes have occurred in educational options open to graduates of the compulsory program. Many of these options are innovative and experimental. Students wishin an academic training attend four years of junior college until age 20. They may then continue four years of either university or teaching training. If, instead, they leave junior college after two years they can choose from a wide variety of two or three year vocational-technical programs in physical education, nursery school teaching or nursing and technician level preparation for the health care professions.

Students who complete the compulsory program also have the option of transferring into business and technical programs. Most of the fishery-related specializations are found in such programs which are of three to seven and one-half years duration. Specializations include four year programs in fish processing plant inspection, marine engineering and navigation. Navigation school requires one year of work training prior to admission.

The Iceland Technical School offers training for managers of fishing fleets and fish processing plants. This programs yields the equivalent of a bachelor degree. Graduates of the compulsory program are required to have two year of work training prior to admission. On entering they take one year of preparatory courses, a year of basic sciences and then three and one-half years of specialized courses. A graduate of junior college may enter to take only the three and one-half year specialization.

PRODUCTIVITY OF FISHING FLEETS AND EDUCATIONAL IMPLICATONS

Having examined the fishery education system in selected countries, it is necessary to ask whether or not there is detectable correlation between a nation's educational effort and its productivity.

Quantitative Measure of Productivity

Only one attempt at quantitative ranking of the productivity of major fishing nations was found in the recent literature. This ranking system, based on gross register tonnage of a fishing fleet and the live weight of its yearly catch, is discussed in Appendix E. But, there are no comparative data available by which one can relate a nation's fishery education effort and either the short-term or long-term productivity of its fishing fleet. However, there seems little question that adding an appropriate level of education and training can improve the productivity of individual fishermen and fishing boats. Experiences that support this assertion are reported in the next section and in Chapter Four of this report. The most important aspect of these educational programs is, unfortunately, also the most intangible to assess. That is, in addition to improving the technical skills of participants in the individual facets (catching, ship handling, processing, etc.) of commercial fishing, the degree to which these facets are integrated to provide individuals with an educational background in all phases of the industry's operations is vital.

Qualitative Measure of Productivity

Professor A. Holmsen, University of Rhode Island, (personal communication) talked with two crews whose vessels, with similar diesel power plants, became disabled at sea. One crew was able to disassemble the engine, diagnose the problem, and communicate with shore about specific replacement parts that were needed. This vessel lost only one day of fishing time whereas the other vessel, whose crew lacked requisite training in diesel engine repair, lost three days of fishing time. Thus, a course in diesel engine maintenance might have made the second crew more efficient and productive.

Beyond the skill level discussed above, Holmsen also cites examples of vessel skippers whose knowledge of fish behavior, technological aids, and market conditions results in higher return on capital investment than that for less well educated skippers.

Although no unique definition of productivity is offered here, the concepts of productivity and efficiency can be combined to suggest that a crew which is able to harvest more fish of a given species in a given time using the same type of equipment as another crew is the more productive. From an economic standpoint the produtive crew would know which species to fish for at a given time and with what equipment in order to maximize the return on investment.

The knowledge necessary to achieve such productivity can be obtained through the generalization of practical experience and through appropriate research and training efforts. Certainly such knowledge can be transmitted, aboard ship, on a one-to-one basis from the possessor to the apprentice. But, when those possessing relevant knowledge, or the ability to acquire it, are relatively few and those desiring it are many then our society has found it best to institutionalize the transmission of the knowledge. The hazards and complexity of commercial fishing operations also weigh against the use of untrained personnel aboard ship. For example, Captain Richard Champlin believes (personal communication) that because of the intense operating conditions aboard Rhode Island commercial fishing boats it is unrealistic for him to hire raw apprentices for on-the-job training. In contrast, he welcomes graduates of recognized commercial fishery education programs as fully functioning and fully paid members of his crew. In a similar vein Charles McLeod comments (personal communication) that equipment aboard a modern fishing vessel and fishing technology is too advanced for use of apprentices as on-the-job trainees. He believes that an associate degree in commercial fishing is a reasonable prerequisite for the new generation of career fishermen. He predicts that future New England fishermen will be heading further offshore in larger and more sophisticated boats. This will require people with appropriate knowledge and skills.

Assuming that a more modern and efficient U.S. commercial fishing fleet would increase productivity over the present, what are the educational consequences of creating such a fleet? As will be discussed in Chapter IV of this report, the creation of such a fleet implies the availability of well-trained pesonnel to operate the vessels and gear. Therefore, the need for more and better formal education programs for fishermen and women is a natural consequence of the desire to increase productivity and safe operation of the U.S. fishing fleet.

Chapter III

SURVEY OF FISHERY EDUCATION IN THE U.S. AND ITS POSSIBLE FUTURE DIRECTIONS

Secondary School Feeder Program

When considering initiation of new fields of study in college or universities, or even expansion of existing studies, the question of supply of students must be addressed. Fisheries sciences and seafood processing technology are relatively new fields of study in U.S. college curriculum. Applicants to associate degree programs are usually interested in career opportunities. Applicants to four-year colleges are usually interested in major and minor fields of study. Those who have no firm feelings about their major/minor fields of study can, theoretically, make such decisions in their sophomore year. However, in most cases, the reality is that those who early identify major/minor fields of study tend to get better advisement and make more rapid progress toward a degree. It is assumed that such ability to specify major/minor is related to a complex set of variables among which are life goals, parental desires, available curriculum and sensitization to fields of study through courses taken in secondary schools.

Therefore, exposure to such high school courses as oceanography, marine biology, fisheries, ocean resources and ocean environment might sensitize students to college studies of fisheries and seafood processing. In Great Britain, for example, a special effort was made by the Hull Fishing Vessel Owners' Association to inform every secondary school student in the North of England about careers in the trawler industry (Fishing News, 1974).

It is assumed that large-scale exposure of secondary school students to such courses might, because of student interest and job potential, create pressure for expansion of existing programs at colleges having the capability to offer fisheries/seafood processing major/minor coursework. Does the secondary school curriculum across the nation currently offer the hope of sensitizing students to such college-level programs?

To answer this question a brief survey was undertaken by the National Sea Grant College Program. Data gathering procedures, raw data and data analysis are presented in Appendix F. In the eight states listed there were 1.47 times as many students enrolled in secondary-level oceanography courses in the 1977-78 school year as compared to the 1972-73 school year. Projected to the entire nation this suggests a total of about 68,000 students enrolled in such courses during 1977-78.

Therefore, many more students than in the past are being sensitized to marine-related topics including fish behavior and fishery resources. Those who are sensitized to fishing industry careers, through secondary-school coursework, but who have little immediate access to entry-level positions in the industry, might be motivated to pursue associate and higher-level college programs as preparation for future employment. Even specialized high schools should not be considered as an alternative to higher degree programs for training entry-level personnel. This general opinion among commercial fishermen is typified by the remarks of Captain Milford Johnson (personal communication) who believes that a career in commercial fishing requires post high-school preparation.

Associate Degree Program

A relatively few associate degree programs are available in the United States for the training of fishermen. One of these programs is offered by the Department of Fisheries and Marine Technology at the University of Rhode Island (U.R.I.). Prior to the begining of the U.R.I. Program it was recognized that the only established school educating technical personnel and fishermen in North America was the College of Fisheries, St. John's, Newfoundland, Canada. The U.R.I. program is strongly related to the actual needs of deepwater fishermen. Its current curriculum is given in Table 1.

TABLE 1

ASSOCIATE DEGREE PROGRAM OF THE DEPARTMENT OF FISHERIES AND MARINE TECHNOLOGY, UNIVERSITY OF RHODE ISLAND

First Semester		Credit Hours
ENG 113	Composition	3
FMT 013	Shipboard Work I	2
FMT 101	Shipboard Safety	3
FMT 118	Intro. to Comm. Fisheries	3
MTH 109a	Algebra and Trigonometry	3
REN 135	Fisheries Economics	5
Second Semester		
FMT 014	Shipboard Work II	1
FMT 110	Marine Technology	4
FMT 121	Fishing Gear I	3
FMT 131	Seamanship	3
SPE 101	Fund. of Oral Communications	3
- -	General Education Elective	3

Third Semester

FMT 235	Fisheries Meteorology	2
FMT 241	Diesel Engineering Tech.	4
FMT 261	Marine Electronics	4
FMT 281	Navigation I	4
FMT 293	Fishing Operationsl Practicum	1
FMT 351	Fish Preservation	3

Fourth Semester

FMT 222	Fishing Gear II	3
FMT 242	Fluid Power Technology	4
FMT 371	Ship Technology	4
FMT 382	Navigation II	4
FMT 393	Fishing Operations	3

The U.R.I. Program may be used as a model for emerging programs as might other schools, such as Clatsop Community College, Astoria, Oregon which have also achieved success in fisheries training (National Fisherman, 1976).

The associate degree program began at the University of Rhode Island's Department of Fisheries and Marine Technology in 1967. There were 108 graduates of the program through the class year 1976. Motte and Merdinyan (1977) estimate that 96 percent of the graduates experienced continuous maritime employment subsequent to graduation. Table 2 lists data on employment category for the 71 graduates actually interviewed.

TABLE 2

EMPLOYMENT CATEGORY OF UNIVERSITY OF RHODE ISLAND ASSOCIATE

DEGREE GRADUATES, 1969-1976, (DATA FROM MOTTE AND MERDINYAN, 1977)

Employment category	Number of Respondents	Percentage of Respondents
Captain/Owner	11	15
Captain/Non-Owner	7	10
Fist Mate	17	24
Engineer/Cook/Deck Captain	20	28
Ordinary Deck Hand	16	23
TOTALS	71	100

A mean position somewhere between engineer and first mate is considered by Motte and Merdinyan as the expected level of employment after a mean of 2.33 years actual on-the-job experience after graduation. Additional years of employment should raise the level of accomplishment.

The University of Rhode Island program was credited by respondents with providing the major portion of fishing knowledge in contrast with only small contributions from father/relatives or practical experience. The average respondent also felt that formal training had provided a three- to five-year lead over someone seeking to become a fisherman through practical experience alone. Additional coursework had been taken by 46 percent of graduates of the associate degree program. Captain James McCauley believes (personal communication) that the associate degree programs serve a dual function. They permit young people to enter the industry even if there is no family tradition of commercial fishing. And, they allow much more rapid progress to the rank of captain.

Bachelor's Degree Programs

In the U.S. undergraduate curricula leading to a baccalaureate degree in fisheries have evolved from the traditionally scholastic disciplines of zoology and biology, from the more vocationally oriented programs of wildlife biology and conservation and from the land-grant schools of agriculture and mechanics. These three different beginnings produced programs characteristic of their origins, but in time, each has been modified so that currently there are more similarities than differences.

A panel convened at the University of Washington (1968) to study the programs identified a poor fit between educational needs of fishermen and existing offerings. It suggested that the following segments be explored to service the needs of the entire fishing industry:

"1. technical training related to the catching process,

2. technical and managerial training related to the processing phase,

3. management and administration of the resource,

4. research by private, federal, state and university organizations,

5. research and training about fishery education."

In spite of the earlier efforts of a few to encourage initiation of baccalaureate offerings, no four-year programs leading specifically to a bachelor's degree in commercial fishing exist in the United States. Therefore, a whole range of more advanced courses is being denied to those, like graduates of the

University of Rhode Island Associate Degree program, who desire increased formal training in the industry. The captain/owner needs extensive knowledge in many disciplines. Leonard Stasiukiewicz, a Certified Public Accountant and manager of the Point Judith Fisherman's Cooperative, states (personal communication) that the captain/owner should have college level knowledge of personnel and group psychology and business economics. This is especially true for captains/owners who are members of fishery cooperatives where complex business decisions are made by and for the group. Lewis Roberts suggests (personal communication) that a common pattern is for bachelor-level programs to provide theoretical courses to round out the applied coursework given in associate degree programs.

An outline of general subject categories, relevant to a four-year program, compiled by J. Doyle (personal communication), is given in Table 3.

TABLE 3

OUTLINE OF A BACHELOR'S DEGREE PROGRAM IN COMMERCIAL FISHING

General Subject Categories:

I Humanities
II Social Sciences
III Basic Science
IV Technology

Examples of Courses Within Categories:

I Humanities
- Communication

II Social Sciences
- Maritime and Fisheries Law
- Business Management
- Food Marketing and World Market Structure
- Accounting and Tax Law
- Economics

III Basic Science
- Algebra and Trigonometry
- Analytic Geometry
- Calculus
- Statistics
- Chemistry (including organic and quantitative analysis)
- Physics
- Zoology
- Oceanography

IV Fishing Technology
- Fisheries Navigation
- Fish Behavior
- Fisheries Oceanography
- Fishing Grounds
- Fisheries Engineering (including hydraulics, diesel mechanics, electronics and refrigeration)
- Processing Technology
- Fisheries Biology
- Fish Stock Management

Graduate Degree Programs

Graduate training can provide fishery specialists, including teaching faculty and researchers and top-level administrators within the industry or in governmental agencies. Whether justified or not, one of the frequent complaints by fishermen is that fishery researchers and governmental administrators have little knowledge of the overall industry and especially of the needs of fishermen. Therefore, fishery specialist graduates of the new programs would fill a clear need.

One example of program needs is given by Professor William Swensen (personal communication) who believes there is a present and future need for extension agents who have graduate training in population ecology combined with practical experience in commercial fisheries. Some of the Conferees, with whom contents of the report were discussed, believe that future managers of fish processing and distribution operations will come from innovative graduate programs in such areas as environmental law, environmental engineering, marketing and marine economics.

Advanced Specialized Programs

An advanced-level training program for fisheries biologists is offered by the U.S. Department of the Interior, Fish and Wildlife Service. The program is given at the Fisheries Academy, National Fisheries Center - Leetown, Kearneysville, West Virginia. The program "...was established to provide advanced or state of the art training to practicing fisheries biologists. Programs selected for development by the Academy are those which are ordinarly unavailable from other sources" (Rober E. Putz, personal communication).

Courses relating to commercial marine fishing problems are not now being offered or even considered by Academy planners. However, the Acadmey might be able to offer short courses, on a fee basis, in such subjects as estuarine ecology and environmental problems related to anadromous fish. Implementing such courses would depend on specialized needs of university-based graduate programs in commercial fisheries that might develop in the future.

Staff Requirements

Cole and Hall (1973) found that for all existing fishery education programs in the world, the overall ratio of staff to trainees was between one to seven (1:7) and one to ten (1:10). These ratios were fairly uniform across countries and across levels of instruction. They recommend a ratio of 1:10 for practical courses and 1:20 for theory courses. They recommend a general maximum of 25 hours instruction per week by each faculty member (Cole and Hall, 1973).

Even where short courses are given involving basic training for fishermen in the use of simple equipment, the instructor should have some amount of specialization. Cole and Hall (1973) state the obvious rule derived from all educational experience: "As a general rule, the higher the level of training the more highly specialized the staff should be." Therefore, efficient high-level instruction usually requires a highly specialized staff based in a relatively large institution. One of the problems in securing an improved educational program in the fishing industry is the availability of well-qualified faculty for associate and higher degree programs. Until graduate programs are in operation and turning out the next generation of faculty members there may be a shortage of qualified faculty--unless foreign nationals are brought in to staff the programs. Therefore, staffing requirements must be given serious consideration when new programs are being discussed.

Chapter IV

EDUCATIONAL INITIATIVES AND EMPLOYMENT POTENTIAL

The offshore fisherman pursues his craft away from the public view in what most land-bound people would consider an hostile environment. His tools for finding and capturing a source of food that swims in a dark, saltwater medium have no common analogs on land. Therefore, most land-dwellers have little idea about fishing and especially about fishing technology. This is well described by Sainsbury (1971):

> "To many eyes the methods and equipment used by fishermen appear crude and unsophisticated; in fact, so far as modern commercial fishing is concerned, the opposite is true in most of the world's important fisheries. Technology, sophistication, complexity and investment in vessels and equipment, together with techniques of finding and bringing fish to port, are showing rapid growth. Increasing investment in research and development is continually improving the efficiency of operation and conditions under which fishermen work."

The need for improved and available fisheries education must be based, firstly, on a belief that this education would produce a more efficient and safer harvester and processor. It should be based, secondly, on the reasonable hypothesis that it is more efficient to train such personnel in a formal education setting rather than on the job. It is recognized that, because of the complexity of modern fisheries practice, the "complete fisher" cannot be produced in the classroon. However, certain technologies and knowledge can be better imparted in a formal educational setting to workers entering fisheries as a profession. And, thirdly, new initiatives in fisheries education should be based on the realistic assumption that research and development efforts will grow around a new cadre of faculty employed in graduate fisheries education. Their presence in a research and teaching environment will foster the potential for U.S. creation of new technological devices for the fishing indusry just as faculty research has led to technological breakthroughs in other disciplines. The beliefs and assumptions listed above are discussed in the remainder of this chapter.

Technological Innovation and Transfer

Technology has made an impact on the navigation and fish finding apparatus found on U.S. commercial fishing vessels. However, a U.S. Department of Commerce report (1976) puts such innovation in perspective:

> "With a few notable exceptions the fishing industry has not responded to the remarkable advances in technology which

have occurred in the last 30 years. For example, blue crabs are still largely picked by hand; little mechanical handling is used on U.S. vessels. Opportunities exist to apply techniques established in other areas to sophisticated fishing strategies, to the speedier location and harvesting of fish, their mechanical handling on board and their processing into a wide variety of new and diverse products to supplement and expand the sale of traditional lines. Well designed technological improvements can not only increase productivity but increase the share in existing markets, while opening new ones to U.S. fishermen.

As new species are developed, modification and testing of new fishing gear will be needed. Shipboard handling and storage methods to maintain top quality must be determined for species which have not traditionally been taken. Freezing characteristics and new packaging requirements must be studied if quality is to be maintained throughout the marketing chain."

Many specific examples of need for technological innovation can be found in the published literature and in personal communications listed below. Charles McLeod (personal communication) describes a recent trip to Peterhead, Scotland during which he learned that Scottish fishing vessels equipped with bow thrusters are able to do purse seining in winds up to 88 km/hr (55 mph). In contrast United States purse seiners are limited to working in wind conditions less than 24 km/hr (15 mph). Further, he reports that Scottish fishery leaders feel that U.S. fishermen are 15 to 20 years behind their European counterparts.

Approximately 100 West Coast fishermen were asked about the adequacy of their gear (Office of Technology Assessment, 1977). The groundfish/bottomfish, gillnetters and trawl operators were the groups least satisfied with their gear. In addition to better gill and groundfish nets there is a need for development of a small-scale, multi-purpose, mid-water trawl and better equipment to freeze, handle and store fish aboard ship.

The electronic navigational and fish finding equipment found on modern fishing vessels costs more and is more complex that an entire fitted fishing vessel of a generation ago. Many present-day captains are not using their electronic equipment to its full capacity. It has been stated that in New England the electronic devices used to find schools of fish are generally not in operating conditions and, if operable, are often not used (A. Clifton, personal communication).

The captain or vessel owner generally receives minimal training in the use of a piece of equipment at the time of purchase. Additional training for captains and crews may sometimes be found at workshops conducted by manufactureres, the Marine Advisory Service, fisherman's associations and others.

Captains of active commercial fishing vessels generally express little interest in extension-type workshops. They claim that they do not have time for such activities and that workshops are often scheduled at inconvenient times for potential participants. Therefore, a key to upgrading the knowledge and skills of practicing fishermen may be a combination of extension agents performing shipboard instruction and availability of porperly scheduled, land-based workshops. Some of the knowledge and skills to be imparted may seem surprisingly basic to those outside the industry; yet the needs seem to be present in all geographic areas. For example, almost all of the commercial fishermen interviewed by the author believe that net mending and rigging instruction are badly needed. Captain Thomas Norris stated (personal communication) that only about one-half of the offshore trawler crews of his acquaintance were experienced enought to mend and adjust their nets.

One example of technological innovation is the recent adaptation of the twin trawl system for use in the Georgia coastal shrimp fishery. Such a system was pioneered by Gulf Coast shrimpers in the 1950's. They found many advantages in towing four small nets rather than two large ones. Benefits include less drag, larger net area and easier handling and repair of the smaller nets. However, the twin trawl system had to be adapted for use in shallow waters off the Georgia coast where the shrimp resource is located.

Redesign and testing of nets, trawl doors and rigging were performed by University of Georgia Sea Grant extension personnel with the cooperation of local commercial shrimp boat operators. Captain Ellis Phillips (F/V Miss Tonya) began using the system. Because of the his increased catch twenty other boat owners converted to the twin trawl system during the next several fishing seasons. Their catch increases of 30 to 100 percent have allowed rapid repayment of the conversion cost.

Difficulty in adapting and improving the twin trawl sytem for use in Georgia waters (Harrington, 1975; Rivers, 1976) suggests that scale model studies in a flume tank might have sped progress toward a final design. Part of the relatively expensive, diver assisted tests of comparative net performance also might have been conducted more expeditiously if a research flume were available in the United States.

In addition to the White Fish Authority Training Center and flume, previously discussed, the technological training of fishermen in Great Britain has been addressed through two innovative programs (Fishing News International, 1974). In 1973 the White Fish Authority began operating in mobile training unit that consists of a trailer-borne mockup of a modern trawler wheelhouse including all the requisite fish-finding electronic gear. The electronic equipment is operated by playback of tapes of fish and bottom echoes recorded on commercial vessels that use the same equipment. The trailer and associate mobile classroom are driven wherever interested fishermen are found.

The next step up from the passive training available on the mobile training unit is the world's first digital navigation and fishing simulator. It began operation at the Hull College of Higher Education in 1974. Specific fishing areas are simulated in the fish finding and navigation equipment through computer programs that are controllable by the instructor. Each skipper responds to the programmed changes in fishing conditions in order to assess his competence in "netting" fish under the simulated conditions. Such technological innovation is considered essential for U.S. fishing education programs.

There have been significant increases in the amount and kinds of environmental data available to fishermen during the 1970s. Although much of this information is valuable in locating and effectively harvesting fish it is rare to find a fisherman with sufficient background to apply these tools. Temperature and salinity data are commonly used by Soviet and Japansese fleets in locating fish and planning fishing strategy. Satellite imagery could be widely used for locating pelagic fishes.

A knowledge of the physical environmental factors and their relation to distribution of fish could greatly increase the efficiency of some fishing fleets. The study of the relationship between the environment and its effects on fish (commonly called fisheries oceanography) is not being pursued with the same vigor in the U.S. as it is in Japan and the U.S.S.R. Fishermen from the latter two countries depend heavily on temperature, salinity, bottom type, currents and other physical factors to guide their fishing efforts. Unfortunately, few U.S. fishermen have the knowledge necessary to apply such aids to their fishing.

A partial solution to such problems lies in students trained in new educational programs that stress the technology of the fishing industry. They would be:

a. trained in design, use and repair of new basic equipment and high technology devices;

b. able to communicate the need and advantage of such innovations to their employers;

c. better able than most personnel to carry information on need for additional innovations back to research faculty with whom they can communicate and aid in planning and implementation.

Technology and the Future of Fishing

Alverson (1975) has commented on the status and future of fishing technology:

> "Existing fish detection and extraction systems are adequate for expanded operations and for harvesting any unexploited concentrated of demersal or pelagic fishes. Technology does provide the basis for increasing the harvest of conventional forms. However, the capacity of existing technology to accomplish this is limited by the fact that most large demersal and pelagic fish stocks are already hightly exploited. Furthermore, although many stocks collectively may comprise large resources, they are sparsely distributed per unit volume of water and their effective use necessitates development of more efficient extraction systems.
>
> Moiseev has noted that any further substantial increase in total catch will depend on man's ability to concentrate fish artificially, to improve the efficiency to fishing gear, and to learn to control the behavior of fish."

Non-traditional (underutilized or unconventional) species offer a second area for technological innovation. A species is underutilized because of problems in harvesting, processing or marketing. Each species of fish has its own unique chemical and physical properties. While certain fish, such as cod, halibut and salmon, are relatively easy to maintain in good quality many of the abundant species such as Alaska pollock and hake are not. To further develop the U.S. fisheries it will be necessary for fishermen and processors to learn to handle properly species of fish that they are now accustomed to handling.

New and more complex equipment may be necessary to handle many of the species of fish not currently harvested by U.S. fisherman to achieve a competitive position in the world fish market. This equipment will range from filleting machines to new or more sophisticated freezing machinery. Specialized training will be needed to provide people capable of operating and maintaining this equipment.

A third area for marine fish resource utilization is described by Alverson:

> "In addition to increased catches which may come from geograhical expansion of fisheries operations and exploitation of unconventional species, gains can be achieved through elimination of waste from species now harvested and through transfer of fish used for industrial purposes to products used for direct human consumption. For

example, by 1985 the equivalent of two million extra tons of fish could be made available as a result of technological changes and utilization patterns of this type, and this value could be increased to approximately 15 million tons by the year 2000."

Through a combination of new technology and new patterns of utilization, Alverson (1975) predicts a substantial increase in fish and shellfish production as shown in Table 4. He comments that, "the natural order of the oceans--the basic biology--provides humanity with the opportunity for substantial increases in fish and shellfish production. Man's social order and his technological development will determine whether the opportunity is seized or lost."

TABLE 4

OPPORTUNITIES FOR INCREASED FISH AND SHELLFISH PRODUCTION, 1985 AND 2000

Resource Category	Potential Increases (Kilotons) 1985	2000
Traditional species (Conventional species)	8,000	14,000
Non-traditional species (Unconventional species)	5,000	35,000
Waste elimination (equivalents)	2,000	15,000
TOTALS	15,000	64,000

Status of Seafood Technology Programs

There are few undergraduate and graduate programs in food technology around the nation that provide managerial and other higher-level personnel to the seafood processing industry. For example, the University of Washington offers undergraduate electives in fishery technology and graduate specializations within the Department of Food Science and Technology of the College of Fisheries. However, only about five (5) undergraduate students per year (30 percent of the undergraduate majors) take the electives in fishery technology.

Because of limited facilities the department is allowed a maximum total registration of only 25 graduate students; the number of graduates with fishery technology specializations is proportionally small.

Most of the undergraduates from the University of Washington program have employment commitments prior to graduation. Graduate students tend to enter academic institutions, become employees of larger research laboratories or federal employees. However, Professor John Liston and Professor George Pigott, University of Washington (personal communication), report that many graduates of the M.S. program are now entering smaller commercial seafood processing operations and that many of the major seafood processing plants in the northwestern U.S. and Alaska employ graduates of the Department of Food Science and Technology in management capacities. They also report an increased interest in such students among employers. Therefore, an expansion of the University of Washington and similar programs or initiation of new programs could serve the future needs of the seafood processing industry.

Industry Attitudes Toward Educational Initiatives

It is an understatement to say that the commercial fisheries industry is a varied enterprise. It is varied in terms of the size of individual productive units in the industry, type of fishery being tapped, educational attainment among members of a fishery and a host of other factors. Therefore, industry reaction to graduates of any new educational program will vary according to the complex of factors operative in a local milieu at that time.

Members of the Study Group who represent the fishery industry or who undertook informal surveys subsequent to the meetings report no industry opposition but little industry support for new educational initiatives (H. Nickerson and J. DeWitt, personal communications). However, this reaction must be balanced against the success of graduates from existing associate degree programs. G. Motte reports (personal communication) that a lack of enthusiasm for the U.R.I. associate degree program prevailed among local captains until graduates of the program were able to prove themselves aboard ship. Now, qualified applicants must be turned away for lack of space in the U.R.I. program and prospective employers desire more graduates than can be produced. Tipman Marine reports (personal communication) a continuing need for well trained fishing boat captains in the New England area. A general salary level of $30 to $50 thousand is not competitive with offers from the offshore oil and other marine industries.

Some fishermen do express enthusiasm for upgrading their own knowledge and that of the next generation. For example, Elliott (1977) cites a statement made by a Marine Advisory Service Agent working in the Great Lakes region:

"The fishermen have indicated they want to be more professional in their approach. They want to be better able to ask more intelligent questions about some of the decisions being made that might or that do have a great impact on their lives and on their investments. More importantly they want to be able to make better assessments of the decisions being made by others."

From literature citations and personal communications it seems that the commercial fishing industry recognizes the need for a variety of education and training programs. Which programs to support will be a decision by men and women of foresight at all levels of government. Vindication of their vision will come as graduates of well designed and managed programs take their place in a revitalized commercial fishing industry. The difficulty in communication between fishery scientists and fishermen cited by Townes (1978) may be ameliorated as more fishery school graduates enter the industry.

Employment and its Relevance to Educational Initiatives

In a country with a well-established industry fewer trained personnel are needed than in a country experiencing rapid expansion of the industry. In the case of a country with an estalished industry, where increased automation and improvement in technology lead to projection of reduced employment, Cole and Hall (1973) state that it is possible to base future training needs on the assumption that everyone entering the industry will require institutional training and that working life expectancy is 30 years. Further, they assume that if there is uniform flow of personnel entering and retiring from the industry then a ratio of 30:1 should exist between those in the industry and those completing training to enter the industry each year. In a survey of nine countries with established fishing industries, Cole and Hall (1973) found the ratio ranged between 23:1 to 1,000:1. The high ratios might reflect such realities as improvement, through further training, of job position within a given segment of the industry to another. Cole and Hall caution that "estimates of working lives must, therefore, be made separately for each occupation or group of occupations within a particular industry and allowances must be made for "wastage" both during training and in service."

Rather than looking at the United States as a nation with a stable industry, it is more relevant, for the purposes of this report, to project employment resulting from capital investment to exploit non-traditional species in the newly created U.S. Fishery Conservation Zone. It is assumed that, initially, the resulting product primarily would be for the export market. A 1978 unpublished estimate by the National Marine Fisheries Service, NOAA, suggests that a total investment of between $3,790 to $4,029 million will result in an annual increase of $3,650 to $3,888 million to fishery business and a consequent increase of 75,038 to 81,016 in number of jobs within the industry and in allied supporting industries. The yearly economic benefit of the total investment would not continue indefinitely. Additional funds would have to be allocated for replacement of vessels, docks, plants and equipment as they aged. Details of the NMFS estimates are presented in Table 5.

Table 5

(UNPUBLISHED) NATIONAL MARINE FISHERIES SERVICE ESTIMATES OF THE IMPACT OF DEVELOPMENT OF NON-TRADITIONAL SPECIES IN U.S. FISHERIES CONSERVATION ZONE AND THE WESTERN PACIFIC

Species	Investment (Millions of 1978 Dollars)				Jobs Created	Business Created (Millions of 1978 $/year)
	Vessels	Plants and Equipment	Docks	Total		
New England Whiting	29.8	46.0	10.0	85.8	1,672	66.7
New England Squid	29.8	52.0	10.0	91.8	5,752	229.2
Pacific Skipjack and Yellowfin	125.0	-	-	125.0	20,306	1,257.9
Pacific Hake	48.0	66.0	6.0	120.0	1,945	77.4
Pacific Anchovy	102.5	30.0	-	132.5	4,362	57.9
Alaska Groundfish	551.3	1,518.0	300.0	2,269.3	23,000	1,464.2
Gulf of Mexico Bottomfish	81.8-136.5	280.0-465.0	50.0	411.8-651.5	8,972-14,950	357.2-595.3
Gulf of Mexico Pelagics	263.5	90.0	100.0	453.5	9.029	189.8
TOTALS	1,231.7-1,286.4	2,087.0-2,267.0	476.0	3,789.7-4,029.4	75,038-81,016	3,650.3-3,888.4

Another way of looking at personnel needs of the U.S. commercial fishing industry is to project employment that would result from U.S. fishermen providing more than the current one-third of edible fish products to the domestic market. If, for example, U.S. fishermen could supply two-thirds of our domestic needs, while also building export markets, then an NMFS (1978) estimate states, "this could add $8 to $10 million to the U.S. economy and create 200,000 to 300,000 new jobs in commercial fishing, food processing and industries that support fishing."

In summary, whether personnel needs are looked at in terms of replacement of current workers, capital investment, or increased catch to meet export and domestic consumption requirements, there is potential for many new workers to enter all levels of the U.S. commercial fishing industry. All of them will require some training. A majority of them would benefit from some type of formal education and training programs offered in post-secondary institutions. A significant percentage of them will desire and benefit from education and training programs that lead to advanced degrees.

Fishing Industry Recruitment

Employment opportunities will generate interest in the fishing industry. However, to assure that successful high school students and others receive up-to-date information about the industry and its educational requirements may mandate a special effort. For example, the U.S. Department of Labor, Bureau of Statistics, in its Occupational Outlook Handbook (1978) fails to give any specific information on employment projections for the fishing/seafood processing sector of the economy. Similarly, the Encyclopedia of Careers and Vocational Guidance (Hopke, 1977) devotes only seventeen lines to what is identified as "...this vast new field." The remainder of their discussion is directed to requirements and rewards of the fish culturist. Obviously, the fishing industry has a serious recognition problem that must be overcome.

Chapter V

UPGRADING OR ESTABLISHING NEW FISHERY EDUCATION PROGRAMS

It was generally agreed that the U.S. commercial fishing industry would benefit from an increase in number, quality and academic range of educational programs available to those already in the industry and those seeking entry. Recommendations, given, below, are basically concerned with post-secondary educational programs and facilities. However, the Study Group recognized that such a complex problem as fishery education must be a continuing topic of discussion among a broad spectrum of U.S. citizens and their representatives.

Actions to consider while building post-secondary commercial fishery education programs include:

1. Improving the image of fishing and seafood processing as acceptable career choices.

2. Sensitizing the kindergarten through twelfth grade (K-12) school population to fish and the fishing industry.

3. Encouraging use of a wide variety of seafood products among the U.S. population.

4. Developing an understanding among the present generation of fishermen and seafood processors of the needs and benefits of the programs.

5. Developing and/or recruiting, from foreign nations, sufficient faculty to staff new college/university programs.

6. Achieving consensus on curriculum for the new education and training efforts.

Short-Term Efforts

Increased upgrading of U.S. fishermen in technology, through National Marine Fisheries Service programs, Sea Grant Marine Advisory Service, college courses and short-courses sponsord by regional councils or others would have a beneficial impact. An implication of funding for such efforts would be the availability of experienced representatives of the industry who would bear the greatest share of actual teaching responsibility. Hugh O'Rourke cautions (personal communication) that many educational programs for present-day commercial fishermen fail because the fishermen do not have enough influence on program planning. He urges that future programs be built around the perceived needs of commercial fishermen. A categorization of vocational skills needed by present-day commercial fisheries personnel is presented in

Appendix B. Such listings should be used in formulating new programs. Expansion of the existing Marine Advisory Service to meet the demands for adult vocational training would require 50 additional agents and specialists at an estimated cost of $2,250,000.

Long-Term Efforts

Study Group members identified merit in planning for upgrading existing formal advanced educational programs, perhaps along the lines of the University of Rhode Island or Clatsop Community College models, where a majority of the graduates hold responsible positions on fishery vessels. A minimum of one associate degree program on each coast -- Atlantic, Gulf and Pacific -- needs to be created or upgraded.

No consensus was achieved as to the total desirable number of nor siting of such associate degree programs because local acceptance and support is such a dominating, yet unknown, factor. Further, the availability, in existing schools, of faculty to teach ancillary courses for the fishery program would bear on the total cost of the program as would the availability of existing classrooms and other facilities.

Stanley Sivertson (personal communication) favors availability of courses and workshops for those already in the industry as well as programs to properly prepare new entrants. However, he cautions that long-term programs should be sited in areas where there is both the potential for expanded commercial fisheries growth as well as availability of youth who desire training. For example, he feels that the present regulatory environment in the Great Lakes region favors sports fishermen. Therefore, long-term stock enhancement and other positive actions may be needed to improve the long-term outlook for commercial fisheries in some areas before educational programs can reach their full potential. Charles Burrows reports (personal communication) that many improvements are already being made in Great Lakes fish stocks and that a commercial potential does exist in some of the larger inland lakes. The closure or potential closure of certain Great Lakes fisheries due to pesticide or chemical contamination is a serious problem in the expansion of commercial fisheries which must be considered.

In addition to the educational efforts discussed earlier there also appears to be justification for the better training of fishermen through four-year under-graduate programs as well as the education of fishery specialists through new graduate programs. A minimum of two such schoools or departments offering bachelor and post-graduate degrees should be established or upgraded: one on the Atlantic coast and one on the Pacific coast. As before, siting the advanced programs at existing universities would have the advantage of providing existing faculty and facilities as support to the fishery effort. Hugh O'Rourke suggests (personal communication) that new programs should be sited in state institutions of higher education and their importance highlighted by offering state scholarships to a majority of the entering students.

It is envisioned that advanced programs will provide the underpinning for vertically integrated nationwide educational effort that also includes public awareness, vocational technical training and K-12 teacher training relating to the commercial fishing industry. The advanced degree schools could fill a leadership role in the evolutionary change of the commercial fishing industry.

As in the case of associate degree programs the total number of advanced degree programs desirable, or sustainable, depends largely on local initiatives which cannot now be predicted.

The Study Group recognized that a successful fishery education system should be flexible enough to provide access to education and training for those who wish to enter or reenter the system after periods of commercial activity.

Cost of Upgrading Associate Degree Programs

Facility and personnel costs for upgrading existing associate degree programs will be quite variable depending on many factors including the nature of existing facilities and construction costs at individual educational institutions. The University of Rhode Island A.A. program can be used as one example of the costs of upgrading. The U.R.I. program is now run in rented facilities and uses an average sized vessel. At present the programs serves 40 freshmen and 22 sophomores with a staff of 8. Projections of cost for an 80 percent increase in enrollment (to 110 students) have recently been made (G. Motte, personal communication).

Capital Costs

Replacement of existing training vessel with a completely outfitted 58-to-60 ft. multipurpose vessel	$ 700,000
Classroom and research building fully equipped, 24,000 square feet floor space	1,800,000
Land cost for a five-acre site having 400 ft. shore frontage	1,000,000
Dock of sufficient design	100,000
Subtotal	$3,600,000

Annual Operating Costs

Vessel maintenance, insurance, fuel	$ 25,000
Expendable supplies and equipment for classroom instruction	100,000
Salary for three faculty and two research associates 5 people at average $20,000/year	100,000
Overhead on salary (55 percent including fringe benefits	55,000
Student aid (fellowships, assistantships, stipends), 20 people at an average $5,000/year .	100,000
Subtotal	$380,000

Clatsop Community College, Astoria, Oregon, provides a West Coast comparison of capital and operating costs needed to expand associate degree programs. At present the commercial fishing option at the school enrolls a total of 24 students. Of these, 20 are freshmen and four are sophomores. The disparity between number of students in the first and second year of the program is primarily the result of students dropping out to enter full-time employment in the commercial fishing industry. This is a similar, but more extreme, example of the phenomemon of first to second year dropout rate seen in the University of Rhode Island program.

At present the Clatsop Community College employs three instructors and one boat operator to serve the needs of both the 24 students in the Commercial Fishing option as well as the 24 students in the Marine Technology option. For a 70 percent increase, to 40 students, in the Commercial Fishing option the following capital and operating expenses are anticipated (D. Phillips, personal communication):

Capital Costs

Replacement of existing training vessel with a completely outfitted 70- to 75-ft. multipurpose vessel	$ 750,000 to 1,000,000
Classroom and research building, fully equipped, 12,000 square feet floor space	600,000
Land and dock	- 0 -
Subtotal $1,350,000 to	$1,600,000

Annual Operating Costs

Vessel maintenance, insurance, fuel	$15,000
Expendable supplies and equipment for classroom institution (Supplemented by industry contribution of new or repairable nets and other equipment	10,000
Salary for one additional faculty member	20,000
Overhead on salary (50 percent including fringe benefits)	10,000
Student aid (fellowships, assistantships, stipends) for 10 people at an average $4,000/ student	40,000
Subtotal	$95,000

For initiating or upgrading three associate degree programs in schools like the University of Rhode Island, or Clatsop Community College, one on each coast, the total expenditure projects to approximately $8,000,000 capital costs and approximately $700,000 annual operating costs. Naturally, such programs sited in existing facilities would require significantly less capital expenditure. This might mean as little as $3,000,000 total capital expenditure if such existing facilities were found. However, operating expenses would still be as projected for the University of Rhode Island and Clatsop Community College examples. Nothing in the foregoing discussion should be construed as an endorsement of funding for either of the institutions mentioned.

Cost of Instituting Bachelor and Post-Bachelor Programs

Because no bachelor or post-bachelor programs in commercial fisheries (of the type discussed in this report) exist in the United States it is difficult to project costs. In fact, adequate associate degree programs might provide most of the facilities and faculty needed for higher degree programs. This would be practical only where both the associate and higher degree programs are part of the same institution such as the University of Rhode Island which is somewhat unique in this report. But, the collaboration might be possible where an associate degree institution is in proximity to a major university which has an interest in fishery education.

For example, at the University of Rhode Island, approximately 40 baccalaureate students could be accommodated with an increase in essentially only the operating costs.

However, it is considered highly desirable to construct a research and training flume, at one of the bachelor's and higher level institutions similar to that built by the White Fish Authority in Great Britain. Its costs are approximately:

Capital costs

Land Acquisition (minimum 1.5 acres)		$ 100,000
Building and Equipment		3,000,000
	Subtotal	$3,100,000

Operating Costs

Flume operation and maintenance including technician salary and overhead		$25,000
	Subtotal	$25,000

Also needed in the United States is a fishery electronics research and demonstration facility which might be located at the second institution of higher education. The cost should be roughly equal to the total for the research and training flume.

Funding Sources

Because relatively few associate and baccalaureate degree programs will serve the needs of large regions, a host state might be reluctant to invest in creating or upgrading such a program. For instance, if the associate degree program at the University of Rhode Island were upgraded to serve a larger constituency (regional or entire East Coast) it seems highly unlikely that any of the capital cost or much of the operating cost would be absorbed by the State of Rhode Island. (G. Motte, personal communication). Federal funds would be the dominant initial stimulant.

Chapter VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In 1977 U.S. fishery product exports reached a record value of $520.5 million. At the same time, however, imports of fish products also reached a record value of $2.621 billion. Such a balance-of-trade deficit reflects a long-standing trend that may continue in spite of opportunities for increased harvest by U.S. commercial fishermen in the recently designated fishery conservation zone.

Would increased emphasis on U.S. fishery educational programs facilitiate increased productivity of the U.S. fishing industry? What types of programs are needed and what should be their geographic location? What are the anticipated costs of the programs? To answer such questions the National Sea Grant College Program initiated a study in mid-1978. Representatives of the commercial fishing industry, educational institutions and the Federal government met on several occasions to pool their expertise on the educational needs of the U.S. fishermen - the first such national study of the educational needs of commercial fishermen and fishery specialists. Recent studies, related to implications of the establishment of a U.S. Fishery Conservation Zone, focused on alternative issues such as stock replenishment, non-traditional (underutilized) species, increased catch efficiency and consumer education.

The U.S. is a relatively late entrant into the effort to train commercial fishermen. Therefore, a brief survey of foreign educational programs was undertaken to identify their strengths and weaknesses. Personal knowledge possessed by Study Group members and reference materials yielded information on programs in the Soviet Union, Japan, Great Britain, Norway, Taiwan and Iceland. In at least two of those countries there is some effort to introduce information about fishing and fishing industry careers into the pre-college educational system.

Secondary-school programs provide a basic vocational training for youths who enter commercial fishing in such successful fishing nations as the Soviet Union and Japan. In the early to mid-1970s each of those nations had about 60,000 students in secondary-school fishery programs. In spite of their political and ideological differences, those nations share a desire to use fish products as a substitute for beef and other animal protein.

In general, foreign nations with successful fishery industries also have schools which offer the equivalent of associate, bachelor, master and doctoral programs to train higher level workers and researchers. Extension-type programs and correspondence courses are common in foreign programs to train or retrain fisheries industry personnel.

Foreign nations have not discovered any unique pedagogical approaches to the education of fishermen or seafood processors. However, availability of technology training aids, modernity of fishing-school vessels and equipment and high admission standards for many of the programs are elements that might well be envied by U.S. fishery educators.

Is the efficacy of the foreign training programs measurable in terms of productivity? One of the few available measures of productivity is controversial. It relates weight of a nation's total catch to the "gross register tonnage" of its fishing vessels. By this measure both the Soviet Union and Japan are less productive than the U.S. and significantly less productive than Norway. However, this analysis compares two "distant waters" fishing nations (including catching and processing vessels) with two "close to home" fishing nations. Obviously, then, the fishery education system, highly structured in the Soviet Union, Japan, and Norway, cannot be evaluated by such a measure of fishing productivity. In the future any measure of the effectiveness of an improved U.S. fishery education effort might be designed to take productivity into account as well as all of the values ascribed to education in a democracy.

The total U.S. effort directed toward a broad spectrum of fishery problems is relatively nascent. More secondary-school students in the U.S. are being exposed to oceanography coursework. Such coursework, and related programs in earlier years, could provide a sensitization to fish and employment prospects in the fishing industry.

Existing extension-type workshops conducted by the Sea Grant Advisory Service, equipment manufacturers, fishing orgnizations and others provide opportunities to some in the industry to learn about new technology, regulations, etc. However, much improvement can be made in this area through revised scheduling procedures and expansion of these programs. This would require the addition of 50 advisory service agents and specialists at an annual cost of $2,250,000.

Well-recognized associate degree programs to help train fishermen exist at several U.S. institutions. The need for trained fishermen might be assessed by the fact that 50 percent or more of the students find employment before graduation from associate degree programs. However, the ultimate success of such programs is revealed by the fact that 49 percent of graduates from the University of Rhode Island program had become first mate, captain or captain/owner of a fishing vessel after a mean of only two and one-third years on the job.

Study Group members consider an expansion and upgrading of associate degree programs to be a necessity. Because the programs generally operate in rented or inadequate facilities, with less than optimal number and kind of technological devices and with marginal training vessels, the initial capital cost of expansion and upgrading is high. The ultimate number of sustainable associate degree programs must be determined by the marketplace, state and regional commitment to programs and the body of operational knowledge that accumulates from the programs. Nevertheless, an initial effort to provide for at least one new or upgraded associate degree program on each of the three coasts is considered desirable. Based on an average cost, drawn from the University of Rhode Island and Clatsop Community College programs such an initiative at three schools suggests a one-time expenditure of $8 million and associated annual operating expenses of $0.7 million to provide full-time associate degree training for about an additional 50 students each year.

Realistically, it could not be expected that state funds would be available for programs that serve needs of fishermen and trainees from a broad geographic region. Federal funds will be needed to stimulate and support these educational programs. Many foreign nations might be inclined to send their students to new or upgraded U.S. fishery education programs. Such students would bring foreign exchange credits that could reduce the cost of the programs.

At present, with the exception of a relatively small effort in seafood technology, there are no bachelor or more advanced fishing industry education programs in operation in the United States of the type described in this report. The Study Group expressed enthusiam for initiation of such programs to train management personnel, produce Ph.D. level fishing industry researchers and develop sorely needed knowledgeable national representatives of the industry.

Because of differences in the available catch and fishing conditions at least two advanced-level institutions are considered necessary: one on the Atlantic Ocean Coast and one on the Pacific Ocean Coast.

Cost of the advanced programs would be minimal if the programs were operated at, or in proximity to, institutions of higher education that housed the newly conceived associate degree programs. A flume for net demonstration and research purposes should be constructed at one of the higher-level institutions. The flume design would be an updated version of that in operation by the White Fish Authority at Hull, England. The second higher-level institution should have a research and demonstration facility for fishing industry electronics.

Optimally these formal educational programs would be flexible enough and integrated in such a way that an individual could progress through the various levels with little administrative difficulty. This could occur directly or through reentry after periods of commercial activity.

In the opinion of the Study Group, the enlightened self-interest of the United States government suggests both an opportunity and an obligation to improve the state of educational programs for commercial fishermen, fishery researchers and industry representatives.

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APPENDIXES

APPENDIX A

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APPENDIX B

VOCATIONAL SKILLS NEEDED BY COMMERCIAL FISHERY PERSONNEL

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NARRATIVE

I. Current Needs

The American fisherman is involved in a complex, somewhat unique industry. Formal education and training to prepare individuals for the harvesting and processing aspects of the industry are limited. Historically, training has been on-the-job on a family boat. In changing times, however, sons are no longer staying with the family boat and outsiders are seeking entrance into the industry.

The commercial fisherman needs specific skill training in five major areas:

1. Fishing gear methods to include design, construction, maintenance, repair, and application to the various fisheries.

2. Marine engineering to include diesel engines, marine electrical systems, marine electronic instruments, marine refrigeration and hydraulics.

3. Navigation and seamanship to include marlin spike seamanship, boat handling, Rules of the Road, piloting, celestial navigation and electronic navigational instruments.

4. Related skills to include fisheries oceanography, commercial fishing business management and economic skills and food preparation and storage aboard commercial boats.

5. Upgrade training and continuing education for those already in the industry.

There are perhaps three major areas where the commercial fishermen needs intellectual training:

1. Oral and Written communications

2. Basic Mathematics, including algebra and applied trigonometry

3. Social skills to include an understanding of humanities, social sciences and behavioral sciences

II. Future Needs

In the future commercial fishermen and processors will need to develop higher levels of sophistication with respect to technology and dealing with the general public. Educational programs will need to focus not only on specific practical skills, but such things as management, marketing, administration and applied research. The modern fisherman will also need the skills to diversify into any and all related industries. This will require a new comprehensive approach to educating fishermen.

OUTLINE

I. Current Needs

A. Sources of Trained Fishermen

1. Family Fishing Enterprise - O.J.T. (on-the-job training)

2. Self-taught fishermen and those receiving primary formal knowledge through Sea Grant Marine Advisory Program-type activities

3. High school programs

4. Post-secondary programs, such as U.R.I., Clatsop Community College, etc.

5. Unspecified sources

B. Methodology for Identifying Intellectual and Practical Skill Needs

1. Competency-based task analysis

2. Surveys and inventories

3. Time-motion studies

4. Request for assistance as initiated by the commercial fishing industry

5. Request for assistance by fisheries, educators

C. Practical Skills

1. Fishing gear methodology

a. Net construction, maintenance and repair, including gillnet, otter trawl and shrimp

b. Proper techniques of employing nets, including mid-water trawls

c. Construction, repair and maintenance of crab pots

d. Proper techniques of employing pots

e. Construction, maintenance, repair and proper techniques of employing troll gear (both salmon and tuna)

f. Construction, maintenance, repair and proper techniques of employing long line gear

2. Marine Engineering

a. Diesel and gasoline (limited) engine operation and maintenance. Sufficient knowledge for troubleshooting and emergency repair

b. Marine Electricity - Basic AC and DC theory, including application to starting motors, generators, alternators, regulators, VOM, electrolysis

c. Marine Electronics - Basics of electronic aids such as Loran, X-Y plotter, ADF, Sonar, depth finders, VHF radio, AM radio and radar, including use in locating and harvesting fish as well as emergency repairs at sea to electronic equipment

d. Marine Refrigeration Systems - icing, chillers, brine and spray and sharp freezing. Analysis of systems with basic skills in maintaining and troubleshooting mechanical systems

e. Hydraulics - basic theory, operation and maintenance of hydraulic systems as found on commercial fishing boats

3. Mariner Skills

a. Navigation to include basic fundamentals of celestial navigation, operation of fathometers, Loran, radios, radar, direction finders and Sonar

b. Basic boat handling, knotting, splicing, rigging, safety and water survival

c. Application and intention of U.S. Coast Guard Rules-of-the-Road

d. Boat maintenance and repair to include oxy-acetylene and electric arc welding proficiency. Almost equal emphasis to repair and maintenance of wood, steel and fiberglas vessels

4. Other Related Skills

   a. Commercial Fishing oceanogrpahy to include study of water temperatures, currents, salinity and food sources in relation to fish migration and habits. Also fish identification and life cycles

   b. Commercial Fishing Business Management to include a review of current and proposed laws and regulations regarding the industry; organization, operation, importance and interrelationships of fisherman's unions, cooperatives, associations, etc.; Basic economics including how prices are established, record keeping, settlements, cost and profit analysis, insurance and taxes

   c. Marine Food Preparation and Storage - selection of basic four nutrients for well balanced diets that can be prepared economically and efficiently at sea. Basic techniques of preparing palatable meals (ed. note: a very critical knowledge and skill level for the entry level deck hand in our area)

D. Intellectual Skill Needs as Identified in N.W. Oregon and S.W. Washington

1. Communications to include basic fundamentals of written and oral communications

2. Mathematics to include basic intermediate college algebra, applied geometry and trigonometry

3. Social skills to include basic psychology, humans relations in business and sociology

4. Other skills such as Advanced First Aid with CPR and job preparation and search techniques

II. Future Needs

A. Practical Skill Needs - The basic "current" methods will continue to provide the foundation at least in the Pacific Northwest. Education will, as a minimum, coincide with technological development

B. Intellectual Skills - The fisherman will become a more sophisticated businessman. Hence, he/she will need additional training in small business management, administration and marketing techniques. This training can be provided within existing institutions.

APPENDIX C

FISHERY EDUCATION IN JAPAN

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Marine Advisory Program

University of Alaska

October, 1978 (Revision)

In 1964 George Borgstrom wrote "the enormous Japanese expansion in fisheries could not have been launched without a broad educational program on all levels." This statement remained true until 1976 when the Japanese world expansion of fishing effort was blocked by the "200-mile limit shock." During the period of 1964-1974 formal and informal educational programs played an ever increasing role in all of Japan's fisheries. The fisheries educational system has impinged on all segments of the fishing industry, from the management of the largest fishing companies to the master of a catcher processing ship or the fisherman operating a 20-foot dory with a 10 hp outboard motor.

In Japan fishery education can start as early as middle school (junior high) with elective courses, and continue through a Doctorate in Fishing Science. Education is considered to be a lifelong process. There are two programs that fulfill that need: (i.e., fishermen's training facilities) the propaganda (extension) section of the Japan fisheries agencies and the propaganda section of each perfectural fisheries department.

The universities provide the central basis for fisheries education and development in Japan. They provide the technical and professional personnel that do the research; manage the resources; train people; and operate the larger fishing vessels. Without the fisheries faculties the fisheries would not operate at any competitive level of efficiency. There are 16 universities in Japan that have fisheries faculties (colleges) or fisheries departments within faculties of agriculture or oceans. Four of these are private universities the remainder are national universities under the Ministry of Education. In addition there are two universities of fisheries: Tokyo University of Fisheries under the Ministry of Education; and College of Fisheries of the Ministry of Agriculture and Forestry. These schools accept a maximum of 1705 students per year. A list of Japanese universities offering fisheries courses, including major subjects, is given in an attachment to this Appendix.

The organization of the Japanese national universities is similar to that found in Europe. The central element is the Chair. Each Chair is composed of a professor, an associate professor, and one or two research associates which are the equivalent of assistant professors or instructors in the American system.

The Chairs are loosely organized into Departments, which are a part of the Faculty or College, under a dean elected by the professors in the Faculty. Each Chair is a fiefdom unto itself and has its own laboratory. After completing the first two years of a basic course, common to all students in the university, a student joins a Laboratory. Although the student takes classes from other professors, most of his guidance and training comes from within his chosen laboratory. In graduate school the student is even more closely tied to this laboratory and will take only a few lectures or seminars outside of his laboratory. This system produces excellent, highly trained scientists.

I think it is necessary to discuss two university programs in some depth. These are the University of Hokkaido Faculty of Fisheries and the University of Tokyo Department of Fisheries, Faculty of Agriculture. The program descriptions are attached to this Appendix. The objectives of the Faculty of Fisheries, University of Hokkaido, are to produce leaders for the fishing and fish processing industry, government fisheries management agencies, fish and food processing corporations, fisheries research scientists and educators. The Fisheries Department, Tokyo University states, "this Department lays greater stress on the fundamental sciences than on the technical aspects of the subject."

The University of Hokkaido Faculty of Fisheries has a teaching and research faculty of 114 members. This includes 30 professors, 30 assistant professors and 65 research technicians. Two hundred and fifteen undergraduate students are accepted each year and from 5 to 20 graduate students may be accepted. The Department of Fishing Science accepts 80 students per year. These students can enter either the course Science of Fishing Grounds or a course of Fishing Technology. There are 11 chairs in this department which, in effect, means there are 11 separate subject laboratories or 11 different courses of study. When a student enters a laboratory most of his elective subjects will be taken from the professor in that laboratory. Students taking the fishing course must spend a 5th year on board one of the training vessels. The primary objectives of the T/V Oshoro Maru is training cadets; however, there is a scientist on each cruise. The captain on each of the training ships holds a professorship and normally has a doctor's degree in Fishing Science or Fisheries Oceanography. During the 1978 Bering Sea cruise of the T/V Oshoro Maru there were 15 cadets, two scientists and a student.

Although Japan is anticipating a significant cutback in their high seas operation within the 200 mile foreign fishing limits, the University of Hokkaido is of the opinion that there will be a need for the Fishing Science course to continue for a number of years. (Personal comment, Capt. T. Fujii, T/V Oshoro Maru, 1978).

The faculty members of the University of Hokkaido do anticipate an increased emphasis in the area of fish culture to futher the development of the nearshore fisheries. This will necessitate an increase in the number of chairs in the Department of Bioloby and Aquaculture. At present there are 7 chairs within this Department. Students in the Laboratories of Marine Botany, Freshwater Fish Culture, and Marine Fish Culture would normally enter an applied field industry or fisheries experiment station. Students from the other laboratories would be more likely to enter a more basic research facility or management agency. At present this Department enrolls 40 students per year and attracts about 40 percent of the graduate students of the entire faculty of fisheries.

In the area of food technology, the faculty has two departments: the Department of Food Science and Technology, and the Department of Fisheries Chemistry. Both have five chairs. With the exception of Marine Chemistry and Analytical Chemistry, both departments are food industry oriented. These latter two should be considered as chairs of chemical oceanography.

The University of Hokkaido Faculty of Fisheries has a broad range of programs that have assisted Japan's fishing industry in all facets of its development. This assistance has been recognized by the fishing industry in a tangible way. The industry has provided funds for the establishment of the Institute of North Pacific Fisheries Research and the Hokkaido Federation of Fisheries Cooperatives provides two manned research vessels on a permanent basis for use by the Institute.

Training vessels are common to all universities with a major fisheries program. Institutions such as the University of Hokkaido, Tokyo University of Fisheries, Kagoshima University and Tokai University have several vessels with at least one vessel over 1000 gross tons. The primary function of these vessels is to train sea-going fishermen. Research is a secondary objective.

The stress on understanding the fishing industry pervades all fisheries programs regardless of their stated goals. The curriculum of the Department of Fisheries of Tokyo University is a case in point. As mentioned above, this department "lays greater emphasis on the fundamental sciences." A quick glance at the curriculum (Attachment) shows fishing methods and gear and technology of marine products are <u>required</u> subjects of all students. Elective subjects include navigation and seamanship, fishing boats, fishing mechanics, seafood production, etc.

At present few fisheries students studying for a Bachelor's Degree in the United States study any of the following: fishing gear, seamanship, navigation, fisheries oceanography, fishing grounds, behavior of fish schools, or naval architecture of fishing boats. Yet in Japan it is possible to major or even receive a Doctor's Degree in any one of those subjects so necessary to a successful fishing industry.

Research is an important function of all fisheries departments be if fishing gear or oceanography. All students must complete a graduation thesis based on their own research findings. This is considered important if the department is to be on the leading edge of change. It is also important that the student be trained in the scientific method regardless if he is to be a fishing captain or a university professor. This must be considered in any fisheries training program.

FISHERIES HIGH SCHOOLS

In many countries fisheries high schools are depended upon to provide the trained personnel and to provde leadership in developing the fishing industry. Japan has an extensive fisheries high school system. In Japan, only nine years of school is compulsory. High school is defined as grades 10 through 12 and is entered by competitive examination. In 1973, Japan had 37 fisheries high schools and 15 high schools with a course in fisheries. These schools are all under the education department of the prefecture. Course content is defined by the prefectures under legal and administrative guidelines set by the Minister of Education of Japan.

All 54 high schools have a fishing course; 49 have a course in fish processing; 33 a course in engineering, 26 in radio communication, 12 in aquaculture and 2 in fisheries management. In 1974 there were 19,172 students enrolled in fisheries high schools. In the same year 6,132 graduated. Of the graduates, 4,783 were employed in the fishing or allied industry, 900 continued on to higher educatio, 449 went to other industries. Graduates of fisheries high schools are expected to be leaders in the field (Tezuka, 1975). A fisheries high school course is expected to be a terminal degree but, due to a steady increase in academic standards, there is an increased number of students continuing on to the university.

Each high school has its own training vessel. The largest vessel is 550 tons, the average is 320 tons and the smallest is 11 tons. Those schools emphasizing aquaculture would have one or two training vessels in the 15 to 20 ton class. It is evident that each of the high schools that specialize in fishing technology has ocean going vessels larger than 299 tons, which would exceed the size of 99% of the U.S. fishing fleet. During fishing classes training on board is the most important part of the course. Without having this practice students cannot obtain a technical marine license and cannot become the executive of the fishing crew, i.e. bosun. These vessels all fish on a commercial basis. For example, the Hakodate Fisheries High School has a training vessel of 500 tons. This vessel makes training cruises to the Bering Sea and Gulf of Alaska every year, fishing crab, salmon and herring and trawling for bottomfish. This vessel normally returns about 90% of its operating expenses, including licensed crew and two instructors. The primary reason for fishing on a commercial basis is not to recover costs but to provide realistic training and to develop the "competitive nature' of the student which is so necessary for successful fishing (Tezuka, 1975). This is an important point to be considered for any U.S. Fisheries training program.

Fisheries high schools, or any schools for that matter, are not allowed to happen on a haphazard basis but are the product of recognized local, regional and prefectural need. The Oshima District in Southern Hokkaido is a good example. Prior to 1970 this district had 3 fisheres high schools. The Hakodate school trained people for the highsea fishing fleet and in their fish processing factory for the fish processing industry.

The school on the eastern side of the district specialized in fish culture and the production of seed. Their primary production is in Laminaria, Undaria, Porphyra, sea urchin and scallop. These are the primary fisheries in that part of the district. The school in the western district bordered on the Japan Sea where oceanographic conditions are not conducive to aquaculture but there is an active inshore fishery (i.e., out to 200 miles). Naturally, this school's major course is Fishing Technology.

An area in the southeast part of the district had a specific problem. It was directly in the normal typhoon path on an open coast. The sea state was further confused by an opposing current. Also the beaches that existed in the area were composed of shifting sand and did not provide a suitable substrate for bottom organisms or kelp. The biological productivity of the area was very high and a highly productive aquaculture industry existed on each side of the area. The communities of the area prevailed upon the prefectural government to approve a fishery high school for the area. The goal of the is school was to develop the technology for aquaculture in that area and train fisherman to practice that technology. By 1973 the technology for culture of Laminaria had been developed and 110 students were enrolled. By 1975 the technology for culture of sea urchin seed and Undaria had been developed and a factory for processing Laminaria into Konbu in operation. In 1977 the products of the school's aquaculture paid for the entire operation of the school and returned $60,000 to the prefecture. The developers of a fisheries educational systems must define the problems to be solved and set the goals of the institution to solve the problem.

CONCLUSION

I can think of no more suitable conclusion that the words of Mr. Takio Tezuka, Chief of the Research Divison of the National Federation of Fisheries Cooperative of Japan: "Excellent technique cannot be effectively worked without capable users."

ATTACHMENT

PUBLIC AND PRIVATE UNIVERSITIES IN JAPAN

OFFERING FISHERIES PROGRAMS

National (Public) Universities	Fisheries Program Areas
Hiroshima	general
Hokkaido	foods, culture, chemistry, teaching
Kagawa	foods
Kagoshima	general
Kochi	aquaculture
Kyoto	general
Kyushu	general
Mie	general
Ministry of Agriculture and Forestry - College of Fisheries	general
Miyazaki	culture
Nagosaki	general
Tohoku	general
Tokyo	general
Tokyo University of Fisheries	foods, culture, teaching, oceanographic environment
Private Universities	
Kinki	general
Kitazato	foods, culture
Nippon	general
Tokai	general

ATTACHMENT

FISHERIES PROGRAMS, HOKKAIDO UNIVERSITY, SAPPORO JAPAN

Faculty of Fisheries

"The faculty of Fisheries is a successor to the School of Fishery established in Sapporo in February 1907 as an attached school to the Sapporo Agricultural College. In 1935 the school moved to Hakodate and became an independent school under the name of Hakodate College of Fisheries. In 1949 Hakodate College of Fisheries and the Department of Fisheries in the Faculty of Agricutlure, Hokkaido University in Sapporo, were combined to establish the Faculty of Fisheries, Hokkaido University, in Hakodate. The Faculty is now composed of four departments with 28 chairs. The Research Institute of North Pacific Fisheries, two training ships, three field stations, and a practice factory on campus belong to the Faculty."

Department of Fishing Science and Technology

Chairs

Applied Ecology for Fishing Ground

Biology of Fish Population

Oceanography and Meteorology

Fishing Navigation

Operation Technology of Fishing

Fishing Gear Engineering

Mechanical Engineering for Fishing

Instrument Engineering for Fishing

Engineering of Fishing Boat

Fishing Boat Seamanship

Fisheries Business Economics

Department of Food Science and Technology

Chairs

Food Chemistry

Biochemistry

Microbiology

Marine Food Technology

Department of Fisheries Chemistry

Chairs

Polymer Chemistry of Marine Products

Chemistry of Fish Oil

Marine Chemistry

Analytical Chemistry

Chemical Engineering

ATTACHMENT

FISHERIES PROGRAMS OF THE FACULTY OF AGRICULTURE,

THE UNIVERSITY OF TOKYO

Department of Fisheries

The chief characteristic of this department is that while other departments of the Faculty of Agriculture have as their object the production of plants and animals on land, this department is concerned with their production in the seas and inland waters, i.e., the hydrosphere.

The educational system of this department lays greater stress on the fundamental sciences than on the technical aspects of the subject. In the third year, students receive instruction in a broad range of general and basic fisheries sciences. Then in the fourth year, under the guidance of a professor, they begin research on a subject in order to write a graduation thesis. During this period they receive instruction in a specialized field. In these two years, during the summer, winter, and springe vacations, they also carry out various field works for a total period of one month at both the marine biological station in Kanagawa Prefecture, an attached facility of the Faculty of Science and the fisheries laboratory in Aichi Prefecture, an attached facility of the Faculty of Agriculture.

Furthermore, those students who so desire can make use of their summer vacations to undergo practical fisheries training in companies, factories, fisheries research institutes, and on research vessels. Every autumn a week's educational tour is also arranged.

This department has six laboratories, which are specialized respectively in fisheries biology, aquaculture, technology of marine products, fish physiology, fisheries oceanography and marine biochemistry. The teaching staff consists of six professors and six associate professors."

Required Courses:

Physics I

Organic Chemistry I

Biological Chemistry I

Outline of Fisheries

Aquatic Invertebrates

Aquatic Vertebrates

Anatomy of Aquatic Animals

Physiology of Aquatic Animals

Aquatic Botany

Fisheries Microbiology

General Biology of Fisheries

Oceanography

Water Quality

Fish Population and Conservation

Fishing Methods and Gear

Aquiculture

Biochemistry of Aquatic Organisms

Technology of Marine Products

Laws of Fisheries

Experiments in Fisheries Zoology I

Experiments in Fisheries Zoology II

Experiments in Fisheries Zoology III

Experiments in Aquatic Botany

Experiments in Fisheries Microbiology

Experiments in Fisheries Oceanography

Experiments in Fisheries Chemistry I

Field Works in Fisheries Sciences

Graduation Thesis

APPENDIX D

FISHERY EDUCATION IN NORWAY

BY

Per O. Heggelund

Marine Advisory Program

University of Alaska

July 13, 1978

Fishery education in Norway has experienced a great deal of change over the last few years. Originally the emphasis was on vocational schools specifically designed for the fishing industry. The vocational schools have now been partly replaced by an integrated fishery program in the regular secondary school system. Moreover, the national educational policy is now geared towards providing the students with a practical background applicable to the fishing industry and at the same time provide an adequate scholastic background to enter universities.

Norwegian fishery education can be categorized as follows:

1. Fishery education in primary and secondary schools

2. Special vocational schools

3. Universities and technical schools

4. Continuous (adult) educational programs

Primary and Secondary Schools

On the primary level, fishery and marine subjects are part of the elective courses the students may choose. On the secondary level, the students may elect two separate majors in fishery education: Fishing Technology and Seafood Processing.

Vocational Schools

a) Fishing Technology

This is a one-year course based on nine years of primary and secondary schooling and prepares the students for the "Second Class Coast Shipper" exams. If the students (17-18 years old) pass the exams, the certificate is not written out until the students have 26 months of vessel experience and have passed the age of 21. This particular course is now given at four schools in Norway. It was first given in 1973-74 and has been well received.

If the students want to further pursue their education in fishing technology the traditional course for fishing skippers at the fishery vocational school is still available. This one-year course prepares the students for "First Class Fishing Skipper" certificates. At present there are five vocational schools with this curriculum in Norway. The course itself may be used as a prerequisite for students who will pursue a general maritime education.

In addition to the one-year course in fishing technology, these vocational schools also offer courses in engineering (engine) and galley cooking.

b) Seafood Processing

Education in this area is also offered at two schools as a 10th year in addition to the compulsory primary and secondary education. An attempt is presently being made to solicity support from the processing industry in providing the students with employment seniority based on their education.

In addition to this one year, vocational training and additional courses are offered at the seafood processing school in Vard. There is only one of these processing schools in Norway.

Other vocational schools for the fishing industry train students at the Norwegian Canners' School, and the Federal School for Food Science.

Universities and Technical Schools

The Norwegian Fishery University was established in 1972 as an umbrella institution for fishery education at the Universities of Tromso, Bergen, Oslo, and Trondheim. The University of Tromso has a broad spectrum of fishery related studies, including: fishery biology, fishery economics, seafood technology, and political organization. The graduates receive the title of Fishery Candidates.

The Universities of Bergen and Oslo, Norwegian Technical University (at Trondheim) and the Norwegian School of Business Administration (at Bergen) provide graduate programs for their students in fishery biology and nutrition, seafood processing and fishery economy.

Bergen's Technical College provides, according to student demand, a one-year course in seafood processing. At present (1977) this course is not being taught due to lack of student interest.

With an education from the Norwegian Fishery University the student may obtain employment in educational and research institutions, private and public sector, extension service and numerous political and cooperative fishery organizations.

Norland Community College at Bodo offeres the following courses related to fisheries:

1. The 2 1/2-year program emphasizes fishery economy, marine biology and seafood processing. Upon graduation, the students qualify for employment in the private and public sector of the fishing industry, fishery cooperatives, political organizations and extension service.

2. The 1-year programs emphasizes fishery resource biology and the utilization of these resources.

3. Two courses of 1/2-year each emphasize fishery biology and marine resources and are offered for teachers in secondary schools.

The commonality of the fishery program at Nordland Community College is its vocational emphasis directed toward educational institutions and the fishing industry in general.

Continuing (Adult) Education

Continuing education is offered by the Directorate of Fishery in fishing gear, electronics, and navigation. Universities and other educational institutions are now also beginning to offer similar short courses, particularly within the framework of the secondary school system. This redirection, which has occurred over the last 4-5 years, will elevate the educational standard of the employees in the fishing industry.

ACKNOWLEDGEMENT

This paper was based on a recent white paper on Norwegian fisheries by B. Myklebust, Norwegian Department of Fisheries.

APPENDIX E

QUANTITATIVE MEASURE OF FISHING

FLEET PRODUCTIVITY OF THE MAJOR FISHING NATIONS

There is no agreement on how to measure the productivity of a nation's fishing fleet because similar data bases are not available for each of the major fishing nations. Such a comparison was attempted by Kravanja (1976) who presents available data on productivity of the largest high seas fishing fleets for the year 1973. Part of these data are listed in accompanying table. Catch for the U.S.S.R and Japan do not include marine mammals, such as whales and seals, for which data are not available. Only vessels over 100 gross register tons are included in the compilations. Gross register tons is a standard volume measure, not vessel weight or displacement.

Attention is directed to the last column of the table which gives a measure of fishing fleet productivity for each country derived from dividing the live weight of its catch by the total gross register tons of its high seas fleet. By this measure, the Russian fleet is the least productive of the major fleets. Kranvaja (1976) explains part of this relatively low productivity as attributable to the fact that more than half of the Russian fishery fleet tonnage is represented by support vessels.

Japan has a high seas fishing fleet of which 14 percent of its tonnage is in support vessels. Nevertheless, all other things being equal, the Japanese fleet is much more productive than the Russian fleet. Kravanja (1976) suggests that this differnce in productivity is related primarily to the political systems of the two countries. That is, the central government role in setting quotas for Soviet fishermen may be contrasted with the profit motive of Japanese fishing corporations.

The table also reveals that, contrary to popular opinion, the United States fishing fleet appears to be very productive. The productivity listed for the U.S. fleet is larger than that for the Japanese fleet. However, because there are relatively few support vessels in the U.S. fleet, an adjustment for this factor would reverse the position of the two nations.

Highest in productivity is the Norwegian fishing fleet which operates in similar fashion in the U.S. fleet. Kravanja (1976) suggests that such productivity is most related to the modern and efficient vessels and gear used by Norwegian fishermen.

An obvious failing of the productivity measure used is its focus on catch rather than on some fish product. For example, some support vessels for the Soviet high seas fleet are factory ships that process most of the catch into items that can be taken from the dock directly to the marketplace. In contrast, much of the Japanese catch and essentially all of the U.S. and Norwegian catches are processed at shore facilities.

Another controversial measure incorporated into the data is reliance on vessels larger than 100 gross register tons to defined size of the fishing fleet. The U.S. has relatively few vessels of that size and, therefore, a small offshore fishery fleet. However, the U.S. has an extensive coastal fishery fleet consisting of vessels under 100 gross register tons. Because the catch of such small vessels is accumulated in the total catch, given in table, the measure of U.S. productivity is highly skewed. It gives a falsely high rating of U.S. fishing productivity. Were it possible to measure total gross register tonnage of the entire U.S. fishing fleet its productivity would be significantly lower.

Size and Relative Productivity of Some of the World's Largest High Seas Fishery Fleets, 1973 (after Kravanja, 1976)

Country	Number of Vessels	Gross Register Tonnage (Millions)	Live Weight of Fisheries Catch-(Millions of Metric Tons)	Productivity
U.S.S.R	4,700	6.50	8.6	1.3
Japan	3,099	1.51	10.7	7.1
U.S.	1,577	0.36	2.7	7.6
Norway	604	0.20	3.0	14.8

* $\text{Productivity} = \dfrac{\text{catch (millions of metric tons)}}{\text{gross register tonnage (millions)}}$

APPENDIX F

SECONDARY SCHOOL, OCEANOGRPHY COURSE ENROLLMENT IN THE UNITED STATES

A brief survey of oceanography course enrollment in the secondary schools of eight states was undertaken as part of the present study. As a first step, inquiries were sent to the selected members of the Council of State Science Supervisors, Inc. (CSSS). The CSSS members were asked to supply information, for their states, about the kinds and amount of marine-related coursework given in high schools during the 1977-78 academic year. The responses are listed in the accompanying table where these data are compared with similar data obtained from a nationwide survey of public secondary school curriculum, for the 1972-73 school year, conducted by the Department of Health, Education and Welfare (DHEW). The DHEW data are based on teacher responses within the oceanography category of secondary school, natural science course offerings (Ostendorf and Horn, 1977). No other categories, relevant to this study, were surveyed by DHEW.

Most states do not have a mechanism for collecting and reporing detailed course and enrollment data on a continuing basis. Therefore, in any future survey it will be necessary to obtain information from local superintendents of schools, science coordinators, science chairpersons or other knowledgeable persons. However, if the present comparison data are representative of the nation then there were 1.47 times as many students enrolled in oceanography courses in 1977-78 than in 1972-73. Ostendor (1976) reports that total U.S. oceanography enrollment in public secondary schools was 46.077 for the 1972-73 school year. Therefore, 1.47 times the 46,077 enrollment in 1972-73 suggests that total U.S. oceanography course enrollment has risen to 67,733 in 1977-78.

But the enrollment project may be too low. Knowledgeable professionals in the commercial publishing industry have suggested that oceanography and marine biology enrollment in all secondary schools in the nation for 1977-78 may actually total 150,000.

Regardless of questions that can be raised about the accuracy of enrollment data discussed above. There is no question that oceanography and marine biology are increasingly present as secondary school courses or as parts of other courses such as earth science.

Comparison of Department of Health, Education and Welfare (DHEW) Survey of Secondary School Oceanography Courses for the 1972-73 School Year and the National Sea Grant College Program Survey for the 1977-78 School Year

State	Agency	Number of Schools	Number of Students
Delaware	DHEW	3	160
	OSG	48	995
Florida	DHEW	30	2,670
	OSG	129	12,385
Hawaii	DHEW	2	51
	OSG	80	2,096
Virginia	DHEW	2	178
	OSG	18	852
California	DHEW	*	13,937
	OSG	*	8,968
Iowa	DHEW	*	165
	OSG	*	45
North Carolina	DHEW	*	393
	OSG	*	676
Rhode Island	DHEW	2	175
	OSG	40-50	approx. 700
Total	DHEW		17,729
	OSG		26,017

* signifies that data are not available