Questions of Strategy in Fishery Management and Development[1]

B. J. ROTHSCHILD

National Oceanic and Atmospheric Administration
U.S. National Marine Fisheries Service
La Jolla, Calif. 92037, USA

ROTHSCHILD, B. J. 1973. Questions of strategy in fishery management and development. J. Fish. Res. Board Can. 30: 2017–2030.

Fishery management draws on the fields of management in general, development, and fishery management. To make significant advancements in fishery management we need to invest in institutions that are capable of asking the right questions, to develop efficient means of making the proper decisions in respect to these questions, and most importantly, to develop the capability to effect actions which will facilitate these decisions.

We need to consider the complexity of the decision environment, and to have techniques for handling this complexity by insisting on analysis rather than intuition and on treating the fishery development problem as a system. The multiple-objectives problem needs to be grasped, and the questions of population dynamics need to be recast to explain departures from the existing simple models. We should consider in more detail the mathematics of programming theory. The most striking concept offered in this paper is that fishery management and development seem to be more preoccupied with tactics than with strategy.

The first concept of fishery management involves the complexity of the decision environment, resulting from increasing technological capability, the rising number of international differences, increasing communication among states, and the aspirations of developing countries.

The second is that because of these complexities more careful judgements must be made, and the scientific method employed more rigorously, including the use of systems analysis.

This requires that we view fisheries as systems, with resource problems separate from biological problems.

The fourth concept is that a broader view must be taken of the management process itself, which must be reviewed as a system. Further, management must appreciate biological, social, economic, and political objectives, and their complex interrelations. Many fisheries are said to be overcapitalized, but there have been few if any computations of optimal capital budgets, and little practical advice on strategies that can be followed by entrepreneurs. Economic objectives must be integrated into all the other objectives.

Biological questions relate to stock and recruitment, yield per recruit, and relation between catch and effort. The phenomena related to these processes are not sufficiently understood to produce predictions useful for management purposes. Some of the models used up to now are outmoded, mostly because they tell us how much can be caught from a single stock, while many stocks may be under exploitation simultaneously. Further, they do not face the major problem in fishery management — that of dividing the catch among those who wish to participate in the harvest. Divisions currently made do not always make sense from the economic or social point of view, and sometimes do not make biological sense. As an index of "sense" we might consider the benefits that could be accrued from a resource if it were owned by a single individual.

The mathematics of modelling for allocation of the catch is easy but the philosophical question of how to evaluate the various elements of the fishing process is not clear. Yet mathematical treatment allows a sharper focus of the problems, and allows us to look at a broader set of decision questions.

The sixth concept is that we need to achieve a simplification of our system. The most important simplification is to partition the problems into those that involve strategy, those that involve tactics, and those that involve operations. For development we wish to maximize the efficiency with which we transform resources into utility. There has been a general disappointment in the performance of development in recent years, and it is clear that economic criteria alone are not suitable for guiding development policy. Social welfare must also be integrated into the system.

To create a favorable environment for strategic decision-making it is necessary to have institutions that consider this problem in an explicit way; of particular relevance is the applied research institution to develop strategy.

[1]Prepared for the "Technical Conference on Fishery Management and Development," of the Food and Agriculture Organization of the United Nations, held at Vancouver, B.C., Canada, February 13–23, 1973.

Printed in Canada (2911)

L'aménagement des pêches fait appel aux techniques de la gestion en général, du développement et de l'aménagement du secteur halieutique. Si l'on veut accomplir des progrès notables dans l'aménagement des pêches, il faut investir dans des institutions capables de poser les questions appropriées, mettre au point des moyens efficaces permettant de prendre les décisions nécessaires en réponse à ces questions, et par dessus tout, offrir la possibilité d'appliquer des mesures qui faciliteront ces décisions.

Nous devons envisager dans toute sa complexité le contexte dans lequel les décisions doivent être prises et disposer de techniques permettant de le faire en ayant recours plus à l'analyse qu'à l'intuition et en considérant les problèmes du développement halieutique comme un système. Le problème – qui présente des facettes multiples – doit être cerné et les questions liées à la dynamique des populations doivent être réexaminés afin d'expliquer les divergences par rapport aux modèles simples existants. Nous devons examiner de plus près l'aspect mathématique de la théorie de la programmation. La notion la plus intéressante exposée dans ce document est que l'aménagement et le développement des pêches semblent se soucier d'avantage de tactique que de stratégie.

L'aménagement des pêches est caractérisé en premier lieu par la complexité du cadre de décision—complexité due à l'accroissement des possibilités technologiques, aux différences internationales toujours plus nombreuses, à une communication accrue entre les Etats et aux aspirations des pays en voie de développement.

Il est également nécessaire, en raison d'une telle complexité, de formuler des jugements plus approfondis et d'appliquer de façon plus rigoureuse les méthodes scientifiques, notamment l'analyse des systèmes.

Pour cela, il faut que nous envisagions les pêcheries comme des systèmes, où les problèmes relatifs aux ressources sont distincts des problèmes biologiques.

La quatrième notion essentielle est qu'il faut considérer dans une perspective plus vaste le processus d'aménagement proprement dit et le concevoir comme un système. En outre, l'aménagement doit tenir compte des objectifs biologiques, sociaux, économiques et politiques et de leurs corrélations complexes. On prétend que de nombreuses pêcheries sont suréquipées, mais il n'existe pratiquement pas d'estimations sur le niveau optimal des budgets d'investissement et l'on dispose de peu de connaissances pratiques sur les stratégies que peuvent suivre les entrepreneurs. Il faut intégrer les objectifs économiques dans tous les autres objectifs. Les questions biologiques touchent les stocks et le recrutement; le rendement par recrue, et le rapport entre les prises et l'effort de pêche. Les phénomènes relatifs à ces processus ne sont pas suffisamment compris pour que l'on puisse formuler des prévisions utiles aux fins de l'aménagement. Certains des modèles utilisés jusqu'à présent sont dépassés, surtout parce qu'ils indiquent uniquement la quantité pouvant être prélevée dans un seul stock, alors que plusieurs stocks peuvent être exploités simultanément. En outre, ils ne résolvent pas le problème essentiel de l'aménagement des pêches – à savoir répartir les prises parmi les pays qui souhaitent participer à la pêcherie. Les répartitions actuelles ne sont pas toujours rationnelles du point de vue économique ou social, et parfois même du point de vue biologique. On peut considérer comme critère de rationalité les bénéfices pouvant être retirés d'une ressource si elle était possédée par une seule personne.

L'aspect mathématique des modèles pouvant servir à la répartition des prises est aisé, mais le problème théorique posé par l'évaluation des différents éléments du processus de pêche n'est pas clair. Cependant, le traitement mathématique permet de mieux définir les problèmes et d'envisager un éventail plus vaste de questions appelant des décisions.

Le sixième principe régissant l'aménagement des pêches est qu'il faut simplifier notre système. La simplification la plus importante consiste à classer les problèmes selon qu'ils nécessitent la mise en oeuvre d'une stratégie, d'une tactique ou d'opérations. En matière de développement, nous souhaitons transformer de la façon la plus efficace possible les ressources à des fins utiles. D'une façon générale, les progrès ont été décevants au cours des dernières années et il apparaît clairement que les critères économiques ne suffisent pas pour orienter une politique du développement. Des mesures de caractère social doivent également être intégrées au système.

Pour créer un cadre favorable à la prise de décisions stratégiques, il est nécessaire de disposer d'institution capables d'envisager ce problème de façon lucide; les instituts de recherche appliquée sont particulièrement désignés pour mettre au point les stratégies nécessaires.

La regulación del sector pesquero incluye aspectos generales de reglamentación, explotación y regulación específicamente pesqueros. Para lograr progresos significativos en la regulación del sector de pesca es necesario suministrar fondos a instituciones que sean capaces de plantear los problemas adecuados, preparar medios eficientes para tomar decisiones oportunas sobre estos problemas, y sobre todo, estar en condiciones de intervenir en la forma necesaria para facilitar estas decisiones.

Hemos de tener en cuenta la complejidad del proceso de decisión y contar con técnicas para abordar esta complejidad insistiendo en el análisis más que en la intuición y tratando el problema de desarrollo del sector pesquero como un sistema. Es necesario captar el problema de la multiplicidad de objetivos, y reformular los problemas de la dinámica de las poblaciones para explicar la falta de coincidencia con los modelos sencillos actualmente existentes. Hemos de examinar con más detalle la matemática de la teoría de programación. El concepto más sorprendente que presenta este documento es que la ordenación y desarrollo pesqueros parecen ocuparse más de tácticas que de estrategia.

El aspecto más immediato de la regulación del sector de pesca es el relativo a la complejidad del proceso de decisión, debido al aumento de la capacidad technológica, el creciente número de diferencias internacionales, a la communicación que existe entre los estados y las aspiraciones de los países en desarrollo.

El segundo aspecto es que, a causa de esta complejidad, es preciso ser más cautos a la hora de emitir juicios, utilizando con más rigor el método científico, especialmente el análisis de sistemas.

Para ésto es necesario considerar las pesquerías como sistemas, en los que los problemas relativos a lo recursos se diferencian de los problemas biológicos.

En cuarto lugar, es preciso tener una perspectiva más amplia del proceso de regulación, que debe examinarse como un sistema. Además, en la regulación hay que tener en cuenta los objetivos biológicos, sociales económicos y políticos, y la compleja interrelación de los mismos.

Se dice que en muchas pesquerías hay un exceso de capitalización, pero son pocos o ninguno los cálculos que se han hecho, del presupuesto óptimo de capital y apenas existen consejos prácticos sobre estrategia a los que pueden ajustarse los empresarios. Los objetivos económicos deben integrarse en todos los demás objetivos.

Los problemas biológicos se refieren a poblaciones y reclutamiento, rendimiento por recluta, y relación entre captura y esfuerzo. Los fenómenos relativos a estos procesos no se entienden lo suficiente para preparar pronósticar que sean útiles a efectos de regulación. Algunos de los modelos usados hasta la fecha han quedado anticuados, la mayoría de ellos porque no dicen cuánto se puede capturar de una población, cuando se pueden explotar simultáneamente varias poblaciones. Además no tienen en cuenta el problema principal de la regulación del sector pesquero: la división de las capturas entre quienes desean participar en la explotación. Las distribuciones que actualmente se hacen, no siempre tienen sentido desde el punto de vista económico o social, y a veces ni siquiera desde el punto de vista biológico. Se puede considerar como criterio racional los beneficios que podrían obtenerse de un recurso si fuera propiedad de un individuo.

Los principios matemáticos en preparación de modelos para la distribución de capturas son fáciles pero el problema teórico de cómo evaluar los diversos elementos del procesco de pesca no esta claro. De todas formas, el proceso matemático permite enfocar más claramente el problema y percibir una gama más amplia de problemas relacionados con la decision.

El sexto punto es que necesitamos simplificar nuestro sistema. La simplificación más importante es dividir los problemas en tres tipos: de carácter estratégico, de carácter táctico y de carácter operativo. Con el desarrollo, lo que queremos es transformar con máxima eficiencia los recursos en algo útil. En los últimos años se ha producido una desilusión general por los resultados del desarrollo, y es evidente que los criterios económicos por sí solos no son adecuados para guiar una política de desarrollo. Es preciso integrar también en el sistema todos los aspectos de previsión social.

Para crear un medio ambiente favorable para tomar una decisión estratégica es necesario contar con instituciones que examinen este problema en forma explícita. Especialmente importante es una institución de investigaciones aplicadas para preparar una estrategia.

In Oddity Land

They're a rather peculiarly mixed up band . . .
I wish you'd remind me to bring them around
We'd all sit about on the floor and the ground
And talk about this and talk about that
Until we had a Very Nice Chat.
We might try to see if we can't agree
On whether there's too much salt in the sea . . .

In Oddity Land dogs ride on merry-go-rounds
This is a merry-go-round.

But if I keep chattering this way
I'll completely forget that I set out to say . . .[2]

that the purpose of this paper is to explore the extent to which the subject of fishery management and development resides in Oddity Land. The discussion relies to some extent on the tenets of system analysis as set forth by Churchman (1968).

The subject of fishery management and development requires definition. It draws upon the disciplines of management in general, development, and fishery management. The thesis explored is that to make significant advances in fishery management and development we need to concern ourselves with constructing and investing in institutions that are capable of asking the right questions in the area of resource management and development; developing the most efficient means for making proper decisions relevant to these questions; and, perhaps most of all, developing the capability to carry out activities which will facilitate these decisions.

When questions concerning fishery management are phrased in terms of population dynamics or economics, or are given as descriptions of the status quo, the questions are stated but frequently explicit attacks are not made on the strategy in fishery management and development. The thesis in this paper is that such an attack is needed. I have assembled a collection of concepts leading to considerations that can be useful when working out a strategy for fishery management and development.

These concepts have relatively little to do with the traditional view of fishery biology or fishery economics (these will, I am sure, be dealt with adequately by other speakers). They deal with the general problem of what kinds of things we need to think of when making resource development decisions. We need to consider, among other things, the complexity of the decision environment, the

[2]The above excerpts are from Edward Anthony's *Oddity Land* (1957).

techniques for handling this complexity by insisting on analysis rather than intuition, and that the fishery development problem should be treated as a system. The multiple-objectives problem needs to be grasped, and even the questions of population dynamics need to be recast to explain departures from the existing simple models. The mathematics of differential equations should remain as a firm foundation for contemporary management problems, but we should consider in more detail the mathematics of allocation or programming theory. Perhaps the most striking concept offered in this paper is that fishery management and development seem to be more preoccupied with tactics than with strategy. Fishery management and development appear to have avoided the expertise of development economists, whose strategies of development would deal with the entire social–political system as well as the economic and biological features of the fisheries. The most important strides are made with practical well-focused regional-scale activities that emanate in response to local problems, rather than from the interest of the academician.

The activity of management is essentially one of organizing and relating decisions. A better job of management will arise from developing a firm conceptual basis for the decision processes or rules of management. I will try to outline some of the concepts that go beyond the traditional scope of fishery management.

Complexity of Contemporary Decision Environment

The first concept involves the complexity of the present-day decision environment. This results from increased technological capability; from an increasing number of international differences generated by the influences of the developing states; from an increasing communication among states with differing political ideologies; and from the aspirations of the developing countries. The consequences of decisions that once could be analyzed by following a few relatively simple deductions must now be interpreted in the context of complex sets of interacting alternatives, as well as in the context of various secondary effects, each of which could explode into problems of even greater consequence than those originally contemplated.

This general problem of complexity in the context of development has been summarized by Gross (1972), who indicates that the world of development is favored by:
"1) more managers and administrators already familiar with various modern management practice and thought;
2) more local experts and technicians, including trainees returning from abroad;
3) more familiarity with the contributions and limitations of transnational technical assistance; and
4) more understanding by international agencies of the importance of administrative capability." However, he also notes that there are:
"1) *more complex problems:* with most developing countries facing growing difficulties in providing sufficient employment, housing, education, health services and other necessities for a rapidly expanding population;
2) *greater environmental uncertainties:* with rapid and unpredictable changes in human aspirations, social structures, coalitions of political power, government policies, and international relations in an emerging world society;
3) *more structural intricacies:* with more and larger organizations, increased specialization and professionalism, and more labyrinthine interrelations within and among organizations;
4) *more performance complexities:* with necessarily conflicting criteria governing organizational activities over large expanses of space, time, and psychic and cultural distances;
5) *uneven technological change:* with dramatic forward leaps in some areas, particularly the military, and comparative backwardness in many others;
6) *unsettling effects of technological change:* with every technological change undermining the status and power of people accustomed to the older ways of life;
7) *the obsolescence of yesterday's innovators:* with yesterday's brilliant men focusing attention on the perfection or use of techniques increasingly irrelevant to tomorrow's problems;
8) *the spreading "Fallacy of Administration as Technical Gadgetry":* with specialized techniques of analysis or control mistakenly viewed (or fraudulently advertised) as substitutes for genuine managerial wisdom, judgement and the more profound developments in managerial approaches;
9) *increased "Brain Drain":* with more modern-style managers and technicians from developing nations moving into positions of higher psychic and monetary reward in developed nations; and
10) *larger "Managerial Gaps":* with a few organizations in developing nations developing advanced managerial capabilities, while others will still not have advanced very far beyond the culture of the ox-cart, the heritage of colonialism or the crude "scientific management" of the early twentieth century."

While the goals of fishery development may at first glance depend on whether this management is to take place in a developed or developing country this does not materially affect the ensuing discussion because, as Gross observes, the first eight of the above factors apply to both. These problems are very evident in fisheries. I have given a view of this situation elsewhere (1971) and italicize in this version a passage that seems particularly appropriate to the present state of world fisheries in the setting of this Conference: ". . . where individual fishing operations can exert tremendous intensities of fishing effort and deplete a stock in a matter of weeks or months; where the number of overexploited stocks continues to grow; where some stocks continue to become virtually extinct; and *where the community of individuals who harvest and process the stocks are, in many instances, neither held accountable nor do they demonstrate a responsibility to conserve the stocks by not overfishing, by not insisting on and supporting research of relevance to fishery problems; and by not contributing needed management data or by contributing data that either contain an inordinate amount of errors or are not timely.* These complexities require that the contemporaneous manager face the above questions and answer even more complex questions concerning how resources should be allocated in the time stream, how resources should be allocated among the states, and how criteria should be established to evaluate the resources so that appropriate allocations can be accomplished."

The Need for Systems Methodology

A second concept is that because of these complexities we need to develop approaches that will efficiently sort out the best alternatives to attain our objective of better resource decisions. In the process we will need to attain further wisdom and exercise more careful judgement in developing criteria that generate an appropriate balance between the social good and the private good. We need to evaluate distinctions between goals of economic welfare and goals of social welfare. Finally we need to make the right decisions that enable us to utilize effectively the alternatives chosen.

The traditional approach in fisheries usually involves either the "muddling through" approach (see Lindblom 1959) or the scientific method. "Muddling through" is based on intuition, and while it is frequently used, there is not much to recommend it. The scientific method, as Quade (1964) pointed out as early as 1964, is not very helpful either, because it seeks contributions to knowledge, understanding, and predictive ability, whereas what we really need is a methodology that both suggests policies and offers a list of alternatives to decision-makers, along with an interpretation of the consequences of each alternative. We need a methodology that aids in the development of policy philosophy: such a method is systems analysis (see Churchman 1968; Hare 1967; Rothschild 1971, 1972b).

Systems analysis begins by formulating objectives; next, alternative ways of reaching the objectives are decided upon; criteria are then developed to judge among the alternatives; and a plan of action is formulated based upon the best alternative. The systems methodology places considerable stress upon cycling through this procedure iteratively, because in systems analyses the objectives are a variable, and after each iteration the analyst should know more about the nature of the problem than when he becan the previous cycle, thus enabling a reiteration of the objectives. The analysis essentially stops when further iterations do not yield a reformulation of the objectives.

The Need to View Fisheries as a System

The third concept is that if we are to use systems analysis to attack fisheries problems we need to view fisheries as a system or a collection of systems. These fishery systems generally constitute a resource problem or a set of resource problems, which are distinct from biological problems in that they involve the linkages between a portion of the biota and man's use of it. These linkages involve biological questions, but they are not necessarily more important components of the linkages than the social, the political, and the economic questions. For any of our fishery resources it is very difficult to demonstrate that we have properly allocated our intellectual and financial resources to maximize the efficiency of these linkages. The fundamental problem of fishery development might very well be the mobilization and allocation of financial and intellectual resources to solve natural resources problems, which by definition involves the development of algorithms or rules for making the right decisions. The inefficient mobilization or misallocations of talent are evident in many circumstances, e.g. when a fishery is managed as a single-species fishery when in fact it catches several species. Another example is when the total disciplinary spectrum is not considered, e.g. the economic aspects but not the biological problems, or vice versa. An even more insidious misallocation of talent is paying lip service to being multidisciplinary. This Conference might do so by having a section on fishery science and methodology, one that deals with the economic aspects of management and development, and a section concerned with technology, but at the end do we merely staple these components together and call this very act of stapling a multidisciplined approach. Do we return to our offices and at some mysterious future date rise, not unlike the fabled Kraken, to attend the next great stapling? Or, on the other hand, do we examine the difficulties and constraints that prevent full utilization, formulate these as problems on a practical regional scale, then proceed systematically to achieve solutions? Being only nominally multidisciplinary will not produce results of multidisciplinary utility, and because of this the more efficient multidisciplinary approaches will in the long run be discouraged.

The Need to Take a Broad View of Management

The fourth concept is that if we are to view fisheries as a system or a collection of systems, then in addition to taking a broad view of fisheries problems we must also take a broad view of the management process itself. Management must be viewed as a system (Blumenthal 1969). This has been discussed by Drucker (1969) as the "new realities" of management, which I have quoted and paraphrased as follows (1971): ". . . all institutions will have to make fulfilment of basic values, beliefs, and purposes a major objective of their continuing activities rather than (having) a social responsibility that restrains or lies outside their primary functions. Further, the quality of life is, in fact, a business opportunity and can be converted into profitable business. There should be more emphasis on adapting the institutions to the needs, aspirations, and potentials of the individual than on adapting the individual to the demands of the institution." Entrepreneurial innovation was not formerly intrinsic to management, but now such ". . . innovation will become the very heart and core of management . . . Existing institutions will have to reach out for changes as an opportunity, (and) will have to learn to resist continuity." Management should also make knowledge more productive, and here Drucker points out that in the production of knowledge there is no single best way to doing a job and ". . . there can be no divorce of *planning* from *doing* in knowledge work."

Drucker further points out that management should ". . . be considered as both a science and a humanity." In this respect ". . . management is . . . a culture and a system of values and beliefs and serves as a channel through which society can productively utliize its values and beliefs," and final emphasis is placed on noting that "economic and social development are the result of management." Thus, for example, ". . . there are not underdeveloped countries. There are only *undermanaged* ones."

Multiple Objectives

The fifth concept acknowledges that if management is to be developed from a rationale that includes inter alia biological, political, social, and economic considerations, then management must appreciate biological, political, social, and economic objectives. Optimizing any one of these may produce advice that is totally unrealistic. The biological, political, social, and economic objectives are by themselves complicated and the manner in which they interrelate is even more so. Additional problems are generated when we remember that the questions of interrelations among objectives must extend among states that are at different stages of development as well as among those with differing economic ideologies. The fundamental question is whether these complications really reflect some unresolvable problems, or whether they result from inadequate attention to the interdisciplinary areas. These areas really have not been examined with the same explicit attention as have the biological or the economic areas. We therefore need to examine the problems in a systematic way. Because the systems approach is iterative, after our initial formulation of the problem we may learn that the interrelations among the disciplines are really not complicated; they may simply appear to be complicated because of the lack of genuine interdisciplinary study. We will consider in turn economic, biological, development, and research objectives. Social objectives will be touched upon in the section on development.

Economic Objectives

Economic objectives involve questions of economic efficiency, the relation between marginal cost and marginal value, and the fact that the return on any investment should be favorable when compared with alternative investments (Panel Report of the Commission on Marine Science, Engineering and Resources 1969). From these higher-level goals there have been studies partitioning various returns to investment, labor, etc. (Smith, undated). While there is a growing body of literature indicating that many fisheries are overcapitalized it is somewhat curious that, to my knowledge, optimal capital budgets have not been computed for any of these fisheries; it is then logically difficult to claim overcapitalization. While theory gives us guidance on questions of economic efficiency we have not had much explicit advice on practical strategies that can be followed by fishery entrepreneurs on a practical everyday basis. Large-scale economic efficiency cannot be attained until the components of the economic system make decisions that are consonant with the rules that appertain to the larger system. The above difficulties, as well as the roots of the multiple social welfare functions, have been discussed by Crutchfield (1972). He hoped "... that the late 1960s marked the end of simplistic controversies over the relative merits of maximum sustained physical yield versus maximum net economic yield as the objectives of fishery management."

Crutchfield went on to review some of the basic problems of the economic and political objectives of fishery management. He identifies several troublesome issues: a, Small groups of "winners" tend to be more influential in constructing a policy that benefits the winners to a greater extent than the long-range public interest; b, There is a zero opportunity cost for what may be an apparent inefficient employment of fishermen; c, It is difficult to appraise the benefits from a fishery that fishes multiple stocks in the same geographic area (e.g. a groundfish fishery) or fisheries that are mobile, fishing several geographical areas (e.g. the U.S. tropical tuna fishery, which fishes in the eastern tropical Atlantic), in terms of benefits accruing from a single stock; d, The range in per capita incomes among countries makes the question of allocation among them difficult. In addition, Gulland (1968) shows how the international disparity among labor and other costs can encourage increased fishing effort in a fishery that is already "overfished"; e, The emphasis placed on various objectives is not the same in different political systems; different desires for foreign exchange, for "status" in fisheries, and for maintaining options for the future (the last highlights one of the essential features of these problems, which relates to the different discount rates with which the various states perceive the various objectives).

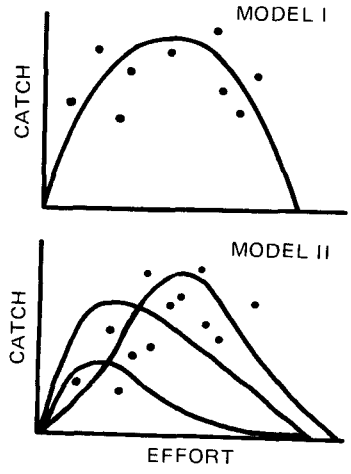
Biological Objectives

The biological objectives of management involve relatively simple technical computations. It is important to understand that while there are great complexities concerning the biological objectives — in particular those that concern stock and recruitment — these are relatively simple technical problems relative to the problem of taking a holistic view of fishery management and development.

The biological questions basically are related questions of stock and recruitment, yield per recruit, and the relation between catch and effort. While the question of stock and recruitment is of immense scientific importance, and an understanding of the question of the magnitude of recruitment as a function of time may very well be one of the fundamentally most important aids to fishery decision-making, the fact remains that the phenomena associated with these processes are not sufficiently understood to place general utility upon recruitment predictions for management purposes. The yield per recruit concept involves determining that combination of fishing mortality and minimum size that maximizes yield per recruit. As multiple gear fisheries become more complex, it becomes very difficult to estimate the appropriate minimum size. Besides, while it is possible to regulate minimum size by adjusting mesh, for example, it has always been difficult to adjust fishing effort. In fact, it is probably because of this difficulty that the term eumetric fishing was coined. The main value of the yield per recruit approach is to achieve an understanding of the effect of changing recruitment size, mortality rate, and growth rate upon the relation between catch and effort. This is perhaps the relation that provides the most important information for the decision-maker. I have discussed the interpretation of the relation between catch and effort in some detail (Rothschild 1971). In essence this discussion concentrates upon explaining departure from the traditional model which, using standard notation, is:

$$\frac{dP}{dt} = \phi(P) - FP$$

It is usually fitted by least squares giving a regression line so that the situation of Model I is achieved (Fig. 1). Any deviation from the line is a random component and we



strive for the equilibrium conditions represented on the line. But nature does not stand still; we cannot expect the constants in the above equations to remain constant. The "constants" are in fact random variables, and as such they are drawn from particular distributions (which we hope will remain constant). This means that each year the parameters are different and so the model then becomes as in Model II of Fig. 1.

The difference in philosophies elicited by Models I and II could be considerable. In I we always strive for the "golden equilibrium"; in II the equilibrium differs each year owing to changes in the scale of F (that is, $F = qf$ implies that q is a simple constant of proportionality between F and f, but in reality q should be considered as a functional operator ø, say, which could be complex) and changes in the stock structure and the usual vital parameters. This means that it is worth investigating the mechanisms that change the spatial distribution of the stocks, the vital parameters, and the function implied by the operator.

When integrated with economic considerations this philosophy enables a "program" (in the technical mathematical programing sense) of fishing in which by Model I we would be underfishing in some years and overfishing in others. However, our program would allocate inputs to the fishing process over a sufficiently long time such that outputs would be maximized. The methodology for such a program could be obtained from the theory of linear programing as is done in forestry or from dynamic programing, which is more realistic but sometimes computationally difficult (but note some computational simplifications in dynamic programing afforded by stochastic dynamic programing — Howard 1960). See also the analytic versions presented by Booth (1972) and Quirk and Smith (1970). Until these theories are utilized the manager will be faced with various empirical approaches such as that most recently suggested by Gulland (1972) for shrimp management:

"a) Examine the extent of the area involved, and estimate, on the basis of comparison with other areas the likely number of trawlers required for operations at the optimum level (for example 50).

b) Issue licenses for the operation of rather less than this optimum number (say 30). A condition of obtaining a license would be provision of full statistical data on the operations, including catches of each size of shrimp, fishing effort and location of fishing.

c) Allow the operation of these vessels for 2 or 3 years without modification. Then examine the statistical and other data, assess the stocks and obtain a revised estimate of the optimum number of vessels, (e.g. 55) this may be above or below the original estimate.

d) Issue further licenses to bring the total number of vessels licensed closer to, but still below, the revised estimate of the optimum (e.g. 45).

e) Make economic studies to estimate the likely profitability of each boat when the fleet approaches its optimum size.

f) Decide, particularly if this profit is large, what use should be made of it, and introduce appropriate additional conditions on license holders, e.g. substantial license fees, commitment also to land defined quantities of fish, etc.

g) Repeat steps c) to f) at intervals."

The reason that the techniques of stock and recruitment, yield per recruit, and the relation of catch-and-effort are simplistic and in a sense anachronistic is not because of any intrinsic failure in the techniques; nor is there any implication that these techniques are not extremely useful interpretative devices. The strictly biological interpretation of these models is not now a major problem since the importance of the value metric has been stressed in the literature for some decades. But it is still not generally recognized that some concepts of management can provide incentives for gross overcapacity, or that MSY as a concept can be economically disadvantageous because if it is not responsive to supply and demand it can generate undesirable fluctuations in price. The major anachronism is that these models simply advise us on how much can be caught from a single stock; but by modifying some of the growth and mortality rates they can show us how to modify the total catch. This in itself is an important problem because it involves the methodology for increasing the supply of fish, which unfortunately tends to be submerged when discussing management. The major difficulty with these models from a decision point of view is that they do not face what is perhaps the major problem in fishery management, that of dividing the catch among those who wish to participate in the harvest. The central question of fishery decision-making – fishery management – is how to allocate the resource in space and time. The other major problem is to increase the supply of fish.

We are continually answering the question of "who gets what," since as long as the catch is shared by at least two entities an allocation is performed. But allocations made implicitly do not always make sense from an economic or social point of view, and one could point to a number of examples where they do not make biological sense. As an index of "sense" we could consider the benefits that could be accrued (and then distributed) from a resource if it were owned by a single individual, and compare these to the benefits that actually accrue under post hoc ergo propter hoc allocation. The after-the-fact allocations are similar to after-the-fact policies. I have discussed the analysis remedy for after-the-fact overdetermined policies (Rothschild 1972), and the same remedy of analysis would apply to allocations.

Allocation Models

Because allocation models are so unusual in fisheries – a seeming paradox – the subject is worth a bit of discussion. For example, with respect to allocating the catch there is a rich framework in the theory of mathematical programing that deals with this. While there have been a few attempts (e.g. Rothschild and Balsiger 1971; Booth 1972; Quirk and Smith 1970), the problem has not really been addressed in depth mainly because, while the mathematics are easy, the philosophical question of how one evaluates the various elements of the fishing process is not entirely clear, although the formulation of these problems in mathematical terms can be helpful in sharpening the questions that can be asked. For example, in salmon management the traditional technique involves allowing sufficient "escapement" (the fish that escape the fishery and are therefore able to spawn). But when formulating the salmon problem as a programing problem we can give many more options to the systems design. For example, Rothschild and Balsiger (1971) maximized:

$$Z = \sum_{i=1}^{M} \sum_{j=1}^{N} c_{ij} X_{ij}$$

subject to:

$$X_{ij} \leqslant R_{ij}$$

$$\sum_{i=1}^{M} X_{ij} \leqslant K_j$$

$$\Sigma \Sigma\, a_i X_{ij} \leqslant T - E$$

$$\Sigma\, X_{ij} \leqslant M - \frac{E \times H}{F}$$

$$\sum_{j} X_{ij} \leqslant S_i - L_i$$

where: M = total number of age-sex categories; N = total number of days in the run; X_{ij} = number of fish caught in the ith age-sex category on the jth day of the run; c_{ij} = value of a fish caught in the ith age-sex category on day j of the run; R_{ij} = number of fish of the ith age-sex category that run past the fishery on the jth day; K_j = capacity of the cannery or canneries in numbers of fish on the jth day; a_i = average number of eggs in each fish in the ith age-sex category; T = total number of eggs contained in the escapement and catch; E = minimum number of eggs required in the escapement; M = total number of males in the escapement and catch; H = sex ratio desired in the escapement, expressed as the number of females per male; F = average fecundity of the female age-sex categories, expressed in number of eggs; S_i = number of fish in the total season run of the ith age-sex category; L_i = number of fish of the ith age-sex category desired in the season's escapement.

Putting the problem in this context allowed us to look at a much broader set of decision questions than is conventionally examined in salmon management. In the "who gets what" context we are allocating different kinds of salmon (identified by age, sex, and day of "entrance" into the fishery) among the catch, taking into account a daily processing capacity, a seasonal processing capacity, and a requirement to allow a certain number of eggs and male fish to survive the fishery for reproductive purposes. Because of the way the model was formulated we could simultaneously study the unused catch or escapement, the unused cannery capacity, and the number of eggs that could be caught and were not. The formulation further enabled us to impose a value to different sizes and sexes of fish, to a salmon egg, and to an empty unit of cannery capacity. These important values are the kinds of information that need to be accounted for in the decision process. The analysis led to further interesting results showing how fish that were ordinarily of less value could become more valuable than fish of greater value.

We have used another example of linear programing to study production functions in fisheries, where we allocated two species of tunas among three size-classes of boats to provide guidance on optimum tuna fleet composition (Rothschild 1972a). In the discussion we indicated the simple extension for allocating the catch among countries. As we try to bridge the gap between the inputs to the fishing process we can see that the usual fishing power calculations are not sufficient to measure and analyze the inputs because these have chance components that need to be handled explicitly. We developed a model for this, evaluating the quality of different decisions in terms of the entropy perceived by the decision-maker. We further gave an example of how the large variances sometimes encountered in fishery work could be treated explicitly.

In reviewing the subject of traditional dynamics we would be remiss if we did not mention the most recent advances, developed by Ricker (1948) and exemplified more or less simultaneously by Gulland (1965) and Murphy (1965), which have been facilitated by computer computation. These derive from the virtual population methods and enable the estimation of fishing effort as a function of age. The second important technique is that of generalizing the production function developed by Pella and Tomlinson (1969). For a recent discussion of the production model, see Fox (in press). For a review and detailed example of the application of these methods the reader is referred to the paper by Abramson and Tomlinson (1972).

Goals in Development

A further set of goals needs to be considered — those for development. An example of these may be found in the Provisional Indicative World Plan for Agricultural Development (FAO 1970). While these relate mostly to agriculture there is no reason why fishery development cannot be guided by them:

"a) Providing the future food supply, with population typically growing at 2.5 to 3% a year.

b) Adjusting to the still more rapid increase in the number of people who can only be reached through marketed output, as well as the changes in the compostion of the diet that accompany urbanization and rising incomes per capita.

c) Adjusting to the specific requirements in food policy, which emerge from the analysis of the main dietary deficiencies (especially protein quality) inherent in the present

composition of food intake under the major dietary patterns.
d) Assuring the raw material base for the processing industries (food and non-food), which are usually dominant in the early stages of industrialization.
e) Earning and saving foreign exchange. Shortage of the latter is one of the most serious bottlenecks to economic growth in most developing countries and most of them depend mainly on agricultural products to earn it. On the other hand, in a great many countries the agricultural sector offers considerable scope for economic import substitution. In more general terms the agricultural sector has a significant part to play in the mutual enrichment of all countries through expansion of international trade based as far as possible on comparative advantage.
f) Providing a large part of the additional employment that will be needed over the period up to 1985; and at the same time permitting some of the increase in the labor force to become available for nonagricultural occupations through an increase in labor productivity on farms.
g) Contributing to the savings needed to finance development.
h) Helping in the diffusion of wealth, which alone can provide a mass market for industry, not to speak of an adequate effective market for agricultural products. The greater part of the population in most developing regions is still agricultural, so that without prosperity here, the whole process of economic development is thwarted.
i) Providing a market for "producer goods" industries, that is farm machinery and equipment, fertilizers, chemicals for control of pests and diseases."

The goals of a research organization and the kinds of information that are applicable have been discussed by Rothschild and Uchida (1968: 46-48).

Simplification Through a Distinction Between Tactics and Strategy

The sixth concept is that we need to achieve a simplification of our system, given the complexity of the contemporaneous decision environment, the availability of a methodology to handle the complexity, the need to view the fisheries as a broadly based system, the need to consider the management of a system from a similarly broad viewpoint, and the complex multiple objectives associated with fisheries. System simplification can be attained in a variety of ways (Hare 1967). One approach is to partition the problem into its components and concentrate on the most important one. Another is to rely on various mathematical techniques to help synthesize the quantitative aspects of the problem. Perhaps the most important simplification was formulated by Anthony (1965), who noted that decision problems could be divided into those that involve strategy, those that involve tactics, and those that involve operations.

In an earlier paper (Rothschild 1971) I considered Anthony's strategic tactical breakdown in terms of the fishing question in the strict sense, where the annual catch is the strategy, and the methodology of obtaining the catch is the tactics. In the present paper I follow Gross (1972), and regard the following distinctions between strategic and tactical decision-making:

Strategic approach	Tactical approach
Broad scope	Narrow scope
Long time-horizon	Short time-horizon
Formulates problem	Seeks objective answer to problem formulated by others
Systems oriented	Operations research oriented
Considers relation of problems to other problems	Considers only solution of particular problem
Concentrates on desirability	Concentrates on feasibility and consistency

If, for example, we consider tactics without considering strategy we could very well be answering the wrong questions, even though perhaps with considerable skill. For the broad questions of fishery management and development we may be concentrating on tactics without having a well developed strategy. Clearly we need to inquire as to the appropriate strategy for fishery management and development.

Development

The seventh concept is that of development. It is complicated by the fact that in the context of fisheries it can mean development in the usual sense, that is, related to the developing countries, or it can mean the development of an underdeveloped industry in a developed country. We can have a developed fishing industry in an underdeveloped country, an underdeveloped fishing industry in a developed country, or an industry undeveloped in the sense that it does not make the most efficient use of available resources.

In the international context the development of fisheries must be responsive to the general international development problem. This is reflected in a number of indices that demonstrate the gap between the "haves" and the "have nots." One commonly used index of the quality of life is the per capita GNP; poor countries are those with a per capita GNP which is less than the world mean per capita GNP (Bhagwati 1966).

There are other measures of the quality of life such as literacy, infant mortality, physicians per capita, etc. The responsibility of the developed nations for facilitating the development of the developing nations is outlined by Myrdahl (1972). Recognition of the need for international development stimulated the United Nations to consider the 1960s as the Decade of Development. While there were some increases there has been a general disappointment in the average development performance during that decade. A diagnosis of the reasons may help us to put in perspective some of the problems in the narrower field of fishery management and development. In a diagnosis of the problem associated with development during the 1960s, Robinson (1971) pointed out that the theme for generating development at that time was the "economic plan." "Essentially, the rationale of the plan was to mobilize economic resources and deploy them on cost–benefit criteria to projects with optimal effects on economic growth rates and structures." Robinson synthesized several views on the best alternative plan for development:

"The view of Ramaswami and Ikram states that in South Asia agriculture would not be a primary sector in development because farm surpluses increase at a lesser rate than rural population; only industrialization can provide a quantum jump for the economy. This industrialization would create a better capital–output ratio than would agricultural development through

- large amounts of capital quickly
- provide resources for its own development
- import substitution which saves foreign exchange."

Robinson furthermore points out that there were reservations associated with the above view of "industrialization": rapid industrialization would likely call for more foreign exchange than would be available; industries would be inefficient owing to stagnation of agricultural incomes.

If the development process concentrates upon industrial technology, then the gap between rural and urban incomes will increase, and migration into urban areas will be encouraged, but as technology advances jobs will be destroyed. This will achieve a high output–capital ratio, but the costs in terms of widespread unemployment and political unrest will be great.

Robinson (1971, p. 3) continues by quoting E. F. Schumacher:

"Industrial concentrations based on the latest technology may give you the best output for capital invested and the best rate of economic growth; but the political and human costs in unemployment in the countryside, in resentment against a policy that leaves 80% of the nation in rural areas worse off than they were before, are so great that society (may) disintegrate and the economy run down."

Dr. Schumacher suggests that the answer lies in the development of "intermediate technologies" that are prosecuted in rural as well as urban areas.

A third point of view, that of Prof. N. Kaldor, is to develop optimal capital output projects in urban areas and then redistribute the income to rural areas; but this would generate difficult political problems. It turned out that the "best of plans based on maximum productive efficiency may yet make bad economic policy." Robinson notes that . . . "the imperious, economic approach in which economic stages and models, economic factors and economic criteria reigned almost unchallenged in principle, as arbiters of development strategy. The tendency of the style was too optimistic. It exaggerated the actual power of economic over noneconomic factors . . ."

From these excerpts we can see that questions of development are wide reaching and that economic criteria by themselves are not suitable for guiding development policy. It is necessary to reconcile questions of social welfare with questions of economic growth. What all this shows is that development is not an economic process or a technological process; it is a process whereby the quality of life will be better tomorrow than it is today.

Since our goals involve increasing the supply of fish through management, increasing the supply of fish through discovery of new stocks, and developing more efficient processing and marketing linkages, we might simply develop programs to undertake attaining these three objectives. Unfortunately there are many such programs, and while they are capable of solving technical or tactical problems, there are not as many successes as one might hope in making better resource decisions. The major problem in both developed and developing countries lies in decision-making institutions, and the major problem in institutional development is that of developing an institutional strategy. This is not a fishery problem per se, but it is relevant since it is the general development problem. Gross (1971) characterizes it as being reflected in organizations that exhibit: a deep-rooted resistance to change, ritualistic rather than genuine planning, and lack of managerial (or administrative) capability. He further observes that the "world of development administration is peopled too much by dinosaurs and ostriches. The ostriches keep their heads and eyes snugly buried in the warm sands of ancient memos and bureaucratic fantasy. The dinosaurs bask in the memory of past struggles for freedom, blind to the world-shaking changes that threaten new forms of servitude. Both are encouraged in these attitudes by the example, advice, or misleading information provided by richer ostriches and more powerful dinosaurs in the so-called "developed" nations. Neither has one of the most important virtues of an administrator . . . the ability to understand rapid and complex environmental changes and help his organization adapt creatively to these changes."[3]

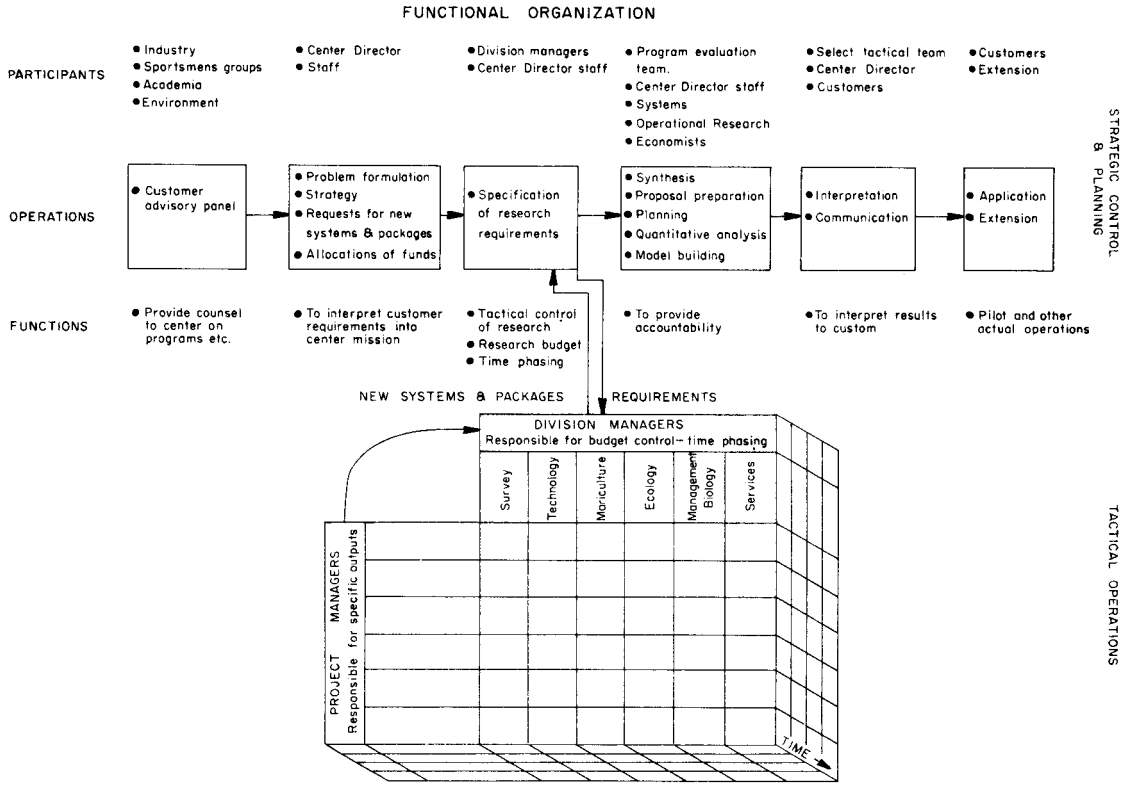
While in some cases the above may be an overstatement it is still quite clear that administrative ability is a considerable constraint on development.

It is generally realized that fishing problems are characterized by underlying roots of conflict generated by "who gets what," but it is not clear that the science of conflict study has been explicitly applied in the fishery area.

Institution Development

The eighth concept is that in order to create a favorable environment for strategic decision-making and the framing of problems in a strategic context, it is necessary to have institutions that consider this problem in an explicit way. While there are many institutions that relate to fisheries, there is one type particularly relevant to our considerations, the applied research institution that can provide the driving force to develop strategy. To build such an institution it is necessary to develop various properties in functional terms. We thus eliminate the usual organizational hierarchy and provide the research institution with a strategy instead of merely factors of the organization. A functional organization might include the following: clearly identified strategies and tactical components; clearly identified participants, operations, and functions; an acknowledgment that participants include "customers" and that an organization's goals can be determined by conducting market research upon the customers; a specific mechanism for communicating with customers; a group of individuals with the specific task of providing accountability in the system; flexibility in program structure so that the tactical operations consist of a mix of

[3] *Appraising Administrative Capability for Development*, p. 10. INTERPLAN Report, Public Administration Division, 1969 (United Nations Sales No. E.69. II.H.2).



projects, each with a starting and stopping date enabling a shift of personnel among projects rather than keeping specialists within their own more or less narrow disciplines. Such a system is presented in Fig. 2.

Approaches to Strategic Decision

The ninth concept is that if we are to develop responsive institutions, then these institutions will need to be built upon the principles of strategic decision-making as outlined, for example, by Gross (1972). Students of fishery management and of development hold considerable differences in opinion concerning the scope and the nature of appropriate solutions in their respective fields. A common thread does exist, the acknowledgement of the complexity and the need to find simplifications that make solutions more attainable. An important simplification involves decomposing a problem into its strategic and tactical elements and letting the elements of strategy guide the programed tactical decisions. Gross (1972) outlines principles of strategic decision-making that I shall paraphrase and annotate. These are: responsible decision-making, conflict essence of problems, selectivity, total system appreciation, relative proportions, sequential model-using (the art of modelling through), problem interrelations, jointed incrementalism, organized and unorganized interests, the emotional basis of rational action, investment in future capabilities, and power mobilization and use.

Responsible decision-making — The strategic decision-maker has a responsibility to deal directly "with changing patterns of multiple purposes and objectives and handle all relevant variables, including those that may be immeasurable or noncommensurable"; to view one's own decision-making in a matrix of others with possibly conflicting decisions, and to realize that each decision changes the decision environment; to be innovative and to create new values and norms that will elucidate problems that have been previously "swept under the rug" because these did not previously exist, and to "subordinate (without overlooking) technical considerations of both feasibility and consistency to longer range considerations of desirability"; and to generate the most appropriate forms of tactical analysis.

Furthermore, "if tactical, nonresponsible decision-making tends, in the absence of a strategic framework, to dominate the decision-making process, then this may be properly called irresponsible decision-making."

Conflict essence of problems — Conflict is particularly characteristic of fishery resource problems. Owing to the tactical nature of fisheries, it tends to ignore the "identification of the parties at conflict and appraising their strengths and their interests, both apparent and actual" as well as the evaluation of the various "conflict outcomes: avoidance, deadlock, defeat or victory, compromise and integration." It is clear that our decision-making needs to take more explicit account of the conflict essence of problems.

Selectivity — One would think that this simple concept, which advises the decision-maker to examine his alternatives and concentrate upon the best set of alternatives, would be rather generally applied, but "many national planning and development documents are tragic monuments of failure in strategic selectivity. Too often they are built on the double principle of a) stringing together separate plans or programs emanating from every major ministry, or b) providing something for every active pressure group and region. This "laundry list planning" sometimes approaches sheer irresponsibility."

Many fishery programs, whether in developed or developing countries, have the above characteristics. Our fishery institutions tend to be structured in a way that encourages this incremental management approach.

Total system appreciation — Suboptimization is a characteristic of a nontotal system view of a problem. If the complexity of the fishery system is not acknowledged this will lead to suboptimization whereby one element of the system, such as the design and construction of a fish plant, may be optimized but the total system ignored. For example, if the supply of fish is ignored it will be impossible to operate the plant.

Relative proportions — This concept demonstrates the inadequacy of priority lists for making decisions. One simply "cannot order the parts of a system;" thus it is necessary to think in terms of "relative proportions." Inasmuch as many fishery decisions are made on the basis of priorities, the relative proportions concept needs to be considered more often.

Sequential model-using (the art of modelling through) — The main point made by Gross is that model building is a scientific endeavor, but model using is an activity employed by decision-makers. Because the model builder often has different objectives than the model user (i.e. the decision-maker), the models produced are usually interesting but not necessarily useful. This reiterates the need for model building to be a sequential iterative process in which the builder interacts with the user so that the model is dynamic rather than static. A good model should mean, not be. Decision-making need not be "muddling through," but it must be "modelling through." Insofar as there are only a limited number of fishery models that actually apply to decision-making, it is difficult to see a widespread applicability of this important technique. This suggests a need for developing additional fishery models.

Problem interrelations — This is another reflection of problem complexity mentioned earlier.

Jointed incrementalism — "A good example is the process of building new development institutions. Thus, in reconstructing an agricultural bank inherited from a colonial period or in building a new institution of this type from scratch, a myriad number of very small, incremental decisions must be made over a rather long period of time. These involve the selection and training of personnel, the mobilization of resources, the development of methods and procedures, the formation of various linkages with farmers, government agencies and other institutions, successive internal reorganizations, etc., etc. If these thousands of steps are pursued on the basis of disjointed incrementalism, the end product is likely to be a rigid institution that operates more like a traditional bank than like a true development agency. Successful institution building is possible only if there is a long-range general model that can serve as a guide to the thousands of incremental decisions. This means jointed incrementalism."

Organized and unorganized interests — The strategic decision-maker needs to consider not only the extent of organized and unorganized interests, but those that will be either organized or unorganized in the future. The strategic decision-maker needs to include within his repertoire the kinds of decisions that can awaken and organize appropriate interests.

The emotional basis of rational action — There are basically two modes of communication, the objective and the emotional. The function of the objective mode is to transmit information, that of the emotional mode to evoke action. The strategic decision-maker must realize that his task most frequently goes beyond simply transmitting information; he needs to elicit action and thus he must develop techniques that utilize an understanding of the emotional basis of rational action.

Investment in future capabilities — In addition to considering investment in terms of the conventional "hard" terms it is necessary to appreciate investment in all areas of management. "a) Investing in people, through education, health, scientific research, and other services or facilities that may make people more productive. b) Investing in the organization and institutions that put hard goods and people together in producing goods and supplying services. c) Investing in the administrative capability that is required to guide organizations and institutions . . . In a certain sense, investing in administrative capability covers all the other aspects of investment, in that administrators – particularly at strategic levels – are directly concerned with continuing decisions on hard goods, people, organizations and other administrators."

Power mobilization and use — The point is made that the strategic decision-maker wants action; plans that do not stimulate action are not particularly useful. The activation of plans involves: "(1) building a support network (or activation base) and (2) the use of various modes of influence (or changing "activation mixes") including persuading, pressuring, and promoting self activation." Gross notes that this is essentially a political process and that politics has been called the art of the possible, but the strategic decision-making in the development area

frequently involves intrinsically competing concepts and here we have the art of the improbable.

The above principles are not often considered in fishery management or fisheries strategy. They lie beyond the perimeter of Oddity Land, providing a checklist of items that need to be ticked off before entering the details of a problem in fishery development. Do we consider these items in fishery management and development? How are these items covered in this Conference? What is our philosophy on the strategy of fishery management and development?

Discussion

In discussing the problem of fishery management and development we have assembled a variety of concepts and assertions. The first of these is that there is such a place as Oddity Land. I have never been there, but they tell me that visas are not too difficult to acquire. On the outskirts of Oddity Land they recognize the complexity of the contemporary decision environment and this complexity is characteristic of the decision processes in developing and developed countries. Because of the complexity, advanced informational techniques are needed to analyze alternative means of achieving multiple objectives and developing criteria. Fisheries must then be viewed as systems, and an important simplification of the fishery system is to partition it into its strategic and tactical components. Travellers tell me that in Oddity Land many of the inhabitants consider only questions of tactics and not questions of strategy. Some of the leading citizens do tend to think of doing things the right way, although I understand that one of their number was deported for this. He had thought about responsible decision-making, the conflict essence of problems, selectivity, total system appreciation, relative proportions, sequential model using, problem interrelations, etc.

Now one might think that to make some positive accomplishment in fishery management and development all we need is some system analysis, a dash of operations research, a pinch of social science, etc. Indeed, as Gross notes, these techniques have been to some extent "sold" to developing countries by a variety of foreign governments, international agencies, private companies, special advisors, consulting firms, management institutes, scientists and researchers. But frequently, as Nathaniel Hawthorne noted, "Thus it is that ideas, that grow up within the imagination and appear so lovely to it and of value beyond whatever men call valuable, are exposed to be shattered and annihilated by contact with the practical."

How do we achieve the practical? How do we get away from Gross's cast of characters? "a) The "humble and obedient" civil servant: "I just carry out policies set by the Government . . ."; b) The technical expert: "Let's concentrate on efficiency, and thus release more resources for those humanistic matters . . ."; c) The economic strategist: "We'll be able to enjoy the luxuries of humanism if we tighten our belts today and concentrate our resources in capital investment . . ."; d) The ostrich: "This is not a problem . . ."; e) The dinosaur: "This proves we shouldn't get involved with these fancy new management techniques . . ."

The answer is relatively simple. We need to build new institutions that are capable of facing explicitly the concepts outlined in this paper. These institutions should be chartered to find solutions to practical fisheries problems on a regional scale.

In building these institutions it will be necessary to examine existing fishery arrangements, such as was undertaken by Kasahara and Burke (MS), and also to develop new organizational patterns that help rather than inhibit fisheries organizations in coping with the problems of supply and management in a general development setting. If we do this we may need another conference because the technical questions of fishery management and development do not really explicitly address these questions of strategy. We need to stop describing the present and move dynamically into planning the future.

ABRAMSON, N. J., AND P. K. TOMLINSON. 1972. An application of yield models to a California ocean shrimp population. U.S. Fish. Bull. 70: 1021–1041.

ANTHONY, E. 1957. Oddity land. Doubleday and Co., New York, N.Y. 64 p.

ANTHONY, R. N. 1965. Planning and control systems, a framework for analysis. Harvard Univ. Grad. Sch. Bus. Admin. 180 p.

BHAGWATI, J. 1966. The economics of underdeveloped countries. McGraw-Hill Book Co., New York, Toronto. 254 p.

BLUMENTHAL, S. C. 1969. Management information systems, a framework for planning and development. Prentice-Hall, Inc., Englewood Cliffs, N.J. 219 p.

BOOTH, D. E. 1972. A model for optimal salmon management. U.S. Fish. Bull. 70: 497–506.

CHURCHMAN, C. W. 1968. The systems approach. Dell Publishing Co., New York, N.Y. 243 p.

CRUTCHFIELD, J. A. 1972. Economic and political objectives in fishery management, p. 74–89. *In* World fisheries policy. Univ. Wash. Press, Seattle, Wash.

DRUCKER, P. F. 1969. Management's new role. Harvard Bus. Rev. 47(6): 44–54.

FAO. 1970. Provisional indicative world plan for agricultural development. FAO Rome. 1:327 p.

FOX, W. W., JR. 1973. Fitting the generalized stock production model with Gulland's method of equilibrium approximation. U.S. Fish. Bull. (In press).

GEYER, R. A. (Chairman) 1969. Industry and technology: Keys to oceanic development. Panel Rep. Comm. Mar. Sci. Eng. Resour. 2: 52 p.

GROSS, B. 1971. Management strategy for economic and social development. Part I. Policy Sci. 2: 339–371.

1972. Management strategy for economic and social development: Part II. Policy Sci. 3: 1–25.

GULLAND, J. A. 1965. Manual of methods for fish stock assessment. Part I. Fish population analysis. FAO Fish. Tech. Pap. 40 (Revision 1–F1b/T40): 68 p.

1968. The concept of the marginal yield from exploited fish stocks. J.Cons. Cons. Perma. Int. Explor. Mer 32: 256–261.

1972. Some introductory guidelines to management of shrimp fisheries. Indian Ocean Program, Indian Ocean Fish. Comm. IOFC/DEV/72/24, FAO, Dev. Program, Rome, August 1972: 12 p.

HARE, V. C. JR. 1967. Systems analysis: A diagnostic approach. Harcourt, Brace and World, Inc., New York, N.Y. 544 p.

HOWARD, R. A. 1960. Dynamic programming and Markov processes. M.I.T. Press, Cambridge, Mass. 136 p.

LINDBLOM, C. E. 1959. The science of "muddling through". Pub. Admin. Rev. 19: 79–88.

MURPHY, G. I. 1965. A solution of the catch equation. J. Fish. Res. Board Can. 22: 191–202.

MYRDAHL, G. 1972. Political factors in economic assistance. Sci. Amer. 26(4): 15–21.

PELLA, J. J., AND P. K. TOMLINSON. 1969. A generalized stock production model. Bull. Inter-Amer. Trop. Tuna Comm. 13: 421-496. (In English and Spanish)

QUADE, E. S. [ed.] 1964. Analysis for military decisions. Rand Rep. (R-387PR): 382 p.

QUIRK, J. P., AND V. L. SMITH. 1970. Dynamic economic models of fishing, p. 3–32. *In* A. Scott [ed.] Economics of fisheries management: A symposium. H. R. McMillan Lectures in Fisheries, Univ. British Columbia, Vancouver, B.C.

RICKER, W. E. 1948. Methods of estimating vital statistics of fish populations. Indiana Univ. Publ., Sci. Ser. 15: 101 p.

ROBINSON, R. [ed.] 1971. Developing the third world: The experience of the nineteen-sixties. Cambridge Univ. Press, London. 289 p.

ROTHSCHILD, B. J. 1971. A systems view of fishery management with some notes on the tuna fisheries. FAO Fish. Tech. Pap. 106: 33 p.

1972a. An exposition on the definition of fishing effort. U.S. Fish. Bull. 70: 671–679.

1972b. The need for analysis in the development of United States fisheries policy, p. 198–210. *In* World fisheries policy. Univ. Wash. Press, Seattle, Wash.

ROTHSCHILD, B. J., AND J. W. BALSIGER. 1971. A linear-programming solution to salmon management. U.S. Fish. Bull. 69: 117–140.

ROTHSCHILD, B. J., AND R. N. UCHIDA. 1968. The tuna resources of the oceanic regions of the Pacific Ocean. Univ. Wash. Publ. Fish. (N.S.) 4: 19–51.

SMITH, F. J. (Undated) Fishing business management and economic information. Oreg. State Univ. Sea Grant Ext. Mar. Advis. Program, Commer. Fish. Publ. 8 p.