Intergovernmental Oceanographic Commission

Workshop Report No. 60

IOC Workshop to Define IOCARIBE-TRODERP Proposals

Caracas, Venezuela, 12-16 September 1989

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IOC Workshop Reports

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No.	Title	Publishing Body	Languages
1	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia (Report of the IDOE Workshop on); Bangkok, Thailand 24-29 September 1973 UNDP (CCOP), 138 pp.	Office of the Project Manager UNDP/CCOP c/o ESCAP Sala Santitham Bangkok 2, Thailand	English
2	CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974 (Unesco Technical Paper in Marine Sciences, No. 20).	Division of Marine Sciences, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock) Spanish (out of stock)
3	Report of the *IOC/GFCM/ICSEM* International Workshop on Marine Pollution in the Mediterranean, Monte Carlo, 9-14 September 1974.	*IOC, Unesco* Place de Fontenoy 75700 Paris, France	*English* French Spanish (out of stock)
4	Report of the Workshop on the Phenomenon known as "El Niño", Guayaquil, Ecuador, 4-12 December 1974.	FAO Via delle Terme di Caracalla 00100 Rome, Italy	English (out of stock) Spanish (out of stock)
5	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources, Kingston, Jamaica, 17-22 February 1975.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock) Spanish
6	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, Suva, Fiji, 1-6 September 1975.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
7	Report of the Scientific Workshop to Initiate Planning for a Co-operative Investigation in the North and Central Western Indian Ocean, organized within the IDOE *under the sponsorship of IOC/FAO* (IOFC)/Unesco/EAC, Nairobi, Kenya, 25 March-2 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
8	Joint IOC/FAO (IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters, Penang, 7-13 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock)
9	IOC/CMG/SCOR Second International Workshop on Marine Geoscience, Mauritius, 9-13 August 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
10	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring, Monaco, 14-18 June 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish (out of stock) Russian
11	Report of the IOC/FAO/UNEP International Workshop on Marine *Pollution in the Caribbean and* Adjacent Regions, Port of Spain Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy *75700 Paris, France*	English Spanish (out of stock)
11 Suppl.	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
12	Report of the IOCARIBE Interdisciplinary Workshop on Scientific Programmes in Support of Fisheries Projects, Fort-de-France, Martinique 28 November-2 December 1977.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish
13	Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area, Port of Spain, Trinidad, 16-18 January 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
14	IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas, Abidjan, Ivory Coast, 2-9 May 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French
15	CPPS/FAO/IOC/UNEP International Workshop on Marine Pollution in the South-East Pacific, Santiago de Chile, 6-10 November 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock)
16	Workshop on the Western Pacific, Tokyo, 19-20 February 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Russian
17	Joint IOC/WMO Workshop on Oceanographic Products and the IGOSS Data Processing and Services System (IDPSS), Moscow, 9-11 April 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
17 Suppl.	Papers submitted to the Joint IOC/WMO Seminar on Oceanographic Products and the IGOSS Data Processing and Services System, Moscow, 2-6 April 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
18	IOC/Unesco Workshop on Syllabus for Training Marine Technicians, Miami, 22-26 May 1978 (Unesco reports in marine sciences, No. 4)	Division of Marine Sciences, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock) French Spanish (out of stock) Russian
19	IOC Workshop on Marine Science Syllabus for Secondary Schools, Llantwit Major, Wales, U.K., 5-9 June 1978 (Unesco reports in marine sciences, No. 5).	Division of Marine Sciences, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian Arabic
20	Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources, Bandung, Indonesia, 17-21 October 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
21	Second IDOE Symposium on Turbulence in the Ocean, *Liège, Belgium*, 7-18 May 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
22	Third IOC/WMO Workshop on Marine Pollution Monitoring, New Delhi, 11-15 February 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
23	WESTPAC Workshop on the Marine Geology and Geophysics of the North-West Pacific, Tokyo, 27-31 March 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Russian
24	WESTPAC Workshop on Coastal Transport of Pollutants, Tokyo, 27-31 March 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock)
25	Workshop on the Intercalibration of Sampling Procedures of the IOC/WMO UNEP Pilot Project on Monitoring Background Levels of Selected *Pollutants in Open-Ocean Waters*, Bermuda, 11-26 January 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (superseded by IOC Technical Series No. 22)
26	IOC Workshop on Coastal Area Management in the Caribbean Region, Mexico City, 24 September-5 October 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
27	CCOP/SOPAC-IOC Second International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, Nouméa, New Caledonia, 9-15 October 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
28	FAO/IOC Workshop on the effects of environmental variation on the survival of larval pelagic fishes Lima, 20 April-5 May 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
29	WESTPAC Workshop on Marine biological methodology *Tokyo, 9-14 February 1981.*	IOC, Unesco Place de Fontenoy *75700 Paris, France*	English
30	International Workshop on Marine Pollution in the South-West Atlantic Montevideo, 10-14 November 1980.	IOC, Unesco Place de Fontenoy, 75700 Paris, France	English (out of stock) Spanish
31	Third International Workshop on Marine Geoscience Heidelberg, 19-24 July 1982	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish
32	UNU/IOC/Unesco Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the *context of the New Ocean Regime* Paris, 27 September - 1 October 1982	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish

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1. OPENING

The Workshop to define IOCARIBE-TRODERP Proposals was opened by the Rector, Universidad Simón Bolívar, Dr. Freddy Malpica-Pérez, at 09:30 a.m., 12 September 1989, at the Department INTECMAR of the University, Caracas, Venezuela. Rector Malpica welcomed the participants, emphasizing the close relationship between the topics to be addressed and relevant activities of the University. He also pointed out the importance of the Workshop to further investigation of resources of socio-economic importance in Venezuela.

Dr. Daniel Novoa-Raffalli, Director General Sectorial de Pesca y Acuicultura, Ministerio de Agricultura y Cría, made a brief account on the development of the IOC-FAO Programme on Ocean Science in relation to Living Resources (OSLR) to which he has been closely associated, the Tropical Demersal Recruitment Project (TRODERP), in particular.

Dr. Alejandro Yáñez-Arancibia, Chairman of the IOCARIBE Group of Experts for TRODERP, thanked, on behalf of the foreign scientists, the facilities made available by the University and Venezuela for the organization of the Workshop. He recalled the need for a concerted action of the IOCARIBE Member States and their scientific institutions so as to contribute to an integrated study of research problems posed by the living resources under the consideration of the meeting.

Dr. Fernando Robles, IOC Senior Assistant Secretary for IOCARIBE and Technical Secretary for the Workshop, welcomed the participants on behalf of IOC and the Sub-Commission and explained the administrative arrangements made for the conduct of the meeting.

The Programme for the Workshop is given in Annex I.

The List of Participants is enclosed as Annex II.

A list of Acronyms and Abbreviations is given in Annex IV.

2. INTRODUCTORY PRESENTATIONS

The Chairman, Dr. Alejandro Yañez-Arancibia, introduced the main objectives of the Workshop, recalling that the Tropical Demersal Recruitment Project (TRODERP) is a joint IOC-FAO collaborative research effort aimed at stimulating, co-ordinating and collaborating with the development of research related to recruitment processes of demersal fishery resources related to tropical areas.

TRODERP forms a main instrument to implement the OSLR-IREP research approach in recruitment processes based on investigations of events occurring during the early life history stages of resources, so as to understand relations and processes governing recruitment and environmental factors. This approach was first adopted during the Workshop on the IREP Component of the IOC Programmes on OSLR (Halifax, September 1983 - IOC Workshop Report No. 33). Additional terms of references, theoretical bases and conceptual framework, including methodological approaches, were produced at the IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities, Ciudad del Carmen Campeche, Mexico, April 1986 (IOC Workshop Report No. 44).

Specific IOCARIBE/TRODERP proposals were recommended by an ad hoc Group of Experts meeting held in Cartagena, Colombia, May 1987. Three Sub-Projects (PREP, FEDERP and CORDERP) were established corresponding to the criteria expressed in the previous meetings, which provided the ground for the Sub-Projects to be developed in this first TRODERP/IOCARIBE Workshop held in Caracas.

TRODERP is motivated by several factors. Firstly, demersal fisheries are extremely important economically throughout the Caribbean and adjacent regions, the value of fisheries amounting to several million dollars per year. Secondly, the marine ecosystems of the IOCARIBE region are experiencing ever increasing impacts of human activities. These include impacts of fishery exploitation, habitat alteration, pollution and the very serious prospect of global climate changes. The populations of marine fish and shellfish inhabiting these systems are not only valuable resources well worth preserving, but are vital components within the operation of each ecosystem as a whole. Improved scientific bases for managing these impacts are urgently needed. Certainly, the idea of steady-state fishery management must become untenable in the face of expected progressive environmental changes.

The TRODERP project proposals to be addressed by the Workshop, are designed to begin to generate meaningful advances in key scientific issues needed to prepare Member States of IOCARIBE for the challenges of the coming decades.

After these introductory remarks, nine papers were presented as a way of orienting the main topics of the Workshop, as follows:

A.C. Vastano, L.S. Incze	"Joint observation of sea surface and J.D. Schumacher temperature, flow and pollock larvae distributions at Shelikoff Strait, Alaska"
A.C. Vastano, G. A Matthews, E. M. Godin and E.F. Wells	"Environmental Influence on post-larval shrimp recruitment into Galveston Bay, Texas"
A. Yañez-Arancibia	"Fish estuarine, deltaic and inner shelf recruitment processes: the IOCARIBE regional approach for FEDERP"
J.W. Day and Yañez-Arancibia	"Coupling of primary productivity nekton A. dynamics in the Laguna de Términos, México"
M.F. McGowan	"Southeastern Florida and Caribbean Recruitment (SEFCAR)"
P. Rothlisberg	"WESTPAC-PREP progress report 1989"
R. Claro	"Report to the IOCARIBE Group of Experts on TRODERP as related to the present state and projection of relevant investigations in Cuba"

G. D. Dennis — "Reef-fish recruitment studies at the University of Puerto Rico, Department of Marine Sciences"

A. Bakun — "Similar themes within SARP and TRODERP"

Abstracts corresponding to these presentations are enclosed in Annex III.

3. PROPOSED STRATEGY FOR THE IMPLEMENTATION OF THE IOCARIBE/TRODERP SUB-PROJECTS

Participants in the Workshop spitted in four Working Groups to develop the proposals suggested in the Cartagena Group of Experts Meeting (May 1987). A fourth proposal was incorporated (Satellite Ocean Analysis for Recruitment (SOAR) - see below). Designated co-ordinators for the four working parties, as well as to follow up future sub-project development, were:

- A.R. Molinet, A.C. Vastano for SOAR
- J.W. Day, A. Yañez-Arancibia for FEDERP
- D. Novoa, P. Rothlisberg for PREP
- M.F. McGowan, G.D. Dennis for CORDERP

3.1 SATELLITE OCEAN ANALYSIS FOR RECRUITMENT (SOAR)

3.1.1 Background

The life cycles of marine organisms tend to be complex. Early life stages typically undergo extensive periods of drift during which their eventual survival may be very much at the mercy of ocean flow pattern variability. The resource populations addressed in the TRODERP project are particularly susceptible in this respect. Larval stages have little ability to direct their horizontal motion and must gain access to suitable habitats. These habitats are often associated with isolated islands, archipelagoes, or restricted estuary entrances and any perturbation of environmental conditions may have serious consequences. In addition, presently unresolved issues relating to spatial scales of larval supply are crucial to designing effective resource management.

Therefore, specification of the ocean flow fields is extremely important to the entire range of the TRODERP scientific activities. Instead of dedicating specific environmental sampling in each project, our approach is to address observations over the broad range of appropriate time and space scales through a single project effort. SOAR (Satellite Ocean Analysis for Recruitment) is proposed as an effective and supportive response to the shared needs of the three other IOCARIBE/TRODERP Sub-projects, FEDERP, PREP and CORDERP.

Satellite remote sensing currently produces observations with high spatial (1.1 x 1.1 km) resolution* and regional coverage at twelve hour

* The satellite sensor characteristics quoted in this report are representative of the NOAA constellation Advanced Very High Resolution Radiometer (AVHRR) instrument.

intervals. Sea surface temperature distributions extracted from AVHRR channel 4 (11 microns) scenes, reveal a wide range of mesoscale and sub-mesoscale sea surface temperature features. These features are first order expressions of the turbulent transport that carries out oceanic mixing. Fronts, plumes and eddies with these scales, their flow fields, and movements are environmental perturbations that can be associated with recruitment variability. Their episodic occurrences have the potential to intervene in recruitment processes and alter a given year class. In these cases, experiments with high resolution biological sampling strategies benefit from the corresponding support of mesoscale/sub-mesoscale physical observations. The SOAR project is proposed for this reason and will provide environmental structure and dynamic results for distributional research with other IOCARIBE/TRODERP Sub-projects.

The SOAR objectives are the study and understanding of relations between the state of physical environments, their variability and the interannual variability observed in biological recruitment through satellite remote sensing results and joint analyses with the CORDERP, FEDERP and PREP programmes. The physical studies will cover the Caribbean and adjacent regions (the IOCARIBE field sites) and have an ability to provide high spatial resolution prediction for short periods. The presently understood range of physical events and the apparent ability to affect larvae, juveniles and their maturation as well as spawning sites and adults suggest that single events or some physical sequence can alter distributions or cause permanent changes in specific year classes. The SOAR research programme will focus on the contributions that satellite quantitative analyses and physical models can make to examining the environmental potential for fishery variability.

There are five suggested SOAR activities proposed to support and interact with other programmes. These are:

(i) Generation of sea surface temperature images and flow fields utilizing infrared satellite imagery.

(ii) Examination of the distributional effects of flow field evolution with sequential observations and model regimes.

(iii) Hindcast and synthetic computations of flow dynamics with time-dependent mesoscale resolution numerical models that are initialized with satellite/field observations and are driven by surface winds.

(iv) Statistical studies of spatial and temporal variability for sea surface temperature and velocity fields to prepare an objective analysis capability for each study site.

(v) Preparation and distribution of near real-time associated flow fields for field experiments.

Each of these activities will be co-ordinated with IOCARIBE projects and phased into operation.

The capability of satellite analyses to contribute results rests on the development of long time series of observations and associated analyses for the region and field sites. In view of the technical and personnel lead time requirements and the importance of initiating the observational sequences, a plan is included for the implementation of the

first SOAR activity.

3.1.2 Initial Action

The following plan establishes co-operative efforts between a satellite-capable institution in the southern portion of the IOCARIBE region, e.g. the Simon Bolivar University, and an institution in the United States holding the appropriate technology, e.g., Texas A & M University. These institutions will ensure the development of data base management and a flow field capacity for the TRODERP Sub-projects and carry out a pilot project during the first two years. Both institutions will gather and archive satellite scenes. The northern one covering the Gulf of Mexico, Mississippi delta and Campeche Sound sites, and the southern one acquiring scenes for the Caribbean Sea covering the Magdalena, Orinoco, and Amazon River sites. The northern institution will carry out flow field analyses for the Mississippi Delta site. After transfer of flow vector technology, the southern institution will contribute flow fields for the Orinoco site.

The technology transfer will begin with a one-week visit to the northern institution by an image analyst jointly selected by the institutions. The visit will result in a detailed plan for the technology transfer and establish the time frame for a one-month return visit for training in the use of flow vector techniques. After returning to the southern institution, the analyst will programme and implement a flow algorithm and a scientist from the northern institution will go to the southern institution for one week to verify the algorithm and completion of the initial flow vector training sequence.

CORDERP project results during the first year will benefit from site-specific sea surface temperature and flow distributions that are related to environment and recruitment variability. SOAR will carry out a collaborative distributional study with CORDERP on the level of an honours undergraduate effort and will allocate resources for this purpose. Second year efforts and funds will be addressed through an additional joint proposal.

The resources required for the initial two-years study will provide for the training sequence, satellite archive initiation and flow field analysis for pilot studies. The entire two-years effort requires a funding level of US$ 163,000.

3.2 FISH ESTUARINE-DELTAIC RECRUITMENT (FEDERP)

3.2.1 Background

The Central Atlantic coast of tropical America receives the highest fresh water inflow in any latitude in the tropical areas. The Mississippi delta (subtropical) in USA, the Usumacinta-Grijalva delta in Mexico, the Magdalena delta in Colombia, the Orinoco delta in Venezuela and the Amazon delta in Brazil, have clear ecological and physical influences on their adjacent continental shelves which support the most important soft bottom demersal fisheries in the IOCARIBE region. These estuaries also represent a natural refuge and nurses area for a great variety of fish species that support the commercial catches. The development of these species in the estuarine habitat occurs during a critical period of the life cycle which determines the success in recruitment in the commercial stocks of the continental shelves as well as the biological recruitment in "critical habitats" of the estuarine system. Orienting references in this approach are Brazil (1986) and Yáñez-Arancibia and Brazil (1986). The development of FEDERP through its various stages should involve the

development of recruitment studies oriented in these five key ecosystems of the region. "Functional groups" of common demersal resources are suggested to be included in this FEDERP approach because of their broad distribution, great biomass and numerical abundance, and because they actually represent important fishery resources in each deltaic influenced area.

3.2.2 Member States involved/Institutions

COUNTRIES	INSTITUTIONS	LIAISON RESEARCHERS	PILOT AREAS	SELECTED FISHERY RESOURCE	ORIENTING REFERENCES
U.S.A.	CENTER FOR WESTLAND RESOURCES L.S.U.; NATIONAL MARINE FISHERY SERVICE; TEXAS A&M; OFFICE OF SEA GRANT; NATIONAL SCIENCE FOUNDATION	John W. Day	MISSISSIPPI DELTA		- Day, J et al.,1982 - Deegan, L. & B.Thompson 1985 - Conner, W & J. Day 1988 - Madden C.J. et al., 1988
MEXICO	INSTITUTO DE CIENCIAS DEL MAR Y LIMNOLOGIA (UNAM); ESTACION EL CARMEN DE INVESTIGACIONES MARINAS (UNAM); INSTITUTO NACIONAL DE LA PESCA; CENTRO REGIONAL DE INVESTIGACION PESQUERA CIUDAD DEL CARMEN. (CRIP).	Alejandro Yáñez-Arancibia	USUMACINTA/GRIJALVA DELTA. LAGUNA DE TERMINOS REGION AND CAMPECHE SOUND	"FUNCTIONAL GROUPS" OF COMMON DEMERSAL RESOURCES ARE SUGGESTED TO BE INCLUDED IN THIS FEDERP APPROACH BECAUSE OF THEIR BROAD DISTRIBUTION, GREAT.	-Yañez-Arancibia A.& P. Sanchez-Gil, 1986; 1988 -Yañez-Arancibia, A. & J. Day, 1988
COLOMBIA	CORPOURABA; COOPESCOR; INDERENA; INVEMAR; UNIVERSIDAD DE ANTIOQUIA, C.V.S; UNIVERSIDAD JORGE TADEO LOZANO, CORPOGUAJIRA; HIMAT; UNIVERSIDAD TECNOLOGICA DEL MAGDALENA; DIMAR-CIOH; SENA.	Comité Técnico Recursos Marinos, Comisión Colombiana de Oceanografía	MAGDALENA DELTA	BIOMASS AND NUMERICAL ABUNDANCE, AND BECAUSE THEY ACTUALLY REPRESENT IMPORTANT FISHERY RESOURCES IN EACH DELTAIC INFLUENCED AREA. FAMILIES FROM WHICH IMPORTANT REPRESENTATIVE SPECIES WILL BE SELECTED INCLUDE SCIEANIDAE, GERREIDAE,	Alvarez-Leon, R. & J. Blanco Racedo, 1985
VENEZUELA	MINISTERIO DE AGRICULTURA Y CRIA; UNIVERSIDAD SIMON BOLIVAR, UNIVERSIDAD DE ORIENTE, CORPORACION VENEZOLANA DE GUAYANA, CORPORACION NACIONAL DE LA PESCA.	Ricardo Molinet	ORINOCO DELTA	POMADASYDAE (HAEMULIDAE), ARIIDAE, BOTHIDAE, LUTJANIDAE, CARANGIDAE.	-Novoa, D. 1982 -Cervigon, 1986 -Novoa, D. & F. Cervigon, 1986
BRASIL	UNIVERSIDAD FEDERAL DE PARA (BELEM); INSTITUTO NACIONAL DE PESCA; SUDEPE (SUPERINTENDENCIA DE DESARROLLO PESQUERO).	Labish N. Chao	AMAZON DELTA		-Uyeno et al.,1983 -Chao, L. et al., 1985 -Berthen, 1986

3.2.3 Hypothesis and Objectives

The general hypothesis is that the fish community is an integral part of the overall ecosystem and a full understanding of fish and fisheries can be much better understood in terms of the overall ecosystem. A number of studies have shown that coastal fisheries and their recruitment variability are related to such factors as river discharge, coastal vegetation, primary productivity patterns, surface area of coastal lagoons and estuaries associated with the deltas, and quality of critical habitats.

The hypothesis is that riverine input not only fertilizes the coastal zone but increases and improves habitat area (Figure 1). During high river flow turbid, nutrient-rich river water covers much of the deltaic-estuarine area. Because of the high turbidity, aquatic primary productivity is low. Because of the high nutrient levels, there is a strong net uptake of nutrients and organic matter by the sediments. Productivity is high at frontal zones because of an optimum mix of light and nutrients (Figure 2). Since there is a high food concentration in the frontal zone, larval fish use the area as a nursery for a short time before moving to shallow subtidal and intertidal wetland areas. Important aspects of this hypothesis include the following: during high river flow, river water spreads out into shallow bays, lakes, and channels and thus ensures a strong interaction between the water column and bottom; a well mixed water column minimizes stratification; in areas where this happens to a great extent (Orinoco, Magdalena) fisheries production per unit area or unit river discharge should be higher than in areas where flow is naturally (Amazon) or artificially channelled offshore; when river flow is into deeper water, stratification occurs, water column-bottom coupling is less, and thus productivity is less.

The broad deltaic plains created by the rivers have allowed the development of high habitat diversity. These habitats include open lagoon and bay waters, estuarine inlets, fringe and riverine mangroves, marine seagrass beds, river mouths, oyster beds, and freshwater submerged aquatic vegetation. The different habitats have different patterns of primary production.

An obvious central theme of this hypothesis is that fish life histories have developed to take advantage of seasonal patterns of river flow and utilization of both permanent (mangroves, marshes) and temporary (ie. frontal zone) habitats. The life cycles of these species have evolved such that different species tend to use different habitats during periods of highest productivity.

Recruitment mechanisms of tropical "estuarine dependent" and/or "estuarine related" fishes (Figure 1) are controlled by two main kinds of processes, physical and biological, which act in simultaneousness during the early life history stages. The physical "control" has the strongest influence during the egg and larvae stages on the inner shelf, the tidal inlets and part of the estuary. The biological "control" has the strongest influence during the distribution and abundance of young and juveniles inside the estuary. Because of this approach, two main levels of studies are recommended:

(i) The ecosystem, including coastal processes, variability of critical habitats, ocean-estuary interactions which are related to recruitment, and fish-habitat affinities.

(ii) The resource, including the biological processes directly coupling with recruitment, such as trophic relationship, reproductive dynamics, growth, nortality, migrations, and biomass seasonability.

This hypothesis also implies that the mix of habitats promotes an overall greater productivity. For example, it has been shown that drainage from mangroves stimulates Aquatic Primary Production (APP). Such interhabitat enrichment should be maximized because of the high habitat diversity in estuarine-deltaic areas. Climatic events will also play a critical role because of the effect on water mass distribution and water column mixing.

These results have strong management implications. Fisheries yield is directly tied to system productivity. Management should be focused at the ecosystem level (coupling critical habitats) rather than on one specific habitat. Finally, it is imperative to maintain habitat diversity and connections among habitats.

In this context, the following specific study objectives are recommended:

(i) For Ecosystem Processes.

a) Dynamic characterization of physical, geomorphic and hydrologic processes.

b) Characterization of nutrient dynamics, primary production (aquatic and littoral vegetation) and spatial and temporal variation of organic matter (in water column and sediments).

(ii) For the Fishery Resource.

a) Define patterns of association of major populations of fishery resources and fish-habitats affinities.

b) Define patterns of distribution and abundance of the functional groups in different stages of the cycle.

c) Select species in each functional group, analyze reproductive and trophic dynamics, growth, mortality, migrations,and biomass and density variability in space and time.

d) Examine the definition and distribution of "critical habitats" (in the sense that if the habitat were altered, the recruitment would be affected) for each selected species in each functional group.

e) Examine alternative harvest strategies to determine the effects of this management on total yields.

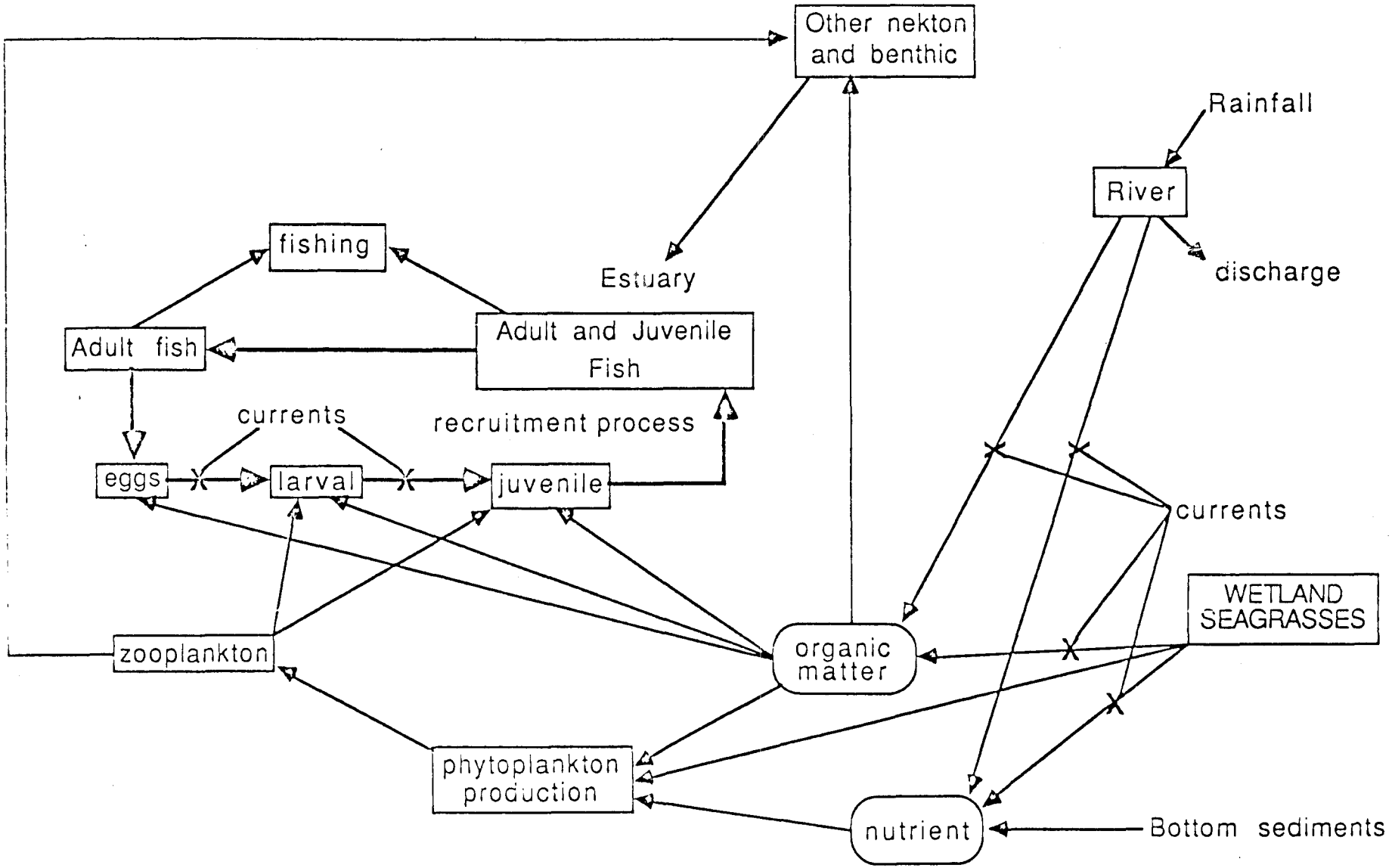

Figure 1. Model of relationships of physical processes and primary production to fisheries productivity.

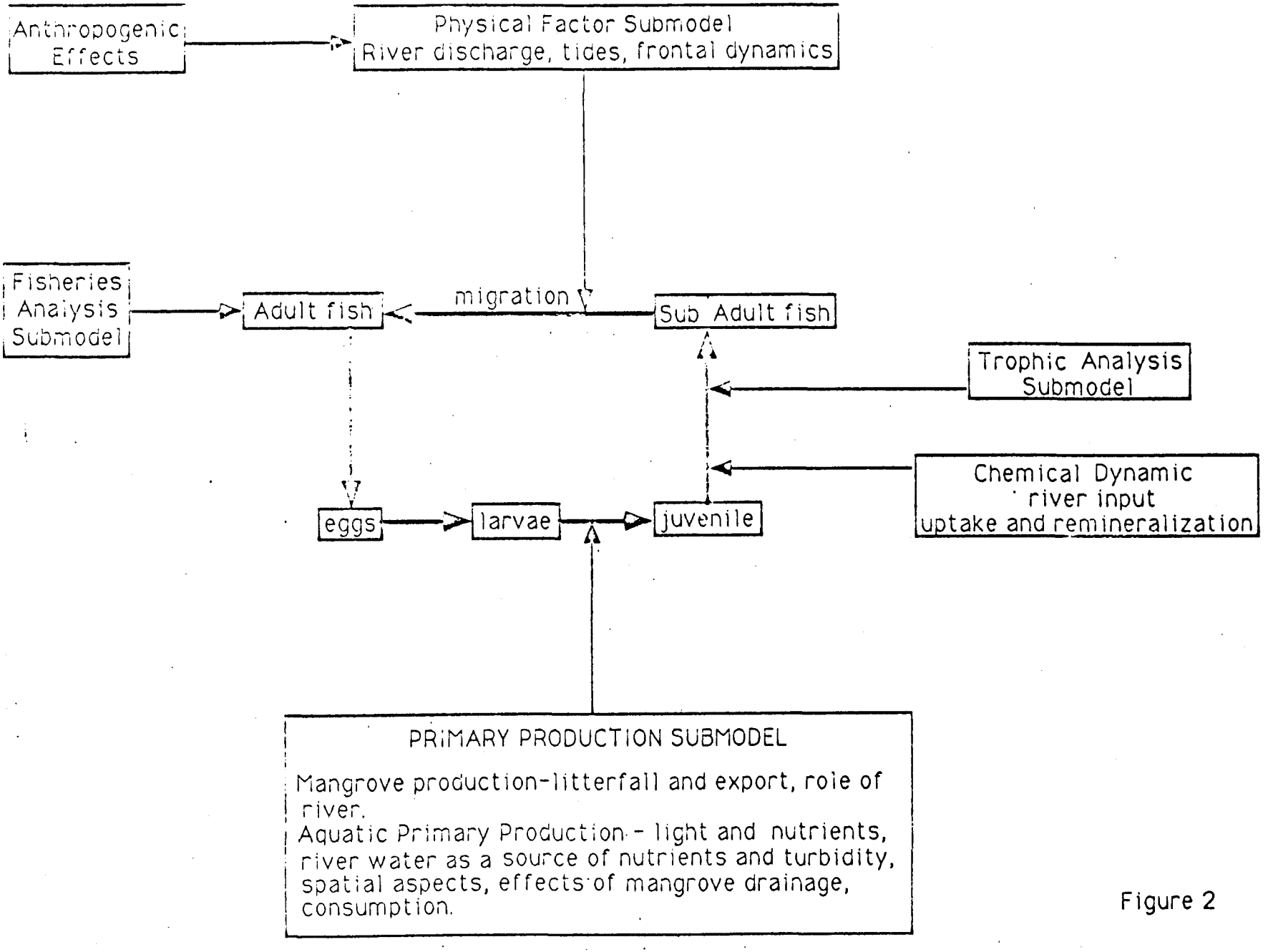
Anthropogenic Effects
Physical Factor Submodel
River discharge, tides, frontal dynamics
Fisheries Analysis Submodel
Adult fish
migration
Sub Adult fish
Trophic Analysis Submodel
Chemical Dynamic
river input
uptake and remineralization
eggs
larvae
juvenile
PRIMARY PRODUCTION SUBMODEL
Mangrove production-litterfall and export, role of river.
Aquatic Primary Production - light and nutrients, river water as a source of nutrients and turbidity, spatial aspects, effects of mangrove drainage, consumption.

Figure 2

3.2.4 Rationale

Motivation for FEDERP comes from the realization that there are extremely valuable existing and potential fisheries associated with large river deltas. Because there is a number of large deltaic systems in the IOCARIBE region, FEDERP was conceived to address the problems of understanding and managing these ecosystems in order to understand the recruitment process at the level of ecosystem approach to maintain and develop fisheries.

Fisheries associated with large river deltas in the IOCARIBE region are a valuable resource. For example, fisheries of the Mississippi delta are valued in excess of US $500 million and those of the Usumacinta region have a value of about US $150 million. In addition, the effects of these large rivers are felt in adjacent areas. For example, the effects of the Amazon are felt in Venezuela; Orinoco water can be detected in Puerto Rico; the Magdalena has an effect to the Gulf of Honduras, the Usumacinta-Grijalva impacts fisheries to the Northern Yucatan, and the Mississippi discharge can be detected to the USA/Texas-Mexican border. These fisheries are extremely important for the regional economies of these areas. The fisheries of the Magdalena, Orinoco and Amazon deltas are not as exploited but studies indicate that there are large stocks of fishes which could be exploited. It is a primary aim of FEDERP to develop information which can be used to maintain these resources.

It is generally considered that a major factor affecting recruitment processes in deltaic areas is the state of the environment. Factors such as river flow, wetland and open water area, primary productivity, and current patterns are extremely important in controlling fishery stocks. Different human activities have the potential to affect different processes which control fisheries. Activities such a damming and channelled of rivers, flood control, aquaculture, petroleum exploration and production, and wetland reclamation for agricultural, urban and industrial purposes have been shown to alter the recruitment process climate changes and sea-level use have a great potential to affect deltaic areas because there are great expanses of wetland habitat which are very near sea-level. Information developed in FEDERP will allow a much better understanding of factors controlling high secondary production in the five deltas and how development in the regions can take place so that fisheries are conserved. This information will also aid in understanding how these systems will be affected by sea-level rise.

3.2.5 Action Plan

3.2.5.1 Data Requirements

Sampling stations should be established sufficient to characterize each system. Intensive observations should be made.

Following the objectives proposed for the sub-project at the two levels (ecosystem and resources), the data required briefly would be:

(i) Ecosystem Processes

a) Physical and hydrological data: temperature, salinity, oxygen, pH, turbidity level, etc. Geomorphic: comparative time studies on land form based on maps, aerial photos and remote sensing imagery, sedimentation and accretion rates (marker horizons $Cs^{1}37$, $Pb^{2}10$). Because physical oceanographic processes, measurements will be made in the coastal

ocean in front of the deltas and within the delta complexes; in conjunction with the SOAR project, measurement of the seasonal movement as well as the formation of frontal zones will be done. Measurements will also be made of parameters such as temperature, salinity, organic matter and suspended sediments. Inside the delta, river discharge current patterns, frontal formation in shallow waters and salinity and temperatures distribution will be measured.

b) Three primary food sources for fish will be measured at selected stations along the systems based on:

- nutrient dynamics: nitrate, nitrite, ammonia, phosphate, silica and remineralization of nutrients from the sediments River input of organic matter and export of organic matter from wetlands.

- primary production from the phytoplankton (chlorophyll and production measurements).

(ii) The Fishery Resource

a) Spatial and temporal analysis of species composition of commercial fisheries (industrial and artisanal) and experimental fishing.

b) Same as above except for the analysis of benthic macroinvertebrate diversity, distribution and abundance.

c) Sampling of catches, commercial and experimental, for select species in functional groups, so as to determine:

- Reproduction (reproductive indexes, gonad histology and fecundity).

- Trophic dynamics (analysis of stomach contents and food consumption).

- Growth and mortality (age structure and length frequency analysis).

- Migration (space and time variation of abundance indexes; analysis of ichtioplankton samples).

d) Sampling to determine seasonal frequency of young and juveniles in a given habitat; food availability; fullness index; and, food consumption. Also reproductive activity and spawning frequency in a given habitat and measurements of recruitment indexes.

e) Using the above data, examine the effects of alternative harvest strategies to determine the effects on total yields.

3.2.5.2 Work Plan

At this stage only a tentative work plan can be forwarded. Two years of preliminary data processing, analysis and co-ordination, with relatively small financial input, would allow to establish a take-off data base and methodological approach. Intensive research of the 5 selected deltaic systems would require 5 additional years of research and substantial financial support.

In the initial stage it is recommended that a technical meeting take place at the national level to present the proposal,to attempt a preliminary description of the national approach, to identify potential participants and co-ordinate activities for preparing the first national workshop. Afterwards, a national workshop is recommended to inform and discuss with the participants the programme strategy, objectives, expected goals and data requirements at the ecosystem and resource levels. Responsibilities should be assigned for the preliminary data processing and analysis within a time schedule. It is recommended that an additional technical meeting or workshop take place before the coming regional workshop.

It is suggested that the first technical meeting take place within the following 6 months after this Caracas Workshop of point 3.2.2, (September 12-16, 1989). In the table of point 3.2.2, the liaison researchers for each country are indicated. National technical meeting and workshop results should be submitted to the IOCARIBE Regional Secretariat in Cartagena, Colombia.

A IOCARIBE Workshop should take place in late 1990 to present advances at the national level and to produce the first comparative analysis of the five deltas, discuss the methodological approach and reorient strategy. The co-ordination of this International Workshop should be under the responsibility of the IOCARIBE Regional Office. It is recommended that 2 or 3 participants from each country attend this Workshop. The terms of reference for this International Workshop should be defined by the Regional Group of Experts TRODERP-IOCARIBE.

Short-term training courses are strongly recommended in the near future to develop research capabilities standardize methodology and improve data management procedures. These training courses will be specifically directed to researchers and technicians involved directly in the national FEDERP programmes. It is recommended that 2 or 3 participants per country attend the training courses to be organized with the assistance of regional experts as instructors.

3.2.6 Tentative Budget

	FIRST YEAR	
(i)	Technical National Meeting	Sponsored by each country
(ii)	Two National Workshops	Sponsored by each country
(iii)	International Workshop	US$ 45.000
	SECOND YEAR	
(i)	First short-training course	US$ 65.000
(ii)	Technical national meeting	Sponsored by each country
(iii)	First regional meeting of national co-ordinators Louisiana State University	US$ 7.000

The estimated budget for the first two years is conceived under the assumption that there will not be strong economic resources with external financial aid. Nevertheless it is estimated that the project should have a duration of at least 5 years. Corresponding subsequent budgets will be formulated during the National Co-ordinators Meeting(s).

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3.3 PENAEID RECRUITMENT (PREP)

3.3.1 Background

PREP is a Sub-project of TRODERP for the IOCARIBE Region that aims to promote better management-oriented research for penaeid shrimp resources through the region. The project is based on a comparative geographical approach to develop our understanding of the effects of environmental variation on reproductive and recruitment dynamics on penaeid shrimps resources, and provide better management advise in each participating country. Its focal area in the IOCARIBE region is centered in the western Gulf of Mexico and northern South America coast.

3.3.2 Focal Areas

The selected areas were chosen on the basis of their scientific, social and economical importance. These are as follows:

COUNTRIES	INSTITUTIONS	LIAISON RESEARCHERS	PILOT AREAS	SELECTED SPECIES
BRAZIL	INSTITUTO NACIONAL DE PESQUISAS DO AMAZONAS, SUDEPE, UNIVERSIDAD FEDERAL DO PARA (BELEM)	LABISH N. CHAO	AMAZONA DELTA	P. notialis P. subtilis P. brasiliensis P. schmitti Xiphopenaeus kroyeri
COLOMBIA	INDERENA, CVS, CORPOURABA	COMITE TECNICO RECURSOS MARINOS COMISION COLOMBIANA DE OCEANOGRAFIA	MAGDALENA DELTA	P. aztecus P. duorarum P. setiferus Xiphopenaeus kroyeri
MEXICO	UNAM, INSTITUTO NACIONAL DE LA PESCA, CRIP, CINVESTAV-MERIDA	ADOLFO GARCIA GASCA	USUMACINTA-GRIJALVA DELTA, CAMPECHE SOUND, TERMINOS LAGOON REGION	P. aztecus P. duorarum P. setiferus
U.S.A.	TEXAS A&M U., LOUISIANA STATE U., NATIONAL MARINE FISHERY SERVICE, OFFICE OF SEA GRANT	RICHARD CONDREY	MISSISSIPPI DELTA	P. aztecus P. duorarum P. setiferus Xiphopenaeus kroyeri
VENEZUELA	UNIVERSIDAD SIMON BOLIVAR, UNIVERSIDAD DE ORIENTE, C.V.G., FUNDACION LA SALLE, FONAIAP	DANIEL NOVOA	ORINOCO DELTA	P. notialis P. subtilis P. brasiliensis P. schmitti Kiphopenaeus kroyeri

3.3.3 Objectives

(i) Define life cycles and basic bioecological aspects of the penaeid shrimps species with important commercial value (i.e., reproductive dynamic, feeding habitats, migrations, predation, mortality, age-structure).

(ii) Define recruitment periods (i.e., index of recruitment).

(iii) Define environmental factors related to the recruitment process of penaeid shrimps, such as rainfall, river discharge and its hydrological cycle, episodic events (storms, hurricanes) and other related dynamic processes.

(iv) Establish inter-annual correlations between selected environmental and biological parameters and appropriate recruitment indexes.

(v) Develop environmental stock-recruitment models for predicting changes in recruitment both by changes in fishery exploitation and environmental/biological factors.

(vi) Define the importance of the artisanal fishery and industrial fishery, in terms of catch, effort and socio-economical benefits.

(vii) Establish the effects of the interaction between the artisanal (estuarine fishery) and the industrial (marine) fishery on the sequential fishery exploitation of penaeid shrimp stocks and the recruitment processes.

(viii) Study the effects of trawling (modification of ocean and coastal bottoms) including the discarding of "by-catch" fauna on penaeid shrimp recruitment.

(ix) Establish basic schemes in the management of penaeid shrimp at the national level.

3.3.4 Rationale

The importance of penaeid shrimps and their fisheries in the IOCARIBE region is well known. The yearly estimate of the total landings is about 200,000 t, obtained from shrimps trawlers and artisanal fishing methods; producing important local profits and effects on the social environment.

Common features of that exploitation are:

(i) The exploitation on the wild population is sequential and very intensive leading to a serious crisis because of shrimp over-exploitation.

(ii) The general knowledge of the biology, population dynamics and ecology is very poor and insufficient. As a result, the exploitation of shrimp resources and current management patterns are inadequate and highly risky in terms of adverse effects that they may have.

(iii) There is evidence that environmental factors, such as river discharge, rainfall, episodic events, sediments and coastal

vegetation cause seasonal and inter-annual fluctuations in the abundance of shrimps.

The development of this PREP project aims to get a knowledge of the penaeid shrimps resources in the IOCARIBE area, permitting the development of management at a national level.

3.3.5 Action Plan

The work plan is conceived as a five year project.

In the first year its goals are:

(i) Designate a Regional PREP Co-ordinator, and a Working Committee, formed by the Regional Co-ordinator, a Regional PREP Technical Secretary and a FAO Regional Officer.

(ii) Commence correspondence with the Director of Fisheries and/or Liaison Researchers in the countries of the Pilot Areas and other countries of the region that may be interested in participating.

(iii) Schedule visits of the Regional PREP Committee to the study sites and meetings with local institutions and personnel interested in the project. A National PREP Co-ordinator will be designated, who will be in charge of gathering all information existing within the past 20 years to be presented in a Regional Workshop to be held within the year.

(iv) Integrate all the published and unpublished information in the study sites, directly related with the objectives of the project by the PREP Regional Co-ordinator.

(v) Present historical information in a Regional Workshop of the study areas involved. Examine data needs and techniques for data collection and analysis for all study sites, to be able to compare results and plan future research and research implementation.

During the second year, meet in a Workshop and review all data processed. Implement methodology and develop training courses for the efficient implementation of the methodologies adopted.

During the third year, meet at a Regional Symposium. Present developments at each study area and results obtained during the periods of research. Make comparisons across species and deltas. Plan future research.

3.3.6 Data Requirements

A list of data requirements (as exemplified in the form that follows) will be handled to the National PREP Co-ordinator of each study area to be analyzed in the first Regional Workshop. In order to increase the quality, compatibility and uniformity of the data to be processed, format and quality of data requested will be distributed to each National PREP Co-ordinator. Selected data sets will be analyzed in the First Regional Workshop.

LIST OF DATA REQUIRED (*)

LIST OF DATA REQUIRED	DELTAS				
	MISSISSIPPI	USUMACINTA-GRIJALVA	MAGDALENA	ORINOCO	AMAZON
Fisheries Data					
1. Total landings (fisherman, processing plant, etc.)					
2. Total landings by commercial species					
3. Fleet Industrial-Artisanal					
4. Fishing effort					
5. C.P.U.E.					
6. MSY (using the surplus yield model)					
7. Preliminary analysis of the exploitation level of the resource					
8. Regulation on management practices					
Biological Data					
1. Taxonomy					
2. Larval abundance distribution					
3. Post-larval abundance distribution					
4. Juvenile abundance distribution					
5. Pre-adults abundance distribution					
6. Adults abundance distribution					
7. Size frequency in different stages					
8. Percentage of ripe females					
9. Population fecundity index					
10. Predator identification					
11. Predation pressure in different stage of shrimp development					
12. Predator abundance					
13. Parasites					
14. Feeding habits in different stages and seasons					
15. Tagging studies (growth mortality rate, migrations)					
Environmental data					
1. Rainfall					
2. River discharge					
3. Sediment distribution					

LIST OF DATA REQUIRED	DELTAS				
	MISSISSIPPI	USUMACINTA-GRIJALVA	MAGDALENA	ORINOCO	AMAZON
4. Water salinity, temperature, nutrients, chlorophyll, water quality, turbidity (as measure of sediment abundance)					
5. Tides					
6. Moon phases					
7. Currents					
8. Vegetation densities (types and abundance)					
9. Wind - Barometric pressure					
10. Hurricanes					

(*) For each data item indicate period for which information is available in your area.

3.3.7 Estimated Budget

FIRST YEAR

- Technical National Meeting	Sponsored by each country
- National Workshop	Sponsored by each country
- Regional Workshop	US$ 45.000

SECOND YEAR

- First short-training course	US$ 65.000
- Technical national meeting	Sponsored by each country
- First regional meeting for National Co-ordinators	US$ 7.000

This estimated budget for the first two years is conceived under the assumption that there will not be strong economic resources with external financial aid. Nevertheless it is estimated that the project should have a duration of at least 5 years. Corresponding subsequent budgets will be formulated during the National Co-ordinators Meeting(s).

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3.4 CORAL REEF DEMERSAL RECRUITMENT (CORDERP)

3.4.1 Background

Harvested coral reef fauna are typically economically important. For example, lobsters, snapper, and grouper are valuable export products. These species comprise a large proportion of the fisheries landings and value in the IOCARIBE region. In order to manage these species it is important to understand their population dynamics. It is especially important to determine whether variations in abundance are caused by fishing or by environmental factors. Environmental effects on the planktonic larval stage of coral reef associated demersal species are now considered to be the most important to population regulation. CORDERP, a Sub-project of TRODERP, will address this problem by a programme of research on fishery-independent factors affecting recruitment in coral reef systems.

A common feature of coral reef demersal organisms is a relatively sedentary adult stage combined with a planktonic larval stage susceptible to wide dispersal by ocean currents. The duration of the planktonic stage is adequate for long distance dispersal but observed and theoretical physical mechanisms exist to account for local retention (e.g., Bakun, 1986). An important unanswered question is whether planktonic larvae of the sedentary adults replenish the population that spawned them or provide the source of recruits to distant populations (Ehrlich, 1975; Johannes, 1978; Sale, 1980; Barlow, 1981; Doherty and Williams, 1988). Definition of stock identity is arguably the most critical problem for resource managers: what is the source of recruits to local populations? Other aspects of recruitment, technical papers, and suggested research proposals were thoroughly treated in IOC Workshop Report No. 44 and its Supplement. It is gratefully acknowledged reliance on those reports and recommended them for additional background information.

In previous proposals, recruitment to isolated islands and research directed towards planktonic processes were emphasized. Although it is recognized that planktonic processes are probably the causal factors determining recruitment, in this document it is proposed to emphasize studies of recently settled recruits because they represent the survivors and integrators of the planktonic processes and they are easier to sample with limited available resources. By attacking a tractable part of the recruitment puzzle first it can be built on successful results and subsequently increase the chance of success in the more difficult parts. It is feasible now to make Pan-Caribbean descriptions of population genetics and otolith daily increment patterns. These data will address meso-scale questions of stock identity and of coincidence of ecological conditions basin-wide. Future studies into specific causal factors will benefit from the analysis of this work and will be able to take advantage of additional physical oceanographic data and tools such as the satellite capabilities proposed in SOAR. Emphasis in this proposal is to begin with tractable, inexpensive research on important questions and then to proceed with confidence to more difficult projects requiring more input of resources.

3.4.2 Member States involved

Among other recruitment questions, the problem of stock identity is relevant for most species in all countries in the IOCARIBE region. Therefore all countries in the region could benefit from participation in the CORDERP programme.

Pilot Areas

Research has already begun in two areas: the south coast of Cuba and the Florida Keys (SEFCAR). In both areas comprehensive recruitment programmes are examining population genetics, juvenile settlement, and planktonic distribution of lobsters and reef fishes. The potential participants in the co-operative regional CORDERP research, are listed in section 3.4.10.

Selected Fishery Resources

Spiny lobsters (Panulirus argus), snappers, and groupers (Lutjanidae and Serranidae) are proposed as the initial target species. These species are important throughout the region and they are the current focal species of the SEFCAR and Cuban recruitment studies. Grunts (Haemulidae) are also found throughout the region where they comprise actual or potential fisheries. They are appropriate experimental model species because they are ecologically similar to snappers and groupers but are more numerous and easier to collect and easier to sample by visual census techniques. The French grunt (Haemulon flavolineatum) would be especially useful as a model reef species because of extensive knowledge of its biology based on previous research. The lane snapper (Lutjanus synagris), the mutton snapper (L. analis), the gray snapper (L. griseus), and the yellowtail (Ocyurus chrysurus) are good representatives of the snappers because they are all important fishery species, they are also targets of the ongoing Cuban and USA recruitment projects, and they are attracted to artificial reef habitats where they can be sampled in statistically adequate numbers.

Several other taxonomic groups such as gastropods and cephalopods, and corals themselves are very important in the region. The processes determining recruitment in these organisms should be conceptually and practically similar to recruitment in fishes. The most obvious difference will perhaps be a shorter duration in the plankton for gastropods such as the conch (Strombus gigas). To a large extent the spiny lobsters and fishes can substitute for these species because the lobster larvae spend 6 months or more in the plankton while the French grunt larvae only spend from 14-28 days. The red snapper (Lutjanus purpureus) is very important to fisheries in some parts of the IOCARIBE region. However, this species differs ecologically from many of the other snappers because it is less dependent on living coral reef habitat and its newly settled juveniles could not be collected by the same methods as grunts and other snappers. Therefore, for initial regional studies it is suggested working with the spiny lobster, the French grunt, and the four species of snapper listed above.

3.4.3 Objectives and Hypotheses

The principal objectives of CORDERP are to determine the sources of recruits to coral reef habitats throughout the region and to determine the causes of variability in spatial and temporal distribution and abundance of recruitment.

The initial hypothesis to be investigated is whether recruitment is Pan-Caribbean or local in extent. The second hypothesis to be investigated is whether the survivors of planktonic processes experienced similar ecological conditions affecting growth and dispersal on a regional or local scale.

3.4.4 Rationale

Stock identification is a fundamental and essential element of knowledge critical to management of reef-associated natural resources. Knowledge of the sources of recruits to a population is also relevant to the evolutionary question of adaptation of sedentary organisms to patchy and ephemeral habitats. This information is also relevant to ecological questions about the relative importance of density dependent and density independent processes, and the question of recruitment limitation vs. anthropogenic mortality relative to population regulation in the marine environment. Therefore the results of these studies will advance the state of scientific knowledge of coral reef systems as well as provide immediate practical benefits for resource managers.

3.4.5 Specific Objectives

(i) To describe the population genetics of spiny lobsters and four species of snapper throughout the Caribbean coral reef biotope using recombinant mitochondrial DNA techniques.

(ii) To determine birth and settlement dates of juvenile French grunts by analyzing daily increments in otoliths. This information will establish limits on planktonic duration (distance travelled). Growth rates and pattern analysis derived from the otoliths will provide a window into the ecological conditions experienced by the survivors and will provide data on the episodic nature of population- regulating recruitment events.

(iii) To identify the settlement habitat of snappers and to develop artificial reef attractors and adequate to monitor snapper recruitment and to collect sufficient numbers of snapperand grouper recruits to perform the genetic and otolith analysis. Light traps are potentially useful alternative samplers for these stages and should also be evaluated for selectivity and efficiency.

3.4.6 Action Plan

It is proposed to proceed with CORDERP in phases from minimal cost participation in ongoing projects to substantially funded investigations of recruitment processes.

The first phase will be to communicate with potential co-operators (see section 3.4.11) to solicit comments on the proposal and to travel collecting samples for genetic analysis of spiny lobster. These samples can be analyzed by laboratories in Cuba or at the University of Miami as parts of their current projects at no additional cost.

The second phase will be the characterization of settlement habitat of snappers and groupers (especially the four focal snapper species) and the development of precise sampling devices (e.g., artificial reefs or light traps) to monitor recruitment of these species. This work can proceed independently by co-operators as local resources permit. National parks are good candidates as sites for this research because of the likelihood of

preliminary data and logistical and administrative support. Adult snapper and grouper specimens will be collected during this phase to provide the genetic reference collection for these commercially important species. Collection of specimens of Haemulon flavolineatum could take place during this phase and the samples stored in alcohol for later analysis of their otoliths.

The third phase will be an experiment to analyze the otoliths from French grunts. The collections should contain 25 specimens collected at 3 month intervals over one year from each co-operating site. This will require obtaining microcomputer-video analysis systems for two locations (Venezuela and Cuba). A third system will be purchased for Puerto Rico from other funding sources.

The fourth phase of research will entail detailed study of selected oceanographic features hypothesized to have important effects on recruitment in specific locations. These experiments will be designed after review of the results from Phases 1-3. The experiments are likely to consist of combined detailed coastal or regional physical oceanographic observations with extensive vertically stratified plankton sampling.

3.4.7 Co-ordination and Communication of Results

A Workshop in Havana, 18-22 June 1990, coinciding with the 2nd Congress of Marine Science and the 23rd meeting of the Association of Marine Laboratories of the Caribbean would be appropriate to present results of ongoing studies and to review this proposal and plan future work in greater detail. There should be enough progress by June of 1991 to justify a major Regional International Symposium to present results on Pan-Caribbean population genetics of lobsters and snappers and the otolith analyses of the French grunt. At this time future directions of CORDERP research could be decided, taking advantage of the satellite capabilities proposed in the SOAR Sub-project and additional data derived from the IOCARIBE Project on Physical Oceanography and Climate.

3.4.8 Estimated Budget

		TOTAL
Year 1		US$ 13,000
Programme Co-ordination	not evaluated	
Spiny Lobster mtDNA Sampling:		
Travel to collect lobster specimens	3,000	
Settlement Habitat Evaluation	on-going	
Co-ordination Meeting (travel)	10,000	

	TOTAL
Year 2	
US$ 82,000	
Settlement Habitat Evaluation	
Materials	10,000
Otolith Analysis	
Systems (2)	40,000
Training & Supplies	10,000
Adult and juvenile snapper mtDNA Sampling	
Supplies	9,000
Travel to collect specimens	3,000
Regional Symposium on CORDERP (travel for co-operative investigators)	10,000
Years 3 to 5	
Physical Oceanography and Ichthyoplankton Survey*	

* Cost to be based on research recommendations at Regional Symposium.

3.4.9 Time Schedule

	Year 1	Year 2	Year 3+
Programme Co-ordination			
Spiny Lobster mtDNA Sampling			
Settlement Habitat Evaluation	----------	----------	
Co-ordination Meeting (Havana)			
Otolith Analysis			
Snapper mtDNA Sampling			
CORDERP Symposium			
Physical Oceanography			
Ichthyoplankton Survey			

3.4.10 References

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3.4.11 List of Potential Participants and Locations in CORDERP

Location	Institutes	Contacts
Bahamas	Caribbean Marine Research Center, Lee Stocking Isl.	Pat L. Colin
Barbados	Bellairs Research Institute	W. Hunte
Belize	Smithsonian Institution Carrie Bow Cay	-
Colombia	Universidad de Bogota INDERENA INVEMAR CVS COLCIENCIAS	Oscar D. Solano Francisco Salazar M. Hernando Sanchez Mauricio Giraldo Ivan Rey Carrasco
Costa Rica	-	-
Cuba	Instituto de Oceanologia Centro de Investigaciones Marinas Centro de Investigacions Pesqueras	Rodolfo Claro Gaspar Gonzalez Sanson Raul Cruz Izquierdo Julio Baisre Adolf Debrot
Curacao	CARMABI	-
Dominican Republic	Centro de Investigaciones de Biologia Marina	-
USA	Univ. Miami, Florida	M. McGowan
Grenadines	-	-
Guadeloupe	Centre Universitaire Antilles	-

Location	Institutes	Contact
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Martinique	-	-
Mexico	Estacion Puerto Morelos de Investigaciones Marinas, Universidad Nacional Autonoma de Mexico (UNAM), Instituto de Ciencias del Mar y Limnologia UNAM,	Enrique Lozano Alvarez y Patricia Briones Foursan
	UAM-I Division de Ciencias Biologicas y de la Salud, Departamento de Hidrobiologia,	Silvia Diaz Ruiz
	Instituto Nacional de la Pesca INP-SEPESCA	Alicia Barcenas
	Centro de Investigaciones y Estudios Avanzados del Instituto Politecnico Nacional CINVESTAV-Merida	Juan Carlos Seijo
Panama	Smithsonian Institution Tropical Research Station	D.R. Robertson
Puerto Rico	Univ. Puerto Rico	G. Dennis
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Trinidad and Tobago		B. Fabres
Venezuela	Fundacion Cientifica Los Roques, Universidad de Oriente, Instituto de Investigaciones Cientificas Nucleo de Nueva Esparta, Isla de Margarita	F. Cervigon L.W. Gonzales

4. ADOPTION OF THE SUMMARY REPORT AND PROPOSALS

The Workshop **adopted** the Summary Report of the Meeting including the four IOCARIBE Sub-projects for TRODERP.

5. CLOSURE

Dr. Andrew Bakun, Chairman of the IOC-FAO Guiding Group of Experts on OSLR, thanked on behalf of the foreign scientists the good facilities and courtesy provided by the host country for the successful completion of the Workshop. He emphasized the Workshop addressed in an appropriate scientific manner, concrete key research issues also of practical importance. He expressed appreciation to the United States Government and institutions for providing support to three scientists who played an important role in developing some of the project proposals.

Dr. Ricardo Molinet, Director, Instituto de Tecnologia y Ciencias Marinas, Universidad Simon Bolivar, Venezuela expressed his appreciation to IOC and its Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE), for the opportunity of hosting the meeting at his University. He enlightened the importance of the subject covered for research going on in his Institution.

Finally, Dr, Daniel Novoa, Director General, Dirección General de Pesca y Acuicultura, Ministerio de Agricultura y Cría, on behalf of the Government of Venezuela pointed out that the meeting was most successful in attaining the proposed aims and objectives. He extended his appreciation to his colleagues of different institutions in Venezuela for their enthusiastic participation in the Workshop and particularly to Dr. Ricardo Molinet for the excellent facilities and organization provided.

The Workshop was closed at 18:00 hours, 16 September 1989.

ANNEX I

PROGRAMME FOR THE WORKSHOP

Tuesday 12 September

Morning

- Registration

- Opening Session
  Dr. F. Malpica-Pérez (Rector-USB/Venezuela)
  Dr. D. Novoa-Raffalli (MAC/Venezuela)
  Dr. A. Yañez-Arancibia (Chairman IOCARIBE/GE/TRODERP)
  Dr. F. Robles (Secretary IOCARIBE)

- A.C. Vastano, et al. "Joint observation of sea-surface and temperature, flow and pollock larvae distributions at Shelikoff Strait, Alaska".

- A. C. Vastano, et al. "Environmental influence on post-larval shrimp recruitment Galveston Bay, Texas".

- A. Yáñez-Arancibia "Fish estuarine, deltaic and inner shelf recruitment processes: the IOCARIBE regional approach for FEDERP".

- J.W. Day and A. Yáñez-Arancibia: "Coupling of primary productivity nekton dynamics in the Laguna de Términos, México".

Afternoon

- M.F. McGowan Southeastern Florida and Caribbean Recruitment (SEFCAR)".

Wednesday 13 September

Morning

- P. Rothlisberg "WESTPAC-PREP progress report 1989".

- R. Claro "Report to the IOCARIBE Group of Experts on TRODERP as related to the present state and projection of relevant investigations in Cuba".

Afternoon

- G. D. Dennis "Reef-fish recruitment studies at the University of Puerto Rico, Department of Marine Sciences".

- A. Bakun "Similar themes within SARP and TRODERP".

Thursday 14 September

Working Groups to develop Project Proposals

Friday 15 September

Plenary	Presentation and discussion of proposals of Working Groups: - SOAR (A.C. Vastano) - FEDERP (J.W. Day) - CORDERP (M.F. McGowan) - PREP (D. Novoa)

Saturday 16 September

Plenary	Adoption of the Summary Report and Project Proposals of the Workshop.

ANNEX II

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ANNEX III

ABSTRACTS OF SCIENTIFIC PRESENTATIONS

JOINT OBSERVATION OF SEA-SURFACE TEMPERATURE, FLOW AND POLLOCK LARVAE DISTRIBUTIONS AT SHELIKOFF STRAIT, ALASKA

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During 1986, Spring recruitment of Alaska Walleye Pollock was studied at Shelikoff Strait by physical and biological observations aboard NOAA ship MILLER FREEMAN and infrared remote sensing via the NOAA satellites. Bongo net tows made during 03-07 May provide a Pollock larvae concentration distribution at the southern exit of the Strait. Sea-surface temperature distributions and a surface flow regime for the same region have been extracted from the AVHRR satellite scenes taken on 28-29 April.

The Alaska Coastal Current was seaward of a cold plume that extends relatively cold and fresh waters offshore and to the south- west from Wide Bay on the Alaska Peninsula. Surface flow vector estimates were computed from temperature pattern displacements in sequential images and indicate a cyclonic circulation around the plume as well as flow of the Alaska Coastal Current seaward and off the continental shelf. The Pollock larvae concentration contours indicate a high degree of correlation between abundance and the colder, fresher waters and the highest numbers of larvae coincide with the central portions of the plume and the associated cyclonic circulation.

ENVIRONMENTAL INFLUENCE ON POST-LARVAL SHRIMP RECRUITMENT INTO GALVESTON BAY, TEXAS

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Erika M. Godwin & Evelyn F. Wells **

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Brown Shrimp (*Aztecus aztecus*) is the most commercially important penaeid fishery in the Gulf of Mexico and biogeographic distributions show the most abundance along the Texas coast. Success in recruitment primarily depends on a springtime influx of post-larvae from shelf waters into bays and estuaries. This influx has shown a high interannual variability in terms of amplitude and modal structure at several monitored entrances.

Previous research suggests positive correlation between atmospheric frontal passage and local post-larval recruitment. Biological, hydrological and meteorological observations made at Galveston, Texas during the Spring 1987 recruitment season are compared with sea-surface temperature distributions and surface flow patterns obtained from sequential NOAA satellite Advanced Very High Resolution Radiometer (AVHRR) images. Images taken on March 31, April 3 and 4 show the generation of a mesoscale front and eddy during movement of waters offshore from Galveston Entrance and interdiction of the nearshore coastal jet that was flowing to the northeast. These events coincided with the strong wind-forced lowering of Galveston Bay's water level on March 29 and 30 that dominated the tidal cycle and introduced a cold water plume ($2^{o}C$ difference) into the shelf water distribution immediately adjacent to the entrance. Recruitment was observed at the level of 1 to 10 individuals per twelve hours at Galveston Entrance on these two days. Cessation of the offshore wind- forcing on March 31 was accompanied by a return of normal tidal oscillations and an increase in recruitment that approached 8000 individuals within twenty-four hours. Twelve hours later, recruitment had dropped to 300 individuals. The satellite-derived flow field for April 3 indicates the re-establishment of the coastal jet past Galveston Entrance with offshore entrainment from an eddy feature that evolved from the cold water plume.

FISH ESTUARINE, DELTAIC AND INNER SHELF RECRUITMENT PROCESSES: THE IOCARIBE REGIONAL APPROACH FOR FEDERP

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The Central Atlantic coast of tropical America receives the highest fresh water inflow in any latitude in the tropical areas. The Mississippi delta (subtropical) in USA, the Usumacinta-Grijalva delta in Mexico, the Magdalena delta in Colombia, the Orinoco delta in Venezuela, and the Amazon delta in Brazil, have clear ecological and physical influence on their adjacent continental shelves which support the most important soft bottom demersal fisheries in the IOCARIBE region. The development of FEDERP through its various stages should involve the development of recruitment studies oriented in these five key ecosystems of the region. "Functional groups" of common demersal resources are suggested to be included in this FEDERP approach because of their broad distribution, great biomass and numerical abundance, and because they actually represent important fishery resources in each deltaic influenced area. Families from which important representative species will be selected include Scianidae, Gerreidae, Pomadasyidae (Haemulidae), Ariidae, Bothidae, Lutjanidae, Carangidae.

The general hypothesis is that the fish community is an integral part of the overall ecosystem and a full understanding of fish and fisheries can be much better understood in terms of the overall ecosystem. A number of studies have shown that coastal fisheries and their recruitment variability are related to such factors as river discharge, coastal vegetation, primary productivity patterns, surface area of coastal lagoons and estuaries associated with the deltas, and quality of critical habitats.

Recruitment mechanisms of tropical "estuarine dependent" and/or "estuarine related" fishes (Figure 1) are controlled by two main kinds of processes, physical and biological, which act in synchrony during the early life history stages. The physical "control" has the strongest influence during the egg and larvae stages on the inner shelf, the tidal inlets and part of the estuary. The biological "control" has the strongest influence during the distribution and abundance of young and juveniles inside the estuary. Because of this approach, two main levels of studies are recommended:

(i) The ecosystem, including coastal processes, variability of critical habitats, ocean-estuary interactions which are related to recruitment, and fish-habitat affinities.

(ii) The resource, including the biological processes directly coupling with recruitment, such as trophic relationship, reproductive dynamics, growth, mortality, migrations, and biomass seasonality.

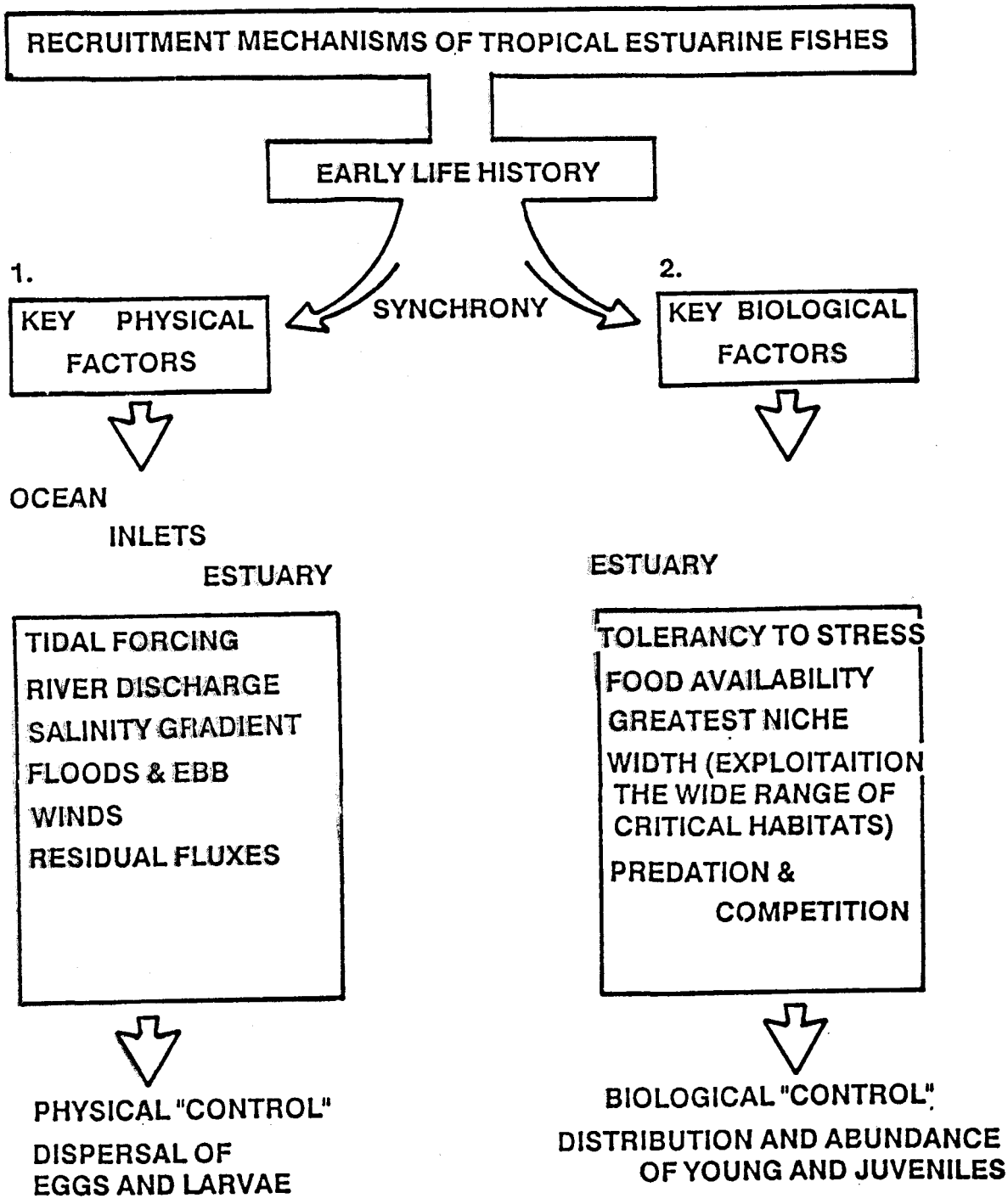
RECRUITMENT MECHANISMS OF TROPICAL ESTUARINE FISHES
EARLY LIFE HISTORY
1.
KEY PHYSICAL FACTORS
SYNCHRONY
2.
KEY BIOLOGICAL FACTORS
OCEAN
INLETS
ESTUARY
TIDAL FORCING
RIVER DISCHARGE
SALINITY GRADIENT
FLOODS & EBB
WINDS
RESIDUAL FLUXES
PHYSICAL "CONTROL"
DISPERSAL OF EGGS AND LARVAE
ESTUARY
TOLERANCY TO STRESS
FOOD AVAILABILITY
GREATEST NICHE
WIDTH (EXPLOITAITION THE WIDE RANGE OF CRITICAL HABITATS)
PREDATION & COMPETITION
BIOLOGICAL "CONTROL"
DISTRIBUTION AND ABUNDANCE OF YOUNG AND JUVENILES

Figure 1

COUPLING OF PRIMARY PRODUCTIVITY AND NEKTON DYNAMICS IN THE LAGUNA DE TERMINOS, MEXICO

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The Laguna de Terminos is a large coastal ecosystem in the Southern Gulf of Mexico. The area supports the largest fishery in Mexico, with a value of about US$ 150 million per year. The regional lagoon ecosystem is characterized by a number of important habitats including open lagoon waters, two estuarine inlets, fringe and riverine mangroves, marine seagrass beds, river mouths, oyster beds, and freshwater submerged aquatic vegetation. Persistent trade winds cause a net flow through the lagoon from east to west. There is a rainy season from June to October and the more than 60% of the river input to the lagoon in the southwest. These net flow, rainfall and river flow patterns lead to strong semi-permanent gradients with strong marine influence in the northeastern part of the lagoon to strong riverine influence in the southeastern portion.

The different habitats have different patterns of primary production. Seagrass beds are dominated by Thalassia and occur in the northern and eastern marine influenced areas of the lagoon. Seagrass productivity and biomass are higher during the dry season, apparently due to higher incident radiation and clearer water.

There are distinct patterns in mangrove distribution and productivity. Near the river mouths, there are stands of riverine mangroves with mainly black mangroves. Along the lagoon side of Carmen Island, there are typical fringe mangrove swamps. Woody growth and litterfall are both higher at the riverine site. Total aboveground net production was 2458 $gm^{-2}yr^{-1}$ at the riverine site and 1607 $gm^{-2}yr^{-1}$ at the fringing site.

There are two main patterns of aquatic primary productivity (APP) in the lagoon. Open waters of the lagoon are most productive during the rainy season (mean APP = 219 gC $m^{-2}yr^{-1}$) while waters near fringing mangroves are most productive during the dry season (APP = 333 gC $m^{-2}yr^{-1}$). These two patterns are related to nutrients and light, respectively.

There are over 150 species of fish which use the lagoon during some part of their life cycle. These include species which spawn in the Gulf of Mexico or freshwater as well as species which spend their entire life cycle in the lagoon. 10-15 species represent 85-90% of the total biomass and numbers. The life cycles of these species have evolved such that different species tend to use different habitats during periods of highest productivity. For example, a number of species use seagrass beds and fringing mangrove waters during the spring when primary productivity is highest. These include marine spawners such as Archosargus rhomboidalis and

Haemulon plumieri, lagoon spawners such as Cichlasoma urophthalmus and Urolophus jamaicensis and very low salinity spawners such as Arius melanopus and Bairdiella chrysoura. Arius melanopus uses the seagrass beds during spring as a nursery by juveniles and for feeding and growth by adults. The adults move to riverine influenced areas during the wet season for reproduction.

These results lead to several conclusions. First, coupling of lagoon habitats leads to overall greater ecosystem productivity. Second, the life history patterns which lead to use of habitats during periods of peak production allow optimum use of food resources. This translates into greater fishery productivity. These results have strong management implications. Fisheries yield is directly tied to system productivity. Management should be focused at the ecosystem level (coupling critical habitats) rather than on one specific habitat. Finally, it is imperative to maintain habitat diversity and connections among habitats.

SOUTHEASTERN FLORIDA AND CARIBBEAN RECRUITMENT (SEFCAR)

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In 1989 and 1990 the University of Miami will investigate the effects of coastal oceanography on recruitment of reef organisms to the Florida Keys. There was preliminary evidence of an eddy located over the Pourtales Terrace which could be a mechanism to retain larvae of reef species near where they were spawned. Alternatively, this eddy may enhance transport from the Florida Current to the nearshore reefs. Variability in this eddy and adjacent currents could account for variability in recruitment. The primary species selected for study are the snappers (Lutjanidae), the groupers (Serranidae), and the spiny lobster Panulirus argus.

The multi-disciplinary study includes physical oceanography (current meters, CTD, XBT, acoustic doppler current profiler, drifters), biological oceanography (sampling ichthyoplankton with MOCNESS, and sampling microzooplankton with Niskin bottle), biochemical population genetics (mitochondrial DNA, electrophoretic isozyme analysis), laboratory experiments (rearing fish larvae, larval behavior), and collecting and censusing recruits (puerulus collectors, SCUBA census).

The experimental design calls for 6 cruises at 3 month intervals during the study and monthly collections or censuses of recruits. During the cruises the temperature, salinity, and density of the study area will be mapped and vertically stratified plankton samples will be collected. The mitochondrial DNA of local recruits will be compared to that of potential source populations upstream in the Caribbean and to local adult populations.

Preliminary data from cruises in June and August 1989 confirms the temporary presence of recirculating water masses which seem to be limited to the upper 60m, not extending to the bottom of the water column. Fish eggs, larval fish, larval lobsters, and total zooplankton were most abundant in the downstream portion of the cyclonic feature in June. Lobster phyllosomata were most abundant between 50 and 25m during June. Other analyses are in progress.

The SEFCAR project is offered as an example of a multidisciplinary approach to recruitment research for coral reef demersal species. Its results should at least be useful as preliminary data for designing studies elsewhere in the IOCARIBE region.

WESTPAC PREP PROGRESS REPORT 1989

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The WESTPAC Penaeid Recruitment Project (PREP) is a joint IOC-FAO collaborative research project aimed at promoting better management-orientated research of penaeid prawn resources through the Indo-West Pacific region. The project uses a geographic comparative approach to enhance our understanding of the effects of fishing and environmental impacts on penaeid resources, as a means of providing better management advice at the national level.

The institutional framework for the project is based on a network of penaeid prawn researchers from Australia, Brunei Darussalam, Indonesia, Malaysia, Papua New Guinea, the Philippines and Thailand. Technical co-ordination is presently provided by Dr. D.J. Staples (PREP Technical Co-ordinator) and Dr. P. Rothlisberg (WESTPAC/OSLR Technical Co-ordinator), CSIRO Fisheries, Cleveland, Australia.

The project forms the main instrument to implement the IPFC/SCORRAD recommendation to develop a strategy for better management orientated research on marine resources. It also intended to implement the IOC/WESTPAC and IOC/FAO/OSLR recommendations to develop programmes for the better understanding of the effects of environmental changes and of fishing on stock recruitment and stability. The project was adopted by IPFC/SCORRAD in February and endorsed by IOC in June 1987 and commented with a mission to the region and formation of a network of researchers in January 1988. Milestones have included the Planning/training workshop held in Cleveland, July 1988 and the presentation of preliminary results at the Second Asian Fisheries Forum, Tokyo, April 1989.

Finance for the projects is provided from a variety of sources. At the national level, funds are provided by the Home Institution of the participating network members, including the Bureau of Fisheries and Aquatic Resources (Philippines), Department of Fisheries (Thailand), Department of Fisheries (Malaysia), Agency for Agricultural Research and Development (Indonesia), Department of Fisheries and Marine Resources (Papua New Guinea) and the Commonwealth Scientific and Industrial Research Organization (Australia). International aid has been provided by the Australian Fisheries Service (AFS), Australian International Development Assistance Bureau (AIDAB), Food and Agriculture Organization (FAO), Intergovernmental Oceanographic Commission (IOC) and the South-east Asian Fisheries Development Centre (SEAFDEC).

REPORT TO THE IOCARIBE GROUP OF EXPERTS ON TRODERP AS RELATED TO THE PRESENT STATE AND PROJECTION OF RELEVANT INVESTIGATIONS IN CUBA

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A review on present ongoing activities in Cuba regarding each one of the TRODERP Sub-Projects was given (e.g. Fish Estuarine-Deltaic (FEDERP), Penaeids Recruitment (PREP) and Coral Reef Demersal Recruitment (CORDERP)) including actions to be implemented during the next five years.

Regarding CORDERP in particular, an expanded and multidisciplinary research programme has been elaborated focused on recruitment of demersal fisheries associated to these systems, especially early life history of lobster.

In these activities several Cuban Institutions take part under the overall co-ordination of the National Oceanographic Committee.

REEF FISH RECRUITMENT STUDIES AT THE UNIVERSITY OF PUERTO RICO DEPARTMENT OF MARINE SCIENCES

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Reef fish recruitment is being addressed at the University of Puerto Rico (UPR) by three programs. The SEAMAP-Caribbean program was recently started with one objective of long-term monitoring of snapper-grouper abundance by ichthyoplankton sampling. Another programme funded by NSF-EPSCOR addresses the question of whether spawning-site selection by reef fishes is due to physical factors. Nearshore current regimes are compared between spawning and non- spawning sites and spawning and non-spawning periods for the bluehead wrasse (Thalassoma bifasciatum). Offshore spawning sites will be compared to nearshore spawning sites to test the hypothesis that reef fishes spawn at times and localities that ensure eggs are swept off the reef and into offshore waters. Lastly a project funded by the UPR Sea Grant Programme is developing an ichthyoplankton sampler to compare the abundance of larval fishes in nearshore habitats, such as, mangroves, seagrass beds, and coral reefs to test the hypothesis that these areas are important recruitment areas for snappers and groupers. The device selected was a small light trap constructed from clear plexiglass and a collection bucket. Preliminary results suggest that successful collection of pre-settlement snappers and groupers can be accomplished in the nearshore environment with this device.

SIMILAR THEMES WITHIN SARP AND TRODERP

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The pelagic species addressed within the SARP project have a larval strategy which appears designed to integrate short time and space scale variability. Thus, averages of effects spread over an extended spawning season may be the ultimate determinant of net reproductive success. For the species addressed by TRODERP, in contrast, larvae with very limited horizontal swimming ability may need to find access to suitable habitat associated with isolated islands, narrow estuary entrances, etc. Thus, even short-scale perturbations in the ocean flow field may be crucial.

However, there are general thematic similarities which are applicable in both contexts. The use of daily marks on otoliths, which has been a hallmark of the SARP design, seems to have great promise for TRODERP species, where both the birthdate and the date of settlement may be accessible. The "high-spatial resolution" approaches being adopted for SARP also appear to be highly suitable for application in TRODERP. In both projects, a focus on vertical structure in flow, stability, food particle distribution, and in distributions of the larvae themselves, may be highly rewarding.

Finally, Global Climate Change is a very serious prospect for marine resource fluctuations, which typically exhibit highly adapted responses to dynamic environmental processes. These processes may be subject to drastic alterations in coming decades. Development the insights needed to appropriately manage the consequences, will be a major challenge to the SARP and TRODERP projects.

ANNEX IV

LIST OF ACRONYMS AND ABBREVIATIONS

APP	Aquatic Primary Production
AVHRR	Advanced Very High Resolution Radiometer
CIOH	Centro de Investigaciones Oceanográficas e Hidrográficas, México
CORDERP	Coral Reef Demersal Recruitment Sub-Project
CRIP	Centro Regional de Investigaciones Pesqueras, México
DIMAR	Dirección General Marítima y Portuaria, Colombia
FAO	Food and Agriculture Organization of the United Nations
FEDERP	Fish Estuarine-Deltaic Recruitment Sub-Project
INTECMAR	Instituto de Tecnología y Ciencias Marinas, Venezuela
IOC	Intergovernmental Oceanographic Commission
IOCARIBE	IOC Sub-Commission for the Caribbean and Adjacent Regions
INVEMAR	Instituto de Investigaciones Marinas de Punta Betín
IREP	International Recruitment Experiment
NOAA	National Oceanographic and Atmospheric Administration
OSLR	Ocean Sciences in Relation to Living Resources
PREP	Penaeids Recruitment Sub-Project
SARP	Sardine-Anchovy Recruitment Programme
SEFCAR	Southeastern Florida and Caribbean Recruitment
SENA	Servicio Nacional de Aprendizaje, Colombia
SOAR	Satellite Ocean Analysis for Recruitment
SUDEPE	Superintendencia de Desarrollo Pesquero, Brazil
TRODERP	Tropical Demersal Recruitment Project
UNAM	Universidad Nacional Autónoma de México
UNESCO	United Nations Educational, Scientific and Cultural Organization

USB	Universidad Simón Bolivar, Venezuela
WESTPAC	IOC Sub-Commission for the Western Pacific Region

No.	Title	Publishing Body	Languages
32 Suppl.	Papers submitted to the UNU/IOC/Unesco Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the Context of the New Ocean Regime Paris, 27 September-1 October 1982	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
33	Workshop on the IREP Component of the IOC Programme on Ocean Science in Relation to Living Resources (OSLR) Halifax, 26-30 September 1983	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
34	IOC Workshop on Regional Co-operation in Marine Science in the Central Eastern Atlantic (Western Africa) Tenerife 12-17 December 1983	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish
35	CCOP/SOPAC-IOC-UNU Workshop on Basic Geo-scientific Marine Research Required for Assessment of Minerals and Hydrocarbons in the South Pacific Suva, Fiji, 3-7 October 1983	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
36	IOC/FAO Workshop on the Improved Uses of Research Vessels Lisbon, 28 May - 2 June 1984	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
36 Suppl.	Papers submitted to the IOC-FAO Workshop on Inproved Uses of Research Vessels Lisbon, 28 May-2 June 1984	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
37	IOC/Unesco Workshop on Regional Co-operation in Marine Science in the Central Indian Ocean and Adjacent Seas and Gulfs Colombo, 8-13 July 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
37 Suppl.	Papers submitted to the IOC/Unesco Workshop on Regional Co-operation in Marine Science in the Central Indian Ocean and Adjacent Seas and Gulfs Colombo, 8-13 July 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
38	IOC/ROPME/UNEP Symposium on Fate and Fluxes of Oil Pollutants in the Kuwait Action Plan Region Basrah, Iraq, 8-12 January 1984	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
39	CCOP (SOPAC)-IOC-IFREMER-ORSTOM Workshop on the Uses of Submersibles and Remotely Operated Vehicles in the South Pacific Suva, Fiji, 24-29 September 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
40	IOC Workshop on the Technical Aspects of Tsunami Analyses, Prediction and Communications Sidney, B.C., Canada, 29-31 July 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
40 Suppl.	IOC Workshop on the Technical Aspects of Tsunami Analyses, Prediction and Communications *Submitted Papers* Sidney, B.C., Canada, 29-31 July 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
41	First Workshop of Participants in the Joint FAO/IOC/WHO/IAEA/UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region (WACAF/2) Dakar, Senegal, 28 October - 1 November 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
42	IOC/UNEP Intercalibration Workshop on Dissolved/Dispersed Hydrocarbons in Seawater Bermuda, USA, 3-14 December 1984 (in press)	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
43	IOC Workshop on the Results of MEDALPEX and Future Oceanographic Programmes in the Western Mediterranean Venice, Italy, 23-25 October 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
44	IOC/FAO Workshop on Recruitment in Tropical Coastal Demersal Communities Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock) Spanish
44 Suppl.	IOC/FAO Workshop on Recruitment in Tropical Coastal Demersal Communities - *Submitted Papers* Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
45	IOCARIBE Workshop on Physical Oceanography and Climate Cartagena, Colombia, 19-22 August 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
46	Reunión de Trabajo para Desarrollo del Programa «Ciencia Oceanica en Relación a los Recursos No vivos en la Región del Atlantico Sudoccidental Porto Alegre, Brazil 7-11 de Abril de 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	Spanish
47	IOC Symposium on Marine Science in the Western Pacific: The Indo-Pacific Convergence Townsville, 1-6 December 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
48	IOCARIBE Mini-Symposium for the Regional Development of the IOC-UN (OETB) Programme on "Ocean Science in Relation to Non-Living Resources (OSNLR)"	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
49	AGU-IOC-WMO-CPPS Chapman Conference: An International Symposium on "El Niño" Guyaquil, Ecuador, 27-31 October 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
50	CCAMLR-IOC Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, particularly Krill (organized in collaboration with SCAR and SCOR) Paris, France, 2-6 June 1987	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
51	CCOP/SOPAC-IOC Workshop on Coastal Processes in the South Pacific Island Nations, Lae, Papua-New Guinea, 1-8 October 1987	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
52	SCOR-IOC-Unesco Symposium on Vertical Motion in the Equatorial Upper Ocean and its Effects upon Living Resources and the Atmosphere Paris, 6-10 May 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
53	IOC Workshop on the Biological Effects of Pollutants Oslo, 11-29 August 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
54	Workshop on Sea-level Measurements in Hostile Conditions Bidston, UK, 28-31 March 1988	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
55	IBCCA Workshop on Data Sources and Compilation Boulder, Colorado, 18-19 July 1988	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
56	IOC/FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP) Cleveland, Australia, 24-30 July 1988	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
57	**IOC Workshop on International Co-operation in the Study of Red Tides and Ocean Blooms Takamatsu, Japan, 16-17 November 1987**	**IOC, Unesco Place de Fontenoy 75700 Paris, France**	**English**