INTER-AMERICAN DEVELOPMENT BANK

Round Table on Non-Traditional Fishery Products
for Mass Human Consumption.

FISH BY-CATCH FROM SHRIMP TRAWLING

The main protein resource for Caribbean Atlantic Countries:

Reality and Potential

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(The opinions expressed in this paper are those of the author and do not necessarily represent the views of the International Development Research Centre.)

SUMMARY

This paper reviews the fish production and consumption imbalance in Latin America and describes the situation with regard to the incidental catch from shrimp trawling in the Gulf of Mexico, on a world-wide basis and then specifically off the Guianas. The literature is summaried on the results of trawl surveys, assessments of quantity and end-use as well as problems of fish varieties, distribution and bulk caught by shrimp trawlers. The particular actions undertaken by the International Development Research Centre-supported project in Guyana are also illustrated by a film. The project has initiated the prepara tion of traditional and non-traditional stable fish products and some specialty products through the use of flesh-and-bone separators. Proposals for the bulk handling of fish at sea and ashore and production needs of local and regional markets are also outlined. Considerations for future industrial develop-ment, as well as the constraints and a comparison with results in other regions of the world, are given. The solution of the by-catch problem is suggested as the most urgent Latin American fisheries problem for the 1980's. The article cites relevant literature but refers to a comprehensive bibliography on by-catch fish which is available.

Acknowledgments

The author has appended to this compilation several maps, diagrams and tabulated data published by other authors to illustrate their investigations. For the purpose of this review paper it was considered desirable to provide the reader with a comprehensive picture of the situation by using such data. The use of these illustrations, each cited from their publication, is gratefully acknowledged. Thanks are also expressed to D.A. Turnbull for the assembling of relevant literature used in this text and for other helpful suggestions.

W.H.L.A.

INTRODUCTION:

During recent years, serious doubts have arisen about the ability of many developing countries to produce enough food to keep pace with rising population and market demands. This is a sobering reality. While the world's fish production has increased from 33.3 million metric tons in 1948 to 72.4 million metric tons in 1978, i.e. more than double, there has been a relative decline in direct consumption of fish from 84% of the landed catch to about 60%, with a comparative rise in industrial processing for livestock feeds. During 1978 21 million tons of the marine catch of 62.4 million tons of fish was converted to livestock feeds - almost the equivalent quantity of fish consumed directly by man some 20 years previously. Most of the fish converted into fishmeal in the Latin American waters is exported and thus, this fishmeal escapes the food economy of adjacent countries. Rather, it enriches the protein economy of the well-fed nations of North America, Europe, and Asia. (See figures 1. and 2.) Nevertheless, Latin America and the Caribbean countries imported during 1978 fish products to the value of US$277 million. (See Table 1.)

In Latin America, the harvest of the seas is rather selective, with an emphasis on high value food species such as shrimp, tuna, etc., while the main bulk of production (like anchoveta) is converted into livestock feed. Additionally, about one million tons are discarded as by-catch in shrimp trawling operations by all vessels fishing in that Latin American area encompassed by WECAF. (Map 1. and Table 1.) Shrimp is a major fishery resource of the Caribbean Atlantic area. This fishery has developed from the Gulf of Mexico to the very broad Continental Shelf of the northern coast of South America between the grand estuaries of the Orinoco and the Amazon Rivers. This area has been described by Bullis as "the greatest shrimping grounds in the Western Hemisphere". The shelf area of these grounds was then estimated at "at least 75,000 sq. miles" but the operational area has since extended to cover the entire north-western coast of Brazil.

This resource was discovered through the Cape St. Mary fish trawling survey done by the Government of Guyana (then British Guiana) in 1956. When unusually large shrimp were found, these were sent for identification first to the British Museum, then to the Dutch Ryksmuseum and, subsequently, to the U.S. Smithsonian Institute. These shrimp were finally identified as brown shrimp, Penaeus aztecus, whose gregarious schooling behaviour was already known. Accordingly, when in 1958 it was suggested that the survey vessel OREGON, which was about to undertake an exploratory fishery survey in the Orinoco region, could extend its survey to cover the Guianas, the Fishery Department and the Government of Guyana readily assisted the exploration. As a result, the published survey of Bullis and Thompson indicated the first practicable commercial fishery for such shrimp. The previous trawl survey of the R.V. Cape St. Mary used heavy trawl gear (suitable for fishing the North Sea) which was only capable of catching shrimp accidentally. However, the OREGON, with gear specially designed for shrimp trawling and particularly adapted for operation in the muddy bottoms of that area, was able to harvest massive quantities of shrimp. (Figure 3.) This resulted in the presence in the area of a maximum number of some 600 shrimp trawlers. The "food-significance" of this discovery and of the development of the shrimp fishery is that there have been and are discarded during the capture of shrimp, vast quantities of edible fish. Juvenile marine fishes and shrimp occur in tropical coastal mangrove swamps. The adult shrimp are harvested but most of the adult edible fish are wasted as human food.

From the time of the discovery of this resource and its active industrial exploitation up to the present, and on the basis of 5lbs. of fish discarded for every pound of shrimp caught, it is estimated that over 4 billion lbs. or 2 million tons of various types of fish have been discarded and destroyed during the period of shrimping activity off the Guianas. This estimate was made by the Ministry of Agriculture of Guyana in 1977. Currently there are some 400 shrimp trawlers operating along the coasts of the three Guianas and it is estimated that the total number of shrimp trawlers operating in the WECAF area would be nearly 2,000. (See figure 4 of trawling system.) Because of the world-wide significance of this problem, IDRC has produced a film on this topic which should be of interest to policy makers.

Such shrimping operations, when first seen aboard shrimp trawlers in the Gulf of Mexico by the author in 1950, stimulated him to undertake the popularization of under-utilized species in Guyana which became known as "the skinfish campaign." Subsequently, the shrimp trawler surveys of Guyana again stimulated an emphasis on the use of unpopular market species of fish which were then discarded, which the author termed "by-catch fish" rather than "trash fish", a term now widely accepted and used. This finally culminated in the current assistance programme in Guyana sponsored by the International Development Research Centre, which started in 1973. A similar project has been established in Kerala, South India, and in Thailand.

FISH BY-CATCH DISCARDED AT SEA

According to the National Academy of Science study on World Food resources, the estimated annual quantity of fish discarded by shrimp trawling, world-wide, varies between 5 million tons and 21 million tons. (Map 2. and Table 2.) This estimate varies depending upon whether the assessment provides a figure of "marketable" fish (according to export market preferences of development countries), or includes "industrial" fish. In tropical countries all edible fish are normally consumed by coastal communities within the area and would, therefore, be considered "marketable". This excludes fish which are so small or so unusual as to be only suitable for industrial processing. Originally, the assessment of Nilson and the results of the various surveys of the exploratory vessels OREGON I and II, CALAMAR and COQUETTE, indicated this difference. These studies give various figures of the catch, depending upon the operational area, the time of the year, and the time of day when fishing. (See figures from Rathjen's (5) and Dragovich's (6) papers.)

It is, however, important to recognize that this is not something that is confined to the Caribbean Atlantic. Similar assessments have been made off India, off Thailand, and off Sabah, and the ratio of fish to shrimp in these tropical areas has been shown to be consistently in the proportion of about 85-90% fish and 10-15% shrimp in the best shrimping areas. However, there are areas where the catches decline to as low as 3% shrimp while in other areas, and with special gear, it has been found that trawl catches of shrimp can seasonally be as much as 60%

shrimp and the rest just a few fish and unusable "trash". (Figure 7.) An assessment recently done by CIDA off the Guianas indicated that there was a total of 52% of currently marketed species, while 43% of the fish were too small for marketing and can be converted into meal. Shrimp constituted, in that particular case, about 5% of the total catch. Several accounts and investigations into the distribution and availability of fish and shrimp are available. The reference list provides further details but, in summary, it may be said that in colder waters the variety of species as well as the proportional quantity of fish by-catch to shrimp is much less. The extremes vary from ratios of 3:1 of fish to shrimp, to ratios of 20:1, but the average for temperate waters is more in the vicinity of 5 to 1 and for tropical waters, approximately 10 to 1.

Observations of a shrimp trawler's operations during the night and during the day indicated the difference in the catch of shrimp and fish, but consistently provided impressions of the vast quantities of edible fish which have to be jettisoned into the sea for want of space. Anyone who is familiar with the problem appreciates the constraints. The incentive for the crew is to make money on shrimp; there is limited storage capacity; the crew is generally only four, and there is restricted operational deck and storage space aboard for fish. The shrimp trawler has been designed for the capture and storage of high-valued shrimp. Nevertheless, it is an unacceptable waste and anyone concerned with the nutritional problem of poor communities must feel implacably committed to a resolution of this problem. Accordingly, a strategy for productive use of the resource has been undertaken in Guyana. (Slides)

The strategy of the IDRC project has been, essentially, "to prove the point by using the by-catch fish as a source of food to replace imported supplies which are no longer available on the local market." The second aspect was to provide the basis for the industrial development of the by-catch. The project first aimed at the development of traditional as well as non-traditional products such as comminuted or minced fish products on a pilot scale. The second aspect aimed at evaluating the species variation in the catch, to determine which species combination could best be used for the industrial processing of fish

products for human consumption. Any products not consumed can be converted into livestock feeds.

The project is assessing the magnitude of supply and composition of fish caught incidental to shrimp trawling; identifying, quantitatively, the important characteristics of selected products made from different groups of fish; and preparing products from such fish for local marketing, mainly. Because of the country's ban on all fish products imports, this was a special opportunity to develop the processing and marketing of suitable fish products required for local consumption. It thus gave indicative trends for the types of products which can be available or may be prepared for other markets throughout the Caribbean.

PROBLEMS OF THE BY-CATCH

By comparison, Nilson's study of the western Gulf of Mexico for the evaluation of markets and estimation of fin-fish caught incidental to trawling in the western Gulf of Mexico indicated that their objective was to examine the current market in the United States. The study, therefore, tried to identify appropriate fish from the trawl catch for the following markets: (a) reduction (fishmeal and oil); (b) fish protein concentrate; (c) pet foods; (d) fish fillets and portion pack; (e) whole fish. Those five product-markets were discussed according to structure, trends, problems, potentials, operating methods and source of supply. These markets were already established so that any unusual fish had to be either adapted or selectively apportioned to them. In the southern part of the Gulf and in the Caribbean, the market, though traditional for certain products and species of fish, was not as selective. Further, it must be clearly understood that the fundamental attitudes fostered by export product-markets, were really seeking "a fillet of the sea" or cheap fishmeal and thus sought to harvest only the prime species demanded by such markets.

The practice of fishermen of some nations external to this region was to process the entire catch into appropriate end-products very much like the total utilization of steer, pig or chicken meat. It is this attitude of total processing and appropriate utilization which is essential to consider with regard to the by-catch fish. It must be appreciated that

there are between 50 and 200 species of fish which are caught, depending upon the geographic location and the temperature and season of the fishing area. Again, it must be emphasized that very few exploratory fishing surveys have been conducted directly for assessing the by-catch during normal operations. Published surveys have been seeking either to assess the abundance of shrimp or to explore trawl fishing capabilities. Accordingly, the actual current operational problem in different areas and varied seasons has not been as fully studied, industrially, as it needs to be.

Quantitative harvests in the by-catch vary according to (1) areal distributions affected by outflow currents; (2) marked yearly differences at a given locality in the marketable and industrial fish, or shrimp catch; (3) seasonal (moon phase and weather) variations within a year; (4) depth or bathymetric variations; (5) sea bottom or substrata variations; (6) daily variations when fishing is done during the day or during the night. In general, even though over 70 species of food fish are caught off the Guianas, they may be grouped into four consistently occurring species' groups: (1) the drums (Sciaenidae); (2) the jacks (Carangidae); (3) the mojarras (Gerridae); and (4) the butter fishes (Stromateidae). The FAO survey (Rathjen and Yesaki) gives ample indication of the results and difficulties in making specific assessments. (Figures 8-11.)

PROCESSING

The significance of the above variations may be well appreciated through Thompson's assessments which gives the proximate composition of Gulf of Mexico "industrial" fish. The data analyzed over a three-year period showed that there was really no significant difference found in the protein and ash content for individual species, either from one end of the geographical area to the other, or from year to year. However, for individual species, the variation in content was not considered to be related either to geographical or yearly variation and had to be considered as being related to environmental factors. In general, the oil and moisture content displayed a strong inverse relationship to each other, within species' groupings, and was possibly related to seasonal variations in the reproductive cycles. The studies classified the species into three different groups. More of such studies are clearly necessary to

determine the reliable and efficient market-end use of the species' groupings which are being obtained from the trawler by-catch.

Because the problem of assessing the variation at sea among some 200 trawlers in the Guyana fisheries proved to be exceedingly difficult and is still under investigation, it was felt to be more productive to start immediately on the processing of those more commonly occurring species and to transform these into products which were suitable for the traditional markets of salted and dried fish, as well as for the markets of new products using flesh-and-bone separator machines. In fact, the main objective was to provide food fish immediately and once it was clear that these products could be made and used, then the other aspects of the entire problem may be progressively attacked. Apart from salted, smoked and pickled products, fillets, portions and comminuted fish products are being made. Perhaps it should be stated that fillets usually refer to the intact piece of fish, while a "portion-pack" is made up of cut-up fillets and trimmings which are then frozen together. Comminuted or minced fish flesh is processed into small items, generally less than a pound, often with a breaded exterior.

It is, therefore, possible to mix the minced fish from different varieties although, in North America, this was not considered acceptable since the minced flesh must be identified according to fish species. However, with the use of the flesh and bone separators which have been developed over the past 20 years, the possibility of obtaining boneless fish flesh as a coarsely minced product from a variety of fish species of similar chemical content and appearance, presents a better opportunity for making a minced product which is now anonymous, but very edible and acceptable. Thus, as Steinberg puts it, the new product of the fish flesh separator "sheds the identity of the individual species and appeals to the consumer on the basis of the attributes alone." That is to say, it is entirely boneless fish protein, very tasty, which is a new raw material that can be hygienically made into various forms which would be directly consumed, when prepared according to the taste and cultural preferences of the consumers as to acceptable dishes. Accordingly, less popular species can become nutritious items instead of unwanted and unused. This offers a wide opportunity for various convenience foods for the mass production

and quick snackfood categories as well as for home-prepared or institutional bulk meals.

The preparation of products from small batches of different samples of the varied species available has not been difficult to accomplish. Samples have therefore been made. The next problem is the collection of industrial quantities which would scale-up the pilot activity to the industrial level of operation. It is essential to preserve the quality of the fish right up to the processing sector, so that only fresh fish can be processed to make top quality products. Accordingly, the procedures for bulk handling at sea, i.e. storage as well as transfer from the "catcher" trawlers to " collector " vessels at sea, and at the landing discharge centres, must be considered. This will relieve the trawlers of a bulk of fish and permit them to stow more shrimp. Because of the bulk of fish, their variation in size and species, the safe handling of the product is a major problem. The catch rate has been shown to vary from 60 kg. per hour in the Gulf of Mexico (with a ratio of 15.5 fish: 1 shrimp) to 607.6 kilos per hour in the case of the CALAMAR cruises off norther-western South America (with a ratio of about 20:1). With double-rig shrimp trawling, fishing during ten hours of darkness, this simply means that the catch of fish aboard a trawler varies from 1 to 6 tons of marketable fish for the nightly operations !

To handle such fish at sea will require considerable arrangements. The experience of separator trawls which are designed to separate the shrimp from the fish catch, has not yet proven to be very satisfactory in tropical conditions. With the use of additional crew, some sorting aboard the vessel has taken place and experiments are in progress to store the fish in tanks fitted in the aft section of the deck in which chilled sea water is continuously circulated. It is hoped that in this way short-term storage of about 5 tons of fish can be held in vessels and then transferred to a collector vessel which will then bring in the bulk fish to a processing plant. The effectiveness of this method has to be examined in all seasons. It is indicated that it would involve more crew, effective rendezvousing at sea, and a safe and efficient transfer technique. It was suggested that the chilled sea water system for a fish storage would be the most effective. (See figure 12) The

the current practice is to store the fish in the hold separate from the shrimp and then to discharge it manually and process it ashore. Subsequently, any new vessels should be built with larger hold space and crew accommodation so that the by-catch can be more effectively handled.

The fish pump system for bulk handling and transferring of fish at sea or discharge ashore which has been developed in the Pacific Northwest is illustrated as an example of a practicable system which can be easily tested with shrimp fleets. It is suggested that such a "mother ship" or transporter vessel equipped to handle about 100 tons of fish in the chilled sea water systems should operate with a fleet of shrimp trawlers with tanks installed on deck for the daily collection of the by-catch. The diagrammatic systems used by the B.C. Canadian Fishing Company are illustrated in Figure 3.

Once the fish is available ashore, they are transformed into traditional products such as salted and dried products, as well as the comminuted minced products. This new raw material is then converted into various products. Products such as fish sausages, fish-burgers, fish-cakes, find a ready market but a special effort has been made to make stable products, which require no refrigeration and which would be suitable for rural marketing areas. In this regard, the minced salted products developed at the Halifax Fish Technology Laboratory, offer a particular promise for tropical countries and the experimentation of this has also proceeded in Guyana.

MARKETING

Previous reference has been made to the vast imports of fish to the region. (Table 1.) The clear needs are for product development and quality standardization. The need for making products which would be acceptable, not only for local markets but to meet the varied tastes within the regional market, has to be carefully organized. It is quite clear that the quantity of fish available from the shrimp trawling operation, even of the Guyana fleet, far exceeds the population consumption capacity of that country. Accordingly, regional markets will have to be sought where there is a market demand. The product types have been developed to replace

imported traditional salted and smoked products, hard currency prices of which have increased with inflationary trends. Formerly, these were available in the Caribbean from the Canadian maritime fisheries. However, the preparation of comminuted products offer a new prospect. It has been suggested that the bulk preparation of the comminuted flesh can be shipped as a frozen minced block to various countries, where it can then be converted into products suited to particular cultural tastes. It can thus be considered a new raw material for local industrial product development. It is also appreciated that the industrial preparation of such products is something that requires very careful arrangements in order to ensure standard quality, assured shelf-life, hygienic packaging and distribution. The shelf-life and keeping quality of these products have to be tested and must be maintained at internationally acceptable food standards.

In this regard, it is quite clear that much need for technical assistance is indicated. At this stage, the pilot operation in Guyana shows very considerable progress from the situation that existed 7 years ago. Fortunately, it is appreciated that the development of a fish products' industry from a pilot operation to an industrial scale requires trained operatives and effectively controlled food plant management. While a modern fish port is being established, it is also necessary to consider the various prerequisites at all stages of development of product types which would be acceptable, by the world market standards for such products, for the Caribbean and Latin American region. Much still remains to be done.

FUTURE INDUSTRIAL CONSIDERATIONS

Various proposals have been formulated to deal with this problem. However, the ideas summarized here deal with the developments suggested for obtaining food for direct human consumption.

Boats: As the fishing vessels of the present design for the shrimping fleet become older, they need to be replaced by vessels of larger capacity and different design. Such vessels will be able to handle the by-catch as well as the shrimp and perhaps with less powerful engines (thus less consumption of fuel) and with more accommodation for crew so

that the handling of the by-catch may be facilitated. Such vessels may also be designed with refrigerated sea water systems so that the bulk handling of the fish will be greatly facilitated, particularly for the transfer of the fish at sea. Similarly, a collector vessel should form a part of the fleet so that a collection of the bulk at sea can take place permitting prompt transfer for processing. Alternatively, a small unit for the flesh-and-bone separation of species and storage in frozen condition may be installed on the collector vessel in order to determine the feasibility of preliminary processing of certain species at sea. The terminals for the discharge of fish would seem, again, to require conditions which will permit the rapid bulk transfer of fish to the industrial processing plant.

In a tropical country, it is essential to recognize that the varied humidity of seasons will cause sweating or deliquescing of salted products so that salted or dried or smoked products will have to be properly and economically packaged in sealed plastic bags. The price of the product must be within the purchasing power of the lower-income groups. To ensure that there is no mold or bacterial spoilage of the products when shipped or stored in various seasons, the use of preservatives or even cobalt radiation treatment should be carefully examined. The regional coordination of such shipments, marketing procedures and demand assessments require further studies. The development of specialty products should prove to be an attractive market possibility.

DISCUSSION OF CONSTRAINTS

It seems evident that there is a large resource of fish which is available to the Caribbean Atlantic along the shrimp fishing areas of the Gulf and Caribbean. It is quite clear that this resource would require no extra expenditure on additional fishing effort but an adjustment in the operational system of fishing to permit its collection from the catch and its industrial processing. The challenge, therefore, is to determine an efficient system for the collection of the by-catch at sea and for its processing ashore. The product development of both traditional and non-traditional products requires considerable standardization and improvement to do it on a large industrial scale so as to ensure the consumer acceptance of the products for import substitution and also

provide standard quality products in the industrial quantities required by regional markets.

Apart from the technical aspects of boats, handling gear, processing, there is considerable need for skilled personnel at all levels in the organization of this operation. When this issue was first raised in the 1950's, it was considered too intractable a problem to be handled, either by the countries or by FAO. Various other organizations have shown that there is a scarcity of fish resources in the immediate vicinity of Island communities or the Caribbean and Latin American countries. When one reviews the quantity of shrimp that is produced throughout the tropical world (figure 2 and table 2) and can visualize the enormity of the fish discards which are wasted for human consumption, and thus only feed sharks and seabirds, the waste of food is too catastrophic to be ignored. It is suggested that the technology of North and Latin America, as well as the appropriate financement by agencies such as the regional banks, should be directed to the solution of this problem.

As food for thought, Shindo records that during 1920-25 "trash fish", or by-catch, in the early stage of the Japanese trawl fishing in the East China Sea was about 50% and was dumped. Even the Korean shrimp (P. orientalis) now one of the most economically important species, was also considered trash fit only for dumping. Recently (1977) the trash fish was less than 5%. He attributes this to improvements of vessels, gear, processing and fishing techniques apart from increased market demand. Similarly, in Keralastate in the South of India Kuriyan reports that more than 80% of the fish by-catch of shrimp trawlers has been utilised directly for food within the last three years and is sold at 1 Rupee (7.6 US¢) per kg in coastal towns. Within this decade, the Caribbean Atlantic shrimp fishery can accomplish a similar enlightened transformation.

CONCLUSION:

In the world's poorest countries, fish is the main protein source of poor people. In some cases, fish is the only thing they have access to and, in others, it's all they can afford to buy or barter. In the

world's richest countries, seafoods are the prime delicacies of the affluent communities. Shrimp, crab, crayfish from tropical sources are mainly sent to such affluent societies and the top revenue earners. Fishmeal made from catches adjacent to countries where there are marked protein deficient consumption patterns, provide the livestock feeds for animal raising in the protein-rich and well-fed world. The by-catch and discard from shrimp trawlers world-wide can help to change the situation by providing edible protein for populations which are presently malnourished and in need of good food. (Figure 14.) This human perspective must not be forgotten. The challenge of the 'eighties should be met by groups such as this, and the 21st century should see new utilization of the resources of the ocean which may have been started by the efforts of the fish-discard situation in the Caribbean Atlantic as an example to the world for the gainful utilization of the seas' vital renewable resource.

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A provisional bibliography relevant to the by-catch problem has been prepared by D. Turnbull, available through IDRC, but a few selected references are herewith cited.

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Table 1. Total Imports of Fish & Fishery Products - 1978

Central America	62,092	Metric tons	Valued at $US 41,145,000
Caribbean Islands	150,757		107,737,000
South America	125,810		128,340,000
Grand Total:	338,659		$277,222,000

Source: FAO 1978 Yearbook of Fisheries Statistics

Table 2. Catches of Shrimp and Prawns by Zones* - 1978

and ***Approximate Fish By-catch

Zone			
31	West Central Atlantic	48,153 M. tons	723,000
34	East Central Atlantic	16,602 M. tons	249,000
37	Mediterranean	5,077	45,900
41	Southwest Atlantic	46,943	703,500
47	Southeast Atlantic	1,557	24,000
51	W. Indian Ocean	215,580	3,233,700
57	Eastern Indian Ocean	46,642	699,000
61	Pacific Northwest	138,835	1,249,200
67	Pacific Northeast	1,569	14,400
71	W. Central Pacific	304,275	4,564,500
77	E. Central Pacific	53,797	807,000
81	Australia	2,430	21,600
	Grand Total:	881,460	12,273,800

* Source: FAO 1978 Yearbook of Fishery Statistics

*** Note: The approximate figures of fish by-catch are obtained by estimating the average quantity of total fish discards to be 15:1 in tropical areas and 9:1 in temperate areas. These figures therefore include both the edible marketable species and unutilized types which may be used for industrial purposes.

Table 3.

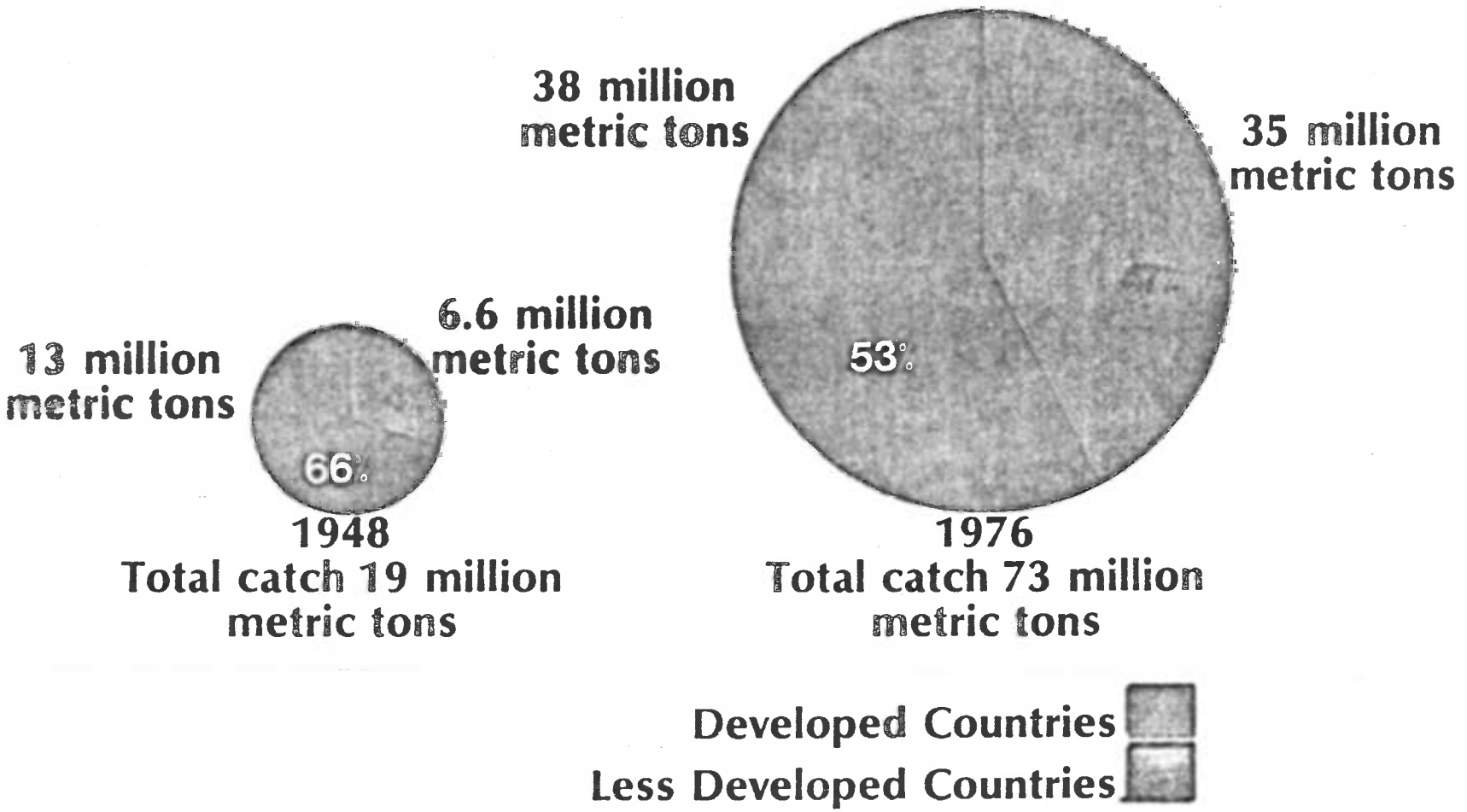
FAO 1978 Shrimp Landings* from Caribbean Atlantic Operations and With Extrapolated Fish By-catch Discards** (x5)

***Barbados	110	Metric Tons shrimp	550	Metric Tons Fish
Belize	13		65	
Colombia	6,130		30,650	
Costa Rica	1,070		5,350	
Cuba	7,600		38,000	
Dominican Republic	74		370	
El Salvador	4,224		21,120	
Fr. Guiana	62		310	
Guatemala	1,581		7,905	
Guyana	3,175		15,875	
Honduras	2,343		11,715	
Japan	2,720		13,600	
Korea Rp.	1,685		8,425	
Mexico	26,110		130,550	
Nicaragua	4,532		22,660	
Panama	8,912		44,560	
Suriname	4,105		20,525	
Trinidad	267		1,335	
Venezuela	3,820		19,100	
United States	121,652		608,260	
Total	200,185	M.T. Shrimp	1,000,925	M.T. Fish

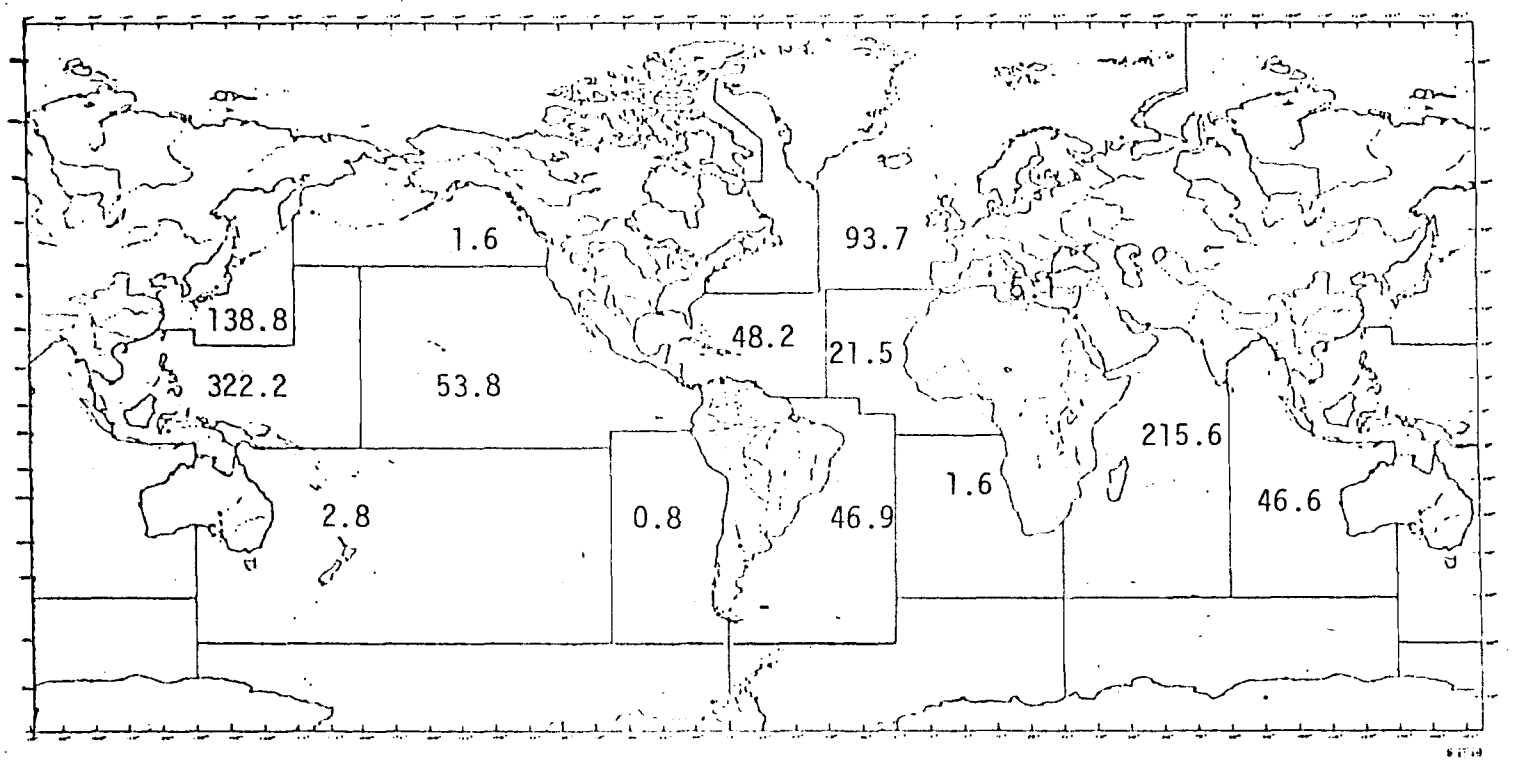
Note: *These figures of shrimp landings are extracted from FAO 1978 Yearbook of Fisheries Statistics (Vol. 46) of the landings of shrimp from Zones 31 and 77 (see map). The figures represent catch landings not exports from the country and may represent shrimp tail weights largely and not whole shrimp.** The figure giving estimated fish by-catch discards gives an approximate quantity of edible marketable fish, not the total catch of fish.

***inserted from Barbados trade figures.

Total World Catch of Fish

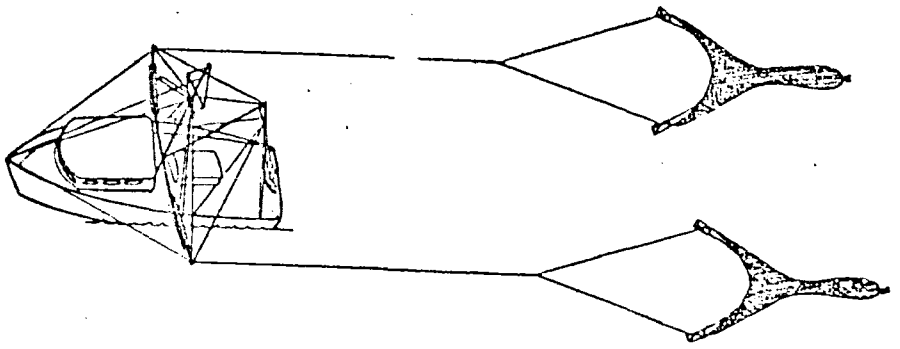


Figure

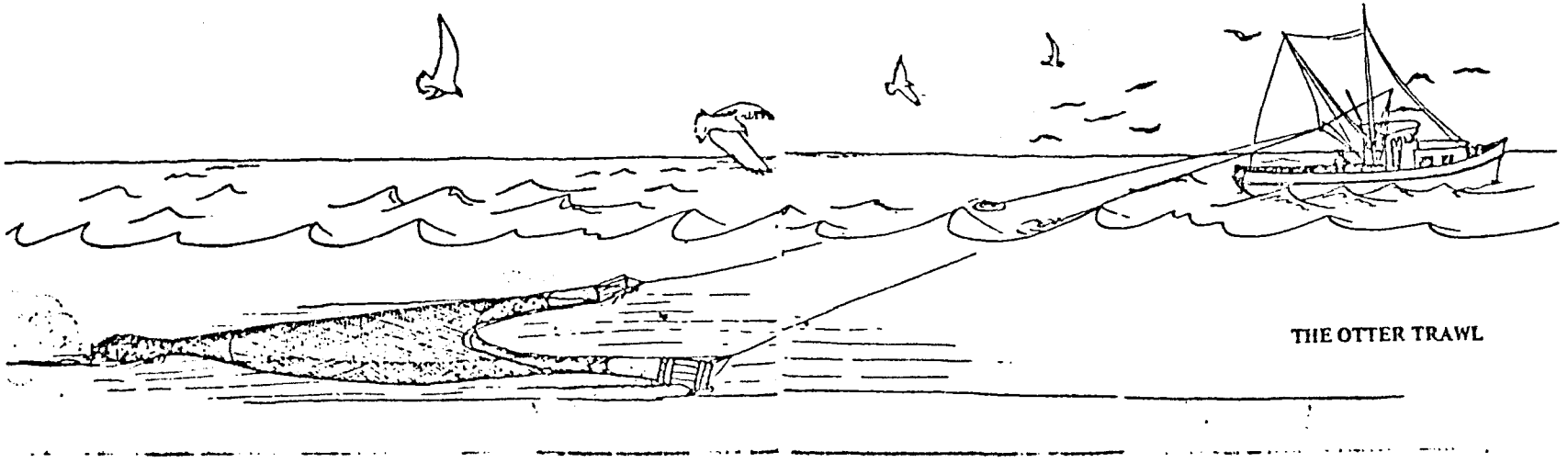


1978 Shrimp landings in 1000 tons in FAO Statistical Zones

Map 1

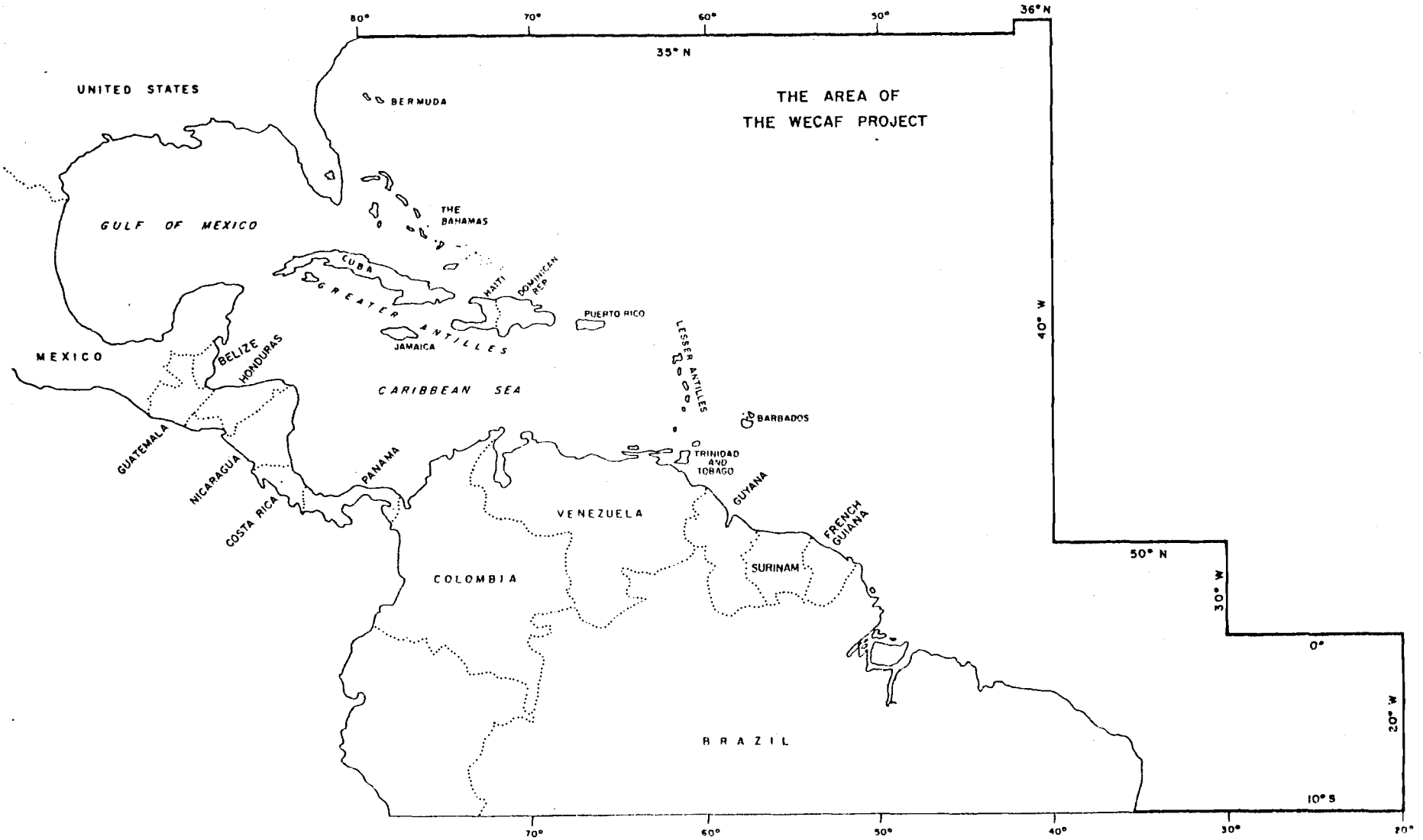


Double-rig trawling



Off-shore Gulf of Mexico Shrimping Operations.

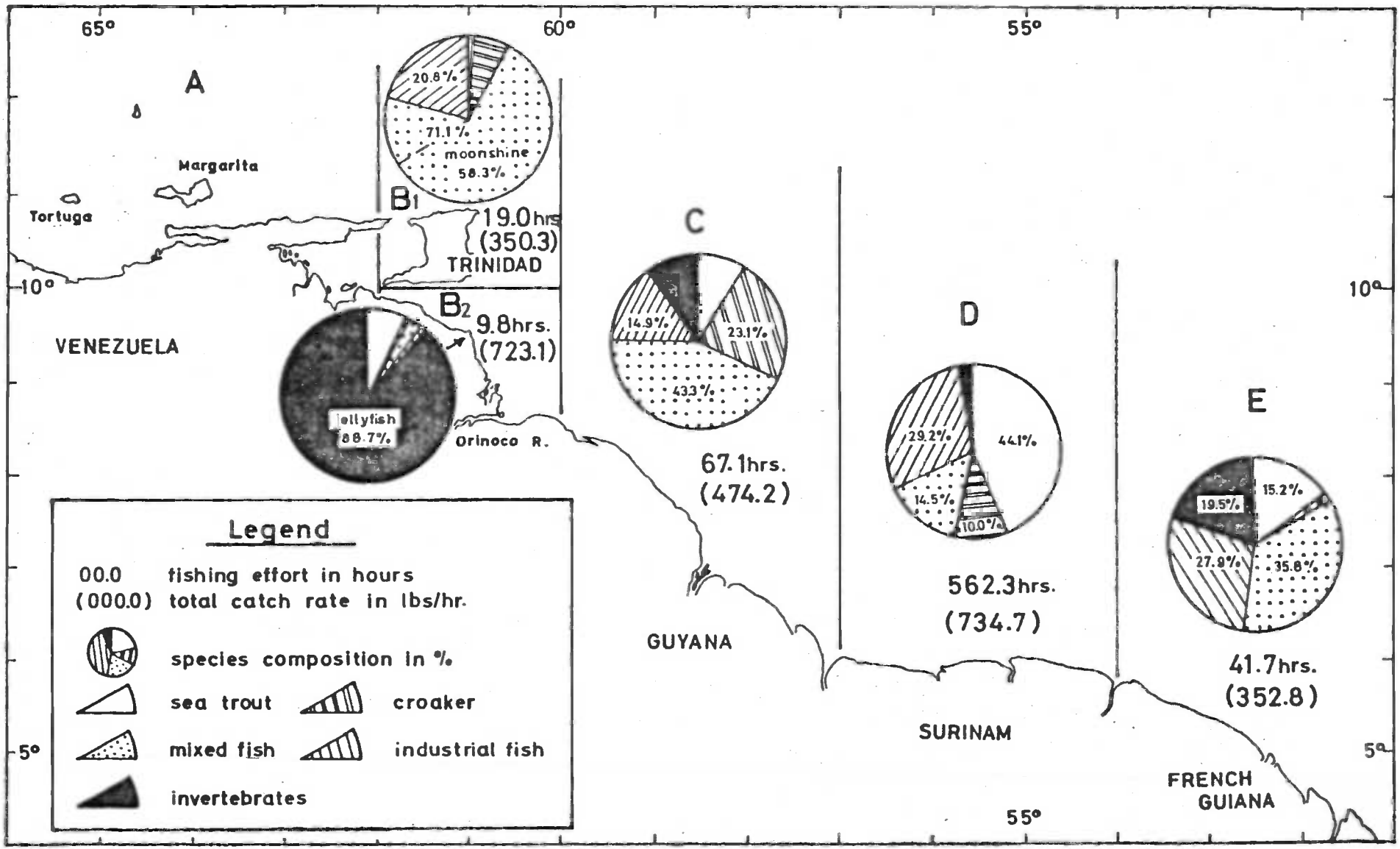
Figure 3



Map 2

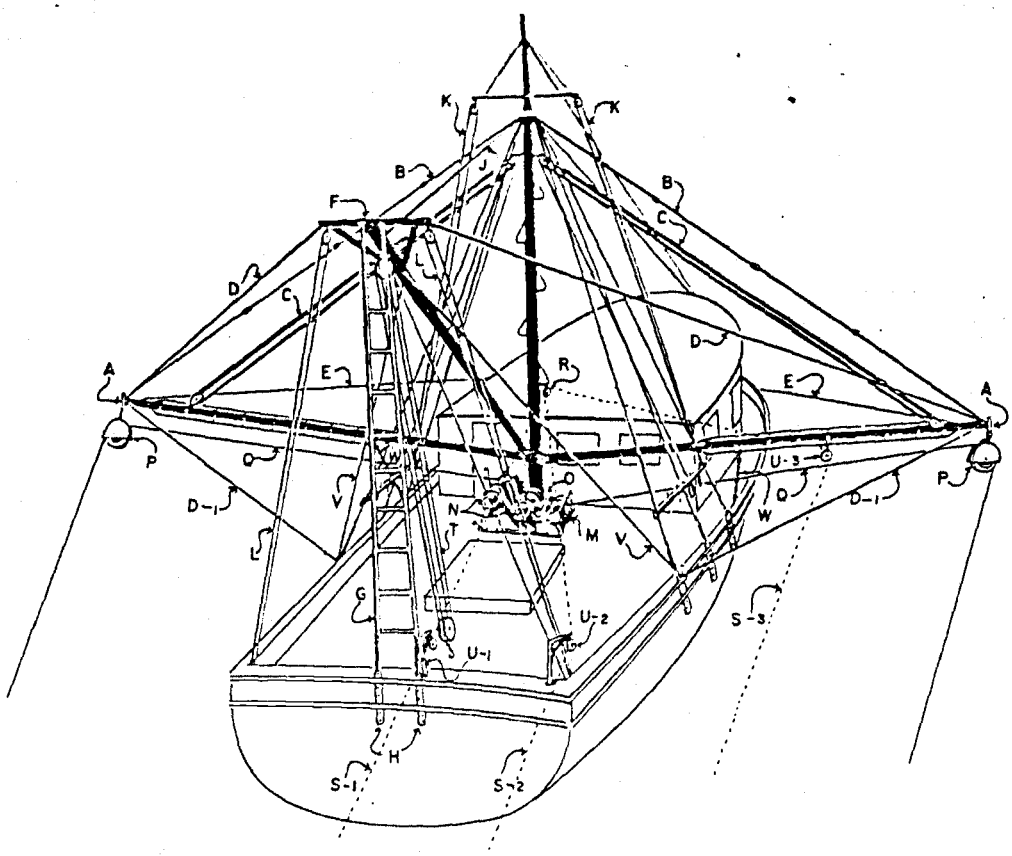
Source: Klima, E.F. 1976. A review of the fishery resources in the Western Central Atlantic. WECAF Studies No. 3.

Figure 5

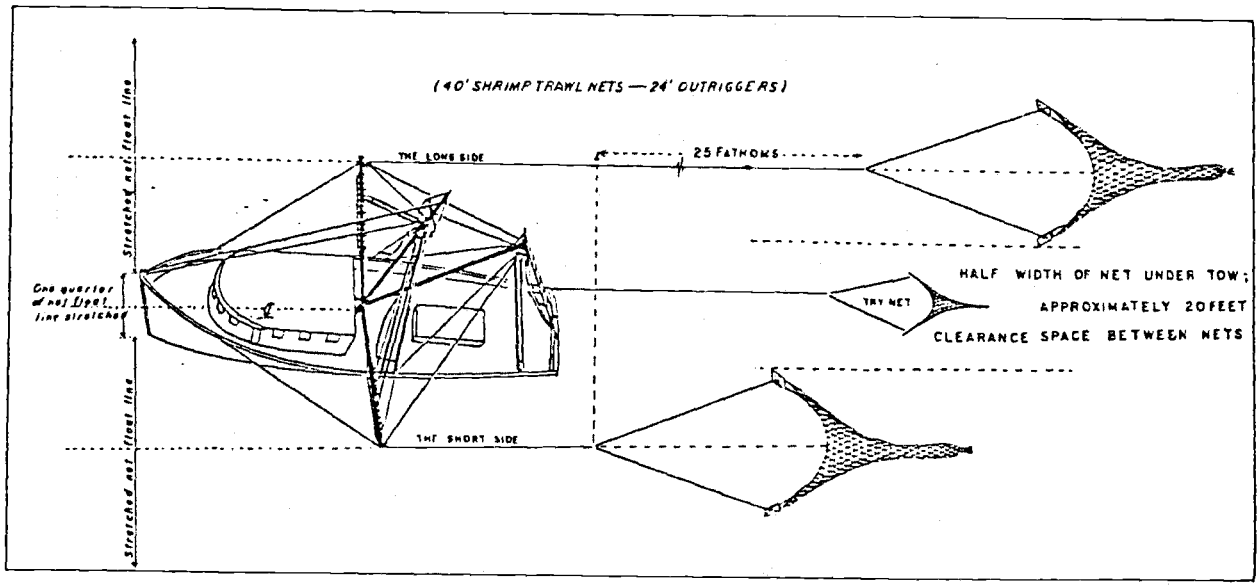


CALAMAR fishing effort, total catch rate and catch composition.

Source: Rathjen, W.F., M. Yesaki, and B. Hsu. 1969. Squidfishing potential off northeastern South America. UNDP/FAO Caribbean Fishery Development Project, Bridgetown, Barbados.



Details of the rigging arrangements required for double-rig shrimp trawling.



A diagramatic representation of a double-rigged shrimp trawler

Figure 4

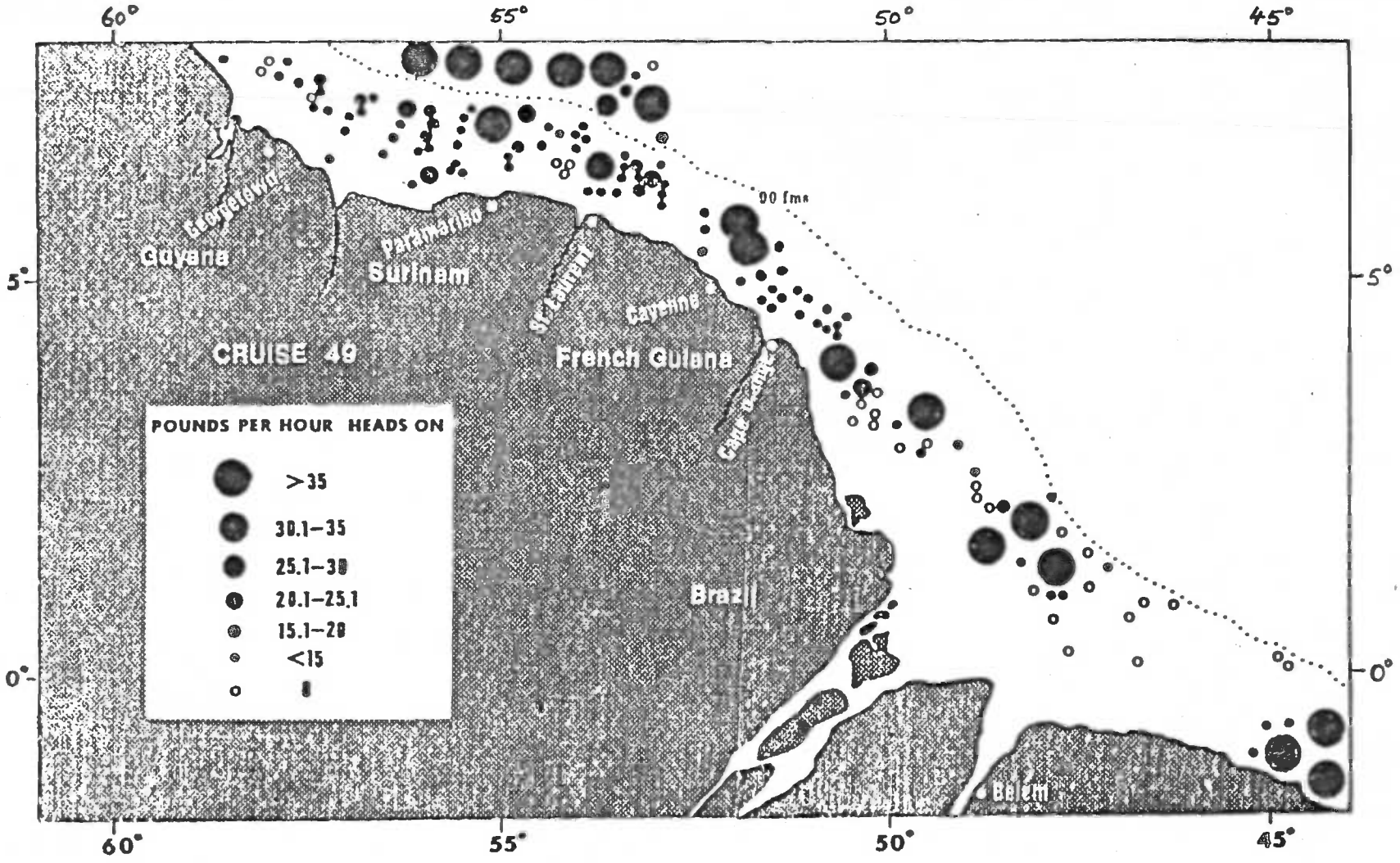
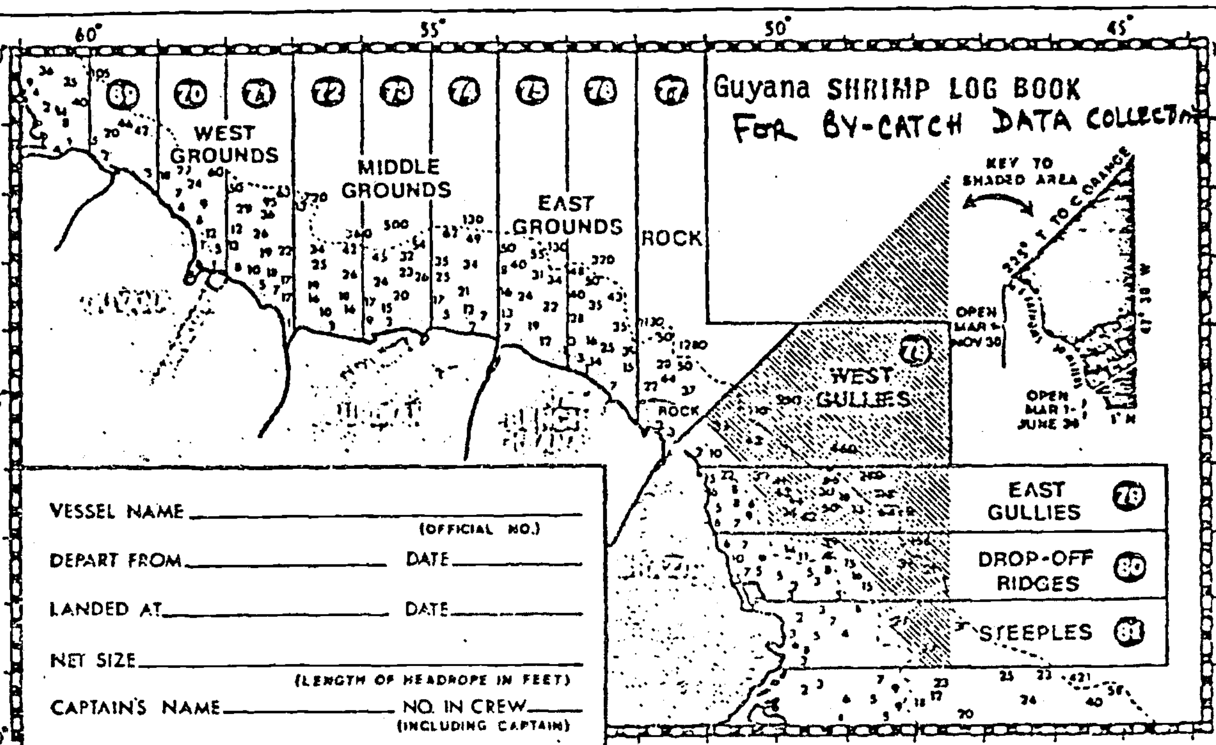


Figure 6 Distribution of the Mean Catch Rate of Commercially Important Species of Shrimp during Cruise 49 and Cruise 58. The plots inside of the 100 fath line represent mean catches of four species (brown, pink, pink-spotted and white) combined, and plots outside of 100 fath line represent mean catch rates of scarlet prawn.

Figure 7



VESSEL NAME ______________________ (OFFICIAL NO.)

DEPART FROM ______________________ DATE __________

LANDED AT ______________________ DATE __________

NET SIZE ______________________ (LENGTH OF HEADROPE IN FEET)

CAPTAIN'S NAME ______________________ NO. IN CREW __________ (INCLUDING CAPTAIN)

DATE	FISHING AREA			FISHING TIME			SHRIMP CATCH							REMARKS
							TOTAL POUNDS (heads off)	KIND					SIZE OF SHRIMP	
MONTH DAY	GROUNDS	ZONE NO.	DEPTH (fms)	DAY OR NIGHT	NO. OF DRAGS	TOTAL HOURS FISHED		PINK	HOPPER	BROWN	WHITE	MIXED		

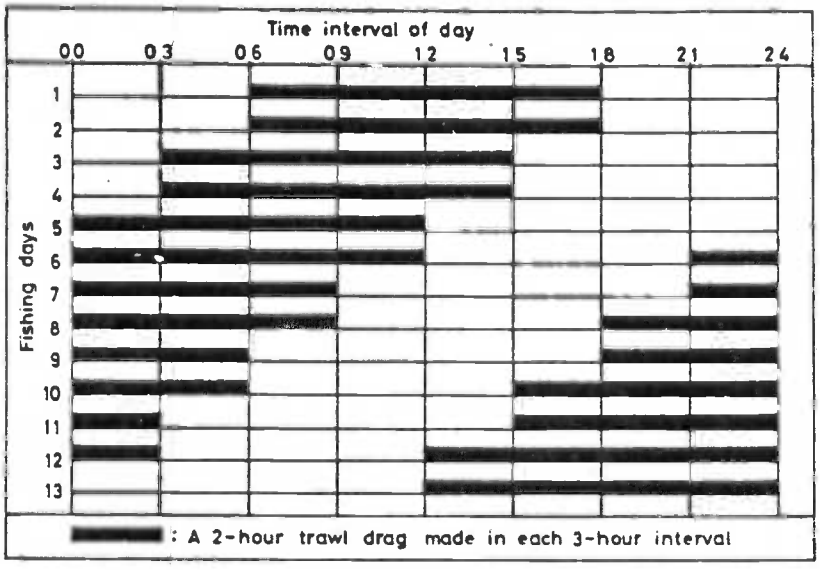


Figure 8 Fishing schedule followed by CALAMAR for testing day and night catch rate.

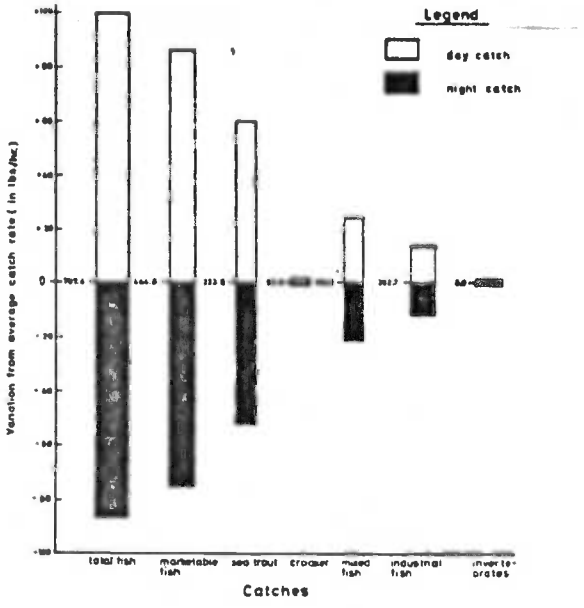


Figure 9 Variation from average catch rate, day versus night catch rate.

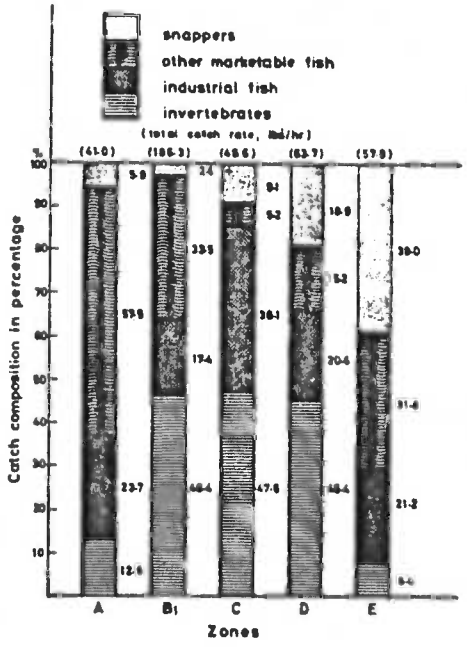
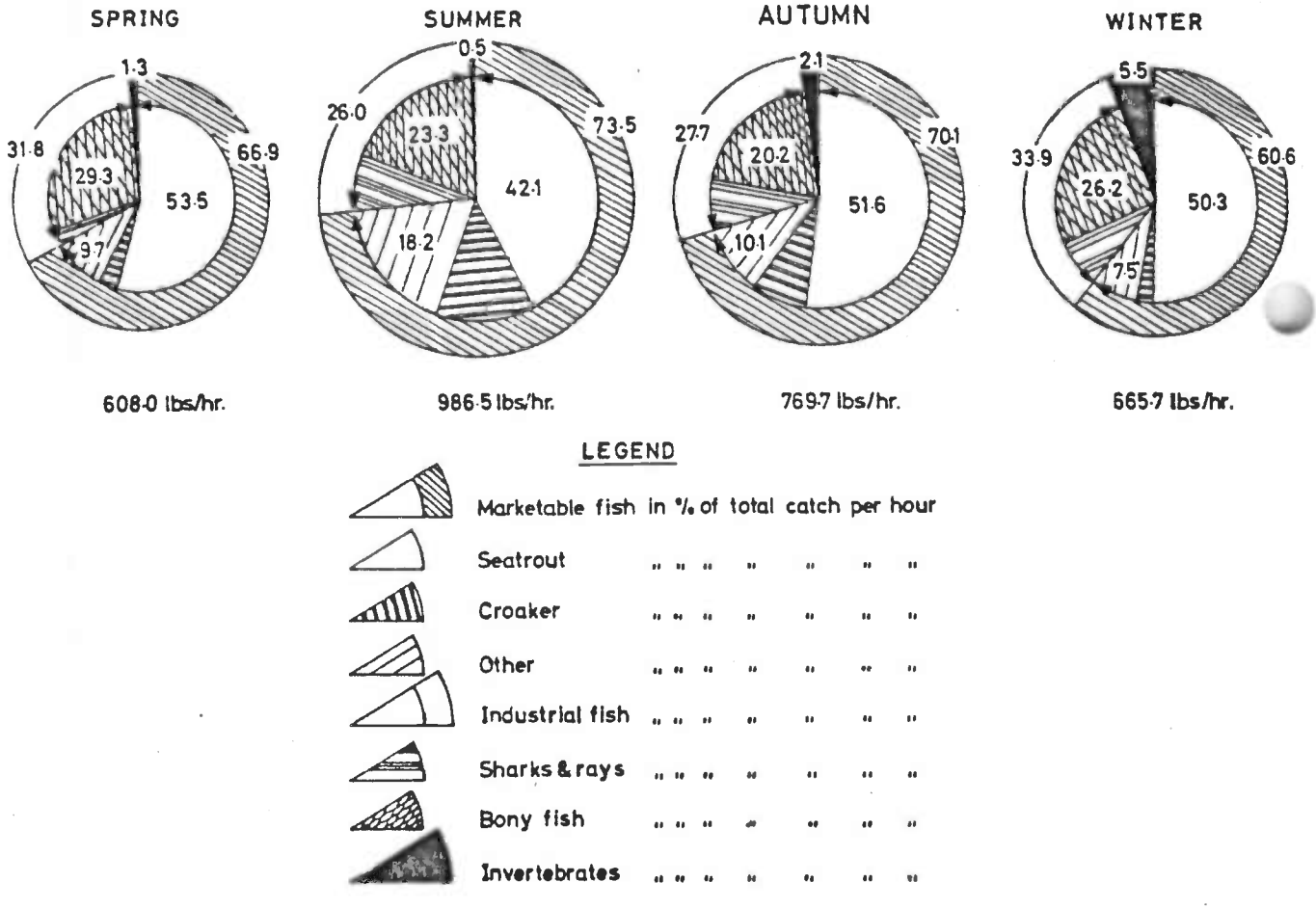


Figure 10 Catch composition and total catch rate of roller-rigged trawl fishing by zone, CALAMAR.

Source: Rathjen, W., M.Yesaki, and B. Hsu. 1969. Trawlfishing potential off northeastern South America. UNDP/FAO Carribean Fishery Develoment Project, Bridgetown, Barbados.

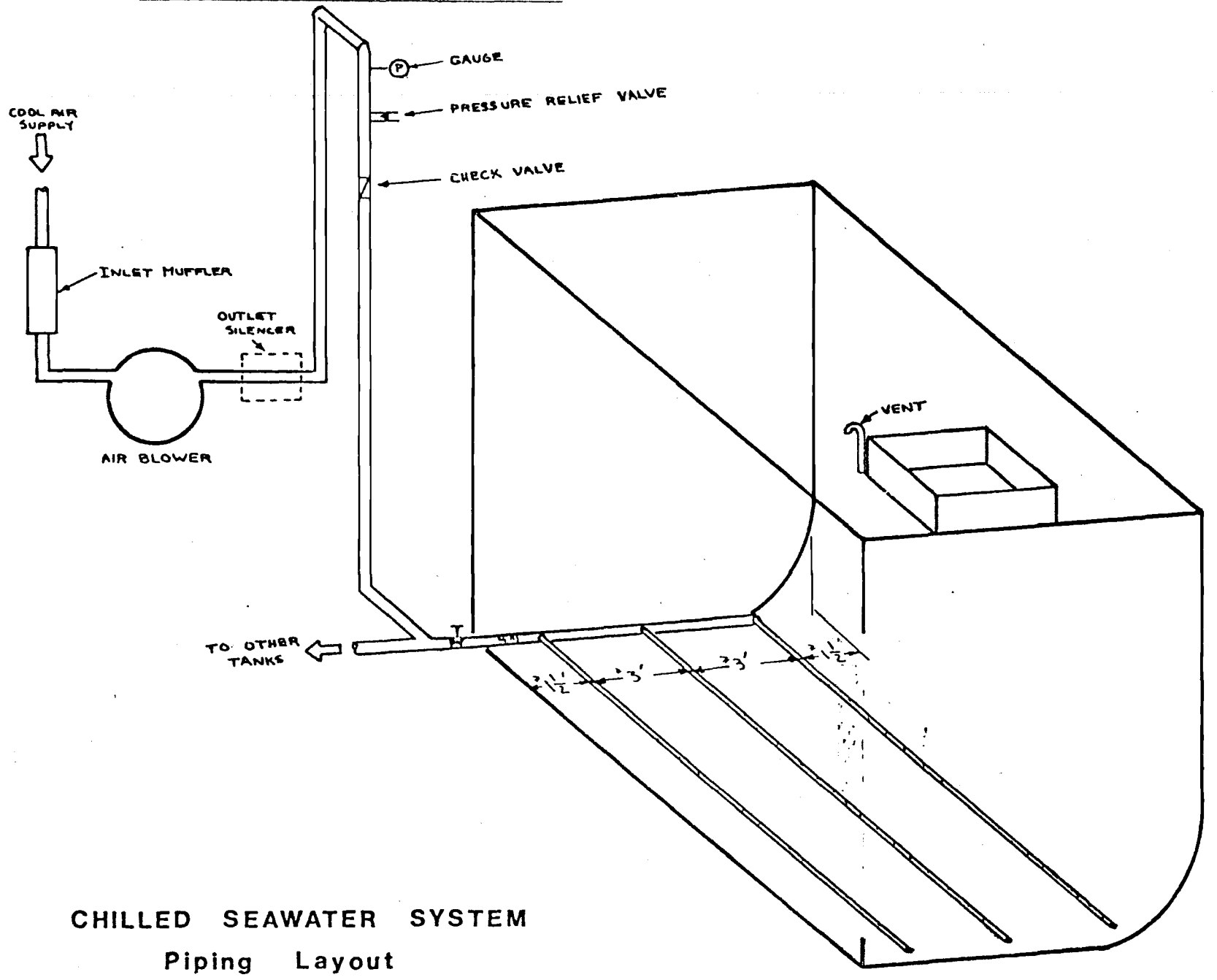
Figure 11



Seasonal catch rate and catch composition northeast of Surinam River, CALAMAR.

Source: Rathjen, W.F., M. Yesaki, and B.C. Hsu. 1969. Trawlfishing potential off northeastern South America. UNDP/FAO Caribbean Fishery Development Project, Bridgetown, Barbados.

CHILLED SEA WATER SYSTEM DATA SHEET - *Glen Gibbard, S. Roach and F. Lee*



CHILLED SEAWATER SYSTEM

Piping Layout

Figure 10

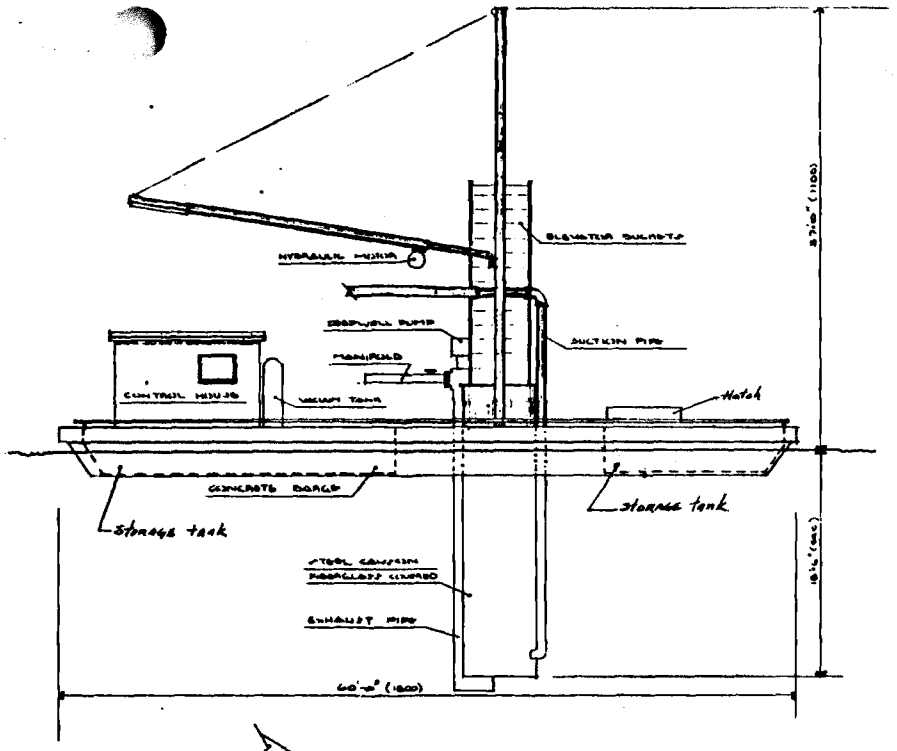
NOTES

1. This type of fish unloader works on the principle of the simple siphon. Fresh water is pumped into the fish hold. (Very little is required in vessel.) A vacuum is created and the water in the boat follows it, falling into a caisson which is deeper than the fish hold. The water is pumped back to the fish hold by a deepwell pump, excess water pumped to a holding tank. Fish which also followed the vacuum are removed by buckets on a continuous elevator.

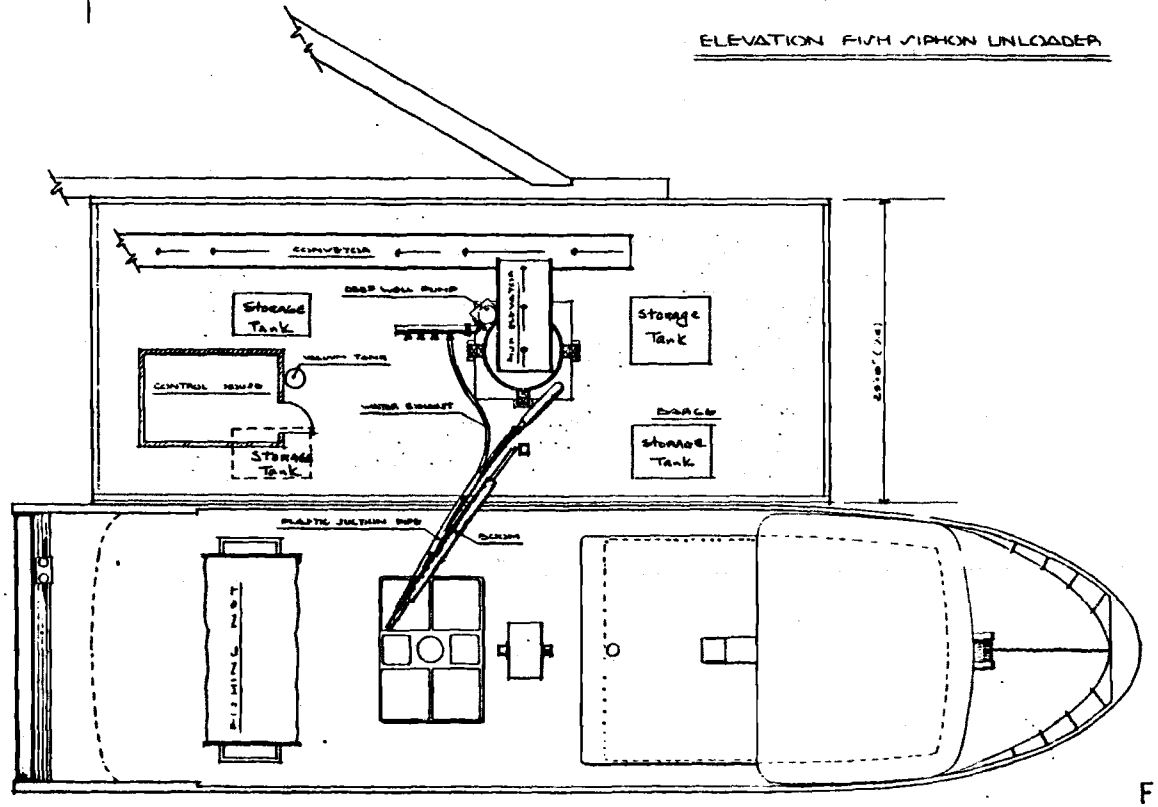
2. Using this system there is no limit to the horizontal distance the fish may be carried and there is no damage to fish.

3. Shown is the permanent installation, the caisson may also be designed to facilitate easy towing of the barge over shallow water.

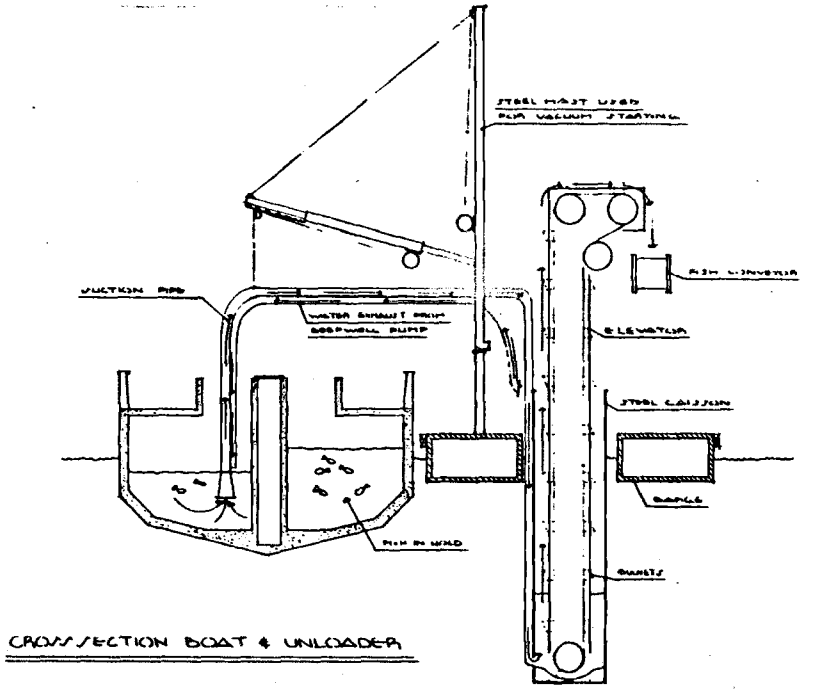
4. The floating installation shown is adaptable to landlocked installations able to carry produce as well as fish.



ELEVATION FISH SIPHON UNLOADER



PLAN VIEW FISH SIPHON UNLOADER



CROSS SECTION BOAT & UNLOADER

FISH SIPHON UNLOADER	
GENERAL ARRANGEMENT	
CANADIAN FISHING COMPANY LTD. STERLING SHIPYARDS DIV.	
DRAWN BY: J. ROLLAND	DATE: NOV 1977
DRAWN BY: [illegible]	DRG. NO. 171
SCALE: 1/8"-1'-0"	

Figure 13

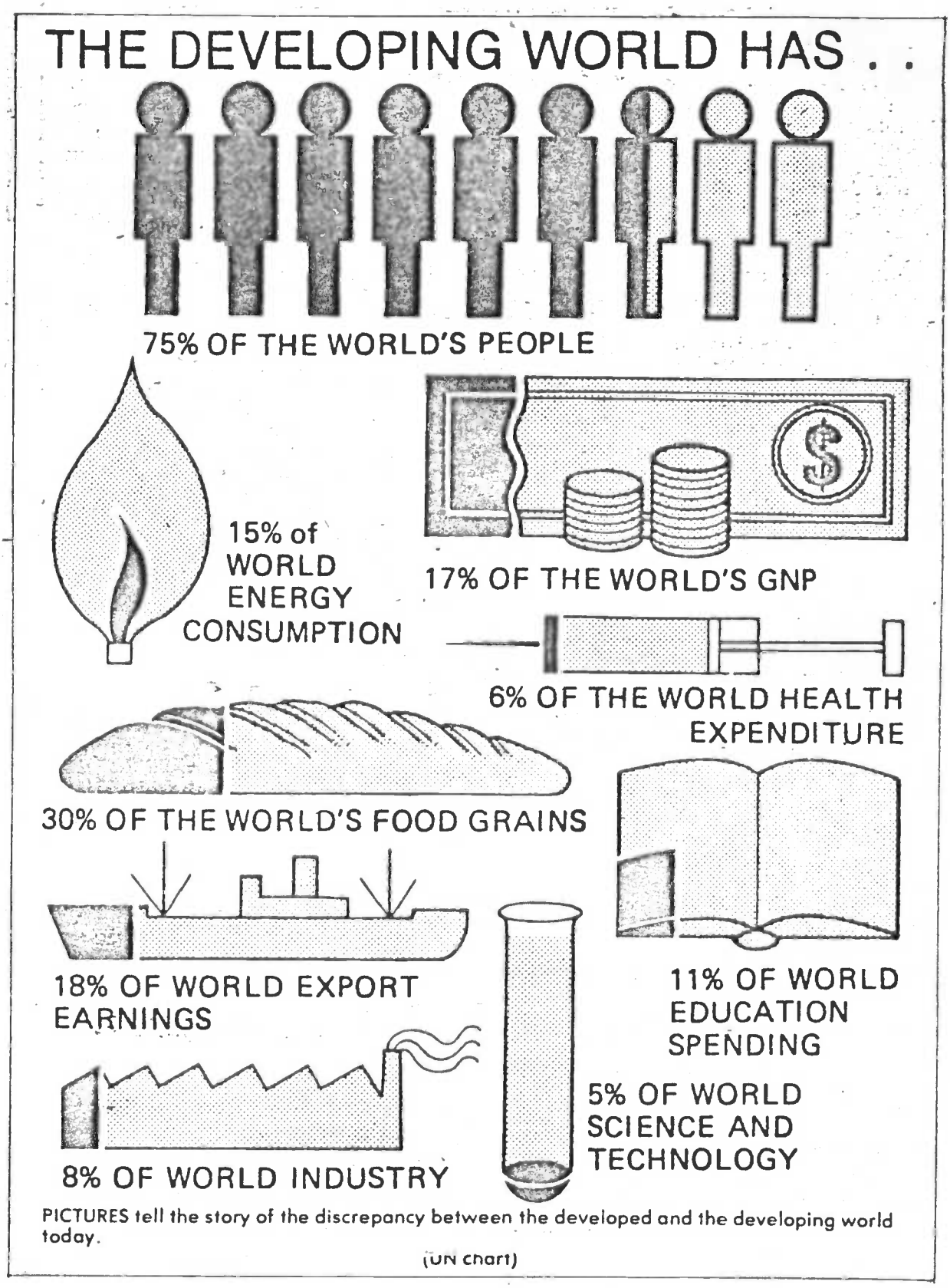

THE DEVELOPING WORLD HAS . .
75% OF THE WORLD'S PEOPLE
15% of WORLD ENERGY CONSUMPTION
17% OF THE WORLD'S GNP
6% OF THE WORLD HEALTH EXPENDITURE
30% OF THE WORLD'S FOOD GRAINS
18% OF WORLD EXPORT EARNINGS
11% OF WORLD EDUCATION SPENDING
5% OF WORLD SCIENCE AND TECHNOLOGY
8% OF WORLD INDUSTRY
PICTURES tell the story of the discrepancy between the developed and the developing world today.
(UN chart)

Figure 14