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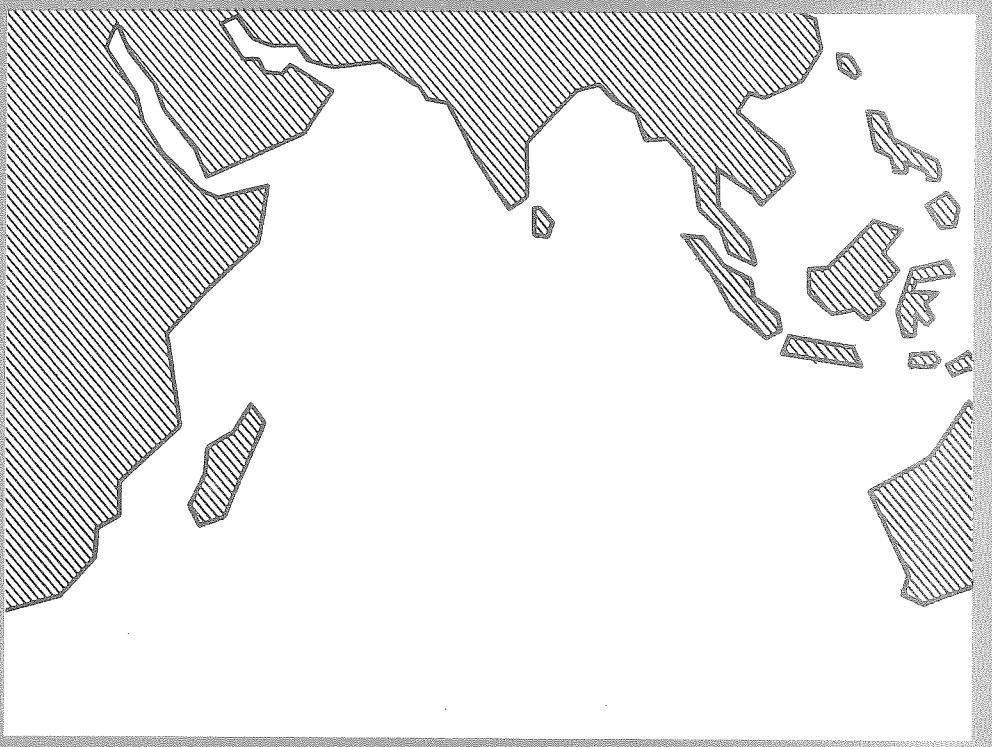
indian ocean fishery commission
INDIAN OCEAN PROGRAMME

some notes on the assessment and management of indonesian fisheries



UNITED NATIONS DEVELOPMENT PROGRAMME

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

Indian Ocean Programme
Indian Ocean Fishery Commission IOFC/DEV/73/31

SOME NOTES ON THE ASSESSMENT AND MANAGEMENT OF INDONESIAN FISHERIES

by

J.A. Gulland

Based on a visit to Indonesia 28 May - 19 June 1973 organized by the FAO/UNDP Indian Ocean Fishery Survey and Development Programme.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED NATIONS DEVELOPMENT PROGRAMME
Rome, June 1973

THE INDIAN OCEAN PROGRAMME

The International Indian Ocean Fishery Survey and Development Programme, or Indian Ocean Programme for convenience, was formally conceived by the Indian Ocean Fishery Commission and its activities are conducted through that body. The Programme is supported by the UNDP and is being carried out by the FAO Department of Fisheries. Put simply, the objective of the Programme is fishery development in the Indian Ocean region.

John C. Marr
Programme Leader

SUMMARY

1. The need to improve the collection and compilation of statistics for the assessment and management of Indonesian fisheries is stressed, and a draft statistical table is proposed.

2. In stock-assessment, priority should be given to fisheries that are developing or likely to develop.

3. Present information indicated that the sardine stocks in the Bali Strait cannot support a fishery very much greater than the present one. High priority should be given to an echo-survey of the area outside the strait in the open Indian Ocean.

4. A total ban on coastal traps is not warrented at this stage, but, pending further studies, the use of estuarine traps should be discouraged.

5. Expansion of shrimp fishing fleets off West Irian should be undertaken with great care and an upper limit of 90 for the total number of vessels is recommended pending further study. In other areas no restrictions are proposed for local fisheries.

6. The ban on engined trawling vessels of less than 25 GRT should be lifted even though the number of trawlers will have to be limited in the long run, because this measure impedes the artisanal fishermen from graduating to slightly bigger boats from the present boats they use.

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RESUME

1. On souligne la nécessité d'améliorer le rassemblement et l'élaboration de données statistiques en vue de l'évaluation et de l'aménagement des pêches indonésiennes et l'on propose un projet de tableau statistique.

2. En matière d'évaluation des stocks, la priorité devrait revenir aux pêcheries en développement ou susceptibles de se développer.

3. Il ressort des informations disponibles que les stocks de sardines dans le détroit de Bali ne sont pas en état de soutenir un effort de pêche largement accru. Il conviendrait d'attribuer une priorité élevée à une prospection par écho-sondage dans la zone à l'extrémité du détroit, en plein océan Indien.

4. Dans l'état actuel des choses, rien ne justifie l'interdiction absolue d'utiliser des nasses côtières mais, en attendant les résultats d'études ultérieures, l'utilisation des nasses estuarines devrait être découragée.

5. L'expansion des flottilles de crevettiers au large de l'Irian occidental devrait être entreprise avec beaucoup de prudence et, en attendant la réalisation d'une étude plus poussée, on recommande un maximum de 90 navires. On ne propose pas de restrictions pour les pêcheries locales dans d'autres zones.

6. L'interdiction d'utiliser des chalutiers à moteur de moins de 25 TJB devrait être levée, même si le nombre de chalutiers doit être limité à la longue. En effet, cette mesure empêche les pêcheurs artisanaux d'utiliser des embarcations de dimensions légèrement supérieures à celles qu'ils emploient actuellement.

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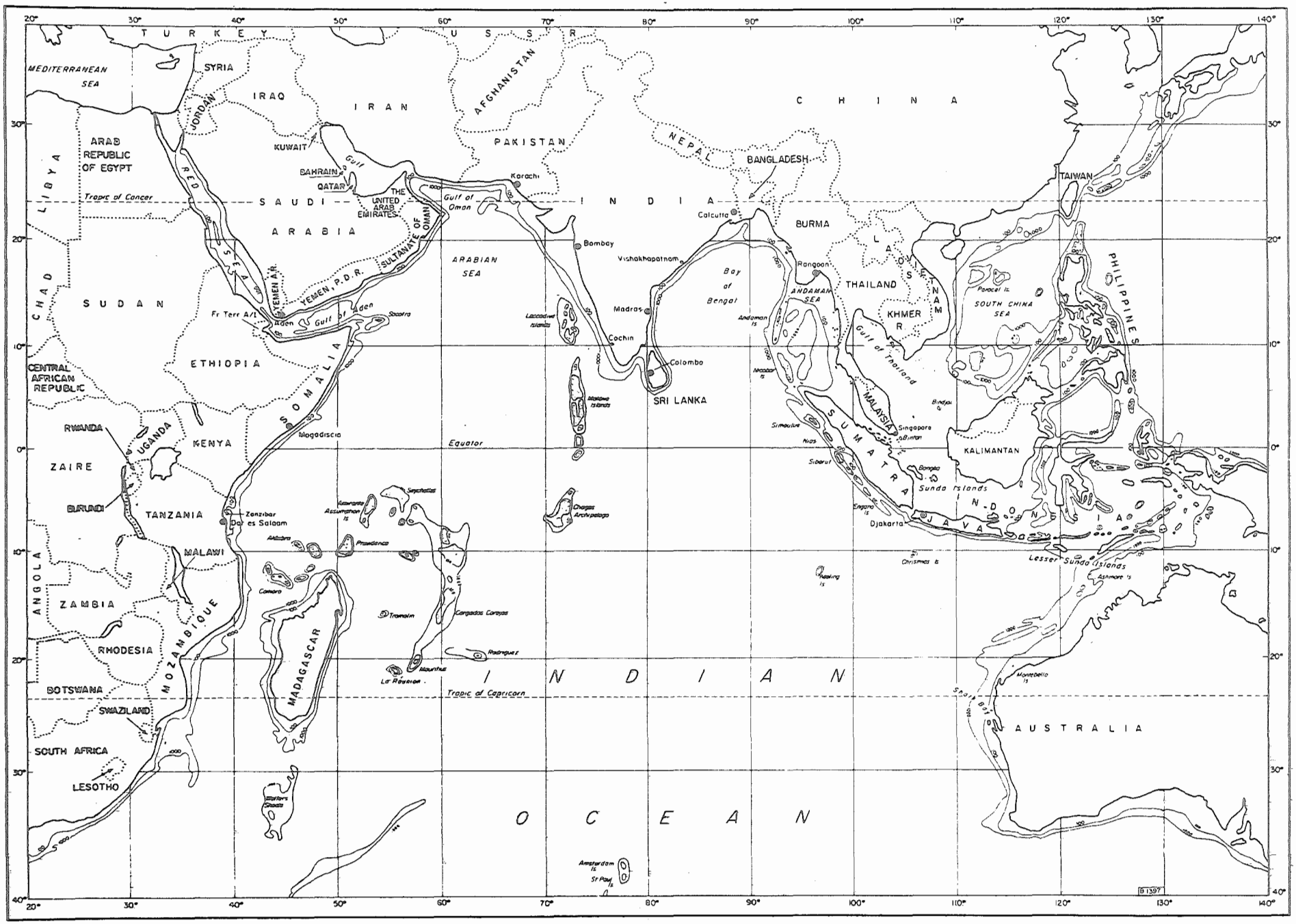
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ABOUT THE AUTHOR

Dr. J.A. Gulland is a mathematician specializing in biological research and now is Acting Director, Fishery Economics and Institutions Division, FAO, Rome. For 15 years he did research at the Fisheries Laboratory, Lowestoft, England. He has a B.A. and D.Sc. from Cambridge University.

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SOME NOTES ON THE ASSESSMENT AND MANAGEMENT OF INDONESIAN FISHERIES

by

J.A. Gulland

INTRODUCTION

The following notes are based on a visit to Indonesia in May-June 1973. During my visit I had the benefit of great assistance and cooperation from the Director-General of Fisheries of Indonesia, Admiral N. Zachman, and his staff, as well as from the provincial authorities in Java, Bali, and Sulawesi. Particular mention should be made of the help I received from Mr. V. Soesanto and Mr. M. Unar and the staff of the Marine Fisheries Research Institute. Assistance was also received from the staff of the FAO/UNDP Fisheries project, particularly Mr. A.E. Jones. The assistance of all these people in providing invaluable information on the fisheries of Indonesia is gratefully acknowledged. Any errors of interpretation are mine.

Summary Conclusions and Recommendations

Statistics

Considerable efforts are needed at regional, provincial, and national levels to raise the collection and compilation of statistics to the necessary level of precision and accuracy.

As a step in this direction it is strongly recommended that a draft statistical table be prepared for the fisheries in Indonesia, to form a model for regular annual statistical publications. It is further recommended that the Marine Fisheries Research Institute staff be assigned to this work and provided with sufficient facilities, particularly for travel. The assistance and cooperation of provincial and other agencies would be essential in their work.

Stock-Assessment

Indonesia has a number of scientists as capable of carrying out stock-assessments as those in most other countries. The chief obstacle to making assessments is the inadequacy of statistical and other data. However, scientists would benefit from regular contacts with experts of high calibre, visits of whom could be arranged through FAO.

In making assessments, priority should be given to fisheries that are developing, or are likely to develop soon, such as the shrimp, trawl, and skipjack fisheries.

Sardines

The data presently available do not permit a precise quantitative assessment of the sardine stock in the Bali Strait region. Information should be gathered from catches of schools of fish giving echo-traces of different intensities, which would permit the results of the echo-surveys to be expressed in quantitative terms, i.e., so many tons of fish. A subjective impression based on present information is that the sardine stock within the Bali Strait could not support catches very much greater than the present ones. The best opportunities for increased catches of pelagic fish in this region appear to be in the open waters of the Indian Ocean, along the edge of the continental shelf from West Java eastwards.

As a first step towards identifying, evaluating, and developing this resource, high priority should be given to an echo-survey by R/V LEMURU in this area.

Management

1) Coastal Traps (Bagan tancaps)

Because of interference with navigation, and with other gears, the use of traps should be limited to specified areas. There does not seem, at this time, to be evidence to support a comprehensive ban on these gears.

2) Estuarine Traps

There is a possibility that these may be damaging stocks of some species (e.g., hilsa and penaeid shrimps), but data are lacking. It is recommended that investigation be made of the quantity, species, and size of fish taken by these traps. Pending results of these studies, increases in the number of traps should be, as far as possible, discouraged.

3) Shrimp

a) West Irian

The catch per unit-effort of the shrimp trawlers in this region, calculated as catch per vessel-month, is beginning to show a slight decrease. The stock abundance is probably decreasing faster than the catch per unit-effort, due to increasing experience of the fishermen, and the extension of fishing to other areas. Further expansion of the size of the fleet should therefore only be allowed with caution. The number of vessels operating in 1973 was understood to be about 70. An expansion to no more than 85 or 90 in 1974 seems desirable. Some further expansion in 1975 might be allowed, depending on the analysis of the 1973 catch-and-effort data.

b) Other areas

No regulation or restrictions are proposed for the local shrimp fisheries, even though some local stocks may be fully exploited. The falling catch-rates in these areas are providing incentives to extend and divert fishing to new areas. This extension, especially in deeper water further offshore, for both shrimp and bottom fish, should be encouraged.

4) Trawling

In principle, the present ban on engined vessels of less than 25 GRT encourages the use of larger vessels, but the step to a 25 GRT vessel from their present boats is probably too big to be made easily by the artisanal fishermen. The ban should therefore be lifted, at least temporarily.

In the long run it will be necessary to limit the number of trawlers, and the pace of development is such that the need could arise within five years. Arrangements should be made now, first to collect the essential statistical data, and second to consider the form the limitations and regulations should take to minimize economic and social disturbances.

5) Tuna

There is no need for regulations on tuna at this time, and the development of fishing, especially for skipjack, should be encouraged. However, development of large-scale fishing for small yellowfin under five kg should be discouraged.

GENERAL REMARKS

I visited Indonesia from 28 May to 9 June 1973, as part of the support given by the Indian Ocean Fishery Survey and Development Programme, to advise on matters of stock assessment and management. My specific terms of reference indicated co-operation with the canning-feasibility mission, which was visiting Indonesia at the same time, assessment of sardines and shrimps, and management of shrimp and of the trap fisheries. General matters concerning statistics, methods of assessment, and principles of management, are discussed in the first part of this report. Matters relating to specific fisheries or programmes are discussed in the second part.

Shortly after my arrival I was informed by a member of a visiting bank mission that Indonesian fish production was increasing by 2.4 to 2.6 percent per year, with the implication that this fact was highly significant in planning and assisting Indonesian fisheries. Though true, this figure of the rate of increase could be very misleading. Very few, if any individual fisheries have ever expanded at a rate of two percent per year. Nearly all fall into one of three groups - - those stagnating usually at a very low level, those that expand at a very rapid rate (doubling every year is not unusual in this case), and those that have reached or are close to the limit set by the resource. Indonesia has fisheries in each of these cases - - some, especially for offshore fish, are undeveloped, some (e.g., for shrimp in Southern Java) are developing very rapidly, and some, probably including those on some inshore stocks, have reached the resource limit.

The problems in each phase and the advice needed on stock assessment and management are very different. In the pre-development stage the problems are mainly technological and economic: how to catch, process, and distribute the fish. No management problems occur, and the advice needed on stock assessment is an estimate (which can be fairly rough) of the potential annual yield from the resource as a guide for planning the scale of development. In a fully developed fishery the need for management based on stock-assessment advice is obvious. Since production cannot be increased by fishing harder, the main opportunity for improving the performance of the fishery is to introduce appropriate management measures. Some increase in catch may be achieved (e.g., through protection of small fish) and there may be opportunities for a substantial reduction in the over-capacity and economic waste inevitable in any fully developed fishery which lacks management.

The problems in a rapidly developing fishery and the opportunities for useful government intervention are less obvious. Fisheries in this phase are at their most successful and are generally making their greatest net contribution to the national economy. It is therefore natural and correct to wish to support this success, e.g., by loans for new vessel construction. At the same time, this is the phase during which it is easiest to take action to avoid much of the economic distress that can occur when the limit of the resource is approached. It is, for example, much easier to discourage the entry of additional fishermen, vessels, or capital into a fishery, than to divert them to more productive occupations (other fisheries or outside fishing altogether) once they have been committed to a particular fishery. Ideally, government intervention in a developing fishery calls for skilful timing of a change from positive encouragement (loans for construction of vessels, provision of infrastructure, etc.), through neutrality and general discouragement, to the final introduction, if necessary, of restrictive regulatory measures. Probably no government has yet been entirely successful in controlling the development of a fishery in this ideal way, but the opportunities to do so exist in Indonesia, and in some instances (e.g., the shrimp fisheries now developing in some areas under joint-venture agreements) the initial steps for such controlled development are being taken.

In all phases of development the provision of good advice depends on three stages - - the collection of basic data (particularly statistics of the fishery, but also from surveys); the scientific analysis of these data by various stock-assessment techniques; and formulation, from the scientific results, of specific management advice for action, taking into account social and economic factors. These are discussed in detail below. It should be stressed that very often the

ability to make reliable assessments (and hence give good advice) depends on the availability of data, particularly statistics, covering different levels of fishing activity, and on a comparison between low and high levels of fishing. If the problems that are likely to arise in the future are to be successfully tackled, the necessary data should be collected now. It is therefore recommended that very high priority be given to ensuring that basic data are being collected.

Statistics

The importance of statistics of catch-and-fishing effort is well known but should nevertheless be emphasized in a report such as this. At the same time it may be noted that in Indonesia, with extremely diverse and widespread fisheries, it is not feasible to collect complex and comprehensive statistics of all the fisheries. Attention must therefore be paid to ensuring that the detail and precision (and therefore the costs) of the statistics collected are commensurate with the importance and value of the uses to which they are put. In general the detail and precision required increase as the fishery develops: for fisheries in the pre-development or early development stages, approximate figures of total catch may be sufficient (it is almost as important to know the degree of precision as to have an estimate of the total catch), whereas in fully developed fisheries in which management measures are being considered detailed catch-and-effort statistics may be very important. Fortunately the ability to collect detailed statistics usually increases as the fishery develops.

The provision of statistics can be divided into three stages: first, the collection of the original information, e.g., the record of the landings of a particular fishing vessel on a given day; second, the general processing of the data; and third, the presentation of the results in a form suitable for the user - - administration, stock assessment biologist, etc. The first two are generally outside my terms of reference and, as far as assistance from FAO is concerned, will be dealt with in detail by Mr. Yamamoto. It may, however, be noted in passing that, according to my information, the permanent staff of the central fisheries administration directly concerned with statistics is only three. While the main statistical work will have to be carried out in the provinces, it is impossible that such a small staff can serve effectively the needs of Indonesia, and it is strongly recommended that the statistics unit be strengthened. The administrative arrangements and responsibilities for statistics also require consideration. In the long run, experience of other countries suggests that the statistical requirements of stock assessment scientists are more detailed and extensive than those of other users, and that if the scientists' needs are fulfilled so are those of others. Thus the responsibility for processing and compilation of statistics may, in the long run, conveniently be handled by the research department. However, until general procedures for the routine collection and compilation of statistics of the desired detail and precision are clearly established, it is suggested that statistic (which are of interest to planners, economists, and others, as well as to scientists) should be the responsibility of a strong independent unit, presently reporting directly to the Director-General of Fisheries.

Although Indonesian fishery statistics undoubtedly can and should be considerably improved, much good statistical material is already available. The value of this material would be increased by the regular preparation of annual tabulations of the available data in forms suitable for use by stock assessment scientists and others. Since the Indonesian fisheries compare in extent and complexity with the internation fisheries of the North Atlantic, the statistical publications of the international bodies of the Northeast (ICES) and Northwest Atlantic (ICNAF) can be taken as useful models, at least as far as the uses by scientists are concerned. With the data currently available, many of the proposed tabulations would be incomplete, or would contain many approximate figures. However, this in itself would be useful in showing where improvements are particularly needed. Even in an incomplete form, such tabulations are likely to be extremely useful in demonstrating clearly to potential users what the value of good statistics could be. Detailed proposals for the basic statistical compilations are given in Appendix I.

Three groups of tables are suggested: a summary table giving the estimated total catch of all Indonesian fisheries; a table for each province giving the main details of the fisheries in that province;

and detailed summary and historical tables of catches of certain major species (or groups of species). In addition, detailed catch-and-effort statistics for the more important fisheries are desirable, but no specific proposals are made here. Important elements in the work will be to draw up standard lists (a) of species with proposed groupings, following as far as possible the International Standard Classification of Aquatic Animals and Plants; and (b) of fishing gears, again as far as possible following international standards. It is not suggested that these lists be completely identical throughout the country.

For fish species, three lists are needed. The first is a standard reference list of all species of any significant present or potential fishery interest, following the standard FAO classification (see especially the reports of the IOFC/IPFC joint working party on fishery statistics). So far as possible, this list should give the Latin name, the English name if available, a standard Indonesian name, and any important local names. This list would include too many items for any general statistical system, so two other lists collecting them into convenient groups are necessary. The first would be a standard list, covering the whole country, containing 30 to 40 items, and it would be expected that all catches, wherever taken, would be broken down into these basic categories (in some cases estimates would be required). The other list would be specific to a particular province, and might contain more details of certain of the basic terms. For example, the reference list might contain 0 species of shrimps. The basic national ist might contain one or two terms (shrimp r penaeid shrimps and others). The list for shrimp fishery might determine the main pecies of penaeids, and also have two or three tems for groups of smaller shrimps. The ook Ikan laut Indonesia by Mr. Dwiponggo, ssued in 1970, contains most of the elements or the first list. It is recommended, subject o any other modification, and with an indication of the precise category in the second national - see Appendix II), and third (provinial) lists into which each species falls, hat this book be given wide circulation to ll those concerned with fishery statistics. t could also be supplemented by a suitable all-chart showing the main species and, for ore detailed work, by the Species Identification Sheets being prepared by FAO and its ollaborators. A proposal for the basic ational list is given in Appendix II.

Surveys

Surveys by special research or survey vessels have been carried out in the waters of Southeast Asia on numerous occasions. These can serve three main purposes: to determine where and when (and also with what gear) commercial fishing would be economically attractive, in terms of the expected catch-rate (catch-per-vessel per day); to estimate the total abundance (standing stock) of the fish in the area, from which an estimate of the possible sustainable annual catch can be obtained (the formula 0.5 X standing stock X natural mortality rate has been found to give a useful approximation) and to provide, from surveys repeated at regular intervals, indices of the changes in the abundance of the stock independent of the catch-and-effort data of the commercial fishery, and not subject to the biasses that can occur in the latter. In addition, surveys can provide additional information on such matters as the species and size-composition of the catch, and changes in these with depth of water, type of bottom, season, etc.

It should be strongly stressed that these objectives are different and have quite different requirements in the way that the work is arranged. Unless the particular objective of a survey, or part of a survey, is kept clearly in mind in determining when and where fishing (or other survey techniques like acoustic surveys) is done, and appropriate records kept, it is highly likely that the results will be of very little value for any purpose.

It is believed that all three objectives can be usefully served in Indonesian waters, and, providing care is taken to ensure that the objective of each operation is properly defined and appropriate records made, surveys of all kinds should be encouraged. In the long run, the third type of survey is likely to be the most valuable. Enough is now known about the offshore demersal stocks of Indonesia to show that they are potentially valuable, and it is likely that a trawl fishery on them will develop soon. From the history of similar fisheries elsewhere, there is a high probability that such a fishery will run

into problems of over-capacity and over-expansion and that, partly due to changing efficiency, the catch-and-effort data from the fishery itself will not give clear evidence on which to base appppropriate management decisions until over-capacity has occurred. It is therefore recommended that urgent attention be paid to setting up a standard grid of trawl hauls which will provide some objective measure of changes in demersal stocks and for which sufficient resources are likely to be available for at least the next five years. In the first instance, such a survey should be limited to the areas most likely to support large new trawl fisheries, i.e., Malacca Straits, South China Sea, and Java Sea. For the first two, cooperation of other interested countries should be sought.

Stock-Assessment

Stock-assessment is basically a simple scientific technique and Indonesia is fortunate in having a number of competent scientists who know how to use it, if they have the necessary material. However, it is not a magical technique: without the basic data, assessment cannot be made. Since many of the detailed methods of assessment consist of comparisons between periods of light and heavy fishing (e.g. in catches-per-unit-effort, stock density, size or age of fish, etc.), the longer the period for which data are available the better. It is particularly valuable if data can be collected as early as possible in the development of a fishery when fishing is still having little effect on the stocks. As already mentioned, highest priority should be given to the collection of catch statistics. Effort statistics are also very important, but it is not essential for these to be comprehensive. Rather, it is necessary to collect data on fishing effort, and corresponding catch, from some sections of the fishery, from which estimate of catch-per-unit-effort and of the total effort of the fishery as a whole can be calculated.

It is also highly desirable to obtain information on the sizes of fish, at least for the major species. Particular attention should be paid to species where it is probable that several age-groups are, or could be, exploited and for which changes in age structure are likely to occur as a result of exploitation - - examples are snappers and other large demersal fish, and yellowfin tuna. Less priority might be given in the first instance to sampling the catches of fisheries where probably only a single year class is exploited. It should also be noted that in some fisheries (e.g., shrimp fisheries) valuable data can be obtained from the fishery itself - - in the case of shrimp from the data on size-categories (counts per pound) in the export trade.

The other aspect of this need for a reasonably long series of data is that stock-assessment problems cannot be solved by a sudden burst of activity, however high the priority given to them, and however skilful the experts concerned. There is often a feeling, once a good statistical system is introduced, that useful assessment results will arise from it within a couple of years. This may be so, if the pattern of fishing is changing fast. More often, all that a stock-assessment expert can do is review the data to ensure that it is of the kind and quality needed, and then place it on file until fishing has developed enough for assessments to be made. This can lead to disappointment on the part of administrators and providers of statistics It is, therefore, important to understand the long-term value of statistics and similar data, and to recognize that there is no risk of deterioration when they prove to be of limited immediate value. (Good statistics can have, of course, many immediate uses as well.)

SPECIFIC COMMENTS

Statistics

The important points concerning statistics are set out in the preceding sections. In the long view, there is no doubt that more time, money, and staff will have to be engaged in improving the statistics. Preparing draft tables of certain basic statistics will be of great value, even though, in the first instance, it will be difficult to insert very accurate figures in many positions in these tables. Though the tables are simple, the information required to compile them is buried in scattered report and files, often in local or provincial offices. It will take time to retrieve this information and one or two persons will have to be engaged full-time in digging it out; an important part of their time will need to be spent in visiting local and provincial offices to

xplain what is required and why.

anagement

1) Coastal Traps (Bagan)

These raise three separate classes of roblems: that they interfere with navigation, r with other fishing methods (e.g., Danish eine); that their lights attract larger ish which cannot be caught with the net, hus encouraging the use of dynamite; and hat, because of the size or quantity of ish caught, they are unduly harmful to the tocks. Only the last involves substantial atters of stock assessment.

It appears that some 60 percent of the atches are anchovy (Stolephorus), the rest eing small pelagic fish, probably including uveniles. The traps are an efficient ethod of harvesting anchovy, though other ears are also used. Though the data are ot available to make quantitative assess- ents, it would seem highly probable that, xcept locally, the anchovy stocks are far rom fully exploited. In that case any eduction in fishing effort on anchovy, hrough restrictions or prohibitions on trap ishing, would cause an approximately propor- ional drop in anchovy catches, and, from hat point of view would be undesirable. It ould, however, be useful to attempt some ough assessment of anchovy stocks, for which t is suggested the following method be used. nformation on the average weight caught hould be collected for as many areas as ossible, together with the number of traps n the area. Then, taking together areas ith similar ecological conditions, the catch er trap could be plotted against the number f traps (or better, the number of traps per ilometre of coast, or per square kilometre f sea out to 10 metres depth). If the atch per trap decreases with numbers of traps, his would be some evidence of the effect f fishing.

For other fish, the effect of the trap ishery will depend on the quantity, species, d sizes caught. Arrangements should be ade, perhaps through the local authorities, or collection of unsorted samples of bagan atches from different areas and at different easons to determine the size and species- mposition. Subject to the results of this ampling, and of the analysis of the general tatus of the stocks concerned (i.e., the ntensity with which they are exploited by gear other than bagans), it would appear on the basis of present impressions, unlikely that the bagan fishery is causing any serious loss of the total catch. That is, the numbers of small fish being taken by bagans are not very large, and if these were not caught, the number that would be caught later by other gears would not be so numerous or so large as to represent a noticeable increase in weight.

The traps might also cause losses to fish which are not caught at all by them, because the effectiveness of other gears is reduced. This is a real possibi- lity, and could be serious if traps extend close together along long stretches of the coast. This problem, and the general problem of interference between gears, could be reduced to a large extent in the same manner as it has been treated in many other parts of the world, that is, to allocate defined areas to each competing type of gear. Certain areas would be specified within which traps could be operated; in adjacent areas traps would be prohibited in order to allow free operation of other gears. Because different gears catch different species, the extent of a single zone open for trap fishing should not be large. It should be small enough to permit fish that are not taken by traps to wander, at some time during their lives, outside the zone, and thus to be readily harvested by other gears. A limit on the order of two to five miles in length might be appropriate.

There seem to be no grounds at present for a complete ban on bagan fishing, and such a ban would probably significantly reduce the catches of anchovy. However, in view of the problems raised, the operations should be linked to specified areas; that is, the form of the regula- tions should be to prohibit trap fishing except in certain areas, rather than to allow their operation except where specifically prohibited.

2) Estuarine Traps

Traps in rivers or estuaries offer special dangers. Because they can take all, or nearly all, the fish passing them, the stocks can (like salmon in the North Pacific) be much more seriously

affected by too much fishing than is generally possible in the open sea. Stocks that could be so affected in Indonesia are the hilsa (shad) when it goes upstream to spawn, and juveniles of some species of penaeid shrimp when moving from brackish water out to sea. There are reports that catches of hilsa are declining. This may well be due to over-fishing, though environmental effects such as the silting-up of the rivers have also been put forward as a reason.

There are not enough data to determine the true cause, but it would seem prudent on the one hand to pursue investigations into the subject, and on the other take action to ensure that the damage, if any, through over-fishing does not become too serious. The main line of investigation, as always, should be to collect statistics on the quantities of fish caught. The information should include data, obtained if necessary from special samples taken from the catches to determine the sizes and species caught. The quantities of hilsa, and of small penaeids, would be particularly important to determine. For hilsa it would also be important to examine the relation between the catches in each river, and the degree to which catches may have decreased over the past few years. If not recorded in formal statistics, data might be gathered from fishermen, taking into account that, in fishermen's reports, fishing is rarely as good as it used to be. Even if data are not sufficient to carry out an individual assessment for any one river, comparison between rivers could be revealing. The assessment for shrimp might in the first instance be a comparison of the number of small shrimp taken in traps with the number of larger shrimp of the same species taken in other fisheries.

The chief precautionary action might be first to discourage increase in the number of estuarine or river traps, and second to limit the fraction of the width of a river that can be blocked by a trap or set of traps. Whether 95 percent or 80 percent of the river is covered may make only a small difference to the catch, but, in theory, it could mean a four-fold difference in the numbers escaping, e.g., going upstream to spawn.

3) Shrimp: West Irian

Good data exist from 1969 onwards from the industrial-scale operations in this region. From these it was possible to calculate two measures of catches-per-unit-effort to use as indices of abundance — the average catch per vessel (as used by Unar 1973), and the average catch per month per vessel as determined from the detailed records of the number of vessels operating each month. The basic data are set out in Table 1.

The catch per vessel shows no decrease; in fact, though there is considerable variation the trend is slightly upwards. However, the average number of months during which each vessel operated during the year has steadily increased, presumably due to more efficient operation and management. The number of vessel-months probably gives a better measure of fishing time, and the catch-per-vessel-month a better idea of stock density. Other measures of fishing time, such as number of days operation, or number of hauls, would in theory give even better measures. Any records, which may be available (e.g., from individual enterprises) should be examined to determine if there has been any change in days operated per month, or hauls per month. If so, effort and catch-per-unit effort should be recalculated in terms of days or number of hauls. If not — and complete data on days or hauls are not easily obtained — number of vessel-months could continue to be used.

Data from individual enterprises were examined and compared. The results, in terms of catch per vessel-month, calculated as a percentage of the value in 1971, are set out in Table 2.

There is general agreement in the trends shown by different enterprises. Some difference is inevitable, given the natural variability in success of individual fishermen, as well as in the size and power of the ships. The higher figure for enterprise A in 1969 is probably due to the operation of a large

300 GRT) vessel in that year, which was withdrawn later. A more detailed study should take into account this and other changes in the size of vessels. Two ways of doing this are, first, to estimate year-to-year changes in terms of only the catch per month of vessels that operated in both years, or, second, to calculate the average tonnage of the fleet each year, and divide this into the catch per vessel-month, i.e., to calculate the catch per vessel-ton-month. Either procedure should give an improved index of stock density.

The index (catch per vessel-month) shows some sign of decreasing stock. The decline between 1969 and 1970 may be exaggerated because of changes in the fleet, but for other reasons the decline in the stock-abundance may have been greater than suggested. First, it is highly likely that the fishermen are gaining in experience and knowledge of the best times and places in which to fish. Second, the area fished is expanding, with quantities of shrimp being taken near the Avu Islands, where the catch compositions appear to be different. The stock in the grounds originally exploited may therefore have declined more than is suggested by the slight fall in catch per unit-effort.

It does not, however, seem that the real decline in abundance is yet serious, and the total catch is still certainly increasing. There is therefore no need yet to prevent new entries to the fishery, though, as always, the rate of increase should be controlled. The number of vessels operating in 1973 was understood to be about 70. A prudent level for 1974 would be about 80 to 90 with perhaps 100 as an upper limit. By mid-1974 the results for 1973 should be at hand. If the most refined index of catch per unit-effort still shows no serious decline (e.g., is still half or better of the 1969 level), then a further increase in fleet for 1975 should be permitted.

TABLE 1

Year	1969	1970	1971	1972
Total catch (tons)	504.5	805.3	2493.4	3349.9
Number of vessels	9	17	42	49
Total months operating	42	91	267	370
Average months per vessel	4.67	5.35	6.35	7.55
Catch per vessel (tons)	56.06	47.25	59.36	68.36
Catch per vessel-month (tons)	12.01	8.85	9.34	9.05
Catch per vessel (as % of 1969)	100	84	106	122
Catch per vessel-month (as % of 1969)	100	74	78	75

TABLE 2

	Catch-per-vessel-month (% of 1971)			
Enterprise	1969	1970	1971	1972
A	186	101	100	94
B	119	133	100	72
C	114	91	100	104
D	-	-	100	102
E	-	-	100	84
Total	129	95	100	97

4) Shrimp: Other Areas

Data on the catches and standing stock (as estimated from surveys) suggest that the shrimp in the Cilacap area of Southern Java are heavily fished. Rather over 100 shrimp trawlers were working in the area at the peak of the 1972 season, and more than 200 are expected in 1973. On the present evidence it seems likely that this doubling of effort will not result in any appreciable increase in total catch. Though data are lacking, it is likely that other local shrimp fisheries (e.g., in east Sumatra) are also fully developed.

If these fisheries were considered in isolation, then it would be clear that controls should be applied as soon as possible on the number of vessels operating. These fisheries are, however, not self-contained. Indeed the Cilacap trawl fishery was largely developed by trawlers coming from Sumatra as catch rates there decreased. Also the situation with regard to shrimp cannot be treated in isolation from the fisheries for demersal fish generally. Taken as a whole, the demersal stocks round Indonesia, especially more than a few miles from shore, are under-utilized. The good prices obtained for shrimp are encouraging the development of a trawl fleet, while the falling catch-rates on heavily exploited local grounds encourage the diversion of the vessels to new areas. It is therefore in the interest of Indonesian fisheries as a whole not to place any restrictions at the present time on the numbers of local shrimp vessels.

5) Trawling

Trawl fishing outside the immediate coastal zone, and especially in the Java Sea, offers a great opportunity to increase the supply of fish. The offshore stocks are at most only lightly exploited and priority at present should be given to increasing the fishing effort. At the same time the stocks close to shore are probably fairly heavily exploited, and developing trawl fisheries on these stocks can give rise to conflict with traditional fisheries. Priority should therefore be given to development of trawling with reasonably large vessels, capable of fishing well offshore. Though the problems of improving catching methods are outside my terms of reference, it would appear that most trawlers are underpowered, and would benefit from reduction gear to allow the use of larger and slower-running propellers.

In principle, prohibition on the construction of new powered vessels less than 25 GRT should have the effect of encouraging the development of the offshore fisheries. However, a vessel of over 25 GRT represents a big step from the small sailing boat used by most of the present inshore artisanal fishermen. The need is as much to encourage and assist these fishermen to take up more modern and productive fishing methods, as to develop the offshore fisheries. Under the 25 GRT limit there is the danger that the trawl fishery will develop quite separately from the traditional fisheries, with different people. There could then be two separate fisheries, a flourishing offshore trawl fishery, and the present traditional fisheries, with the latter presenting growing economic and social problems as their productivity remains constant or even declines (due to competition with more modern gears). Everything should be done to enable the artisanal fisherman to take part in the growth of the modern types of fishery. For this, the present ban on vessels under 25 GRT should be modified. If the ban is not lifted completely, it should be permissible for any fisherman presently owning a non-powered vessel to replace it by a small powered vessel.

While, in the short run, the need in trawl fishing is for development and expansion, in the long run problems of management and regulation will become important. Though large, the demersal resources around Indonesia are not unlimited, and even with improved catching, distribution, and marketing, the demand for fish in Indonesia exceeds the supply. The classic stages of a boom followed by a crisis of over-expansion, shown well by the Thailand trawl fishery, will occur unless suitable action is taken. Two actions are needed: ensuring that the right information will be available, and an actual move to control capacity. Though some of the details of this move can be decided later, consideration should be given now to some of the principles likely to be involved. The general lines have been set out very often (e.g., in several papers for the Vancouver Conference). For the Indonesian trawl fisheries, as it seems likely that they will develop, the best method

f control would be to limit the number of essels allowed to operate. The critical uestion is: at the time when limitation on umber of vessels becomes necessary (possibly n 1978), with trawl fishing highly successul, and many people anxious to enter (as in 967 in Thailand) how will the limitation be pplied? If the scientific studies show hat, for instance, only 100 new licences hould be issued (and whatever the details f control, a system of licences, and the bility to refuse to grant licences, is essenial), and there are 300 requests for icences, how will the fortunate 100 be chosen? ossible criteria would be the location of the ase, whether the applicant is already engaged n fishing, the payment of a substantial icence fee. The system of granting licences ill likely be simpler, and better adapted to he general needs of Indonesia, if some onsideration is given to these questions now.

The need to ensure adequate information s even more urgent. One aspect is statistics n how much is caught. The other is an index f stock abundance. One index should be btainable from the trawl fishery itself, rom the data on catch and corresponding ishing effort (number of trawlers, number of ays fishing, etc). The difficulty is likely o be that during the development phase a good nit of effort may be hard to obtain. Vessels ill likely be increasing in size and fficiency: corrections can be made for some f this increase, e.g., by calculating the verage size of horsepower and expressing the ffort as number of vessels times average onnage or horsepower, or by collecting good ata on fishing time (number of hauls, etc.), ut it is unlikely that all improvements can e measured (improvements in the average skill f the fisherman will be particularly difficult to measure). Then, the catch per unitffort may not accurately reflect the changes n the stock. The difference may not be erious, but it would be desirable to obtain ther indices of abundance, such as the atches taken, through regular routine monitoring urveys by a special standard vessel.

6) Aquarium Fish

The export of live fish for marine aquaria s becoming a significant economic activity. s is possible that the collection of fish or this trade may threaten stocks of particularly valuable, long-living, or otherwise ulnerable fish and other animals. It is ore likely, given the growing interest in roblems of the environment, that concern for the stocks will be expressed. The complete resolution of such questions will require good data, but a useful precautionary measure might be to close certain areas to the collection of aquarium fish and other animals. This will provide a sanctuary against over-exploitation and, if the areas chosen are typical of ecological zones from which collections are made, will also provide reference areas against which the effects of collection in other areas can be measured.

7) Sardines: Bali Strait

Catches of sardine around the Bali Strait have fluctuated around some 10 000 tons per year. The major reasons for these fluctuations are presumably environmental (variations in the current structure, rainfall, etc.) There has not been a sufficient range of variation in the amount of fishing over the period for which statistical data are available for the effects of fishing on the stock (as measured by the catch per unit-effort) to be detectable.

The other source of data from which assessments might be made is the surveys made by R/V LEMURU. These have shown the general distribution of pelagic fish, as given by echo-traces, within the Bali Strait, but, because fishing on the traces could not be done, the species involved could not always be identified, nor could the results be expressed in quantitative terms. The results to date do suggest that pelagic fish are reasonably abundant in the area, but in view of the relatively small area involved — roughly 2 500 sq. km, of which more than one-third is relatively deep water apparently only rarely occupied by sardine — the total quantity might not be large. The current average annual yield corresponds to four tons per sq. km, which is a reasonably high figure (approximately equal to the yield from the North Sea). It would therefore seem unreasonable, on present evidence, to expect much increase in yield, unless there is substantial immigration from outside the Bali Strait. In any case, any increase in the amount of fishing, though it might increase the total catch, would almost certainly decrease the stock abundance, and hence the catch of the individual fishermen

(or at least those that do not adopt new techniques). In view of the large number currently involved in the fishery, this could raise severe social problems.

The biggest opportunity to increase pelagic catches in the region appears to be outside the Bali Strait, in the open Indian Ocean from Central Java eastwards, whether or not fish from there migrate into the Strait. In this region there are, at certain times and places, considerable upwellings, which would be expected to produce good primary production, and hence, through the food chains, good availability of pelagic fish. The only way of checking this supposition is to go there and see. High priority should therefore be given, in the programme of R/V LEMURU, to surveying, with echo sounder, the area to the south of Java eastwards to Flores, and to fishing on any traces observed.

8) Tunas

At present about 10 000 to 12 000 tons of skipjack, and probably about half this quantity of yellowfin are landed annually in Indonesia (though some of the relevant statistical data are not very reliable and need to be improved). The information from the fisheries, including exploratory fishing by joint ventures shows that skipjack are widely distributed, occuring in nearly all Indonesian waters except for the shallow water of the Java Sea and the South China Sea. The total area containing skipjack and accessible to short- to medium-range vessels from Indonesia (i.e., out to about 100 miles into the Indian Ocean) is about one million square nautical miles, or some 3 400 000 sq. km. The current yield therefore represents an average of 3 to 3.5 kg per sq. km.

For the Pacific as a whole, the potential yield of skipjack has been (probably conservatively) estimated as 500 000 to 800 000 tons (present yield is around 300 000 tons), from a total area of about 100 000 000 sq. km, i.e., a potential of five to eight kg/sq. km. If the waters round Indonesia are as productive of skipjack as the tropical waters of the Pacific taken as a whole, then one might expect that present catches of skipjack could be approximately doubled. (The potential per unit area in the Atlantic is probably about the same, or possibly rather higher.)

If the waters round Indonesia do differ in productivity from the Pacific as a whole they are likely to be more productive. As regards primary production, much of the tropical Pacific is poor, except for the zone of equatorial upwelling, and the higher production tends to occur in the marginal area. Similarly the good catches of skipjack are mainly taken towards the eastern and western margins (chiefly by the U.S. and Japanese fleets respectively). This suggests that the Indonesian waters should be more productive of skipjack than the Pacific generally, and a sustained increase to well over double the present catch (i.e., to at least 30 000 tons) should be possible.

In all oceans yellowfin tuna appear to be less abundant than skipjack (a potential yield of approximately one-fifth, i.e., about 145 000 tons in the Pacific, and 40 000 tons in the Indian Ocean). Compared with these estimates (based largely on the history of the long-line fisheries) the current catches of yellowfin in Indonesia look quite substantial. Until better data are available to make proper assessment of the local stock (or stocks: a research task of reasonably high priority should be to determine the relation between the fish caught in the main Indonesian fishing areas, such as the Macassar Straits, and those in the oceanic long-line fisheries) it would therefore be prudent not to plan for any substantial increase in catch, but rather to improve the use made of the present landings.

Analysis of yellowfin populations in other areas has shown that the total catches will tend to be reduced if small yellowfin (under, say, five kg) are landed in appreciable quantities. The same is likely to be true of Indonesia. Though it would not be appropriate at the present time to introduce specific regulations to prevent the landing of such small yellowfin, it would seem a sensible precaution to discourage the development of any large-scale fishery for small yellowfin.

It was noted that in South Sulawesi some assessments had been made of the local resources of tuna and other pelagic

fish. It is welcome news that such assessments are made and are being used in planning at the provincial level. However, the method used -- a comparison of the area in which fishing actually takes place with the whole area, within the region, in which the fish species concerned occurs -- can give misleading results. On the one hand, even in the exploited area only a part of the potential yield may be being taken, leading to an underestimate of the potential. On the other, the movement of fish may allow most or all of the potential of the entire region to be harvested in a small area; this would lead to an overestimate. Specifically, in the case of South Sulawesi it seems that the potential of yellowfin may have been overestimated, and that of decapturus underestimated. The estimates for skipjack and bonito seem as reasonable as any that can be made at the present time.

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APPENDIX I

Outline Tables for Compiling Statistics

Table A. (Three tables for all Indonesia) a/

	Province or Sub-Province b/	Total
Species Group		
1		
2		
3		
40		
Total		

Notes: a/ One table should certainly be provided giving the total annual catch in tons. Another table could be useful, giving the value of the fish at the point of landing or first sale, and possibly, there should be a third table giving the average price, in rupiahs per kilo.

b/ Certain provinces (e.g., East, Central, and West Java) with distinct fisheries should be divided, i.e., into north and south coasts in the case of Java.

Table B. (One for each Province)

Gear and Vessel Class [a]/

Gear and Vessel	Trawl 0-25 GRT	Trawl 25-50 GRT	Traps	Mixed	Unknown/Unspecified	Total
No. of Fishing Units [b]/ [c]/		Full-time				
No. of Fishing units		Part-time				
No. of Fishermen		Full-time				
No. of Fishermen		Part-time				
Fishing effort [d]/						
Catches						
Total [e]/						
Species 1						
2						
3						
60						
Unknown						

Notes: [a]/ The precise classification of gear and vessel may differ from province to province, especially for local types of gear. As far as possible the same general system of classification (e.g., trawl nets, surrounding nets, hook lines, etc.) should be followed throughout Indonesia. The standard FAO system of classification and grouping (e.g., division between tonnage classes), could well be used as a model, particularly for modern types of gear and larger vessels.

[b]/ These items would not add horizontally. The number of full-time fishermen will be greater than the sum of fishermen who are engaged full-time in one type of fishing only. On the other hand, the total number of part-time fishermen will, because of duplication, be less than the sum of fishermen who engaged for part of their time in particular types of fishing.

c/ The normal fishing unit will be the vessel, but in some fisheries other units, e.g. traps, would be more appropriate.

d/ Space should be left for recording several units of effort, making allowances for the fact that the most detailed and generally most useful units of effort are usually the most difficult to record. It is to be expected that initially only the entries corresponding to the simplest unit of effort will be filled in, but that as the statistical system improves, more advanced measures can be collected. Possible units of effort in rough order of detail are: number of vessels or fishermen engaged at any time of year; average number engaged each month; total number of landings; number of days spent fishing; number of unit operations (e.g., hauls by trawlers).

Priority should be given to providing data for more modern types of gear and for developing fisheries. For traditional or artisanal fisheries the simple measures like number of fishermen will be sufficient for most purposes, such as monitoring the general health of the fishery and determining whether changes in catches are due to changes in stock or in the amount of fishing. It is not generally to be expected that effort data from artisanal fisheries will be good enough for the application of sophisticated stock assessment techniques.

e/ The species list for each individual province could contain more detail than the national list, but the national list must remain the basic list. Additional detail should be obtained by splitting one or more items in the national list. Examples are:

i) separating Bombay duck from item 15, for East Sumatra;

ii) splitting item 20 for several provinces, possibly in different ways;

iii) identifying different species of billfishes in group 27 (which will also contain bigeye and albacore) in provinces where catches are appreciable, and identification possible;

iv) showing mangrove crab separately from other crabs;

v) showing oysters (or mussels or cockles) separately from other molluscs.

Though individual provinces might not identify more than 60 items, a total of perhaps 100 different items might be identified in one or another part of Indonesia. The important point is that each provincial item should be uniquely related to a particular species group on the national list.

Table C. (One for each major species, or species group, i.e., potentially some 40 tables in all) a/

/Example for skipjack/ b/

Province and Fishery c/	1967	1968	1969	1970	1971	1972
S. Sumatra	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)
Bali	(500)	(500)	(500)	(500)	(500)	(500)
S. Sulawesi	(4000)	(4000)	(4000)	(4000)	(3900)	(4000)
N. Sulawesi (total)	2933	3299	3454	3231	... d/	...
Aertembaga (Govt.)	1283	1397	1512	1578	1326	598
Ambon (total)	...	(400)	(500)	(700)	(700)	(1000)
Ambon (Govt.)	...	311	447	633	624	919
Ternata	(2000)	(2000)	(2000)	(2000)	(2000)	(2000)
Others	...	...	...	...	...	...
Total	About 10 000 to 12 000 tons annually					

Notes: a/ While it would ultimately be desirable to prepare tables such as this for all major species, in the first instance it would be much better to concentrate on the more important groups. These might be the following: Total; Total marine; Total demersal (i.e., the sum of groups 8 - 15); total pelagic (16 - 32); oil sardine; anchovy; skipjack; rastrelliger; penaeid shrimp; total shrimp; i.e., about 10 tables in all.

b/ This table has been prepared as a rough illustration of how the table should be laid out. It was prepared rather hurriedly, and should not be considered as an authorative statement of present skipjack catches. Figures in brackets are rough approximations.

c/ Each province with substantial landings of the species in question should be listed separately. Where there is a separate and readily identifiable fishery, such as the government fleet at Aertembaga, this can be shown as a sub-total under the province concerned.

d/ Symbol ... is a standard symbol denoting data not available. In the final version of tables of this type some approximation should be inserted, preferably by the person most familiar with the fishery concerned.

APPENDIX II

Basic List of Species Groups for Compiling National Statistics [a]/

Freshwater fish	Species	Code* [b]/
Carps, barbels and other cyprinids		11
Tilapias		12
Miscellaneous freshwater fish		13
Anadromous fish		
1 River Eels		22
5 Milkfish	Chanos chanos	24.4
6 Shads		rest of 24
7 Miscellaneous Anadromous fish	Lates calcarifer +	25
Marine fish		
8 Flatfishes	Psettodes erumae +	31
9 Catfishes		33.2
10 Groupers	Epinephelus spp.	33.5
11 Slipmouths	Leignathus spp.	33.7
12 Croakers	Johnius spp. Otolithus spp. Pseudosciaenea spp.	33.9
13 Goatfishes	Upeneus spp. Parapeneus spp.	33.11
14 Snappers	Lutjanidae	33.10
15 Miscellaneous and unidentified bottomfish	Saurida spp. Pomadyiys spp.+	remainder of 3
16 Flying fishes	Cypsilurus spp.	34.2
17 Mullets	Mugil spp.	34.4
18 Threadfins	Polynemus spp.	34.5
19 Scads	Decapturus spp.	34.7
20 Horse mackerels	Caranx spp. Selar spp. +	34.8
21 Pomfret	Strematеidae	34.10; 34.11
22 Indian Oil Sardine	Sardinella longiceps	35.2
23 Anchovies	Stolephorus spp.	35.3
24 Oceanic skipjack	Katsuwonus pelamis	36.8
25 Yellowfin tuna	Thunnus albacares	36.10
26 Little tuna	Euthynnus spp.	36.7
27 Other large pelagic fish		remainder of 3

		Species	Code
28	Spanish mackerels	Scomberomorus spp.	37.1
29	Rastrelliger spp.		37.2
30	Hairtails	Trichiuridae	37.3
31	Other small pelagic fishes	Hemiramphus spp. +	remainder of 34 and 35
32	Sharks	Sphyrna spp. +	38.1
33	Micellaneous and unidentified marine fish		
34	Crabs		42
35	Lobsters	Panulirus spp.	43
36	Large shrimp	Penaeid	45.1
37	Small shrimp (including unidentified crustaceans)		45.2 and 45.3
38	Molluscs (other than cephalopids)		52, 53, 54, 55, 56
39	Cephalopids		57
40	Miscellaneous marine products (seaweeds, turtles, etc.)		

s: a/ This list is, if anything, too long. Some condensation could be achieved by ining (e.g., 36 and 37 under shrimp; 9, 10, 12, and 13 under large demersal fishes).

b/ For species under each FAO code see report of IOFC/IPFC Working Group on istics.

* Report of Second Session of IPFC/IOFC IWP, Appendix VII.

\+ Other species included in addition to those limited.

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