R E P O R T R E S U M E S

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THE NEED TO ESTABLISH A MARINE SCIENCES TECHNOLOGY PROGRAM AT SHORELINE COMMUNITY COLLEGE.

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DURING THE SUMMER OF 1966, FACULTY MEMBERS OF THE COLLEGE CONDUCTED AN INTERVIEW SURVEY TO DETERMINE THE FEASIBILITY OF ESTABLISHING A MARINE SCIENCE TECHNOLOGY PROGRAM. MANPOWER NEEDS OF 70 INDUSTRIES, INSTITUTIONS, AND GOVERNMENTAL AGENCIES CONCERNED WITH THE FIELDS OF OCEANOGRAPHY AND MARINE BIOLOGY WERE STUDIED IN TERMS OF JOBS PERFORMED BY MARINE BIOLOGICAL TECHNICIANS, PHYSICAL OCEANOGRAPHIC TECHNICIANS, AND GENERAL BIOLOGICAL TECHNICIANS. TECHNICAL SUPPORT PERSONNEL WERE MOST COMMONLY TRAINED ON-THE-JOB OR THROUGH MILITARY SERVICE. EMPLOYERS EMPHASIZED THAT THE WORK OF TECHNICIANS COULD NOT BE DONE BY A PERSON TRAINED IN THE CONVENTIONAL SCIENCE COURSES IN A UNIVERSITY WITHOUT LONG ADDITIONAL TRAINING PERIODS. AT PRESENT, ON THE COMMUNITY COLLEGE LEVEL, ONLY TWO INSTITUTIONS HAVE TECHNICAL TRAINING PROGRAMS RELATED TO THE MARINE SCIENCES. IN THE THREE CATEGORIES, MORE THAN 1,000 NEW POSITIONS WILL BE OPEN IN THE NEXT 3 YEARS IN THE AREA SURVEYED. TO MEET THE NEEDS, THE ATUTHORS SUGGEST THAT A PILOT PROGRAM IN MARINE TECHNOLOGY BE ESTABLISHED AS SOON AS POSSIBLE AT THE COLLEGE. (AL)

OCEANOGRAPHY TECHNICIANS

A Report

to the

Vocational Division

of the

Department of Education

Olympia, Washington

1966

THE NEED TO ESTABLISH

A

MARINE SCIENCES TECHNOLOGY PROGRAM

AT

SHORELINE COMMUNITY COLLEGE

by

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The Division of Vocational Education

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Olympia, Washington

INTRODUCTION

Recent advances in the industrial, institutional and governmental areas have made it increasingly evident that there is a great demand for personnel with specialized training in Marine Science Technology.

During the summer of 1966, Faculty members of Shoreline Community College conducted a survey to determine the feasibility of establishing a Marine Science Technology program at a two-year institution. This survey was financed through funds from the State Office of Vocational Education, Olympia, Washington

Although the term technician often refers to a person with a Baccalaureate degree, in this report it is used to designate a person without a degree, who is trained to use instruments and record and handle data.

This report is divided into the following sub-sections.

I. Purpose
II. Procedure
III. Summary of data
IV. Job analysis
V. Assessment of existing training facilities
VI. Conclusions

I. PURPOSE

PURPOSE

At a preliminary meeting with Dr. Ray Jongeward and Dr. Fred Miner, Office of Vocational Research, Division of Vocational Education, the authors of this report outlined the purposes as follows:

> a survey of industries, institutions and governmental agencies concerned with the fields of Oceanography and Marine Biology.
>
> a tabulation of the jobs performed by technicians in these fields.
>
> an assessment of those facilities which are already established to train these technicians.
>
> the feasibility of setting up a Marine Technician training program at the community college level.

II. PROCEDURE

PROCEDURE

A survey form was developed to collect the following information: agency and person interviewed; type of technicians employed; jobs done by technicians; equipment used and training of present technicians; approximate salary, number presently employed, personnel turnover; and plans for future employment.

A survey was made of industries, governmental agencies and institutions that employ marine-related technicians.

The number of employees in the following three categories was totaled:

marine biological technicians
physical oceanographic technicians
general biological technicians[1]

A job analysis was made from the data collected in these three categories.

Information on the interview sheets was analyzed to find where the technicians are now being trained.

From the job analysis, the feasibility of setting up a program at the community college was assessed.

In addition, at the end of each interview, the interviewee was asked to suggest other employers in the Marine Sciences or related fields. These suggestions were followed up whenever feasible.

This survey was conducted using the personal interview technique. It is felt that a better response would be obtained and more information collected by using this method.

[1]This latter category was included, because it appeared to be large in scope, related to the marine work, and undeveloped by any schools.

III. SUMMARY OF DATA

SUMMARY OF DATA

The summary is divided into:

I. Marine Biology Technicians

II. Physical Oceanographic Technicians

III. General Biological Technicians

IV. Other employees needed in the marine related industries, and an alphabetized list of all agencies interviewed.

I

Marine Biology Technicians Needed In The Next Three Years

EMPLOYER	FULL TIME	PART-TIME
Battelle Northwest	5 per year	
Essa Pacific Oceanographic Lab.	1 per year	
Metro	4 per year	
Oregon State University	4 per year	
Pulp Mills	1 per year (per mill)	
Rayonier Laboratories	2 per year	5 per year
San Juan Fish and Packing	1 per year	
Seattle Public Aquarium		4 per year (summer)
Standard Oil Co. Exploration	1 per 2 years	
State Dept. of Fisheries	1 - 2 per year	
State Shellfish Lab	1 - 2 per year	
U.S. Bureau of Commercial Fisheries, Portland, Ore.	13 Fisheries Aids 3 Physical Science Aids	
U.S. Bureau of Commercial Fisheries, Seattle, Wn.	2 per year	
U.S. Dept. of Health, Purdy, Washington.	10	
U.S. Fish & Wildlife	1 for 2 years exploratory fish 1 per year fish technology lab 5 Biology lab	3 per year
U.S. Fish & Wildlife Fish Disease Lab.	3	
U.S. Fish & Wildlife Marine Mammal Lab.		9 per year

EMPLOYER	FULL TIME	PART-TIME
U.S. Water Pollution Fed. Control Board	1 per year	
U. of W. Oceanography	2 - 3 per year	
U. of W. Rad. Biology	3 per year	
Weyerhauser	10	

Jobs to open up in Marine Biology in the next three years

TOTAL: 157

Part-time - 26 per year - openings.

TOTAL: 78

II

Physical Oceanographic Technicians Needed In The Next Three Years

EMPLOYER	NEED PER YEAR	PART-TIME
Applied Physics Lab.	2	
Oregon State U. Oceanography	2	
U.S. Coast & Geodetic Survey	30	
U. of W. Oceanography	2 - 3	
Total hired in three years ---	111	

III

General Biological Technicians Needed In The Next Three Years

EMPLOYER	FULL TIME	PART-TIME
Arden Farms	1 per 2 years	
Bar S Foods	12	
Carnation Dairy	1 per 2 years	
City Public Health Dept.	3 per year	8 per year
Crescent Manufacturing Co.	1 per year	
Doctors Hospital	1 per year	
Enzomedic Laboratories	15 per year	
Foremost Dairy	1 per 2 years	
H & N Hatcheries	2 per year	
King County Public Health, Pollution Control Board	Great demand	
Libby McNeill Libby Co.	5 per year	50 per year
Lyndon Farms & Western Farmers Association	1	
Nalley's Inc.	2 per year	4 per year
Pathologists Central Lab.		5 per year
Physicians Clinical Lab.	5 per year	
U.S. Dept. of Agriculture	3 per year	
U.S. Dept. of Health Ed. & Welfare	4 per year	
U.S. Public Health Hosp.	Estimates six per hospital in 2 - 3 years.	
U.S. Water Pollution, Fed. Control Board	8 per year	
U. of W. Professional Placement Office	180 per year (could double with new facility)	
Vitamilk Dairy	1 per year	

EMPLOYER	FULL TIME	PART-TIME
Weyerhauser	20 per year	

Need for General Biology Technicians in the next three years

TOTAL: 767

Part-time need - openings

TOTAL: 201

IV

Other Employees Needed In The Marine Related Industries

EMPLOYER	NEED	TYPE OF EMPLOYEE
Alaska Steamship Co.	Great need	Machinists, seamen, stewards, pipe fitters, firemen, auto mechanics, metal workers, and deck and engine room officers
Battelle Northwest	3 - 4 per month	Instrumentation techs. electricians, machinists, engineering ass ts.
Bonneville Power Admin.	Large turnover	Power systems control, electronic tech, craftsmen, meter & relay, maintenance
Foss Launch & Tug	100	Deck & engine room officers
Marine Construction & Design	2 per year	Mechanical engr. tech.
Northwest Laboratories	1 per year	Chemical tech.
Pacific Maritime Assoc.	Many longshoremen	Crane operators, vehicle operators, winch operators, cargo supervisors.
Port of Seattle	100	Marine engineers, deckhands, officers
San Juan Fish & Packing Co.	100	A need for refrigeration techs. was pointed out.
Standard Oil Co.	2 per year	Geological techs. Paleontological techs.
U.S. Army Corp of Engrs.	10 - 15 per year	Engr. Aids, Survey Aids
U.S. Bureau of Mines	Several per year	Metalurgical Chem. techicians

EMPLOYER	NEED	TYPE OF EMPLOYEE
U.S. Navy Facilities Engr. Command	Expanding	Cartographers, electronic & engr. ass'ts.
U.S. Navy Shipyard	50 per year	Electronics techs. Engr. Aids.
U.S. Weather Bureau	Several per year	Meteorological electronic techs.

Alphabetized List Of All Agencies Surveyed

EMPLOYER	NON-DEGREED EMPLOYEES	PROJECTED NEED IN THREE YEARS	TYPE
Alaska Steamship Co.	50 or 60 (all categories)	Great need for people in all capacities	Machinists, Seamen Stewards, Pipe fitters Auto mechanics Deck and Engine room Officers, Metal workers.
Applied Physics Lab.	33	3 Elect. per year 2 Engr. per year 2 Phys. Oceanogr.	20 Electronic 12 Engineering 1 Instr. Repair
Arden Dairy Association	3	1 per 2 years	Biological Lab.
Battelle N.W.	1000 Plus new force to be at Sequim, Wn.	Need 3 - 4 per month Now in all categories Could increase to 15 - 20 per month	75 Instrument 50 Electrician 50 Machinists 4 - 500 Engr. Ass'ts. (Included in this are Chem. Ass'ts. & Biol. Ass'ts.)
Bonneville Power Admin.	100	Large turnover and growing	Power System Control Electrician, Craftsmen Meter & Relay maintenance.
Carnation Dairy Co.	3	1 per 2 years	Biological Lab.
City Health Sanitation Department	30		
City Public Health Dept. Lab. Seattle, Wn.	30	5 per summer, part-time 2 - 3 per year, full time	Biological Lab.

EMPLOYER	NON-DEGREED EMPLOYEES	PROJECTED NEED IN THREE YEARS	TYPE
Crescent Mfg. Co.	1	1 per year	Biological Lab.
Doctors Hospital	Few	Slight	Nurses Aids X-Ray
Enzomedic Laboratories	Several	Will hire 2 - 4 in a year and a half. Once mfg. begins 10 - 15 per year.	Quality Control
Fisher Flour Mills		None	Quality Control
Foremost Dairy	2	1 per 2 years	Quality Control
Foss Launch & Tug	100 (All hired through Union)	Several hundred licensed men could be used right now. (Deck & Engine Room Officers) Foss needs 20 licenses men now.	Deck & Engine room Officers.
H & N Hatcheries	5	2 per year (Many Labs. throughout U.S. 6 Techs. needed constantly)	General Lab.
Honeywell Corporation Seattle Development Lab.	100	5 per year 5 per year 5 per year 2 per year 5 per year 2 per year 2 per year 2 per year andexpanding operations	Engr. Ass't. Engr. Aids Engr. Techs. Project planners Assemblers, Product Engr. Aids Sales Tech. Writers
King County Public Health Pollution Control Board	Great demand		

EMPLOYER	NON-DEGREED EMPLOYEES	PROJECTED NEED IN THREE YEARS	TYPE
Libby, McNeill, Libby	100	50 part-time per season plus 5 per year	
Lyndon Farms & Western Farmers Assoc.	2	Slight	General Biol. Lab.
Marine Construction & Design:	10	2 per year	Welders Mech. Engr. Tech.
Metro	9	Up to 27 if they go to a 24 hour shift, if not, about 4 per year	Marine Biological
Nalley's Inc.	6 full-time 4 part-time	2 per year 4 part-time summer	Quality Control
National Park Service	0	0	Professional Oceanogr. only
Northwest Consultant Oceanographers	0	0	Use only 4-year College Graduates.
Northwest Laboratories	0	1 per year	Chem. Tech. Use only Grad in Chem. at this time.
Ocean Marine Corporation	0	0	Shipwrights, Carpenters, and Welders only. No Technicians.
Ocean Systems Inc.	0	Possibility of hiring several if Seattle becomes an Oceanographic Center.	John Lundberg heads operation. No Technicians at present. Would want Marine Biol. & Oceanogr. Tech.

EMPLOYER	NON-DEGREED EMPLOYEES	PROJECTED NEED IN THREE YEARS	TYPE
Oregon State University Fish & Game Dept.	10 - 13	Hire only own students	General Biol.
Oregon State University Oceanography Dept.	30	Up to 9 per year covering turnover and new hiring.	Marine Biol. will need 16 seamen, also, and Oceanogr. Tech.
Pacific Maritime Assoc.	1300 Longshoremen	On-the job training	Drivers, Crane oper.
Pacific Oceanographic Laboratory	3	1 per year In process of planning new facility.	Marine Biological
Pathologists Central Lab.	2 full-time 5 part-time	5 part-time per year	General Biological
Physicians Clinical Lab.	5	5 per year	Gen. Biol. Tech., with Histolo. & Cystology.
Port of Seattle	Very great number	A desperate need for Marine Engrs. & Deck-hands in both apprentice-ship and upper grades on ships right now.	Marine Engrs. Deck Officers, Deckhands.
Pulp Mills (Confirmed by Rayonier & Weyerhauser)	All mills need Quality Control people and at least 1 lab. Gen. Biol. Tech.	1 per mill	General Biol. Lab.
Rayonier Laboratories	2 permanent 5 part-time	2 permanent each year 5 part-time, summer, per year	Marine Biol.
San Juan Fish & Packing Company	1	1 - tremendous need for Refrigeration Engr. Tech. 100	Quality Control Refr. Engr. Tech.

EMPLOYER	NON-DEGREED EMPLOYEES	PROJECTED NEED IN THREE YEARS	TYPE
Seattle Public Aquarium	4	4 per year, seasonal	Aquarist Marine Biol.
Standard Oil Co. Exploration Dept.	6	2 per year	Phys. Ocean. Gen. Biol.
United Control	Information coming	-------	
U.S. Army Corp of Engrs. Portland, Oregon	100	10 - 15 per year	Engineers, Surveying Tech.
U.S. Bureau of Commercial Fisheries, Seattle, Wn.	6	12 (2 per year turnover)	3 Marine Biol. 3 Phys. Sci. Aids
Harvey Moore, Director Private Research	300 +	25 per year	Commercial Fishermen
U.S. Bureau of Commercial Fisheries, Portland, Ore.	16	Need is growing and need many during summer	13 Fisheries Aids GS4's - 65's 2 Phys. Sci. Aids.
U.S. Bureau of Mines	455	Turnover small in this area. Greater in Albany, Ore. & Spokane	Metalurg. Rsch (Chem. Tech.)
U.S. Bureau of Outdoor Ed.	0	0	Use only 4 year Graduates.
U.S. Coast Guard	(Letter sent)		
U.S. Coast & Geodetic Survey	100	30 per year	29 Surveying 1 Marine Biol.
U.S. Dept. of Agriculture	24	3 per year	Conservation or General Lab.
U.S. Dept. of Interior U.S. Fish & Wildlife Fish Disease Lab.	6	3	Marine Biol.

EMPLOYER	NON-DEGREED EMPLOYEES	PROJECTED NEED IN THREE YEARS	TYPE
U.S. Dept. of Interior (continued)			
U.S. Fish & Wildlife Montlake Blvd. Exploratory Fishing	5	1 per 2 years	Marine Biol.
U.S. Fish & Wildlife Montlake Blvd. Technology Lab.	3	1 per year (3 per yr. part-time summer)	Marine Biol.
U.S. Fish & Wildlife Montlake Blvd. Biology Lab.	4	4	Marine Biol.
U.S. Fish & Wildlife Marine Manual Lab.	9 part-time	9 per year part-time	Marine Biol.
U.S. General Services Admin.	1	0	Data Processing
U.S. Health Ed. & Welfare Food & Drug Admin.	5	4 per year	General Biol.
U.S. Navy, N.W. Division Naval Facilities Engr. Command	10	Expanding	Cartographers Electronic Aids Engr. Aids
U.S. Navy Shipyard	700	50 per year	Electronics Engr. Aids, Craft Electric Mechanical
U.S. Public Health	10	10	Marine Biology
U.S. Public Health Hosp.	Very few	Up to 6 per hosp. when they are hired again.	General Biol.

EMPLOYER	NON-DEGREED EMPLOYEES	PROJECTED NEED IN THREE YEARS	TYPE
U.S. Water Pollution Fed. Control Board	10	2 per year	Marine Biol.
U.S. Weather Bureau, Seattle, Wn.	13	1 per year	Meteorologist Tech.
U. of W. Food Technology School of Fisheries	Dr. Pigott "Demand is overwhelming -- 50 - 100 Technicians with back ground in Chem., Biol., and Micro-Biol., and Statistics, could be used immediately.		
U. of W. Oceanography	21	4 - 5 per year	Marine Biol. Lab.
U. of W. Prof. Placement Office	530	15 per month	General Biol. Aids, Ass'ts.
U. of W. Radiation Biology	13 (8 Marine Biol. 5 Hatchery)	3 per year	Marine Biol.
Virginia Mason Hospital	0	0	All 4 - year people.
Vitamilk Dairy Inc.	0	1	General Biol. Lab.
Washington State Dairy Association	0	0	Only 4 - year people.
Dept. of Fisheries	150	15 per year 1 - 2 per year	Hatchery Tech. General Marine Biol.
Shellfish Lab. Quilcene, Washington	4 permanent 5 part-time	1 - 2 permanent 5 part-time per year summer	Marine Biol. Lab.
Weyerhauser, Inc.	200	30 per year (20 per year 10 per year)	General Biol. Lab. Marine Biol. Lab.

IV. JOB ANALYSIS

JOB ANALYSIS

From the actual interview sheets the jobs performed were summarized in each of three categories:

1. Marine Biology Technicians: do laboratory work which relates directly to the biological aspect of marine environments. These technicians work in laboratories, such as radiation biology laboratories, shellfish research laboratories, etc.

2. Physical Oceanographic Technicians: work with physical processes which occur in the marine environment. These technicians work for the Coast and Geodetic Survey, the Oceanography Department of the University of Washington, etc.

3. General Biological Technicians: do routine laboratory work relating to the biological sciences but not necessarily the Marine Sciences. These technicians work in food processing plants, for institutions such as the University of Washington research labs, etc.

All of the technicians surveyed were proficient in certain common skills. In general, they were all able:

1. to communicate with people.
2. to record scientific material and follow directions.
3. to record and organize data, draw graphs and prepare preliminary reports.
4. to solve linear equations.
5. to do simple statistics, (mean, goodness of fit, chi^2).
6. to use calculators and slide rules.
7. to understand the basic use of computers and to punch information on cards.
8. to prepare chemical solutions, using concepts of molarity and normality with gravimetric and volumetric methods.
9. to perform simple repair of electronic instruments by using schematic diagrams and electronic testing equipment.

THE SPECIFIC JOBS PERFORMED BY TECHNICIANS WERE:

Marine Biology Technicians

1. To prepare and sterilize media and instruments, using sterile handling techniques, incubators and autoclaves.
2. To maintain pure culture lines; protozoan, algae, bacterial and tissue.
3. To maintain sterile conditions within a laboratory.
4. To prepare tissues for microtome, use microtome and prepare and stain slides.
5. To measure acidity, using the pH meter.
6. To analyze unknowns with colorimeters.
7. To use microscopes: compound, monocular, binocular, dissecting and phase microscopes.
8. To operate microprojectors.
9. To operate cameras for microscopes.
10. To develop film and print, using enlarger.
11. To identify chemicals with spectrophotometers (light and ultra violet); to make spectrographs.
12. To analyze gases with gas analyzers and chromatographs.
13. To weigh, using all kinds of balances.
14. To separate suspensions by using various kinds of centrifuges.
15. To read and operate oscilloscopes and impscopes.
16. To operate a kymograph.
17. To operate timers and recorders: barometric, temperature and others.
18. To measure volts, ohms, milliamperes.
19. To measure radioactivity, using counters, films and dosimeters.
20. To operate fluorometers.
21. To read photometers.
22. To measure refraction with refractometers.

23. To set up and use samplers

24. To use transducers to measure flow, temperature and pressure in living organisms.

25. To measure conductivity with conductometers.

26. To record respiration, using respirometers or Warburg apparatus.

27. To count blood with hemocytometers or electric counters.

28. To distill liquids and read Ion exchange columns.

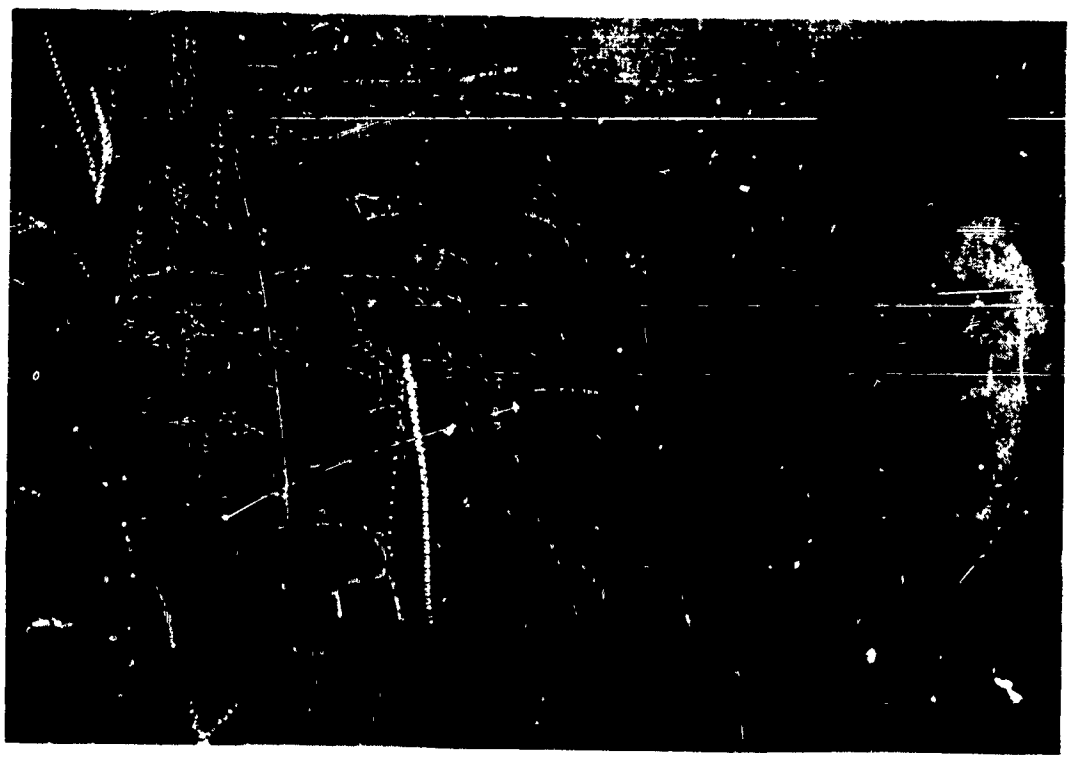
29. If sea-going, to do shipboard duty and be acclimatized to the sea.

30. To clean, using ultrasonic devices.

31. To apply knowledge of reproduction, symbiosis, metabolism, respiration, evolution, energy cycles, and other basic biological principles to the job at hand.

32. To identify common marine fauna and flora.

33. To apply knowledge of Physical Oceanography: currents, tides, temperature curves, effects of geological formation, etc., to the job at hand.



Left: Marine Biology Technician operating a Warburg Respirometer. Instruments of this type are important in obtaining data relative to the metabolic activities of biological material.

Right: Technician operating a Microtome in the preparation of microscope slide. The Microtome slices tissue preparatory to mounting and staining on a glass slide.

Physical Oceanographic Technician

1. To read the compass, tie knots, practice shipboard ethics, swim, skin dive, scuba dive, practice first aid, work on a ship without getting sea sick, and to cook in emergency.

2. To take water samples with Nansen bottles, Van Doren bottles, drogues, drift bottles.

3. To record temperatures with bathythermographs.

4. To record pressure with barographs.

5. To use pyrheliometers.

6. To record current with Robert current meters, and Eckman current meters.

7. To record depths with fathometers.

8. To locate sound sources with hydrophones.

9. To determine location, reading radar, shoran, loran.

10. To determine bottom contours with sonar.

11. To probe water salinity, alkalinity, density, acidity, oxygen content and phosphate content, with proper instruments.

12. To take core samples with Phleger corer and Kullenberg piston corer.

13. To take a bottom sample with clam shell grab, orange peel grab, Peterson grab, dredges and anchor dredge.

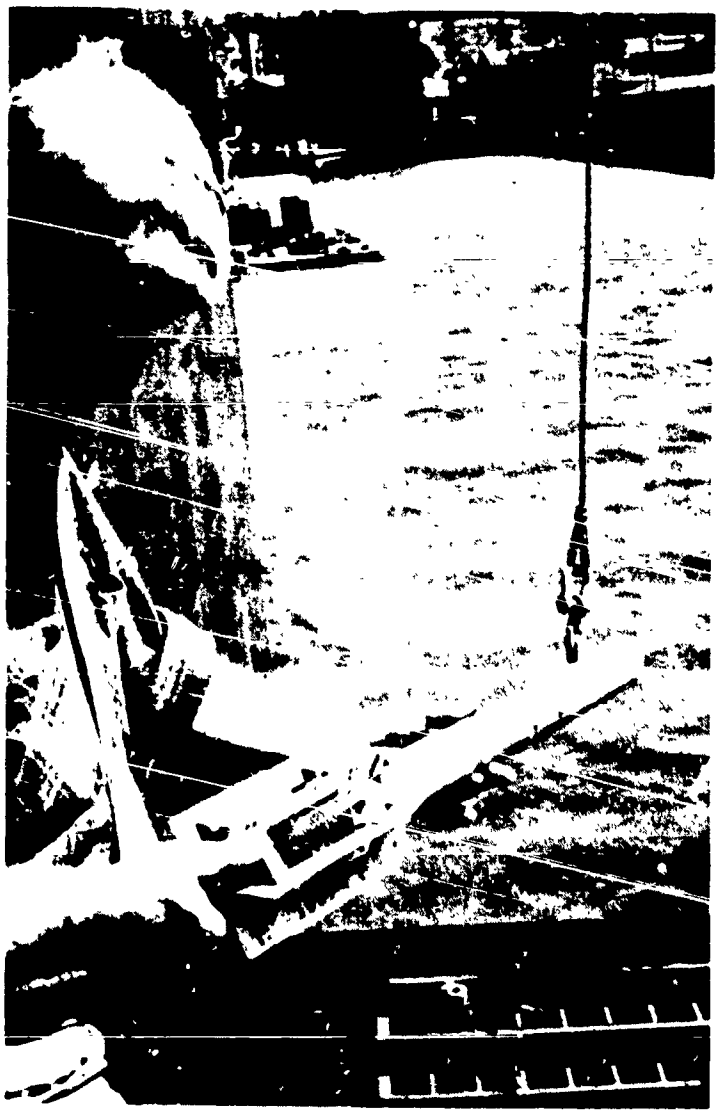
14. To collect samples with otter trawl, ring trawl, beam trawl and midwater trawl.

15. To collect plankton of different sizes with plankton nets.

16. To read charts, maps, and plot a map from aerial photographs.

17. To develop a negative, print a picture, and operate a camera.

18. To apply knowledge of Oceanography (currents, tides, temperature curves, effects of geological formation, etc.) to problems at hand.



Left: Physical Oceanographic Technician adjusting a Bathythermograph. This instrument records temperature against pressure usually in the upper 150 meters of the area to be sampled

Right: One of the Technician's jobs on ship is taking water from Nansen bottles. These devices take water samples at sub-surface levels for physical and chemical studies. The Technicians perform routine analysis on the water samples to obtain this data.

General Biological Technicians' Jobs

1. To prepare and sterilize media and instruments, using sterile handling techniques, incubators and autoclaves.
2. To maintain pure culture lines: protozoa, algae, bacteria and tissue.
3. To maintain sterile conditions within a laboratory.
4. To identify organisms, using keys.
5. To prepare tissues for microtome, use microtome, and prepare and stain slides.
6. To recognize human tissues.
7. To analyze blood and urine.
8. To measure P^H with P^H meters.
9. To analyze chemicals using colorimeter.
10. To operate microscopes: compound, monocular, binocular dissecting and phase microscopes.
11. To operate microprojectors.
12. To take pictures of microscope slides.
13. To develop film, use an enlarger, and print pictures.
14. To analyze matter with spectrophotometers (ultra violet and light).
15. To analyze gas, using a gas analyzer.
16. To weigh with all kinds of balances.
17. To separate suspensions by using centrifuges.
18. To apply knowledge of reproduction, symbiosis, metabolism, respiration, evolution, energy cycles, to the job at hand.

V. ASSESSMENT OF EXISTING TRAINING FACILITIES

ASSESSMENT OF EXISTING FACILITIES

Technical support personnel in the Marine Sciences are currently trained in several ways. The most common training method is "on the job training." This on the job training consumes much time and involves great expense. Of course, some on the job training is invaluable, but training in basic skills could well be done elsewhere, saving employers this time and expense. Many technical support personnel are trained in military service. Personnel with specific training in electronics, instrumentation, vessel operation and maintenance, as well as many other areas, are employed as a result of military training.

The employers emphasized that the work done by these technicians can not be done by a person trained in the conventional science courses in a university. At present, people with this background are found on these jobs but are only valuable after long training periods on the job and then are often unhappy with the routine aspect of the work.

At the community college level, Penninsula College, Port Angeles, Washington, and Clatsop College, Astoria, Oregon, are the only two institutions, on the Pacific Coast, which have technical training programs related to the Marine Sciences. The program at Penninsula is Fisheries Technology. The Clatsop program is marine technology.

VI. CONCLUSIONS

CONCLUSIONS

The total need for new employees in the next three years is:

Marine Biology Technicians	157
Physical Oceanographic Technicians	111
General Biological Technicians	767

There is also a need by marine industries for diesel engineers, refrigeration technicians, cooks, stewards, yeomen, trained commercial fishermen, net makers, and licensed Merchant Marine officers.

Some of the reasons for the phenomenal demand for these technicians are:

A. Improved environmental prediction and modification.

B. Pressure for development of new sources of raw materials.

C. Interest in more exploitation of biological resources in the sea, ranging from fish yields to biomedical applications.

D. Concern with pollution of beaches, estuaries, and other waters.

E. Improvement in ocean navigation, ship design and ports.

F. National defense.

G. Awareness of the lag in ocean exploitation by the U.S. compared to other countries of the Pacific Rim.

H. Replacement of engineers and scientists by technicians, where routine data taking is done, freeing the high salaried professional scientist or engineer to do work for which he alone is qualified.

The data gathered in this report indicates that there is a need for the establishment of at least one Marine Biology lab technician training program and, in conjunction with this because they are so closely related, the establishment of a training program for Physical Oceanographic technicians.

The data indicate that there is a great need for General Biology Technician training programs in the Puget Sound area.

Community colleges and vocational schools should be aware of the need for the other types of training listed above.

The existing training programs and resources are not sufficient to train the technicians needed by industry and research today.

Curricula should be developed at the community college level to train students to do these jobs. Because of location, enthusiastic interest by the present faculty, (eight of who have been employed in these areas recently) and community and school board support and approval, Shoreline Community College is an ideal choice to proceed with the task of training marine related technicians. Already large numbers of students, sufficient to begin a pilot program, have indicated interest in enrolling in these programs and are waiting for them to be developed.

A laboratory facility to train personnel in Marine Science technologies should be planned and developed around the curricula for these programs. A main feature of this laboratory facility should be the inclusion of an instrumentation section to be used in the training of technicians. The latest instruments used in the marine sciences should be available to teach their operation and maintenance to prospective technicians. The other unique feature of the facility should be flowing salt water to provide living specimens and actual operation of instruments under the fresh and salt water conditions students will meed on the job.

Included in our survey were twenty-eight of the major Marine Science laboratories on the Pacific Coast. The operation of each

laboratory was observed. Although they were sea water labs, none of these provided the type of training we envision. The good points, as well as problem areas, were noted. It is hoped that with this information at hand, the design and operation of the laboratory facility at Shoreline Community College will be optimal.

Facilities such as those described above would attract trainees and would develop a program by providing:

> courses for adult education in the fields of natural history and conservation of marine resources. Courses would also be offered to local fishermen to update their knowledge of the latest electronic gear available.
>
> Teacher In-Service courses. These courses would be aimed primarily toward elementary, high school teachers and counselors, so they may teach the importance of the Marine Sciences to the students, and acquaint them with career opportunities.
>
> a Marine Science field trip center for elementary, junior high and senior high schools to introduce students to the Marine Sciences. This facility could also be used during the summer for interested students to participate in Marine Science Institutes.
>
> a study facility for those portions of other programs such as: Biology, Botany, Chemistry, Electronics, Engineering, Geography, Geology, and Physics, which pertain to the Marine Sciences.
>
> a small, local aquarium and museum for the Marine Sciences and industries.

In view of the above data it is evident that a pilot program in Marine Technology should be established as soon as possible at Shoreline Community College.