Intergovernmental
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2

Training Course Reports

IOC Regional Training Course for Marine Science Technicians

Held at the Australian Institute
of Marine Science

Cape Ferguson, Queensland
1-28 June 1980

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IOC Training Course Reports

No.	Title	Language versions
1	IOC Indian Ocean Region Training Course in Petroleum Monitoring. Held at the Australian Department of Science and the Environment, Perth, 18 February-1 March 1980	English
2.	IOC Regional Training Course for Marine Science Technicians. Held at the Institute of Marine Science, Cape Ferguson, Queensland, 1-28 June 1980	English

I.O.C. REGIONAL TRAINING COURSE

FOR MARINE SCIENCE TECHNICIANS

COURSE REPORT

Prepared by

Mr. B.D. Scott, Course Co-ordinator

CONDUCTED AT THE AUSTRALIAN INSTITUTE OF MARINE SCIENCE,

CAPE FERGUSON, QUEENSLAND, AUSTRALIA

1 - 28 JUNE, 1980.

PREFACE

As part of its programme of Training, Education and Mutual Assistance in the Marine Sciences (TEMA), the Intergovernmental Oceanographic Commission (of Unesco) organizes from time to time, through one or more of its Member States, a training course in one or other field of marine sciences, as a means of increasing the capacity and capability of its Member States, especially the developing countries, to participate effectively in the IOC's programmes.

The present course, on physical, chemical and biological matters used in the study of coral reef and coastal marine environments, was prepared and conducted by the Australian Institute of Marine Science, at Cape Ferguson, Queensland, from 1 to 28 June 1980.

This report gives an outline of the course and a summary of its virtues and defects, as a means of making the experience available to other Member States that may wish to give a similar course, whether it be for candidates from the donor Member State, or from the region in which the donor Member State is situated, or from any other Member State.

Such courses can be an effective means of transferring marine scientific technology amongst the Member States, which is becoming increasingly necessary as a result of the emergence, from the UN Conference on the Law of the Sea, of a new ocean regime, with its new and expanded responsabilities for the Member States.

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Foreword

THE ROLE OF MARINE TECHNICIANS IN FUTURE MARINE SCIENTIFIC RESEARCH

Technicians are the front line troops of marine research. It is mainly through their skill, experience and dedication, that the collection of high quality data on the marine environment can continue unchanged into the future.

Much of the success that meteorologists have attained in their understanding of weather phenomena, is attributable to a large amount of weather data that their observers have gathered during the last 50 - 100 years. Oceanographers do not have much more than a decade or two of similar data of a much more restricted nature, in a very patchy pattern, throughout the oceans for the understanding of the ocean weather patterns.

Whilst buoys both drifting and fixed in the oceans, will supply increasing amounts of data in the future and whilst satellite and other forms of remote sensing will provide detailed surface information, every advance of this nature will require skilled and dedicated technicians to service the buoys and maintain a diligent watch on the quality of the data collected in these ways. Technicians are the watchdogs for posterity to ensure that data of today as of yesterday will be strictly comparable with future data within the same 50 - 100 years time span of the meteorologist.

Marine science encompasses a broad range of disciplines and activities, including physics, chemistry, geology and geophysics and biology carried out in mobile floating laboratories subject to the various erratic motions of the sea. The ocean doesn't easily give up its secrets to the researcher and much repetition in the same area or within the same phenomena is needed before a separation of the signature associated with the phenomenon, from the natural variability of the sea itself, can be effected.

The techniques practiced at sea must take account of the instability of the working platform itself, of the hostile nature of the ocean environment, of the effects of corrosion, pressure and temperature variation with depths upon instrument performance and reliability.

The marine technician must be capable of using and maintaining equipment of varying degrees of sophistication under these difficult working conditions. Working at sea is his major role in marine research, unlike the scientist who can spend considerable time away from the sea working up and interpreting data.

Through the United Nations Conference on the Law of the Sea (UNCLOS) the countries of the world have been obliged to think positively about the facilitation and encouragement of marine research and there can be no turning back from the global concept of the oceans that UNCLOS will foster.

The role of the marine technician is therefore a vital one for the future of marine science. For the technician himself there is a positive and exciting future as new techniques are applied to the study and understanding of the world's oceans, leading to their better utilization within the limits that must be set for their protection.

Background

This particular course was one of a regional series proposed by the Intergovernmental Oceanographic Commission (IOC), in conjunction with the UNESCO Division of Marine Sciences and was recommended by the IOC Working Committee for the Technical Education and Mutual Assistance Program (TEMA) at its second session held in New York in July 1977. The recommendation for a technician level course recognised the lack of adequately trained personnel essential for the support of scientists and engineers engaged in marine activities in developing countries.

The Australian National Commission for UNESCO agreed to organise the course in conjunction with the Australian Institute of Marine Science (AIMS) Townsville and the CSIRO, Division of Fisheries and Oceanography, Cronulla. The course was held from 1 - 28th June, 1980 at AIMS situated on the Queensland coast in a national park at Cape Ferguson, 50 km south of Townsville.

The major objective of the course was to provide training to technicians attached to institutions engaged in marine scientific and technological research in developing countries of the Western Pacific region (WESTPAC) and to acquaint them with basic techniques used in routine oceanographic studies. The course was funded by UNESCO with administrative support and staffing provided by CSIRO, AIMS, The Australian National Commission for UNESCO and the Department of Science and the Environment.

Participants

The number of participants selected was restricted to ten due to the limitations of accommodation at AIMS Townsville and on the CSIRO and AIMS research vessels. Several of the WESTPAC countries did not nominate participants and the group of ten was completed by selecting an additional participant from both Malaysia and the Philippines. The participants names and institutions are listed below:

Liang Jingzhou, Second Institute of Oceanography, P.O. Box 75, Hangzhou, China.

Sunia Waqainabete, Ministry of Agriculture and Fisheries, Rodwells Road, Suva, Fiji.

Hadikusumah, National Institute of Oceanology, Pasir Putih 1, Kompleks Bina Samudra, Ancol-Timur, Jakarta Utara, Indonesia.

Ki-Bong Lim, Oceanography Section, Fisheries Research and Development Agency, Yongdo-ku, Pusan, Republic of Korea.

Adrian Oswald Kessler, School of Biological Sciences, University Sains Malaysia, Minden, Penang, Malaysia.

Liew Kim Seng, Zoology Department, University of Malaya, Panai Valley Kuala Lumpur, Malaysia.

Gil Jacinto, Marine Sciences Center, University of the Philippines, Diliman, Quezon City, Philippines, 3004.

Honorio Untalan, Bureau of Coast and Geodetic Survey, 421 Baracca St., San Nicolas Manila, Philippines.

Somsak Ketsamut, Marine Fisheries Laboratory, Department of Fisheries, Ministry of Agriculture and Co-operatives, Bangkok-12, Thailand.

'Ulungā Manu Fa'anunu, Fisheries Division, Ministry of Agriculture, P.O. Box 14, Muku'alofa, Tonga.

Instructors

The principal instructors were selected from the scientific staff of both AIMS and CSIRO.

AIMS

Dr. K. Boto, mangrove ecology

Dr. B. Clough, mangrove ecology

Mr. N.C. Duke, botanical curation

Dr. P. Gentien, chemical oceanography

Mr. H. Mueller, chemical analysis

Mr. J. Neal, computing

Dr. E.G. Rhodes, geology

Dr. P. Sammarco, benthos

Dr. W. Williams, numerical analysis

CSIRO, DIVISION OF FISHERIES AND OCEANOGRAPHY

Mr. F. Boland, physical oceanography

Mr. G.A. Major, marine pollution

Mr. A. Pearce, physical oceanography

Mr. B.D. Scott, phytoplankton

Dr. D. Tranter, zooplankton

The instructors were assisted by the following technical officers:

AIMS

Mr. P. Dixon

Mr. A.W. Mitchell

Mr. A.L.J. Nott

Mrs. V. Ryle

Mr. R.G. Sim

Mrs. D. Smith

Mr. A.B. Thompson

CSIRO, DIVISION OF FISHERIES & OCEANOGRAPHY

Mr. F.N. Davies

DEPARTMENT OF SCIENCE AND ENVIRONMENT

Mr. T.R. McKay

COURSE CO-ORDINATOR

Mr. B.D. Scott, CSIRO.

Additional lectures on a variety of topics are noted in the section "Other Activities".

Course Outline

During the first two weeks of the course accommodation and meals were provided for the participants and visiting instructors at AIMS. The programme for the first phase of the course consisted of introductory lectures, descriptions of equipment and methods, demonstrations and practical work, to enable participants to become familiar with and develop skill with some of the simpler methods and equipment. The subjects covered by the course included physical oceanography, marine geology, chemical oceanography, marine pollution, mangrove ecology, numerical analysis of data, phytoplankton, zooplankton, benthos, and botanical curation. Instruction was directed mainly towards methods applicable in coastal marine environments.

In the second phase of the course the ten participants were divided into two groups of five to work on the two research vessels, R.V. 'Lady Basten' (AIMS) and R.V. 'Sprightly' (CSIRO). There were two five day cruises aimed at providing practical experience with physical, chemical and biological methods in coral reef and coastal water environments. The two groups changed vessels after 5 days at sea.

In the third phase of the course the participants returned to the AIMS site where they examined the data collected on the cruises. During this time they also supplemented the instruction given earlier in the course and were introduced to computing on the AIMS computer.

During the first and last phase of the course the participants viewed a variety of films, experienced lectures and excursions designed to broaden their knowledge of the marine and Australian social environments.

Course Detail

The content and schedule for instructional periods in the course, appear in the "Course Program and Synopsis" which was followed with only a few minor changes. These changes were mostly to the evening program to accommodate the availability of films and lecturers on special topics. In the outline which follows only the main features of the lectures, demonstrations and practical work are recorded.

Orientation

The course commenced with a guided tour of the AIMS laboratories, workshops and marine facilities, with an explanation of the current research projects by the AIMS staff. The tour was followed by three introductory talks.

1. Dr. S.M. Haq, Assistant Secretary of IOC, welcomed the participants and explained the past role of Australia in oceanography in the Indo-Pacific region, and how this course was a part of Australia's and IOC's commitment to assist other countries participating in marine science in the WESTPAC region. Dr. Haq also explained the organisation of IOC and its functions in international ocean science.

2. Mr. D.J. Rochford, Chief of CSIRO Division of Fisheries and Oceanography spoke on the scope, present and future nature of marine science, and the role and responsibilities of marine technicians. Part of this address has been included in the foreword of this report. Mr. Rochford illustrated his talk with a short film showing an example of new technology in the application of satellite-tracked buoys to the study of ocean currents.

3. Dr. J.S. Bunt, Director of AIMS, welcomed the participants to the institute and introduced the instructors, who briefly described their role in the course.

Physical Oceanography

The lecture described the topography of the main oceans and the importance of topography for currents, particularly at the continental margins. The large scale circulation processes in the world oceans and atmosphere were described together with the temperature and salinity structure, water masses, boundary currents, Kuroshio and East Australian Currents, and eddies. Smaller scale processes on the continental shelf were shown to depend upon bathymetry, tides, winds, density effects, daily and seasonal variations, fronts, upwelling and surface and internal waves. Methods described for measurement of currents in coastal waters were: surface drift cards and bottles, bottom drifters, floats tracked by eye, radio, radar and satellite, ship drifts, GEK, current meters suspended from the ship or moored, moored buoys, jelly bottles and dye markers. The limitations of these methods were discussed and the data processing methods outlined. Methods and equipment for measuring depth, wind, temperature, salinity and tide were described, including: lead-line, echosounder, anemographs, thermograph, surface samples, Nansen and Niskin samplers, XBT, CTD, bathysonde, airborne radiation thermometer, satellite sensing, salinograph, conductivity meters, and simple and recording tide gauges.

In the laboratory the following methods and equipment were demonstrated: drift cards, bottom drifter, surface-tracked float, GEK system, Aanderaa current meter, deck-readout current meter, Aanderaa and Lambrecht anemographs, Nansen and Niskin sampling bottles, bathythermograph, XBT, and conductivity meter.

In shallow water close to AIMS the participants gained experience in: current estimation by surface float with curtain drogue and dye marker, salinity and temperature measurement using surface sampler and Niskin sampler, and salinity-temperature probe, and wind measurements with anemometers.

Geology

The lecture with film and other visual aids described the types of geological formations encountered in the marine environment, and in particular the formation of recent deposits in estuarine and coastal regions. The methods appropriate for geological sampling in various environments were explained and their limitations noted. These methods included: grab sampling and dredging for surface sediments, coring at sea, coring in the coastal zone, auger sampling and reef drilling for stratigraphic sampling.

Auger sampling of sediments was demonstrated in shallow water using a barge to support the equipment, and a simulated coral reef was drilled in the AIMS grounds. Grabs, dredges and corers were also shown to the participants.

In the laboratory participants practised and received demonstration in simple physical methods in the preparation of sediment samples, and in the estimation of grainsize and proportions of mud and sand by sieving and by sedimentation. Geochemical analysis methods were also demonstrated for the estimation of calcium carbonate and organic matter in the sediment samples.

Chemical Oceanography

The lecture described the chemical composition of seawater, and its conservative and non-conservative properties. The major conservative properties, their utility for oceanic studies, and the various chemical and electrochemical methods for them were also discussed. These properties included dissolved oxygen, phosphate, nitrate, nitrite, ammonia, silicate, and dissolved organic matter. The concept of the relationship of primary production to nutrient flux and nutrient cycling was introduced, with a brief description of carbon, nitrogen and phosphorus cycles in the marine environment, and the biological and chemical processes of nutrient regeneration in both oxic ocean waters and anoxic estuarine waters and sediments. The factors governing sampling schemes for nutrients in oceanic, coastal and estuarine regions were examined, with reference particularly in separating samples, to both space and time.

Laboratory demonstrations and practical work for the participants concentrated on chemical and instrumental methods of analysis for dissolved oxygen, nutrients, and dissolved organic matter.

Marine Pollution

The lecture and discussion was divided into four sections. The first section described the causes of pollution from domestic, industrial agricultural and transportation operations, and the dominant types of waste from each of these, their accumulation in the marine environment, and ranking by their threat to resources. The second section described the detection of nutrient loads, pathogens, organics and inorganics from point and dispersed sources, and the methods for sampling in the field. The methods for storage, transport and analysis of the samples were also described. The third section of the lectures dealt with the legal requirement for standard methods, long-term monitoring techniques, long-term prevention of pollution, and emergency clean-up after accidents. The fourth section described the occurrence of both natural and man-made organic compounds in the sea, and the problems encountered in sampling these substances. Methods of analysis were also described for specific elements and organic substances.

Three specific analyses were selected for the laboratory practical work to demonstrate different methods. Water samples were analysed for nitrate using the cadmium column reduction method, oyster tissue was analysed for mercury content using atomic absorption spectrophotometry, and tissues from a crocodile were examined for pesticides by gas chromatography.

Mangrove Ecology

The participants were introduced to the special characteristics of mangrove ecosystems and measurement techniques during a two day excursion to the AIMS mangrove research area at Hinchinbrook Island. Here the participants were acquainted with the basic techniques used for sampling and measurement of biomass, productivity, and sediment chemistry. A variety of different sites were inspected to demonstrate the effect of various ecological factors such as interstitial salinity, degree of freshwater or groundwater input, anaerobic stress, nutrient stress, canopy characteristics and physiological aspects. Sediment cores were collected for measurement of pH and redox potential in the field and for chemical analysis later in the laboratory.

The field trip was followed by an illustrated lecture emphasising the types of mangrove forest and possible factors affecting productivity and species distribution. The methods for estimating biomass, growth and net primary production were described, including the measurement of critical physiological parameters influencing net primary production and turnover of biomass. The importance of establishing accurate carbon budgets by litter fall studies, etc. was emphasised. Methods for the measurement of soil redox, pH, salinity and nutrient status were also detailed.

In the laboratory, soil analyses were demonstrated using an auto-analyser. Other instruments for ecophysiological measurements were also demonstrated. The methods for collecting, preserving, classifying and storing plant material from mangrove systems were explained and shown to the participants.

Phytoplankton

The lecture described the distribution of phytoplankton and its relationship to mechanisms of nutrient cycling and other determinants of primary production in oceanic, coastal and estuarine areas. The major groups of marine phytoplankton were introduced with an explanation of their distribution and size. The pathways of carbon fixed by primary production through soluble excreted products, secondary production, zooplankton grazing and decay of detritus were described. The methods available for estimating phytoplankton biomass and production were described and compared including; carbon 14 uptake and oxygen evolution at constant and in situ irradiances, photosynthetic pigments by spectrophotometry and fluorometry, ATP, particulate organic carbon, light attenuation, and cell counts. The estimation of primary production from various light-biomass models was briefly introduced, and the methods and importance of correct underwater irradiance methods discussed.

The participants collected water samples containing phytoplankton and measured underwater irradiance at a number of positions in the shallow bay adjacent to AIMS, and later in the laboratory examined these samples. Particulate matter was concentrated by centrifuge and examined by microscope to find algal cells and observe the much larger proportion of detritus. Phytoplankton biomass was estimated in the samples by the spectrophotometric method, and by the in vivo fluorescence method with and without the addition of DCMU, which enhances the in vivo fluorescence.

Zooplankton

The "pyramid of production" in the ocean based on primary production by phytoplankton was described, with particular reference to the role of both herbivore and carnivore zooplankton in this pyramid. Methods were described for estimating both biomass and production of zooplankton. Methods for sampling zooplankton were also discussed in detail with particular emphasis on the size and speed of the zooplankton, the vertical and horizontal distribution patterns of zooplankton, and the nets used to capture them. Other sampling devices such as bottles, pumps and light traps were also discussed for sampling particular types of zooplankton.

Successive zooplankton samples were collected by each of the participants in shallow water near AIMS using a net towed behind a launch. In the laboratory the zooplankton biomass was estimated from these samples, and the distribution of biomass with size determined. The samples were examined by microscope and the major components identified.

Benthos

The lecture concentrated on the factors which influenced any sampling program for benthos, such as changes with space and time, soft and hard bottom habitats, whether the organisms are sessile, sedentary or vagile, and whether the sampling can be destructive or non-destructive. The methods for sampling benthos were discussed including: photography, visual observation, sledge hauls, grabs, cores, vacuum pumps, quadrants, percent-cover grids, belt transects, line transects, chain transects, random points, and the size and number of samples.

This was followed by an exhibition and demonstration of various types of benthic sampling equipment, and a field trip to the intertidal area near AIMS. The participants were shown the different types of habitat in the intertidal zone, and the possible sampling methods and schemes that could be applied. The local marine flora and fauna were identified.

Lady Basten Cruises

The cruises were of about five days duration, which allowed time for three days work at Davies Reef located 40 miles to the NE of AIMS. At the reef the participants assisted instructors from AIMS in sampling water, suspended particulate matter, and sediments on several transects across the reef and its lagoon. Water samples and interstitial waters from the sediments were analysed on board for ATP, phosphate and ammonia. Suspended particulate matter from the water and sediment samples were prepared then frozen and stored for later analysis at AIMS for carbon, nitrogen and phosphorus.

Sprightly Cruises

These cruises were also of five days duration, allowing three full days for training the participants at a number of positions along a transect between the coast at Lucinda, and Myrmidon Reef on the edge of the Great Barrier Reef. At each position the participants collected water samples at about 10 m intervals to the bottom using Niskin samplers, and these were used for measurement of salinity, dissolved oxygen, inorganic phosphate, and ^{14}C uptake at constant irradiance. Reversing thermometers attached to the Niskin samplers were used to measure the temperature at each depth. Water samples were also preserved for later analysis of nitrate and silicate at CSIRO. Other work done during these cruises included the recovery and redeployment of moored current meters near Myrmidon Reef, collection of zooplankton, and the measurement of temperature in the deep water to the NE of Myrmidon Reef using XBT probes. After returning to AIMS the participants calculated the corrected temperatures, salinities and oxygen concentrations, then plotted these to show the change in these properties along the transect.

Computing

The participants were given instruction in the use of the interactive terminals to the AIMS PDP11 computer, and in simple programming using BASIC/PLUS language. The participants were then given individual problems which required a program to be written, put on file in the computer, tested, and rewritten if necessary to eliminate errors or expand the program. Those participants who completed their problem quickly went on to more problems or assisted the other participants.

Other Activities

The participants attended a number of lectures on a variety of topics. Some of these were given only to the participants, while others were a part of the seminar program at AIMS. Dr. J.S. Bunt, Director of AIMS, gave a short talk on mangrove ecology illustrated by a videotape film which also showed some of the mangrove fauna not seen on the excursion to Hinchinbrook Island.

Dr. R. Strickler, an AIMS scientist, showed a remarkable film on the feeding mechanism of a marine copepod, and gave a short talk on copepod feeding behaviour and the methods used to obtain the filmed feeding sequences.

Dr. J. Lewis, a visiting scientist gave an illustrated talk on the feeding behaviour and food of soft corals.

Mr. L. Zell, of the Great Barrier Reef Marine Park Authority gave an illustrated talk on the features of the reef, and the work of the Authority.

Dr. C. Limpus, of the Queensland Parks and Wildlife Service, spoke to the participants on the species distribution of marine turtles in the world, and the behaviour and life history of these animals. This talk was illustrated by slides and a short film, and a collection of preserved specimens.

On a few nights documentary films were run to show the participants some aspects of Australia. These films included: "Call of the Bellbird", a description of life on a cattle farm near Gympie in Queensland; "Vista Boulevard", showing the people and surroundings at the opal mining town of Coober Pedy in South Australia; "Faces of Australia", a glimpse of the multicultural and multiracial nature of the Australian community and their urban environment; "Kangaroos", "Platypus" and "Koalas" describing some of Australia's best known native animals; "Neptune's Daughter", showing some marine life in the Great Barrier Reef; and "18 footers" describing the premier sailing yachts in Australia.

A number of excursions enabled the participants to see some of the surrounding country and meet local people other than the AIMS staff. An excursion to Ravenswood, 100 km south of Townsville, showed the participants one of Australia's many ghost gold mining towns. By coincidence this excursion was on the occasion of a rare "Ravenswood Festival" so that the town was seen to more advantage than is usual. The excursion to Hinchinbrook Island along 140 km of the coastal highway showed the participants scenery typical of most of Queensland's coastline, while at the Hinchinbrook Island resort a barbecue dinner allowed the participants to meet other visitors to the island in an informal atmosphere. Two Thursday night shopping excursions to Townsville were organised to allow an opportunity for shopping and recreation. Some of the participants inspected a sugar mill at the nearby town of Giru, guided by the mill engineer, Mr. J. Abercrombie. Some participants attended a performance of "Carmen" by the Queensland Ballet Company in Townsville. A barbecue was held at AIMS to which the participants, resident AIMS scientists, and other guests from the AIMS staff and Townsville were invited to meet members of the Senate Standing Committee on Science and the Environment, who were visiting AIMS as part of their inquiry into Australian marine science.

Most of the participants made use of the small amount of spare time available to read and copy literature in the extensive AIMS library, while some discussed with the instructors, problems experienced in their own research work. One student was given instruction in the use of a polarograph at his request.

During the orientation period and the lectures and demonstrations which followed, a large amount of printed material was distributed. This included notes for some of the lectures, reprints describing particular equipment, methods and application, commercial literature describing the equipment, and tourist information.

Presentation of Textbooks

Each participant was provided with a copy of:

"Exploration of the Oceans: An Introduction to Oceanography"; Weihaupt, J.G.: Macmillan, New York, 1979 (ISBN 02450406)

In addition, the Department of Science and the Environment provided each participant with the following set of books from the Open University Series on Oceanography S334 -

1. Physical Processes
2. Chemical Processes
3. Biological Environments
4. Sediments
5. The Changing Oceans.

Presentation of Certificates

At the conclusion of the course the AIMS staff and the visiting CSIRO instructors attended a short ceremony at which Dr. J.S. Bunt, presented each participant with a unique printed certificate stating that they had successfully completed the marine science technicians course.

COURSE ASSESSMENT

Assessment by Participants

Near the conclusion of the course the participants replied anonymously to a written questionnaire designed to obtain their opinions on various aspects of the course. These questionaires were examined by the course co-ordinator and then the more important aspects were examined in a group discussion with the participants. The participants all agreed that the accommodation and meals had been good. They also agreed that they had benefited from all aspects of the course, and that others in their countries or institutions would benefit from a similar course. Most were of the opinion that the course was too short for the amount and range of instruction given, and that either the course should be lengthened to about three months, or that a more specialised course could be conducted over the one month period. They all thought that they needed to do more practical work to gain both skill and confidence, particularly in laboratory work involving the preparation of reagents, handling of equipment, and analyses, while some participants expressed a desire for more data analysis experience, including work on the computer. Most agreed that they had been exhausted at the end of each day and that there had not been enough time for private study or recreation. They suggested that one days recreation every week would be sufficient.

Opinions on the quality of the instructors and instruction as indicated by the questionaire answers were interesting since they did not appear to depend on the particular interests of the participants but on the instructor. In the group discussion the participants emphasised the importance of clear speech. Participants were pleased to receive written notes on lectures and practical work so that where the participant had not understood the spoken words he could refer to it again later.

The participants all agreed that they had enjoyed the course, and particularly the opportunity to meet and work with technicians from other countries.

Assessment by Co-ordinator

The participants were experienced in various divisions of marine science ranging from geology and physical oceanography to algal and fish biology. These individual interests did not seem to influence each participant's attitude toward the various subjects taught. The participants understanding of the lectures appeared to depend more on their command of English and on the instructor's clarity of presentation. Participation in practical work seemed to depend less on language and more on previously acquired manual skills. All the participants appeared to understand written English very well. Some were disadvantaged by their poorer command of spoken English, but they improved during the course often with the aid of the other participants acting as interpreters and teachers. The participants attitude to each other, the instructors, and the AIMS staff

was above reproach, and a definite spirit of camaraderie was present between them by the end of the month's course. Their ability to work as a team at sea was just one example of this bond which was probably created and strengthened by the course being on neutral territory, and by the fact that there were no more than two participants from any one country. However the bond tended to keep them in a group and this probably inhibited them from establishing contact with AIMS staff members other than the course instructors and the canteen staff. All the instructors used the time available to advantage and the lectures and demonstrations were of a good standard. The clarity of presentation varied among the instructors, but in each subject the instructor chosen was the best available from within the staffs of AIMS and CSIRO. Some instructors did not prepare written lecture notes for the participants, or provided only brief notes, but this appeared to be due to their busy research programs. A fault of all the instructional periods was the lack of sufficient time for practical work, which prevented the participants from gaining adequate experience, skill and confidence with some of the equipment and methods. In some cases there was only sufficient time for demonstration with little time for practical work. This was due in part to a wide range of methods demonstrated, and also to the limited availability of equipment for 10 participants. Clearly there was a need for time for practical work to be increased by a factor of five to ten but the lecture and demonstration times could not effectively have been decreased. Thus increased practical work time could only have been achieved by lengthening the course, decreasing the range of subjects, or decreasing the number of participants. None of these options were possible once the course had started. The only exception to this was the cruise work where adequate time was devoted to practical work, but this work was limited to only a few operations with enough repetition to ensure that both skill and confidence were acquired by the participants.

Close co-ordination of the training course was essential to ensure that no time was lost either by starting any activity late, or lost in changing from one activity to another. The co-ordinator was essential in providing an easy formal link between the participants, instructors, and the AIMS administrative staff on a range of course related and personal matters at all times. The co-ordinator's task was made easier by residing at the AIMS site with the participants and visiting instructors. Although the task of co-ordinator was demanding at times it was an enjoyable and satisfying one due to the cheerful co-operation of all concerned, and to the successful completion of all phases of the course as planned.

The standard of housing provided at AIMS was very good with no more than two participants to each bedroom of the two bungalows. The meals provided by the AIMS canteen were of a good standard with sufficient variety, and all the participants seemed satisfied. Fish meals were more popular with the participants, and it was noticed that they particularly appreciated the supply of fresh fruit, which they ate with or after most meals.

The time and facilities for recreation were limited but the two Thursday night shopping excursions to Townsville were appreciated by the participants. A number of games were provided (cards, chess, draughts, chinese chess, mah-jong, go, dominoes and backgammon) but the only game that was common to all the participants was mah-jong. Some participants expressed a desire for a facility for physical recreation such as table tennis. At Hinchinbrook Island several of the participants showed that they were enthusiastic pool players. The "other activities" were appreciated by the participants, particularly those outside the scope of

the course. The guided tour to the sugar mill, the barbecues and the films provided relaxation as well as an educational experience.

Since the conclusion of the course, the co-ordinator and some of the participants have had written correspondence on both personal and course related subjects, and there are indications that this will continue into the future.

Recommendations from Course Co-ordinator for Future Courses.

A similar broad-based short course such as that conducted at AIMS during June 1980 should not be held again unless the main objective is to widen the perspectives of the participants, with an introduction to a range of marine science methods. The reason for this recommendation is that the participants are unlikely to acquire particular skills unless the course is more specialised, or considerably longer.

A scheme to train a large number of marine science technicians from the WESTPAC region is obviously needed, and Australia as a developed country in this region is perhaps one of the best places to conduct such a scheme. However, the training should be designed to give the maximum benefit to the student and his institution. The student can only benefit if he or she gains skill and confidence in particular methods, and at the same time learns the reason for doing the work and its limitations. To achieve this the student must concentrate on one particular group of methods for a sufficient period to gain the necessary experience. A period of about six weeks should be sufficient for the average WESTPAC student to gain experience in any particular group of methods, but this will vary depending on the complexity and range of the methods taught. The efficiency of this instruction will also depend upon the number of students, since the time of the instructor and the equipment must be shared. Probably about four students for each instructor would be the maximum number.

This type of training for small groups of technicians could be carried out at various and separate institutions in Australia from time to time, but such a scheme would depend on the ability of research and technical staff to reallocate sufficient time to instruct and supervise the students. Also the institutions would have to be compensated for this loss of research time and any hidden costs of the courses. The rewards and satisfaction to be gained from instructing and supervising WESTPAC technicians would be less than carrying out research work, so that it may be unreasonable to expect research institutions to willingly provide repeated technical courses.

A better solution to the problem would be to set up a training centre or college administered by an existing college of advanced education, university or other institution, with the specific task of training marine science technicians. This would have the advantage that the courses could be planned with definite timetables and syllabi, that lecture materials and equipment would be prepared in advance, and that staff would be dedicated to this particular task. Instructors would also become accustomed to the problems commonly encountered by WESTPAC students and would be prepared for these problems.

The proposed training centre should be located close to a suitable deep estuary and the ocean so that training could be carried out in small boats and launches on a daily basis rather than depend on the availability of training time on larger ships. These small vessels could be easily shared between the various courses at the training centre. The training centre should also be located close to a major city with an international airport so that the problems of transporting students to the centre, and the transportation costs are minimised. The centre could provide instruction to technicians in a range of courses with the addition of concurrent language instruction. A suitable annual program structure would have three terms, each divided into two sessions of six to seven (five day) weeks. A student who completed a six week session could either return to his home or continue his training in another course in the next session. No student should be allowed to complete more than two sessions, and preferably each student should complete only one session before returning to his home and institution, since these technicians should be regarded as specialists. The students should be encouraged to devote time, outside the normal hours of instruction, to the study of written course material and other library resources.

It would be preferable for the students to be accommodated with Australian families, to improve their language skills and their knowledge of the local social and geographic environment. This would allow the student to organise his own recreation, but the staff of the training centre should ensure that the students were not left in a social vacuum when not at the centre.

Students should be accepted for training courses after nomination by an institution or government department in the WESTPAC countries, and their suitability confirmed at an interview with a staff member, or an agent of the training centre. A student's suitability would be determined principally by educational and technical background and command of English. The staff member or agent would also have the task of determining the present and future needs of each marine research institution, and the task of observing the deployment and progress of students from previous courses. The training centre and the costs of transporting WESTPAC students could be financed as a part of Australia's foreign aid to these countries, but this should not prevent institutions in other countries outside WESTPAC from nominating students to be trained at the centre at the expense of their own institution. This same condition could also apply to Australian students. All students would be subject to the same selection procedure, with priority given to those from WESTPAC countries. Preference should be given to students who are employed in scientific institutions in their home countries, since these students are likely to be more highly motivated.