INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Reports of Meetings of Experts and Equivalent Bodies

IOC-FAO GUIDING GROUP OF EXPERTS ON THE PROGRAMME OF OCEAN SCIENCE IN RELATION TO LIVING RESOURCES

First Session
Paris, 16-20 July 1984

SC-85/WS/18

Unesco

IOC-FAO/GGE-OSLR-I/3
Paris, 11 February 1985
English only

TABLE OF CONTENTS

1. OPENING

The IOC Assistant Secretary, Mr. R. Griffiths, on behalf of Dr. M. Ruivo, Secretary of IOC, called to order the First Session of the Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources at 09.00 on 16 July 1984 at Unesco House, Paris, and welcomed the participants.

On the next day, Dr. Ruivo welcomed the participants, emphasizing the importance of interaction of this Group with other IOC Programmes, particularly TEMA and Ocean Services as well as with the regional subsidiary bodies of both FAO and IOC. He also called the attention of the Group to the importance of considering the OSLR problems related to multispecies coastal systems. (*)

Professor G. Hempel, Chairman of ACMRR of FAO, stressed that OSLR is one of the major programmes of IOC, being of a similar level to CCCO, IGOSS, Marine Pollution and Non-Living Resources (OSNLR). The developing countries view OSLR as perhaps the most attractive exercise of IOC. It is the first attempt to link marine biology, fisheries science and physical oceanography on a global scale, unifying the efforts of many Member States in addressing major ecological problems. Professor Hempel further stressed the importance of OSLR for the development of marine science, integrating various biological and physical disciplines and various laboratory programmes around the world, in such a way as to serve the national interests of coastal states. He emphasized that the framework provided by OSLR, IREP (and SARP, in particular) favours the development of workable projects that can serve as useful first steps. He urged continual consideration of the general objectives of OSLR, particularly its dual importance for marine sciences and for the specific needs of many Member States.

Professor R.J.H. Beverton, Chairman of the Workshop on the IREP Component of the IOC Programme on Ocean Science in Relation to Living Resources (Halifax, Canada, 26-30 September 1983) briefly reviewed the conclusions and recommendations of that meeting (summarized in Annex III), recommending a focused approach as represented by the "Minimum Plan", rather than some premature global synoptic attack.

The list of participants is given in Annex I.

2. ADMINISTRATIVE ARRANGEMENTS

2.1 ELECTION OF CHAIRMAN AND DESIGNATION OF RAPPORTEUR FOR THE SESSION

Dr. J.P. Troadec was unanimously elected Chairman for the Session. Mr. A. Bakun was designated as Rapporteur.

The IOC Resolution XII-1 on OSLR including the Terms of Reference for the Guiding Group is given in Annex II.

2.2 CONDUCT OF THE SESSION

The IOC Assistant Secretary, Dr. F. Robles, reviewed the List of Documents available for the Session and proposed a provisional time-table for the conduct of the meeting.

(*) A list of acronyms is given in Annex VI.

3. THE PROBLEM

The Guiding Group noted that variations in recruitment are major causes of fluctuations of fishery resources. They also noted that recruitment variation is most often attributed to environmental (i.e., oceanographic) fluctuations. They therefore supported the development of IREP as the primary initial research thrust within the OSLR context. There was also general acknowledgement that the early life history (ELH) stages of fish may be particularly vulnerable to adverse conditions, especially to predation and to shortages of the proper kinds of food.

Figure 1 illustrates the successive stages which individual fish must survive in order to ultimately recruit to the adult stock. (Note that the slopes shown are arbitrary and are not intended to represent the actual relative mortality among stages of any particular species group.)

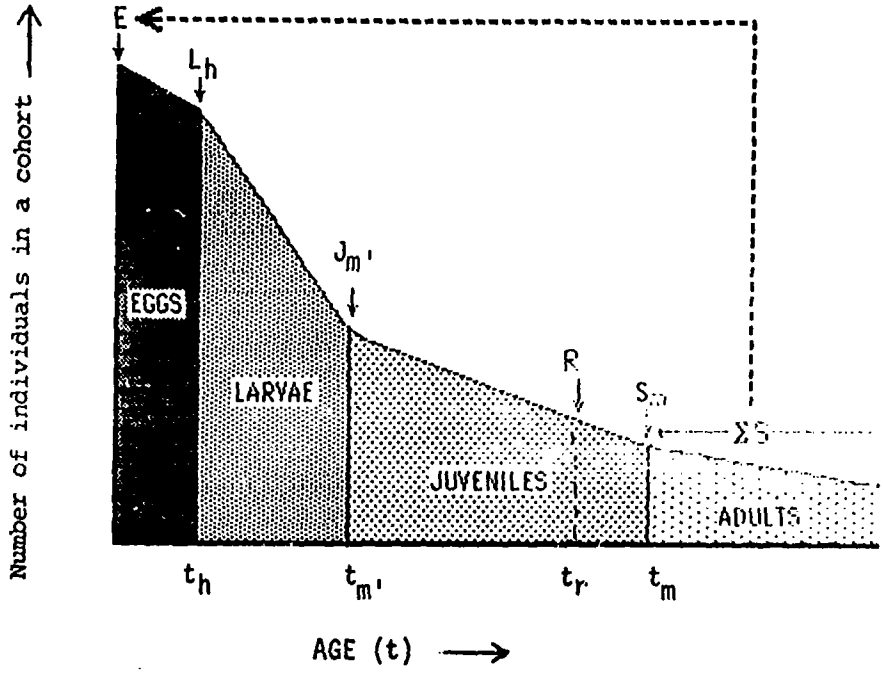


Fig. 1 - Conceptual diagram of the life history stages of a cohort of fish.

E = number of eggs spawned

t_h = age at hatching

L_h = number of newly hatched larvae

$t_{m'}$ = age at metamorphosis

$J_{m'}$ = number of newly metamorphosized juvenile

t_r = age at recruitment (usually, but not necessarily, $t_{m'} \leq t_r \leq t_m$)

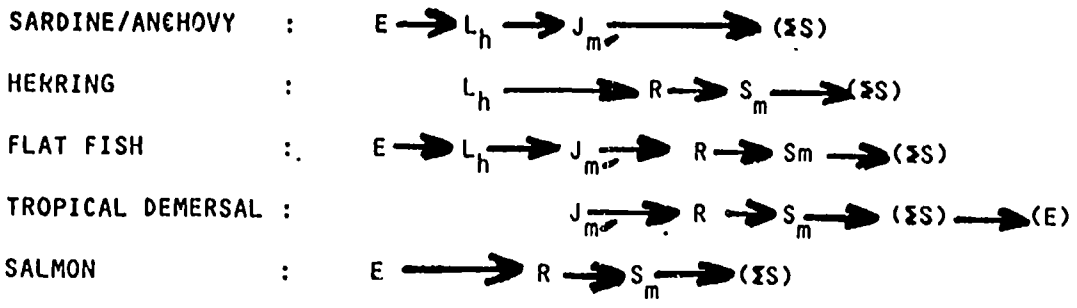
R = number of individuals entering, or being recruited, into the exploitable stock

t_m = age at maturity or first spawning

S_m = number of (newly mature) fish entering the adult stock

ΣS = spawners pool (generating E)

The segments of the life history of selected species where ELH investigations are feasible are illustrated as follows:



(Each sequence starts with the earliest stage for which quantitative field observation is possible).

Variability was considered to be the key element in selecting particular mechanisms for investigation. Processes which may involve very high mortality but are quite constant from spawning period to spawning period would be less germane to the recruitment variability question than processes which are highly subject to (e.g., interannual) variation. It is probable that starvation and predation in the ELH stages exert important controls on recruitment success, at least in some situations. However the possibility of important effects at later life history stages, even the possibility of mechanisms which would act to rectify variability introduced at earlier stages, cannot be discounted.

Not all stages of fishes can be properly sampled and investigated with available techniques. The segments depicted at the bottom of Fig. 1 are intended to illustrate the fact that experimental design would necessarily differ somewhat among species groups. In herring for example, eggs are difficult to sample quantitatively. A herring investigation would probably have to begin at the stage of newly hatched larvae. A more extreme example is provided by some rock lobster species where substantial recruitment variability is thought to be generated at the post-settlement stage which is extremely difficult to sample.

4. SPACE AND TIME SCALES

The Guiding Group noted that recruitment studies must be based upon a sound understanding of the spatial and temporal dimensions of the biological and physical processes involved. When a particular fish population is chosen for an IREP study, the known life history characteristics of the population should be examined in relation to known characteristics of its habitat to identify the most appropriate space and time scales for study. When those scales have been identified they should guide the programme of field observations on biological characteristics of the stock and physical characteristics of its habitat that are the prime element of the recruitment study. Special attention should be paid to life history stages of the population that are thought to be most vulnerable to environmental pressures and therefore of particular significance in recruitment variability.

The time and space scales relevant to recruitment studies range from, say 10^{-5} km (1 cm) to 10^{3} km (1000 km) and from 10^{-3} years ($\sim$8 hours) to 10^{2} (centuries), depending on the physical process and corresponding life history stage

being considered. Tables 1 and 2 list biological and physical processes that could be involved in recruitment studies of a given fish stock, where it should be noted that a substantial overlap might be expected amongst the chosen scales for the processes listed.

TABLE 1 - SPATIAL SCALES OF BIOLOGICAL AND PHYSICAL PROCESSES THAT MAY BE INVOLVED IN RECRUITMENT

SCALE	BIOLOGICAL PROCESS/STRUCTURE	PHYSICAL PROCESS/STRUCTURE
10^{-5} km (1 cm)	Biological layering (e.g. Neuston, epi-benthic layers)	Sediment formation Salt fingers
10^{-4} km (10 cm)	Vertical patchiness	Physical microstructure
10^{-3} km (1 m)	Larval settlement Bioturbation	Intrusions Tidal Amplitude Kelvin-Helmholtz instability
10^{-2} km (10 m)	Dinoflagellate migration Larval ambits Plankton patchiness	Thermoclines Current shear Surface and bottom mixed layers Amplitude of internal waves Ekman depths
10^{-1} km (100 m)	Fish schools Intertidal communities Local spawning aggregations Vertical migration	Light penetration Upwelling Langmuir circulation (horizontal scales) Continental shelf depth
10^{0} km (1 km)	Horizontal patchiness Medium-large spawning aggregations	Frontal structures
10^{1} km (10 km)	Coastal migrations Larval drift Estuarine migrations Large spawning aggregations	Horizontal scale of upwelling Major convergences Baroclinic Rossby radius Coastal and bottom topography
10^{2} km (100 km)	Adult migrations Habitats of fish stocks Spawning areas	Mesoscale eddies Horizontal topography
10^{3} km (1000 km)	Habitats of stocks (oceanic) Spawning areas Adult migrations	Wind systems Geophysical wave scales

TABLE 2 - TIME SCALES OF BIOLOGICAL AND PHYSICAL PROCESSES THAT MAY BE INVOLVED IN RECRUITMENT

SCALE	BIOLOGICAL PROCESS/STRUCTURE	PHYSICAL PROCESS/STRUCTURE
10^{-3} years (~8 hours)	Vertical migration Spawning thythmicity Starvation of larvae	Turbulent mixing Re-stratification Internal waves
10^{-2} years (~3-4 days)	Phytoplankton blooms Serial spawning frequency	Layering of phytoplankton)intrusions)Re-stratification)Frontal formation)Tidal processes Wind events Topographic waves Current reversals Baroclinic instability
10^{-1} years (~1 month)	Lunar periodicites Dispersion of larvae Seasonal spawning	Seasonal upwelling Ocean eddy formation Equatorial waves
10^{0} years (1 year)	Annual breeding Annual migration	Baroclinic Rossby waves Monsoon reversal Ocean climate Annual stratification Water column dynamics
10^{1} years (decades)	Demographic effects Life span Changes in migratory patterns Species replacement Seasonal productivity	Interannual variability current systems ENSO-type oscillations
10^{-2} years (centuries)	Man-induced pollution	"Global" ENSO events

Life cycle strategies are generally adapted to characteristic seasonal variations. Thus it is the non-seasonal ("abnormal") fluctuations that are likely to cause disruptions that will be reflected in recruitment variability. Difficulties in properly accounting for the large amplitude seasonal ("normal") variability have resulted in the conventional practice of pooling higher frequency biological variations to form annual composites. However, the higher frequency components are often of larger amplitude compared to the residual differences between annual composites, leading to a low signal to noise ration in the resulting annual time series. Also annual series contain relatively few data points within periods for which a fishery situation can be considered to be reasonably stationary. Most importantly, the within-year fluctuations of a given annual set may not all have been caused by the same environmental mechanism. Thus, it is not surprising that

empirical efforts based on annual composites have had a poor record of accomplishment in developing understanding the factors causing recruitment variability.

5. NEW DEVELOPMENTS

The Guiding Group observed that recently several new technical developments have occurred. These appear to offer very promising tools for recruitment research and allow, among other things, within-year variations in survival processes to be addressed.

a) The egg production rate method

The Southwest Fisheries Center in La Jolla, California, has developed a powerful tool for estimating spawning biomass which has the advantage of permitting the variance of a number of parameters to be calculated. By-products of the determination are better estimates of egg and early larval mortality than are available by conventional techniques. There is also considerable economy in days at sea required, because it reduces the need to cover the whole spawning season. The use of this method has also suggested that fecundity estimates in serial spawners made by conventional methods, are erroneous.

b) Daily aging of larvae and juveniles

Aging of larvae and juveniles, where feasible, provides a way to compare larval production with relative survival of juveniles. This technique has been used successfully in a study of northern anchovy recruitment, of California. The potential of this technique in recruitment studies makes it appropriate to consider convening a meeting of scientists working in this field to evaluate recent progress and explore its application to other stocks.

c) Histology of larvae

Starvation of larvae in the sea had never been directly observed until recently when specific histological criteria were established. These new techniques provide another important tool for recruitment studies.

d) Length-based approaches

New methods based on the detailed analysis of length frequency data from catch samples or survey data have been developed in the last decade which largely overcome the previous uncertainties of length-based methods. Several of these methods can be implemented with widely available, inexpensive micro-computers; by offering the possibility of reliably estimating vital statistics such as growth and mortality from length-frequency data, these methods overcome the major constraints generally associated with recruitment studies of tropical fishes, (e.g. difficulties with aging, short life span, etc.) and hence allow indirect (though relative) estimation of spawning stock size and recruitment with population dynamic methods.

6. THE SARP PROGRAMME

The Guiding Group acknowledged that the Sardine Anchovy Recruitment Programme (SARP) should be designed to take advantage of the new developments indicated in the previous sections. This approach basically involves repeated larval surveys of a region encompassing the total spawning grounds of a stock unit to indicate the variation of spawning through the spawning season. The early juveniles are sampled after the end of the season and the frequency distribution of birthdates determined. This distribution is compared to corresponding egg or larval production to yield the variation in survival throughout the season. A physical and biological oceanographic sampling programme will be designed to characterize environmental processes hypothesized to control this survival. Various "integrations" of these processes are examined for best fit to the observed survival variations.

SARP is considered to be particularly promising in that it allows utilizing large amplitude within-season variability in the analyses. By using the daily ring technique to establish the exact age of each individual larva in the samples, it allow a proper filtering of the interference due to strong annual periodicites by incrementally determining both the inputs (larvae) and outputs (survival) at each time increment. It thus represents a previously unavailable opportunity in recruitment research, providing information on possible density dependent effects, including egg mortality rates and early larval mortality rates.

SARP-type species complexes exist off the USA, Mexico, Ecuador, Peru, Chile, Brazil, Uruguay, Argentina, Portugal, Spain, Morocco, Mauritania, Senegal, Ivory Coast, Ghana, Congo, Angola, Namibia, South Africa, Somalia, Oman, India, Australia, Japan, etc. The Guiding Group proposed that implementation of the SARP programme should occur in three stages. The first stage would involve an Eastern Pacific exercise undertaken largely by scientists from countries of the CPPS region (mainly Ecuador, Peru and Chile) and the United States; at the same time observers from candidate nations, particularly of Latin America, would be invited to be involved in the on-going activities preparatory to undertaking similar efforts in other regions. It is expected that a Southwestern Atlantic exercise should follow some years later, building on the experience of the initial group. Expansion to other regions is envisaged as the methodology is established, of which rigorous testing of the validity of the daily ring technique is the key step.

Initiation of the first stage will be via a workshop to be held in La Jolla, California, in November 1984. The purpose of this workshop will be mainly to formulate the Eastern Pacific stage of the SARP programme. There, the formulation of the accompanying environmental sampling programme may focus particularly on larval starvation through turbulent mixing of micro-scale food particle strata, presence or absence of substantial predator populations, removal from favourable habitat by adverse advection (larval transport), etc. (Terms of Reference for this SARP workshop are given in Annex IV).

7. OTHER WITHIN-YEAR INVESTIGATIONS OF RECRUITMENT

The Guiding Group considered the approach and methods of the SARP programme to be probably applicable in varying degrees to recruitment studies of other exploited fish and invertebrate species. The Group discussed possible stocks in terms of their suitability for such investigations.

The results are presented in Table 3. Interested national and international bodies are invited to consider the formulation and implementation of such recruitment investigations, including studies of environmental mechanisms and factors likely to govern biological processes for the particular environments and early life history stages involved.

The criteria for inclusion of a species or a species group in Table 3 have been adapted from the Halifax Workshop Report, and are as follows:

a) Information on the life history, adult biology, spawning area and stock population dynamics should be known.

b) The geographical dimensions of the population habitat should be known.

c) There should be discrete stocks.

d) Fish must be amenable to daily ring technique or equivalent.

e) Population should be highly variable.

f) Fish should be of commercial importance.

g) A fishery with adequate sampling and statistics must exist.

h) An on-going fisheries programme should be in progress.

i) Facilities for oceanographic research and egg and larvae surveys should be available (e.g. ships, oceanographic equipment, ect.).

Table 3 - Some species/stocks identified by the Guiding Group as potentially suitable for investigations under IREP

Species	Examples of Area or Stock	Some potentially relevant countries/organizations	IREP Minimum Plan Criteria								
			a	b	c	d	e	f	g	h	i
Pelagic species											
1. Sprat (*)	North Sea, Skagerrak, Baltic (discrete stocks)	ICES coutries (Denmark, Fed. Rep. Germany, Norway, Sweden, UK)	X	X	X	?	X	X	X	X	X
2. Herring (*)	North Sea, adjacent waters	ICES countries (Denmark, France, Fed. Rep. Germany, Netherlands, Norway, UK)	X	X	X	?	X	X	X	X	X
3. "	Baltic	ICES countries (Denmark, Finland, Fed. Rep. Germany, German Democ. Rep., Poland, Sweden, USSR)	X	X	X	?	X	X	X	X	X
4. "	North-West Atlantic	ICES/NAFO countries (Canada, USA, USSR)	X	X	X	?	X	X	X	X	X
5. "	North-East Pacific	North American countries (Canada, USA)	X	X	X	?	X	X	X	X	X
6. Mackerel (*)	West-British Isles	ICES countries (France, Iceland, UK)	X	X	X	?	X	X	X	X	X
7. "	North Sea	ICES countries (Norway, UK)	X	X	X	?	X	X	X	X	X
8. "	North-West Atlantic	ICES/NAFO countries (Canada, German Democ.Rep., Poland, USA, USSR)	X	X	X	?	X	X	X	X	X
9. Tuna (*)	Southern bluefins and other stocks with restricted well defined spawning and nursery areas	Australia, Japan, New Zealand	X	X	X	X	X	X	X	X	X

Species	Examples of Area or Stock	Some potentially relevant countries/organizations	IREP Minimum Plan Criteria								
			a	b	c	d	e	f	g	h	i
Gadoids											
10. Cod (*)	Arcto-Norwegian	ICES countries (Norway, USSR)	X	X	X	X	X	X	X	X	X
11. "	Baltic	ICES countries (Denmark, Fed. Rep. Germany, German Democ. Rep., Poland, Sweden, Finland, USSR)	X	X	X	?	X	X	X	X	X
12. "	North-West Atlantic: Flemish Cap	ICES/NAFO countries (Canada, Fed. Rep. Germany, USSR)	X	X	X	?	X	X	X	X	X
13. "	North-West Atlantic: Gulf St. Lawrence and Georges Bank	ICES/NAFO countries (Canada, USA)	X	X	X	?	X	X	X	X	X
14. Haddock (*)	North-West Atlantic (Georges Bank)	ICES/NAFO countries (Canada, USA)	X	X	X	?	X	X	X	X	X
15. Pollock (*)	Bering Sea	INPFC countries (Korea, Japan, USA, USSR)	X	X	X	?	X	X	X	X	X
16. Place	Southern North Sea	ICES countries (Belgium, Denmark, Fed. Rep. Germany, France, Netherlands, UK)	X	X	X	?	X	X	X	X	X
17. Dover Sole (*)	Southern North Sea, English Channel and Bay of Biscay	ICES countries (Belgium, Denmark, Fed. Rep. Germany, France, Netherlands, UK)	X	X	X	?	X	X	X	X	X
18. Sole Species	North East Pacific	North American countries (Canada, USA)	X	X	X	?	X	X	X	X	X
19. Halibut	North East Pacific	Int. Halibut Commission countries (Canada, Japan, USA)	X	X	X	?	X	X	X	X	X

Species	Examples of Area or Stock	Some potentially relevant countries/organizations	IREP Minimum Plan Criteria								
			a	b	c	d	e	f	g	h	i
Salmoids											
20. Atlantic Salmon	European and North American stocks	ICES countries (Canadan Iceland, Ireland, Norway, UK, USA)	X	X	X	?	X	X	X	X	X
21. Pacific Salmon species	North American stocks	North American countries (Canada, USA)	X	X	X	?	X	X	X	X	X
Invertebrates											
22. Penaeid shrimp (✗)	Stocks of inter-tropical belt (e.g. Gulf of Carpentaria and other discrete stocks in Indo-Pacific area, etc.)	Various countries	X	X	X	-	X	X	X	X	X
23. Squid	North-West Atlantic	ICES/NAFO countries (Canada, USA)	X	X	X	-	X	X	X	X	X
24. Scallops (✗) oysters, mussels	Coastal waters in relation to development of extensive aquaculture	France, Spain, Japan Mexico, Chile	X	X	X	X	X	X	X	X	X

(✗) These species groups were considered as the most likely initial candidates for IREP.

8. RECRUITMENT-RELATED ECOLOGICAL PROCESSES IN TROPICAL COASTAL DEMERSAL RESOURCES

The Guiding Group pointed out that among the living resources in the inter-tropical belt (e.g. the Caribbean Sea, Western Central Pacific Ocean, Tropical Indian Ocean, Gulf of Guinea, etc.), demersal resources have major socio-economical and scientific importance

All countries in these regions have developed important coastal fisheries (i.e., shrimps, other crustaceans, molluscs, and fishes). Nevertheless, knowledge of these resources is at present limited, especially as regards environmental processes linked with recruitment. Because of this, among other reasons, their exploitation and management are presently inadequate.

In the physical environmental framework in the tropical coastal zone, with interactions between marshes, lagoon-estuarine environment and the continental shelf, the living resources have a complex biological organization. The Group was of the opinion that the term "multispecies fisheries" as often applied to these highly diverse, tropical communities is somewhat misleading as exploited multispecies assemblages also occur outside the tropics; the term "tropical coastal demersal" was preferred. In this context, applied ecology would be the cornerstone of the development of studies on identification, evaluation, exploitation and management of demersal living resources in these areas. These high diversity resources present different management options, depending on each country's interest, but in any case, some knowledge of the recruitment processes and their environmental framework (i.e. coastal processes, biological processes, biological production mechanisms, etc.) is necessary. Figure 2 illustrates the complexity of such systems.

Specific features of these tropical communities which collectively distinguish them from the "multispecies assemblages" of temperate waters are:

(i) Juvenile habitats that are spatially separate and structurally different from those habitats of the adults and the early stages (eggs and larvae).

(ii) Eggs and larvae that are taxonomically indistinguishable among possibly many kinds of species co-existing in the same locality.

(iii) Strong biotic interactions between the various species of the communities, particularly involving predator-prey at the juvenile stage.

The juvenile habitats mentioned in (i) involve marshes, lagoon-estuarine environment, sea grasses, mangroves; all of these either do not occur, or/and do not serve as nurseries in temperate waters. The well defined habitat separation between juveniles on one hand and adult or early life stages on the other hand, makes recruitment studies in tropical demersal fishes particularly important, especially as regards the effect of degradation of coastal environments; but, as will be elaborated further below, this offers the possibility of studying recruitment processes by monitoring juvenile stages using very cost effective methods.

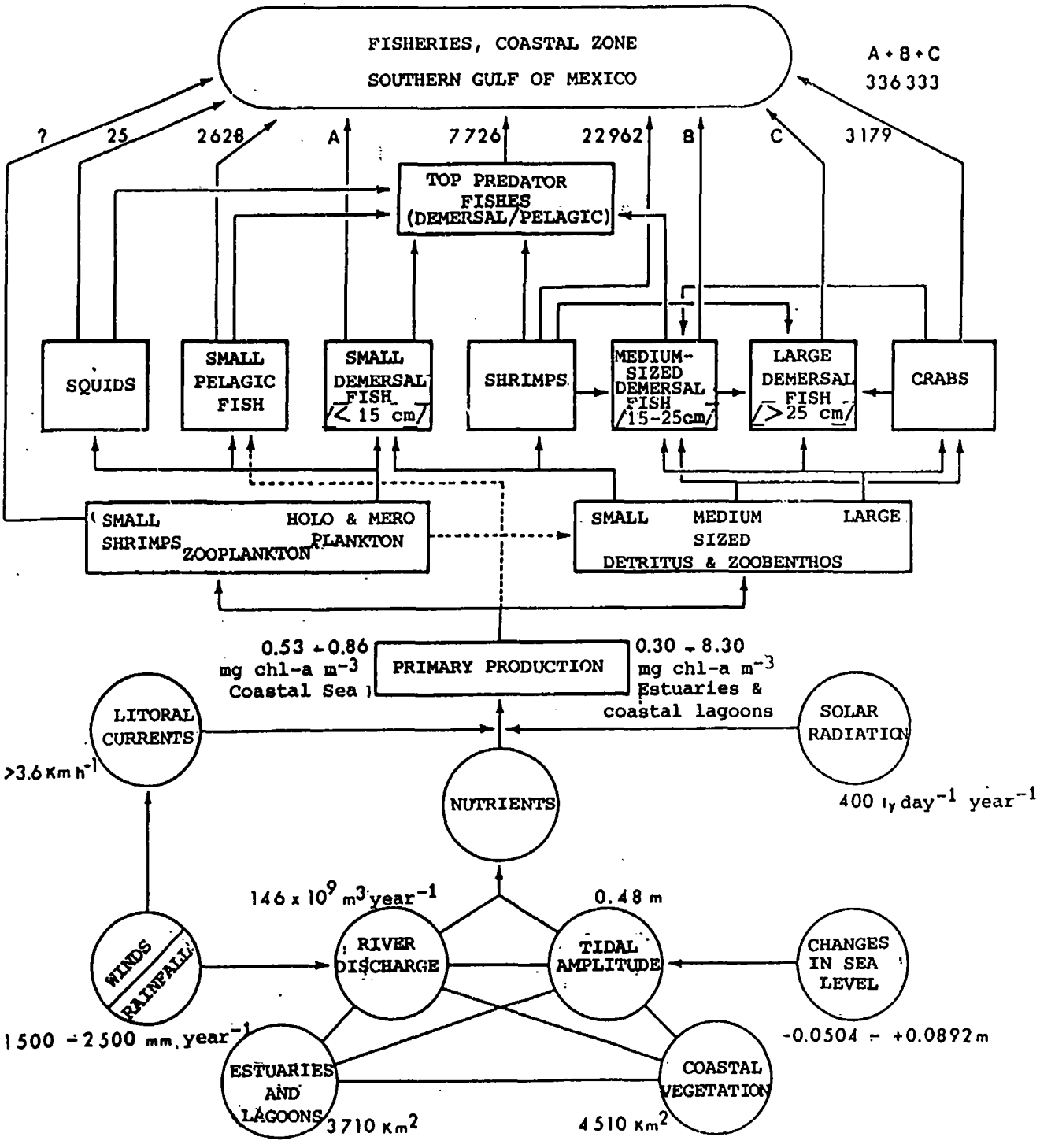


Figure 2 (Legend overleaf)

Figure 2. Trophic Structure and Demersal Resources in a Tropical Coastal Ecosystem (Southern Gulf of Mexico, IOCARIBE region)

The arrows indicate the main route of energy flow through the faunal groups of each block. Recruitment of tropical demersal resources is related to coastal processes, biological processes and biological production mechanisms, which are indicated by circles in the lower part of the diagram. The catches are given in metric tons per year. The fish catches (A, B, and C) are based on the ratio fish/shrimp = 12 : 1. The data on squids, small pelagic fishes, shrimp, crab and top predator fishes are annual averages for the years 1977 through 1981 in the States of Veracruz, Tabasco, Campeche and Yucatan (source : Secretaría de Pesca, México). The block of small pelagic fishes includes sardines (Clupeidae) and anchovies (Engraulidae). The block of top predator fish comprises sharks, dogfish, grunts (Pomadasyidae), snooks (Centropomidae), meros and groupers (Serranidae), red snappers and snappers (Lutjanidae). The block of small demersal fish (< 15 cm) is comprised i.e., of flat fish (Soleidae and Bothidae), mojarras (Gerreidae), scorpion fish (Scorpaenidae). The block of medium-sized demersal fish (between 15-25 cm) includes giltheads and yellow jacks (Carangidae), croakers (Sciaenidae), porgies (Sparidae), puffers (Tetraodontidae), sea robins (Triglidae) and others. The block of large demersal fish (> 25 cm) includes among others, ribbon fish (Trichiuridae), rays (Dasyatidae), sea catfish (Ariidae), lizardfish (Synodontidae), croakers (Sciaenidae). (from A. Yañez-Arancibia pers. comm.).

The separation of different life stages among radically different habitats also suggests strong relationships between fishes and specific features of their habitats, thus making "ecological" studies particularly relevant to recruitment studies.

The issues raised in (ii) concerning taxonomic problems with early life stages of tropical demersal fishes applies to both eggs and larvae. Fish eggs of different species are inherently similar to each other and identification of eggs collected in plankton surveys, even when conducted in species-poor water, still involves problems; in areas where hundreds of similar species co-occur, attribution of eggs to their respective species becomes impossible. The consideration concerning eggs also applies (if to a lesser extent) to larvae.

Finally, it should be mentioned that the rapid development time of eggs and larvae in tropical waters, which can be as short as 8 hours from spawning to hatching (in eggs < 1 mm, at 30°C), implies a very high sampling frequency if quasi-synoptic coverage is to be attained.

For all these reasons, recruitment studies in tropical demersal communities, cannot feasibly be structured around evidence obtained from direct sampling of eggs and larval stages. However this problem can be avoided (rather than "solved"), and reasonable inferences still be drawn on recruitment processes. With reference to Figure 2, this amounts to studying recruitment variability from the pool metamorphose stage on, and using spawning biomass to estimate egg production, the point being that species-level identification becomes possible (usually) after metamorphoses.

These approaches are all "single-species approaches" in the sense that they require data (catch per effort, length-frequency; or age data on adult and juveniles) to be expressed on a per species basis. However, they are relevant to tropical demersal coastal stocks because the specific methods in these approaches are neither work nor cost intensive and thus can be applied to a large number of species representative of the multispecies stocks as a whole. That such methodology is available is not widely known. This is one of the reasons why the recruitment variability in multispecies stocks in tropical waters are generally perceived as intractable.

The Guiding Group therefore endorsed strongly the suggestion that a workshop be held on recruitment in tropical coastal demersal stocks. This "OSLR-IREP Workshop on Recruitment in Tropical Coastal Demersal Communities" should be preferably held in the second half (e.g., October) of 1985. Mexico City and the "Instituto de Ciencias del Mar y Limnología (UNAM)", have been tentatively suggested as venue and host institution, respectively.

The following terms of reference of this workshop are suggested:

- To identify analogues for comparative studies in tropical demersal communities (i.e., identification of areas with comparable communities throughout the intertropical belt);

- To evaluate reported cases of biotic interactions suggestive of "biotic control" of recruitment in tropical demersal communities;

- To evaluate environmental factors suggestive of "physical control" of recruitment in tropical demersal communities;

- To suggest coast-effective ways by which juveniles can be sampled quantitatively in the inshore habitats (i.e., marshes, lagoon estuarine environment, sea grasses, mangroves);

- To examine in detail length-based methodologies that have recently become available with regard to their suitability to estimate vital statistics in tropical demersal communities, with emphasis on recruitment related information;

- To test whether the critical features of SARP-type projects (daily age distribution of juveniles, batch fecundity and spawning frequency) are applicable to tropical demersal fish;

- To evaluate the role of man-made perturbation of coastal habitats in recruitment of tropical demersal communities.

The Guiding Group proposed that the venue of this Workshop be submitted for consideration to the next session of IOCARIBE to be held in Curaçao, Netherlands Antilles, 20-25 August 1984, and that WESTPAC and other relevant IOC/FAO subsidiary bodies and organizations should be kept informed of the decisions on this matter taken at the SC-IOCARIBE-I session.

9. LABORATORY EXPERIMENTS

9.1 MARICULTURE EXPERIENCE

The Guiding Group noted that mariculture operations constitute controlled experiments pertinent to IREP and OSLR. Development of some forms of mariculture in open waters (e.g. shell fish culture, various kinds of sea ranching, etc..) depends on enhancement of natural recruitment, requiring some understanding of the factors determining success of recruitment. In addition, intensive aquaculture yields information on the biology of early stages (e.g., duration, starvation thresholds, etc.). Ntoing that much pertinent information may have been developed which is not systematically available, the Group advocated the review and assembly of such information in support of IREP.

9.2 ESSENTIAL STUDIES FOR SARP-TYPE EFFORTS

The Guiding Group considered that vital information for SARP and similar early life history observational programmes includes:

(i) dependance of egg development rate on temperature, and

(ii) threshold food particle concentrations for successful larval first-feeding. Laboratory programmes for evaluation of these parameters are suitable for implementation in developing countries.

9.3 OTHER LABORATORY EFFORTS

The Guiding Group noted that a number of other types of laboratory investigations would be highly useful to IREP programmes. For example, establishment of accumulation time of larval food concentrations due to

swarming behaviour by motile food organisms would be very useful in formulating indices of effects of turbulence on first feeding success. Similarly, the Group encouraged the on-going ICES studies on reaction of larvae to stratification, predation on larvae, etc., as indicated in the recommendations made by the ICES Larval Fish Ecology Working Group.

10. OTHER OSLR APPLICATIONS

The Guiding Group emphasized that although IREP is identified as the initial priority programme category, other ocean science applications to resource problems are suitable objects for OSLR. The Group discussed briefly the following examples (this list is in no way considered to be exhaustive).

10.1 HABITAT STUDIES

Studies of resource habitat variation (including neritic spawning and feeding grounds such as estuaries, sea grass beds, etc.) should be promoted within the OSLR context.

10.2 OCEAN FACTORS AFFECTING RESOURCE DISTRIBUTION AND/OR MIGRATION

The Group expressed interest in the FAO efforts concerning mapping of fishery resource distributions. These efforts should be encouraged within the context of OSLR, and as far as possible be complemented by research investigations concerning disruptions of migration or distribution patterns by ocean anomalies.

10.3 COMPARATIVE STUDIES

The comparative approach may provide a powerful deductive method for identifying and understanding mechanisms linking distribution and abundance of living resources to environmental variation. The Group noted that both the recruitment projects discussed and the proposed workshop on tropical coastal demersal communities, involve strong comparative components.

11. RELATIONSHIPS WITH OTHER BODIES

The Guiding Group noted that WESTPAC, the IOC regional subsidiary body in the Western Pacific, has established a Task Team on OSLR (a statement by Dr. D. Tranter, Chairman of this Task Team is appended to this report as Annex V). Such initiatives were welcomed by the Group. Corresponding action by the IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE) including consideration of Recommendation 2 below, would be similarly welcomed. The Group also noted the considerable interest in relevant activities existing in ICES and CPPS (see Recommendations 1 and 3 below). In addition the Guiding Group acknowledged the interest expressed by SCOR WG-73 on OSLR/IREP. (See Recommendation 9 below).

The Guiding Group stressed the need to strengthen the links between OSLR and IGOSS/IODE with particular interest having been expressed in timely access to data on variation on mean sea level and to synoptic information from remote sensing. Variations in mean sea level are sensitive indicators of large scale anomalies in ocean flow, including internal variation in water mass structure. Likewise, mapping of resources by remote sensing (e.g.,

Coastal Zone Colour Scanner) is possible, and infra-red temperature imagery can be an useful diagnostic tool in field efforts. Thus sea level data and remote sensing can help in defining the enlarged time and space context of the OSLR effort.

12. TEMA COMPONENT OF OSLR

Dr. S.M. Haq, Assistant Secretary of IOC, introduced the TEMA programme and concepts to the Group deliberations. The Group noted that the TEMA component is implied essentially in all the recommended OSLR operations. The Group considered that the TEMA component should be an integral part of any OSLR exercise and therefore recommended specific identification of TEMA aspects in any OSLR proposal, particularly as regards OSLR projects developed in the framework of IOC/FAO regional subsidiary bodies.

13. RECOMMENDATIONS OF THE FIRST SESSION OF THE GUIDING GROUP OF EXPERTS ON THE PROGRAMME OF OCEAN SCIENCE IN RELATION TO LIVING RECOURCES

The Guiding Group of Experts recommends:

Recommendation 1.

(a) The SARP-Programme be adopted as a pilot initiative of OSLR/IREP, as suggested at the Halifax Workshop and expanded during the present session of the Guiding Group. Its implementation is envisaged in three stages:

(i) The Eastern Pacific Region (West Coast of North America and the CPPS countries;

(ii) The Southwestern Atlantic region (Brazil, Uruguay, Argentina); and

(iii) Other regions with similar species complexes (e.g., regions off the Iberian Peninsula, NW and SW Africa, etc..).

(b) CPPS be invited to seek participation of its Member States (Ecuador, Peru, and Chile, in particular) in the SARP-Programme.

(c) The OSLR sponsoring agencies (IOC and FAO) be requested to co-sponsor a consultation by the Southwest Fisheries Center (NMFS, NOAA), to be organized, in November, 1984, in order to define the operational elements for the SARP Programme in the Eastern Pacific.

Recommendation 2

An "OSLR-IREP Workshop on Recruitment in Tropical Demersal Communities" be organized, with focus on: analogues for comparative studies in the inter-tropical belt, evaluation of biotic interactions and environmental factors in recruitment processes, and examination of the available methodologies and new approaches applicable to tropical demersal fish recruitment.

Further, that this initiative be addressed to the First Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE) to be held in Curaçao, Netherlands Antilles, 20-25 August, 1984.

Recommendation 3

IOC be requested to bring the aims and proposed development of interdisciplinary investigation of the recruitment problem under IREP to the attention of ICES and to invite ICES to consider collaboration in the development and implementation of these integrated early life history and associated environmental investigations on relevant exploited fish and invertebrate stocks.

Recommendation 4

NMFS be contacted by IOC/FAO to assess the status of the planned NEFC workshop on daily otolith readings and to explore the possibility of co-ordination of this workshop with ICES.

Recommendation 5

A training course for Latin American participants be sponsored by IOC and FAO on the Egg Production Rate Method as an element of the SARP exercise. This training course will be held preferably in Lima, Peru, in 1985, and the "Instituto del Mar del Peru (IMARPE)" and the "Programa Cooperativo Peruano-Alemán de Investigación Pesquera (PROCOPA)" be invited to host and support this initiative, respectively.

Recommendation 6

The NMFS be contacted by IOC/FAO to suggest consideration of implementing a training course in egg production rate/daily otolith ring methods at the Southwest Fisheries Center.

Recommendation 7

That the convenors of a Symposium on Penaeid Resources (Alder, Australia, October 1984) be invited by the Chairman of the Guiding Group, to arrange discussions at that forum on the development and implementation of an IREP component for penaeid resources.

Recommendation 8

That the convenors of the NAFO Special Session on Biology and Ecology of Squid (Dartmouth, Nova Scotia, September 1984), be contacted by the Chairman of the Guiding Group to request that this meeting considers an OSLR/IREP-oriented component in elucidating the problems involved in recruitment variability in squid stocks.

Recommendation 9

The links between the IOC/FAO OSLR Programme and SCOR, be re-inforced particularly by acknowledging the interest expressed in IREP by SCOR WG-73 on Theoretical Ecology in Relation to Biological Oceanography, and common grounds for closer collaboration be sought. Further, that the interest JABO has expressed in this context in high diversity marine ecosystems, particularly with reference to multispecies type fisheries and the study of specific habitats (e.g., marshes, deltas, lagoon-estuarine environments, sea grasses

and mangroves) in tropical coastal areas, be acknowledged and the assistance of IABO in stimulating basic studies that are of direct relevance to recruitment, be welcomed.

14. DATE AND PLACE OF NEXT SESSION

The Group suggested convening its next Session in about 12-18 months, preferably in the WESTPAC region (e.g. Manila, Philippines).

15. ELECTION OF OFFICERS OF THE GUIDING GROUP

Mr. A. Bakun was unanimously elected Chairman of the Group for the intersessional period.

Dr. P. Bernal was likewise unanimously elected Vice-Chairman.

16. ADOPTION OF THE SUMMARY REPORT

The Summary Report of the Session was adopted.

17. CLOSURE

In closing the Session, the Chairman expressed appreciation to Professor R.J.H. Beverton for his help in formulating the OSLR/IREP Programme, particularly in chairing the Halifax Workshop and assisting in producing the corresponding Report. The Session was closed at 18.00, 20 July 1984.

ANNEX I

LIST OF PARTICIPANTS

Members of the Guiding Group

Mr. A. Bakun	Pacific Environmental Group National Marine Fisheries Service P.O. Box 831 Monterey, CA 93942 USA Tel: (408) 646-3311	(Nominated by SCOR)
Dr. P.A. Bernal	Departamento Biotecmar Pontificia Universidad Católica de Chile Casilla 127 Talcahuano Chile Tel: (041) 425 92 (Ext. 34) Telex: 260 191 PUCST CL	
Prof. R.J.H. Beverton	Department of Applied Biology UWIST P.O. Box 13 King Edward VII Avenue Cardiff Wales CF1 3Xf United Kingdom Tel: (0222) 42588	
Prof. Dr. G. Hempel	Alfred-Wegener Institut für Polarforschung Columbus Center Bürgermeister-Smidt-Str. 20 D 285 Bremerhaven Federal Republic of Germany Tel: (0431) 49006 Telex: 0238695 POLARD Cable: POLAR BREMERHAVEN	(Nominated by ACMRR)
Dr. R. Lasker	Southwest Fisheries Center National Marine Fisheries Service P.O. Box 271 La Jolla, CA 92093 USA Tel: (619) 453-2820 Telex: 910 337 LA JOLLA CA	
Prof. P. Lasserre	Station de Biologie Marine Place George Teissier 29211 Roscoff France Tel: (98) 69 7230 Telex: 930 660	(Nominated by IABO)

Dr. A.R. Longhurst (Unable to attend)	Bedford Institute of Oceanography P.O. Box 1006 Dartmouth, Nova Scotia B2Y 4A2 Canada Tel: (902) 426-3492 Telex: 019-31552	
Dr. P. Pauly	International Center for Living Aquatic Resources Management P.O. Box 1501 MCC Makati Metro Manila Philippines Tel: 818-0466 Telex: 45658 ICLARM PM	
Dr. D. Tranter	CSIRO Division of Fisheries Research P.O. Box 21 202, Nicholson Parade Cronulla, N.S.W. 2230 Australia Tel: (02) 523-6222 Telex: 24875 Cable: CORESEARCH	(Chairman, WESTPAC Task Team on OSLR)
Dr. J.P. Troadec	IFREMER Direction des Ressources Vivantes 66, Avenue d'Iéna 75116 Paris France Tel: 723 55 28/720 53 01 Telex: OCEANTX 610775 F	

Representatives of Organizations

Unesco	Dr. B. Mwaiseje Division of Marine Sciences Unesco 7, Place de Fontenoy 75700 Paris France Tel: (1) 568.39.67 Telex: 204461 Paris
ICES	Dr. B. Parrish General Secretary International Council for the Exploration of the Sea Palaegade 2-4 DK-1261 Copenhagen K Denmark Tel: (01) 15 70 92 Telex: 22498 ICES DK Cable: MEREXPLORATION COPENHAGUE

Observers

Dr. J. Alheit
Programa Cooperative Peruano-Alemán
de Investigación Pesquera (PROCOPA)
Instituto del Mar del Perú
Apartado 22
Callao
Peru
Tel: 297094
Telex: 21093 PE GTZ

Dr. D.F. Novoa
Departamento Pesquero
Corporación Venezolana de Guayana
Av. Germania
Apartado Postal 209
Ciudad Bolivar, Estado Bolivar
Venezuela
Tel: (085) 47138
Telex: 86447 CVGVE

Dr. G. Shaffer
Oceanografiska Institutionen
Göteborg Universitet
Box 4038
40040 Göteborg
Sweden
Tel: (031) 12874

Dr. A. Yañez-Arancibia
Instituto de Ciencias del Mar y Limnología
Universidad Nacional Autónoma de México (UNAM)
Apartado Postal 70-305
Mexico
Tel: 5505215 (Ext. 4855)
Telex: 177-7429 CICME

Secretariat

IOC
Dr. F.L.E. Robles
Head, Ocean Sciences Unit
Intergovernmental Oceanographic Commission
Unesco
7, Place de Fontenoy
75700 Paris
France
Tel: (1) 568.39.79
Telex: 204461 Paris
Cable: UNESCO PARIS

FAO
Mr. J. Csirke
Fishery Resources and Environment
Fisheries Department
FAO
Via delle Terme di Caracalla
00100 Rome, Italy
Tel: 57971 (Ext. 6506)
Telex: 610181 FAO I
Cable: FOODAGRI ROME

ANNEX II

Twelfth Session of the Assembly
Paris, 3-20 November 1982

Resolution XII-1

OCEAN SCIENCE IN RELATION TO LIVING RESOURCES (OSLR)

The Intergovernmental Oceanographic Commission,

A

Recalling Resolution XI-17 approving the development by the Commission of a Programme of Ocean Science in Relation to Living Resources (OSLR),

Expresses its appreciation to SCOR and ACMRR for the report of their joint Working Group No. 67 (document IOC-XII/8 Annex 1a) which was submitted to the Assembly in response to the Commission's request for advice on this programme;

Adopts OSLR as a new scientific programme of the Commission.

B

Agreeing with the SCOR view that the first major objective of the Commission's OSLR Programme should be to gain a better understanding of the effect of environmental conditions on recruitment of fish stocks, this being one of the central and long-standing, but still largely unresolved, problems in marine science in relation to living resources,

Noting that progress towards this objective would be of direct assistance to Member States in their task of achieving the best management of fish resources and in support of FAO activities to that effect,

Acknowledging that the multi-disciplinary research involved is particularly demanding logistically and calls for the concerted application of a wide range of scientific skills, together with the necessary facilities, at sea and ashore, on a long-term basis,

Agreeing also with the conclusion of SCOR/ACMRR Working Group No. 67 that a promising approach would therefore be to develop an international programme comprising a network of investigations into the relevant aspect of the quantitative ecology of selected fish species, co-ordinated in space and time and using similar techniques (hereafter called the International Recruitment Project, IREP),

Noting also that one possible form that this programme could take is that described in the report of the SCOR/ACMRR Working Group No. 67 as IREX (International Recruitment Experiment),

Being aware that much consultation and detailed planning will be required before such an international programme can be undertaken,

Invites the FAO to co-sponsor the OSLR Programme and the International Recruitment Project in particular;

Establishes a Guiding Group of Experts on the OSLR Programme, with the terms of reference contained in the annex attached to this resolution;

Requests the group to report on progress to the Executive Council at its Seventeenth Session;

Accepts with appreciation the offer from Canada to host a workshop on the future planning of the IREP;

Accepts also with appreciation the offer from the Unesco Division of Marine Sciences to sponsor a working group to examine the special problems of high-diversity ecosystems in the context of the OSLR Programme.

Annex to Resolution XII-1

TERMS OF REFERENCE OF THE GUIDING GROUP OF EXPERTS ON THE PROGRAMME OF OCEAN SCIENCE IN RELATION TO LIVING RESOURCES (OSLR)

1. To plan further the development of the OSLR Programme, and in particular the International Recruitment Project (IREP), along the lines of the IREX proposal or in other ways, paying particular attention to methodology, techniques and logistics.

2. To provide scientific and technical advice to the IOC regional subsidiary bodies involved in the implementation of regional components of the OSLR Programme.

3. To seek the co-operation of SCOR, IABO, appropriate regional bodies (ICES, CPPS and regional fishery bodies of FAO, in particular) and national institutions.

4. To liaise with IOC subsidiary bodies (e. g. Joint SCOR/IOC CCCO, Working Committee for IGOSS and Working Committee on IODE) that might be able to assist in one or other aspects of the OSLR Programme, particularly IREP.

5. To co-operate with the Unesco Division of Marine Sciences on the special problems of high-diversity ecosystems in the context of OSLR.

6. To consider how best to ensure the participation of developing countries, in the OSLR Programme, by including TEMA components therein.

ANNEX III

SUMMARY OF THE WORKSHOP ON THE IREP COMPONENT OF THE IOC PROGRAMME OF OCEAN SCIENCE IN RELATION TO LIVING RESOURCES (OSLR)
(Halifax, Nova Scotia, 26-30 September 1983)

INTRODUCTION

The concept of OSLR as a long-term programme of marine research was formally adopted (Resolution XII-1) by the IOC Assembly at its Twelfth Session (3-20 November 1982). The Resolution provides for the establishment of a Guiding Group of Experts for OSLR.

A central aim within this general programme is to promote co-ordinated regional research projects aimed at elucidating the factors (physical, chemical and biological) determining the recruitment to fish populations, with particular reference to commercial fish stocks. This was denominated the International Recruitment Project (IREP). The Government of Canada offered to host a Workshop on the future planning of IREP. Accordingly, the Secretary organized a Workshop on the IREP component of the IOC Programme on Ocean Science in Relation to Living Resources, which was held in Halifax, Nova Scotia, from 26 to 30 September 1983, with the local support of the Bedford Institute of Oceanography. The Workshop was attended by twenty-five marine science specialists (biologists, physicists and ecologists) from twelve different countries. In addition, during the first two days of the Workshop, seven invited lectures were offered on the recruitment problem.

GUIDELINES AND MAIN APPROACHES DISCUSSED

The main task of the Workshop was to formulate a set of objectives and a strategy for practical research projects, or group of projects, to implement IREP. Besides the background material from consultations organized before the Twelfth Assembly of IOC, certain criteria to guide the Workshop were derived from an informal meeting held on April 23, 1983, during the course of the FAO Expert Consultation to Examine Changes in Abundance and Species Composition of Neritic Fish Stocks, in San José, Costa Rica, 18-29 April 1983.

Also pursuant to Resolution XII-1, the International Association for Biological Oceanography (IABO), in co-operation with the Unesco Division of Marine Sciences, sponsored a meeting on High-Diversity Marine Ecosystems (Roscoff, 6-9 September 1983) the report of which was made available for the Workshop in Halifax.

Three main approaches were examined during the Workshop regarding research on the recruitment problem: (i) direct observations related to early life-history surveys and studies; (ii) inferences from relationships between year-class strength and environmental factors; and (iii) experimental and ecological approaches to the biological oceanography, particularly of the high-diversity ecosystems.

Regarding time scales relevant to fisheries management problems, three kinds of variability patterns which can be associated to recruitment changes,

were recognized, in general terms. These correspond to the three "streams" of the World Climate Programme; namely, seasonal variability, interannual changes and long-term (decennial) trends. Perturbations observed vertically and horizontally in the ocean, mainly due to variations observed in the respective thermal gradients, can be interpreted by reference to these three time scales.

Also in general terms, it was recognized that, although recruitment management requires knowledge of a relationship between spawning parental stock size and recruitment, there is not yet enough basis for a single ecological theory to explain this relationship. The year-class strengths in many fishes seem to be determined also by factors other than the size of the spawning stock, such as food availability, predation and various environmental influences.

CONCLUSIONS AND RECOMMENDATIONS

In the first category (direct methods) an IREP Minimum Plan was delineated for countries that have limited facilities but wish to participate in recruitment research at a certain level; different criteria for selecting ensembles of species to be studied under this Minimum Plan were recommended. As part of this approach the Workshop identified a Sardine-Anchovy Recruitment Programme (SARP) to be implemented as a pilot project of IREP, in the eastern-boundary-current region of the Pacific Ocean. It was anticipated that the Eastern Pacific SARP experiment will benefit other nations in the short run by providing useful comparison with studies elsewhere.

In the second category (inferential approaches), several methods that can be applied to the study of recruitment-related problems in a variety of marine ecosystems were identified. These included inferences drawn from studies on: adult reproductive potential, comparison of ecosystems and life histories, changes in catch composition, length-based frequency analysis approaches, growth-ring information, and sediment records, all of them in conjunction with time series of environmental data. Cross reference was made to five types of areas where these methods can be applied; namely, shelves and banks (tropical and temperate), reefs (including coral reefs), upwelling areas, the open ocean, and lagoons, estuaries and areas of inter-tidal vegetation. The Workshop agreed that the methods proposed can be generally applied by single or small groups of investigators and are suitable for use in developing countries. Also, this approach has a valuable training aspect in that it exposes the investigators concerned to a broad range of scientific methods and fosters interpretative skills.

The third category (ecological approaches) was proposed to be developed in the OSLR framework but rather in a supportive and parallel way to the IREP exercise. The main activities envisaged through these approaches include: improved concepts and models of high-diversity marine ecosystems; different types of comparative field studies in various locations; experimental studies in controlled ecosystems to test physical and biological perturbations and manipulations; and investigations on large-scale variability in high-diversity ecosystems by remote sensing imagery. These activities will be concentrated in regions where multispecies fisheries exist and/or where there is a strong dependence on estuaries, coastal lagoons, mangroves and coral reefs.

The review by the Workshop of the present state of knowledge of the recruitment problem and its variability, indicates that an integration of experimental and field studies is being initiated which could lead to the formulation of comprehensive models of the reproductive strategies evolved to maximize recruitment.

The Workshop concluded that IREP represents a particularly good case for co-operative and interdisciplinary research aimed at achieving this objective in terms of cost-sharing logistics, liaison between developed and developing countries, cooperation between fisheries and academic research institutions and experts, data processing and exchange and corresponding TEMA components.

Although the Workshop was as specific as possible in examining and formulating its proposals, further definition and implementation of IREP components will require consultation within the Guiding Group of Experts for OSLR. To attain this goal, it would be essential for the Guiding Group of Experts to seek the co-operation of relevant working groups of ACMRR, IABO, SCOR, regional organizations (such as ICES and CPPS) and interested national institutions, and regional subsidiary bodies or other mechanisms of IOC and FAO.

The Workshop agreed that, in the context of present recruitment problems, particular attention should be paid to supporting research and development and concurrent Training, Education and Mutual Assistance (TEMA) efforts in studies related to aging, fecundity, sampling gear and recruitment theory, modelling and statistics.

Also, in recognition of the high costs involved in the sorting and identification of fish eggs and larvae, and their planktonic prey and predators, and of recent technical advances to deal with this particular problem, it was considered useful to convene a specific workshop on this methodological aspect, with the following objectives: (a) to review the capabilities of new systems available or under development for the collection, sorting, and identification of fish eggs and larvae; (b) to evaluate the potential application of these systems in support of IREP studies; and (c) to identify modifications to the most promising systems for operation in developing countries.

ANNEX IV

TERMS OF REFERENCE FOR THE CONSULTATION ON SARP
(co-sponsored by IOC and FAO)

1. Objectives

1.1 It is the interest of the IOC-FAO Consultation on SARP (to be held under the auspices of the Southwest Fisheries Center, La Jolla, California) to produce a proposal under the Sardine/Anchovy Recruitment (SARP) initiative of IREP to be presented for consideration to funding agencies.

The initial proposal will include a pilot SARP project of comparative studies of upwelling systems in relation to the recruitment of sardines. This initiative will be developed with particular reference to the Western coast of the Americas where the sardine-anchovy complexes represent major fishery resources. The proposal will consider the precepts of OSLR, and is therefore aimed at studying the mechanisms by which the biotic and abiotic environment influence recruitment including the physical oceanography and meteorology of the sardine/anchovy habitat. It is proposed that physical oceanographers will take an active part in the planning and implementation of SARP.

The new techniques of aging by daily rings, histology of starving larvae, and the egg production method of biomass analyses will be part of the methodology of the proposal. Stocks and areas to be studied will be selected.

1.2 One of the main objectives of the SARP Consultation will be the prospects for training and mutual assistance in new techniques and methods. It is intended that potential future participants in SARP be asked to attend the meeting to explore the desirability of participation, the timing of such a work, and the possibility of training so that within a year or two, each interested country has a team of workers prepared to participate in SARP. Latin American countries with sardine/anchovy resources (e.g. Mexico, Ecuador, Perú, Chile, Argentina, Uruguay and Brazil) are potential candidates. Other countries actively involved in sardine/anchovy research or otherwise interested in SARP-types of studies will also be offered the opportunity to send representatives to the Consultation.

2. Methodology to be discussed

A. Biomass assessment with the egg production method.

B. Biological and physical measurements related to recruitment:

(i) Larval production

(ii) Juvenile birthdates (otoliths)

(iii) Vertical measurements of larval food distribution and planktonic predators

(iv) Larval starvation histology

(v) Larval growth rates

(vi) Fishery-related data

(vii) Mesoscale current and density fields (with moored and profiling current meters and CTD)

(viii) Small scale mixing (profiling current meters)

(ix) Satellite oceanography.

C. Data collection and Management

3. Dates and place for the Consultation on SARP

5-9 November 1984, SWFC, La Jolla, California.

ANNEX V

OSLR/WESTPAC
(Statement by the Chairman of the
WESTPAC Task Team on OSLR)

The Ocean Science Living Resources component of the regional IOC programme known as WESTPAC is developing on a parallel and, to some extent, converging course with the global OSLR recruitment programme. WESTPAC/OSLR shares with IREP the assumption that the factors governing living resources in the sea cannot properly be understood without an intimate understanding of the physical processes that shape the habitat of those resources. OSLR is therefore perceived by WESTPAC to be not a biological programme per se but an interdisciplinary programme at the interface between fisheries research and oceanography.

OSLR/WESTPAC has in common with IREP and with its immediate expression SARP that it is process-oriented. However, whereas IREP and SARP are concerned directly with recruitment processes, OSLR/WESTPAC is concerned with those biological production processes that sustain and influence survival of the larvae. The slightly different emphasis of the WESTPAC programme may have some basis also in the fact that the Western Boundary Current regions of the world are considered to be less variable in interannual recruitment than Eastern Boundary Current regions. Thus the motivation for a sardine-anchovy research programme has come from the Eastern, not the Western Pacific. However the ocean upwellings of the tropical Eastern Pacific have their meteorological analogue in the variability of the monsoons which play an important role in regional productivity and recruitment, as evidenced by the direct link between the annual catch of penaid prawns in some parts of the Gulf of Carpentaria and the monsoonal rains. There is evidence that the reproductive strategies of many of the fish, crustacea and molluscs of the region are closely attuned to the periodicity of the monsoon. In this respect the supposed lack of variability in tropical habitats is an illusion.

Two of the predominant habitats in the WESTPAC region are mangroves and coral reefs. The former thriving on silt brought down by the rivers, the latter requiring silt-free conditions for survival. The WESTPAC area contains also some of the largest sea-grass habitats in the world, considered generally to be an important nursery habitat for many fisheries.

The oceanic habitat of the WESTPAC area is dominated by the Kuroshio and East Australian Currents and their eddies. Even the western coast of Australia has more in common with western that with eastern boundary current situations; (e.g. there is no analogue there of the Peruvian or Benguela upwelling). However, both the Kuroshio and East Australian Currents are considered to play significant roles in recruitment to fish stocks, particularly on their frontal margins: they also provide recruitment corridors for equatorial species, such as skipjack tuna, to sustain high latitude populations.

Perhaps because the western Pacific area is not a major upwelling area of the world, there is more emphasis there on coastal habitats and on mariculture; more concern, for example, with prawn fisheries than with sardine-anchovy fisheries (although where those fisheries do occur, their annual recruitment is also characterized by considerable variability).

The OSLR/WESTPAC programme is habitat-oriented in its approach. There are four study groups on the OSLR Task Team: one concerned with production processes at the land-sea interface (mangroves, coral reefs, estuaries), one with production processes on the continental shelves, one with ocean productivity; and, a fourth with a very specific practical problem related to increasing frequency of red tides and their adverse effect on coastal fisheries and fish farms.

In May 1984 the OSLR/WESTPAC Task Team held a Workshop on Toxic and Anoxic Phenomena associated with Algal Blooms and a collaborative network of activities is now established in the region. Members of the Task Team in Japan will be met in July 1984 to develop other segments of the OSLR/WESTPAC programme. That will be an opportunity to acquaint them with the outcome of the First Session of the Guiding Group of Experts on OSLR and canvas the question whether their activities might be directed more closely towards recruitment processes. There is a developing interest in the region in comparative studies of the productivity of shallow semi-enclosed basins like the Gulf of Thailand and Gulf of Carpentaria and advice from the Guiding Group will be welcomed on ways in which such studies could be linked with IREP.

There is considerable interest within the WESTPAC group in comparative studies of the Kuroshio and East Australian Currents and during May 1985 a WESTPAC workshop on the topic (involving also USA scientists working on the Gulf Stream), will be held in Tokyo. WESTPAC physical oceanographers are directing their primary attention to the equatorial area north of Australia where the El Niño - Southern Oscillation has its birth; it is inevitable, therefore, that the OSLR/WESTPAC programme will have an El Niño component. One of the members of the OSLR/WESTPAC Task Team is monitoring the birth of El Niño in the region north of New Caledonia and these activities may be of particular relevance to the sardine-anchovy research programme which will presumably be concerned with its downstream consequences.

It is believed that regional programmes such as WESTPAC are an ideal vehicle for putting global programmes such as OSLR into practice, although it should be recognized that there will undoubtedly be regional differences in perspective and emphasis. It is also believed that a strong link is now established between OSLR/WESTPAC and the IOC/FAO Guiding Group of Experts on OSLR.

ANNEX VI

LIST OF ACRONYMS AND ABBREVIATIONS

ACMRR	Advisory Committee on Marine Resources Research (of FAO)
CCCO	Committee on Climatic Changes and the Ocean (IOC/SCOR)
CPPS	Comisión Permanente del Pacífico Sur (Colombia, Chile, Ecuador, Perú)
ENSO	El Niño - Southern Oscillation
FAO	Food and Agriculture Organization of the United Nations
IABO	International Association for Biological Oceanography
ICES	International Council for the Exploration of the Sea
IGOSS	Integrated Global Ocean Services System (IOC/WMO)
IHP	International Hydrological Programme (Unesco)
INPFC	Indo-Pacific Fisheries Commission
IOC	Intergovernmental Oceanographic Commission
IOCARIBE	IOC Sub-Commission for the Caribbean and Adjacent Regions (IOC)
IODE	International Oceanographic Data Exchange (IOC)
IREP	International Recruitment Project
NAFO	North-West Atlantic Fisheries Organization
NEAFC	North-East Atlantic Fisheries Commission
NEFC	North-East Fisheries Center (USA)
NMFS	National Marine Fisheries Service (USA)
OSLR	Ocean Science in Relation to Living Resources (IOC/FAO)
OSNLR	Ocean Science in Relation to Non-Living Resources (IOC/UN(OETB))
PROCOPA	Programa Cooperativo Peruano-Alemán de Investigación Pesquera
SARP	Sardine/Anchovy Recruitment Programme (IOC/FAO)

SCOR	Scientific Committee on Oceanic Research
SWFC	Southwest Fisheries Center (USA)
TEMA	Training, Education and Mutual Assistance in the Marine Sciences (IOC)
Unesco	United Nations Educational, Scientific and Cultural Organization
WESTPAC	Western Pacific, Programme Group for the Western Pacific (IOC)
WMO	World Meteorological Organization