INFORMATION FUNCTION IN FISHERIES DEVELOPMENT

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Summary

From a theoretical examination of the nature of development in general, and a consideration of the structure of fishery industries, an examination is made of the role of information function in the management of a fishery and in promoting its development.

INTRODUCTION

Economic development today engages the attention of a great proportion of the world's population, more than it ever did before; each country, whatever its present standing and whatever its immediate and long range objectives, is striving for development of some degree. This drive can scarcely be challenged, least of all with respect to the so-called developing countries, for in them the provision of the necessities of life and of certain amenities, even to minimal level let alone to the standard reached in certain fortunate countries, requires considerable industrial and social change. But, although the problems of development have been much written about by economists and others, there is still no infallible recipe for it. Intensive studies of development in various countries still leave us unable to say with confidence why some countries have achieved startling recovery from war damage and have maintained high level of economic expansion, whilst others have achieved results no more than disappointing, and still others seem quite unable to break the chains that bind them to a large measure of poverty. Nevertheless, a theory of development is emerging out of these studies. It treats, inter alia, of capital flow, institutional structure, balance of payments, human productivity, and the role of science and technology; and presumably this theory will eventually support an effective practice by which economic development can be decided upon, planned, and controlled. In this paper we attempt to make some contribution to that theory, with special reference to fishery industries.

Whilst we do not suggest that economic development is a simple matter, it is our conviction that its main prerequisites are information and intention; that is, that development is effected as an act of volition, illuminated by knowledge, directed by understanding. Without information developmental action will be at best ill-directed; without intention development moves, if it moves at all, only sluggishly. The two are inextricably intertwined: intention is formed on a basis of information and is reshaped as new information comes to light; at the same time, whilst some information comes by chance, the gathering and systematic reduction of information is itself a matter of intention.

We are unable to contribute to a discussion of the formation of intention, but we propose in this paper to examine some of the implications of this conviction in connection with the information function. We have set out to

This paper was first presented at a Fisheries Development Conference held at Caracas, Venezuela, 1967.

identify the information channels of fishery industries, to examine their functions, and to show that creation of these channels and facilitation of their use are essential elements of any development programme. We have at the outset to be precise about what we mean by development.

Industrial development has many faces: it consists of a multiplicity of modifications, additions and rearrangements, is brought about in many ways, takes place in a diversity of circumstances, and has a wide variety of consequences. In its multivarious aspects, development is frequently referred to as though it were

(1) the plans for it,

(2) the technical, administrative, and other activities by which it is promoted and guided,

(3) the results that flow from it,

as well as being what it is itself. We believe that the use of this term in these several ways must lead to confusion. Industrial development is a particular kind of change; namely, a progressive change in kind distinct from growth and retrogressive change, and distinct from what brought it about, or what resulted from it.*

Development planning then has special character. It does not consist in a nomination of results such as increased production, or increased earnings from exports, however desirable these might be. Development planning begins with an identification of an opportunity to bring about a change in the physical and organizational character of the industry: the prospects for the development (and for the benefits that might flow from it) depend upon the genuineness of the opportunity. Such planning therefore, implies knowledge of existing structure and function, and recognition of inadequacies and defects in them; it also implies knowledge of possible alternative structure and function. Thereafter, each step in a sequence effecting a change implies access to and the transmission of knowledge. And whilst most of the actual changes - for example, the building of boats and plant - are physical, the direction, speed, and efficiency of these physical activities are largely influenced by the effectiveness of the information network.

It is obvious that if one wishes to construct a modern trawler he must have detailed drawings showing the shape and dimensions of every part and the relations of each part with every other. It is equally obvious that the operation of such a vessel involves a variety of functional relations between its several parts, decisive role being played by various instruments and mechanisms which transmit information (such as, engine revolutions) and convey commands. Apparently, it is less obvious that one is equally in need of information if he wishes to construct an industry, or to remodel an existing one: he needs design information during construction or remodelling, and he needs to ensure the incorporation of effective information devices in the structure. We suggest that

* See Kesteven and Burdon, "Fisheries Development", in this Circular pp 25-60.

if principles can be established for the preparation of structural design for fishery industries, including the information network, we shall make a contribution to a general theory of industrial development.

In this paper we are not concerned with particular operational choices, such as of resource to bring under exploitation, of type of fishing gear to use, or of how much capital to employ, but with the conditions under which such choices can be identified and grounds established for sound decision with respect to them.

DEVELOPMENT CONSIDERED GENERALLY

Every industry is a system; that is, it is a set of components which operate in various relations with one another to perform some function; in the case of fisheries the function is to exploit living aquatic resources and to provide various products of direct and indirect use to man. Comprising both natural and human+ elements, a fishery is constantly in a state of flux, each of its characteristics undergoing some periodic (diurnal, monthly, and seasonal) change.* The fluctuations of certain characteristics are around some more or less fixed mean position, whilst those of others are around some mean position which is itself changing, either up or down. We may use the term "industrial stability" to refer to the former condition (of unchanging mean position) and "industrial change" to refer to the latter. Both these conditions can take a diversity of forms. A stable industry may have regular or irregular periodic changes; it may be stable at low or high values of characteristics such as productivity, profitability, and level of realization of its potential. Industrial change may be short term or long term, and may be progressive or regressive. Among these forms of industrial condition only that of progressive change constitutes development.

Although it is obvious that the seeds and opportunity of development lie in industry in stable condition, as does the evidence of earlier development having taken place, there are important advantages, we believe in not confusing development proper with either its antecedent or consequent. We shall seek to demonstrate these advantages by proposing a definition of development and then showing the disadvantages of less precise definition and of looser usage.

Kesteven and Burdon** defined development as "a qualitative change in the physical components of an industry, in its operational techniques or in its organizational forms, or in a combination of any or all of these". Through this definition we intended to direct attention upon the central fact of development, namely the change in structure and organization of an industry; and although we showed in our text that we thought that direction of change was implicit in our definition, we (Kesteven and Burdon) believe we should rephrase the definition, in general terms to cover this aspect, thus: Development of a system is a change of its physical components and of its organization,

+ We refer both to humans and to machines, etc.

* See Kesteven, "Diagnosis of the Condition of a Fishery" in this Circular pp 7-24. ** "Fisheries Development", in this Circular pp 25-60.

erally increasing its complexity, which gives the system greater competence, acity and efficiency for discharge of its function."

Thus, from the foregoing discussion development is:

(1) change, out of stable state into stable state regardless of the duration of those states;

(2) change, in the direction of improvement (see below as to the criteria of improvement);

(3) change in the system itself; essentially it is a structural and/or organizational change of the system;

(4) not (a) that out of which it takes place, nor
(b) that which brings it about, nor
(c) that which results from it, not even the changes in system characteristic, such as productivity, by which its effectiveness may be signified.

This view of development has a number of important results. First, it ords some economy, because it helps us avoid a waste of time which must ur if we direct our attention solely upon the benefits we expect to have in consequences of development. To effect development we must know the icture and the organization of industry in stable state, its potential for ter performance and the ways in which that potential may be released. The efits of greater productivity may be the starting point for development ewhere in the economy; and the prospect of such benefit may be the induce- t to undertake development, but they do not offer an operating base. The isions as to which changes can be made in an industry, and as to which nges should be made to achieve specified results, must be based on the dis- lines concerned with the structure and operation of fishery systems, that on fisheries biology, gear technology, naval architecture, food technology, economics (which hang loosely together as fisheries science). These disci- nes are separate from those concerned, on one hand, with judging the need fishery development in the total economic context and with allocating dev- omental resources and responsibility, and on the other hand, with accommo- ing the consequences of fishery development.

Moreover this concept of development emphasizes that, at least in the case industry, an opposition of "developed" to "underdeveloped" has no real ning, for industrial development has no fixed term or end-point: that which said to be developed can be developed still further, whereas no country ch is said to be underdeveloped is in fact without some history of develop- t. Every existing industry is "developed" in some fashion and yet at the e time, being capable of further development, is also "underdeveloped" in e degree. In other words, there is no state or condition of being absol- ly and finally developed.

This view of development places emphasis on increase in competence: it s that development brings an increase in an industry's ability to accomp- n its industrial task; generally this results in improved quality of out- , or a change in kind of output, or a rise in efficiency of operation, and

in general the last should be a change toward increased human productivity.

Since development is almost invariably accompanied by an increase in size, a change in magnitude is often mistaken for development because it is so obvious. Increase in size, however, is either a result or a precursor of development proper; in the latter case it induces changes in organizational form and in managerial practices, leading (in accountant's terms) to a spread of overhead. If increase in size takes place without development, disorder is inevitable and in real terms there will be retrogression.

Thus, in any general discussion of development we can distinguish between

(1) development proper, in respect of its

  (a) nature (that is, which kind of resource, which industrial sector),

  (b) degree,

  (c) mode (what kind of component or organization change),

  (d) timing,

  (e) pace;

(2) promotion and implementation of development, in respect of

  (a) agency - Govermental (public) or private sector,

  (b) method - financial, educational,

  (c) incentive;

(3) consequences of development, manifested

  (a) within the industry itself, as change in productivity, in profitability, and/or in conditions of work,

  (b) in output, as to kind, quantity, quality, and value of product,

  (c) in the economy generally,

  (d) in the community.

In fisheries there are three principal categories of developmental opportunity:

(1) to create industry

  (a) where a resource is not being exploited,

  (b) where a new product can be made;

(2) to expand industry

  (a) where a resource is being exploited, but not to the full,

(b) where landed catch is incompletely utilized;

(3) to increase the productivity of industry

where return per unit input and efficiency can be increased.

Development may take place haphazardly, or, at the other extreme, in controlled fashion according to strict plan; obviously there can be intermediate stages or forms of such developmental patterns. However, whichever pattern is adopted, government has some kind of role to play, and has opportunity of influencing (1) timing, (2) pace, (3) direction of development, and (4) the level of productivity or of efficiency to which development is to bring the industry.

At each stage in developmental sequence there will usually be a number of options with, often, very little to choose between alternative options. However, there will also be good reason for rejecting certain of the offered options, and the exercise of choice can be made only on the basis of effective information. Since government operates essentially through an information function, its primary task in respect of development is to draw together the fullest possible array of information relevant to the developmental situation. Making this information available through advisory and other services, government can guide the decisions to be made, and assist in their implementation. Government's role in this matter is scarcely distinguishable from that of management within industry, but this similarity merely reinforces the case we wish to present with regard to the importance of the information function.

Thus in this view of development the starting point must be the structure of industry with respect particularly to its information function.

INDUSTRIAL STRUCTURE

All fisheries are based on living aquatic resources existing as unit stocks. Many of the particular features of fisheries (of which there is some discussion in Section "Information Function") flow from the natural characteristics and the legal status of these stocks.

The basic industrial unit is a unit fishery (see Fig. 1) which is a more or less homogeneous set of fishing units engaged in the exploitation of one or more unit stocks. Whilst the output of a unit fishery at any unit of time is largely a function of the number and efficiency of the fishing units exploiting its resource, the upper limit of production in a space of time is set by the natural characteristics of the unit stock. It is possible that man will be able in the future to intervene in these unit stocks so as to change their location, their magnitude and their productivity, but the essential relation between unit fishery and unit stock will remain, and it will continue to be true that the operations of a unit fishery will be largely determined by characteristics of the unit stock.

The primary operating unit of all fisheries is a fishing unit, a set of equipment (generally boat and gear) which, with its manpower is able to operate autonomously as an independent economic entity. The counterparts in other

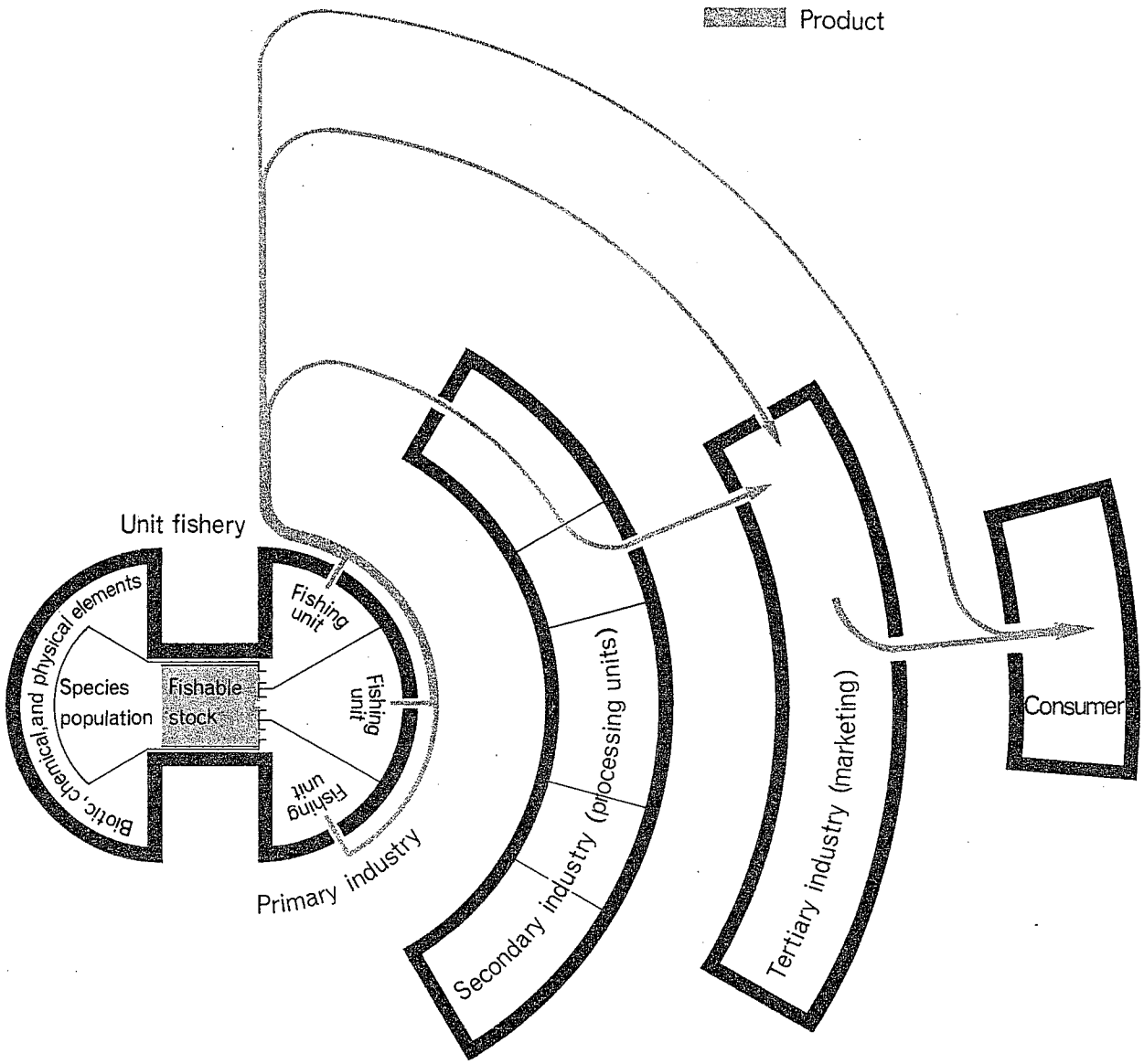

Fig. 1.- Industrial structure.

sectors of the industry are processing units (such as canneries and meal plants), and markets, wholesale establishments, and storage plants. Thus, a fishery is composed of a number of operating units, each of which consists of equipment and manpower, and these are organized in industrial sectors (again, see Fig. 1). The fishing units, of primary sector, are engaged in exploitation of natural resource; the processing units, in secondary industry, are engaged in converting the fish as caught into some other form; and the selling and other units, in tertiary industry, are engaged in transporting, storing, and selling the products. The whole of this organization operates for utilization of aquatic resources; some of the harvest reaches the consumer in processed form by way of secondary industry, whilst other part moves directly from primary sector to tertiary sector and on to the consumer. Some small proportion of total catch is sold direct by fishermen to consumer, bypassing both secondary and tertiary sectors (see the indication of product flow in Fig. 1).

Whilst each operating unit functions within one of the three sectors according to the operation it performs and the kind of equipment it employs, the units are not a loose unconnected agglomeration within each sector, but instead, in this (as in other industries) there is some measure of horizontal and vertical integration.

There is, of course, a basic integration of components within each production unit. This is most clearly demonstrable in the case of canneries, in which different types of equipment are organized in production line so as to perform a set of operations in sequence (see Fig. 2 detail). In a production line the separate components are present in such number with such capacity and operating at such pace as to permit continuous, uninterrupted flow of material through the system. A production line being designed for a particular capacity, management's objective is to ensure that that capacity is fully used for the largest possible proportion of time. To achieve this objective, management has to ensure continued adequate supply of raw material at the beginning of the production line and the continued efficient operation of each of the components of that line. For this purpose management must have an efficient information service through which to be informed of movements in raw material supply and of the current progress of operations. A co-ordinated production line thus implies structural and functional balance between the operating components, and constant and effective information flow.

The units of one sector may be organized into groups within the sector, for example, the fishing units may be organized into integral operating fleets. Similarly at secondary level, canneries, meal plants and other operating units may belong to a corporation and operate in integral fashion. Again, there can be common ownership of units in two or even three sectors and management and direction of operations so as to achieve across the three sectors the same effect as that which is achieved in a cannery production line. One other form of integration must be taken note of; namely, the industrial associations of fishermen, fleet owners, cannery operators, wholesalers, and others.

Over and above all these forms of integration, there stands government, which, in accordance with policy, exercises various functions to ensure that industry operates within prevailing law and toward the achievement of various

objectives, such as with regard to gross national product. These forms of integration are not, however, of the physical and geometric kind one sees in the integration of the structural members of an office building, that is to say, a fishing boat is not physically connected to the cannery plant. Instead, the connections of which we speak here are those of management which are in essence the information function.

INFORMATION FUNCTION

The diagrams by which we represent the structure of industry are illustrative essentially of this information function. This illustration is achieved in Figures 2 to 3 by the use of two categories of symbol which we must now take time to explain. The first category of symbol represents control systems, the second represents kinds of information.

Control systems are represented by the Chinese symbol of Yin and Yang. The control system is the site of decision function, that is, it is the place where decisions are made as to the equipment to be used (capitalization) and the operations to be performed. These decisions may be as to where and when things are to be done, how they are to be done, with what speed, and what result is to be sought.

The control systems stand at various levels with regard to the industry as a whole and as to its several sectors and operating units. We assume that the overall strategy of operation of an industry is decided upon, with varying degree of co-ordination, both in government and in industry itself. On the part of government this decision is made with respect to national policy. In industry the decision is made, at least in capitalist societies, with respect to the prospect of sale and profit, but even where profit motive is the determinant, the strategy is really concerned with the overall prospect of putting the assigned equipment and manpower to best use, on the one hand to exploit the resource and manipulate the raw materials, and on the other hand to satisfy a consumer demand.

In our diagram we have labelled the levels of decision as C1, C2, C3, etc. Through this device we seek to represent that a controller at one level, say at C2, makes decisions in the light of data and advice furnished him at his level, and of directives handed down from the level above, and that he issues directives and/or advice to the level below. Because of the complexity of real situations it is impossible to represent all the modes of control system for any sector in these diagrams; the single symbol C2, for example in Figure 3, may stand for the manager of the secondary sector of a situation where there is in fact only one manager, or it may stand for the corporate intelligence of all the managers where there are many separate and independent units in that sector; it also represents the situation of corporate intelligence assembled in industrial association.

We have represented three different types of informational transfer by the colours green, brown, and blue. The green line represents data, i.e. recorded fact and the early stages of manipulation of record. By the term "advice" we signify the passing on of some interpretation of data, whereas by the term

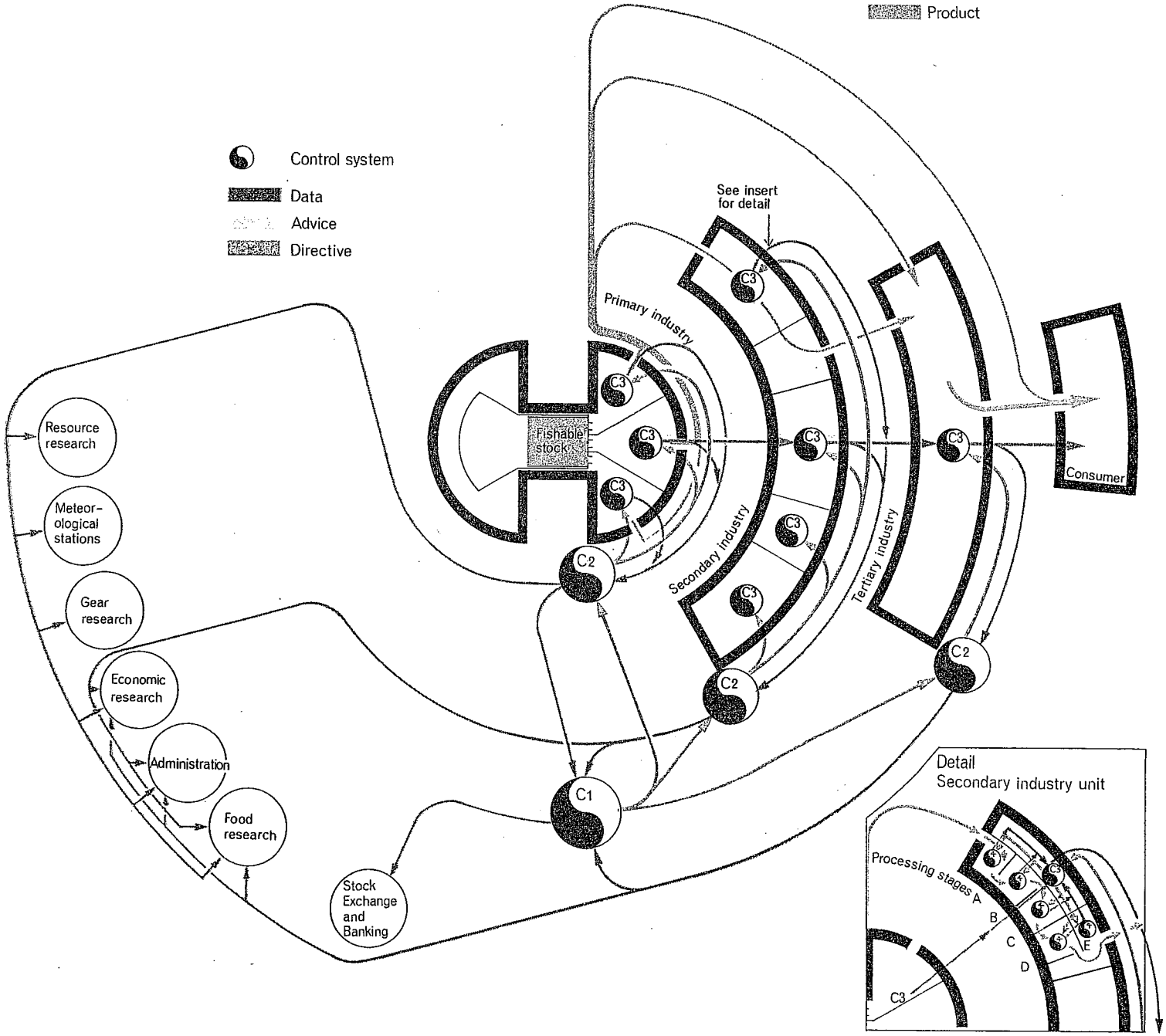

Fig. 2.- Information function in industrial structure.

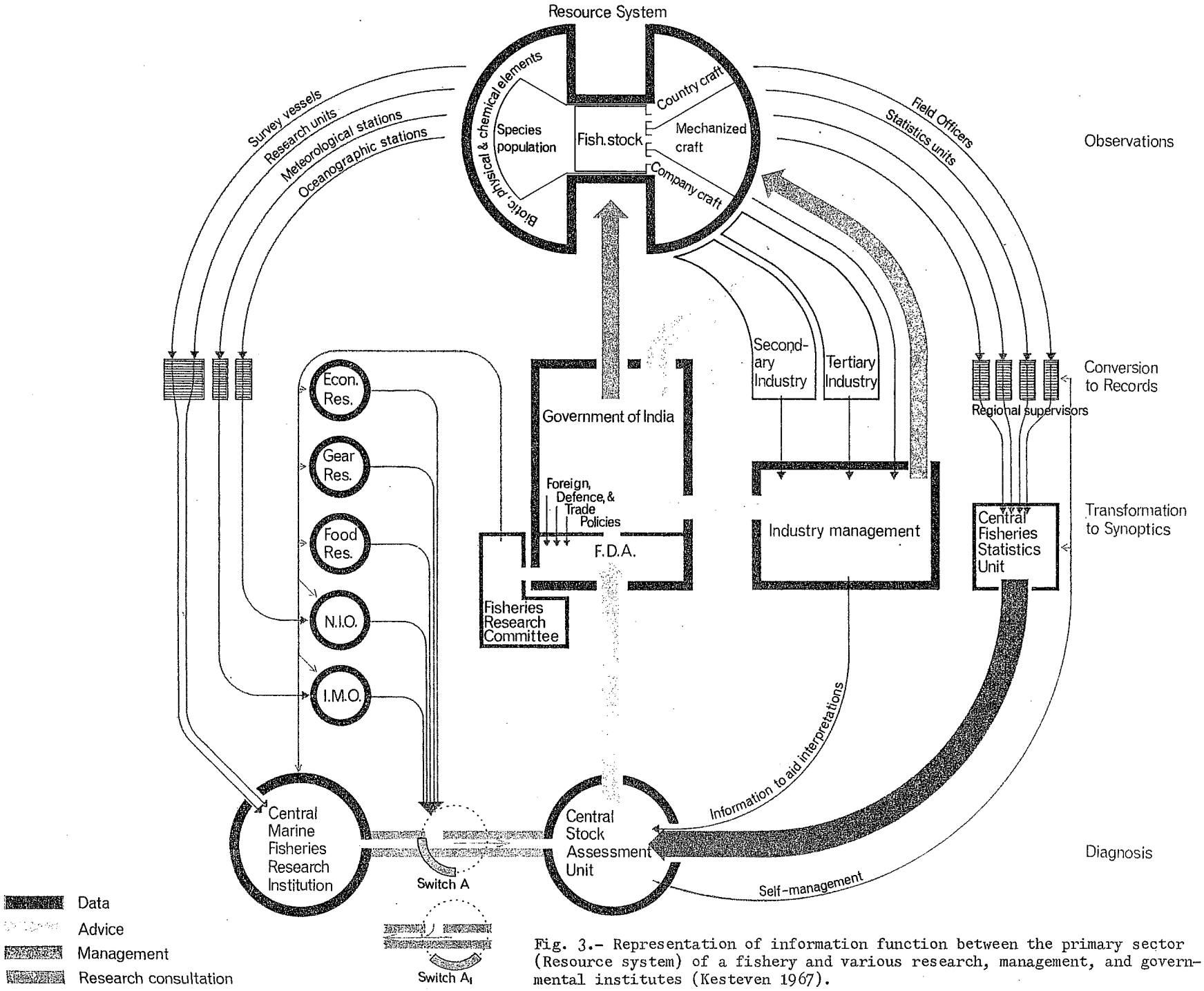

Fig. 3.- Representation of information function between the primary sector (Resource system) of a fishery and various research, management, and governmental institutes (Kesteven 1967).

"directive" we signify the passing on of an instruction to act in a certain way, which presumably also is based on data.

The data represented in this diagram are basically the input of the informational services. This input may come as industrial record, as administrative record, as the automatic recording of services such as meteorological bureaus, or as the result of scientific investigations. One of the matters with which we are deeply concerned is the setting up of apparatus for obtaining data.

The raw data must then be transformed. In the first phase there are elementary steps of tabulation and of reduction to appropriate synoptic form since information is often better conveyed by, for example, a mean figure than a set of raw observations. The synoptics, however, must then be submitted to diagnosis in accordance with the prescribed rules, and from this diagnosis a prognosis is made as to the likely course of events. The consequence of prognosis is then transmitted as advice or directive.

Information Function for the Primary Sector

Some special arrangements for information function for primary industry are represented in Figure 3 which is taken from a report to the Government of India (Kesteven 1967*).

This diagram is a representation of informational relations between the primary sector (resources system) of a fishery and various research, management, and Governmental institutions. It is not intended to represent administrative structure although doubtless it has implications in that sense. The diagram has been drawn expressly with a view to the Indian situation, and although it does not presume to be entirely complete (in fact certain items are expressly omitted), it probably contains all elements that need at this stage to be considered. In particular it should be noted that the diagram carries no representation of Governmental institutions of the several States that have a seaboard; it presumes that appropriate arrangements will be made through the Fisheries Development Adviser (FDA) for contributions to the operation of the system by the State institutions.

The diagram is based on a concept of a resource system model constructed by a fisheries research institution and to be used by a Continuing Resources Survey (CRS).

The resource system (or unit fishery) is represented as a species population in its environment and subject to the operations of a number of fishing units. The species population is surrounded by biotic, physical, and chemical elements. One part of the species population, the fishable stock, is marked off, as subject to exploitation by the industry which itself in some sense shares the environment of the species population.

* Kesteven, G.L. (1967).—Colombo Plan fishery resources research, India. Report to Government of India. CSIRO Aust. Div. Fish. Oceanogr. Rep. 41.

The CRS is represented essentially by the outer circuit, on the right-hand side of the diagram, from the field officers (at top right) who make observations, through regional supervisors and a central fisheries statistics unit, to a central stock assessment unit.

The field officers of the statistics unit are engaged in making observations and measurements of certain attributes of the primary industry and its resources system. The set of attributes to be observed and the programme of observation (specification of time/space cells and of order of accuracy) are determined by the research institution's model. These field officers should be grouped into regional teams.

Each regional team should be managed by a regional supervisor who should have responsibility for directing the work of the field officers. It should be his responsibility to ensure that the field officers carry out their observational programme in accordance with the rules provided. With the assistance of suitable clerical staff the regional supervisor would receive the data sheets from the field officers, edit these and submit them to quality control, and make a conversion of them to suitable record form for transcription into computer operations.

The records would then pass from the regional supervisors to the central fisheries statistics unit which would be responsible for reduction of the data to suitable tabular form and for their transformation into designated synoptics. In this work the statistics unit would make use of computer equipment.

The tabulated data and synoptics would then pass to the central stock assessment unit where the synoptics would be submitted to the diagnostic rules appropriate to the model furnished by the research institution. Diagnosis would take into consideration the information drawn directly from industry through industry management. It would also, and still in accordance with the diagnostic rules furnished, make use of information drawn from the research institutions shown on the left. In the Indian situation the major contributor of such information would be the Central Marine Fisheries Research Institute, transmitting the results of the operation of survey vessels and research units. The National Institute of Oceanography and the Indian Meteorological Office would furnish environmental information, whereas units concerned with economic research, gear research, and food research would furnish information concerning the operation of the industry generally.

The switch A is intended to represent that the stock assessment unit would operate in routine fashion on these several sets of data within the terms of the model furnished by the research institution, but that in the event of the resource system behaving outside the predictive range of the model, the research institution would then be placed in relation with the stock assessment unit so as to permit of a review of the model. In such a novel situation the entire research apparatus would, with the stock assessment unit, make a review of all data and examine whether the schedule of attributes to be observed and the rules of observation should be modified in any way, and similarly whether modification should be made of the synoptics and of the diagnostic rules.

The attributes to be observed are identified by the research institution, and the usefulness of the selected array of attributes and of the synoptics drawn from them depends very largely on the degree to which the institution's model has been developed. Initially, under prospecting conditions the attributes are essentially presence or absence of various species. Later, catch and effort are the principal attributes. Still later, species, size, and age compositions of catch are critical attributes. The synoptics drawn from the date of these attributes are of the form c/g, $\bar{l}$, and $\bar{t}$. The diagnostic rules are those furnished by yield isopleth diagrams and similar schemes. The models that specify these attributes and synoptics are chiefly those of Beverton and Holt and of Schaeffer.

The stock assessment unit would report the results of its assessment to the Fisheries Development Adviser who, as part of the Government of India, would pass information and advice to industry management and to secondary and tertiary industry. Government of India also would, through the Fishery Development Adviser, take this information into consideration in its work in promoting changes of the industry and in its management activities. Finally, the information from the stock assessment unit would be communicated to the research establishments through the Fisheries Research Committee. This channel of communication would serve in influencing the programme-forming and direction activities of these institutions. One other managerial line has to be noted: namely that the activities of the field staff, regional supervisors, and the central fisheries statistics unit will be controlled by the central stock assessment unit in the light of evidence on the operation of the CRS.

The system represented in Figure 3 has been described above chiefly in respect of its operation for an established industry, and, moreover, as though for stable industry. However, its principles hold for all industrial conditions. (We ignore the possible case of a country without any fishery industry whatsoever.)

In the case that an industry is to be created for exploitation of an as yet totally neglected resource there are, of course, no fishing units (in the resource system), and no flow of information along the green line to the right; also there is to begin with no flow of managerial directive. We assume that the Governmental services represented on the left of the diagram are in operation and are gathering information which, after interpretation, is transmitted to industry management and to government services for the promotion of development. This information will relate initially to the location and dimensions of the resource and soon will include (1) technological advice on fishing gear and methods and on the methods of handling and disposing of the catch, and (2) economic advice on costs, prices, and markets. As these kinds of information and advice become available the full informational network represented in Figure 2 should develop.

As soon as commercial operations begin the information system represented on the right of Figure 3 should be initiated so that the results of these operations should contribute to the body of knowledge about the resource and its response to exploitation. As the fishery moves toward stability this total service will accumulate information on the distribution patterns of the

resource, on its behaviour (especially in response to fishing gear), and on its yield characteristics; development of the industry will come from application of this information. The service should then furnish information on which an appropriate regime of fishing may be formulated. If and when stability is achieved in full exploitation of the resource the function of the service is to maintain a watch for undesirable changes. The service represented on the right of the diagram will register effects being produced in the resource system, and, if all goes well, will detect such effects whilst they are still incipient so that appropriate measures can be adopted to deal with them. The system represented to the left of the diagram, concerned with the processes of the resource system (as opposed to the results of those processes), may be able to detect changes in those processes which will have undesirable effects; for example, it might detect a progressive change in success of recruitment, or increase in average fishing power of the fishing units. Again, such information may serve as basis for measures to prevent the onset of undesirable conditions.

FORMATION OF INFORMATION SERVICES FOR FISHERIES DEVELOPMENT

The nature of information services for any industry must conform with the structural and functional characteristics of the industry concerned. In the case of fisheries these characteristics are summarized in the following statement from Kesteven and Burdon*:

"(1) The natural resource is living and renewable, but (2) with the exception of the still relatively small section concerned with culture, the bulk of the resources are wild and to these man makes no contributions such as are made in agriculture by ploughing, sowing, and so forth.

(3) Because the resources are wild, man cannot control what is to be available for harvesting at any time and his best course of action is to predict (from studies of the resource and its habitat) what will be available and to control exploitation to make the best use of this.

(4) These resources are generally public property and to a large extent international. Because of this, the exploitation of these resources becomes a matter of uncontrolled competition unless means are found, by agreement between the fishermen or by regulation imposed by Government, to ensure that operations are carried out according to some rational plan. Because of this situation, governments have, at least in the primary sector of the industry, a more direct and continuing participation than they would normally accept for other industries.

(5) Fishing itself is a hazardous occupation calling for special skills and equipment. The circumstances of operation, which include a high degree of isolation when danger is most pressing

*See Kesteven and Burdon, "Fisheries Development, in this Circular pp 25-60.

encourages an extreme individualism. Two-way radio may reduce but it can never remove this isolation. The risks in the primary sector are such that Government generally concern themselves deeply in matters relating to the fitness of equipment and the competence of personnel. They also maintain special rescue services for sea-going personnel.

(6) Fishing is an irregular, intermittent occupation which is largely dependent on the weather. But even when this is favourable the fish must be located and be vulnerable to capture, and the gear must be successfully operated, before the catch is secured. In consequence catches, fishermen's income, and market supplies are subject to marked uncertainty.

(7) Fish is a highly perishable commodity which is difficult to handle. The agents of spoilage, which are numerous, are difficult to control. Moreover, because fish is a wet commodity consisting of discrete units of various sizes and shapes, its handling presents special technical problems which are particularly acute in respect of refrigeration and processing.

(8) The problems in handling, storing, and processing are aggravated by the uncertainty of supply. Fishermen cannot give any assurances of when they will make their catches nor of the quantity of fish they will land. Constant supply to processing plants is rarely possible and most fisheries must be organized for "seasons" which in some cases are short but with a heavy supply."

The conduct of an industry with characteristics such as the foregoing obviously calls for the maintenance of a closely integrated and efficient information network and a fishery development plan must have provision for the creation of such a network, in addition to its own reliance on and use of information. The principle of production line co-ordination so well-developed in secondary industry holds, at least as ideal, for an entire industry, as represented in Figure 3. Structural (physical) balance of the industry should be based, primarily, on the yield capacity of the resource, although, at the same time the capacity of the primary sector should not exceed the use-limits of the markets.

These characteristics have the following consequence with respect to the information function.

(a) Because of item (3), and considering items (1) and (2), the dimensions of a fishery (or of a group of fisheries) exploiting a resource are set by the dimensions of the resource and the exploitative characteristics of the fishery. It follows that knowledge of the resource is a prime necessity for any development.

(b) Because of item (4) (and again reverting to earlier items) resources information must be common property and its

acquisition must be a charge upon the community.

(c) Because of item (5) the industry requires an effective system for transmission of warnings about hazards and for reception of distress signals.

(d) Because of item (6), aggravated by item (7), and enhanced to some degree by item (5), the industry requires an effective system for transmission of information about quantities (and kinds) of supply and should have arrangements to adjust its operations to accommodate fluctuations in supply.

Together, these characteristics mean that fisheries are "risk" industries. To some degree, under-use of equipment, waste of effort, and spoilage of product are inevitable; the most direct means to their reduction is by the development of the information function.

In theory, even if it cannot be so arranged in practice, these consequences mean that fully effective exploitation of a resource can be achieved only by a total integration, horizontally and vertically, of its industry.

We hope that the diagrams of this paper will enable the reader to see the systems, relations, and events of fishery systems in a single span. To do so is essential for a grasp of the significance of horizontal and vertical integration, as a matter not of ownership, but of information - structurally and dynamically.

SUMMARY

The thesis of this paper is that since the organization and conduct of a fishery (as of any industry) is largely a matter of information, the creation and putting-into-use of an effective information network must be a principal element of a fishery-development plan. It is further argued that fisheries have special characteristics that give added importance to the industrial information function. The argument is developed along the following lines:

1. An industry can be in a condition of stability or of change, and each of these conditions can have various forms and values.

2. Development is one of the forms of industrial change and is defined in this paper as: "Development of a system is a change of its physical components and of its organization, generally increasing its complexity which gives the system greater competence, capacity, and efficiency for discharge of its function."

3. This definition of development identifies a particular kind and direction of change, to be distinguished from simple growth and from regression, from that out of which it took place, from that which caused it, and from its own results.

4. Fisheries are based on living aquatic resources and the principal structural and dynamic features of each fishery are consequences of the characteristics of the resource exploited.

5. Operations in fisheries are conducted by operating units distinctive of each of the separate sectors of the industry, thus of fishing units in primary sector, processing units in secondary sector, and of handling, storing, transporting, and selling units in tertiary sector.

6. The conduct of these operations is effected through a flow of information, horizontally within each sector, and vertically between sectors.

7. The development of an industry, and its subsequent efficient operation, are dependent to a large degree on the effective organization and use of an information network.

8. Creation and use of the information network is of especial importance in the primary sector because of the natural characteristics and legal status of the resource and of the circumstances under which fishing must be conducted.

9. The information network for the primary sector must include research units able to provide information of the resource and to give advice on fishing regimes. The information from these units must be available to all fishermen, and all fishing operations must accord with principles enunciated on the basis of this information.

10. The structure of fishery industries and the nature of the information network are represented in this paper by symbolic diagrams which enable one to grasp in one view the intricacies of these features and the significance of informational integration, both horizontal and vertical.