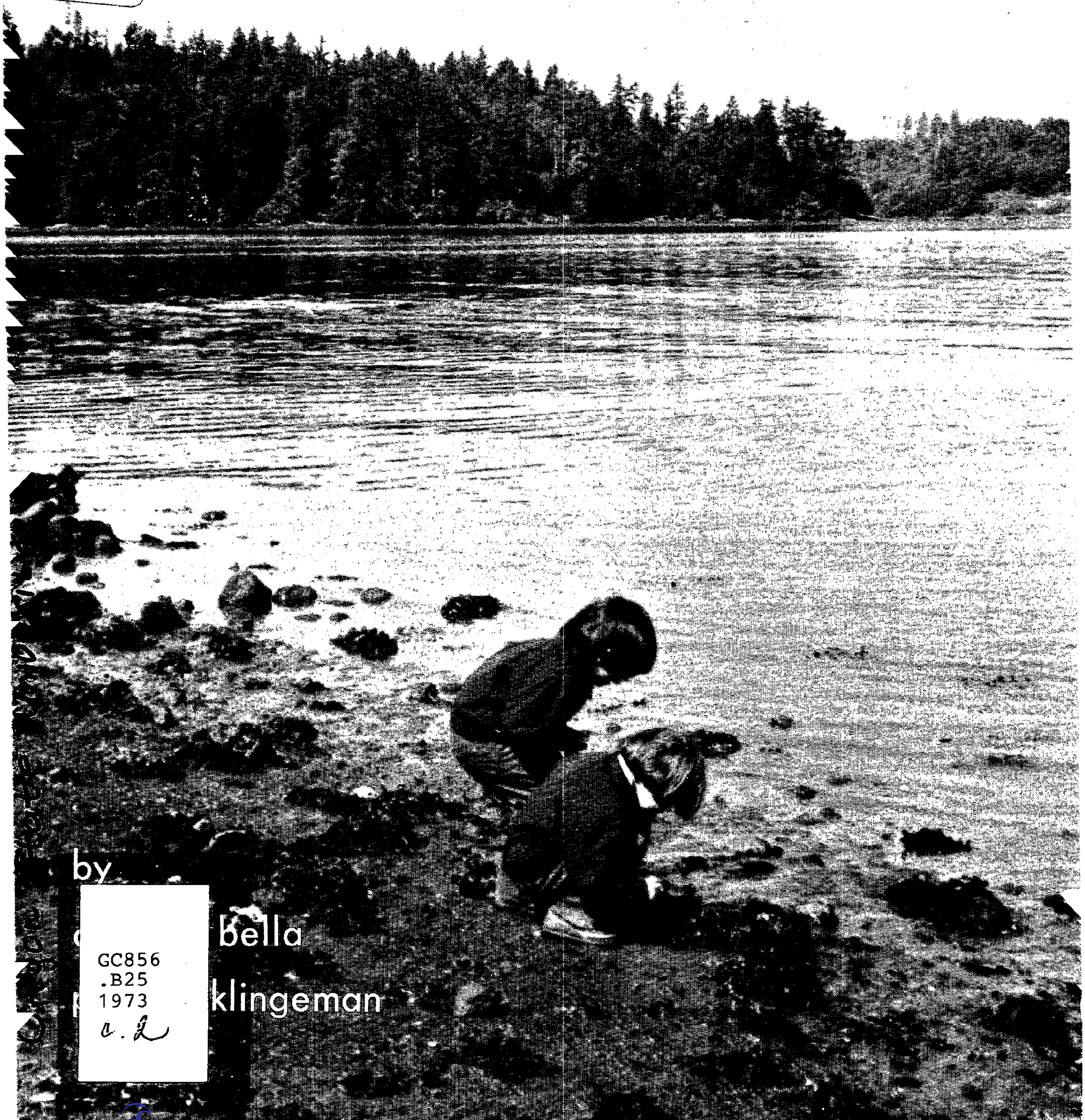
general planning methodology for oregon's estuarine natural resources



by
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The Water Resources Research Institute has provided the administrative coordination for this study by virtue of the Institute's broad experience in interdisciplinary research activities and its responsibility to coordinate, integrate, and facilitate the efforts of scientists from various disciplines. It is Institute policy to make available the results of significant water-related research conducted in Oregon's universities and colleges. The Institute neither endorses nor rejects the findings of the authors of such research. It does recommend careful consideration of the accumulated facts by those individuals concerned with the study of recognized problems.

The Water Resources Engineering Program at Oregon State University provides study programs and research which emphasize scientific, technological and environmental principles in several specialty areas concerned with water resources. This program is based on a broad comprehensive viewpoint which extends beyond hydraulic engineering and water quality engineering to include general resource planning and management. This study has been carried out as part of the Water Resources Engineering Program.

The Ocean Engineering Program at Oregon State University coordinates interdisciplinary research activities in cooperation with the several academic departments with special interests in ocean science and maintains contacts with many off-campus individuals, groups and agencies concerned with coastal resources, activities and problems. The initial organization of this study and continual cooperation have been provided by the Ocean Engineering Program, under the direction of Dr. Larry S. Slotta.

The work described in this report was performed for the Oregon Study Team of the Pacific Northwest River Basins Commission under contract with two of the member agencies of the study team: the U.S. Army Corps of Engineers and the National Oceanic and Atmospheric Administration. Work was conducted under Contract No. DACW57-72-C-0143 between the U.S. Army Corps of Engineers, Portland District, and the University and under Contract No. 03-3-208-69 between the National Oceanic and Atmospheric Administration and the University.

The general objectives of this study, begun in May 1972, were to develop a general methodology for making planning and management decisions for Oregon's estuarine natural resources, including determination of the information requirements for such a methodology, to illustrate the methodology's implementation and use at various planning levels, to determine the scientific information limitations which might constrain planning analyses, and to develop a framework for future activities to improve the general planning methodology.

GENERAL PLANNING METHODOLOGY FOR OREGON'S ESTUARINE NATURAL RESOURCES

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ABSTRACT

Fundamental concepts and concerns for comprehensive environmental planning are examined. It is reasoned that meaningful planning must effectively deal with the inevitable ignorance concerning man and the ecological systems of which he is an inseparable part. A "diversity approach" is presented which calls for the uneven distribution of man's activities among natural resource systems. This approach places a high value on environmental variety, including a wide range of undeveloped ecosystems. It is further reasoned that environmental planning must be organized into levels having varying scopes of responsibility. The responsibilities of each organizational level must be determined by the nature of the decisions that need to be made. The decision levels of broad responsibility are designated as strategic while the more local decision levels are defined as tactical. The environmental strategy presented herein calls for a developmental variety such that a number of estuarine systems would be developed using the best information available while actions are taken to prevent development in a variety of other estuarine systems. The strategy thus rejects the concept of a dispersed uniform development. A procedure for implementing this strategy is presented. Detailed planning is done at the tactical level which operates under strategic constraints. Environmental tactics presented herein to effectively treat detailed tactical planning call for the establishment of an intermediate planning level to formulate guidelines for natural resource use in particular estuaries, coordinate planning, and provide a broad range of professional functions and services for local planning in individual estuaries. These services include data gathering, data evaluation, habitat identification, and advance planning of alternative actions and their environmental impacts. Preventive planning is also an important tactic at this level. Procedures for implementing the tactical methodology are given. Recommendations include the implementation of developmental diversity at both the strategic and tactical decision levels. Specifically, cluster communities with intervening open space are strongly recommended. In addition, the approach presented herein calls for the restriction of shoreline development to those uses which specifically require waterfront locations, provide sufficient public benefits, and comply with strategic constraints and guidelines. Specific recommendations for Oregon's estuaries include several management actions which can be implemented immediately under the existing organizations, immediate actions to improve the availability of existing information, studies to improve the planning methodology of this report, organizational changes to effectively use the presented planning methodology, and studies to broaden knowledge of estuarine natural resources.

PREFACE

Purpose of This Study

This study was initiated to develop a general planning methodology for Oregon's estuarine natural resources. Such a methodology is required to help estuarine planners determine what information is important for decision making and to aid them in identifying, selecting from, and making maximum use of the available scientific information about the natural resources present in these complex systems. The scientific community responsible for developing knowledge of the estuarine physical-chemical-biological system has not fully recognized or appreciated the informational needs related to resource planning and management. The two groups, scientists and planners, outwardly appear headed in opposing directions--the scientists striving to broaden the base of knowledge and the planners seeking a distillation or simplification of this knowledge in order to relate it to other planning and management considerations. Hence this study attempts to offer the planner ways in which he might analyze estuarine natural resources based on what is known, assumed, or not known about those resources by the scientific community. The study focuses on environmental rather than social-economic-political elements of natural resource analysis. Hence, an essential future activity remains that of combining these several elements into a single comprehensive methodology.

Four objectives were established to guide this study. These were:

1. to develop a general methodology for making planning and management decisions for Oregon's estuarine natural resources;

2. to determine the information requirements needed to implement this methodology at different planning levels;

3. to examine basic interrelationships among physical, chemical, and biological characteristics of Oregon estuaries which might affect the decision-making process, in order to illustrate how such a general methodology can be implemented and utilized at various planning levels;

4. to determine the limitations in scientific information which might constrain analyses needed for planning activities affecting estuarine natural resources and develop a framework for future activities to improve the general planning methodology for the analysis of estuarine natural resources.

The decision-making process was examined in relation to the four objectives. This was necessary to properly perceive the multi-level planning approach used with respect to water and related resources. Because each planning level treats natural resources at a different level of resolution, the information requirements must likewise differ. Therefore, recognition has been given to these planning levels in treating the objectives regarding a planning methodology for estuarine natural resources and the associated information requirements and limitations.

Organization of This Study

The study was organized to include scientists from several disciplines concerned with estuarine natural resources and having interest in resource planning and management. They all shared a willingness to attempt the task of advising planners and policy makers in methods for analyzing estuarine systems and the associated natural resources.

Two groups of scientists were formed to assist the principal investigators in developing the study objectives. The first, identified as the "strategic planning" group, examined the objectives from a comprehensive, regional, long-range viewpoint of resource utilization. This emphasis somewhat parallels the functions of higher levels in the planning hierarchy. The second group was identified as the "tactical planning" group and treated local, detailed, short-term and long-term resource allocation such as often occurs for individual estuaries and involves local or state planning levles of the planning hierarchy. The two groups worked in close cooperation because the corresponding planning levels are also closely interrelated, each supplementing the other, even though the methods, assumptions, and information requirements may be quite different at each level.

The strategic study group was led by and served as consultants to Dr. David A. Bella, Associate Professor of Civil Engineering at Oregon State University, who has special interests in environmental strategies and the water quality dynamics of estuaries. Members of the group included Dr. Michael S. Inoue, Associate Professor of Industrial Engineering (O.S.U.), with special interests in systems engineering and decision theory; Dr. W. Scott Overton, Professor of Statistics and Forest Management (O.S.U.), with special interests in decision theory and ecology; Dr. Courtland L. Smith, Associate Professor of Anthropology (O.S.U.), with special interest in socio-cultural aspects of water resource development; and Mr. Jeffrey M. Stander visiting summer consultant (University of British Columbia) with special interest in decision processes.

The tactical study group was led by and served as consultants to Dr. Peter C. Klingeman, Associate Professor of Civil Engineering at Oregon State University, who has special interests in water resources planning and engineering. Members of the group included Mr. Danil R. Hancock, Instructor of Oceanography (O.S.U.), with special interests in biological oceanography and benthic ecology; Dr. Howard F. Horton, Professor of Fisheries (O.S.U.), with special interest in estuarine fishery resources; Dr. C. David McIntire, Associate Professor of Botany (O.S.U.), with special interests in aquatic ecology and limnology; and Dr. Larry S. Slotta, Associate Professor of Civil Engineering and Director of Ocean Engineering Programs (O.S.U.), with special interests in ocean engineering systems and coastal hydraulics.

Information gathering and assimilation was primarily the responsibility of two technical staff members: James B. Kennedy and Katherine L. Percy. Mr. Kennedy provided liaison and coordination between the strategic and tactical study groups, carrying out various assignments for those groups. He also met with and interviewed numerous individuals to obtain information useful in this study. Ms. Percy sought out and assembled a considerable body of information on the status and characteristics of Oregon's principal estuaries. This information was required both for this study and for a study on dredge spoil distribution and estuarine effects sponsored by the National Science Foundation Research Applications to Nation's Needs (RANN) program. Ms. Percy worked under the guidance of the authors and Dr. Charles K. Sollitt, Assistant Professor of Civil Engineering, a team-leader for the NSF-RANN study who cooperated closely with the tactical study group.

The strategic and tactical study groups were greatly aided by several individuals from within and outside of Oregon State University whose specialized knowledge was sought on a number of technical questions.

The study was conducted under a severe time constraint of six months.

Reports Prepared Under This Study

Two reports have been prepared under this study. The first is this report, General Planning Methodology for Oregon's Estuarine Natural Resources. It presents the proposed methodology for analysis of estuarine natural resources, including the underlying rationale and concepts, the information requirements at different planning levels, suggestions for implementation and use of the methodology at different planning levels, constraints due to limitations inscientific information, and recommendations for activities which should be initiated immediately to improve estuarine planning. The second report, titled Descriptions and Information Sources For Oregon Estuaries, presents considerable data and numerous citations for additional data describing the physical-chemical-biological characteristics and related features of Oregon's princiapl estuaries. Each estuary is treated separately in accordance with a standard format and the report is intended for periodic amplification so as to provide a continually current reference on Oregon estuarine resources for all scientists and planners who gather or use such information.

Acknowledgments

This study was sponsored by the Pacific Northwest River Basins Commission through its Oregon Study Team (consisting of federal agency and State of Oregon members), as part of the Pacific Northwest Comprehensive Joint Plan. A close working realtionship was established and maintained with the Oregon Study Team through frequent meetings during the period of this study. The financial support for this study came from two federal agencies who are part of the Oregon Study Team: the Portland District, Corps of Engineers, U.S. Department of the Army, and the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Representing these agencies on the study team were W.H. Daudistel, Portland District C. of E., and Charles S. Koski, National Marine Fisheries Service, NOAA.

The encouragement of all Oregon Study Team members and their leader, Jack G. Johnson of the Oregon State Water Resources Board, is gratefully acknowledged.

The appreciable support of the Oregon Coastal Conservation and Development Commission, particularly James F. Ross, Executive Director, and Wilbur Ternyik, Chairman, and of Paul Coyne, President of the Oregon Coastal Ports Federation, in obtaining information and in arranging meetings to exchange ideas with numerous knowledgeable individuals from state agencies, port authorities, coastal towns and counties is gratefully acknowledged.

The cooperation of the Sea Grant Program, Oregon State University, is acknowledged. Particular thanks are expressed to William Q. Wick, Head of Marine Advisory Programs, Oregon State University Sea Grant.

Considerable help and information was also provided by many other individuals whose assistance is collectively acknowledged here. The authors also wish to acknowledge Mrs. Elisabeth Schafer, who prepared this report through several drafts and numerous revisions.

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I

INTRODUCTION

Planning is the systematic process for determining the ways to accomplish desired goals and objectives. The general planning methodology presented in this report is based upon two types of planning and decision-making considerations: strategic and tactical. Each contains several elements or steps which are to be included in the analysis of estuarine natural resources. These are supported by several environmental concepts and by particular ways of seeing the natural resources as part of the larger estuarine system. However, the general planning methodology is not a specific procedural check list of what to do and how to do it.

The purpose of this introduction is to prepare the reader for the text that follows. The text is primarily devoted to the development of an environmental planning methodology for Oregon's fifteen estuaries (see Figure 1). The following statement will serve as a definition of the term estuary (Pritchard, 1967):

> "A semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage."

The text is the result of a six month study and has been prepared by two authors. Chapters II, III and IV have been written by David A. Bella. Chapters V, VI and the Appendix have been written by Peter C. Klingeman. The remaining portions of the text have been a joint effort. While steps have been taken by the authors to integrate the different portions of the text, the reader should be prepared for some differences in writing styles.

The material within the text covers a broad spectrum of subject areas. We have found that a number of words used in the text have slightly different meanings in different professional disciplines. The reader should be aware that such differences do exist and should make an effort to interpret meanings of words within the context of the text. We have attempted to use meanings of words as found in common (nontechnical) dictionaries.

The text is concept oriented. Thus, very little specific information or data on Oregon estuaries are presented in the text. Such information and data have been compiled in a separate accompanying report.

In the course of this study, a large number of planning reports have been examined. This text, however, is different from most in that it begins from a broad, low-detail, perspective. As one proceeds through the text, focus is sharpened and detail is increased. It is not until Chapter V that focus is sharpened to the degree normally found in the

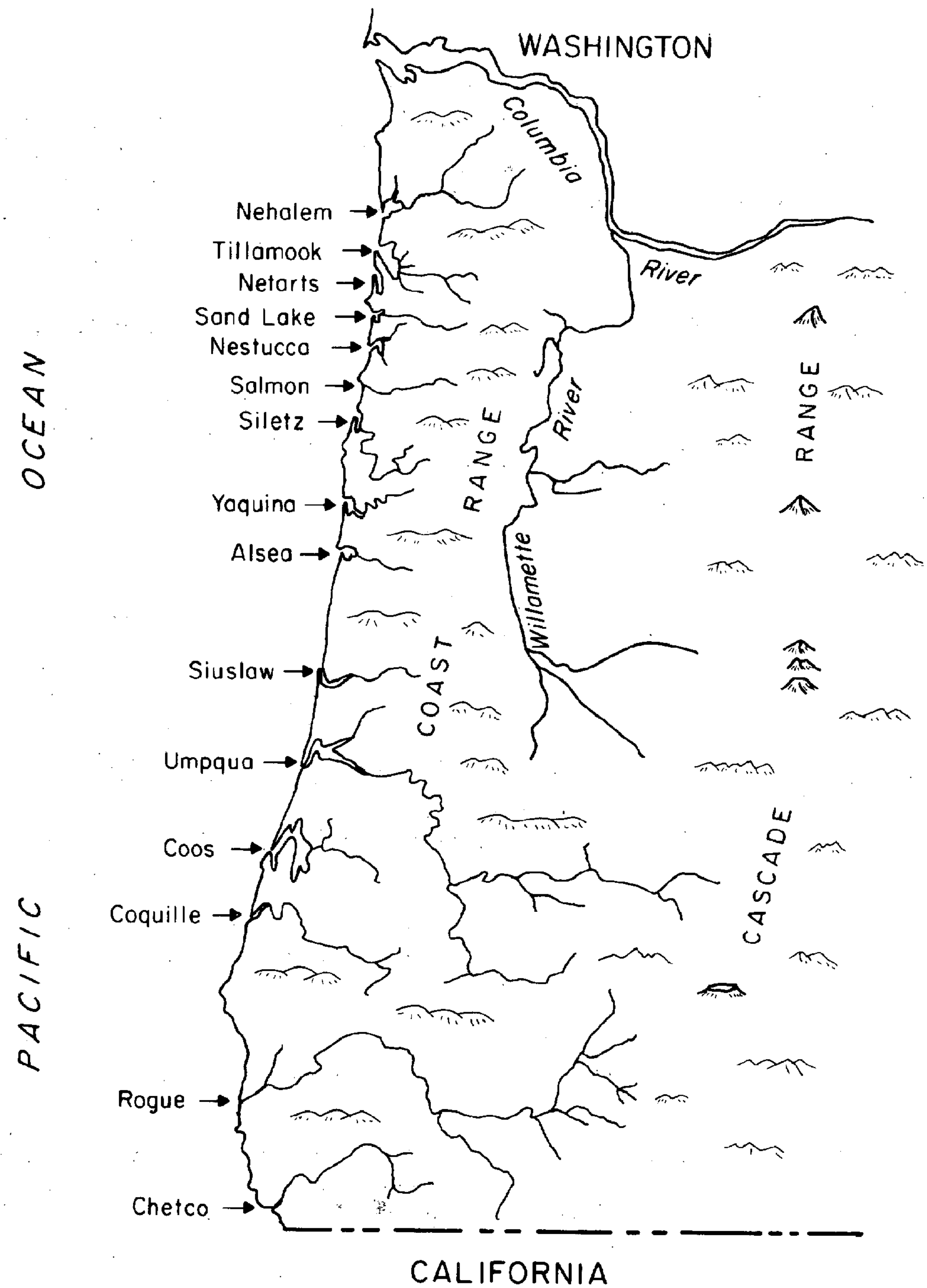

FIG. 1.-OREGON ESTUARIES

environmental engineering and management literature. Readers may feel that the beginning chapters are too "philosophical" or "conceptual" (particularly chapters II and III). The authors, however, strongly believe that the traditional approach to planning has not been of sufficient breadth and has been based on extremely weak (and often undefined) conceptual foundations. Thus, while the beginning chapters are broad, conceptually oriented and lack traditional detail, we believe that they are an essential part of the planning approach presented herein. The text does end with specific recommendations. However, the meaning and importance of these recommendations rests on an understanding of the preceding chapters.

Concepts presented in the text are interrelated. A written text, however, must proceed in a linear fashion. That is, concepts must be presented in a sequential order. The reader, therefore, must often go back to examine the relationships of new concepts to those previously given. We have attempted to eliminate much extraneous detail. However, the reader should expect to spend more time in reading and reflection than normally required from a text of this length.

Finally, it is emphasized that terrestrial and aquatic regions of estuarine systems are inseparably interrelated. Thus, the text considers land use planning and management as an essential and integral aspect of effective estuarine resource planning and management. Moreover, many of the concepts developed herein, particularly within chapters II and III, are applicable to general land use planning and management.

II

BASIC CONCERNS FOR ENVIRONMENTAL PLANNING

The Quality of Life

The general goal of environmental planning is to improve the quality of life as perceived by this and future generations. Because the "perceived quality of life" is too general to be applied to specific plans, there is the tendency of environmental planners to restrict use of this term to the general introduction of their planning reports. They then attempt to define goals which are specific, measurable and objective. This tendency reflects the notion that a rational approach begins with the specific definition of measurable quantities. There are dangers in this approach, however, for it is biased by the capacity of the planner to obtain specific measurements and to arrange such measurements into a specific framework which is defined as knowledge. It is meaningful, therefore, to proceed with a planning approach which recognizes the indeterminant and changing nature of the concept, "quality of life," yet, which does not abandon this concept too quickly in order to conform to currently accepted planning techniques.

"Goods" and "Bads"

Let us view the quality of life as influenced by environmental and social conditions. Those conditions which decrease the quality of life will be defined as "Bads" while those conditions which increase the quality of life will be defined as "Goods" (not to be confused with merchandise). At this point the reader should not be concerned with specific definitions and examples but should rather subjectively acknowledge that Bads and Goods do exist. If we can accept from our own personal experiences that bad conditions (Bads) and good conditions (Goods) can exist, it will be meaningful to examine, without being specific, the characteristics of Bads and Goods. If we cannot accept that Bads and Goods exist, then the concept, "quality of life" is meaningless.

Dominating Bads

Without becoming involved in the specifics of Bads, it is possible to generalize with regard to their properties, particularly those that are most severe. There is a set of Bads, each of which singly has the capacity of dominating the quality of life. A Bad such as starvation or extreme exposure has the capacity to guarantee an undesirable quality of life regardless of the other conditions present. As an example, if all conceivable human needs were provided except for adequate food, the quality of life would still be highly undesirable. There are no sets of Goods which have this capacity of dominating the quality of life. That is, one cannot provide a Good which guarantees that the quality of life will be highly desirable regardless of the other conditions present. Thus, only Bads have the capacity to dominate the quality of life. Those Bads which are recognized as individualy having this capacity will hereafter be defined as dominating Bads. There are no dominating Goods. Therefore, as a condition becomes more dominating, its chances of becoming a Bad increase while its chances of becoming a Good decrease.

Significance of Large-Scale Irreversible Change

The destruction of the quality of life may result from a complex set of Bads rather than a single dominating Bad or from a number of conditions which individually do not appear dominating or even significant but, in combination, lead to dominating Bads. It is possible to further generalize with regard to those Bads which result from significantly undesirable ecological states. First, such Bads will be wide in consequence, affecting a large segment of society. Second, such Bads will be uncorrectable, so that upon recognizing the Bads, man is unable to take actions which will lead to their removal.

An undesirable ecosystem state is correctable if the ecological process can be reversed so that the system returns to its initial state or to a more desirable different state. Most acceptable corrective actions will likely have some reversible properties. One can thus be certain of avoiding (or at least lessening) extreme ecological Bads by avoiding large scale irreversible changes. Similarly, serious noncorrectable Bads can result only if irreversible changes have occurred. Thus, while one cannot say that all irreversible changes contribute to significant ecological Bads, one can say that the most significant Bads are associated with large scale irreversible changes (Bella and Overton, 1972).

Properties of Goods

Unlike Bads, Goods do not have the capacity of domination, either individually or collectively. That is, there is no single Good or set of Goods that can guarantee that the quality of life will be desirable regardless of the other conditions present. Goods can only exert significant influence on the quality of life if dominating Bads are absent. The inability of Goods to dominate means that they are not readily subject to quantifiable measurement. They are essentially non-decomposable properties of environmental systems and are therefore relatively indeterminant by decomposable analytical approaches. Goods are the result of the complex relationships between the components (both human and non-human) of environmental systems and thus cannot be simply examined by the isolation of these components.

The Environmental Predicament And Its Influence On Decisions

The Environmental Predicament

The basic analytical approach which has provided modern man with his technological power is based on methods of qualitatively analyzing simply organized systems. Such methods were developed during the 17th, 18th, and 19th centuries (Weaver, 1948).

The design and development of complex systems has been possible by decomposing such systems into simply organized sub-systems suitable for mechanistic analysis. That is, complex systems have been analyzed and designed by an examination of their basic parts. The behavior and properties of these basic parts are examined and quantitatively measured without the need to consider the total complexity of the entire systems. Entire systems can then be understood, designed and constructed by integrating the behaviors and properties of the individual parts. Because of the reliance upon the ability to decompose complex systems into simple subsystems suitable for analysis and measurement, this general approach will be defined as analytical decomposition. In the area of engineering, the free body diagram, a variety of physical test procedures, the use of basic design manuals, and a variety of engineering design and analysis approaches are familiar examples of the use of analytical decomposition. The assumption of the analytical decomposability of complex systems (expressed in various manners) has been so widely accepted that it is seldom listed, examined, or even recognized along with other stated assumptions. The analytical decomposition approach has resulted in the design and development of complex man-made systems and has enabled man to significantly transform ecological systems, either intentionally or unintentionally. It is meaningful, therefore, to examine the adequacy of analytical decomposition when applied to ecological systems.

Ecosystems have continuously adjusted over evolutionary time to environmental changes by a selection process involving numerous species and systems of species. To survive, a species or system of species must be able to successfully compete within the system for necessary resources. Systems of species which cannot effectively withstand the extremes and perturbations of their environment are eliminated and succeeded by systems of greater durability, resilience or stability. Thus, ecological systems have been tested and modified at all levels of organization so as to continuously adapt to existing conditions. The result of this evolutionary process at any given time is a complex net of interlocking systems selected on the basis of past survival from a large number of less durable possibilities.

Man seeks to predict the ecological changes that would develop as a result of his actions so as to control his actions in a manner that would preserve and even enhance ecological systems for his benefit. One must examine the relative applicability of the assumption of analytical decomposition when applied to ecological systems. As described above, the evolutionary process has led to complex nets of interlocking systems. The survivability of ecological systems depends to a large extent on the system properties that result from the complex interaction of the parts. One must say, therefore, that ecological systems are relatively less decomposable than are man-made systems. It can be reasoned that social systems are similarly less decomposable. A broad definition of ecological system should include social systems and the systems of man's design. Within such broadly defined ecosystems, those features which are of man's analytical design are most subject to analytical decomposition. Recall, however, that analytical decomposition is a principal method that man uses for analyzing systems.

A predicament that man faces should now be apparent if one considers both the analytical capabilities of man and the nature of the systems (man-made and ecological) which are the objects of his study. Analytical decomposition is more applicable to man-made systems than to ecological systems; yet such decomposition is an important and useful means of obtaining knowledge. That is, the process of analyzing systems through the relatively isolated examination of their basic parts is more applicable to the systems of man's design than to the ecological and social systems which contain man and his works. Our knowledge is thus bias toward the more analytically decomposable systems of our own design. Man's capacity to expand man-made systems and change ecological systems, can be expected to exceed by increasing amounts his ability to foresee the ecological and social consequences of his actions. We can expect significant advances in the environmental and social sciences. The relevant point, however, is not that the environmental and social sciences will significantly advance but rather that it is unreasonable for us to expect that this advance can keep pace with the more rapid development of our capacity to expand the systems of our own design. Man is faced with an environmental predicament which can be stated as: man's ability to modify the environment will increase faster than his ability to foresee the effects of his activities (Bella and Overton, 1972). Our inability to foresee our own reactions to the actions that we are capable of taking may be the most significant aspect of the environmental predicament.

The environmental predicament can be expressed in another simplified way. Man's knowledge of ecological systems will increase but, because his capacity to change these systems will increasingly exceed his capacity to foresee what such changes will be, man's ignorance relative to environmental decisions will also increase. This concept is conceptually illustrated in Figure 2. Both the ability to produce change (line A) and the ability to foresee what such change will be (line B) are shown to increase with the former increasing at a higher rate than the latter. The shapes of lines A and B are not significant. What is significant, however, is the positive slope of both lines and the steeper slope of line A relative to line B. The difference between the two lines is defined as the relative ignorance because it defines the difference between the ability to produce environmental changes and the ability to foresee what such changes will be at a given time. As shown in the figure, the magnitude of this relative ignorance increases with time. It is important to realize that the actual construction of Figure 2, particularly line B, would be impossible yet the figure does serve to simply illustrate the basic concept of the environmental predicament.

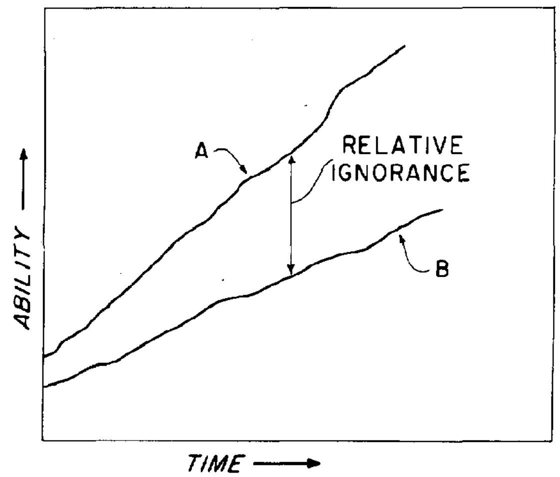

FIG. 2.-ABILITY TO PRODUCE ENVIRONMENTAL CHANGE (A)
AND ABILITY TO FORESEE ENVIRONMENTAL CHANGE (B)

The environmental predicament strongly suggests that we must increasingly recognize our inability to determine the total consequences of our combined actions. In the past, however, environmental decisions have been based principally on the presumption of adequate knowledge, particularly at higher levels, often because of the political difficulty of admitting uncertainty or the possibility of undesirable outcomes. It is true that modern decision theory does not treat all outcomes of considered actions as certain but rather assigns a probability to each member of a set of possible outcomes. The set of possible outcomes chosen and the probabilities assigned, however, both result from the beliefs of the decision maker and thus reflect the bias and limitations of the knowledge available to the decision maker.

Influence of Decision Bias

When considering undesirable ecological and social conditions, there is a tendency to relate these conditions to a specific set of inappropriate actions by man. Such undesirable conditions, however, might be more appropriately related to the general nature of the decision methods used in selecting the actions taken by man.

Consider the influences of a generally accepted (and used) decision method which assumes the adequacy of available knowledge. The nature of the knowledge of the decision makers will have an influence on the transformation of the actual systems under management. That is, the response of the actual systems under management will depend on the perceived systems of the decision makers. The bias and limitations of the decision makers will have a continued influence on the transformation of the managed system. In general, decisions based on a given knowledge will, over time, tend to resist, reduce or eliminate those system properties that do not fall within the scope of that knowledge. The systems may, of course, resist such transformations and, thus, the degree of system transformation will depend on the capacities of the decision-makers to overcome such resistance.

Recall that analytical decomposition of complex systems is an important aspect of man's means to knowledge. If man's knowledge is assumed to be adequate, decisions based on this knowledge will tend to transform, over a period of time, ecological and social systems into more readily analytically decomposable systems. That is, the acceptance and use by modern decision makers of knowledge obtainable primarily through the analytical decomposition of complex systems will eventually tend to resist, reduce or eliminate those properties of the managed systems which are least subject to analysis by decomposition.

While few would doubt that man's technological progress has enabled him to significantly improve his quality of life, primarily by avoiding dominating Bads, there must be concern over the loss of those system properties which do not readily conform to man's analytical techniques. There is a danger that objective management decisions essentially deny the existence of that which does not readily conform to these techniques. Reality becomes a function of analytical decomposability, existence is equated to quantifiable measurement and value is equated to price, despite the subjective beliefs of the decision makers to the contrary. Complete reliance on analytical technique, technolatry, results in the means justifying the ends where the ends are characterized by a decline of those system properties which are least compatible to analytical decomposition.

It is generally believed that the complex interrelationships within ecological systems provide these systems with stability and resilience. The increased productivity of a relatively few components desired by man, however, is more readily subject to analytical decomposition than are the complex interrelationships on which the self-regulatory capabilities of ecosystems depend. A major concern of ecologists is that the efficiency of this limited productivity may be ultimately purchased by the unacceptable sacrifice of these self-regulatory capabilities. Social systems also contain complex interactions (fellowship, community, love, etc.) and social critics have likewise expressed concern that the gains obtained through the use of established analytical techniques may be exceeded by the loss of those system properties which do not readily conform to these techniques.

The Avoidance of Dominating Bads

Those Bads which have the capacity to dominate the quality of life can be defined and measured independently of the remaining non-dominating conditions which influence the quality of life. That is, dominating Bads may be decomposed from the remaining conditions which determine the quality of life. The response of corrective actions to eliminate dominating Bads can thus also be analyzed and measured by a decomposable approach. It is understandable therefore, that the techniques and methods which assume the analytical decomposability of complex systems have been particularly useful in avoiding dominating Bads. The technological innovations (i.e., improved farming, shelters, medicines, transportation, etc.) of man have led to significant reductions in the dominating Bads (i.e. starvation, disease, and exposure). There is an error, however, in assuming that the same techniques and methods successfully used to avoid dominating Bads can successfully be used to avoid all Bads and pursue Goods. This error has been examined in the previous subsection; however, a more subjective illustration might serve to clarify this concept.

Consider a family in our society which has a total annual income of $1000 per year. Also assume that no additional welfare or public services which might supplement this income are provided. The efforts of such a family would be essentially devoted to avoiding the obvious dominating Bads such as starvation, exposure and disease. If the income was wisely spent, the family's capacity to avoid these Bads could be measured by their annual income. Until the income was sufficiently high to assure survival, it would be unreasonable to expect this family to take vacations, spend significant time together apart from work, take up hobbies and participate, in any significant way, in activities and experiences which did not directly contribute to their income and thus increase their chances of survival. We could not criticize such a family for devoting their entire efforts to avoiding the ever present dominating Bads, in fact, we would likely respect them for their efforts and sympathize with them because of their conditions.

Consider this same family now with an income of $20,000 per year. It would not be unreasonable to expect this family to now take vacations, spend significant time together apart from work, take up hobbies and participate in a variety of activities and experiences which did not directly contribute to their income. We would not likely respect such a family for devoting their entire efforts to increasing their income, though, we might sympathize with members of the family, particularly the children, for such an attitude.

The above example illustrates, in a manner with which we can subjectively identify, that the techniques and approaches which are reasonable and acceptable for avoiding dominating Bads are not reasonable and acceptable to avoid all Bads and pursue Goods.

With the general discussion of the previous sub-section and the above example, it is possible to identify a number of differences between the techniques and methods useful and often necessary to avoid the dominating Bads and those approaches which are more appropriate to avoiding the remaining Bads and pursuing Goods. The avoidance of dominating Bads is characterized by specific objective measurable indicators of success, and the relative success of techniques and methods which assume the analytical decomposability of complex systems. In contrast, the avoidance of the less dominating Bads and the pursuit of Goods are characterized by more subjective feelings of success and by the capacity to establish quality relationships which cannot be readily examined by isolating the components. Moreover, the pursuit of Goods involves the creation and preservation of conditions where Goods <u>might</u> happen rather than specific plans with predictable and quantifiable results.

We can recognize, both from the discussion of the previous sub-section and the example presented above, that the traditional approaches to environmental planning have been strongly influenced by the assumption of analytical decomposability and the avoidance of dominating Bads. The rigorous use of the terms "efficiency" and "optimum" in planning approaches often reflects the domination in the planning process of system properties which can easily be subjected to analytical decomposition and quantifiable measurement. These approaches have resulted in changes that have improved the quality of life, yet their universal application to the avoidance of non-dominating Bads and the pursuit of Goods may ultimately result in the deterioration of the quality of life or, at the least, a quality of life far below our potentialities.

If environmental problems are to be met in the next decade, so as to result in an improved quality of life, a revolution in the way we approach problems and make management decisions must occur. The traditional approaches alone are not sufficient to deal with man's expanding capacity to change his environment and the unjustified presumptions of knowledge concerning his capacity.

The Tragedy of the Commons

In a paper on the problem of over population, Garrett Hardin discussed a general condition which he calls "the tragedy of the commons" (Hardin, 1968). The basic concepts illustrated by Hardin have been frequently identified with a variety of environmental and social problems and thus any meaningful environmental planning approach should deal with these concepts.

Hardin illustrates "the tragedy of the commons" by describing a common pasture open to use by a number of herdsmen. Each herdsman seeks to maximize his own gain and does so by trying to raise as many cattle as possible on the commons. A question faced by each herdsman is "what is the utility to me of increasing my herd by one animal." Since each herdsman receives all the proceeds from the sale of one animal, the positive component of this utility is nearly equal to the value of one animal. The negative component of this utility is a function of the additional overgrazing in the commons due to the additional animal. The effects of overgrazing, however, are distributed among all herdsmen and thus, the negative component of the utility for the single herdsman is considerably less than the positive component. Because the individual net utility is positive, the practical herdsman will conclude that the rational decision for him is to add the additional animal. Each herdsman sharing the commons reaches the same conclusion. "Therein," Hardin states, "is the tragedy. Each man is locked into a system that compels him to increase his herd without limit-- in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in the commons brings ruin to all..... The individual benefits as an individual....even though society as a whole, of which he is part, suffers."

The "tragedy of the commons" can be identified in economics, air and water pollution, land use and a wide variety of areas related to environmental planning. In each case, the benefits resulting from a given decision are more localized (concentrated) than the losses. Localized decision levels can receive the benefits while accepting only a portion of the losses. Moreover, if the number of such local levels is large, each will separately rationalize that its contribution to any higher level problem is insignificant, and often indeterminant. Thus, while separate decisions made at local levels may indicate a net benefit to the local level with negligible losses, the combined results of such decisions brings a net loss to all.

If we return to the common pasture described by Hardin, we find that the "tragedy of the commons" does not occur when the demands on the common pasture are considerably below its carrying capacity. Thus, when the total number of animals is small relative to the capacity of the commons, the decisions reached individually will likely be best for the entire society.

Under such conditions, however, success eventually leads to the "tragedy" unless a different management approach is adopted before the size of the herds exceeds the carrying capacity of the commons. The older management approach of individual choice of herd size was not wrong when the commons were undergrazed, rather, the success of this approach lead to its own obsolescence. The management approach necessitated by the continued growth must include controls or influences (coercion) sufficient to avoid exceeding the carrying capacity of the commons.

Modern societies are far more complex than the society of herdsmen described by Hardin. The impacts of modern man on his life support systems are multiple and complex, yet the lesson of the herdsmen still ultimately applies. "Freedom in a commons brings ruin to all." If the tragedy of the commons is to be avoided, there must be a direct relationship between increasing controls on individual environmental management decisions and growth, both in terms of numbers of people and per-capita environmental demands. Thus, despite their appeal and their historical compatability, growth and localized management decisions will increasingly conflict.

Social Inertia

Inertia and State of Motion in Society

In the physical sciences, the term "inertia" is used to describe the tendency of an object to remain in a given state of motion. The state of motion of an object defines the future positions of that object in time and space if the state of motion is not changed. The force (or set of forces) required to produce a given change in the state of motion is proportional to the inertia. A greater inertia will require a greater force to produce a given change in the state of motion. A change in the state of motion produced by a given force (or set of forces) will be inversely proportional to the inertia of the object.

While social systems cannot be described by the laws of motion for physical objects (Newton's laws), it is helpful to use the terms "inertia" and "state of motion" to describe certain behaviors of social systems. The state of motion of a social system defines the environmental and social conditions that will be most likely to occur over time. The combined influence of the laws, tax structures, values, customs, history, institutions, etc. of a society determines which changes (environmental and social) will be acceptable and profitable and thus persist and grow and which changes will not be acceptable and profitable and thus will be competitively excluded. Initiative and originality in society may be encouraged, however the success of such action depends on its compatibility with the social state of motion. While decisions taken by man often appear to have a random, non-rational component, the general nature of analytical decision methods gives direction to the collection of decisions and thus is a significant determinant of the social state of motion. Thus, the influence of decision bias previously discussed is relevant even though the directions of decisions have non-analytical components.

The state of motion of a society is significantly different from that of physical objects (as described by Newton's Laws). The social state of motion defines a range of environmental and social conditions which have different probabilities of occurrence. Within such a range, the occurrence of specific conditions is indeterminate though the general system properties resulting from many specific conditions may be reasonably predictable. The social state of motion describes a wide variety of environmental and social changes of varying degrees of interconnectivity. That is the social state of motion is multi-dimensional. The state of motion of many societies displays tendencies for acceleration (in numbers of people, energy use, technological innovations etc.) while the state of motion of physical objects involves no change in velocity unless and external force is applied.

A society also establishes an inertia which is a measure of the tendency of society to maintain a given state of motion. Many of the laws, tax structures, customs, institutions etc. tend to support their own survival and thus provide resistance to changes which would threaten (or appear to threaten) their survival. The perceived history of a society also contributes to its inertia by providing past examples of how to and how not to make certain decisions. Not all factors within a society support the same state of motion. Rather, many aspects of a society encourage different states of motion and thus the resultant inertia of a society does not necessarily reflect an agreement on the state of motion but may reflect a domination of certain influences and/or a complex combination of influences.

The Projection Method

A common approach to planning involves the projection of past measurements (such as population, water needs, per capita energy demand, traffic flows, resource utilization, etc.) to future dates and the development of plans and recommendations for specific projects which will meet the requirements of such projections. Too often, the desirability of the projections themselves are not sufficiently examined. Moreover, the plans developed often are not significantly concerned with changing the state of motion so as to enable more desirable outcomes than those of the projection. It is useful to examine the projection method from the standpoint of a social state of motion and a social inertia.

First, this approach tends to accept or nearly accept the social state of motion as reflected in the projections. This acceptance results from an approach which assumes that (a) the perceived social state of motion is essentially invariant (fatalistic approach) or (b) the current (and recent past) perceived social state of motion is assumed to be the most desirable (optimistic approach).

Second, plans based on the projection method increase the perceived social inertia. That is, the results of the planning process make future changes in the social state of motion more difficult. Increasing the perceived social inertia can be justified (or at least tolerated) by assuming that (a) the social inertia is essentially infinite and thus any additional change is insignificant (fatalistic approach); (b) the existing state of motion is the most desirable possible (optimistic approach); or (c) future changes in the social state of motion are undesirable regardless of their nature (deterministic approach). The deterministic approach places a high value or control itself though it is difficult to see how control in itself contributes *a priori* to the quality of life.

The use of the projection method by planning agencies and professional planners is often itself a result of the social inertia. Often, the use of the projection method as well as other constraints are imposed prior to the involvement of those persons normally identified as planners. It is obvious that the placement of such constraints is itself an important part of the planning process and those responsible for such constraints should be able to support and defend their contribution. There are many instances, of course, where projections are useful to the planning process. Too often, however, the projection method dominates planning and those responsible for its domination fail to justify (or even attempt to justify) its use. An effective environmental planning process must have the capability of changing the social state of motion and social inertia so that more desirable environmental outcomes can be obtained.

III

A BASIC APPROACH TO ENVIRONMENTAL PLANNING

Effective environmental planning must be able to cope with the related difficulties discussed previously under the three general headings "The Environmental Predicament," "The Tragedy of the Commons" and "Social Inertia." The ability of a planning approach to effectively cope with all of these three areas of concern and contribute to the improved quality of life can serve as a basis for evaluation. Such an evaluation is demanding and most general planning approaches fail to satisfactorily cope with one or more of these three areas and/or fail to incorporate the relatively non-decomposable aspects of the "quality of life" into the planning process. In the following chapter, a basic general environmental planning approach will be developed.

The Avoidance of Dominating and Large-Scale Irreversible Change

The environment predicament forces one to acknowledge that unforeseen outcomes can occur as a result of the actions which man is capable of undertaking. Moreover, the scope and magnitude of such unforeseen outcomes is rapidly increasing in response to rapid technological growth. It would be unreasonable to expect all such unforeseen outcomes to be beneficial to the quality of life, in fact, the most significant of these outcomes would likely be highly destructive if permitted to occur. A major requirement of effective environmental planning is the avoidance of unforeseen outcomes which have the capacity of significantly destroying the quality of life.

While it is not possible to define a causal relationship between the combined actions considered by man, the outcomes of such actions and the resulting changes in the quality of life, it is possible to identify certain characteristics of those actions or sets of actions which are most likely to lead to conditions which are destructive to the quality of life. An environmental planning approach can avoid actions and sets of actions which display these characteristics.

First, it has been discussed that as a condition becomes more dominating, its chances of becoming a Bad increase while its chances of becoming a Good decrease. The environmental approach presented herein is based, in part, on the avoidance of those actions or sets of actions which over time result in the domination of a few system properties or components. This concept is defined as the rule of dominating change which can be stated by the following two similar (though not identical) statements: (1) actions or sets of actions which lead to the domination of a relatively few system properties or system components are to be avoided; and (2) actions and sets of actions which tend to make variety less compatible and which encourage conflict and competitive exclusion between varieties are to be discouraged. The above two statements do not imply that change is to be discouraged. Statement (1) does, however, suggest that if extremely rapid change becomes a dominating property of ecological and social systems, it should be avoided. A convincing (and sometimes exhausting) argument that the rapidity of change is producing significant individual and social problems has been presented by Alvin Toffler in his best seller "Future Shock" (Toffler, 1970).

Second, it has been argued that one can be certain of avoiding or at least lessening the extreme ecological Bads by avoiding large scale irreversible changes. This concept has been defined as the rule of irreversible change and can be stated by the following statement: actions or sets of actions which lead to large scale irreversible ecological change are to be avoided. The intended meaning of large scale irreversible change can be interpreted by examining the following examples of such change (Bella and Overton, 1972).

1. Ecological components such as species, sets of species, habitat types, etc. are eliminated (become extinct) before their importance is recognized and effective action is taken.
2. A harmful condition or set of conditions becomes so widespread, before detection, that effective corrective action becomes impossible or requires unacceptable risk.
3. Increasingly catastrophic ecological changes result from system modifications upon which society has become so dependent that removal of these modifications would be catastrophic in itself.
4. Environmental and social damage is such that, by the time it is sufficiently recognized by society, its effect on society results in the loss of capacity to take effective action.

Type 2 irreversibility is implied in the other types, particularly types 3 and 4. An increased use of pesticides to support an expanding population might be an example of type 3 while an expanding use of drugs in society might be an example of type 4.

Actions which lead to dominating changes and large scale irreversible changes are most likely to contribute to Bads and thus, the rule of dominating change and the rule of large scale irreversible change seek to avoid such actions. A general approach must be developed which satisfies both of these rules.

The rule of large scale irreversible change suggest that flexibility and impermanency be an important aspect of all actions taken by man. Under such an approach the filling of tidelands (as an example) would be considered less desirable that the construction of floating fish rearing tanks because the latter action is less permanent and thus, more easily removed. While the avoidance of permanence in actions taken by man has certain desirable properties, a number of serious shortcomings can be identified. First, the purposeful lack of permanence in actions taken by man contributes to the increased rates of change to which society is subjected. As previously stated, the rapidity of change is itself becoming a dominating system property which appears to have deleterious effects (both real and potential) on society and thus is a violation of the rule of dominating change. Second, while the actual physical removal of a system change may be a simple matter, the reliance of society on that change may result in a social inertia sufficient to resist its removal. Thus while the action may be physically reversible, it may be relatively socially irreversible (see type 3 irreversibility defined above). Thirdly, the purposeful reversal of a system change would most likely result from an identification of a deleterious effect and its relationship to the system change. Such an identification may not be possible as is suggested by the environmental predicament. Finally, while the specific system change taken by man may be easily reversible, the ecological effects of this change may be relatively irreversible. As an example, the introduction of hatchery fish to an aquatic system can be more easily terminated than can the re-establishment of the native system which may have been competitively excluded, in part, by the hatchery fish. Thus, while flexibility and lack of permanence can be part of a planning approach under certain conditions, their limitations must be recognized.

The Diversity Approach

An approach which satisfies both the rule of dominating change and the rule of large scale irreversible change calls for the uneven distribution of man's environmental influences. Developmental efforts are confined to a number of selected systems and regions while specific steps are taken to prevent and even reduce development in others (Bella and Overton, 1972). This approach, hereafter called the diversity approach, specifically places a high value on environmental variety, including a wide range of essentially untouched ecosystems, and thus avoids widespread dominating environmental changes without the requirement of prior identification. Under this approach, decisions to preserve ecosystems should be as binding as decisions to develop others. Moreover, the environmental predicament forces one to reject the notion that specific proof, in the traditional form, is needed for each decision to preserve. Rather, decisions to preserve are based, in part, on the concept that environmental planning must deal with the limitations and bias of available knowledge. It follows that, the greater the rate of population and technological growth, the greater will be the indeterminancy of outcomes and thus the greater will be the need for preserving essentially undeveloped ecosystems. The diversity approach, however, is not intended to substitute for the long term stabilization of environmental demands, resource use and population levels. Resources are finite and, thus, unchecked growth cannot occur indefinitely.

The diversity approach should not imply that environmental quality is of little importance within those systems and regions selected for development. The best available information should be utilized within such regions so as to provide an environment which is beneficial to the quality of life. While use of this information is necessary, it alone is not sufficient because of its limitations and bias. The use of available information is thus complimented by the diversity approach which, in essence, acknowledges and places a value on those things which do not fall within the scope of this knowledge. The diversity approach seeks to preserve species, systems of species, habitat types, etc., without specifically defining their needs or their specific relationship to the quality of life; it seeks to prevent widespread harmful conditions prior to the identification of such conditions; it seeks to maximize the return information gained from past mistakes by providing controls for comparison and study; it seeks to avoid the domination of system properties or components without their prior identification; and it serves to preserve environmental options, thus enabling greater capabilities of adjustment to indeterminant and changing value systems.

With regard to Oregon estuaries, the diversity approach rejects the notion that a standard planning approach be developed for all of these estuaries. Rather, the approach calls for developmental efforts be confined to a number of estuaries while specific steps to prevent development be taken in others. The remaining estuaries would have varied developments with the maintenance of developmental diversity and the preservation of a wide range of habitat types given a high priority. Within estuaries selected for development, developmental diversity should also be encouraged.

The Pursuit of Goods

For man, life, in its fullest sense, involves a continuance of experiences and relationships that extends far beyond his basic biological needs. Each person has a wide range of experiential and relational potentialities. Moreover, such potentialities vary from individual to individual. These potentialities can only be realized, however, if conditions are favorable to their development. Whether the stimuli for the development of these potentialities come from social or non-social forces, the diversity of the environment is of major importance (Dubos, 1970). The preservation and enhancement of compatible diversity is ultimately the preservation and enhancement of the human potential to experience, to relate, to live, (Mumford, 1966; Dasmann, 1968; Dubos, 1970). The public rally to preserve the redwood forests, to protect the whooping crane or to save the brown pelican is most likely motivated by a desire to preserve human potentialities rather than from an understanding of ecological systems. The pursuit of Goods is thus a striving for the realization of human potentialities and this can be enabled by a variety of compatible stimuli. The diversity approach, therefore, is meaningful to the pursuit of Goods.

The diversity approach can also make compatible what appear to be two fundamental needs of man: the need for close human communion and the need to experience environments free from the dominance of his own artifacts. Moreover, if a society does value freedom of choice, then it must strive to preserve that from which choice can be made; the diversity approach thus serves to protect the capacity to choose. This approach does not call for a return to the primeval past but rather calls for a mosaic of environments which include those which reflect the most advanced stages of man's cultural developments as well as those which reflect man's evolutionary and cultural past. A variety of specific plans for the pursuit of Goods, particularly for the development of human communities, should be incorporated into this approach. We must recognize, however, that such specific plans must be considered as experimental for we cannot constrain the pursuit of Goods by the limitations of our analytical techniques.

Ecosystem Organization

"An ecosystem is a historical construction, so complex that any actual state has a negligible *a priori* probability" (Margalef, 1968). With such a statement, one wonders if the comprehensive study of ecological systems can lead to any meaningful predictive ability. While comprehensive prediction in detail is impossible, general trends and responses to man's activities can be identified by directing attention toward the ecosystem level of organization rather than confining environmental study to the components of particular ecosystems. That is, properties and behaviors of entire ecosystems can be examined without the necessity of reducing such systems to their basic parts. This broader, ecological approach can complement the more detailed reductionist approaches common to many areas of environmental science.

Ecological systems have the capacity of being altered into a multitude of different states. These states must compete for available resources within the environments to which they are subjected. System states which are best able to persist under the existing conditions competitively exclude the less durable states. The process is continual and directional, with persistence under existing conditions determining the selection from a range of potential alterations. Successful alterations change the range of potential alterations from which future direction is selected. Thus, the process continues with successful alterations contributing to the conditions under which future alterations compete. Ecological systems thus possess a self-organizational capacity which is continually directed toward increased persistence under existing conditions. This self-organizing process can be viewed from two similar, though distinctly different perspectives: evolution and succession. Evolution involves a long term adjustment of ecosystems to long term changing environmental conditions. The long time span of evolution enables the development of new species and systems of species as part of the self-organizing process. Succession involves the short term adjustment of ecosystems to environmental conditions.

Succession must essentially rely upon the biological resources developed at a given time through the evolutionary process. Environmental management must be viewed primarily on the time scale of succession. Man cannot rely on the evolutionary process to accommodate his actions, for evolution is a long term process and the actions of man are essentially instantaneous on an evolutionary time scale.

Succession is a self-organization process which provides a directed change of ecological systems from immature states to mature states. Properties commonly associated with immature ecosystems are: weak biological organization, low species diversity, high ratio of primary production to total biomass, greater responses to environmental changes, domination of species of high reproduction rates, tendencies to fluctuate in wide and unpredictable manners, shorter food chains, shorter life cycles and less specialization. In comparison, mature ecosystems are generally characterized by: stronger more complex organization, increased diversity, lower ratio of primary production to total biomass, increased physical structures (e.g.; burrows, paths, territory markers, etc.), increased stability, longer food chains, longer life cycles, lower intrinsic growth rates and more specialization (Margelef, 1968; Odum, 1969). The differences between the characteristics of mature and immature ecosystems reflect, in general, the continued competitive selection of the most persistent system alterations. The selection of ecosystem alterations is, thus, directed toward an increasing control or homeostasis with the environment so as to maximize protection from its perturbations. In short, succession involves the continued channelization of energy and resources into internal structure so as to maximize "protection" of the system (Odum, 1969).

In using the environment, man's goal can be defined as maximum "production," that is, the highest yield of those goods most useful to man (Odum, 1969). The pursuit of maximum "production" for man (particularly modern man) tends to reverse succession. That is, man's traditional goal of maximum "production" is in direct conflict with the maximum "protection" which is the goal of succession.

Consider several related ways in which man uses the environment. First, the environment is modified to produce the maximum yield for a limited number of crops (monoculture farming is an example). Such modifications result in a reduction of diversity and community organization. That is, man intentionally changes the system to a less mature system in order to divert the energy and resources away from internal structure into the production of relatively few products suitable for his use. Less mature systems, however, favor opportunistic species which increase rapidly in numbers, quickly recover after heavy losses, disperse easily and exhibit strong unreliable fluctuations in numbers and environmental impact. Second, widespread environmental changes are produced which result in conditions significantly different, in character, magnitude and/or frequency from those under which the system has evolved. On an evolutionary time scale, such changes are sudden and thus the evolutionary process cannot adjust the systems to such changes within an acceptable period of time. As a result, succession, which must draw upon the resources of evolution, can only progress to less mature states. Again, the opportunistic species, in general, tend to be most favored. Third, specific groups of species are harvested or removed from natural or near natural systems. Most often, such harvesting is concerned with species associated with more mature systems, that is, larger species, ones of more stable populations, ones with longer life spans, and ones higher on the food chains. The decimation of such species results in less mature systems and thus, again, results in conditions more favorable to opportunistic species. Fourth, the utilization of aquatic ecosystems for waste disposal results in conditions of physiological stress which reduce or eliminate the advantages of specialization and which are particularly harmful to species high on the food chains. Opportunistic species are relatively favored and thus the system is forced into a less mature state.

In all of the above examples, man's actions tend to reverse the direction of succession and lead to conditions of immature states. Man's use of ecological systems for maximized "production" of desired goods is thus purchased by a price of ecological "protection," that is, a decrease of the ecological stability and resilience of mature systems upon which man depends. In the past, "protection" could be assumed and thus man's efforts could be devoted primarily to "production." Both, however, are necessary for an improved quality of life and it is necessary that modern man, with his increased capacity to transform his environment, be concerned with both. Management strategies, however, must recognize that "protection" and "production" cannot be significantly provided by the same ecosystem; they may be traded but cannot be simultaneously pursued in the same system. Rather, a variety of ecosystems must be provided whose primary reliable function is either "production" or "protection" (Margalef, 1968; Odum, 1969). In other words, a mixture of ecological communities of different successional ages should be a goal of environmental planning. Such a goal can best be pursued by an uneven distribution of man's activities so as to preserve a wide variety of essentially undeveloped ecosystems for the purpose of "protection" while developing others for "production." In short, the diversity approach previously discussed appears to be most reasonable for providing this balance.

The Need for Planning Levels

The example of the common pasture used by Hardin to describe the "tragedy of the commons" illustrates the need for levels of planning. While the scope of consideration for the individual herdsmen was, no doubt, an adequate and often the best basis for making a variety of decisions, it was not adequate for dealing with the combined overgrazing of the commons. Dealing effectively with this problem would require an expanded scope of consideration which included the demands of all herdsmen on the common pasture. In short, a decision or planning level of broader scope than the individual herdsmen was needed to prevent the ruin of all herdsmen.

The need for levels of planning with differing scopes or ranges of responsibility can be demonstrated by considering the difficulties associated with preserving and enhancing environmental diversity. Consider a coastal region (such as the Oregon Coast) consisting of an even number of estuaries each of which is designated by number indicating its relative position along the coast. Three plans are submitted for the general development and preservation of these estuaries: (A) all even numbered estuaries are to be developed and all odd numbered estuaries are to be preserved in undeveloped states, (B) all odd numbered estuaries are to be developed and all even numbered estuaries are to be preserved in undeveloped states, and (C) all estuaries are to receive moderate (intermediate) development. Without becoming involved in details, plans A and B are essentially the same with regard to the preservation of diversity, while plan C is radically different from plans A and B. From a local level (from within each estuary), however, plan A appears to be the exact opposite of plan B. That is, for each estuary, plans A and B propose to either develop the estuary or preserve it in an essentially undeveloped state. From the local level, plan C appears to be a compromise between plans A and B because it proposes an intermediate development rather than the all-or-nothing alternatives of plans A and B. Thus, from a local level, plans A and B are opposites and plan C is an intermediate compromise while from a higher level, plans A and B are essentially the same and plan C is the opposite of plans A and B. Developmental diversity between these estuaries must be incorporated into the planning process through a decision level whose scope of responsibility encompasses a number of estuaries. Local compromise would not be likely to provide for such diversity.

The example presented above and the example of the common pasture both demonstrate that the nature of environmental decisions reached is strongly dependent upon the nature of the organizational structure of the decision makers. In both examples, a localized decision structure was found to be essentially incapable of arriving at certain decisions which would result in mutual benefits. Overgrazing and environmental diversity reduction were the respective outcomes despite the undesirability of these outcomes. In both cases, the scope of responsibility of the decision bodies was narrower than the scope of the problems with which they had to deal. These examples do not suggest that all localized decisions should be transferred to higher decision levels. It would not be difficult to identify a long list of problems which have resulted from decisions structures too far removed from actual problems. Rather, the examples cited here suggest that the organization of the decision making structure should be determined by the nature of the decisions that need to be made.

The most effective environmental planning structure would consist of a number of planning levels of varying scopes of responsibility. Such planning levels would not only be related to each other but would also relate to other components of the entire socio-economic structure. Those planning levels with wider scopes of responsibility can be defined as strategic while those with more limited scopes of responsibility can be defined as tactical (Bella and Overton, 1972). Tactical plans need to be subordinate to strategic plans while strategic plans will be significantly determined by tactical capabilities.

As man's environmental demands increase, the scope of the environmental responses will expand. Thus, the relative importance of the strategic aspects of environmental planning will increase. Unfortunately, however, the environmental engineering and management literature has been dominated by subjects of a tactical nature. In addition, the expanding scope of environmental responses will make identification of problems, causes and solutions less determinable prior to large scale irreversible change. The indeterminancy of environmental outcomes and the knowledge gap expressed in the environmental predicament must be, therefore, increasingly accommodated at the strategic levels of planning.

IV

STRATEGIC PLANNING METHODOLOGY FOR OREGON'S ESTUARIES

Introduction

Investigators from different professional backgrounds studying the same real world system have traditionally formed conceptual models having different levels of resolution (different levels of organization). As an example, consider a waste outfall in an estuary. An organic chemist would normally choose a conceptual level of sufficiently fine resolution to describe the numerous different types of organic compounds being released from the waste outfall. An engineer would often select a lower level of resolution to examine this same problem. Thus, he might define the waste collectively by its biochemical oxygen demand, BOD. The chemist might argue that the larger grouping of BOD omits detail which is essential to understanding the system. The engineer might argue that if one divides the waste into separate chemical compounds, the number of components in the conceptual model becomes so numerous that it becomes impossible to define the relationships between the components and thus obtain a workable model of the system. In a sense, both arguments are correct, for the increase in detail sought by the chemist is gained by a loss in perspective while the gain in perspective sought by the engineer results in a sacrifice of detail. The information obtained from both of these levels of organization should complement each other and provide a better understanding of the actual real world systems.

The rapid increase in environmental demands resulting from increased human populations and technological growth necessitates the examination of higher levels of ecological organization than have been traditionally used in the areas of environmental planning. With regard to tidal estuaries, the examination of topics such as the role of BOD and dissolved oxygen (DO) in tidal estuaries is no longer sufficient. The examinations must be expanded to include the role of tidal estuaries within the larger marine systems and ultimately within the entire biosphere. The development of lower-resolution, broader-scope models relevant to this latter topic can complement the more traditional higher-resolution, narrower-scope models of estuaries and can contribute to a better environmental planning approach.

The Strategic Role of Estuaries

Tidal Estuaries Within the Biosphere

The role of tidal estuaries in the biosphere and the influence of modern man on this role is illustrated in Figure 3. Both modern man and tidal estuaries are components of a larger system, the biosphere. Tidal estuaries perform functions within the biosphere (illustrated by the dashed lines of Figure 3). These functions contribute to the overall self-organization of the biosphere which has the primary function of self maintenance and increased survivability. To perform these functions, estuaries receive resources from the biosphere (energy and materials) and direct solar energy from the sun. The tides are a particularly important form of energy utilized by estuarine systems. The ultimate source of tidal energy is the momentum of the earth-moon-sun system. The evolutionary process has continually tested ecological systems at all levels of organization so as to select those most capable of using the available energy and material resources for survival within the environment to which they are subjected. It is naive to consider certain of these resources, such as tidal energy, as wasted (not being used by the system). Any systems which did not utilize the full range of resources available would have been excluded in the evolutionary process by systems which could use these resources for increased survivability.

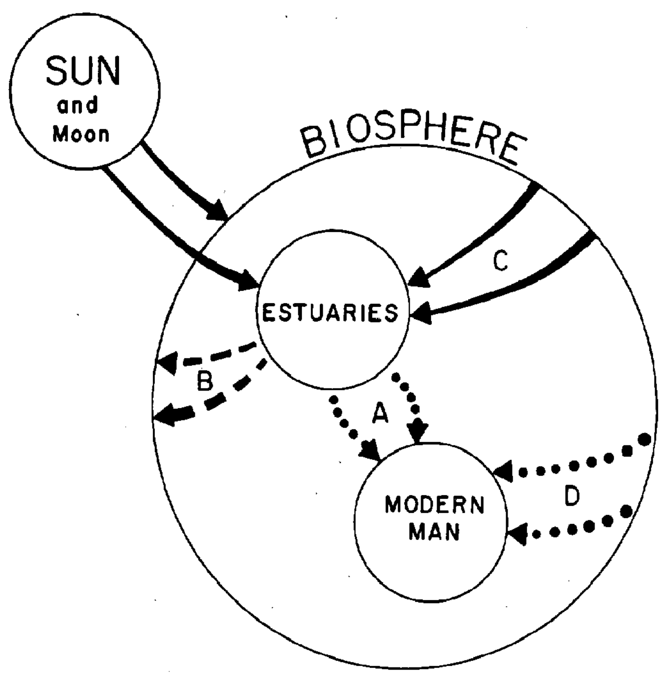

FIG. 3.-ESTUARIES AND MODERN MAN
WITHIN THE BIOSPHERE

Modern man utilizes the biosphere (dotted lines of Figure 3) for his basic survival and for increasing his quality of life. These uses are, of course, extremely varied (e.g.; transportation, food, energy sources, shelter, life support) and include both those which are perceived and those which are not recognized as uses but are instead assumed as unlimited properties of nature. The rapidly increasing use of the biosphere by modern man is paid for by losses of other uses which are needed by man. Man lives in a finite world and cannot expect to get something for nothing. The danger is that those uses which now appear to be most beneficial may ultimately be purchased by an unacceptable loss of those uses which are now poorly understood and often assumed to be unlimited.

The photographs of earth obtained through the space program have led to a greater appreciation of earth as a space ship with a life support system. However, environmental planning approaches have only poorly incorporated this appreciation into meaningful actions. A major difficulty has been the failure of these approaches to examine higher levels of organization. With regard to estuaries, these approaches have examined man's uses of estuaries with the object of avoiding or correcting conditions in which one use prevents or hinders other desirable uses of estuaries by man. Environmental planning has been concerned with the loss of uses shown in region A of Figure 3. These approaches have focused attention on the internal behavior of estuaries with the objective of preserving as many internal desirable uses of estuaries as is deemed feasible.

Man's use of estuaries, however, is purchased by losses in use to man which extend far beyond those defined within individual estuarine systems. Man's use of estuaries (A of Figure 3) is paid by a price in the capacity of estuaries to function within the biosphere (B of Figure 3) either through a diversion of estuarine resources (C of Figure 3) to man or through a change in the internal organization of estuaries. This price is ultimately paid by a loss in use by man of the biosphere (D of Figure 3). Because of the complexity of the biosphere, it is extremely difficult to relate uses at A to losses at D (Figure 3) which include losses in the self-organizational capacity of man's life support system. Two major difficulties of controlling these losses can be identified. First a significant loss in the capacity of man's life support system to satisfactorily maintain itself might not be specially identified until after significant, essentially-irreversible damage had occurred. Second, this loss would likely not be identifiable with specific actions by man. An effective environmental planning approach must account for these two difficulties. The fundamental concepts for such an approach have been presented in Chapter III. These concepts, however, can be supplemented by a better understanding of the functions of estuaries in the biosphere and the types of actions by man which would be most likely to be detrimental to these functions.

Temporal Organization

In order to gain a better understanding of the functions and requirements of tidal estuaries it is meaningful to examine the general organization of these systems. Before proceeding with such an examination, however, two types of organization common to a wide variety of systems will be examined.

The first type will be defined as a stimulus-response organization. Within such an organization, components of the system respond to stimuli from other components and they in turn, may provide stimuli to other components. The stimuli may involve the exchange of energy, matter or information. Machines are, in general, characterized by a stimulus-response organizational structure. The parts of a machine respond to the behavior of the other parts to which they are connected. Each part is connected or in some way influenced by one or more of the remaining parts. While ecological systems are generally far more complex than man-made machines, it has often been useful to describe them in terms of a stimulus-response organizational structure. The use of a systems diagram showing the connections between the system components has been a useful tool for describing ecological, social and man-made systems. The free-body diagram commonly used in engineering is a stimulus-response description of a component or set of components from a system that is assumed to be analytically decomposable. Such diagrams and related descriptions imply a stimulus-response organization of the system. The stimulus-response organization structure has been so frequently assumed that too often a system is assumed to be relatively disorganized if it does not significantly display such a structure.

A second type of organization will be defined as a "temporal organization." As an illustration, consider the offensive plays used in American football by a good team. Each member of the offense has a definite function in a play. It would be difficult, if not meaningless, to describe the function and actions of a single player without describing the functions and actions of the remaining players. That is, the actions of the players are highly interdependent. A well-run offensive play is a highly organized process; yet it cannot be classified as a stimulus-response organization because little or no communication exists between the members of the team during the play. Where such communication does occur, it usually involves the choice among a limited number of options which had been incorporated into the play. The organization of an offensive play is characterized by the timing of the specific and different actions of the individual players. Such organization has been "programed" into the offensive team by repetitive practice. Diagrams of football plays describe the sequence of actions of the individual players. Such diagrams seldom display a connection or communication between the individual components of the offense as is typical of stimulus-response diagrams. A system organization that is characterized by a timing of the specific actions of the components of the system will be defined as a "temporal organization."

Ecological systems display both stimuli-response and temporal organizational characteristics. The former may often be described as an organizational structure while the latter would better be described as an organizational process. Ecological systems cannot be expected to display a clear distinction between these two organizational frameworks; they will rather display characteristics of both. Such distinctions, however, encourage a broader approach to the examination of ecosystem organization.

Two general approaches often used to study the biological organization of estuaries involve the continued study of a single species (or a limited collection of species) and the examination of a limited number of detailed inventories of species collected at specific times from a portion of the system. While both of these approaches can lead to a better understanding of the biological organization of estuaries, the limitations of these approaches should be recognized. The analogy of the football game is illustratively useful. It would be difficult for a person unfamiliar with football to gain an understanding of the organization of offensive plays by following the actions of a single player or by examining a limited number of more detailed still photographs. A more profitable approach would be to examine the rules which govern the offensive plays. While it is true that there are essentially an infinite number of combinations by which eleven players and one ball can move, all within the constraints of the rules, it is possible to speculate on the basic characteristics of those particular combinations most likely to be successful. Such speculation would permit a more meaningful interpretation of the actions of single players and of the detailed photographs. It is similarly profitable to speculate on those basic biological organization characteristics of estuaries which would be most successful, in terms of persistence and survivability, within the environmental conditions to which they are subjected. That is, a better understanding of estuarine organization can be obtained by examining the environmental conditions within which the organization evolved.

Biological Organization of Estuaries

The direction of the evolutionary process is toward an increased probability of survival of the evolving systems within the environments to which they are subjected. The environments of temperate tidal estuaries are characterized by two significant properties. First, wide fluctuations in salinity, temperature, water depth, water velocity, and turbulence are typcial. Such fluctuations can produce physiological stress. However, these same fluctuations provide "services" to the system such as nutrient dispersal, waste removal and distribution of pelagic life stages. Moreover, within temperate estuaries, including those of the Oregon coast, such fluctuations are dominated by the tides and by distinct seasonal changes and are thus reasonably predictable. Second, tidal estuaries are relatively open systems in that they are freely connected to the open ocean and to fresh water streams. This openness is accentuated by the tides which result in extensive mixing of oceanic and estuarine waters.

The question that is now posed is what type of biological system would best survive in an environment which has reasonably predictable fluctuations and is open to the large relatively stable environments of the open ocean. The evolved system can be expected to take maximum advantage of the "services" provided by these fluctuations. The system which results from the evolutionary selective process would be likely to possess a temporal organization which could "anticipate" the predictable components of the fluctuations (Slobodkin and Sanders, 1969). Such "anticipation" is a result of the evolutionary process which continually selects those species and systems of species whose behavioral characteristics best conform to the predictable components of the fluctuations. As an example, seasonal changes in the needs and requirements of individual species and systems of species can be expected to conform to the most probable seasonal environmental changes within the estuaries.

The biological system can also be expected to take maximum advantage of the openness of the estuarine environment. Thus, the temporal organization can be expected to include a wide variety of "part time" members whose behavioral characteristics of tolerances, migration, reproduction, feeding and shelter needs conform to the predictable components of the estuarine fluctuations. Such part-time members can participate within estuarine systems at selected times when their needs are most likely to correspond to conditions within the estuaries. The organizational participation of these part-time members occurs because, through the evolutionary process, they have been able to better utilize the available resources for persistance than competing full-time resident populations which would have had to be able to withstand the extremes of the estuarine fluctuations.

Estuaries also possess wide spatial variations of environmental conditions, including variations in salinity, temperature, water depth, sediment characteristics, turbulence, currents, tidal exposure and light levels. Spatial variability is an important environmental property for systems such as tidal estuaries which rely upon a temporal organizational process. Such variability enables localized environments to be open to a variety of other different local environments within the system. The organizational process relies upon exchanges between these varied environments and such exchanges can be expected to display a temporal order.

There are unpredictable components of environmental conditions within tidal estuaries which, in the past, have usually resulted from weather conditions. Estuarine ecosystems can be expected to possess the ability to adjust to those unpredictable fluctuations which have been a part of their evolutionary past. Moreover, such fluctuations can be expected to provide for nutrient exchange, removal of wastes, oxidation of reduced environments and other related "services" to estuarine systems, particularly if they reoccur with a seasonal frequency. As a general rule, extensive unanticipated fluctuations and conditions of severe physiological stress (such as depletion of dissolved oxygen) will result in immature ecosystems (see Chapter III). While the extremes of natural unanticipated fluctuations within estuaries can at times appear severe, they are likely no more severe than those experienced by most ecosystems within the temperate zone.

The temporal organization of estuaries includes a variety of "options" which enable the system to adjust to unanticipated conditions. Such "options" include a variety of interrelated sequences of events employing a variety of system members. The openness of estuarine systems and the internal spatial variability of these systems permits a wide variety of organizational options and reserves for readjustments. Estuaries should not be considered as highly stable ecosystems in the sense of consistency of structure but rather should be considered as resilient systems, capable of a variety of adjustments to environmental conditions. In addition, estuarine systems should not be universally considered as immature systems (see chapter III), though estuaries which have been subjected to extensive and severe unanticipated fluctuations (many Gulf coast estuaries) may be considered as immature. The notion that estuarine systems are immature often arises when one attempts to evaluate estuarine organization entirely from a stimulus-response framework. Finally, the belief that estuaries are characterized by a limited species diversity must be seriously questioned. Such a belief has arisen from measurements of species diversity within estuaries at specific locations and at specific times. The openness, high spatial variability, and temporal organization of tidal estuaries all indicate that the number of species participating in and depending on a given estuary is considerably greater than measured at any given location within that estuary at any given time.

The Function of Estuaries

The high level of nutrient input to estuaries from inland runoff and from oceanic upwelling and the circulation provided by the tidal currents result in high levels of productivity within tidal estuaries. Their predictable fluctuations and openness to marine and fresh water systems has resulted in a temporal organization in which a large variety of "part-time" members participate along with a resident population in the utilization of this production. Such members (generally fish and birds) are most often high on the food chain. In addition to adult feeding, estuaries are used by these members for shelter, spawning and rearing of young. Thus a major function of tidal estuaries is to provide a variety of essential services to numerous species which are generally high on the food chain. It has been estimated that 65 to 90 percent (depending on the geographical area) of the commercial catch of finfish in the United States consists of estuarine dependent species (Sykes, 1968).

In addition to those species of commercial value, tidal estuaries make available a wide variety of ecological options which have become part of the self-organizational structure of the oceanic systems that are, in turn, responsible in large part for the self-regulatory capabilities of the biosphere. A mutual organizational partnership thus exists between the coastal zones, including estuaries, and the larger oceanic systems. One must not think that because of the overwhelming size of the oceans this partnership is unimportant to the oceanic systems. One half of the fish production of the worlds oceans occurs within the coastal zones (Ryther, 1969). Estuaries, which are significant parts of the coastal zones, are among the most biologically productive areas known on the earth and a wide variety of species depend upon estuarine systems.

Finally, the openness and temporal organization of tidal estuaries enables them to be a principal connecting system between marine and fresh water systems. In a sense, the estuarine zone serves as a barrier. Yet, where exchange of information between fresh water and marine systems has been found beneficial to the survivability of these systems, the evolutionary process has resulted in organizational selection to favor such an exchange.

It would be difficult to identify any ecosystem type of comparable size which contributes as significantly as tidal estuaries do to the larger functioning of the biosphere.

Man's Impact on Estuarine Systems

Evolutionary Departure

Estuarine ecosystems and the larger marine systems of which they are a part are not fragile systems. If they were fragile, there would be some rational for rebuilding them to provide a more reliable basic life-support system for man. These systems, however, are highly reliable self-organizing systems which man cannot hope to replace. Therefore, maintaining the capacity of these systems to reliably self-organize must be among the highest priorities of environmental management. Such management must be based on a firm recognition of the inadequacy and bias of available information. This inadequacy is particularly relevant to tidal estuaries because of their complexities and interrelationships with oceanic systems. The basic concepts presented in chapter III are thus highly relevant to the management of estuaries. However, it is possible to further define the general characteristics of those actions and uses by man which are most likely to disrupt the reliable functioning of tidal estuaries within the biosphere.

The biological organization within tidal estuaries has resulted from an evolutionary selective process. Those environmental changes which can be expected to be most disruptive to the long-term organization and functioning of tidal estuaries are thus most likely to be those which result in the greatest departure from the conditions which have been part of the evolutionary experience. Two general types of such departures can be identified: type A; introduction of materials and conditions which are significantly different from those of the evolutionary experience; type B; changes in relative dominance, frequency, distribution, and magnitude of environmental conditions which have been part of the evolutionary experience.

While it may often be useful for discussion purposes to define the above two types of departures, classification of specific environmental changes into either of these two types will often be highly subjective. Both types of departures can be expected to lead to less mature ecosystems characterized by a decreased reliability. While some natural departures from the evolutionary experience will occur, as they have in the past, the overwhelming majority of such changes will increasingly result from the actions of modern man. Evolutionary departure can thus be considered as a form of strategic pollution. This does not mean that all evolutionary departures can and should be avoided any more than all pollution (defined in the more traditional manner) can and should be avoided at all costs. Nor should it imply that all evolutionary departures have a net negative effect on the quality of life. Rather, evolutionary departures must be interpreted as risks to the reliable self-organizational capabilities of ecological systems.

A variety of evolutionary departures have been identified and incorporated into environmental protection programs. Most of these can be best classified as type A departures (i.e.; DDT). This report will not attempt to summarize or add to the literature on these departures but, instead, will focus attention on departures which might best be classified as type B.

Estuarine Departures

The principal characteristics of the estuarine environment which, through the evolutionary process, have determined the biological organization of estuaries are: (a) an openness to the larger more stable marine systems and fresh water systems; (b) significant spatial environmental variabilities; (c) a relatively predictable set of environmental fluctuations; and (d) a variety of relatively non-predictable environmental variations. Significant departures from these characteristics can be expected to result in changes of organizational properties and thus changes in the functioning of estuaries. Because of the resilience of estuarine systems, recovery from short-term departures can be expected. What is of greater concern, however, are the longer term departures which can result in changes of estuarine system properties. Such organizational changes would not likely be detectable until relatively irreversible changes had occurred. Moreover, man's impact might have its greatest effect on options within the system and the effects of such option loss might not be noticeable until later when such options were needed. The "cause" of a resulting problem would then most likely be identified as the more immediate conditions (possibly natural conditions) rather than the impacts which removed the options that could have led to a satisfactory adjustment to these conditions. Thus, management strategies must be based principally on the avoidance of impacts by man which would most likely lead to significant organizational and functional changes, rather than relying on the identification of particular problems before corrective action is taken.

A number of examples of departures from the principal environmental characteristics given above can be identified. The openness of estuarine systems to fresh water systems can be significantly reduced by the construction of dams. Major dams affecting the Oregon estuaries are located on the Umpqua and Rogue Rivers, though several sites are being considered for a number of other estuarine-river systems. The Umpqua and Rogue are the only Oregon coastal rivers which extend inland east of the Coast range (see Figure 1). Construction of dams which have been authorized, proposed or under study would significantly reduce the openness of these estuaries to the inland fresh water systems.

Upstream dams intentionally reduce predictable and non-predictable variations through the regulation of upstream flows. The purpose of low flow augmentation is to even the seasonal fresh water flows so as to provide additional dilution water during the low-flow periods. Such smoothing of seasonal flow variations, as well as flood protection, can lead to organizational changes within estuarine systems. Such changes would encourage the development of resident populations at the sacrifice of the "part time" members. Thus, while low-flow augmentation may provide higher dissolved oxygen concentrations and lower temperatures during the low-flow periods, such potential benefits to anadromous fish may eventually be negated due to their exclusion from the system by resident populations.

A reduction of summer river flows into estuaries due to inland diversion can result in a more even distribution of sea water in the estuaries during the summer and early fall periods. Such reductions in spatial environmental variability are of particular concern for the smaller estuaries along the Oregon coast.

As a further example, consider the littoral currents which flow along the Oregon coast and are located in the near proximity of the shoreline, principally within the surf zone. The direction of these currents along the coastline changes with the seasons. Such currents provide for an exchange of phytoplankton, zooplankton, pelagic larvae and other current-borne organisms along the coastal regions. Jetties which are constructed at the entrances of estuaries for harbor protection and which extend beyond the surf zone intercept and disrupt these currents and thus may reduce the openness of estuaries to the near shore regions. Of the estuaries included in this study, all but five (Alsea, Nestucca, Netarts, Salmon, Sand Lake, and Siletz) have jetties constructed for harbor protection.

As a final example, the filling and diking of tidelands, in addition to removing the most biologically productive portions of estuaries, significantly reduces the spatial variability of the estuarine environment.

Dominating Environmental Changes

Estuarine ecosystems display organizational responses to changing environmental conditions. As a particular change or set of changes becomes more significant in magnitude and scope, it begins to have a dominating effect on the system organization. That is, the system organization becomes more strongly influenced by the dominating change and relatively less influenced by the remaining environmental conditions. The system response is similar to a reduction in the spatial variability of the environment. Those species and systems of species which are best suited to the dominating environmental changes will tend to dominate the system. A reduction of species diversity can be expected, with those species of rapid growth rates generally excluding the more specialized species. Thus, any dominating environmental change can be expected to reduce the maturity of the system and thus reduce its reliability. If such dominating changes are of long duration, they will be likely to reduce the reliable self-organizing capabilities of estuarine ecosystems and the larger coastal and marine systems of which estuaries are an integral part.

The rule of dominating change (Chapter III) thus is particularly relevant to environmental changes within tidal estuaries. With regard to such changes, this rule may be expressed by the following statement: actions or sets of actions which lead to dominating changes within ecological systems are to be avoided.

It may be reasoned that many types of dominating changes have been part of the evolutionary experience of each estuary and thus dominating changes by man of similar nature and magnitude should not be the cause of great concern. As an example, a natural forest fire results in increased watershed erosion, siltation within an estuary and a reduction in mean particle size of the bottom deposits. One may conclude that such natural reduction of mean particle size within estuaries is not significantly different from that caused by the construction of dams, dredging activities, construction of jetties, sand and gravel operations and increased erosion due to logging and road construction. There are however, important distinctions. Natural dominating environmental changes tend to be bi-directional. As an example, at any given time a variety of natural factors within a number of estuaries may influence changes in particle size. Some may encourage a decrease in size, others may encourage an increase, while still others have a stabilizing effect. While any such change may occur at given locations, no single dominating change will likely occur throughout a collection of estuaries. Thus, the variety of conditions within the collection of estuaries is preserved. Natural large scale changes that do occur within an entire collection of estuaries can be expected to normally occur over geological time scales. By contrast, dominating changes resulting from the actions of man tend to be unidirectional, that is, many of man's actions tend to favor directed environmental changes rather than a set of compensating changes. Moreover on a geological time scale, man-caused changes are relatively sudden though they may be considered long term on man's time scale of planning. Construction of jetties and dams, dredging activities, sand and gravel operations and logging activities occur in some form within the majority of Oregon estuaries. All such activities appear to favor a decrease in the particle size of the sediments, though the extent of such a decrease is unknown. There are no comparable sets of man's activities which tend to encourage an increased particle size. Consequently such activities may result in a universal decrease of particle size within the collection of estuaries along the Oregon coast and thus may contribute to the reduction of ecological options (diversity) within this collection. The widespread distribution of all such activities which result in unidirectional environmental changes should be avoided in order to reduce the probability of irreversible dominating changes.

The Diversity Approach

Development and Conservation

While man's use of estuarine systems is purchased by a price of losses or increased risks of losses in other uses (either actual or potential), benefits often obtained cannot be ignored. Dams do control floods and thus reduce losses of life and property. Dredging does contribute to more efficient transportation systems. Jetties do protect harbors and thus enable a greater harbor use at lower risk to life and property. Moreover, jetties may serve as attachment places for many sessile organisms, attract sports fish and facilitate the movement of fish and crustaceans into estuaries. A large variety of other benefits resulting from a wide range of man's actions can be similarly identified. While these benefits do contribute to man's quality of life, the rapid expansion of man's capacity to extend the scope and magnitude of his actions necessitates a sound management approach so that the benefits obtained are not ultimately purchased by a price that exceeds these benefits. Technological corrective methods, such as sewage treatment plants, can contribute to such a management approach. However, not all of the consequences of man's actions are subject to technological treatment. Moreover, emphasis of such an approach tends to reduce the reliability of ecological systems to the operational reliability of the corrective technological devices. Thus, while the more traditional technological approaches can reduce the risk of unacceptable outcomes of man's actions, they must be complemented by a preventative approach which assures the functioning of estuarine systems without the requirements of a capacity to predict the total impact of man's actions.

The diversity approach developed in Chapter III is an essential basic feature of a meaningful environmental planning methodology for Oregon estuaries. Principal general advantages of this approach are briefly reviewed below:

1. the probability of large scale irreversible change is reduced without the requirement of identification;

2. the probability of large scale dominating environmental change is reduced without the requirement of identification;

3. the preservation of developmental diversity concentrates development and provides undeveloped controls for comparison and study and thus increases the return information of environmental impacts;

4. environmental options are preserved, thus providing greater capabilities of adjustment to indeterminant and changing value systems and unanticipated environmental impacts;

5. a high quality of life is related to a variety of potential experiences provided by a diverse environment;

6. the self-organizing capabilities of ecosystems are preserved without the requirement of complete knowledge of these systems; and

7. a balance is provided between conservation and development in a more workable manner, from a management viewpoint, than a method which tends to establish uniform policies and guidelines.

The diversity approach can best be employed by considering the collection of 15 Oregon estuaries as a basic managerial unit, rather than considering each estuary separately as the basic unit of management. A mixed approach which calls for an unevenly distributed variety of development and conservation actions among this collection forms the fundamental basis for the recommended environmental strategy for the Oregon estuaries.

Strategic Designation of Estuarine Systems

Within a number of the larger estuaries, several relatively separate estuarine systems can be identified. As an example, the South Slough near the entrance to Coos Bay can be considered as an estuarine system which is relatively separable from the other, landward portions of Coos Bay. The smaller estuaries (such as Netarts), however, should be considered as single estuarine systems. In all cases, an estuarine system designated at the strategic level must be relatively separable from other estuarine systems and must contain a wide variety of estuarine habitat types. The term "estuarine system" includes both the aquatic regions and adjacent lands. Opposite shores on an estuary would not qualify as separate estuarine systems at the strategic level. Within the collection of 15 Oregon estuaries, approximately 20 to 30 estuarine systems can likely be identified at the strategic level. Each of these systems may be further broken down at the tactical planning level. The present chapter, however, deals exclusively with the management of those larger separable estuarine systems defined at the strategic level.

Function Classification

The terms "production" and "protection" (Odum, 1969), introduced in the previous chapter, will be employed as descriptions of the principal reliable functions of estuarine systems. "Production" will refer to man's use of estuarine systems for the highest yield of those goods most useful to man (not to be confused with biological production). "Protection" will refer to the self-organizing capabilities of estuarine systems and the larger marine systems of which estuaries are an integral part. The environmental strategy presented herein calls for a mix of "production" and "protection" estuarine systems. This concept is illustrated in Figure 4 which relates developmental and conservation efforts to the primary functions of particular estuarine systems. Developmental efforts refer to the construction of facilities and modification of estuaries and adjacent lands for the primary purpose of increased "production" while conservation refers to the prevention of developments. Different ratios of development and conservation efforts are recommended for the estuarine systems within the collection of Oregon estuaries. That is, the collection of Oregon estuarine systems should be distributed along the horizontal axis of Figure 4 rather than being concentrated within any single region of this axis.

Three classifications of estuarine systems ("production," "mixed" and "protection") can be identified based upon their primary reliable function and relative developmental and conservation efforts. The following paragraphs will expand on the appropriate developmental and conservation actions and uses for each of these three classifications. It must be stressed that the use of the above classifications has been principally based on the inadequacy of available information, (the environmental predicament) not on the willingness or lack of willingness to employ it. The "production" classification should not imply that sound environmental practices within such systems can be abandoned; rather, the best available information should be utilized in order to minimize adverse environmental impacts. It is the inadequacy of this knowledge and a recognition of the incompatability of different uses of estuarine systems that necessitates a variety of estuarine systems whose primary reliable function is that of "protection."

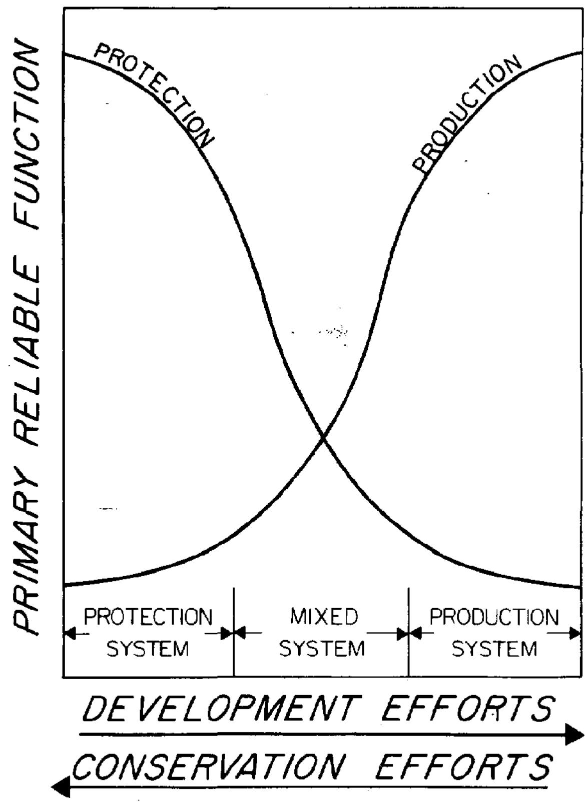

FIG. 4.-GRAPHICAL ILLUSTRATION OF FUNCTIONAL CLASSIFICATION FOR ESTUARINE SYSTEMS ASSUMING SOUND LOCAL ENVIRONMENTAL MANAGEMENT

Production Systems. These estuarine systems will include the principal industrial and residential centers. Facilities for transportation, power, waste disposal, etc., should be provided so as to encourage business and industrial development that will make best use of the available resources. Within production estuarine systems, the best available information should be employed to minimize adverse environmental impacts and to provide a useful and aesthetically pleasing environment for the residents of the area. Intensive use recreational facilities should be provided and a variety of areas should be set aside for such purposes. Within such estuarine regions environmental diversity should be encouraged for aesthetic, sociological and environmental reasons. Specifically, cluster communities with adjacent open space should be encouraged where feasible. Shoreline development should be restricted to those activities which require waterfront locations.

Mixed Systems. Limited business, industrial and residential activities would be included in such designated areas. A wide variety of ecological habitats within such estuaries would be selected for preservation in relatively undeveloped states. Activities which may result in significant evolutionary departures and dominating changes are to be avoided. A greater emphasis, as compared to production estuaries, should be placed on maintaining the reversibility of actions and environmental changes. Camping, hiking, boating, fishing (commercial and recreational), farming, logging and related activities would be permitted under stricter controls than those of "production" estuaries. Restrictions, zoning, public purchase of lands and conservation easements, water and waste water facilities, and transportation systems should be developed to encourage cluster housing with open spaces rather than the more conventional dispersed housing which results from one-acre or similar zoning. Heavy-transportation facilities, such as shipping which requires significant maintenance dredging, should be avoided.

Protection Systems. Business, industrial and residential development in such designated estuaries and adjacent lands would remain at present levels, or, where feasible, be reduced. Additional business, industrial and residential development would be severely restricted, and in all cases confined to very limited regions. Transportation facilities would be minimal and, where additional environmental protection is warranted, reduced from current levels. Limited recreational activities such as hiking, boating, fishing, hunting, and camping in restricted areas could be encouraged under controlled conditions. In all cases, the influence of all man's activities should be kept at minimal levels. Such designated estuaries would have high research and educational value. Different types of estuarine systems should be included in the "protection" status. That is, within the sub-set of "protection" systems, system diversity should be given a high priority.

Strategic Planning Methodology

General

The diversity approach is the basis for the strategic environmental planning methodology presented herein. The specific goal of the strategic planning level is to provide developmental diversity among the estuarine systems within the collection of Oregon estuaries. This is accomplished by the removal and placement of constraints and guidelines on the tactical planning which occurs within such systems. That is, strategic environmental planning is generally not involved with detailed design planning for specific projects within individual estuarine systems but rather establishes constraints and guidelines which must be sufficiently varied to provide for a developmental and functional diversity among the collection of Oregon estuarine systems.

Removal and Placement of Constraints

A major objective of many state and federal programs is to remove the constraints which prevent development at local levels. As an example, transportation projects such as highway construction and dredging operations remove significant constraints imposed by the natural landscape. Without the removal of such natural constraints, most existing local development would have been impossible. The "benefits" used to justify a variety of federal and state projects are most often a measure of the anticipated local developments resulting from such projects and/or the services provided to existing local developments by such projects. Thus, by providing facilities for transportation, energy, education, communication, etc., higher management levels (usually state and federal) have removed significant constraints which would have severely restricted local development.

Though higher management levels have also imposed constraints upon local actions, the net effect has been one of constraint removal. Few truly local levels could have accomplished their present development without the net removal of constraints by higher levels. Moreover, the environmental constraints which have been imposed have generally been tactical in nature; that is, they have been primarily concerned with the internal functioning of individual estuarine systems rather than the broader functioning of a collection of estuarine systems within the coastal zones, oceans and biosphere. The proposed strategic planning methodology deals with this broader concern through a balanced yet varied distribution of constraint removals and placements among the collection of Oregon estuarine systems (see Figure 4).

Placement of Strategic Constraints

Although a variety of state, regional and federal programs have dealt effectively with the removal of constraints on local development, there has not been a comparable set of established programs capable of imposing the strategic constraints necessitated by the environmental strategy proposed herein. Specifically, there are no standard established procedures or programs for the placement of constraints sufficient to maintain a variety of estuarine systems in a "protection" status. An effective strategic planning process, therefore, must be sufficiently flexible to make maximum use of available opportunities and must influence future effective legislation. A number of mechanisms can be identified which, given effective leadership, have the potential for establishing "protection" estuarine systems.

Section 101 (b) of the National Environmental Policy Act of 1969 specifically states that:

> "it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may--
> (1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
> (2) assure for all American safe, healthful, productive, and esthetically and culturally pleasing surroundings,
> (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;

(4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice;

(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

Section 102 of this same act requires the development of environmental impact statements for all federal projects. Irreversible and irretrievable commitments of resources are specifically identified as areas of concern. Thus, the spirit and, in some phrases, the letter of this act are closely compatible to the reasoning and approach of the environmental strategy set forth in this report.

The Pacific Northwest River Basins Commission (with the participation by federal and state agencies) appears to now provide a mechanism for coordinating Federal plans, functions, programs and resources in a manner compatible to the proposed environmental strategy. Specially, the commission should establish policies and guidelines for preserving developmental and functional diversity among the collection of Oregon estuarine systems. It would be difficult for any agency or group of agencies utilizing federal funds to violate these policies and guidelines without violating the spirit and, in some cases, the letter of the National Environmental Policy Act of 1969. Moreover, it would be difficult to justify federal funds unless state and local plans were reasonably compatible to these policies and guidelines.

The Coastal Zone Management Act of 1972, section 312, makes available to coastal states grants of up to 50 per centum of the cost to establish marine sanctuaries. Such funds could be used to establish "protective" estuarine systems. In the hearings preceding the passage of this act, the Alsea and Netarts Bays were specifically identified as potential marine sanctuaries.

Currently, consideration is being given to including the Salmon River estuary into the Siuslaw National Forest. Such an arrangement could provide for the management of this estuary as a "protection" system, although conservation efforts, including additional purchase of lands and easements, beyond those currently recommended (U.S. Forest Service, 1972) would likely be necessary to assure a "protection" status as defined in the context of the proposed strategic environmental plan.

Land use legislation is currently being considered at the national and state level. Such legislation can additionally contribute to the implementation of the environmental strategy presented herein and thus should be of principal concern at the strategic and tactical levels.

Enforcement of strict regulations on individual sewage disposal systems coupled with sewerage plans which purposely do not provide services in areas where developments are not desired can serve as an effective means for encouraging cluster communities and preserving open space (Li, 1973).

Gravity sewers can be provided in regions designated for development while interceptors are avoided or force mains are employed in designated open spaces. This approach not only can encourage the preservation of open space, but can provide economic savings (Li, 1973).

Finally the authority to implement the proposed strategy must be balanced by a responsibility toward the fair treatment of local residences. The cost of implementing this strategy cannot be borne by local residents alone but rather, must be financially supported by the larger public.

Strategic Planning Process

A proposed strategic planning process for the implementation of the environmental strategy developed herein is diagramed in Figure 5. All decisions reached in this process are based on the continued evaluation of a balance of developmental diversity among the Oregon estuarine systems. The central feature of this planning process is, thus, a set of procedures which continually provide the decision body with evaluations of the developmental variety (actual and potential) within the collection of estuarine systems. That is, the decision body is presented with an evaluation of how successfully actual developments, projected developments and potential developments under the imposed constraints provide for a balanced distribution of "production," "mixed" and "protection" estuarine systems. In addition, such an evaluation should provide indications of the system variety within each of these functional classifications, particularly within the "protection" classification. The evaluations of developmental variety will be determined by personnel who are not members of the decision body from evaluations of the constraints and guidelines imposed on each estuarine system, examination of the projected developments within each system and the monitoring of actual developments. A number of procedures for evaluating developmental variety are now being examined. The operation of this process does not, however, depend on a single standard evaluation procedure. Rather, a variety of different procedures used by different members of the decision body may actually contribute to a more obvious distinction between the functional classifications and thus contribute to the maintenance of a greater developmental variety. Moreover, where disagreement occurs, a bartering system in which several estuarine systems are involved might also lead to a greater developmental diversity.

All procedures for defining the functional classification of particular estuarine systems must be based on the effectiveness of conservation efforts to assure the appropriate "protection" function. Functional classification must not be based on the capacity of a system to produce goods for man's use. Wastage of resources within an estuarine system through poor local environmental management reduces the "protective" function of the system even though "production" may remain relatively low. By basing functional classification on "protection" capabilities, the strategy discourages poor local environmental management by associating it with a reduction in potential regional productivity and income.

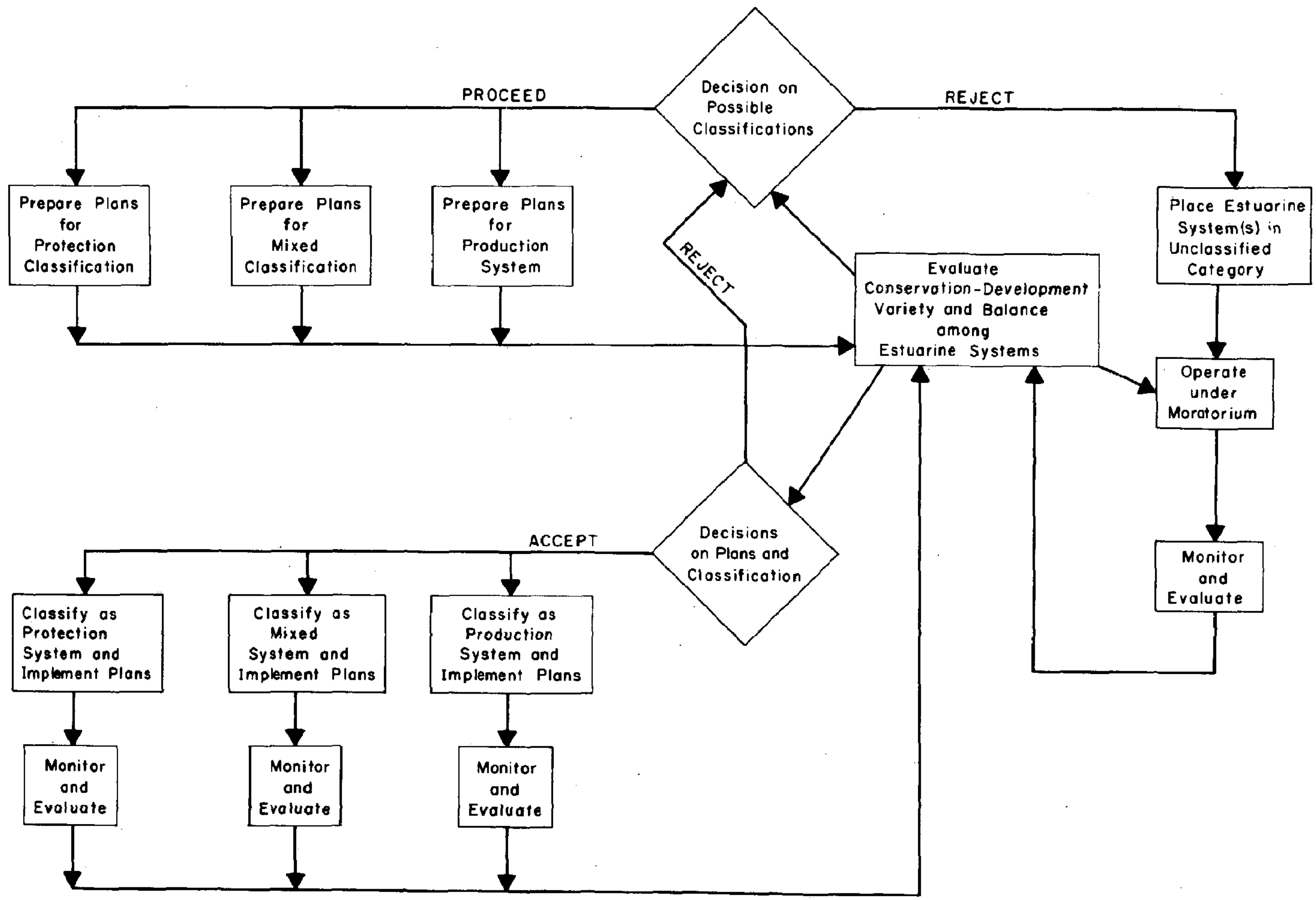

FIG. 5. -STRATEGIC PLANNING METHODOLOGY FOR OREGON'S ESTUARINE SYSTEMS

The strategic decision body must be capable of making decisions which result in developmental diversity among the estuarine systems. A decision body which relies upon trades of different policies and sets of constraints for different estuarine systems would be more desirable than a body which relies upon broad compromises. A task force formed under the Pacific Northwest River Basins Commission might be used for this decision body. Membership would come from representatives of state, regional and federal agencies which have varying development and conservation responsibilities. As previously discussed, it would be difficult for any agency to ignore the decisions of such a body without incurring the critical review (e.g.; of environmental impact statements, programs, budgets, etc.) of the remaining member agencies. Members of this decision body should be committed to the concept of developmental diversity rather than to pursuing the narrower goals of their parent institutions or agencies. Primary responsibility of members would be toward this task force for the duration of their membership. One or more members with broad ecological backgrounds and with no institutional or agency responsibilities should also be included within this body. Decisions by this body should require substantially more than a majority vote (two thirds or more). Such a voting policy would discourage voting blocks which could be detrimental to the concept of developmental diversity. The organizational structure for coastal zone management will likely significantly change within the near future particularly as a result of the Coastal Zone Management Act of 1972 and other pending legislation, therefore, the planning process presented herein need not be related to the existing organizational structures.

Initially, all estuarine systems would be placed in an unclassified category. A moratorium on developmental activities, particularly those of a dominating and irreverisble nature, would be imposed on all unclassified estuarine systems. It is expected that economic pressures will be in the direction of increased development and removal of such a moratorium, particularly within the more developed estuaries. However economic development would be encouraged only within the constraints of the functional classifications designated for each estuarine system. The strategic decision body could remove estuarine systems from the unclassified category into one of the three functional classifications.

Two general steps are shown in Figure 5 for classifying estuarine systems. The first involves the formation of specific plans suitable to proposed functional classifications. Local land use, transportation and sewerage plans would be reviewed, guidelines for environmental impact statements would be developed and all other plans, programs and constraints would be examined with regard to their compatibility to the particular functional classification for the particular estuarine system being considered. Plans which were considered adequate would then be implemented. When sufficient plans, guidelines and constraints had been established which were compatible to the desired functional classification, the particular system, would be removed from the unclassified category and designated under the appropriate functional classification. Estuarine systems which had been so classified would then no longer operate under the constraints of the moratorium but would rather operate under the particular constraints necessitated by the functional classification. The primary function of the strategic decision body, however, is to maintain a developmental variety. This body would be committed to maintaining a balance of functional classifications among the collection of estuarine systems. Thus, removal of a system from the unclassified category into the "production" classification would require simultaneous actions to maintain a developmental balance by also designating an appropriate "protection" system (or systems). Moreover, the evaluation of developmental variety would be influenced by the effectiveness of the constraints and policies both within the classified systems and within the unclassified systems. Thus, developments, policies and plans which were environmentally unsound, contrary to the appropriate functional classifications, or which resulted in dominating and essentially irreversible changes within unclassified systems, would all tend to disrupt the developmental-conservation balance in the direction of development; that is, in the direction of decreased "protection." The appropriate response of the decision body would be to seek to retain this balance or, at the least, not to disrupt it further. Under such conditions, additional development would be increasingly discouraged and existing developmental constraints would be increased. Regional development would, thus, receive its greatest support from this decision body when all developments, policies and plans were compatible with the maintenance of a functional and developmental diversity among the collection of estuarine systems.

The strategic decision body would have the responsibility of reviewing all environmental impact statements. This body would not be responsible for commenting on the tactical aspects of each proposed project, but would rather examine the compatibility of each project to the functional classification guidelines for the particular estuarine system (or systems) influenced by the proposed project. Where unclassified systems were involved, proposed projects would be critically reviewed with regard to the moratorium on unclassified systems.

Principal Difficulties

Two major difficulties encountered in the above general planning process, or any process which seeks to implement the diversity approach among the Oregon estuarine systems, warrant specific identification.

The first of these difficulties is the actual and potential waste of ecological resources caused by unsound residential housing developments. The current desirable environment of the Oregon estuarine regions is conducive to residental development, particularly for vacation and retirement homes. The small size of most Oregon estuarine systems, however, makes them particularly vulnerable to unsound residential development. Current practices do not favor cluster communities with open space (as recommended in this report), but rather favor reduced environmental diversity, lack of control of waste products, and greater expenditures of resources. As an example, the traditional lawn, which is encouraged by conventional zoning, is a highly immature ecological system (see chapter III) which requires expenditures of resources and dispersal of a variety of pollutants to keep it in its immature state. Such systems contribute little to the satisfactory self-organization capacities of the larger ecological systems of which they are a part and are, in fact, likely detrimental to it. Moreover, current economic and zoning practices often favor development of shoreline regions within estuarine systems. Such dominating changes serve to destroy the important shoreline regions of estuarine ecosystems, provide barriers between the terrestrial and aquatic portions of these systems, facilitate the distribution of pollutants (nutrients, herbicides, pesticides, petroleum wastes, etc.) to the critical intertidal zones, encourage the filling or cut off of tidelands, marshes, tidal streams and surge zones, and ultimately require "safeguards" against the ecological system itself in the form of flood control facilities, erosion control projects, etc. (usually at public expense). To argue that such developments merely reflect the choice of the customers is not valid because the environmental costs are not paid by the customer nor are innovative alternatives offered to the customer. To direct environmental protection efforts principally toward large industries and governmental projects without complimentary efforts directed toward residential developments and their supporting facilities is not in the best interest of sound environmental and economic planning. Wastage of resources resulting from unsound housing development will ultimately lead to increased environmental degradation and decreased utilization of resources for other uses (industrial, commercial, recreational, ecological protection, etc.). A sound environmental strategy for Oregon estuaries must deal with effective land use planning which provides for residential developments that are most compatible with the satisfactory functioning of the ecological systems of which they are an integral part.

The second major difficulty is the lack of suitable mechanisms for maintaining "protection" systems. Often the fairest and most effective means of attaining a meaningful "protection" status is through public purchases of lands or conservation easements, particularly within critical regions. Present public lands within Oregon estuarine systems are not now sufficient to maintain any "protection" systems. Most public land is forest land within the mountain regions. The present population and development within many Oregon estuarine systems is sufficiently low to enable the establishment of a variety of "protection" systems through public purchase (complimented by appropriate zoning, conservation easements, land exchanges, etc.) at a relatively low cost in comparison to public expenditures for developmental projects within this region. Moreover, there now exist a number of relatively undeveloped estuarine systems so that the establishment of "protection" systems could now be accomplished with a minimal impact on existing commercial, industrial and residential activities. These opportunities are rapidly disappearing and, unfortunately, there is an attitude which considers purchase of land for preventing development as being, in some way, wasteful. This attitude often comes from an outdated notion that vast undeveloped regions are readily available and that ecological "protection" is unlimited. Unfortunately, the facts do not warrant such a conclusion, particularly with regard to estuarine systems. In addition, such purchase of land is often viewed only from a tactical perspective, so that the appreciation is lost that such a purchase is part of a larger balanced environmental management plan. The establishment of "protection" systems is a necessary part of the environmental strategy presented herein and will call for initiative and leadership in any effective strategic planning process.

V

A BASIS FOR TACTICAL PLANNING

Introduction

The previous chapter has described strategies and a strategic planning methodology for Oregon's estuarine natural resources. This methodology seeks the retention and protection of diversity among Oregon's estuarine systems while providing for a balance of conservation and developmental uses of these estuaries. The strategic methodology must be implemented in part through the establishment of guidelines and the placement and removal of constraints on intermediate-level and local-level planning, where many decisions must be made involving specific tactical details.

In this chapter the concepts which form the basis for a tactical planning methodology are presented. Tactical planning and decision-making for estuarine natural resources, as used in this report, are primarily concerned with local, small-scale, immediate, detailed aspects of resource use and management involving both short-term and long-term commitments. "Local" and "small-scale" are intended to mean that the largest region or area likely to be included in a specific tactical-planning context is a single estuary. Therefore, tactical planning and decision-making applies to a variety of situations ranging in scope from the preparation of a comprehensive use plan for a particular estuary and its resources to the planning of a small project potentially affecting only a limited portion of that estuary and its natural resources.

Concepts for Tactical Planning

Several concepts specifically applicable to natural resource analysis have been examined and modified for use in tactical-level planning and management of Oregon's estuarine natural resources. The concepts include: (1) recognition and description of the estuary, its sub-units, and its natural resources as a group of interrelated "systems;" (2) use of a "systems" approach for analytical treatment of estuarine natural resources to show roles, functions, characteristics, and interrelationships; (3) identification and preservation of habitats for biological resources; (4) use of environmental impact assessment as an integral part of the entire planning process; (5) use of preventive planning to avoid errors and poor judgment; and (6) flexibility as an important feature of current plans in order to preserve future options which may be required due to present ignorance of the estuarine system and changing knowledge, needs, and capabilities.

System Recognition and Description

The focus upon the system for which planning is being carried out and decisions are being made is much different at the tactical level than at the strategic level. A considerably finer and more detailed resolution is required for the tactical planning of estuarine natural resources. The broad view of the biosphere, estuaries, and man must be replaced by the specific view of a particular estuary, its physical-chemical-biological functioning, and the human activities which exist or might be possible in and around that estuary. The gain in detail is thus obtained at the cost of a loss in perspective; that is, by a loss of breadth.

The system. An estuary, as viewed for tactical planning, is a complex river-mouth system in which a great many physical, chemical and biological interactions occur. These vary spatially and with time and determine the system properties or state of the system at any given moment. Among the physical, chemical and biological processes which occur in and characterize the estuary system are the following: (1) mixing of fresh water and sea water (this process is the common basis for defining the word "estuary"); (2) transfer of tidal energy; (3) mixing and energy transfer from the wind to the water by means of waves; (4) energy transfer to the water and aquatic vegetation from the sun by solar radiation; (5) other forms of energy transfer through the air-water interface by radiation and evaporation; (6) energy transfer among biological species; (7) diffusion processes involving physical and chemical properties; (8) dispersion and mixing processes for physical, chemical and biological properties or species; (9) flocculation of small particles; (10) sediment transport, deposition, and resuspension processes; (11) biological rhythms regarding spawning, migration, rest periods, and active periods; (12) population dynamics; (13) oxidation and reduction processes (aerobic and anaerobic processes); and (14) reaction and equilibria processes for various chemicals and chemical compounds.

The estuarine system receives and mixes fresh and ocean waters, together with the associated dissolved, suspended, or floating matter and that material dragged along the bottom. Much of this water is exchanged and released to the sea, along with some of the transported matter, the remainder staying in the estuary. The system provides habitation for a variety of biological species, including those which possess self-mobility and those which are captive to the currents. The system is subject to complex, intricate reactions and interactions among its physical, chemical and biological components. It is a dynamically stable system. It possesses considerable resiliency, within the limits of its complex balance and stability, to adjust to environmental fluctuations and to limited incremental system changes. The state of the system at any given time is a function of the present and past environments, with carryover and residual effects of system changes sometimes persisting over long periods.

Although the estuary is a complex system, this does not prevent taking the system apart into its analytically decomposable parts. Some of its properties are decomposable (e.g.; bottom depths may be classified and separated via contour lines) while others are not (e.g.; zones of velocity or salinity ranging between two specified limits; the "iso-lines" depicting velocity cannot be drawn without first specifying a number of constraints regarding time of year, fresh-water inflow, wind conditions, and exact tidal conditions). It is often quite useful and sometimes very necessary to attempt decomposing the estuary into parts in order to analyze the natural resources. But there is a danger in doing this--that once the decomposition has occurred and dividing lines have been drawn for properties, the system will thereafter be viewed by planners as static rather than dynamic (after all, the properties and their dividing lines can be drawn on maps, can't they!) and the parts may not be related to the whole when specific actions are contemplated. Therefore, tactical planning must recognize the limitations of analytical decomposition and incorporate such recognition into the plans themselves by preserving an awareness of the estuarine system as a whole.

The task of describing a particular estuary as a system is not simple. The tendency would be to build up a description from the combined information about the discrete elements (analytically decomposable parts). With good fortune, a reasonably good description of the estuary might result. But it is more likely to be a limited description of the present state of the system which is biased by the limitations of our knowledge of the system. Furthermore, combining the analytically decomposable parts will not give a complete description of interactions. For example, the combined description of salinity variation, current patterns, and bottom-sediment sizes throughout an estuary is not completely adequate to describe what happens to river sediment loads when they enter the estuary--inferences can be made about the interactions, but to do so reliably depends upon knowing more than just the distributions of properties in the estuary.

To describe an estuarine system, an understanding of the processes involved must be developed together with information about the properties and discrete elements of the estuary. In the previous example, an understanding of sediment transport and flocculation processes together with the distributions of the three properties mentioned would be the basis for an answer to the question posed--what happens to river sediment loads when they enter the estuary?

A schematic model of the estuarine system and its natural resource systems may be developed. Representing the estuary with a box, the internal part of the box corresponds to the system and the boundaries of the box to the system boundaries. The estuarine system is subject to a variety of inputs which are physical, chemical, and biological in character. Similarly, there are system outputs and these are physical, chemical, and biological in character. Alterations or modifications of the estuarine system may occur by natural forces or through man's actions and are included in the schematic model. Within the system, a large number of processes occur (physical, chemical, and biological). The system has an extensive array of physical, chemical, and biological properties. Many interactions (physical, chemical, and biological) occur among these properties because of the processes which occur. Figure 6 shows such a model.

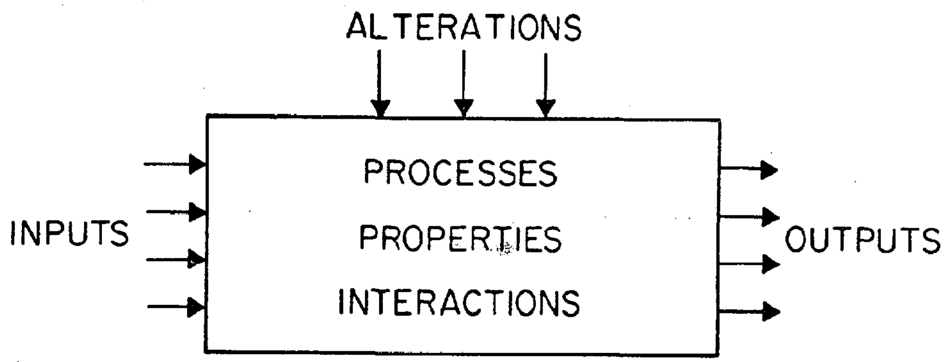

FIG. 6.-AN ESTUARINE SYSTEM MODEL FOR TACTICAL PLANNING

The most basic aspects of the environment from the standpoint of the estuarine system are the tides, currents, winds and waves along the coastal zone, the hydrologic conditions influencing drainage and river runoff from the adjacent lands, and the physiographic features (both natural and man-made) of the estuary boundary (shore and bottom). The physical inputs for the system and the physical features of the system dictate in large measure how the fresh and sea waters will mix, circulate and disperse. Thus they also control the natural chemical features of the system, since these waters transport an extensive range of chemical constituents. The particular details of flow and circulation are governed by the interactions of physical and chemical characteristics, particularly salinity (chemical structure of the water) and the temperature and density variations (physical structure of the water). Hence, estuary features such as flow stratification, density currents, and shoal zones are contingent upon the interplay of chemical and physical properties of the system. Man-related chemical or physical inputs, such as heated or polluted discharges, usually exhibit interdependency with rather than domination over the natural physical features for the system. The planner should recognize how importantly the physical features dominate an estuarine system, for it is most frequently the physical features of an estuary which are altered by development plans.

The biological features of the estuarine system may be placed in a somewhat different dependency relationship with physical features. While not entirely correct to do so, it may help the planner to consider that the biological features may be superimposed upon the mix of physical-chemical features. That is, particular biologic systems will generally be found in relation to particular combinations, ranges of combinations, or gradients of physical-chemical conditions--in particular parts of the system which might be termed habitats or localized environments. And it is critical that the planner be able to recognize habitats or potential habitats early in the planning process.

Superimposing biological features upon physical-chemical conditions of the system has the limitations of showing neither the biological interdependency within species nor the biological interactions with the environment. For example, a species which is highly adaptable to system changes may have a food web in which one or several links have a more limited tolerance to the physical-chemical environment. Consequently, superimposing of biological species on favorable environmental conditions will allow a planner to identify potential desirable habitats for various organisms within the system, but the food web must also be examined in determining the viability of habitats. Also, a species might be able to survive in a different physical-chemical environment, based on such information as laboratory study, but might not be able to interact favorably with other species found in the altered natural setting, due to competition or predation. Furthermore, biological processes such as respiration and photosynthesis modify these environments, so that the attempted superpositioning of species upon physical-chemical conditions in the system has restricted validity.

Variability in the system. The estuary has been described in the previous chapter as a relatively open system with free connections to the tributary rivers and the ocean. Further, it is subject to fluctuations in the magnitude of its inputs, many of which are reasonably predictable and exhibit short-term cyclical patterns (e.g.; tidal phenomena) or seasonal patterns (e.g.; climate, rainfall, streamflow). Internally, the estuary exhibits considerable spatial variability among its system properties (e.g.; depth, width, type of bottom material, plant communities) and processes (e.g.; current mixing, nutrient transport). Figure 7 illustrates the typical variability of some system inputs and properties for Oregon estuaries. The openness of the system, the reasonable predictability of many environmental fluctuations, and the spatial variability of system characteristics combine to provide many different, interconnected, localized environments. The planner may be able to use this to advantage in identifying different habitat types for selected species.

An open estuarine system with predictable cyclical, periodic, and near-periodic inputs (e.g.; solar energy, fresh water, minerals, nutrients), will exhibit a system state that varies in response to environmental variations. If the system is also subject to non-predictable inputs, the nature, time of occurrence, and severity of such inputs will determine the nature of the interactions and will indicate the degree of biological system response. The outputs from this system will be fluctuating and have predictable and non-predictable components. The resiliency of the ecological system, developed by evolutionary and successional processes, gives organisms the ability to persist under the range of system states encountered in Oregon estuaries.

It is likely that the ecosystem has even greater resilience than man has had the opportunity to observe. The limits of this resiliency range might be considered as the boundaries of system stability (Holling and Goldberg, 1971).

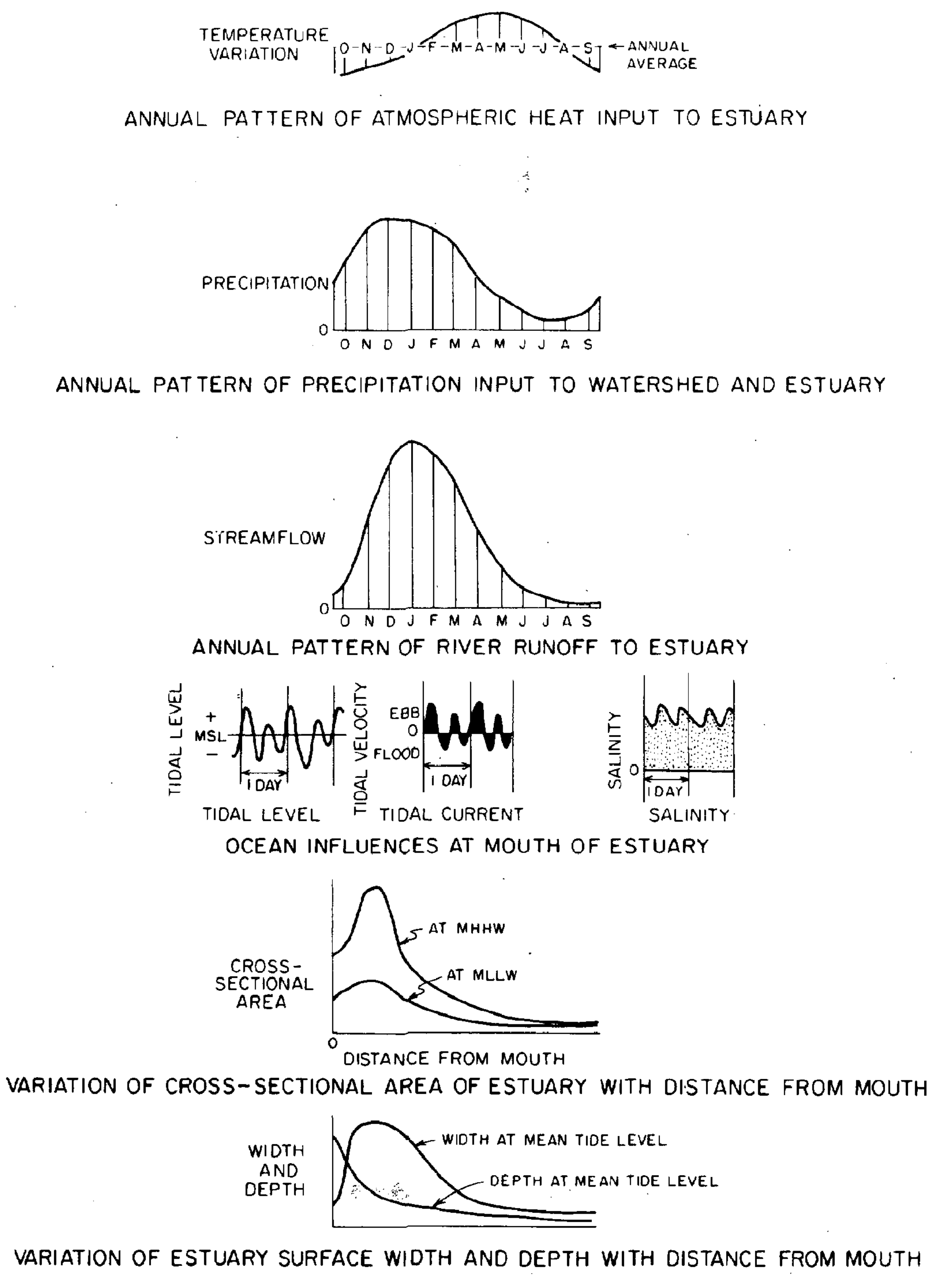

FIG. 7. TYPICAL VARIABILITY OF SYSTEM INPUTS AND PROPERTIES FOR OREGON ESTUARIES

System alterations. With respect to tactical planning, this broad range of system resiliency means that the natural ecological system can be expected to absorb some incremental change. If the actions are limited in scale and scope, so as to preserve system complexity and resilience, it is reasonable that the system state will remain stable. These actions, where more than one are planned for an estuary, should be diverse in character so that several "small" actions don't become equal to one "large" action. For example, several localized landfills around the periphery of an estuary are really equal to one large-scale action to fill tidal margins (San Francisco Bay placed a moratorium on such fills a few years ago because of the magnitude of the cumulative effect). Similarly, the dredging of a small-boat harbor in part of an estuary might not upset the complexity and resiliency of the system whereas dredging a deep-water channel and turning basin for large vessels might be of such scale and scope as to severely affect the system.

Small-scale local changes may have an appreciable influence on the immediate component of the system where the change occurs, even though they may not significantly alter the complexity and resilience of the entire estuary system. This can range from complete loss of local habitat (e.g.; land fills, dredging of clam beds) to partial change of localized environment (e.g.; sewer outfalls, altered currents and nutrient transport near piers and docks). The abruptness and extent of change may drive the local system state beyond its previous domain of stability. The openness and spatial variability of the entire estuary will accomodate some displaced members of the ecosystem while others may vanish from the system. The changed local area may disrupt reliable, satisfactory self-organization of the local biological community and may permit proliferation of particular species which can adapt rapidly to the new conditions and which no longer are held in check by former members of the local ecological community. Hence, an ecological shift may occur which by succession leads to a new domain of resilience and stability for this portion of the estuary.

If several small-scale local alterations are made in an estuary, the above-noted changes will take place in several portions of the estuary. The cumulative effect of several incremental changes will affect the overall system. When several alterations are made in an estuary simultaneously, the combined effect will differ from that for the case where the same alterations are made over a prolonged period of several years. This results from the ability of the resilient system to accomodate environmental change and alter its state. In the first case (simultaneous development), all of the alterations are superimposed on a single state of the system whereas in the second case (staged development), each alteration may occur at a different system state. Also, in the latter case each alteration might drive the system processes, properties and interactions in a different direction. Consequently, the interactions due to the new alteration have many possible forms compared to the case with simultaneous development.

Detecting the effects of system alterations. Often the effect of a small-scale alteration of the estuary system may go unnoticed. The resiliency of the ecological community under stress and the limited observational efforts of man to monitor the state of the system make it unlikely that the effect of the alteration will be signaled immediately and detected.

This inability to note minor changes in system state poses an element of risk in all planning that involves estuarine resources. If a single, limited alteration does not cause immediate and apparent system responses, planners who are conditioned to look for cause-effect relationships may conclude that the action evoked no reaction and therefore had no effect upon the system. There are two reasons why this type of evaluation is risky: (1) the effects may not be immediately apparent; and (2) the effects may be too small to be detected by routine or special monitoring, if such monitoring exists. In the first case, system interactions may be set in motion which take time before the effect can be noticed (e.g.; removal of river gravel used for spawning in streams tributary to the estuary may not show any effects until a few years later when the returning run of anadromous fish is below normal). Or the effect may be lost among other changes in system state due to fluctuating inputs. For example, the turbidity caused by dredging or land-fill operations may be obscurred by river turbidity during a period of storm runoff. In this connection, it may be noted that the ecological system is highly adapted and possesses temporal organization to persist in the face of naturally turbid runoff. It might therefore be best able to accept the additional stress caused by dredging if the dredging occurred during the runoff season rather than at other times of the year. Further, the system is better able to disperse the localized effect of dredging turbidity during the runoff season. In the second case cited above, the system might not be understood well enough to know what species or estuary property to monitor. In either case, it is risky to assume that an action has no effect on the estuary. Virtually all actions taken by man in an estuary are likely to have side effects (Committee on Tidal Hydraulics, 1969).

The planning risk caused by inability to detect system response to alterations becomes greater as the magnitude of the alteration increases. As with a small alteration, not all of the effects of a large alteration may be apparent immediately after the change is made. The complex system interactions can generate unexpected and undesirable results which become particularly severe if the alterations are massive or represent a series of incremental changes. The construction of entrance jetties and related channel dredging at an estuary mouth will show some immediate effects, such as interception of littoral sediments and increased exchange of water between the estuary and the sea. But the more subtle environmental and biological changes which occur thereafter may not become critical until years later. Thus, the possibility of medium-draft shipping which results from the constraint-removal action of deepening the estuary entrance may lead to the introduction and accumulation of new pollutants to the point where toxic levels are reached. Or biological species which formerly did not enter the shallow mouth may now enter the deeper entrance and upset the biological organization of the estuary due to preditory or parasitic behavioral characteristics. Moreover, with delayed subtle changes it will be difficult, if not impossible, to identify these changes with specific causes.

Recognition that the estuary ecosystem has self-organizational capabilities and that biologic species have definite habitats or preferences for particular environmental conditions can provide the planner with a useful indication of the state of the system. Some organisms act as sensitive indicators of physical-chemical-biological conditions. The presence of particular pollutants due to a new waste outfall (e.g.; temperature or particular chemicals) may cause different species to thrive or die off. The changed environmental properties due to changed mixing and flow circulation after some physical alteration of the system has occurred may also cause the thriving, die off, or displacement of organisms from particular parts of the system. Loss of some forms of organisms can lead to rapid further alteration of the chemical-biological character of an estuary. Therefore, it is important, as in the second case cited in a preceding paragraph, to identify the biological indicators which might be monitored.

Planning questions posed about the system. Once an understanding of the estuarine system has been developed for planning purposes, a number of questions will be posed about the system. These include: what inputs it is subject to; what processes occur, and how and why; what are the system properties; what interactions occur; what outputs are there from the system; where does one get information to answer these questions; how much information is required about such a complex system in order to do planning and decision-making for comprehensive plans or for specific projects; what does the basic schematic model of the system look like when more detail and refinement are added; if alterations are made to an estuarine system, how can their influence be detected and evaluated; will alterations add to or decrease the tendency toward instability; are alterations likely to trigger chain reactions within the system or is there considerable system dampening because of the system resiliency and openness to other systems; and what are the limitations and biases of available information.

System Concepts for Analysis

Several concepts related to "the estuary as a system" are particularly important in planning and analysis of the estuarine natural resources and have been grouped together for discussion here. These include: system boundaries and spheres of influence; system diversity; system state, resiliency and self-organization; adaptivity of system components; system carrying capacity; system "health" indicators; perception of the system; system ignorance; and system uniqueness.

System boundaries and spheres of influence. Earlier in this chapter the system and its boundaries were discussed in detail. For planning of estuarine resources, the system must be considered to be the entire estuary or some major isolatable portion thereof, rather than only that part of the estuary where proposed actions will occur. The system boundaries must be defined accordingly. This yields an open system subject to a variety of inputs and outputs. Consequently, the system is not totally isolated or independent; it is part of a much larger ecosystem and socio-economic system. To describe the relations of the estuarine system and its boundaries to the larger environment of which it is part, the concept of "spheres of influence" might be added.

For a typical Oregon estuary system, the spheres of influence concerning natural resources include the following: the ocean fishery of the northern

Pacific, the freshwater fishery of hinterland streams, the Pacific wildlife flyway, the timber-based industry of the hinterland and its trans-Pacific market, and the recreation-tourism pattern for west-coast residents and, to a lesser extent, others which is based on the natural features offered by Oregon's estuaries and nearby coastal zones.

Because the spheres of influence exceed the system boundaries of a particular estuary, natural resource planning must consider many of the relationships at the strategic level. Still, tactical-level planning must maintain an awareness of spheres of influence, particularly in relation to environmental impact analysis.

System diversity. Another important system concept is diversity, as contrasted with sameness. Natural systems are diverse, complex, and highly coupled. Man-made systems, on the other hand, tend to be simpler (analytically decomposable) and are often characterized by a narrowly defined function (purpose) and sameness. For example, even large comprehensive water resource development schemes concentrate water usages into a limited number of "multiple purposes." While these schemes generally make more water available to several of these uses, in doing so they thereby remove some of the former diversity. For instance, the water delivery systems in such schemes are frequently "hydraulically improved" compared to the former natural waterways, such that much of the diverse aquatic life is destroyed.

The need to create large-scale similarity for economic reasons is well-understood by planners and developers. It is more economical to mass-produce, to offer products from a limited selection than to custom make them, to develop a large waterfront area for housing and commercial use than a single lot, to offer a limited number of home styles rather than individual plans, to excavate and fill large areas rather than single lots, to dredge a large boat basin or channel rather than a small one, to build dock facilities for several hundred small boats rather than for a dozen, to develop a large waterfront docking and storage facility for forest products rather than a small one.

Planning for estuaries must recognize that the maintenance of diversity is just as important to the natural biological resources as is large-scale similarity to the economics of development. The multitude of biological species found in an estuary depend upon the diverse system characteristics to which they have adapted over time. Consequently, large-scale changes should not be made which would greatly restrict the diversity of a system, by grossly altering its physical-chemical characteristics, unless there is a willingness to accept the risks of significant changes in the composition of biologic resources.

Another aspect of the diversity concept is that a diverse system provides a much broader range of alternative ways for human use and ecosystem self-adjustment. This may be better appreciated when translated to human economic terms: an estuary community with a diverse economic base can adjust more successfully to a decline in numbers of salmon caught by the local fishermen than can a community with only a commercial-fishery economic base. Risk, in terms of an ability to survive and support a population in a healthy manner, is increased as the diversity of a system is limited. Conversely, adaptation and survival are protected by maintaining a diverse system.

Waterfront development can have a significant effect upon system diversity, both from the human viewpoint and with regard to biological resources. In the first case, residential and commercial developments which tend to be of a "strip" nature, or which string out along the estuarine shoreline for several miles, are detrimental to aesthetic diversity and diversity of land use. "Clustering" of the same amount of development can provide the same total development at a lower cost in service facilities such as water, gas, electricity, and sewer lines and will at the same time maintain the shoreline diversity. In fact, the shoreline diversity may increase over the previous, entirely natural condition. Regarding the biological resources, strip development along the shoreline contains the threat of some loss of mud flat, marsh, and surgeplain-floodplain areas, all of which play an important role in the ecosystem. Therefore, cluster developments separated by preserved open spaces should be given high priority in tactical planning (see also Chapter IV).

System state, resiliency and self-organization. Estuarine systems have been described in preceding paragraphs as resilient to fluctuating external inputs. The particular resiliency and self-organization which is found in natural estuaries may be considered to be desirable because of the rich variety of biologic life normally found there. The state of an estuarine system and its components after man-made alterations have occurred is difficult to predict in advance. Man-made systems are designed to perform in a stable, predictable manner. But the estuary which is affected by the alteration may not respond in similar fashion.

The concept of system state, resiliency and self-organization requires that proposed changes in an estuary be analyzed to determine if they will have any effect upon system state or resiliency and to determine the direction of such changes, if they are expected. It is important to avoid too great a change in the system so as not to upset its reliable, satisfactory self-organization. Severely altering the dynamically stable system, as by development of seasonally polluting industries whose effluent enters the estuary out of phase with other chemical or bacterial loadings, may disrupt the resiliency and eliminate some species which are unable to adapt. Reducing the variability of states for the system or its inputs, as by development of a large upstream reservoir which effectively dampens out the seasonal floods, can likewise be detrimental. Consequently, the anticipated effects of all modifications upon the state and resiliency of the system must be carefully considered.

Adaptivity of system components. The biologic life of a natural estuary is generally well-adapted to its surroundings, having had thousands of years to reach such a state. The biologic life of most Oregon estuaries, where technological man's influence has been felt to a limited extent for several decades, may still be reasonably well adapted to its environment. But wherever modifications in an estuarine system have been made, humans and other biologic species have had to make some adjustments or adaptations to continue living and reproducing.

Human adaptivity should be considered separately from that of estuarine biologic species with regard to the adaptivity concept. Man is highly adaptable. Yet if he perceives that his adaptation is inadeuqate, he is capable of altering his environment in accord with his preferences and desires. The many physical changes made in estuaries demonstrate this ability. Within the human community there are great differences in adaptivity to the estuarine system. At one end of the human spectrum is the "hunter-fisherman" adaptation made by those who make their living by direct harvesting of the biological resources of the system. At the other end of the human spectrum are those whose "exploitational" adaptation consists of capitalizing upon the interests and efforts of others involved in use of estuary resources (i.e.; by non-resident investors seeking profitable undertakings, of whatever type, wherever the opportunity arises). People identified with one end of the spectrum are entirely dependent upon the estuary for their livelihood, while for those at the other end of the spectrum the estuary appears to be merely incidental.

Planning must fully appreciate human adaptivity in order to obtain public support. Proposed system changes should not tax the limits of desired human adaptation. If an estuary modification is likely to alter human life-styles or perspectives on life by creating a new tempo of living, bringing in new people with different attitudes, or taking away existing occupations by destroying or making inaccessible particular natural resources, then this must be adequately examined during planning.

Adaptivity involves estuarine biological resources in quite a different manner from humans, because the biological resources are, comparatively, incapable of altering their environment other than by moving to new surroundings. It is likely that the present mix of biological species found in Oregon's estuaries today are not as well-adapted as those existing several decades ago, under more nearly natural conditions. This means that planning can have two rolls concerning the adaptivity of biological resources. First, these resources must be protected against system modifications which would create greater stresses than could be satisfactorily adapted to by the biologic species in the estuary. Second, there is an opportunity to modify or manage the estuarine system in order to permit a better adaptation by selected (or all) biological species, particularly in estuaries which have experienced poorly planned environmental development. This could involve such measures as habitat improvement, preditor control, water quality control, or disease control.

The need for biological adaptibility can be minimized in some instances by controlling the time or rate of system change. Rapid man-made changes at the wrong time might be destructive of biological resources whereas the same modification might be carried out less-rapidly and at a different time without harming many of the same biological species. For example, channel dredging at a time when many anadromous fish are in the estuary or when certain resident species are active will have much different biological effects than the same dredging at a different time when no anadromous fish are in the estuary or when the resident species are dormant.

System carrying capacity. The carrying capacity of an estuarine system can be given different meanings. Regarding pollutants, the term can mean the amount of introduced foreign matter with which the system may be loaded by means of steady or irregular effluent releases. The term also represents the limiting size of biological populations (including humans) which the estuary can tolerate without showing deleterious effects to beneficial uses of estuarine resources. The concept of system carrying capacity has particular significance with regard to management practices for estuarine natural resources. It is describable in terms of population numbers, by concentrations, and by intensity of use.

Some of the risks and dangers inherent in pushing an estuarine system to the limit of its carrying capacity are biological overcrowding and an overdraft of the environment. Overcrowding leads to severe competition for space, food and reproductive opportunity among individual members of the biological group. Thus the health and reproductive capabilities of the species are endangered under crowded conditions. Biological overcrowding can lead to an overdraft of other natural resources, such as consumption of aquatic vegetation by "grazing" species. Loading the waters with nutrient-rich effluents from waste treatment plants can stimulate population explosions among algal communities with subsequent rapid population declines, decay, and eutrophication. Heavy loadings with settleable foreign matter or disturbed watershed soils may lead to rapid deposition in localized parts of the estuary bottom with adverse effects upon benthic organisms and the overlying waters.

System "health" indicators. Another concept for tactical planning is to use sensitive biological species as indicators of the "health" of the estuary system prior to and after the initiation of estuary alterations. The adverse effects of changes such as increasing the heat, nutrient or toxic load to an estuary or of altering the salinity structure are more likely to be noticed first through behavioral changes or vitality of sensitive biological species then through a routine water quality monitoring program which does not monitor the sensitive species. Therefore, the sensitive indicators in a particular estuary should be identified where possible and placed under surveillance early in the planning process to provide "base line" measures of species behavior for later comparison. Unfortunately, our limited knowledge of estuarine organisms makes it difficult to know which species will be the best sensitive indicators in each situation and what types of effects to expect. Where the human presence is well established, biodegradation of wastes is often the most significant estuary interaction of the biologic community with man's activities (Schaefer, 1972) and suggests a common situation for which suitable indicators must be sought.

Perception of the system. An important concept in estuary planning is that the system and its processes are not perceived or understood in the same way by all knowledgeable people. The system is perceived based upon what is known or thought to be known about it and based upon what people want to do with it. Such perceptions are often inaccurate. A person whose livelihood depends upon harvesting the biological resources of the estuary will see the system, its processes and system alterations in an entirely different manner from the town realtor or motel operator who has no occasion to be "on the water." Land-use planners will have a different perception of the system than shopping-center developers; dredge operators will have a different perception than fisheries biologists.

The estuary planner must recognize that his "public" does not have a single, common perception of the system (the perception also differs among estuary planners). He must also recognize the limits of his own perception, based as it is on rather limited knowledge. He must pay considerable attention to the greater physical, ecological and social systems which extend beyond the boundaries of his immediate estuary system.

System ignorance. In tactical planning of estuarine natural resources, considerable data and basic information will be missing. Therefore, the planner needs to incorporate "ignorance of the system" into his planning methodology. He must assume from the very beginning that he will never during the planning process fully understand the system he is working with, its intricate processes, and the complex interactions which may be triggered by proposed alterations. While this seems to suggest that the planner must act timidly with great caution, it does not preclude bold, large-scale planning which will severely alter an estuary--as long as such an undertaking is worth the biological risks and losses involved.

System uniqueness. The concept of system uniquenss has been applied at the strategic planning level, where a comprehensive regional view of estuarine natural resources and comparison of all estuaries is obtained. However, the focus upon individual estuaries at the strategic level is not as sharp as at the tactical level where specific plans for particular estuaries are prepared. Hence, recognition of unique features of the estuarine system or of its elements may not occur until tactical-level information gathering takes place. Therefore the concept of system uniqueness needs application at both planning levels.

Habitat Identification and Preservation

The identification and description of different habitats for estuarine biological resources is possible. The habitats usually are not sharply delineated nor mutually exclusive. Organisms are distributed along gradients of environmental conditions, rather than in absolutely isolateable regions. Thus, habitats will tend to be limited by zones of change in the values or characteristics of the aquatic environment's physical and chemical properties.

Habitat identification and description serve the useful planning purpose of showing the functions that different components of an estuary provide to the biologic species in the system. Hence, the description of habitats should include statements regarding the relationship and role of each habitat with respect to the total estuarine system. Any uniqueness should also be identified.

Even though the habitats are not sharply delineative, they provide a method of classification that can infer the types of biological resources that may be present. This provides the planner with a means for making evaluations of potential biological resources and resource capabilities even though he may not have available an extensive inventory of existing biological species for such habitats. Furthermore, habitat classification is a concept which is generally familiar to or easily learned by land-use planners. The main caution required is that when habitat classification is used, the estuary must still be viewed as a dynamic, changing resource rather than a static parcel of real estate.

There are many approaches for identifying and classifying the biological resources of an estuary and their habitats. These include: (a) taxonomic classification of species present; (b) functional classification based on biological production (producers, consumers, and decomposers); (c) classification based on the value of organisms to man--direct commercial, recreational, or aesthetic values, indirect values (organisms important in the food web or as bait for directly important organisms), or no known direct or indirect value; (d) classification according to biologic group or behavioral characteristics (plankton, neuston, nekton, benthic organisms, epiphytes); (e) classification based on the portion of the life cycle spent in estuarine waters (entire life cycle restricted to estuary, estuary used only for spawning and reproductional activities, estuary used as part of migration route); and (f) classification based on physical-chemical characteristics of spaces within estuary (margins, inter-tidal, sub-tidal, brackish, marine).

The manner in which a planned development or modification in an estuary will affect the biological resources will determine which of the classification schemes is most useful to the planner. Recognizing that most estuarine planning is "space" or "location" oriented (i.e.; it can be described by placing lines on a map), it is recommended here that a classification system based upon (b), (c), (d) and (f) and designated as "habitat classification" be used for biological resource analysis and for the corresponding planning concept of habitat preservation. Habitats could be described by suitable combinations of the terms shown in Table 1.

Several examples of general habitat types common in Oregon estuaries may be given. These include:

1. High salinity (usually greater than 25 parts per thousand-ppt) channels, washed by tidal currents, stable bottom of boulders or compacted clay or clay-sand mixture, attached seaweeds common, and frequented mostly by marine fishes such as black rockfish, lingcod, greenling, flounder, Pacific herring, northern anchovey, and salmon. Invertebrates such as shore and commercial crabs are common. Sea birds and seals are also common visitors to this habitat. Major natural resource value is recreational fishing and crabbing.

2. High salinity mud and sand flats adjacent to the mouths of estuaries, periodically inundated and exposed by tides, sometimes blanketed with filamentous algae, and typified by the presence of numerous clams and other invertebrates. Estuarine fishes such as flounder and viviparous perches frequent such areas when they are inundated. Such habitat is important to shorebirds and waterfowl for feeding and loafing areas, and harbor seals use the beaches for "haul-outs." Major natural resource value is recreational and commercial clamming.

Table 1. Considerations in habitat identification and description.

I. Features of Space

Water depth:
- floodplain/surgeplain zone
- surf splashzone
- marshes
- intertidal zone
  - upper
  - middle
  - lower
- subtidal zone
  - shallow
  - deep

Location in estuary:
- entrance
- near-mouth
- middle reaches
- upper end
- riverine
- channels
- constrictions, points
- embayments
  - deep
  - mudflat
  - marshy

Typical salinity range:
- near-marine
- intermediate, high salinity
- intermediate, low salinity
- near-riverine, mildly brackish

Bottom sediments and substrate condition:
- bedrock
- rocky, boulders
- gravelly
- sandy
- muds
  - silty
  - clayey
- vegetation, plants
- organic debris
  - wood chips
  - logs

Vegetation type found:
- shoreline
- aquatic, intertidal
- aquatic, subtidal
- sedges
- grasses
- algae

Association with structures:
- pilings, piers
- jetty rocks
- log booms

II. Value of Species to Man

Direct:
- commercial
- recreational
- aesthetic

Indirect:
- commercial
- recreational
- aesthetic

Basic life support

Non-essential

III. Functional role of Species

Producers

Consumers

Decomposers

IV. Biological Group or Behavioral Characteristics

Plankton

Neuston

Nekton

Benthic

Epiphytes

3. Medium salinity (usually 15-25 ppt) channels, regularly washed by tidal currents, stable bottom of compacted clay-sand, and typified by fluctuations of salinity and temperature. Dungeness crabs and viviparous perches use these channels for access to shallower feeding grounds in spring, summer, and fall. Jack smelt and anchovies also congregate in these areas during summer. Anadromous salmonids pass through this habitat on their migrations to and from the ocean. Major natural resource values are crabbing and fishing for salmon.

4. Low salinity (usually less than 15 ppt) channels, regularly washed by tidal currents, stable bottom of compacted clay-sand often covered with a shallow layer of silt and detritus, typified by extreme fluctuations of salinity and temperature. Softshell clams, flounders, sea-run cutthroat trout, and sculpins frequent this habitat. Major natural resource value is recreational fishing for flounder and cutthroat trout.

5. Medium salinity (usually 15-25 ppt) mud and sand flats and proximate sloughs, periodically inundated and exposed by tides, commonly blanketed with filamentous algae in mid-summer, often supporting emergent plants such as eel grass, and typified by the presence of numerous cockles and gaper clams. Such habitat is important to waterfowl for feeding and loafing areas. Furbearers, particularly raccoons, frequent these areas searching for food. Flounders, viviparous perch, and crabs feed extensively on these grounds when they are inundated. Major natural resource values are for clamming, crabbing, and recreational fishing.

6. Low salinity (usually less than 15 ppt) mud and sand flats and proximate sloughs, periodically inundated and exposed by tides, often blanketed by filamentous algae in mid-summer, commonly supporting emergent plants, and typified by extensive populations of softshell clams. Waterfowl and furbearers frequent these areas in search of food. Deer and bandtailed pidgeons obtain salt and some sustenance from this habitat. These areas often serve as nursery grounds for the young of viviparous perch, flatfish, herring, shad, striped bass, and crustaceans such as crabs and Crago shrimp. Shad and striped bass often utilize this habitat for spawning grounds. Major natural resource value is clamming, waterfowl hunting, and spawning and nursery areas for those species listed above.

7. Freshwater areas under tidal influence at the heads of estuaries, typified by well defined river banks and sluggish water flows. This habitat supports extensive populations of anadromous cutthroat trout and crayfish. Other migratory salmonids linger in these areas on their journeys to and from the ocean. Diving ducks nest and feed in this habitat, and puddle ducks rest and preen on these waters. Major natural resource value is habitat for anadromous salmonids and recreational fishing.

8. High or medium salinity, rocks or shells at various levels of the intertidal zone, such as breakwaters, dikes, and revetments in bays.

9. Pilings and logs at various levels of the intertidal zone.

10. High salinity, spray and splash zones in or above intertidal zone, usually rocky and near the open coast, such as jetties.

An important feature of tactical planning for estuarine natural resources involves the concept of habitat preservation. This concept is aimed at protective use of estuarine natural resources for beneficial purposes on a continuing basis. It provides one effective means for implementing the diversity approach discussed at the strategic level (see Chapter IV). Each proposed action should be tested against what might happen to the habitats which are needed by the biological community. Some actions may create habitats (e.g.; the rocky habitat formed when a jetty is built) whereas others may temporarily or permanently destroy habitats (e.g.; dredging or land fill). Some proposed estuary uses may have neglibigle effects on habitats.

Habitat preservation requires that the planner identify the different types of biological habitat in the estuary system which his planning will affect. Concurrently, he should determine which biological organisms in the estuary are of direct value to man. These can then be related to the habitats which have been identified. At this stage, the planner will have learned whether the contemplated action will occur in the same locale that provides habitat for directly valuable organisms, although indirect influences will not yet have been identified. He also will know what habitat losses or displacements of directly valuable species might occur.

The indirect influences must be evaluated next. First, the food webs of valuable organixms must be determined and the habitats of food web organisms identified to see if the contemplated action might adversely affect the valuable species by disrupting their food webs. The effects of such losses or displacements must be considered for the system. Second, a habitat which will be altered by the proposed action must be further examined to determine what other organisms (beyond those already considered) will be affected and what their loss or displacement will do to the system. Third, the influence of a proposed action upon habitats and organisms away from the immediate locale of the action must be evaluated.

Once the direct and indirect effects of a contemplated action upon biological habitats in an estuary have been examined to that extent possible with the limited available information, it may be possible to state whether beneficial uses can be made of the biological resources on a continuing basis after the action is taken. Other repercussions within the biologic community should also have become more apparent. Whenever adverse effects are either likely or suspected of having some chance of occurrence, the contemplated action should be reviewed and revised to obtain better protection of the existing biological habitats. Moreover, a recognition of the limitations of knowledge will call for the preservation of a wide variety of habitat types.

It will not be possible to preserve all habitats in an estuary. But selectivity can be practiced regarding which habitats to protect or how much habitat to preserve. The progressive loss of habitats by development activities will place an increasing value on the remaining habitats, if the estuary is to maintain biological diversity. This, in turn, will be a constraint against subsequent actions which would affect the remaining habitats. Hence, if one of the goals of a comprehensive plan for an estuary is to maintain variability of the estuarine biological resources, then early actions should include provisions to preserve rather than disturb habitats as much as possible so that later options are not narrowed too greatly.

Use of Environmental Impact Assessment Throughout Planning

The environmental impact statement has been developed to test specific plans and proposed actions against their anticipated outcomes and impacts upon the environment (natural, economic and social). Since its formal adoption with passage of the National Environmental Policy Act of 1969, this procedure has served as a form of review and revision at the end of the planning process.

One of the key elements of tactical planning should be the examination of environmental impact. However, instead of placing the environmental impact assessment at the tail end of the planning process where the final decisions to take action are made, the concept of evaluating environmental impact should be applied from the very start of the planning process and form a part of the basis for all preliminary and intermediate decisions regarding alternative courses of action. Doing this would permit environmentally better actions to be proposed for final consideration. It would anticipate and avoid the proposal of many courses of action which are environmentally unacceptable to the public. This procedure would also make better use of available planning resources.

Several facets of environmental impact which require assessment in planning are given in Table 2. Others are implicit in the other concepts presented in this chapter.

Environmental impact assessment is an evolving methodology. such assessments were already made in less formal terms by many conservation agencies prior to passage of the National Environmental Policy Act. However, with new requirements the techniques are being modified and new procedures are developing (e.g.; Dittion and Goodale, 1972, Environmental Protection Agency, 1971; Leopold, et.al., 1971). Therefore, those responsible for guiding the planning process for estuarine natural resources must continually revise and update the detailed procedures of environmental impact assessment.

The task of developing a proper environmental impact statement is difficult, time-consuming, and costly. But so is the task of developing a good plan. Because the two are so closely related when proposed actions directly involve estuarine natural resources, combining the two tasks seems logical. At several steps in the planning process, a partial assessment of environmental impact would help direct the planner toward improvements in his plan and rejection of particular alternative choices which will

Table 2. Elements of environmental impact assessment.

I. Statement of proposed action

II. Existing conditions in context of proposed action
- Area involved
  - Condition of area
  - Problems
- Resources involved
  - Condition of resources
  - Problems

III. Alterations of existing conditions by proposed action
- Physical changes proposed
- Area to be affected by physical changes
  - Immediate
  - More-distant
- Systems to be affected by physical changes
  - Biological
  - Physio-chemical
  - Human
  - Other
- Time frame for alterations to occur

IV. Probable environmental impacts
- Resources impacted
  - Aquatic
    - Biologic
    - Mineral
    - Other
  - Terrestrial
    - Biologic
    - Mineral
    - Other
  - Interrelationships of resources
- Time frame
  - Short-term (during construction)
  - Long-term (during post-construction operations)
- Areas involved
  - Immediate (local) area
  - Distant areas within estuary
  - Distant areas beyond estuary
  - Interrelationships of areas
- Character of impacts
  - Direct vs. indirect
  - Primary vs. secondary
  - Avoidable vs. unavoidable
  - Isolated vs. cumulative
  - Beneficial vs. detrimental
  - Enhancement vs. deterioration
  - Reversible vs. nonreversible
- Possibilities for future modification
  - Renewability of resources affected
  - Reversibility and retrievability of resource commitment
  - Loss of future options
  - Restriction on range of beneficial uses

otherwise have to be rejected later. The effort made to assess impact throughout the planning stages will minimize the effort needed at the end of planning when the complete environmental impact statement is required. While such statements are currently required in Oregon only for projects which involve federal funds, the time may be near when projects involving state or local government funds could also require environmental impact statements. Such a prospect may conjure visions of mountains of reports and long delays. However, this need not be the case. The tactical planning methodology proposes a means for accomplishing better environmental impact assessment more efficiently and rapidly.

Preventive Planning

Another concept recommended for tactical-level planning of estuarine natural resources could be termed "preventive" planning. The concept recognizes that much can be learned from past mistakes and inadequacies arising from poor planning or the lack of planning and that careful examination of what went wrong elsewhere can help the planner avoid repeating these mistakes. Preventive planning thus involves avoidance of those schemes or alternative choices of action which have proven inadquate or unsuccessful elsewhere and for which similar circumstances exist in the estuary where planning is underway. This, of course, does not assure that other mistakes won't be made. An earlier chapter has examined at length the avoidance of "dominating bads" and the difficulty in avoiding unforeseen outcomes in making planning decisions.

To see how preventive planning might be used, consider first the way in which its counterpart is already widely used. A common practice in planning and executing a project has been to seek answers to the problems at hand based on solutions which have worked well in the past. However, there is a risk involved in doing this--that the circumstances describing today's situation are different enough from yesterday's circumstances so that yesterday's solutions have become obsolete. But this is generally avoided by "adapting" past plans to present circumstances.

A great deal may be learned by examining past failures as closely as past successes. In fact, it is frequently quite evident why a particular project failed, whereas the reasons for the success of a project may be much more elusive. Often with projects which have been unsuccessful or partially successful it is possible to find a relatively few causes for the lack of success. Those causes should be examined in sufficient detail to identify the cause-effect relationships, trace repercussions through the estuarine system, and test the projects against the planning concepts and methodology offered in this study. By example, then, this will build into the planning process a sounder awareness of system and resource behavior.

While the concept of preventive planning is easy to grasp, the idea needs particular reinforcing at the local planning level. Here, planners may not have the breadth of experience or information sources to know what projects have been unsuccessful elsewhere. Also, the planners are not likely to have the time or budget to learn about the details of unsuccessful projects of others under the pressure of conducting their own immediate planning work. Documentation of case studies by a cooperating planning group, such as a task group of state and federal agency representatives, would be a significant contribution to all levels of planning and planning review.

Flexibility to Preserve Future Options

Until recently, it has been generally accepted that proposed actions might be taken unless it could be shown that the action would have adverse effects which give cause for concern or alarm. Because estuarine natural resources are part of a highly complex and dynamic system, there is a considerable domain of uncertainty or lack of basic data and information by which to judge adverse affects. Further, the types of actions which are currently being proposed in estuaries include actions of sufficient magnitude that there is a definite risk of uncertain and unexpected consequences if the action is carried out, including large-scale irreversible change.

In Chapter IV the need to avoid large-scale irreversible change was stressed and was placed within the concept of diversity. At the tactical level involving a single estuary, the concept of flexibility as a feature of current plans may often be equally critical in dealing with large-scale irreversible change. (The diversity approach is a basic concept at the tactical level, as well as for strategic planning, and underlies the concept of habitat preservation.)

As viewed at the tactical level, a large-scale irreversible change would be one that affects a particular estuary in a major, readily-apparent or not-so-apparent way and is not subject to reversal. Such a change could result from intentional plans and actions undertaken in the estuary for reasons which were considered to have dominating importance. Or the change could result as an unforeseen outcome of actions taken for an entirely different purpose, due to the knowledge lag which makes prediction of the results of change much more difficult than the ability to change the environment.

There are several facets to the concept of maintaining flexibility of choice among future options as current plans are developed. In the first place, the knowledge of estuarine natural resources is sufficiently limited that unforeseen outcomes are probable rather than improbable. Present ignorance of the system is great. Second, by maintaining options and avoiding large-scale irreversible change, ecological correctability in the future will be possible should the biological resources suffer from estuary alterations or uses or should the biological resources assume a relatively greater future importance in the particular estuary. Third, the planner should not aim to predict and design the one and only future of the estuary and adjacent lands in terms of detailed specific types of development and use. Instead, he should provide the framework in which an assortment of futures might be possible, some immediately or in the near future in response to immediate needs and some left for future generations whose needs might be totally different from those of the present generation. Fourth, there are some uses of shorelines and wet lands which have sufficiently short life-cycles before removal or replacement of facilities is required that a time-projected apportionment of land use is possible to preserve future options (Brahtz, 1972). However, the social inertia to maintain a given action which originally had been considered flexible should not be underestimated. Fifth, the lowest-cost alternative based on present considerations may not remain lowest-cost if there were an adequate way to evaluate some of the unknown future needs and effects. Therefore, the relative merits of alternatives in preserving future flexibility should be weighed heavily against the economic costs to assure choice of the <u>best</u> alternative rather than the cheapest alternative.

Technology and human capabilities will change along with human needs. Therefore, it would be extremely shortsighted to implement expedient plans which minimize future flexibility of choice. Instead, under most circumstances those alternative proposed actions which offer considerable flexibility in exercising future choices or options should be favored over alternatives which cause significant loss of future choice.

VI

TACTICAL PLANNING METHODOLOGY FOR OREGON'S ESTUARIES

This chapter presents a tactical planning methodology for Oregon's estuarine natural resources and an explanation of how the methodology should be implemented. The tactical planning methodology pertains to individual estuaries and is directed at an intermediate planning level between that at which regional strategic plans are formulated and the local level where plans for specific actions usually originate. The local level, in the sense used in this chapter, is broadened to include not only the public and private groups which are normally considered geographically "local" to a particular estuary, but also to include state and federal agencies with respect to their specific projects in that estuary.

The tactical planning methodology is based upon the belief that an intermediate planning element between regional policy and local action plans is needed for Oregon's estuaries. Such an intermediate level must be concerned with the development of specific guidelines and tactics by which to implement policies evolved at the intermediate and strategic levels. It must provide a substantial interdisciplinary expertise in natural resource planning and environmental impact assessment that would not ordinarily be available at the local level. It must also be capable of general pre-planning (advance planning) in order to best help the local groups who propose and develop specific plans that may affect the natural resources of a given estuary.

Features of Other Pertinent Methodologies

Many approaches are evolving for what is here called a tactical-level planning methodology for estuarine or marine resources. A few of these are briefly described here because of their pertinence to the proposed methodology.

One representative approach which covers the initial steps of such a methodology consists of six functional steps: (1) identification, classification and brief analysis of resource related problems confronting planners and decision-makers; (2) categorization of data and knowledge requirements for making sound decisions; (3) assessment of the availability and adequacy of the required information; (4) determination of data gaps and of needed data gathering and research activities; (5) formulation, implementation and monitoring of a priority-oriented data collection and research program; and (6) development of a system for organizing, synthesizing and analyzing resource information for planners (Pitchai and McGuinness, 1972). This approach can be made as detailed as necessary to fit a particular planning situation.

Another approach is to establish proposed guidelines for coastal resource use and management that should be followed by local governments in developing comprehensive use plans for a described area (e.g.; State of Washington, 1972). The guidelines cover a wide spectrum of economic, historical, cultural, and recreational activities and shoreline modifications. They serve to influence planning but with a minimum of interference in the detailed planning process.

Several of the approaches focus on land-use planning methods and their extension to estuarine waters, based upon environmental resource analysis, recognition of the importance of natural processes, and emphasis upon man's relation with his environment as a whole (e.g.; McHarg, 1969). Physical characteristics are generally more heavily emphasized than are chemical or biological characteristics. Such approaches typically treat resources by means of zones of demarcation, gradients, and tolerances.

In common with several systems-analysis approaches to planning with natural resources (e.g.; Belknap and Furtado, 1967; Brahtz, 1972) the land-use planning techniques generally include steps such as: (1) definition of a region or area for analysis; (2) inventory of the environment; (3) information gathering systems; (4) data handling, processing and interpretation; and (5) classification based on natural units, with different patterns of units for each type of resource. A limitation of these approaches results from the difficulty in treating the dynamic aspects of the physical environment, including ecological interactions and natural cycles. Further, it is not entirely adequate to superimpose overlay maps showing different natural features, as is done in much land-use planning, because as one area is allocated to one use the value of not doing the same thing elsewhere increases. Information gathering and analysis is made more difficult and the results less meaningful because the data normally represent a series of instantaneous images of a continually changing system. Nevertheless, the methods may be well suited to lands adjacent to the estuarine waters and thus may have an important role in estuary planning. It should be recognized, however, that planning for actions within the water zones and wetted zones is different from planning for lands adjacent to the estuarine waters. In the former case there are direct effects on many of the estuarine natural resources; in the latter case there may be relatively few direct effects but many indirect effects on these resources. Consequently, water-use and land-use planning are related and should be treated in an integrated manner. Balance must be achieved between estuarine and water-oriented resource uses.

The well established and more conventional methods of water resources planning and analysis may readily be applied to comprehensive planning for estuarine natural resources. This methodology can be described in terms of six distinct phases: (1) the establishment of goals, policies, and priorities for the use or preservation of natural resources; (2) the assembly and analysis of data describing these natural resources; (3) the identification and examination of alternative ways for use, development and management of these natural resources; (4) the testing of alternative forms for use, development and management against their impact upon the natural resources and against their effects upon local and regional goals; (5) the comparison and weighing of social, economic, and natural resource benefits and costs among alternative choices of use, development and management; and (6) the selection of an acceptable alternative for natural resources use, development and management. Each of these phases involves several detailed steps and procedures. These steps may be found in numerous texts on water resources planning and management (e.g; Kuiper, 1965; Linsley and Franzini, 1972; Salvato, 1972).

Proposed Methodology for Tactical Planning

The strategic methodology for planning with estuarine natural resources provides strategies for achieving basic goals and policies. Strategic constraints and guidelines imposed upon tactical planning will be concerned primarily with the preservation of developmental diversity (the diversity approach), both between and within estuarine systems. A tactical methodology is needed to further define plans within the strategic constraints and guidelines. The concepts which guide this methodology have already been presented. Some features of applicable methodologies have also been summarized. The concepts will next be applied in the form of a proposed methodology for tactical planning. This tactical methodology will be most applicable to production and mixed estuarine systems (see Chapter IV).

Establishment of Intermediate-Level Planning and Planning Services

A central feature of the tactical planning methodology is to establish an intermediate planning level between the broad strategic planning level and the specific local planning level and to define the role and functions of this intermediate level.

The purposes of the intermediate planning level would be to formulate guidelines for natural resource uses in particular estuaries, to coordinate planning activities, and to provide a range of functions and services which will greatly aid in the local planning for individual estuaries through such means as advance planning, data gathering, and data evaluation. This intermediate level is needed to provide a tangible, effective way for translating into meaningful terms the general concern for beneficial use and protection of estuarine natural resources. Carefully coordinated planning is required to protect the public interest while at the same time fully recognizing and protecting private property rights, consistent with public interest, and providing for fair treatment of involved individuals and groups of individuals. The tactical methodology will provide such coordination.

Table 3 shows the relation of this intermediate planning level to strategic and local levels. Both the intermediate level and the local level carry out tactical planning which is guided by and interacts with strategic plans. Information on local capabilities and limitations may be fed back to the strategic level via this intermediate level, in order to coordinate planning efforts.

Table 3. The intermediate planning level and its relation to strategic and local planning levels.

Planning Level	Planning Purpose	Planning Group
Strategic-level planning for Oregon estuaries as a group	Regional strategies to improve quality of life, protect natural resources, maintain diversity of estuarine resources and types. Interagency cooperation to implement strategies.	Federal-state interagency group with regional level coordination.
Intermediate-level advance planning for individual estuaries	Policies and guidelines for natural resource use in the estuary. Professional services. Coordination and clarification of responsibilities.	Federal-state coastal zone interagency group, separate from the above, with state-level coordination.
Local-level specific planning for individual estuaries	Specific plans, both comprehensive and limited in scope. Implementation of plans. Management.	Public and private entities "local" to the estuary and vicinity. State and federal agencies with specific projects or programs in the estuary.

The membership of this intermediate-level group would come from state and federal agencies and other appropriate groups involved in natural resource activities. They might function as a task force or by similar arrangement, and would probably be coordinated at the state level, perhaps by the Oregon State Water Resources Board and Oregon Coastal Conservation and Development Commission. To be effective, a realistic portion of each participant's annual activity would be assigned to this task force by his agency.

Tactical Planning Process at the Intermediate Level

With the role of the intermediate planning level described, attention may now be given to the broad features of the intermediate-level tactical planning methodology. This is a 9-step methodology by which the intermediate-level group can provide professional services. The methodology is to be applied to estuaries individually rather than collectively as done at the strategic level. Such planning would operate under the strategic constraints designated for the particular estuarine systems.

The individual estuaries which receive advance planning under the intermediate-level planning methodology must be selected on some sort of priority basis, as they cannot all be examined simultaneously without greatly lengthening the advance-planning timespan for each. The priorities should be set at the strategic planning level. Those estuaries which have not been classified would have lowest priority; those which are classified as production or mixed estuaries and hence subject to alterations would have the highest priorities. Protection of estuarine systems would, of course, require appropriate conservation actions. Broad conservation actions suitable for the development of protection systems would probably be initiated at the strategic planning level, although initiation could occur at all levels. Within the high-priority group of estuaries, priorities might be based upon the nearness in time of future alterations so that effective evaluation of proposed plans will be possible.

The general features of the intermediate-level tactical planning methodology are presented diagrammatically in Figure 8. Explanation of the diagram will proceed from the upper left hand corner in a counter-clockwise direction.

One of the initial steps (1A in Figure 8) must be the designation of the estuary boundaries and the identification of existing uses, problems, and conflicts in the estuary. Such identification is basic to all planning. The uses, problems and conflicts differ from one estuary to another; yet many are common to several Oregon estuaries. Therefore, this step in the methodology should be carried out simultaneously for all estuaries. Some of the ideas presented in the first and second concepts for tactical planning (system identification, description, and analysis--see Chapter V) will find application here. The existing activities and uses in each estuary should be grouped for convenience under collective headings such as commercial fishing, recreation, wood products, shipping, and so on. The existing problems and conflicts should also be grouped for reference, with headings such as water quality problems, biological resource problems, encroachment on estuary boundaries, problems related to shoaling and navigation, or problems of waterfront uses (commerce, industry, residential, recreational).

Another initial step (1B in Figure 8) is to identify and inventory the natural resources and to develop descriptions of the system features of each resource. Defining the resources and showing how they fit into the estuarine system is a lengthy but critical step. It probably should be carried out separately for each estuary to expedite planning. Many state and federal agencies have programs underway to obtain this information for the limited resources which fall under their responsibility

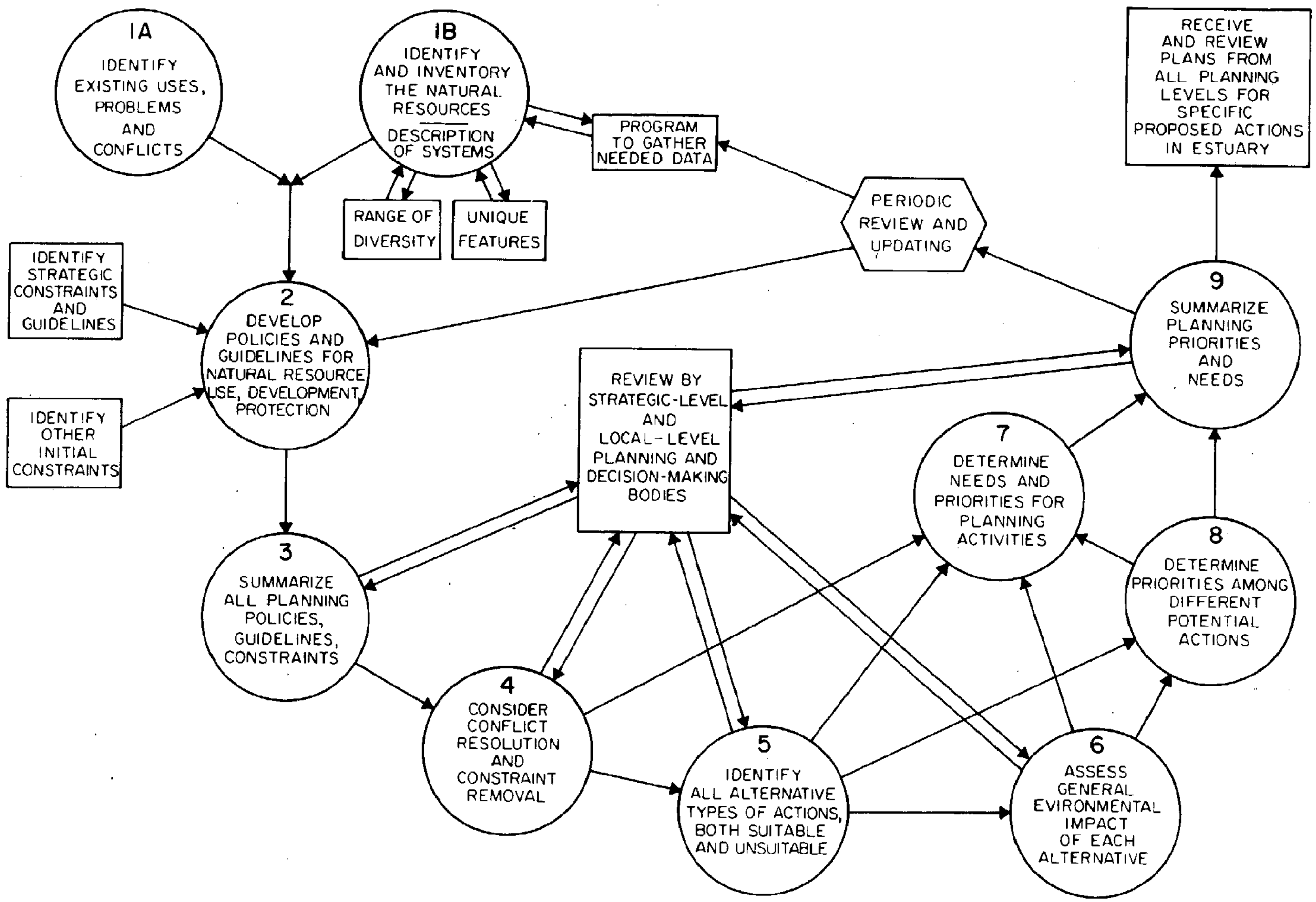

FIG. 8.-INTERMEDIATE-LEVEL TACTICAL PLANNING FOR INDIVIDUAL ESTUARIES

or scope of activity. This information must be compared for its collective completeness. The most effective way to accomplish this comparison is through a task group such as the intermediate-level planning group proposed here. A data bank might be assembled. Alternatively, a listing of information sources and types of information (in detail) might be assembled.

The suggested procedures to follow in natural resource identification and description are briefly discussed here. The first three concepts described in Chapter V (system identification and description, systems analysis, and habitat identification) should all be applied. First, the region to be included in the analysis must be defined. This region will generally be somewhat larger than that designated in Step 1A because of the watershed and coastal influences upon the estuarine resources. Next, the natural resources of the estuarine system must be identified and inventoried. This involves seeking answers to three questions: (1) what resource data are available now; (2) what environmental data are available now; and (3) what resource data or environmental data are missing?

Once knowledge has been acquired of the collective existing information about estuarine natural resources, the intermediate-level planning group must develop a program for further data gathering. The actual data collection would be done by appropriate state, federal or local agencies or groups. However, the resources for which data are missing must be specified, the kind of information needed must be identified and the urgency with which the data are needed must be stated and justified. Then arrangements can be made to implement the data collection program. Subsequently, periodic review and updating of this program will be needed.

The intermediate-level planning group must next prepare descriptions of the several natural resource systems found in each estuary. These would show the characteristics, roles and functions of each natural resource, the locations or habitats where the resources are found, the processes which govern the resource, any variability in the amount of the resource or its "quality", interrelationships with other resources and with environmental conditions, the factors which directly influence the resource, the factors which can indirectly influence the resource, influences of the resource beyond the chosen system boundaries, the ways in which the resource is self-managed or self-maintained under natural environmental conditions, the resiliency and stability of the resource, adaptability of the resource to system changes, and a statement of the state of knowledge or ignorance about the resource.

It should next be possible to classify many of the natural units of the estuary, based on the natural resources and the role of natural components of the estuarine system. The natural units include water flowways (both major and lesser channels), water storage zones (intertidal and shoreline margins subject to occasional inundation), isolatable sloughs or other embayments, habitats for the numerous biological resources, and so on. The natural units may serve multiple roles in the estuary and may overlap considerably, expecially for the biological resources. In such cases the dominant roles and uses should be identified.

After the identification and inventory of natural resources has been made for an estuary and the resource systems have been described, it should be possible to make a statement on the range of diversity encountered in the estuary. This statement could also be placed on comparative terms by contrasting the diversity of the given estuary to that found in others. Similarly statements should be made at this point regarding any unique features found in the estuary.

The initial steps in intermediate-level tactical planning for an estuary which have been discussed above must be followed by the development of policies and guidelines for natural resource use, development and protection in that estuary. Elements of all six concepts presented in Chapter V will find application here. This step (2 in Figure 8) must begin with the identification of initial constraints on planning. The strategic-level functional classification (protection, mixed, production, unclassified) of the estuary must first be determined and all strategic plans for the estuary examined. This will serve to identify initial constraints imposed at the strategic level. The initial constraints imposed at the local level must also be identified. Such constraints may result from existing development, existing resources, or existing local plans for the estuary. Not all initial constraints may be considered acceptable by the intermediate-level planning group; however, the constraints must be recognized. The intermediate-level group may later decide that certain constraints should be modified or rejected because of factors deemed important at the intermediate level which were either overlooked or given different emphasis at the strategic and local levels.

The development of policies for natural resource use (step 2 of Figure 8) which are evolved at the intermediate level should specifically deal with: (1) biological resource protection and management; (2) habitat preservation; (3) subsystem protection (in mixed or production estuaries); (4) waters-edge occupancy and development; (5) protection of delicately-balanced resource systems; (6) assurance of future options; (7) provision of an environmental safety factor (or risk factor or margin for error) to allow for the limited scientific information available; (8) land easements and land acquisition through purchase, lease, or swapping; and (9) land zoning. As these policies are developed they must be checked for inconsistencies, incompatibilities or conflicts and modified accordingly.

Once the policies are developed, specific guidelines will be required and must be developed to permit application of the policies. The guidelines should take into consideration the several concepts for environmental impact assessment and the concept of preventive planning. Case studies should be prepared to show how difficulties may be avoided through preventive planning and to demonstrate how the policies and guidelines would avoid difficulties which have occurred elsewhere. As with the policies, the guidelines must be checked for inconsitencies, incompatibilities or conflicts and modfified accordingly.

The development of policies and guidelines at the intermediate planning level imposes new planning constraints. Several of these may conflict with the initial constraints considered at the start of step

2 (Figure 8). Therefore, at the completion of step 2 it will be necessary to reconsider the initial constraints and determine if they are acceptable in terms of intermediate-level policies and guidelines and the strategic functional classification of the estuary. If certain constraints are capable of change or rejection and it is found important to do so, arguments and justifications must be developed in order to make a request to the appropriate planning group for constraint removal (steps 3 and 4 of Figure 8). These could even include a request for a functional classification change by the strategic planning level (recalling that strategic plans are limited by tactical capabilities).

The combined set of policies, guidelines and constraints which have been developed at the strategic, intermediate and local levels or due to natural resource limitations must next be summarized (step 3 of Figure 8). This is necessary so that reviews can be made at all three planning and decision-making levels. The intermediate-level group may be in the most advantageous position to make the summary because of its having just completed step 2 (Figure 8). In the process of summarization, conflicting policies, guidelines and constraints must be identified for consideration by all planning levels and the suggestions from the intermediate-level group for conflict resolution and constraint removal should be advanced for consideration at the strategic and local planning levels.

Step 3 (Figure 8) as described above, immediately leads to review and possible modification of policies and guidelines for the estuary. It and the review also initiate step 4 (Figure 8) in which serious attempts are made at conflict resolution, which may involve the removal or addition of constraints, payments for losses, or charges for desired facilities.

It should be recognized that the completely satisfactory resolution of conflicts and the removal of constraints are unlikely. Vested interests of agencies, governmental units, and private property owners may be strong enough in some cases to permit only tentative agreements in principle regarding conflicts and planning constraints. This may suffice for intermediate-level advance planning if strategic constraints and guidelines are fulfilled, because the alternative plans can include some choices which contain unresolved conflicts or unremoved constraints as well as others in which no conflicts or constraints are apparent.

Constraints which result from the existing state of development or from the existing state of natural resources need not hinder advance planning. The alternative plans should include some in which such constraint removal is one of the important features (e.g.; urban waterfront redevelopment or provision of a navigable entrance to an estuary). Constraint removal can thus be used to attain a greater degree of protection or production for an estuarine system.

The next step in the intermediate-level tactical planning methodology (5 in Figure 8) involves identifying all types of alternative proposed actions which would be or would not be suitable for the estuary from the viewpoint of natural resources. All six concepts presented in Chapter V will find application here. The alternatives must be sufficiently specific so that the environmental impact might later be assessed. For each estuary the alternatives are likely to include potential actions to extend existing shoreline development and uses elsewhere, to increase the intensity of resource use and management, to permit new uses of the estuary and its resources, to maintain protected research-study areas, and to solve existing problems involving land-based activities and aquatic activities. To identify alternatives, the intermediate-level planning group might start with existing plans and the alternatives considered by their planners in developing them. Then the intermediate-level group can develop alternatives based on actions or proposed actions in other Oregon estuaries. The concept of preventive planning should be applied to determine additional alternatives, many of which would illustrate unsuitable proposed actions. In organizing the alternatives for subsequent steps of the methodology, they might be placed in a sequence which emphasizes the strategic concept of avoiding dominating bads (see Chapter II) and the tactical concept of preventive planning (i.e.; alternatives to avoid undesirable consequences, alternatives which can not be shown to avoid undesirable consequences, alternatives which avoid undesirable consequences and provide desirable conditions).

The following step (6 in Figure 8) is critical in later assisting the local planner to formulate proposed actions. In this step, the environmental impact of each identified alternative and its compatibility with established guidelines and constraints must be assessed. This may have to be done in rather general terms in some instances because of the comparatively unspecific way in which some alternatives will be stated (e.g.; extension of residential housing or development of condominiums along a particular part of the estuary shoreline without specifying the number of structures or their exact location). In other words, to develop each alternative and the associated environmental impacts at this stage a minimal amount of functional planning or design may be required but no detailed planning or design is necessary.

The environmental impact assessment for each alternative must be based upon all of the concepts for tactical planning which were presented in Chapter V. The assessment must also consider the policies, guidelines and constraints imposed upon the estuarine systems involved. The assessment should show how conformity of the plan with established guidelines and constraints is achieved, if it is achieved. The assessment should also show how any constraints are removed by the plan, how existing problems are solved, and how the quality of life is improved. for each alternative a decision must be made regarding whether the alternative is suitable or unsuitable for the particular estuarine system.

The result of steps 5 and 6 (Figure 8) will be to give local planners appreciable technical assistance (planning service) in identifying, illustrating and evaluating alternatives and their relation to natural resources. This will be particularly advantageous in situations where the contemplated local plan has features resembling one of the alternatives found suitable for the estuary by the intermediate-level group. As long as his plan does not also contain unsuitable features, the local planner will be able to feel confident of support and approval rather than antagonism when his plan is later presented to state and federal agencies for review.

Considerable feedback can develop between the intermediate and local planning levels with respect to steps 5 and 6 of Figure 8. Local planners can make their ideas known to the intermediate-level planning group in order to obtain technical services. The intermediate-level group could then include the proposed ideas among the alternatives being examined and could make a general environmental impact assessment for the proposed action. The results of this analysis would be provided to the local so that he could make appropriate modifications in his plans. The modified plans could be re-examined by the intermediate-level group as required so that the local planner could provide his "client" with an environmentally sound proposal. This feedback would also serve to guide the intermediate-level planning group in meaningful and timely activities. Review of alternative proposed actions and their environmental impact by the strategic level and by other local planning entities would also accompany steps 5 and 6 of Figure 8.

The next steps in tactical planning which can be carried out as a planning service at the intermediate level (step 7 and 8 in Figure 8) involve priorities. The establishment of planning priorities and needs for each estuary must be based upon the policies, guidelines, and constraints developed or identified at steps 2, 3 and 4 of Figure 8. They will also be influenced by the types of alternatives identified and evaluated in steps 5 and 6.

Two categories of priorities must be considered: (1) priorities and needs for planning activities; and (2) priorities among different types of suitable potential actions which might be proposed by local planning groups. The category dealing with planning activities must consider the needs and priorities for information. This includes the acquisition, compilation, analysis, evaluation, summarization, and dissemination of resource and environmental data. The needs and priorities for estuary-related planning activities by different organizations--federal, regional interstate, state, regional intrastate, and local--must also be considered. Different priorities will be found for each estuary regarding suitable potential actions. Elements of the third, fifth and sixth concepts presented in Chapter V (habitat preservation, preventive planning, and preservation of future options) will be applicable here. Estuaries functionally classified for protection will probably give highest priority to habitat protection and preservation, land acquisition, and purchase of conservation easements. At production estuaries, the higher priorities may include channel deepening, jetty improvements, shoreline development having a high commercial-industrial value, recreation access, pollution abatement, and so on. Cluster housing with open surroundings away from the shoreline will be a high priority for all estuaries to prevent residential sprawl and environmental-aesthetic deterioration.

After planning priorities and needs have been established, they should be summarized for review by other planning levels (step 9 of Figure 8). Modifications of priorities and needs may be necessary at this point.

At completion of the 9 steps shown in Figure 8, the intermediate-level planning group will have provided a comprehensive planning service for each estuary. Information will have been gathered and evaluated, supplemental data gathering will have been initiated, planning concepts will have been translated into specific types of alternatives suitable for the use, development and management of estuarine natural resources, and priorities for planning activities will have been recommended. All of this effort will not have produced a comprehensive plan for the estuary. But it will have produced a framework for comprehensive planning so that local planning groups charged with this responsibility or with narrower, more specific planning might proceed on as sound an environmental basis as the current state of knowledge will permit. The intermediate-level group must review all definite plans for an estuary or affecting estuarine natural resources to assure that such plans are environmentally sound.

In recognition that the store of knowledge of estuarine systems is continually being added to, and to avoid obsolescence, periodic review and updating of the intermediate-level advance planning is required. The timing of such review might be contingent upon the pace of the data gathering program and would be on an annual basis unless an all-out effort at data gathering was underway and required more intensive review.

Implementing the Tactical Planning Methodology

The tactical planning methodology proposed in this report focuses on an intermediate level between regional strategic planning and local tactical project planning for specific estuaries. The three planning process levels (see the Appendix) of policy, functional planning and project planning are all important at this intermediate level. The methodology requires an intermediate-level group which can provide a broad range of advance planning functions and professional services to assist local planning for individual estuaries and can coordinate that planning with regional strategic planning.

The scope of activity and the need for professional expertise in resource planning both indicate that the membership of the intermediate-level group would be interdisciplinary. Collectively, the membership should include state and federal agencies and other appropriate groups so that all aspects of resource use and management which are significant for Oregon's estuaries are considered. The comprehensive scope of responsibility indicates that the tactical methodology must be implemented at the interagency level rather than within a particular state or federal agency. This is further argued for as follows: Nearly all agencies are organized around a limited number of specific functions; the use of a regional authority or interagency group provides a means for cutting across, coordinating, and, where necessary, superseding the individual agency authorities dealing with various functions and fragments of the estuarine ecosystem (Schaefer, 1972). The strategic decision group and the intermediate-level tactical planning services group should not be identical because the first is policy oriented and the second is professional-services oriented.

Coordination of the intermediate-level group could be provided by the Pacific Northwest River Basins Commission, the Oregon State Water Resources Board, or the Oregon Coastal Conservation and Development Commission. State-level coordination might be preferable to regional coordination at this tactical level. The Oregon Coastal Conservation and Development Commission's limited staff and budget may presently restrict such efforts by that group. Nevertheless, the intermediate-level group will want to work closely with all three agencies no matter how the group is coordinated. Therefore, some form of joint coordination might be most workable. In fact, the intermediate-level group should absorb the local-state-federal agency technical advisory group which has been recommended in a different capacity by the Oregon Coastal Conservation and Development Commission (1973A) and, together with the strategic decision body, should absorb some of the functions of the Oregon Study Team of federal agencies under the Pacific Northwest River Basins Commission. The members should be assigned and budgeted to the intermediate-level group by their own organization so that real participation will be possible instead of only brief attendance at meetings.

The intermediate-level tactical planning methodology has been put in a framework which makes it compatible with the strategic planning methodology. Interactions between the strategic and tactical groups are encouraged in both methodologies. However, separation of the two groups is necessary because of the different responsibilities and different types of expertise required of the group members, as already mentioned.

The intermediate-level tactical planning methodology should mesh well with programs of the state and federal agencies. The individual efforts of agencies to carry out narrower programs for use-problem-conflict identification (step 1A of Figure 8) and natural resources inventorying (step 1B) will become coordinated and allow the elimination of duplication of effort. The joint development of policies, guidelines and constraints (steps 2 and 3) and the joint efforts to resolve conflicts and remove or add constraints (step 4) will beneficially influence agency planning and programs. Identification of alternatives and general assessment of environmental impacts (steps 5 and 6) will improve agency plans. Priority determination (steps 7, 8 and 9) will guide agencies into activities most urgently needed for estuarine resource use and management.

The compatibility of the intermediate-level tactical planning group with local planning efforts is also a favorable feature of the proposed tactical methodology. This may be seen from examination of the local planning process. In simplistic terms, the local planner presently deals with four questions: what do we want? what do we want to avoid? what do we have? are our "wants" and "haves" compatible, either as conditions now exist or through some modifications? In somewhat more detail, the key questions regarding local planning decisions and actions include: What should be done? Why? Who should do it? What must be avoided? How? What are the relevant factors in allocating resources? How should it be done? What should the activity level be? What should the schedule be? What is the plan? How have conflicts been treated? How should the plan be monitored, controlled, evaluated, and modified through feedback? Who will perform this function? (See also Sternlight, 1972.)

One important role of the intermediate level is to continually keep the local level aware of the "Bads" (see Chapter II) and the critical importance of avoiding Bads as the local level seeks to focus on pursuit of "Goods" in its planning. Local plans should demonstrate the avoidance of undesirable conditions as well as the achievement of desirable conditions.

The Oregon Coastal Conservation and Development Commission, working with representatives of several state resource agencies (including the authors of this report), has just developed estuary planning guidelines describing the process for local groups and local task forces to use in planning for individual estuaries in order to answer these questions (Oregon Coastal Conservation and Development Commission, 1973A). The guidelines may be represented diagrammatically as in Figure 9. Several review steps are included to maximize involvement and cooperation with state and federal agencies. These reviews offer a means for applying and removing constraints and for agreeing upon among goals, objectives, policies, strategies, and tactics.

At several steps in the local planning process of Figure 9 the availability of technical services regarding natural resources would be essential for the local planning group. This is shown in Figure 9 by the TAG designation (technical advisory group) whenever the guidelines specifically mention such assistance. Furthermore, comparison of Figures 8 and 9 shows that the technical services might be beneficially applied to other steps in Figure 9. Hence, intermediate-level tactical planning is compatible with local planning.

Furthermore, the efforts of the Oregon Coastal Conservation and Development Commission to date have been primarily directed to establishing management goals, objectives, policies, and standards and helping local planning groups organize and begin long-range land and water use planning. The natural resource planning methodology proposed in this report would coordinate and increase the participation of federal and state agencies in estuarine planning in a manner which will greatly complement the efforts of the Oregon Coastal Conservation and Development Commission.

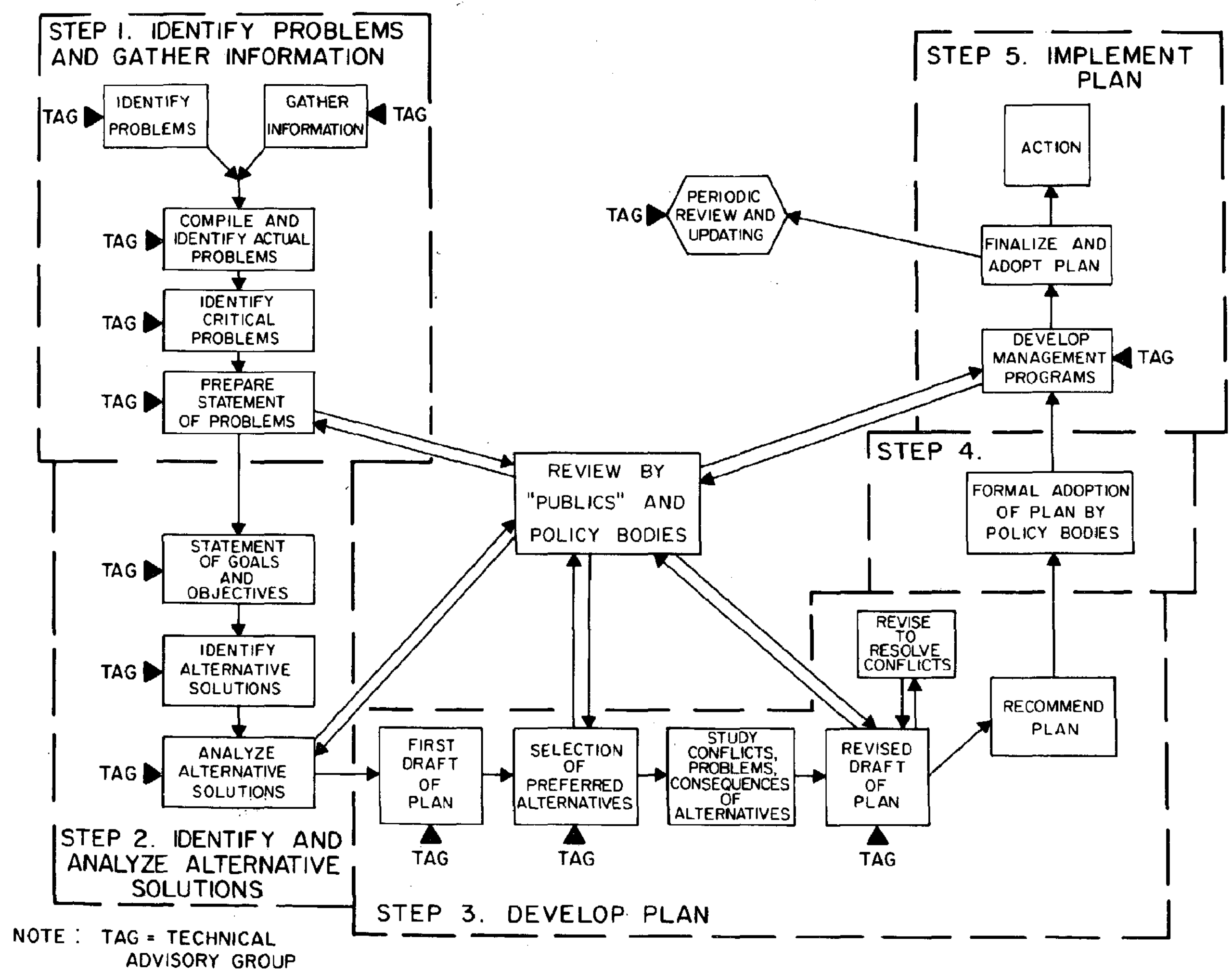

FIG. 9. -REPRESENTATION OF PROPOSED GUIDELINES FOR LOCAL-LEVEL PLANNING (AFTER OCC&DC, 1973A)

VII

INFORMATION REQUIREMENTS TO IMPLEMENT THE PROPOSED METHODOLOGY

Information Survey

During the initial phases of this study, it became apparent that the lack of a comprehensive survey of available information and data on Oregon's estuaries was a major deficiency for effective environmental planning. It was obvious that such a survey was needed before specific information requirements could be identified. A significant portion of the study effort was therefore devoted to such a survey as a step in removing this information deficiency. The results of this effort are included in a separate report entitled "Descriptions and Information Sources for Oregon Estuaries." Additional references are now becoming available. Moreover, a number of studies which will significantly contribute to this survey are now nearing completion. It is anticipated that revisons to this information report will be continued through June, 1973, under the direction of the principal investigators. The report has been prepared on a magnetic-tape typewriter to permit frequent additions and revisions without the need to extensively re-type the report. The expansion and up-dating of this survey would provide planners at all planning levels with a valuable information source. The authors encourage the continuation of this survey beyond the June, 1973, termination date.

Information Requirements for Strategic Planning

A major assumption used in developing the environmental strategy presented within this report is that complete information will never be available. Thus, the implementation of the proposed strategy can proceed now, without waiting for the illusionary information that will answer all questions. Additional information can, of course, improve the strategy. Moreover, because the strategy seeks to preserve options, it is particularly well suited for incorporating future information. In the paragraphs below, a number of information inputs which would serve to improve the strategy are identified.

The strategic functioning and biological organization of tidal estuaries (see Chapter IV) should be further examined. This higher-level study would likely differ from the more conventional studies now conducted. The use of mathematical models has led to a better understanding of estuaries. At this higher study level, however, the use of "self-organizing" models may be particularly useful. The properties of open self-organizing systems with relatively predictable fluctuations would likely provide insights into the biological organization of estuaries and thus might contribute to a more effective environmental strategy.

Such studies should be complemented by field measurements which might indicate the state of the system. It now appears that field measurements of benthic communities might provide the best indicators of the estuarine system state.

Methods of detecting dominating environmental changes (see Chapter IV) within the collection of Oregon's estuaries should be examined. Particular attention should be given, for example, to the decrease in particle size within the bottom deposits and the extent and distribution of bark and wood fibers due to log storage.

To implement the diversity approach, data and methods of organizing data so as to develop estuarine indicies which show relevant similarities and differences between estuarine systems will be useful.

Methods of evaluating development-conservation diversity and balance among Oregon's estuarine systems should be developed. A number of such methods can serve as central features in the strategic methodology.

Economic and legal information is needed so as to implement the strategic methodology by the fairest and most effective means possible.

Finally, the strategic methodology and its basic concepts should themselves be further studied and expanded to better incorporate social, ecological, legal, economic and other relevant considerations. Such studies must be approached with an open mind, for the authors strongly believe that many of the conventional approaches are simply not adequate to the problems which must be faced.

Information Requirements for Tactical Planning

The tactical methodology requires the intelligent use of all available scientific information related to estuarine natural resources. However, the basic data and information on Oregon's estuarine natural resources are limited. This will affect the tactical planning and decision-making process in several ways: (1) a constraint will be placed on data analyses because the information will not be available to analyze or interpret; (2) a data-gathering program will be required in order to provide missing information; (3) feed-back of the newly gathered data into the planning process will be required; (4) plan reevaluation in the light of new information will be essential; and (5) caution or delay of some plans deemed "risky" will be important in view of insufficient data to show environmental impacts.

The specific natural resource information requirements for making tactical plans and decisions include: (a) extensive environmental data to accurately describe the physical-chemical characteristics of the estuarine environment; and (b) improved inventory data to describe the status (number, type, characteristics, condition) of the estuarine natural resources. Statistical summarizations and data condensations to characterize the information will be useful (Schneidewind, 1972) but not as essential as the basic data themselves, so that the properties, processes, and interactions for each resource may be determined.

The necessary environmental and resource information should be grouped by categories when assembled. Separate classifications such as (a) physical characteristics, (b) chemical characteristics, and (c) biological characteristics might be used. Or the information might be placed under the classifications of (a) environmental data, such as hydraulic characteristics, climatic characteristics, water quality data, etc., and (b) resource inventory data, such as biological information, mineral resources, vegetation resources, etc. Each of these three categories should have subdivisions to show the location of the resource, such as the estuary, the tributary lands and waters, and the nearby coastal zones. Such a grouping will facilitate receiving and combining data from several agencies and other sources for use in tactical planning.

After the environmental and resource data have been assembled in accord with a basic format such as that just described, the several estuarine natural resources will be identifiable and describable in some detail. At this point, the "system" characteristics of each resource must next be examined and developed, as discussed in Chapter VI.

Status of Present Information

The report "Descriptions and Information Sources for Oregon Estuaries," which was prepared to accompany this report, illustrates the types of information needed to implement the tactical planning methodology. From that report it is also clear that much information is not readily available which is needed to plan specific actions and to examine the potential effects of such actions upon estuarine natural resources.

Based upon the information presented in the companion report, the following general statements may be made regarding data availability for Oregon's estuarine natural resources.

Information allowing a general physical description of each estuary and its drainage basin is generally available.

Data and information which would permit a hydraulic description of each estuary are often inadequate. Tidal characteristics and currents can be described at some locations, but detailed current patterns and water circulation patterns can not be constructed reliably for most estuaries. River discharges to the estuaries are only known on one or two principal streams in each case, such that analytical techniques would be required in order to estimate the total freshwater inflow and its variability for each estuary. Salinity information is sporadically available from a limited number of locations. Sediment types found on the estuary bottom can only be dealt with in general categories (sands, gravels, muds) in most estuaries. Sediment transport data do not exist, although some information on riverine suspended sediment is available. Therefore, a coordinated effort is needed to improve the hydraulic description of each estuary. This effort should provide more and better information on tidal levels, currents and circulation patterns, salinities, estuarine bottom sediment and vegetation types, and suspended sediment (or other particulate matter) transport. Both temporal and spatial descriptions of the above are required.

The data and information describing the water quality of Oregon's estuaries is primarily based on recent surveillance sampling in connection with waste disposal at selected locations. Emphasis should be placed on interpreting the significance of these data and on making this information more compatible with a better description of the estuarine system. Temporal and spatial variations in the various measures of water quality need better definition.

Biological data and information are primarily available for commercially and recreationally important fish and shellfish. The information consists mainly of species identifications and enumerations. Some information can be found on food chains and life-cycle features for these species. Also, identifications are available for many waterfowl species, sea animals and shore animals. Aquatic and shoreland vegetation has been identified to some extent. Considerable effort is still needed to augment the inventory of biological resources, particularly for non-commercial and non-recreational species. Even greater efforts are required to describe the biological resources as systems so that the effects of estuary alterations upon the biota can be better assessed.

Information on man-made physical alterations of the estuaries is reasonably good in describing what changes were made. But there is little documentation of the effects of these alterations upon the estuarine system. Such documentation is sorely needed so that case studies can be assembled as illustrations for tactical planners.

Information and data on estuary uses for human activity are adequate. Efforts are needed to examine other potential uses so that as broad as possible a spectrum of planning alternatives can be developed at the intermediate planning level.

In summary, information concerning the environment and natural resources of Oregon's estuaries is fragmentary but covers many important areas of concern in planning. However, greater efforts are needed to relate data gathering and research to man's understanding of the estuarine systems and their functioning.

Some General Aspects of Information Gathering

The environmental and resource information is required before good planning can properly begin. Yet collection of the data itself requires considerable planning. Randomly collected data or data which are collected on a schedule fixed solely by the calendar can be misleading and may overlook important events which require sampling or other measurement. Therefore, much attention should be devoted to the planning of data gathering by those responsible for this essential function.

Most planners, particularly local planners who are likely to have less experience in working with natural resource data, will need some degree of data summarization before they are able to undertake the difficult task of data interpretation. Most of this summarization probably should be provided by those who accumulate the basic data. The degree of summarization will differ for tactical and strategic planning, the former retaining considerably more of the detail and specific information than the latter.

Overlaps and omissions in data summarization are likely for those resources and types of environmental parameters for which data are collected by more than one organization. To avoid this and to minimize future duplication of effort, a coordinated data gathering program should be established by the intermediate-level tactical planning group to assist in data compilation and summarization. Some thoughts regarding data coordination are given in the following paragraphs.

A data center or information clearing house might be formed where a complete index system or abstract record of natural resource data and related information for Oregon's estuaries can be maintained in convenient reference form. The complete data need not be maintained at the data center, however. This data center probably should be located within one of the state agencies with a broad resource mission, because of its prior experience in assembling resource data and because much of such estuarine data may already be assembled there. Placement within a state agency is recommended because the intermediate position occupied among planning levels makes the state agency readily accessible by and in easy communication with all other planning levels. It also makes possible budgetary support which might not be available at lower planning levels and assures that state interests will not be subject to federal budget cuts that could affect the data center if it were placed at a higher planning level. The responsible state agency should work in cooperation with the Oregon State Library and the Industrial Engineering Department at Oregon State University with regard to some aspects of information handling and operating procedures.

Initial organization of the method of providing estuarine resource data and related information would require the cooperation of the state and federal agencies which have already obtained such information, so that an acceptable, meaningful, easy to understand format is followed for each type of natural resource data. For example, a standard form might be developed for reporting all data on tidal levels, currents, salinities, etc. Once the formats have been developed, the several agencies should adopt them for compiling and reporting all new data. Whether all previously collected data should also be made to conform to the chosen formats would depend upon the extensiveness of such data and the willingness of each agency to undertake the task. Presumably the new data formats will resemble those currently used by the agencies most active in collecting particular data, so that such tasks should not be so extensive and time consuming. A cross-referenced filing system involving subject matter and agency headings would be followed. The data abstracts would be placed on microfilm for storage and for distribution upon request.

After the data center has assembled the initial information, it should annually solicit abstracts of all new data from agencies and other groups, all submitted in suitable formats. In this way an up-to-date reference system for all information on each Oregon estuary will be continually available for planning or other purposes. Any agency or group requesting information on a particualr subject would receive from the center a set of microfilm cards showing abstracts of the desired information under the designated subject heading and related headings.

Such a data center would be advantageous to all groups except special agencies which might be the sole collectors and users of particular data. Many agencies will undoubtedly continue to exchange data reports in the same manner as presently done. But the data center will permit broader and better organized distribution of information owing to the cataloging and classifying system and the completeness of records. For example, a local planning group or its consultant would be able to come to a single office to have access to all of the pertinent information gathered by many agencies and other groups. People would know where to come to get information. Further, there would be a two-way flow of information because the staff of the data center would learn who is interested in using the data and why, allowing opportunities to obtain supplemental data or at least to keep abreast of local planning activities.

A very significant advantage of a centralized data center is that it quickly will become apparent exactly what information exists or does not exist on Oregon's estuaries. It will no longer be necessary to make assumptions about what data particular agencies have. It will be possible to determine the adequacy of existing data for particular purposes and the gaps which need filling by additional data collection programs.

The Limitations of Scientific Information

The complexity of estuaries as environmental systems, the alterations already made by man within or near estuaries, the difficulties and costs involved in data gathering for such changeable systems, and the sometimes haphazard or irregular sampling programs previously carried out all point to the situation that there are many limitations, deficiencies and omissions in available information about Oregon's estuarine natural resources. The limited amount of sound, usable, meaningful data about these resources can severely constrain the analyses which should be made as part of estuarine planning activities. However, such data limitations have not in the past prevented planning or implementation of plans--although success has been variable.

Actions involving the environment and natural resources have sometimes been taken in a near-vacuum of scientific information. Others have only had a fraction of the information deemed necessary. Those actions which have been successful are generally characterizable as having had a large safety factor or margin for error built into the action. As examples: spillway design floods for dams represent the "worst" probable combination of conditions; moon exploration involves several redundant systems so that if one fails alternatives are still available.

Several options are available to the planner faced with insufficient scientific information about estuarine natural resources. First, he can delay his planning and decision-making activities until the needed data have been collected and analyzed. Second, he can proceed with planning and with tentative decisions while the needed data are being gathered, with the intention of modifying his plans and decisions should the new data warrant it. Third, if the data are not likely to be available in the near future but may eventually be obtained he can limit the scope of his planning or stage the implementation of his plans so that the early actions will involve an adequate base of scientific information and the later actions will be revisable when the missing scientific information is eventually available. Fourth, he can incorporate a large safety factor or margin for error in his plans, by means of cautious design or through choice of actions which are not irreversible and irrevocable should they meet with failure or limited success. Fifth, he can stage the implementation of an action over a long enough timespan so that the successive stages test the system response to progressively more severe alteration. This would help minimize the risk of an abrupt change in system state. Sixth, he can try variations or combinations of the already-stated options.

Decisions made about planned actions where the scientific information is limited should carefully weigh the risks to natural resources and the potential for recovery of a badly damaged resource. For example, a proposed action to dredge gravel from an estuarine channel should be evaluated on the basis of such factors as increased risk of pier scour at bridges, of exposure, scour or infestation at piling structures, of bank scour and channel shoaling, of loss of spawning or rearing habitats, and on the basis of replenishment of the gravel resource from upriver. If the risks and likelihood for recovery are known in advance, it will be easier to evaluate the adequacy of safety factors and margins for error in advance as well as to decide if the proposed action is acceptable.

Certain actions which are deemed as high-risk because of limited scientific information may be found to be worth the risk in a particular instance for a particular estuarine system. Thus, they may be both tactically feasible and desirable. The strategy of preserved diversity could then be evoked to permit such an action in that estuarine system but block that course of action from being implemented in any other system for as long as a risk is thought to be associated with the first such action. Only after sufficient observation time has passed without serious adverse consequences might approval of such an action be given for other estuarine systems--and then only to one or two in order to maintain diversity among the entire group of Oregon estuaries.

Mistakes will be made about planning actions, as they have in the past. However, the use of advance planning by the intermediate-level group will allow some planning actions to be anticipated so that data availability and needs can be examined and supplemental data gathering can be initiated. The methodology proposed here will not prevent planning-and-decision mistakes; but if properly used, it will minimize the risks and adverse effects of such mistakes. The alternative to accepting mistakes and risk is to wait until complete scientific information is available. It is doubtful that this delay will be acceptable along the Oregon Coast because the level of scientific funding will not permit collection of complete information within a reasonable time span of a few years and because each sizeable man-made change in an estuarine system will provide a new system state for which additional information will be required.

VIII

SPECIFIC RECOMMENDATIONS

This chapter presents the specific recommendations for implementing the methodologies developed in the preceeding chapters.

Immediate Management Actions

The following recommendations can now be implemented under the existing organizational structure, without the need for further studies.

1. We strongly recommend that Oregon Study Team of the Pacific Northwest River Basins Commission establish a task force whose primary responsibility would be to prepare cost estimates, plans and specific implementation recommendations for the establishment of a variety of "protection" estuarine systems (as defined within the text of this report). Funds for services and consultants should be provided and the study should be approached with the same degree of financial, professional and administrative support as any major developmental project. Because of the continued development within the Oregon estuarine regions, we believe that this recommendation deserves the highest possible priority.

2. We commend and support the recent study of the Salmon River Estuary by the National Forest Service. However, we strongly recommend that additional conservation efforts, including greater purchase of adjacent land and conservation easements, be employed so as to qualify the Salmon River Estuary as a "protection" system (as defined in Chapter IV of this report). We specifically urge that the above recommendation be forwarded to the appropriate decision bodies with the support of the Oregon Study Team.

3. We recommend that a moratorium on those kinds of developments which would reduce management options should be established until the strategic methodology can be implemented. Such a moratorium is particularly important within those estuarine systems which might be considered for a protection classification. Developmental plans should be concentrated within those estuarine systems most likely to receive a production classification.

4. We recommend that all levels of planning take steps to encourage a greater use of cluster communities with intervening open space. In addition, all shoreline developments (particularly residential developments) within tidal estuaries should be discouraged unless such development specifically requires a shoreline location and provides sufficient public benefits to justify the environmental loss.

Immediate Actions to Improve Information Availability

The following recommendation is concerned with improving the availability of information on Oregon estuaries. No significant organizational changes or future studies are needed to implement this recommendation.

5. We recommend that the compilation of information on Oregon's estuaries, which has been initiated under this study, be continued. The study report entitled "Descriptions and Information Sources for Oregon Estuaries" has been placed on magnetic tape suitable for MTS typewriters. The use of magnetic tape permits revision of the report without extensive retyping. It is anticipated that additional revisions will be incorporated into this report through June, 1973 under the direction of the principal investigators of this study. Copies of the magnetic tapes can be made to facilitate a continuing effort beyond June, 1973.

Studies to Improve the Planning Methodology

The following recommendations are concerned with future studies which would support and improve the planning methodology presented herein. The initiation of these studies should not be delayed until the organizational changes are completed.

6. It is recommended that studies be undertaken to develop a number of methods to evaluate the conservation-development variety and balance among Oregon estuarine systems. Such methods are relevant to the strategic planning methodology presented herein (see Figure 4).

7. An interagency study should be initiated which would determine which estuarine systems would best qualify as "production" systems (as defined in Chapter IV of this report). Specific needs in the areas of transportation, power, waste disposal, housing, recreation, open space, etc. should be identified.

8. We recommend that a study be established which would examine all methods (including specific laws, zoning, tax revisions, public funding of water and waste water facilities, transportation facilities, etc.) which would provide greater ecological compatibility for residential developments, specifically examining the use of cluster communities with open space and the avoidance of development within the shoreline regions.

Planning Organization

The following recommendations are concerned with organization changes needed to implement the planning methodologies presented herein.

9. We recommend that a strategic decision body be formed from members of federal and state agencies under the sponsorship of the Pacific Northwest River Basins Commission whose primary objective would be the implementation of the diversity approach as described in Chapters III and IV of this report. Approximately seven members from state and federal agencies of different development-conservation responsibilities plus approximately two independent members with ecological backgrounds should be included in this body. Particular attention should be given to the establishment of policies and guidelines for evaluating environmental impact statements which would provide for developmental diversity and avoid major changes within estuarine systems until such systems could be operated under the functional classifications described in Chapter IV of this report. Funds for services and consultants should be provided. The establishment of this strategic decision body can be pursued independently from the establishment of tactical groups.

10. We recommend that an intermediate-level tactical planning group be formed as an interdisciplinary, interagency group to carry out and coordinate advance planning and to provide a broad spectrum of professional services to local planning groups at individual estuaries, as described in Chapters V and VI. Members should be from federal, state, and other agencies and would include the technical advisory group proposed by the Oregon Coastal Conservation and Development Commission as well as the Oregon Study Team of the Pacific Northwest River Basins Commission. Joint sponsorship by the Oregon Coastal Conservation and Development Commission, Oregon State Water Resources Board, and the Pacific Northwest River Basins Commission is recommended. The group membership will number from 25 to 50 representatives; a nucleus of perhaps a dozen working members should be assigned and budgeted to this planning group by their parent agencies. This planning group can be established independently from the establishment of a strategic decision body.

Studies to Improve Information

The following recommendations deal with improving the knowledge and information concerning Oregon's estuaries. These recommendations are intended to improve the planning methodologies presented in this report. However, the preceding recommendations should <u>not</u> be delayed until the following recommendations are initiated or completed.

11. We recommend that a greater degree of research effort be devoted to the strategic functioning of estuaries. This broader examination of estuaries has not been pursued in the literature with the same degree of

technical aggressiveness as have subjects of a more narrow nature. There is a danger that research will be too constrained by narrowly defined problems which already have been clearly identified. A more balanced approach is needed which recognizes that the most serious environmental problems (both actual and potential) may be of a broad nature and may now be undefined.

12. It appears that the most feasible area for coordinated water quality sampling is concerned with the temporal and spatial variations of salinity and temperature within Oregon's estuaries. It is therefore recommended that all agencies concerned with salinity and temperature measurements meet and form a coordinated sampling and reporting approach. The coordination of these very basic measurements should serve as a model for more extensive information exchange.

13. Many pending actions would physically alter portions of several estuaries, as by dredging, landfill or other construction. Improved hydraulic descriptions are thus needed for those estuaries so that anticipated effects can be better evaluated. It is recommended that an interagency group meet with Oregon State University ocean engineers to review and compare the existing data on tidal levels, currents, circulation patterns and salinities. Once the reliability, representativeness and completeness of such data have been identified, a coordinated program and priorities for supplemental data collection by appropriate agencies should be established and initiated by the group.

14. We recommend that improved descriptions of the estuary "bottom" be obtained through cooperative efforts of the several state and federal agencies involved. This will permit better habitat identification, planning and evaluation of specific actions, and environmental impact assessment. The improved descriptions should focus upon confirming the existing hydrographic surveys of bottom depth, upon sediment sampling at numerous locations to provide spatial and temporal identification of sediment types and composition as well as to give vertical profiles of the bottom sediments, and upon identification of the vegetative character of the estuary bed, both spatially and temporally.

15. We recommend that the current mapping program of the Oregon Division of State Lands be continued and amplified to include identification and mapping of all shoreline uses and shoreline habitats.

16. We recommend that an interagency/interuniviersity group meet to review and compare the existing data on estuarine biological resources with the aim of planning a coordinated program of supplemental information gathering by the respective agencies and university research programs to better identify and describe species, food webs, life-cycle features, roles and functions served in the estuary, and critical environmental factors influencing each of the biological resources.

17. We recommend that agencies which have in the past made, authorized, or approved physical alterations in an Oregon estuary be asked to make a followup study of each such action in order to document the observable

or assumed effects of such alterations upon the estuary (i.e., a post-construction environmental impact assessment). This information is urgently needed to provide case studies "close to home" that can be used in tactical planning as part of the preventive planning and environmental impact concepts (see Chapters V and VI).

18. We recommend that an up-to-date directory be prepared for use by planners at all levels which gives the names, addresses and phone numbers of all state, federal and local agencies having coastal responsibilities. The nature of responsibilities and functions or activities should be described for each. Names of contact individuals within each agency for particular types of information might also be provided.

IX

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APPENDIX

THE ROLE OF PLANNING LEVELS FOR OREGON'S COASTAL RESOURCES

A review of the general features of the present planning process for natural resources and specifically for Oregon's estuaries will help illustrate the implementation of the proposed planning methodology. The planning levels and planning groups which currently influence estuarine natural resources must be identified and some characteristics of these planning levels and groups need description. From this examination it should become evident how the general planning methodology of this report might be implemented and used.

Strategic and Tactical Planning

In this report considerable stress has been placed upon the distinction between strategies and tactics as offering two categories of concepts and procedures used to accomplish goals and objectives. The concept of planning "strategies" was carried over into the water resources field several years ago (e.g.; Engelbert, 1966). More recently the concept of planning tactics in conjunction with planning strategies was introduced to the water resources field (Bella and Overton, 1972).

Strategies for natural resources planning and decision-making are here considered to be the concepts and procedures followed in the comprehensive employment of resources to accomplish set goals. Tactics are here considered to be the concepts and methods followed for the immediate or local employment of resources to accomplish the set goals. Further, it is recognized here that tactical plans and actions are subordinate to strategic plans and that strategic plans are limited by tactical capabilities. It follows that strategic decisions are decisions based on comprehensive plans for resource employment and that tactical decisions are decisions based on immediate or local plans for resource employment.

The concepts of strategies and tactics and their hierarchal relationship, with tactics subservient to strategies, are not new. However, when many water resources plans and decisions are examined it appears that a great deal of planning and decision-making is done on a tactical level by organizations operating in a strategic vacuum. The federal water resources acts enacted since 1965, the formation of the Water Resources Council, the National Water Commission and the several river basins commissions, have all helped to alter this situation at the federal level. But many federal and state agencies may incorrectly believe that their agency "mission" or "role" is equivalent to their planning and decision-making strategy. Moreover, the attitude of many state and federal agencies appears to be dominated by a local point of view, as opposed to a regional or national viewpoint (see also Crutchfield, 1973).

Present Levels in the Planning Process

The planning process for natural resources can be viewed in terms of the decisions which must be made. When placed in such a context, three distinct levels of planning and related decision-making can be identified. These are: overall policy planning and decisions, functional planning and decisions, and project planning and decisions. These are sequential, the second following the first and the third not possible until the second has been carried out.

The first level among planning steps encompasses general, overall policy planning and decision-making. At this level the goals, aspirations and objectives of estuarine planning and management are identified or established. In terms of the Oregon coast, comprehensive examination would be given the entire coastal region; or, if planning activities are focused upon a particular estuary, then those activities would be viewed in the context of the entire coastal region at this level. The result might be some type of comprehensive framework plan. A comprehensive plan evolved at this level would be expected to be a statement of goals and policies that provides a framework of general strategies to follow in coastal development and management on a regional basis. Relatively little specific planning detail would be expected to be given at this level, but the general patterns for development and management might be given in relation to the goals, policies and strategies. Further, the goals, policies and strategies evolved will suggest certain priorities which need to be followed in planning and project implementation. Tactics which might be employed to accomplish these ends might also be considered at this planning level.

The second level of planning and decision-making steps for estuarine natural resources is called functional, preliminary, advance, or feasibility planning. The several ways in which the estuaries might be developed or managed would be considered in some detail at this level. The variety of functions to be served and the feasibility of providing some or all such functions would be examined. This would be done both on a regional scale and for a particular estuary. A number of basic support studies and resource inventories would be required for this planning level.

From planning and decision-making at this second level, a number of alternative forms for use, development and management of estuarine natural resources should emerge, together with an understanding of their relative advantages and disadvantages. The compatibility with goals and policies established at other planning levels should be determinable, as well as compatibility with natural resource strategies and tactics. It is conceivable that functional planning might lead to some revision of goals and policies at other planning levels.

The third level among planning and decision-making steps encompasses project planning. At this level, specific and detailed plans might be developed to carry out particular projects or to designate locations where certain types of activities might or might not be carried out. Specific proposals for action might also be received and reviewed. The basis for decisions at this planning level would be the goals and policies developed and the functional possibilities described at other planning levels. The product of this planning level is likely to be a comprehensive framework plan for the use, development, and management of natural resources of a particular estuary. It may be given status and authority through the adoption of a land-use plan or a zoning ordinance. Alternately, its authority may rest in its mutual acceptance by agencies and political entities with regulatory powers over elements of the estuary and environs.

Present Planning Organization Groupings and Levels

There are organizational levels in planning estuarine natural resources, just as there are levels in the planning process. The planning and management for Oregon coastal zones is carried out by five distinct groupings or levels of agencies and organizations. These are the federal agencies, the regional interstate organizations, the state agencies, the regional intrastate organizations, and the local organizations. Each group has a different role and range of responsibilities regarding estuary planning and management. Further, the scope of total activities and proportion of effort devoted to estuaries varies among and within groups.

The first organizational level consists of the federal agencies and organizations. These are empowered by congressional acts and administrative directives to fulfill rather specific missions. The number of such entities is extensive. Principal among them are the following: Water Resources Council, National Water Commission, Army Corps of Engineers, Coast and Geodetic Survey, National Marine Fisheries Service, Bureau of Sport Fisheries and Wildlife, Soil Conservation Service, Forest Service, Bureau of Land Management, Environmental Protection Agency, Public Health Service, Bureau of Reclamation, Geological Survey, Weather Service, Federal Power Commission, Bureau of Outdoor Recreation, National Park Service, and Department of Transportation.

The second organizational level consists of the regional interstate organizations which have been formed to coordinate the activities of various agencies or to pursue other specific missions. The Pacific Northwest River Basins Commission and its predecessor, The Columbia Basin Interagency Committee, are prime examples. Bonneville Power Administration is another such organization.

The third organizational level is made up of the numerous state organizations. Prinicpal among them are the following: Water Resources Board, State Engineer, Division of State Lands, Game Commission, Fish Commission, Port Authorities Commission, Marine Board, Department of Environmental Quality, Board of Health, Department of Forestry, Department of Transportation, Public Utilities Commission, Department of Geology and Mineral Industries, Soil and Water Conservation Commission, Natural Resources Planning Committee, Local Government Relations Division, and the Oregon Coastal Conservation and Development Commission.

The fourth organizational level consists of regional intrastate organizations which include the coastal zones within their sphere of activity. Principal among these is the Oregon Coastal Conservation and Development Commission which, as a state agency, has an intrastate-regional rather than statewide sphere of activity and is more appropriately placed in this fourth grouping. Other organizational units include the coastal counties and the councils of governments.

The fifth organizational level is local in extent, being limited to each individual estuary and its immediate surroundings in terms of the scope of its activities. Included are city councils, port districts, and other special units such as fire, water, or sewer districts.

A number of voluntary groups also exert influence upon the planning and management of Oregon's estuaries through their interactions with the five-level organizational structure. These voluntary groups may be either "public" or "private" and may be national, statewide, regional or local in their makeup. Among these are the following: conservation groups, environmental groups, recreational groups, industrial and commercial groups, civic organizations, chambers of commerce, property owner or taxpayer groups, cultural and ethnic groups, other citizen groups, and individuals informally united in favor of or opposition to specific proposals. The primary input to planning and management by these voluntary groups usually is to point out existing problems and urge their correction, to caution about the consequences they see from proposed actions, and to react to specific proposals and plans. Occasionally, such voluntary groups may themselves undertake the development of a plan to meet a particular need.

Each of the five organizational levels makes use of consultants. Some consulting services for local organizations may cover all three planning process levels, although policy and goals formulation is normally excluded. Consulting services required at other organizational levels tend to be more limited in scope, this report being one such example.

Comparison of the Present Planning Process and Present Planning Organizations

Most planning organizations are involved in all three planning process levels (policy, functional, and project), although the degree of emphasis may vary considerably, with some organizations being primarily concerned with policy matters and others almost entirely with project planning. Similarly, most organizational units are involved in planning activities or decision-making of both a strategic and a tactical nature, whether they approach such activities in this manner or not (in many instances the strategic aspects are "understood" rather than formally expressed).

Figure A-1 gives a representation of the relative degree to which the various organizational groups might be expected to be involved in different levels of planning-process and strategic-tactical activities.

While the width of the bands representing each element are quite arbitrary in size, they convey the important impression that all organizational levels have some role with respect to planning and decision-making, even though the scopes of responsibility vary.

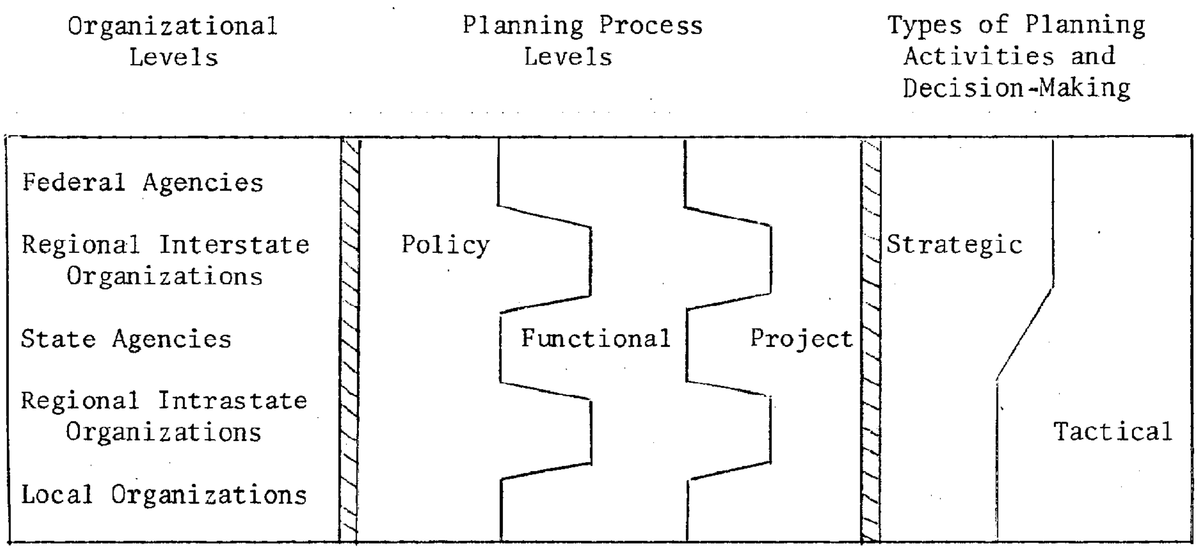

Figure A-1 Interrelations Among Planning Processes and Planning Organizations.

Most federal and state agencies are functional-planning and project-planning oriented with regard to Oregon's estuarine natural resources. This is a result of the scope of authority and activity assigned to each agency. Thus, one finds that commercial fisheries are separated from sport fisheries at both the state and federal agency level, and that dredging and landfill regulation are under a state agency and a federal agency distinct from the fisheries agencies even though principal concern over dredging and landfilling has been with respect to the effect upon fish and shellfish of commercial or sport/recreational value. Each agency carries out its mission or purposes only with respect to a single function or limited number of functions compared to the total potential functions which the Oregon coastal zone possesses. These agency functions may involve policies, programs, or specific projects to meet current or anticipated needs for a narrow spectrum of natural resource uses. Two state agencies which are exceptions to this statement and have rather broad authorization regarding overall estuarine planning are the State Water Resources Board and the Oregon Coastal Conservation and Development Commission (the latter is not a statewide agency).

Regional interstate and intrastate organizations formed to coordinate and consolidate planning functions are less likely to be restricted in their scope of responsibility. In effect, they may have the natural resource planning responsibility, (although probably not the management authority) for a particular region that otherwise is under the jurisdiction of some 30-to-40 federal and state agencies. The Pacific Northwest

River Basins Commission, a regional interstate organization, is thus involved in estuarine planning through its Oregon Study Team of federal agency representatives working cooperatively with representatives of the State Water Resources Board and other state agencies. The planning level involved may be most closely related to policy planning, rather than functional or project planning. The Oregon Coastal Conservation and Development Commission, as a regional intrastate agency, has the potential for involvement in all levels of planning: policy planning, functional planning and project planning. However, it may not achieve this potential in other than a coordinating role because of a limited professional technical staff.

Local organizations have a considerably narrower scope of responsibility and activity than other organizational levels because local organizations are limited to individual estuaries. There is some emphasis on all three planning process levels (policy, functional planning, and project planning). However, policy formulation is narrow in perspective and strategies have not been well-defined. Consequently, local governmental entities rely upon tactical planning and decision-making in connection with their own projects and in fulfilling their review and approval functions for local non-governmental projects. Another characteristic of local organizations is that they are highly dependent upon other organizational levels for planning and for project implementation.

Trends in Estuarine Planning

The current trend in planning for Oregon's estuarine resources by different organizational levels may be summarized in rather general terms. A review of what is now happening will help identify the places where the strategic and tactical planning methodologies can best be implemented.

Presently, regional interstate organizations are most involved in strategic types and least involved in tactical types of planning activities and decision-making for Oregon's estuaries. Their current activities focus on regional comprehensive studies. The likely emphasis of such organizations in the near future regarding tactical planning can be viewed as one of examining the planning concepts, goals and objectives involved and how these mesh with regional concepts, goals and objectives. A policy and philosophical influence on tactical planning can be expected in the future by such groups, with the Pacific Northwest River Basins Commission acting as a prime mover in these efforts.

Some federal agencies are very much involved in tactical-level planning activities and decision-making. Most federal agencies do relatively little strategic planning. Under their agency missions of maintaining navigability, of providing a viable commercial fishery, of administering recreational areas, or of otherwise managing particular natural resources the federal agencies will continue to carry out their own missions and tactical-level projects and to offer cooperation whenever it is requested by other groups and planning levels. The agency programs will contain strategic features only with regard to limited resources;

thus most actions by these agencies may be considered as tactical rather than strategic. A relatively large number of constraints on other planning levels and on other agencies in the state-agency or federal-agency levels are likely from the federal-agency group. These constraints will be expressed whenever planning at a different level or by a different agency at the same level involves a resource over which another agency has mission responsibilities.

The state agencies are in a somewhat similar position to federal agencies regarding strategic and tactical-level estuary planning and management and with respect to placing constraints. Some state and federal agencies have parallel functions. But other state agencies have a greater role in policy and management for Oregon's estuaries than do federal agencies. To date, the state agencies collectively (there are exceptions) have been more involved with tactical-type planning and decision-making than with strategic activities, although agency missions and goals tend to be strategic in content. This situation is undoubtedly due to pressures on these agencies to devote much effort to reacting to proposals and planning activities of other groups, both private and public. The state agencies individually are limited in their authority to deal comprehensively with total resource use and management. Therefore, some state agencies which have felt the need for comprehensive planning have exerted their authority by means of moratoriums or delays on activites which they regulate until such time as local governmental organizations have developed comprehensive plans for their estuary. Present circumstances are likely to prevail into the near future. Meanwhile, the Oregon State Water Resources Board and Oregon Coastal Conservation and Development Commission will be prime movers in efforts to develop local comprehensive plans. Their probable roles will be to help establish policies, goals, planning concepts, and planning methodology. This will relate to both the strategic and the tactical types of planning activities and decision-making.

The regional intrastate organizations and the local organizations at individual estuaries are most definitely involved in tactical types of planning activities and decision-making. They still lack comprehensive plans and strategies for natural resource planning and management, as most emphasis has been placed upon economic development rather than upon resource management and use by these groups. Local governmental groups have not had a broad base of public and financial support to do much long-range planning beyond developing county and city master plans. Most of their activities have been purely tactical, such as reviewing development proposals against master plans or zoning ordinances. Although these organizations have placed economic considerations ahead of natural resource considerations in many of their actions, they have at times been constrained from permitting or taking some actions by state agencies which are charged with husbandry of the natural resources. However, the policy and philosophical basis which exists at state and federal levels is not yet clearly established at the local levels where many decisions for estuarine modification have been made.

Local organizations will continue to deal primarily with planning and decision-making at the tactical level. They will not be in a position nor have local support to concern themselves with regional comprehensive planning, other than how it will personally affect their estuary. Instead, they will rely upon different organizational levels to establish the strategic and tactical constraints within which they must conduct their planning activities. Greatest reliance probably will be placed upon the Oregon Coastal Conservation and Development Commission, which as a regional intrastate group may serve as an intermediate planning level between the local estuary planning organizations and the larger regional intrastate, state, regional interstate, and federal organizational levels.

Land-use planning in estuarine zones probably will largely remain the prerogative of local government. Such activities will involve limited powers over small jurisdictions, often fragmented and overlapping, and will be conducted with limited staff and funding capabilities (Twiss and Sorensen, 1972). However, constraints and guidelines from higher planning levels will be necessary for sound comprehensive environmental planning. Local problems will color the approach of local government to the broader problems of the Oregon Coast and these governments will tend to act competitively rather than cooperatively on many regional matters.

The Oregon Coastal Conservation and Development Commission is charged with preparing and recommending coordinated plans and their methods of implementation for the wise management of the natural resources in the coastal zone. The Commission has developed a set of estuary planning guidelines for use by local planners and is pursuing its major task of developing policies and standards for managing the use of the natural resources of the coastal zone (Oregon Coastal Conservation and Development Commission, 1973). At present and in the immediate future the Commission will find itself in the position of (a) organizing planning support for local groups, (b) funneling policies, goals, concepts, methodologies, and constraints downward from higher organizational levels and adding to these or modifying them in the process, (c) reviewing and coordinating proposed actions of state and federal agencies to see that they are compatible with local planning desires, and (d) providing a forum for discussion and debate among local groups whose tactical plans may not fit regional strategic plans and who will probably be reluctant to have their tactical planning be subordinate to strategic planning. Thus, an organization such as the Oregon Coastal Conservation and Development Commission has a critical role in estuarine planning. It therefore has a responsibility of maintaining a somewhat independent posture from the local estuarine groups whose representatives comprise the majority of the Commission membership. Otherwise the necessary functions which it should fulfill will have to be assumed by other state organizations. If not, the long-range protective use of estuarine natural resources may suffer to the detriment of the human "quality of life."

Conclusions

The foregoing discussion has shown that five organizational levels exist for the planning and management of Oregon's estuarine natural resources. Ideally, each planning level should have a different scope of activities and range of responsibilities. Further, it is desirable to have different organizational levels for planning and decision-making. Some types of decisions are best made at the local level so that the decision-making structure is not too far removed from the actual problems (e.g.; what type of waterfront land zoning will best meet the future needs of an estuarine community). Other types of problems cannot be adequately made at the local level because the focus, authority, or capability is too narrow or because of the incapability of local decisions to be to the best mutual benefit of a broader region (e.g.; how best to preserve a diversity of estuarine types along the coast).

It has also been shown that the several organizational levels have all had some involvement in the three elements of the planning-process policy, functional planning, and project planning. But to coordinate these activities in a more satisfactory manner, as far as the natural resources are concerned, the organizational levels need to better define and understand the strategic and tactical features of their planning and management actions.

There have been too many tactical decisions made regarding estuarine natural resources without due regard to broader regional strategies that would better assure protective and sustained beneficial use of these resources for the present and future generations. A sharper distinction between strategies and tactics is urgently needed in planning for Oregon's estuarine natural resources. Therefore, the general planning methodology presented in this report treats separately the strategic and the tactical features of natural resource planning and management.