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# A Model of Adaptive Behavior in the New England Fishing Industry, Report to the National Science Foundation, Volume III

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**REPORT TO THE NATIONAL SCIENCE FOUNDATION  
VOLUME III**

**A MODEL OF ADAPTIVE BEHAVIOR  
IN THE NEW ENGLAND FISHING INDUSTRY**

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**UNIVERSITY OF RHODE ISLAND, UNIVERSITY OF MAINE STUDY OF SOCIAL  
AND CULTURAL ASPECTS OF FISHERIES MANAGEMENT IN NEW ENGLAND  
UNDER EXTENDED JURISDICTION**

**JAMES M. ACHESON  
PRINCIPAL INVESTIGATOR**

INFORMATION RESOURCES  
NATIONAL SCIENCE FOUNDATION



REPORT TO THE NATIONAL SCIENCE FOUNDATION

VOLUME III

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Any opinions, findings, conclusions  
or recommendations expressed in this  
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Errata: In the process of photocopying on two sides, page numbering in a few cases varied from the original manuscript; there is an extra (unnumbered) blank side on the back of p.39; the section between pp.341 and 345 contains only two numbered sides, not three as it might appear from the final numbering system.

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INTERNATIONAL DAY

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## PREFACE

This volume is the third in a three volume series of reports submitted to the National Science Foundation for a project entitled "University of Rhode Island, University of Maine Study of Social and Cultural Aspects of Fisheries Management Under Extended Jurisdiction" (N.S.F. Grant Number AER77-06018).

This project was funded through the RANN Directorate of N.S.F. (Research Applied to National Needs), and was designed to provide data on social, cultural, and economic aspects of the New England fishing scene which would be of value to those in industry and government concerned with managing the marine fisheries of the northeastern part of the United States, particularly those concerned with management under PL 94-265, the Fisheries Conservation and Management Act of 1976. It is important to note that PL 94-265 calls for the management of U.S. fisheries not only for biological ends, but with economic and social factors in mind as well. The Congress clearly recognized that the management of marine fisheries affects both the fish resources and the economy and culture of coastal communities. The data in each of the three academic areas most directly involved in fisheries management are very uneven. There is a great deal of information about the biological aspects of U.S. fisheries; less on the economic sphere; and virtually no social and cultural information on fishermen and fishing communities in New England. This current project was initiated with a view toward correcting that imbalance.

All told, there were 13 people who worked on the project: five from the University of Rhode Island and eight from the University of Maine. The entire University of Rhode Island crew were anthropologists. Five of the University of Maine group were anthropologists; two others were economists; and one was a graduate student in oceanography.

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This project had five objectives which were stated in the original proposal as follows: (a) to provide baseline data on the fishing communities and fisheries of New England, (b) to provide information on key values and social institutions, (c) to collect and analyze data on innovation in the New England fishing industry, (d) to provide a model which other social scientists could use to apply social science information to problems of fisheries management, and (f) to integrate social, economic, and biological information in ways that provide a coordinated picture of fishing behavior. Volume I of this report contains the information on the baseline data. This information is published in two parts. The port study information on the area between Eastport, Maine and the New Hampshire/Massachusetts boundary has been published (1980) by the University of Maine Sea Grant Office in a volume entitled The Fishing Ports of Maine and New Hampshire: 1978. Port study data on Massachusetts, Rhode Island, and Connecticut are contained in a volume entitled The Small Fishing Ports of Southern New England, published (1980) by the University of Rhode Island Sea Grant Office. Information on values and social institutions, innovation, and specific fisheries management plans (objectives b, c, and d) is contained in Volume II of the Final Report.

In this third volume, we are using an adaptive model to provide a new and integrated view of fishing behavior. This accomplishes the fifth objective of the project.

Accomplishing the first four objectives did not require an unusual approach. The port studies contain factual information; the 22 articles that comprise Volume II required conceptual tools and methodologies commonly used in anthropology and economics. This third volume required a unique approach--one that has never been attempted before in exactly the same way. Our object was to synthesize social, economic, and biological information, because it is increasingly recognized that those interested in managing the fisheries have

been getting piecemeal information from a variety of specialists in different disciplines which does not give any consistent, complete picture of fishing behavior. Understanding the need for a view of fishing behavior which takes into account biological, social, and economic factors is one thing; producing such a model is quite another. The basic problem is that integration of data from all of these diverse fields necessitates an integrative device--a model. Unfortunately, we discovered no existing model which would allow us to account for the phenomena we discovered in the fishing industry. Thus, in order to provide an integrated view of fishing behavior, we first had to develop such an integrative model. Much of the time one of the authors (Wilson) spent on this project has been devoted to this task alone. Frankly, it has been a very difficult but rewarding experience. The result, we believe, is a different view of fishing and fishing behavior. The model developed has allowed us to bring into focus some aspects of the behavior of fishermen which has previously gone completely unnoticed. It also allows us to explain diverse aspects of behavior ranging from innovation and secrecy to overexploitation of fish stocks, reference group behavior and the formation of institutions among fishermen.

No model in the social sciences (or another academic field for that matter) is completely without antecedents. This model is no exception. In essence, we have taken concepts concerning adaptation, strategic interaction and exchange from anthropology and sociology, combined them with concepts developed by a few economists, and produced a new model of the behavior of the firm. In the past three years, we have read so many articles and books in these diverse fields that it is no longer clear even to us where the germs of many of our ideas originated. However, our debt to Frederick Barth, John Bennett, and George Homans is very obvious

and needs to be formally recognized. The same is true for economists Kenneth Boulding, Oliver Williamson, Kelvin Lancaster, and John Common.

The model presented in this book is essentially adaptive or evolutionary, and as such is very different from the static textbook model of the firm. We were interested in using this model to explain fishing behavior, but we believe it can be applied to firms in a large number of industries in the industrialized western world. This model, we would like to stress, is neither an economic model nor an anthropological model. It is a general social science model of the behavior of firms in modern industrial settings.

This model relies heavily on certain concepts such as "institution," "exchange," "rules," "transaction," and "cluster." These terms have been used in so many different ways that some standardization of meanings was necessary to avoid confusion. Accordingly, we have followed John R. Common's usage consistently throughout the book; we did so because he defined them clearly and because he developed his terminology with an analysis of the firm in mind.

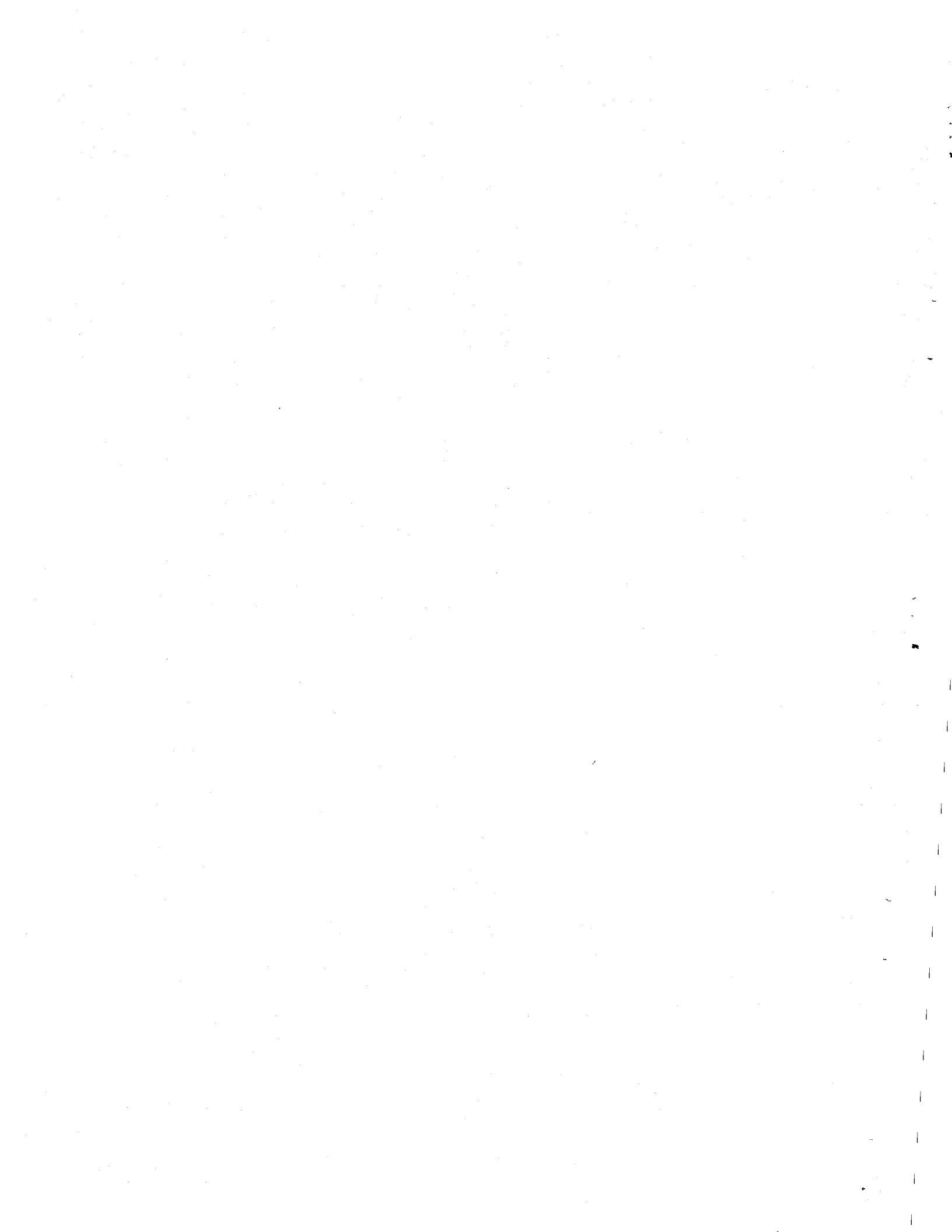
This volume was written so that it could be understood independent of the other volumes. Nevertheless, it does contain a summary of many of the ideas developed in the course of this project. Most of the volume is devoted to the development of concepts and their application. We draw very heavily on data presented in the port study volumes and in Volume II to exemplify certain points and to test hypotheses suggested by our adaptive model. Very little new data is presented in this volume, save for Part III, which does contain data which has not been presented elsewhere in the final report. In fact, many of the articles in Volume II were written with the requirements of this third volume in mind.

Part I of this volume reviews the social, economic, and some of the biological literature applicable to fisheries

problems and demonstrates the need for a new integrative model. Part II presents the model itself. In Part III, the model is used to explain aspects of fishing behavior in New England. In this section, certain hypotheses suggested by the adaptive model are tested, using data from various fisheries. In Part IV, we apply some of the insights provided by our model to aspects of fisheries management.

James Wilson wrote all of Part II (a critical section concerning the model) and did all of the editing on it. He also wrote the first draft of Part IV. James Acheson wrote and edited the preface, Part I, and Part III. He also wrote a final draft of Part IV. The authors edited the drafts produced by each other but made no attempt to jointly write each section. Wilson and Acheson have been working together for almost a decade on one or another fishing project and are fully cognizant of the fact that they have such different writing styles, work habits, and methods of approaching problems that any attempt to sit in the same room to write a single section or page could only end in disaster. They have, however, been working together long enough to learn enough of each other's disciplines to make effective communication possible.

The authors are indebted to Jane Brooks, Rosemary Shorey, Donna Rog, and Faye Whelock who typed the great bulk of the manuscript and to Steve Bicknell, Judith Cooper, and Claude Westfall who drew the figures. Justine Shea did a very fine job cleaning up the final details of the manuscript, including typing the preface, Part IV, and the bibliography. Very special thanks are due Hugh Briggs, who worked long and frustrating hours to rescue Part II from the bowels of a troll-like word processor, and to Ann Acheson who worked even longer hours editing and proofreading the entire volume through its multiple drafts.



PART I

THEORETICAL BACKGROUND

## CHAPTER 1

### INTRODUCTION

In the intellectual history of the West, the concepts of "progress" and "growth" have played a prominent role. Man has been the measure, and what gave man greater control, more leisure, higher income, more energy, or a higher standard of living was automatically good and desirable. Very little attention has been paid to the side effects of our headlong attempts to industrialize, modernize, and grow. It is only in the last few decades that it has become widely understood that the unparalleled economic development experienced by the United States has been purchased by running through a whole continent of resources in less than 200 years, and that the price of technical progress has been severe damage to the environment. In the environmental sphere, the list of unfortunate tradeoffs is a long one. Massive increases in the production of electricity have been purchased at the expense of radioactive pollution; increases in ease of transportation are exchanged for air pollution; production of synthetics results in chemical pollution; increased food production has led to DDT damage to a large number of animals and plants. Reluctantly, we are coming to the conclusion that man is not separate from nature, but a part of an incredibly complicated natural system which he can disturb only at his peril. Sadly, with a sense of national malaise, we have begun to come to the conclusion that our assets are not unlimited, that rapid economic growth can only be purchased at a very high cost, and that we have got to begin to conserve our national resources.

Our attitudes and experiences with marine fishery resources have paralleled our experience with other natural resources. In the late 1950's and early 1960's it was thought that the resources of the oceans were large enough to provide a general

solution to starvation in the world. There was a spate of interest in farming the sea, and predictions that increases in fishing efforts in the offshore, mid ocean regions would result in massive increases in catches. Of course, attempts to greatly increase fishing pressure typically brought increases in catches for a few years, and then stock failure. In many cases, the decrease in fish catches were as spectacular as they were precipitous. The anchovy production off the coast of Chile fell from 12.3 million tons in 1970 to approximately 3 million tons in 1973, a decline of over 75 percent in a three year period (Idyll 1973:29). The Georges Bank haddock catch, once the mainstay of the New England fishery, declined from 120 million pounds in 1965 to a mere 11.7 million pounds in 1972 (Alexander 1973:192). The list is a long one. In the United States, for example, similar declines have been seen in the past few years in bluefin tuna, northern shrimp, the southern shrimp (penaeus species), Pacific sardine, northern lobster, dungeness crab, cod, herring, Pacific halibut, Atlantic halibut, surf clams, and numerous other species. In the case of certain andromadous species, for example, Atlantic salmon the problem is easily traced to dams and the pollution of major rivers. In other cases, natural environmental factors play a major role. The collapse of the northern shrimp industry, which occurred between 1973 and 1975, was due in large part, experts agree, to a cyclical increase in water temperature in the Gulf of Maine. But a major problem in most cases has ostensibly been overfishing. That is, the dangerous declines of most species have been caused by excessive predation by man.

By the mid 1960's it became increasingly clear that the marine fisheries of the United States would have to be managed, and that only the Federal Government could do the job properly, given the range of fish stocks and the international implications of fisheries management (Hutton 1973:62-67).



The passage of PL 94-265, the Fishery Conservation and Management Act of 1976, marks a milestone in the annals of fisheries management. The law extends U.S. jurisdiction over fisheries to 200 miles and provides a set of mechanisms and guidelines for conservation and management of marine fisheries. Under this law, the coastal areas of the United States are divided up into eight regions. The fisheries of each region are managed by one of eight Regional Councils, composed of Federal and state officials and members of the industry. Most important, the law calls for the management of U.S. fisheries for Optimum Sustainable Yield (PL 94-265: Sec. 301). This means, in essence, that the U.S. fisheries are to be managed not only for biological ends but also with economic and social factors in mind. The authors of the bill recognized that management of marine fisheries affects both the fish resources and the economy and people of coastal communities. Simply managing to protect fish stocks alone would inevitably cause a good deal of disruption to the fishing industry and inevitably result in political opposition. Moreover, implicit in the OSY concept is the recognition that marine fisheries management involves some very difficult tradeoffs between fish resources, catch, income, and goals of coastal people.

In fisheries management circles, the dependence on Optimum Sustainable Yield as a management tool was met with mixed feelings. Many people in state and Federal agencies charged with managing marine resources recognize that management plans must take into account data from both biological and social sciences and that these data must be integrated in some way. They are fully aware that the history of fisheries management is studded with cases where biologists have suggested regulations which have stirred up massive political opposition, instances in which legislators proposed plans which would not solve the problem of overexploitation, and other cases where

social scientists put forth plans which turned out to be patently illegal. They were very optimistic about the OSY concept, because it promised to bring together social, economic, historical, and biological data in a way that it could be used to effectively conserve the fish while minimizing social disruption and political opposition. Others experienced with fisheries management were very skeptical about the OSY concept. They pointed out that there was no precise agreement on the definition of the concept of Optimum Sustainable Yield, and no real agreement on what social, biological, economic, and legal data are needed or how it should be integrated. In 1976, one officer of the National Marine Fisheries Service phrased the problem in the following way: "We have just passed a bill to manage all the fisheries in the United States with a certain concept in mind, and no one even knows how to define that concept."

In the years since the passage of the bill, the fears of the skeptics have so far proven justified. There has been very little additional work published on Optimum Sustainable Yield since 1976, and certainly nothing of a degree of specificity that would aid a Regional Council in formulating management plans. The eight Regional Councils have reacted to the absence of information on OSY in somewhat different ways. Most have simply ignored the OSY concept, which is supposed to guide management efforts, and have framed fisheries management plans with two factors in mind: 1) Maximum Sustainable Yield, and 2) political pressure. That is, they have set quotas and other regulations which would result in coming as close to achieving Maximum Sustainable Yield figures for a given species as they dared, given the political pressure from the fishing industry. They are aware that this technique achieves OSY, if at all, only by accident (Sissenwine 1978: 41-42). Both fishermen and biologists have been unhappy with the results. The fishermen have resented being regulated for

a variety of reasons (Acheson 1980c; 1980f); the biologists tend to insist that fish stocks are still being over-exploited and that future catches are being sacrificed for political expediency.

The general unhappiness with the results of fisheries management efforts is perhaps inevitable since the procedure being used by the Regional Councils has three very serious flaws.

Reliance on Maximum Sustainable Yield, a biological concept, orients management toward maintaining the largest biomass possible. Unfortunately, a large biomass of fish, or even large catches of fish, does not automatically translate into large incomes for fishermen or increased amounts of fish for consumers, since some fish are worth a great deal in the market and others are relatively worthless. In addition, the emphasis on MSY orients managers to thinking solely in terms of cutting back fishing effort by whatever means. It does not focus attention on the social and economic effect of various management options. This can lead to some odd priorities and unworkable suggestions. For example, Maximum Sustainable Yield can most easily be achieved by a complete moratorium on fishing and this solution has been seriously proposed by lab-bound biologists working in the MSY analytical frame. It is, clearly, a solution which would be unacceptable to fisherman, producers or consumers, who would have no fish at all to catch, process and eat.

The procedure used by the Regional Councils almost completely ignores social, cultural, economic, and historical data in formulating management plans except insofar as such concerns are embodied in political opposition on the part of fishermen.

The procedure used by the Councils is not based on any clear understanding of what is being sacrificed or gained as

any particular management option is put into effect. Management, as it is currently being practiced in the New England Regional Council, is essentially a contest between biologists who want to protect the stocks and fishermen who want high current incomes. The tradeoffs needed to obtain an optimum have receded into the background.

The Regional Councils have had little choice but to ignore the concept of Optimum Sustainable Yield in the formulation of fisheries management plans. They cannot be expected to apply a concept that no one can specify concretely. The failure to adequately define Optimum Sustainable Yield has left fisheries management in a limbo for the time being. The fact that such a key concept has received so little attention points to an intellectual failure of the first order of magnitude on the part of academics interested in resource management. It is clearly a concept that deserves a great deal of attention on an increasingly crowded planet where the need to manage all resources becomes more obvious with every passing year.

Certainly one of the prime objectives of fisheries management is to maintain catches, and thus a knowledge of the dynamics of fish stocks is critical for effective management. But the major problems with fish stocks are ostensibly caused by human beings. Thus, the object of management is to control the predation by people exploiting those stocks. If the essential problem, then, is caused by our treatment of nature, then the search for solutions must include an examination of human desires, needs and motives. Focusing on the fish alone will not get at the genesis of the problem -- namely, the behavior of people in the fishing industry and the economic and social institutions in which they participate. Unfortunately, there is very little information on the behavior of those in the fishing industry and the way their social and economic institutions are systematically connected to fisher-

ies resources.

In the absence of definite information on the culture and social structure of fishing communities, fisheries managers and economists have simply assumed that fishermen were interested in nothing but selfish gain at the expense of the fish resources. In this respect, they appear to be following Garrett Hardin who assumes that those using common property resources are locked into a system in which it is only logical that they increase exploitation without limit, and that they are callous enough to escalate their abuse to the point where those resources are stripped bare (Hardin 1968:1244). Bonnie McKay expresses this attitude nicely when she says: "The analytical model used by fisheries economists assumes that all fishermen behave as anarchic villains in a 'tragedy of the commons' which leads inexorably to resource depletion and economic waste (e.g. Christy and Scott, 1965; Crutchfield and Pontecorvo, 1969)" (McKay 1978:398). In short, it is assumed that there are no social and economic mechanisms which halt increasing investment, technical advance and fishing pressure, short of stock failure (Crutchfield 1964). It also assumes that predation by humans has been the primary factor in causing the demise of several fish stocks. More specifically, it has been axiomatic among population dynamacists studying fish that recruitment into the fishery (number of harvestable-sized fish) was determined by the number of eggs laid by adult fish whose numbers, in turn, were influenced by the amount of fishing effort. Thus, excessive fishing effort on the breeding stock lowers the number of eggs in the water and ultimately catches (Royce 1972:196-97). This picture of fishermen and fishing behavior is clearly flawed.

First, great fluctuations have been observed in fish stocks and landings, but there is increasing uncertainty about man's role in causing them. This is a radical depar-

ture from conventional wisdom regarding fish populations. In the past several years, data have been collected challenging the assumptions about the relationships between fishing effort and recruitment. For example, stocks of haddock and cod were overfished in the mid 1960's to the point where fisheries biologists were speculating that the breeding stock was so small that these species might never rejevenate and that their biological niche would be taken over by other types of groundfish (for example, hake). In the past several years (1977-1979) survey data from the Gulf of Maine have shown that there are two very large year classes of haddock and cod, now almost of harvestable size, which came out of a very small adult stock. This indicates that a small adult stock may produce a large number of progeny if factors such as water temperature and food supply favor high survival rates. If this is true, then predation by man may not be the most important factor affecting future abundance of harvestable fish in all circumstances. Similar observations have been made in other fisheries.

Second, there is substantial evidence that all ocean areas are not common property resources, and that fishing communities do have certain informal institutional means to regulate their exploitation of fish populations. In the literature, there are instances when fishermen have normative systems excluding newcomers from the fishery; in other instances they have expropriated informal ownership rights to ocean territories; and in other cases, fishermen control access to concentrations of fish by secrecy and control over information, which established short-term property rights (Acheson 1972,1975a, 1980a ; Andersen 1972; Stiles 1973; Brox 1964; Catarinusi 1973; Forman 1967). Sometimes all three mechanisms are found in the same fishery. In some cases, there is little question that these reduce fishing effort (Acheson 1975a; Acheson and Acheson 1980). In this current project, a great deal of additional information has

been gathered on such institutions in various parts of New England. (These institutions, and their effect on fishing effort, will be described in detail in Section III, Chapter 4 of this volume).

Third, some fishermen are very clearly concerned with the resource on which their livelihood depends (Acheson 1975b; 1980f). In parts of New England, at least, a very high percentage are in favor of certain government regulations on fishing, even though there is rarely consensus on exactly what regulations should be imposed on any given sector of the industry (Acheson 1975b; 1980f).

Fourth, in industrialized societies it takes a good deal of capital to establish a viable fishing business at the threshold level; and once one has entered the business, there are real limits on the amount of capital that can profitably be invested. In all cases, fishing success depends largely on the skill and knowledge of the captain and crew. This may be the most difficult asset to obtain. Knowledge, skills and experience clearly limit the species one can fish for and the effectiveness of fishing effort. The notion that anyone can enter any fishery and expand their exploitive effort on any stock is not true (Acheson 1980b).

While there has been very little information on fishermen and their behavior, it is clear that they are motivated by a great deal more than a simple desire to take ever-increasing amounts of fish. Certainly, modern commercial fishermen are competitive, and unquestionably they fish for money, not sport. But the assumptions of economists and biologists about the behavior of these people are overdrawn. The question remains: What are the aims and goals of fishermen? What social, cultural, and economic factors guide their behavior? More importantly, how can a picture of the behavior of fishermen be integrated with existing biological and economic information to generate a conceptual frame to pinpoint

Optimum Sustainable Yield for any given fishery?

There are two very serious problems in attempting to pinpoint Optimum Sustainable Yield.

First, the data in the academic fields necessary to refine the concept of Optimum Sustainable Yield are very uneven. A great deal of effort has been expended to obtain information on the fish stocks; there is far less on the economics of fishing; and almost no social, cultural or historical data on fishermen or the communities in which they live. In this regard, it should be pointed out that the state and Federal agencies responsible for marine fisheries management are staffed almost exclusively by biologists. The research these agencies finance, not surprisingly, is almost exclusively biological in nature. In addition, social scientists have shown very little interest in marine resource management. Most social scientists apparently believe that resource management problems await some sort of technical solutions, and thus are properly in the realm of the natural scientist.

Second, and far more important, there is no agreement on what social, biological or economic data are needed or how it should be integrated to begin to approach Optimum Sustainable Yield estimates.

The problem is not confined to fisheries alone. There is no model anywhere which can be used to integrate information from all these academic fields. Thus, the problem of defining OSY cannot be attacked by borrowing an integrative model from some other field and applying it to fisheries. This means that if some means of attaining Optimum Sustainable Yield is to be achieved, a new integrative model must be developed. In this volume we will attempt to present such an integrative model and apply it to data on New England fisheries to develop a new theory of fishing.



Chapter 2 of this section will be devoted to an examination of the literature on previous attempts to integrate data from biology, economics and anthropology. Special attention will be focused on cultural ecology and the theory of adaptation, since we believe work in this field contains the seeds of a kind of evolutionary model which can be used to integrate data from the biological and social sciences. In Part II of this volume will be focused on developing this kind of model. In Part III, specific hypotheses stemming from the adaptive model will be discussed, using data concerning New England fisheries. As we will see, this model focuses attention on certain aspects of the behavior of fishermen which have not been adequately described before, and allows us to account for a good deal of that behavior. In the last part of this volume, we develop a new theory of fishing behavior based on the adaptive model.

While no attempt will be made in this volume to define Optimum Sustainable Yield for any given fishery, the volume does contain a model allowing us to integrate social, economic and biological information in ways producing a new and more accurate picture of fishing behavior. This, we believe, is a first, and perhaps the most important step in defining Optimum Sustainable Yield.

## CHAPTER 2

### INTEGRATION OF SOCIAL, ECONOMIC AND BIOLOGICAL DATA: THEORETICAL PERSPECTIVES

While there is no adequate model to integrate data from economics, anthropology, and biology, there have been numerous attempts to link two of these three fields (for example, biology and economics, anthropology and biology). Some of these attempts are blind leads for our purposes; others are not. For these reasons, it is useful to discuss some of the major attempts to integrate these three fields.

#### A. Bio-economic Models

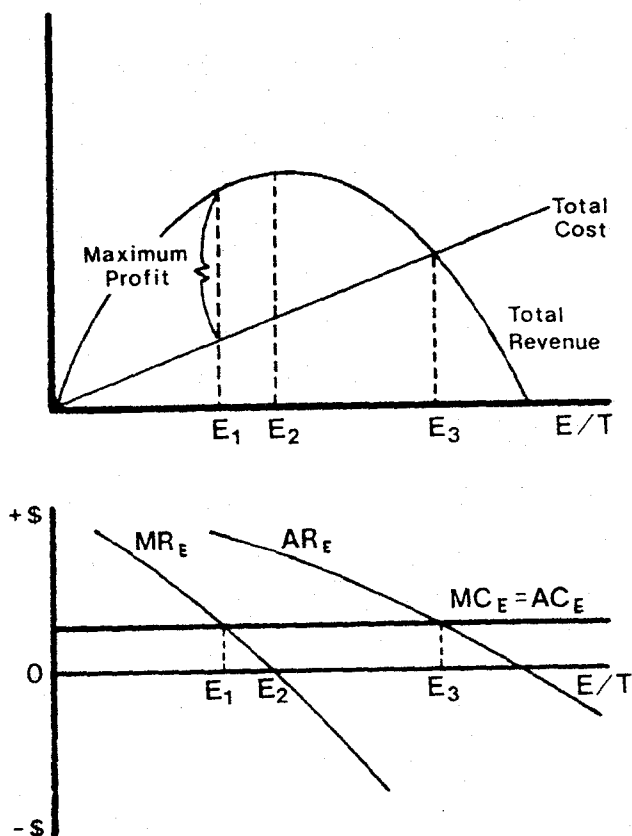
Some of the most useful recent work with application to fisheries management has been done by economists working with what are called "bio-economic models." Most of the work done in this field is based on Schaefer curves -- a set of biological concepts linking recruitment into the fishery, or size of the total stock of fish to fishing effort (Clark 1976:30; Gulland 1969:84-93; Royce 1972:325; Schaefer 1954:34-36). Economists using these or closely related models are essentially trying to identify that level of fishing effort giving some sort of Optimum Economic Yield. This goal is usually phrased in terms of the marginal concepts. As Bell (1972:156) phrases it "The optimum management strategy for any fishery is to permit effort to expand to the point where the marginal cost of the resources (capital and labor) needed to produce a pound of fish is equal to the price consumers are willing to pay for that last pound of fish produced."

Some of the best work in this field has been done by Lee Andersen (1977:31) who uses a series of curves to explain the relationship between fishing effort, total cost and revenue

and marginal revenue (Figure 1).

FIGURE 1

Open Access and Maximum Economic Yield



Source: Anderson 1977:31.

It has been assumed by several researchers that bio-economic models, such as the ones proposed by Anderson, could somehow be modified or expanded into an Optimum Sustainable Yield concept. We do not believe this is so. First, as has previously been mentioned, the situation in the cod and had-dock industries calls into question the ability to link any given level of fishing effort to recruitment. If this is true, then it is impossible to specify exactly what Maximum Economic Yield for any fishery will be.

Moreover, we see no realistic way to expand such models to include social variables. Such models, after all, contain nothing about perception, social structure, values, and all the other factors influencing opinions and reactions of people. One has to stretch one's imagination to even conceive of a possible link.

One possible way that social and cultural factors could possibly be linked with such bio-economic models is through the concept of fishing effort. That is, social variables influence fishing effort, which in turn affects catches, stock sizes and recruitment. The problem is that a very large number of factors influence fishing effort, including skill, responsiveness to innovations, commitment to the industry, ethnic group membership, ability to switch fishing gears, and others (Acheson and Acheson 1980). Moreover, such factors are very difficult to quantify. Other sets of technical and natural factors influence the catches of any given type of fishing gear. In the lobster fishery, for example, catches of traps are influenced by at least 15 factors ranging from the season of the year and length of the trap, to the type of heads in use and the depth of water (Acheson 1980d). Thus, in the lobster fishery, fishing effort can only be measured if one knows the number of traps in use as well as the effectiveness with which they are being used. Given our present state of knowledge, it is impossible to quantify all of these various factors for every fishery, much less adequately describe the role they play in affecting fishing effort. Even if one could pinpoint the socio-economic factors influencing effort, it would be impossible to specify a given stock size and recruitment level that would be associated with any level of effort. Theoretically, however, the concept of fishing effort might be used as a link between biological and socio-cultural spheres. At present, however, it must remain only a possibility until more information is obtained on the fishing industry and the effect

of behavior of fishermen on the stocks.

Bio-economic models in fisheries management are really being used by economists to answer essentially economic questions about rates of utilization of fish resources. Their aim is to answer certain questions concerning resource allocation -- not questions about the fish populations per se. Certain biologists have attempted to link biology and economics in still another way -- namely by using the economics of resource allocation as a framework for viewing ecological processes. In this case, it is biologists who are borrowing economic tools in an attempt to calculate such things as optimal foraging strategies of predator populations to maximize energy intake or reproduction, or the use of cost benefit analysis to understand the relationship between population growth and the quality and quantity of food resources open to them (Shoener 1971, Cody 1974, Emlin 1968). Such attempts to use economic theory in ecology have been criticized by economist Kenneth Boulding, who asks, "What if anything in the biosphere corresponds with the concept of the price system, and especially to an equilibrium price system in economics?" (Boulding 1972:366).

Certain ecologists believe that such studies will someday be of use to resource management. For example, Rapport and Turner state that "the existence of common ecological-economic models suggest that it is possible to unify methodologies, concepts and theories which have independently developed in the two fields. The prospect should be of interest to strategic planners and managers of our resources" (1977:373). However, such authors leave no doubt that while it may be possible to unify economic and biological theory in this way for purposes of resource management, little has actually been done to date. Whether applying micro-economic theory to animal ecology could ever be of use to fisheries managers remains doubtful, since it promises to increase

knowledge only of animal populations -- not human populations (i.e. fishermen) and their relationships to their natural environment.

#### B. Socio-Economic Models

Despite the fact that anthropology and economics are social sciences, there have been very few models developed to integrate these two fields. Economists have used models which they call socio-economic models, and some of these have been applied to fisheries problems. However, most of these models are completely economic in content. Periodically a variable such as age, education, or family size will be fitted into the equation. But the aim of such models is to predict such things as changes in income levels or the economic impact of changes in policy. There is very little about perceptions, social structure, aspirations, institutional factors or any other factors motivating or constraining human behavior. Such economic models certainly have their uses when applied to certain issues of fisheries management. One of the authors of this volume has used such models to predict the effect of an increase in the legal lobster measure. We have been able to calculate the changes in total pounds of lobster caught and revenues to fishermen for every 1/16 inch increase in the measure (Acheson and Reidman 1980b). But this is an economic model exclusively. There is nothing in it which tells us anything about the behavior of fishermen or the communities they live in, and literally no way to get such information into the model.

Anthropologists, working essentially without the aid of economists, have attempted to develop a set of concepts to integrate data from anthropology and economics to understand the social and economic systems of tribal and peasant societies. These anthropologists have taken their clue from Max Weber, who distinguished between "formal rationality," and

"substantive rationality." "Formal rationality" was used by Weber in referring to abstract universal rules aimed at obtaining maximum output at minimum cost. "Substantive rationality" refers to efficient procedures as defined by the people of a given culture operating with a particular set of socially-acceptable goals and constraints.

The result has been a long and bitter debate in anthropology between the so-called "formalists," who maintain essentially that economic concepts and models can be used to interpret data on the economies of non-Western societies (Goodfellow 1939; Cook 1966; Burling 1962; LeClair 1962; Firth 1972) as opposed to the "substantivists," who insist that the opposite is true and that anthropologists will have to develop another set of concepts to properly interpret the economic systems of such cultures (Polyanyi, Arensberg and Pearson 1957; Polyanyi 1944, 1947, 1959; Kaplan 1968; Dalton 1968, 1969, 1971). After some 20 years, the debate has petered out, but no consensus has yet been reached.

There has been no attempt on the part of economists to build bridges between their own discipline and anthropology.

In great part, the reason no integrative models have been developed stems from the fact that economics and anthropology have traditionally been operating with two different paradigms. As Dusenberry (1960:233) phrased the difference: "economics is all about how people make choices. Sociology (and anthropology) is all about why they don't have any choices to make." Indeed, economics has tended to emphasize the fact that people make maximizing decisions and has tended to play down the institutional frame within which those decisions take place. In economics, the problem of defining goals, aims and motives of people of various cultures has been subsumed under the concept of utility. Anthropologists and sociologists, by way of contrast, have tended to emphasize only the institutional aspect of behavior, and have at times

presented people as mere robots programmed by their culture to behave in certain rigid, inflexible ways. They have placed great emphasis on describing cultural differences and variations in motivation and goals.

This distinction between economics and anthropology is no longer accurate. In anthropology, especially, there is widespread recognition that people do have a good deal more latitude for individual decision making than had been hypothesized previously, and that a great deal of intracultural variation exists (Pelto 1975). In several fields on the cutting edge of social anthropology, much attention is currently being focused on the kinds of choices that people make and the constraints influencing strategies and goals in various cultures. In economic anthropology and studies of innovation, emphasis is on the choices made regarding production, consumption, new technology, and so on (for example, Burling 1962; Barth 1967; Salisbury 1962; Ortiz 1973; Plattner 1969; Schneider 1974; Dewalt 1975; Prattis 1973; Acheson 1972; Greenwood 1976; Wharton 1971). Anthropologists interested in network analysis, exchange theory, and strategic interaction all emphasize the choices people make to manipulate their social relationships to achieve certain ends (Barth 1959; Bailey 1969; Boissevain and Mitchell n.d.; Blau 1964; Homans 1961; Heath 1976; Mayer 1966; Thibault and Kelley 1959 provide examples of studies of this kind). This new emphasis on decision strategies, games and goals, and so on makes it very difficult to distinguish clearly between anthropology and economics. The fact that anthropologists are focusing on what people will do and will accept under varying circumstances, in the words of Norman and Dorothea Whitten, "places the anthropologist at the heart of economic theorizing, one of the crucial questions of which deals with the problem of 'maximizing'" (1972:259). The area of overlap between the fields is further increased by the fact that some anthropologists see economic theory as a model for all



social exchange (for example, Heath 1976).

While bridges are clearly being constructed between anthropology and economics, there are some enormous differences between the two fields yet.

(1) Most important, economics tends to deal with formal models, emphasizing rational behavior under conditions that are characterized as ideal. Anthropologists are completely oriented toward an inductive approach to explain actual behavior of people "on the ground." The fact that economists are interested in how people ought to maximize their ends, while anthropologists are interested in whether people are maximizing something and what they are doing creates an enormous chasm between the practitioners of the two disciplines when it comes to what they study and the data they collect.

(2) Economics is a policy-making science; anthropologists, on the whole, have been very reluctant to work with policy makers.

(3) The ceteris paribus reasoning of economic theory tends to place a strong emphasis on the relatively short period of time during which all other things might be supposed to remain unchanged. Furthermore, the difficulties of formally specifying rational behavior under conditions of uncertainty have further limited the time horizon of economic theory -- especially those parts which have pretensions of practicality. Anthropology, by way of contrast, has tended to emphasize a broader range of behavior and far longer periods of time. Despite these differences, new theoretical connections between the two fields are very much in evidence.

The fact that economics and much of current anthropology focus on decision making within institutional parameters is of little help, in and of itself, in integrating social,

economic, and biological information in any way that will be useful for purposes of fisheries management. There is, however, a whole body of theory, which is closely related to this shared decision model, which, we believe will aid in integrating information from these intellectual disciplines -- namely, the theory of adaptation.

### C. Social and Biological Models

There is a massive amount of information on the relationships between biological systems on the one hand and cultural systems on the other. A relatively small amount of work has been done by sociologists, geographers and psychologists. A few biologists -- most notably Eugene Odum -- have attempted to use biologists' concepts such as energy flow in analyzing the relationships between man and nature (Odum 1971). But much of the work in this area has been done by anthropologists. In fact, the relationship between man and his environment has been one of the major foci of interests in American anthropology in the past thirty years. The major contribution of these anthropologists deserve attention, since some of the concepts they have developed are of particular use for our purpose.

In recent years, much of the most interesting work in this area is being done by anthropologists who describe themselves as cultural ecologists. The cultural ecologists, following the lead of Julian Steward, essentially view man as a part of nature, not separate from the natural world or above it. Man, from this point of view, is an animal, and like all animal populations, human populations are part of eco-systems. Like other animals, human beings depend on other living organisms and non-living substances for their very survival, and in turn, affect other parts of the eco-system. Humans do not interact directly with their environment, but articulate with it through their culture. Culture

from this point of view is a kind of "equipment" in the struggle for survival (Rappaport 1973:245). It is, of course, a very effective kind of equipment since it has provided man with a far greater capacity to exploit a variety of niches than other animal species enjoy.

The cultural ecologists have very diverse interests and have explored a wide range of topics. Some have focused on the effects residence rules or group membership have for allocation of available resources (Meggitt 1965; Leeds 1965; Isaac 1980). Other studies have inquired into the effect of warfare on resource utilization (Sweet 1965; Vayda 1961). There are projects which have explored the effects of religious concepts and rites on population (for example, birth and death rates, health) (e.g. Benedict 1973; Harris 1965; Nag 1962; Newman 1970; Marshall and Polgar 1976). Others have studied the way man regulates the environment and the resources at his disposal (Acheson 1975a; Rappaport 1967).

The underlying question behind all of these studies is whether social behavior enhances or reduces the survival of the people involved, and whether this behavior enhances or degrades the physical environment. In much of this body of literature, there is an emphasis on the social and cultural factors operating to keep man in balance with his natural environment. Rappaport, for example, argues that Tsembaga rituals and warfare operate to maintain an equilibrium between human populations and their resource base. In his words, this pattern of activity helps to maintain "an undegraded environment," . . . adjusts man-land ratios, distributes local surpluses of pigs throughout the regional population, and assures people of high quality protein when they are most in need of it (1967:28-29).

In a whole series of studies Marvin Harris uses what he calls "functional explanations" (1960) to argue that cultures contain built-in controls regulating the use of natural re-

sources. In one recent article, he argues that the strong preference for eating meat seen in most cultures is a strategy to ensure survival, because such norms allow people to cope in times of stress and warfare when the body's need for protein rises sharply (Harris 1979:32). In another article he argues that the Indian Government's program to slaughter sacred cattle is unwise, since the cattle provide goods necessary for a peasant economy (i.e. dung and hides).

In still another study, Lee argues that Bushmen women keep the birth rate down by spacing their children three to five years apart. A small population is desirable since it allows the Bushmen to live at a level of efficiency to permit adequate living and a good deal of leisure.

These studies are very different in many respects, but there is a common theme running through them -- namely the balance between man and the resource base in tribal and peasant societies. The emphasis is not on growth or change, but rather on cultural and institutional feedback mechanisms operating to keep these societies in equilibrium with the flora and fauna on which the human population depends. In essence, the cultural ecologists are interested in how the use of natural resources by humans influences and is influenced by the value systems and socio-economic organizations of different cultures.

One might assume that a body of literature concerning social factors maintaining resource control would be of immediate practical value to those interested in understanding overexploitation of natural resources in our own society. The cultural ecologists, after all, are describing situations in which people do not compete to over-exploit fish or other resources. One might assume that such a body of literature would contain insights into the fundamental nature of our own resource utilization problems, and perhaps a set of analytical tools that might be borrowed to analyze policy

options in this area. The knowledge that there are societies in the world which have built-in mechanisms restraining the use of natural resources is very useful. It underlines, as nothing else could, the fact that our own escalating misuse of the natural environment is not "natural" or "inevitable," but rather the product of a set of specific cultural circumstances which are far from universal.

The conceptual apparatus used is another matter entirely. There are three sets of problems which make cultural ecology and its intellectual apparatus inapplicable to fisheries problems. First, the conceptual tools used were developed to understand aspects of small, stable tribal and peasant societies. The findings of such studies can be applied to modern industrial societies and the resource problems they face only with great difficulty.

Second, the explanations used by most cultural ecologists are clearly functionalist in nature. That is, the social and ecological systems are seen as a set of interconnected parts; and any single unit of the system is explained in terms of its use or function for other units of the system. The function of the norms prohibiting the killing of sacred cattle in India is to ensure the supply of dung, hides, and so on needed for peasant agriculture. The function of ritual among the Tsembaga, to use Rappaport's example, is to maintain a balance between the human population, pig population, and flora. As Jarvie has pointed out, such "explanations" explain nothing. A second flaw is that they attempt to explain an institution or other social patterns in terms of its accidental aftereffects (Jarvie 1968:199f). To continue our examples, the Tsembaga rituals may result in keeping the pig populations in the future from denuding the countryside, which could occur if their population grew unchecked. But that clearly is not the reason that the people themselves hold such rituals in the present. In fact, there are only

the barest hints that the Tsembaga themselves are even aware of the ecological aftereffects of their pig feasts. In a similar vein, it has been argued that infanticide among hunter-gatherer groups prevents such groups from increasing in population to the point where they outrun their resource base. This may be one of the manifest functions, but this is scarcely an adequate explanation for the behavior involved. A woman who kills her baby has something far more immediate in mind than a potential problem with the man-land ratio which might occur fifty years in the future.

Third, the cultural ecologists are oriented toward explaining total societies in *statis*. The emphasis is on "second order abstractions and statistical tendencies" (Bennett 1976:223), describing whole systems of norms and institutions and their relationships to aspects of the environment at a particular point in time. When those interested in cultural ecology do become interested in change, their emphasis is apt to be on describing long-term evolutionary stages in taxonomic terms. In this literature, there is little emphasis on the processes which occurred over the long-term to produce gradual transformations of individual societies. Rather, we are presented with a series of snapshots of different types of societies at several different points in time, each with its characteristic technologies, institutions, value systems, and so on. In this literature, there is the clear understanding that some societies have participated in the entire sweep of cultural development and have gone through several different stages, but there is no indication of how those changes have occurred, for example, how some hunting-gathering societies have become agriculturalists (Cohen 1971: 6-15).

Fourth, and most important, there is no indication in the literature on cultural ecology of the mechanisms connecting social and environmental variables. The cultural ecolo-

gists have described a series of social systems which are in balance with their environment, but they give very little indication of the various mechanisms in the systems they are describing which maintain their balance. One example is afforded by Lee who argues that Bushman population is maintained at a low level by the desire of women to space their children to avoid undue work (Lee 1972a, 1972b, 1972c). What we do not know is the mechanisms these women use. Is some form of birth control used? Does infanticide or abortion figure into the picture? Are they avoiding sex for years on end or is it traditional to obtain sexual satisfaction without intercourse? Is there some glandular factor which prevents ovulation for years after the birth of a child? Lee provides us with no answers to these questions, and since he does not really tell us what these Bushpersons are doing, he leaves us with the certain knowledge that his description of the system is incomplete, and the uneasy feeling that the factors controlling Bushman populations are vastly different than those he describes. We know that the resources of the Khalahari are scarce, and that the human population is correspondingly low. The mechanism maintaining that balance is incompletely described at best. Recent work has shown that the mechanism producing this birth spacing is probably physiological in nature; fertility rates among Bushmen women are apparently related to diet and its associated effect on body fat and hormonal levels (Kolata 1974:932-33).

Anthropologists such as Lee give some hints about the feedback mechanisms controlling the ecosystems with which they are concerned; other authors, like Harris, do not even give that. To return to our two examples, Harris argues that most cultures have strong norms concerning preferences for animal protein, since high quality protein has great survival value, especially in times of stress or warfare. Somehow this explains the widespread preference for meat.

Yet he gives no indication what the causal linkages are. Is it possible that there are physiological factors behind the strong preference for meat? Have the people of these cultures noted consciously that people who ate meat were healthier? There is no clue in Harris' work. Harris may be correct in assuming that there is "wisdom" in traditional culture. But all too often he writes as if the balance between man and nature were invented and maintained by "mother nature" or some other equally benevolent force working outside the conscious direction of man. He has been seriously criticized, by Bennett among others, for substituting "just so stories for scientific explanation."

From our perspective, there is a still more serious flaw. In the entire literature on cultural ecology, we have no picture of the kinds of decisions and choices made by actual people operating with different assets and constraints. In short, the cultural ecologists completely jump over the entire subject matter of economics. In the process, they are very vague on the switching rules used by the people of a culture to respond to changes in their environment or to produce changes.

There can be little doubt that the cultural ecologists have made a significant contribution to understanding the relationship between man and his environment, but they have not developed a set of concepts that can automatically be applied to questions concerning management policy for marine fisheries in the United States. One problem stems from the fact that the cultural ecologists have focused on small, isolated societies in balance with nature and fisheries managers must deal with a complex heterogenous industry which is sometimes out of balance with the marine resource base. The most serious problem is that the cultural ecologists ignore the mechanisms by which human beings and their societies affect the environment and the kinds of decisions people



make in response to that environment.

The whole object of fisheries management, after all, is to affect the decisions of fishermen concerning target species, level of effort, and so on. That is virtually impossible to do unless one understands the kinds of decisions being made regarding the marine environment and the factors influencing those decisions. Thus, the utility of "cultural ecology" for practical resource management is strictly limited.

In very recent years, those interested in the relationship between social systems and environmental systems have approached the topic through what has become known as the theory of adaptation. The theory of adaptation is an outgrowth of cultural ecology, and the debt these anthropologists have to Julian Steward and the cultural ecologists is very evident. Nevertheless, there are certain critical differences which need to be discussed in detail -- particularly since a focus on adaptation, unlike the older cultural ecological approach, holds forth great promise in applications to problems of resource management. This is not to indicate that those interested in adaptation have developed a set of intellectual tools which can be applied directly to resource problems in the U.S., but the potentiality is clearly there.

#### D. Adaptation

"Adaptation" has multifarious definitions. Biologists use the term to talk about the changes in the gene pool of an organism which produce evolutionary developments over the course of generations. Traditionally, anthropologists -- especially the cultural ecologists -- have talked about adaptation in terms of the long-term changes in the stages of development of a civilization which occurred as humans unconsciously altered established patterns to fit into environmental niches and avoided strategies which were maladaptive. Cohen, for example, talks of hunting-gathering, horticulture,

pastoralism, agriculture, and industrialism as major forms of adaptive strategies (Cohen 1971:7-10). The emphasis here is on describing societies at a particular stage of development, and the ways their social structure fits with the physical environment. The focus is not on the processes and mechanisms producing those adaptive alterations in the society as a whole.

Very recently, several eminent anthropologists, most notably John Bennett, have suggested that studies of adaptation be shifted to the individual level. In this sense, adaptation refers to the behavior of an individual "during its life by which it attempts to cope with its environment" (Bennett 1976a:848). It is the result of a series of choices or strategies as the individual tries over the course of time to gain his ends and solve immediate problems. As Bennett phrases it, "in adaptation, the organism plays a game with the environment, endeavoring to learn, manipulate, or change the rules in order to realize goals, satisfy needs, or maintain a degree of freedom of choice and action" (Bennett 1976a:848). In the last analysis, adaptive behavior is niche-seeking behavior. In adaptation, human beings are seen as using the social, economic, and physical environment in ways which maximize chances for physical survival, while maintaining valued institutions and those goals and things which give life its meaning.

In this body of literature, the environment is perceived as including not only climate, natural resources, and the demands of the economic system, but also social groupings and the normative system as a whole. It is, in short, anything which the individual has to take into account in making decisions to solve problems. Unlike the cultural ecologists, who tend to think of the environment and human behavior as a fixed system in stasis, the newer studies of adaptation accept the natural environment, technology and economic systems as

givens and then go on to study the way people maneuver to attain their ends. Sometimes these maneuvers take place in ways which leave the social and physical environment intact; at times the environment is changed in the process.

The problem-solving decisions of individuals certainly have long-term consequences. Bennett, for example, distinguishes between "adaptive strategies" and "adaptive processes." Adaptive strategies are the patterns formed by the many separate adjustments that people devise in order to obtain and use resources and to solve the immediate problems confronting them; adaptive processes are the changes introduced over relatively long periods of time by the repeated use of such short-run strategies. In short, it is the decisions individuals make in the short run which, if repeated by enough people, will produce long-run changes in the social system. Thus, it is the decisions of individuals which produce long-term processes and ultimately evolutionary changes. By implication, it is the decisions of individuals which are the key to understanding not only the present, but also long-term future trends in which whole social structures are altered in ways which make them more amenable to the demands of the environment.

For these reasons, it is the adaptive strategies stemming from the decisions of individuals which are the focus of attention in this body of literature -- not the long-term processes or results.

Several aspects of Bennett's short-run adaptive strategies should be noted. First, individuals are well aware of the kinds of the maneuvers in which they and other people are engaged. As Bennett points out, every language has a large number of words to describe such strategies: "coping, changing, rectifying, correcting, curing, ameliorating, modifying, manipulating, bringing-up-to-standard, swindling, deceiving" -- are English words referring to ways of altering circumstances.

Another set of terms refers to the psychological outcomes for the individual following the use of strategies: "satisfying, gratifying, disappointing, making happy, fulfilling, and many others" (Bennett 1976b:272). As a rule, the people of a given culture have few words to describe the very long-term evolutionary changes, and may not even be aware of them.

Bennett's work on adaptation focuses primarily on those kinds of decisions and goals which relate to the environment, technology, production, and other matters influencing the ability to survive physically. People, of course, make decisions and maneuver in many other aspects of life -- for example, kinship, politics. However, for Bennett and his followers, these goals and values are of concern only if they impinge on the choice of occupation or the ability to make a living.

Bennett stresses that in solving problems individuals take into account two sets of factors: (a) the means one can employ to attain one's ends in the most efficient manner (i.e. optimization, maximization), and (b) moral precepts and duties towards other people. These two sets of factors influencing decisions correspond to what Bailey calls "pragmatic rules" and "normative rules" (Bailey 1969:4-5). In every society, there is a good deal of maneuvering room which individuals can use, but any study of adaptation must take into account not only the choices and maneuvers employed to solve problems, but the constraints the normative structure places on their use.

For our purposes, the theory of adaptation as conceived by Bennett and others holds enormous promise in two critical areas.

First, it is very clear from Bennett's most recent work that the adaptive behavior model is, in his mind, one that will produce a great deal of useful information to "policy makers" (Bennett 1976b:3, 26-28, 15, 148, 291). He believes

that people of any culture always have a range of choices regarding the way they use the natural environment in their attempt to find a secure niche. Some of these choices are more environmentally productive or more destructive than others. Some are clearly preferable to users of natural resources. A knowledge of the adaptive responses would presumably give policy makers some insight into ways to avoid triggering destructive decisions concerning the environment. It would also presumably give them a way to avoid policies which would threaten the adaptive niches the users of resources have achieved. In this regard, it should be noted that a good deal of the opposition to fisheries management comes from fishermen who are afraid that regulation will lower their incomes, make it more difficult to earn the same income, or remove them from the business altogether. Presumably, a knowledge of the range of choices open to fishermen and an understanding of the things fishermen must do if they are going to survive economically would allow the selection of policy options that would conserve resources and minimize political opposition.

Second, work like Bennet's holds the promise of providing a general model which can be used to integrate social sciences and the biological sciences. Certainly, a full-fledged integrative model has not developed from such studies of adaptive behavior, but the promise is apparent.

The biological connection is obvious. Studies of adaptation, after all, involve the ways that people make decisions regarding natural resources to make a living. The maneuvers and choices they make regarding those resources have implications for the way the society evolves in the long run.

The connections with psychology and linguistics are also apparent. Adaptive systems are characterized by flexibility, as people modify their behavior to meet new demands. On one level, an adaptive system might be thought of as a set of switching rules which define the options open to an individual

in a given culture and the choices open to him under a given set of circumstances. On another level, adaptation is dependent on the ability to learn new skills and responses. In both cases, the adaptation involves the ability to understand, judge, and respond to new situations. This underlines the fact that adaptive behavior is ultimately traceable to the cognitive processes of individuals involved. Since the cognitive maps defining choices and strategies are embedded in language, there is an obvious connection with socio-linguistics as well.

Adaptation, as Bennett conceives it, is also closely connected to some of the most exciting fields of social anthropology and sociology. As was previously pointed out, in the past decade or so anthropologists and sociologists have begun to develop a general model of social life, which emphasizes the fact that the key to social relationships of all kinds is exchange. In the closely related fields of exchange theory, strategic interaction, network analysis, and symbolic interaction, a great deal of attention has been paid to the kinds of decisions and choices people make vis-á-vis these transactions. Of course, a study of adaptive strategies focuses on the way people enter into transactions and exchanges to attain their goals and solve problems.

For our purposes, it is important to note that the theory of adaptation provides important linkages with economics. One connection can be seen in the fact that adaptive strategies involve optimizing choices and decisions -- the subject matter of economics. Not too surprisingly, anthropologists interested in adaptation have borrowed whole sets of elementary tools from economics (i.e. opportunity costs, marginal concepts, cost benefit analysis) to analyze choice responses (for example, Bennett 1969:311-312). The debt of these anthropologists to economics is very obvious.

In economics certain parallel developments are taking

place. While the term "adaptation" is somewhat foreign to the language of economics, there are many aspects of the theory which implicitly focus on adaptation. One example is the basic price change-response, and similar types of comparative-static analysis so common to economics. Although the main corpus of economic theory, does not make the transition from adaptive to evolutionary theory, there are certain recent trends which at least point in this direction. We might cite in this regard the growth of human capital theory (Becker 1962), which stresses the importance of a trained and educated work force for economic development; the insurance parable (Arrow 1971; Knight 1965); organization (hierarchy) theory (Cyert and March 1963; Williamson 1975; Arrow 1974; Hurwicz 1973; March and Simon 1958; Olson 1968; Simon 1972; Solo 1967; Alchian 1950; Boulding 1950; Nelson and Winter 1973); the rebirth of interest in the elemental transaction itself (Williamson 1975; Akerloff 1970; Coase 1937; Demsetz 1968; Marschak 1968; Shubik 1973) and the explicit attempts by Boulding and others to develop an evolutionary economics. All of these interests of economists center on the problem of how a firm or individual transforms or consciously adapts itself to its environment. Of course, this is exactly the focus of anthropologists such as Bennett.

In all of economics, Schumpeter's work shows the most conscious concern with an adaptational model. In arguing against the restricted vision of the economic theory of his time, Schumpeter proposed a broader view of economic behavior in his famous chapter on the process of "Creative Destruction" which he saw as an "evolutionary process" (Schumpeter 1969: 41).

"In other words, the problem that is usually being visualized is how capitalism administers existing structures, whereas the relevant problem is how it creates and destroys them. As long as this is not recognized, the investigator does a meaningless job. As soon as it is recognized, his outlook on

capitalist practice and its social results change considerably.

The first thing to go is the traditional conception of the modus operandi of competition. Economists are at long last emerging from the stage in which price competition was all they saw. As soon as quality competition and sales effort are admitted into the sacred precincts of theory, the price variable is ousted from its dominant position. However, it is still competition within a rigid pattern of invariant conditions, methods of production and forms of industrial organization in particular that monopolizes attention. But in capitalistic reality as distinguished from its textbook picture, it is not that kind of competition which counts, but the competition from a new commodity, the new technology, the new source of supply, the new type of organization (the largest unit of control for instance) -- competition which commands a decisive cost or quality advantage which strikes not at the margins of profits and the outputs of the existing firms, but at their foundations and their very lives.

In the case of retail trade, the competition that matters arises not from additional shops of the same type, but from the department store, the chain store, the mail order house, and the supermarket which are bound to destroy those pyramids sooner or later. Now a theoretical construction which neglects this essential element of the case neglects all that is most typically capitalist about it; even if correct in logic as well as in fact, it is like Hamlet without the Danish prince." (Schumpeter 1969:43-45)

In our view, Schumpeter's proposition is consistent with the broader notions of adaptation of anthropologists such as Bennett. We believe the work of Schumpeter and Bennett contains the seeds of a model which could be formalized in the interests of integrating social and economic data of use to fisheries managers.

To date, the anthropologists and economists interested in adaptive behavior have not attempted such an integration. In fact, they seem unaware of each other's efforts.



Despite the promised potential of adaptive studies, very few such studies have been done. While some of those studies begin to pull together social, economic, and biological data in discussing the kinds of decisions and strategies people in different cultures employ which have an effect on the physical environment, the types of models and intellectual tools used are relatively unsophisticated. Moreover, the policy implications are scarcely explored at all. One of the best studies of adaptation is Bennett's Northern Plainsmen, which explores the adaptive strategies used by the people of four different cultures living in one small area of Saskatchewan not far from the U.S. border: the ranchers, farmers, Indians, and Hutterites. Bennett does a remarkable and convincing job explaining how these four different sets of people, faced with the same environment but different kinds of values and social organization, make different sets of decisions to attain some very different goals, and survive in ways that give their lives meaning. There is very little quantitative data in the study, and almost no analysis of the variation in decision-making by people within each of these four cultural groupings. This is not to suggest that Bennett is unaware that individual Indians, ranchers, or whoever make different choices depending on the situation in which they find themselves, but the emphasis of the book is on outlining generalized patterns of responses characteristic of each of the four ethnic groups involved. Bennett does a particularly good job in describing the ways that hard economic factors and ideational factors both influence the selection of means to achieve valued ends.

However, the economic concepts used are relatively unsophisticated. The key concept used through Northern Plainsmen to analyze economic decisions is that of opportunity costs. Moreover, the role of social and cultural variables in influencing decisions and adaptive strategies are described qualita-

tively. Throughout the book, one gets statements such as the following concerning opportunity costs and the way decisions are modified by values:

"Hutterite investment opportunity costs are of course low: by their own rules the Bretheren cannot sell their colonies and they realize relatively high rates of return. But we must again qualify the results by pointing out that many farmers and ranchers, aware of the inferior position of their enterprises, prefer to accept lower rates of return of their labor and capital investments because they like the life. The concept of opportunity costs must, therefore, always be qualified by cultural preferences." (Bennett 1976b:312)

As a result, there is a strong tendency for ranchers and Hutterites to remain in their respective occupations, while a far larger number of farmers and/or their children tend to leave farming.

While Bennett's analysis is superficial from some points of view, he was one of the first anthropologists to recognize the value of opportunity costs in analyzing decisions. Recently, anthropologists have begun to publish more studies using the concept of opportunity costs (for example, Barlett 1980:140-142), as well as a good many other concepts from economics to analyze decision making, including concepts from financial analysis (for example, Acheson 1980h:252-255); statistical analysis (Chibnik 1980:87ff; Dewalt 1980:300-308); and decision trees (Gladwin 1980:62-65).

It is critical to note that the kind of analysis done by Bennett for the four ethnic groups in Saskatchewan will not work in understanding the decisions made by fishermen. A far more sophisticated analysis is called for if we are to understand the choices various kinds of fishermen make in their attempts to remain economically viable and reach valued goals.

A great deal of difficulty stems from the fact that

fishermen and fisheries operate in a highly fluid environment where rapid, radical change is the rule rather than the exception. It is not only that fishermen make major changes in fishing techniques, crew size, and so on to take advantage of predictable changes of availability of fish stocks, markets, and other such factors. They must also take into account the fact that there are drastic changes in prices, species, locations of fish schools, and other variables from one year to the next. In addition, fishermen are constantly adding new gear, changing boats, searching out new marketing outlets, or innovating in other ways. They have also demonstrated that they are perfectly capable of innovating their way around regulations designed to limit fishing effort (Smith 1977). Recently, large numbers of fishermen are joining together in groups and associations in an effort to affect the regulatory process and the legal parameters under which they will operate under PL 94-265. They are also forming cooperatives in unprecedented numbers. There are, in short, a very wide variety of coping strategies fishermen are using concurrently in an effort to solve problems and remain economically viable. If one wants to assess what fishermen will do in response to management regulations of various kinds, and more to the point, which regulations will threaten the viability of fishing firms of various kinds, one must know a good deal about the possible strategies open to owners and captains operating under various conditions. It is exactly this kind of information that an adaptive model should provide. Bennett points the way toward this kind of analysis. But neither he nor his colleagues have done much in the way of providing a methodology that can be used in analyzing specific, complex, rapidly changing adaptive strategies such as the ones occurring in the fishing industry.

The theory of adaptation, if it is going to be of use in understanding adaptive choices in complex modern industries

has to be modified and extended. Bennett in anthropology and Schumpeter in economics roughed a general framework, but a good deal more model building needs to be done. In the next section, we attempt to develop a set of specific concepts concerning adaptation, integrating concepts from both anthropology and economics. In the third section, this model will be applied to the fishing industry in New England. We hope that it will result in a more accurate picture of what fishermen are doing in their attempts to attain their goals.



PART II

THE ADAPTATIONAL MODEL

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## CHAPTER 1

### INTRODUCTION

The following theory grew out of a desire to reconcile the conflicting models of microeconomic behavior used by anthropologists and by economists, especially those models concerning the exploitation of wild resources. The desire took us much further afield than we expected. The result is a fairly general theory (rather than one applicable to the exploitation of wild resources only), capable of taking into account the broad adaptive paradigm of anthropology and the 'competitive' paradigm of economics. It is basically a formal theory, much closer in methodology to the approach of economics than of anthropology, but in substance it is a mix, to a certain extent a synthesis of the views of the two disciplines.

The relationship of this broad theory we propose to trends in economic theory today is this: over the last ten or so years there has grown up an extensive literature on information, transaction costs, organizations and institutions, non-market exchanges, and a variety of other matters which, in a sense, are extending the boundaries of economic analysis. These are subjects which have long interested anthropologists, and the trend has led some enthusiastic economists to perceive a kind of 'intellectual imperialism'. From our perspective this new literature is not necessarily widely at variance with the behavioral notions of competition embedded in neoclassical economic theory, but it does seem to strain that model and open the door for an alternative concept of the competitive process which is more consistent with its concerns and findings. The theory proposed here is the result of our search to find that kind



of consistent framework. We do not look upon it as a form of intellectual imperialism simply because the most basic ideas about competition embedded within it are more common to anthropologists than economists.

In their broadest outlines, anthropological and economic theory do not present mutually exclusive views of the world--successful competition may in fact be nothing more than successful adaptation to the environment (if one includes competitors in the environment). From the practical point of view, however, there are great methodological and substantive differences between the application of the 'adaptive' paradigm of anthropologists and the 'competitive' paradigm of economists. These differences appear to have developed in response to different sets of questions about behavior. It would be possible to elaborate the extensive differences in the two paradigms' interpretations of similar behavioral phenomena. However, this is not really necessary here, for the point of departure for this theory is rather easy to describe.

Economists have always cast their 'competitive' paradigm in terms of the decision making process of the individual economic entity. In the pervasive neoclassical paradigm, the particular form of the competitive decision making problem is stated in terms of a profit maximizing solution to the simultaneous determination of price and quantity of output of a product; the product is assumed as given. Competitive success or efficiency (the two are virtually synonymous) arises from the proper solution of this problem. The firm is assumed to exist in a world of well defined, homogeneous products and corresponding industries and markets. Full or almost complete knowledge is usually assumed as is the mobility of resources, and so on. The question of what the firm is to produce is not accorded formal treatment.

The theory presented here takes a different view of the

competitive decision making problem. Rather than the neo-classical price/quantity problem, the firm is viewed as if its competitive problem is what to produce or do. In Schumpeter's words, "...in capitalist reality as distinguished from its text book picture, it is not that kind of competition [i.e., neoclassical price/quantity decision oriented competition] which counts, but the competition from a new commodity, the new technology, the new source of supply, the new type of organization...--competition which commands a decisive cost or quality advantage which strikes not at the margins of profits and the outputs of the existing firms, but at their foundations and their very lives" (1969:44). By rephrasing the basic competitive question in this way, the view of competition as the result of decision making is preserved in conformance with the most general view of economics; however, the substance of the decision making problem is transformed into one which is much closer to the general view of adaptive behavior held by anthropologists. Nevertheless, as one might expect this alternate formulation of the basic decision problem of the firm eventually leads to a very different view of the competitive process and the welfare or normative implications of that process. Right now this paper cannot pretend to be anything more than an outline of that process and, to a certain extent, those welfare implications.

This rephrasing also almost automatically thrusts one into a world which is not easily delineated by the usual assumptions of economics. Most fundamentally, the question of what to produce or do immediately implies a world in which the range of commodities and services cannot be captured by a simple aggregation into "n" given products or services. Rather the question of what to produce, if it is to be taken as a non-trivial question, implies that the competitive process depends upon the actual and potential existence of

an almost continuous variation in products. Capturing this kind of competitive environment and process in a theoretical framework requires the ability to conceptualize the basis for variations of competitive importance for existing products and services, and, more importantly, for an infinite number of non-existent products and services which may or may not be the object of competitive, adaptive behavior.

A world of this sort also implies an environment in which information and knowledge are scarce resources simply because the environment itself, when viewed this way, is infinitely more complex than in the traditional view of economics. Incomplete knowledge in turn implies uncertainty, the importance of individual, group and collective learning behavior and, for the system as a whole, indeterminacy. Time also appears important since the rate of adaptation or the timing of what to produce or do in a changing, complex environment is very important to any firm's or individual's competitive posture.

In summary, by changing one's basic view of the competitive problem one is also forced to change one's theoretical description of the world, that is, the strategic assumptions with which one chooses to simplify the real world.

In the presentation which follows, a formal theoretical world is created, one which it is hoped is appropriate to the question of competition through decisions about what to produce and do. The formal approach is cast into three basic parts. The first presents a mathematically deterministic theory of the economy in the short period. The point of this short period model is to define the instantaneous relationships between firms (where the word firm is used as a kind of short hand to indicate any economic decision making entity), the objectives of firms, and some fundamental assumptions about the environment of the market and production. The short period model is not a decision making or a

behavioral model--all decision making, all action takes place in the long period. Rather, it is used to represent the changing relative competitive position of firms (vis-a-vis each other and the environment) as a result of earlier (long period) decisions by those firms.

The mathematical form chosen for the short period model is a system of differential equations in which there is one equation for each firm in the economy. Within each equation there is a product or factor market interactive term for each other firm. Mathematically the system yields equilibriums, but conceptually it is treated as if it were simply a snapshot view of a system in perpetual disequilibrium.

The reason for this treatment of the short period is elaborated in the third part which deals with the nature of decision making by the firm. Before getting to this part, however, the second section of the model delineates the assumptions about demand, knowledge and information, the nature of transactions and institutions, and a variety of other important factors which define the long period environment. The attempt in this section of the paper is to define a heterogeneous, complex and changing environment in a manner which provides a logical foundation for the analysis of long period behavior.

Building on this foundation, the next section of the paper begins to explore the nature of decision making by the firm. The long period model is what has been called a pattern or process type model. It does not yield long run equilibriums or equilibrium paths. Instead, it is rather modest in its assumptions of its own knowledge of the economic environment and is more or less content to identify patterns of behavior which, on the basis of its definition of the environment, might be thought to be reasonable representations of the nature of economic activity.

The methodology of this approach presents a strong

contrast to recent work in economics addressing similar questions (e.g., Spence (1975), Lancaster (1971,1975,1979), Dixit and Stigler (1977)). This work tends to deal with the problem of complexity by carefully specifying (as if the modeler were fully knowledgeable of the environment), and usually in a mathematically tractable form, what are thought to be reasonable forms of complexity (for example, the distribution of consumer preferences, own and cross product elasticities, and so on). These forms are then logically investigated with respect to their implications for efficiency and equity, with some interesting conclusions. In effect, this method is a kind of logical/mathematical case study approach. The great advantage it offers is the logical rigor and specificity of conclusions which it allows. However, the methodological requirement of exact specification of the environment appears to attribute to the theorist a form of omniscience somewhat contrary to the investigation of imperfect knowledge. More important, the approach tends to direct attention towards possible outcomes (given the specification chosen by the theorist) rather than towards questions about the behavioral processes people actually engage in when they are faced with complexity and imperfect knowledge.

For these reasons the theoretical means for dealing with uncertainty and complexity relies heavily upon sub-theories of institutions and knowledge. Summarized briefly, the theory of institutions proposes that in the presence of complexity and uncertainty, exchange and competitive interactions are subject to strong, collectively degenerative tendencies towards opportunistic behavior. We argue that the recognition of this potential collective loss, coupled with repetitive interactions under roughly similar circumstances leads to the evolution of behavioral rules or institutions. The purpose of institutions is to reduce or

suppress opportunistic behavior and thereby minimize the uncertainty about future outcomes of exchange and competitive interactions. In effect, these behavioral rules tend to substitute for very costly or unattainable information about future states of the environment, and, very importantly, tend to create regularity in an otherwise very complex, changing and unpredictable environment. This regularity is information.

Our theory of knowledge proposes that in a complex, changing environment, competitively valuable knowledge is not only scarce but also very particularistic, causing competitive strategies to become essentially learning strategies. In other words, adaptive competition is seen as the acquisition of particularistic, advantage-conferring bodies of knowledge. Combined, the two sub-theories propose that the costs of acquiring knowledge are conserved (1) through institutions which lower the collective costs of exchange related information, and (2) through the choice of competitive strategies which, because of the particularistic attributes of knowledge, allow firms to limit their pursuits to relatively narrow niches. In such niches it is possible to attain relative competitive advantage with only limited expenditures on the acquisition of knowledge. These two sub-theories are then used to analyze the decision making (product choice) behavior of the firm and to arrive at collective or aggregate patterns of behavior which should be expected in the long period.

The last part of the theory extrapolates from the 'general' theory of the first three parts into an alternative explanation or view of the process of exploitation of wild resources. The relationship of this theory to the problems of the exploitation of wild resources may seem somewhat obscure at first. But to the author the relationship is a fairly clear result of having watched and worked with fish-

ermen for a number of years. Their competitive problem-- seen most clearly in a multiple species fishery--and the one described by the theory is not a question of choosing a profit maximizing level of output, but rather a question of what to try to catch. This, for the fisherman, is equivalent to the question of what to produce. This decision must be made in the face of relatively imperfect knowledge of a highly variable resource, a rapidly changing market, and a host of actual and potential competitors, all of whom interact with and affect the success of the fisherman. The fisherman's problem is only secondarily one of cost minimization given a set of prices. It is much more a question of how much and what can be caught given relatively constant costs of operation. Quantity is not a choice variable for the firm but, once the decision about what to fish for is made, is instead almost the sole indicator of the competitive appropriateness of the firm's decisions. In sum, the relationship of the formal theory laid out in the first three sections of the paper to the theory of the exploitation of wild resources in the nature of the competitive decision problem laid out in the theory and actually faced by fishermen.

#### A Note on Attributions

Part II of this volume contains few references to the ideas of others who have worked on similar problems and ideas. This is not meant to imply a (mistaken) sense of strict originality. Earlier drafts of the theory did contain many references and ponderous comparisons between a point in the text and that made by a given author. It became apparent that these references were not very useful and were almost always tangential to the argument being presented. On the other hand, the works of these authors were the source of ideas even if those ideas were stated in a context inappropriate to that of our theory. The problem

was resolved by eliminating the unuseful textual comparisons and simply citing at the end of the text those writings which have bearing on the points discussed.

There are nevertheless several authors whose work has been particularly stimulating and influential: John R. Commons, Oliver Williamson, and Fredrik Barth and George Homans for their ideas on transactions and institutions; Herbert Simon (and his colleagues) for the notion of bounded rationality; Kenneth Boulding for his cross disciplinary perspective; Kelvin Lancaster for characteristics theory and, of course, Schumpeter for his sense of dynamic competition.



## CHAPTER 2

### THE SHORT PERIOD

#### A. Introduction

In the course of this presentation a model of the economy will be developed which treats the firm as an organism which consciously adapts to and even molds--in a very constrained way--its environment. In this section of the paper, however, a snap shot view of the economy is developed. Specifically, firms are viewed as they exist over a very short period of time, a period of such short duration that they are only capable of marginally altering their level of output/sales. Prices, product characteristics, production technology and unit costs of production are all assumed constant and outside each firm's realm of control. This very short period view of the economy is modeled as a deterministic system of differential equations. Mathematically it is a system which, given sufficient time, will move to an equilibrium state. In spite of this mathematical characterization of the short period, we wish to treat it as a system which 'dissolves' long before equilibrium is ever reached. Specifically, we view the very process of moving toward equilibrium as eliciting responses from the firms within the system. These responses (decisions) destroy the old equilibrium-producing parameters of the system by creating new parameters which cause the system to tend towards a new equilibrium. For example, we would expect changes in the rate of sales of any firm to produce adaptive responses from that firm or other firms in the form of decisions affecting price, product type, technology of production, and so on--decisions whose very purpose is to alter the set of likely outcomes if the world is left as it is.

As a result of these decisions the system then tends toward a new equilibrium, but this tendency in turn is destroyed by yet another decision purposely designed to thwart the set of outcomes represented by that potential equilibrium situation. In short, the short period is a very brief period of disequilibrium that lasts only as long as the interval between decisions.

#### B. Objectives of the Firm

Throughout the paper we will assume that the firm's short period objectives are, first, survival and, second, an increased rate of growth. Since survival for the firm means nothing more than the avoidance of a zero size and the rate of growth is nothing more than the rate of change in size, both objectives may be subsumed by reference to the direction and speed of change in the firm's size, or the relative rate of change in the firm's size. But what is meant by size? A variety of measures are available--assets, employment, sales, and so on. At this point in the paper we choose to adopt what may seem to be a very simple minded measure of size--the value of sales. Although it may be objected that much better measures are available, it should be noted that when the firm is constrained to the extent assumed here--no changes in prices, technology, costs or product characteristics--the value of sales is an appropriate measure of firm size, for when the firm can only change its rate of sales and that change is deemed to have no effect on prices or costs, then there is little else but the rate of sales which the firm may use as an indication of its success. Consequently, let us simply note at this point that we consider the firm attempting to maximize its relative rate of growth:

$$(1/N) (dN/dt)$$

where N denotes net revenue and we take t to represent continuous time. In a sense we are using net revenue, N, which

is really a time dependent or flow concept, as an indicator of changes in a stock measure, assets for example, of the size of the firm. Throughout this section we assume away inventory problems and equate output and sales. This assumption is not necessary for what follows but it does considerably simplify exposition of the model.

### C. Constraints on the Objectives of the Firm

If we were to conduct a cross-sectional survey of a market economy we would note that some firms were faring well and others not so well. We would want, of course, to attribute this differential success to differing characteristics of the firms we observe. Some have learned to cope well, others have not. By coping well we mean simply that they have learned at some time how to minimize the effect of the constraints they face in the attainment of their objectives relative to other firms. Neoclassical economics teaches that, all other things equal, the primary constraint the firm faces is in the area of production. Cost minimizing efficiency is the key to success. The logic of this proposition is inescapable once it is assumed that the firm is a small operator in a stable, large, homogeneous product market. Under these circumstances the firm does not have to worry about the definition (or change in definition) of its product and the relationship between sales and revenue (or price) occasioned by the way it defines its product. If these assumptions of the neoclassical model are removed then it follows that the firm will have additional problems to solve. The choice of an appropriate product and the resulting revenue effects are those problems. In short, our cross-sectional survey may lead us to suspect that the differential success of firms is attributable to their ability to cope with production efficiency, choice of product and pricing problems. We may not be led to disagree with the neoclassical notion that all other things being equal, cost

minimizing efficiency is what counts. Rather, the notion emerges that the inequality of the other things may frequently be the determinant of the firm's success or failure. Consequently, we begin to sketch out here a view of how these other things are likely to affect the individual firm's behavior and the collective process of market competition.

### C.1 The Financial Constraint

Our survey of the economy would quickly turn up the fact that all firms are faced with what we call a financial constraint--the resources at their disposal are not infinite. In the short period we would note that the firm's primary flow of resources originates from the sale of its product. Provided the process of purchasing inputs, producing, selling and receiving of revenue take place instantaneously this flow of resources would prove to be sufficient for the maintenance of production over time. Since this process does not take place instantaneously and/or because the rate of production may be increasing at a rate exceeding revenue inflow, we note that firms tend to rely on other resource bases, primarily short term credit. The firm's access to short term credit, however, is constrained by the costs the firm incurs through borrowing and the lender's (and firm's) desire to secure the value of the borrowed resources against unforeseen and unfavorable developments. From the firm's and lender's point of view this generally dictates a reasonable limit determined by the cost of the borrowing necessary to compensate for the actual lag in the receipt of revenue. As a consequence we note that in the short period the rate of inflow of resources to the firm from both cash flow and borrowing will work out to be approximately proportional to the value of output/sales.

Consequently, for the moment we choose to relate the financial constraint of the firm to its basic indicator of

success or failure, the rate of change in its size or sales. We note that in general the function is a simple proportional relationship, i.e.

$$\frac{dN_i}{dt} = a_i N_i \quad (2.1)$$

or dividing through by  $N_i$ , we find that the financial constraint of the firm is a constant when taken in terms of the relative rate of sales of the firm, i.e.

$$\frac{1}{N_i} \frac{dN_i}{dt} = a_i \quad (2.2)$$

In short, we assume for the moment that the short period financial constraint facing the firm is such that the absolute level of resources flowing into the firm in the short period is proportional to the value of sales of the firm and that it remains constant over time. The first part of this proposition is trivial; the second part is not trivial, obvious or true. It will be modified below when we discuss the effects of the firm's and its competitors' actions in the market.

## C.2 The Production Constraint

The process of production obviously requires the expenditure or outflow of resources. Some of these expenditures arise from the purchase of inputs (materials and services including financial) from other firms in the economy and from others for 'internal' resources such as labor skills, managerial talent and the imputed cost of the firm's borrowing from itself.

In those circumstances in which a firm is observed to have a constant rate of output and constant unit costs with respect to the flow of its output over time we would note that the expenditure of resources for internally provided inputs would be proportional to its output; hence, we could write

$$\frac{dN_i}{dt} = b_{ii} N_i \quad (2.3)$$

or

$$\frac{1}{N_i} \frac{dN_i}{dt} = b_{ii} \quad (2.4)$$

where  $b_{ii}$  reflects the rate of 'internal' resources expenditure. But for total unit costs to remain constant over time we would have to observe that the flow of expenditures for inputs purchased from other firms also remained constant, i.e.

$$\frac{dN_i}{dt} = b_{ij} N_i, \text{ for all } j, \text{ or} \quad (2.5)$$

$$\frac{1}{N_i} \frac{dN_i}{dt} = b_{ij}, \text{ for all } j \quad (2.6)$$

where  $b_{ij}$  denotes the rate at which units of output of firm  $j$  are purchased by firm  $i$ . It should be emphasized that this definition of constant costs is not the same as is normally used in economics. All that is meant here is that for a given rate of flow of output, unit costs do not change over time. Usually the term constant costs refers to identical unit costs for differing rates of output. In the notation used above the usual definition for constant costs would be indicated by

$$b_{ij}/N_i = b_{ij}^*/N_i \quad (2.7)$$

for  $t$  of some given duration, where  $N$  is output for the period for which the rate  $b_{ij}$  is defined and where  $b_{ij}^*$  and  $N_i^*$  correspond to another rate of output. If the right hand side of the equation was greater (less) than the left the equation would indicate the existence of the traditionally defined increasing (decreasing) costs.

Further examination of the reasons why unit costs might not remain constant with changes in the rate of output might turn up the fact that some of the firm's expenditures were fixed without regard to the rate of output. Furthermore, the method of production used by the firm may be conducive, because of plant size, etc. to a certain rate of output so that variations from that rate would produce unfavorable changes in unit costs. For a given rate of output we can

note the effect of fixed costs as:

$$-\text{SUM}(j=1 \text{ to } n)b_{ij}^* - b_{ij}N_i - \text{SUM}(j=1 \text{ to } n)b_{ij}N_i \quad (2.8)$$

where  $b_{ij}^*$  here denotes the rate of expenditures on fixed costs--those unrelated to incremental changes in the rate of output.

In the case of an optimal rate of output dictated in the short period by plant design or some other factor, we would note (if it were possible to hold all else equal) that as the rate of output is increased from a rate below to a rate above the optimum, the change in unit costs would decline and then rise, with the change in direction occurring at the optimum rate (i.e., a u-shaped cost curve). This is impossible to show with our notation without creating a cumbersome series of differences between the cost equations for each rate of output so we will let the matter stand with this verbal description.

These definitions are equilibrium definitions, but this is not likely to be a state the firm will witness. It will be remembered that our concept of the short period is one in which the system is moving towards a continually shifting equilibrium. Consequently, the interpretation we put on the firm's experience is this: during the course of the dynamic adjustment towards equilibrium the rates of flow given by the parameters of its equation will change from the values (or tendencies) consistent with the old equilibrium towards those consistent with the new. For example, during the period the firm may begin to experience difficulty obtaining supplies at the rate necessary to sustain its current rate of production. That is, as the economy moves towards a new (unlikely to be attained) equilibrium the firm finds that its old rates of output and intermediate product purchases are not consistent with the rates of output occasioned by the adjustment in sales towards the new equilibrium level.

We look upon these dynamic adjustments in the rates of

flow of variables such as sales, purchases, and so on as the indicators which cause the firm to make decisions. In the case of this example, the firm may respond by bidding a higher price in order to assure an adequate flow of inputs; it may sign another contract with another firm; it may alter its method of production, its rate of output, and so on. The methodological point is that it is changes in the rates of flow experienced by the firm which cause it to act.

This formulation of the production constraint facing the firm in the short period is, of course, virtually identical (in equilibrium) to the basic Leontief type production model if fixed and variable costs are lumped together and only the observed rate of output considered. When the equations for all firms are written together we can interpret each  $b_{ij}$  as either purchases by firm  $i$  from firm  $j$  or sales by  $j$  to  $i$ --in short all the off-diagonal elements conform to those in the intermediate product matrix of a Leontief system. The diagonal elements,  $b_{ii}$ , differ (in a non-substantive way) from those in a Leontief system in that they include internal purchases of financial and labor services (primary inputs) as well as intermediate products. Finally, our system relates firms to one another whereas the Leontief system is generally used to relate aggregations of firms, or industry to industry.

### C.3 The Market Constraint

Our survey would also reveal that the success or failure of the various firms depends to a large extent upon their relationship to the (broadly defined) marketplace. We should note that the firm's sales rate is constrained by (1) the limited size or extent of demand for the particular product it is producing and (2) by the relative success or failure of other firms competing for that same demand with the same or similar products, that is, by the nature of the firm's interaction with other firms in the marketplace.



In order to define the effect of the firm's and its competitors' sales on itself, it is first necessary to give a rough picture of what we will call the consumer environment. This is discussed in greater detail in Chapter 4. We consider the consumer environment to be such that potential purchases of the firm's product arise as a flow over time. The rate of this flow is given by consumer product preferences, budgets, and the relationship of the characteristics (including price) of the firm's product to other products in the market.

Implicit in the notion of the consumer environment is a concept of consumer behavior which is based either on satisficing with regard to utility objectives or on an inability to optimize consumption choices because of ambiguous, incomplete or biased information. This point of view will be elaborated in Chapter 4. For the moment it should be enough to note that in the case of satisficing we may think of a world in which consumers are searchers, whose search process is costly, and who are consequently often willing to trade-off search costs for a possibly less than optimal consumption purchase. The probability of such trade-offs being made would appear to increase as consumers approach indifference between the firm's product and any other. Hence if the firm could actually 'move down its demand curve' it would most likely encounter a declining rate of sales which could only be offset if larger selling costs were incurred in order to reduce the search costs of consumers. These costs can be thought of as drains on the firm's resources either in the form of actual expenditures or in a declining frequency of sales. We choose to look upon them in terms of their effect on the firm's rate of sales.

A similar process would occur if consumers received ambiguous, incomplete or biased information about the products offered to them in the marketplace and/or if the quantity of information available to them was potentially so great that

the costs of analyzing (or even the ability to analyze) that data prevented optimization of their buying patterns. Here again, the probability of less than optimal buying decisions would be likely to increase as consumers became more and more indifferent between one or another product because of the more accurate and costly information required to make a marginal decision and the declining benefits relative to a correct non-marginal decision. In this case also each additional sale by the firm can only be made if accompanied by a compensating decline in the frequency of sales. (Changes in selling costs, prices and/or product type could maintain or increase the frequency of sales, but in this model these are only long period options.) In short, once consumer preferences and relative product characteristics are given as they are for the short period by definition we view the conditions governing individual transactions as the primary determinant of the frequency of sales.

Another way of looking at this is that as the firm itself makes sales it finds that it has reduced the potential rate of flow of purchases accordingly. That is, relative to a zero rate of sales the firm finds that the potential frequency of sales is diminished. To use an analogy with the physical world, say we were slowly sending a stream of marbles at a constant rate past a little boy who was trying to grab as many as he could by rapidly and randomly poking his hand into the stream. At any instant in time the boy's chances of getting a marble would depend upon how many he had already pulled out of that part of the flow of the stream accessible to his hand. The more he had already pulled out of that part of the stream the lower would be his remaining chances at that moment.

The larger the firm is relative to the flow of potential purchases the greater will be the relative impact upon itself of a change in its own rate of sales, just as our little boy's chances of getting more marbles would become

less the greater the number he had already pulled out of the stream. We can represent this notion mathematically as:

$$\frac{1}{N_i} \frac{dN_i}{dt} = -c_{ii} N_i \quad (2.9)$$

which we interpret as meaning that the relative reduction in the firm's unconstrained rate of potential revenue inflow is a function of the rate of sales of the firm itself. It is this effect of the firm upon itself (as well as the effect of other firm's sales, discussed below) which causes the gross revenue of the firm to vary with the rate of sales of product. Consequently, considering only the effects of the firm's own actions we can take

$$\frac{1}{N_i} \frac{dN_i}{dt} = a_i - c_{ii} N_i \quad (2.10)$$

to be the relation determining the relative rate of inflow of gross revenue resulting from the firm's sale of a product of given characteristics. That is, the potential rate of revenue inflow,  $a_i$ , associated with a zero rate of sales is reduced as the actual rate of sales,  $N_i$ , is increased.

Sales by other firms will also reduce the rate of inflow of revenue to the firm. Hence, in a similar vein we might write

$$\frac{1}{N_i} \frac{dN_i}{dt} = a_i - c_{ii} N_i - \text{SUM}(j=1 \text{ to } i-1, i+1 \text{ to } n) c_{ij} N_j \quad (2.11)$$

where we note that the relative effect on firm  $i$  depends upon the size of the other firms ( $N_j$ ) as well as the relative rate at which they are removing revenues which might have been removed by the firm itself.

This notion may be elaborated further by illustrating some special cases which are usually distinguished by economists. Take, for example, the special case which arises when the products in question are perfectly homogeneous, i.e., one for one substitutes.

In this case, a sale by firm j will tend to reduce the potential frequency of sales by firm i to exactly the same extent as would have been the case if firm i itself had made the sale. Therefore, we can note that

$$c_{ij}/c_{ii} = 1 \quad (2.12)$$

will hold for the special case of homogeneous products.

For products which are less than perfect substitutes for one another the inhibitory effect on firm i of a sale by firm j will be less than in the homogeneous product case.

That is,

$$0 < c_{ij}/c_{ii} < 1 \quad (2.13)$$

As the products tend towards close substitutes this ratio will tend towards one and as the products tend to be less and less substitutable the ratio will tend towards zero.

In a similar manner we can distinguish the case where the products are complements of one another. By complements we mean here when products tend to be used in a joint consumption process (e.g., gasoline and tires), and/or when the consumer is faced with joint search and information costs. In this case greater output and sales by firm j will have a favorable impact on the rate of sales of firm i. This allows us to write,

$$c_{ij}/c_{ii} < 0 \quad (2.14)$$

as the condition for complementary products.

It should be emphasized that equilibrium conditions are implicit in the definitions we have applied to the effect of the size and rates of flow of sales of the firm and other firms on the firm's own market. We do not visualize the firm as actually experiencing equilibrium conditions. Rather what it will notice is the movement away from one and toward another equilibrium or equilibrium trajectory. This will show up as changes in the rates given by the parameters of the firm's equation and, it is expected, will provoke a response from the firm itself or from other firms. For

example, a retail store would probably notice a decline in its rate of sales if a similar store were to move in across the street. We would expect the firm to respond (with a sale, change of product, or whatever) in an attempt to thwart the new equilibrium tendency represented by the change in its rate of sales. Exactly how it might respond depends upon its circumstances--a question we will not broach until we get to the long period model.

In sum, in the short period we view the firm as faced with a limited market. Its sales and those of its competitors tend to exhaust the market in a way that affects the rate of change in the frequency of each others sales. Changes in the frequency of sales due to equilibrium tendencies of the system are considered to be one of the firm's prime indicators of short period success or failure. Its response (in the form of decisions about price, product type, etc.) to this and similar indicators causes a new short period to be initiated.

#### D. Summary

The short period model of the firm views the operations of the firm in terms of a set of variables affecting the relative flow of net revenues of the firm -

$$(1/N_i) (dN_i/dt).$$

These variables are:

(1) The unconstrained inflow of revenues--unconstrained in the sense of there being no limits to the market. The rate of this flow -  $a_i$  - is viewed as being proportional to sales of the firm.

(2) The rate of outflow of resources associated with expenditures for production. These outflows are viewed as arising (a) from 'internal' expenditures -  $b_{ii}$  - also proportional to sales and (b) from expenditures for intermediate inputs purchased from other firms -  $b_{ij}$ . And

(3) outflows, perhaps more accurately described as

leakages of resources associated with a reduction in the frequency of sales in a limited market brought about by sales by the firm itself -  $c_{ii} N_i$  - and sales by other firms -  $c_{ij} N_j$ .

A simple adding up of these inflows and outflows yields the rate of change in the net resource position of the firm. If the firm were faced with only one other firm in the economy we could write out all the relevant variables affecting its net relative resource flows as:

$$(1/N_1)(dN_1/dt) = a_1 - b_{11} - b_{12} - c_{11}N_1 - c_{12}N_2 \quad (2.15)$$

A similar equation may be written for firm two as well as for any firm in any economy with any number of firms.

When the equations for all the firms are written one below the other the model is easily summarized as a system of simultaneous equations. This might more readily be written in matrix notation as

$$X = A - B - CN \quad (2.16)$$

Since a system of this sort gives the factor and product market relations for firms selling heterogeneous products it may be fair to think of it as a general equilibrium approach to a monopolistically or imperfectly competitive economy.

It should be emphasized that the arguments on the right hand side of the firm's equation are implicit functions of the competitive environment in which the firm finds itself--the terms under which it purchases inputs, the costs of negotiating contracts, the reliability of supply, the existence of consumer substitutes for its product, its own and other firms' advertising, consumer preferences, and so on.

#### E. An Alternative Interpretation: Inventory Flows

In the explanation of the operation of the firm in the short period offered above, the inflows and outflows the firm experienced were interpreted as flows of generalized resources. This view implies the ability to measure all

flows with a common measure, obviously money value, and hence, that the net flow of the resources of the firm,  $dN/dt$ , is in a sense the bottom line of the firm's balance sheet.

However, firms are rarely in the position of being able to accurately measure the value of the flow of resources in the short period. The process of accurately accounting these resource flows is itself so costly that a system that records changes in the value of rates of flows would be prohibitive if done on a continuous basis. An adequate approximation for the purposes of the firm, especially in the short period when prices are fixed, is the actual enumerable flows of resources themselves, i.e.  $x$  units of sales,  $y$  units of output,  $z$  units of input from firm  $j$ , etc. In short, an inventory system which lends itself to very easy and inexpensive (relative to costs and revenues) measurement, is one which provides the firm with adequate (but not perfect) measures of its performance in the short period.

Following this approach we may reinterpret the variables we have used to describe the firm as:

(1)  $dN/dt$ , the net rate of change in product inventory.

(2)  $f(a)$ , the rate of inventory outflow of product unconstrained by limited market size factors.

(3)  $k(c)$ , the marginal change in the rate of inventory outflow attributable to limitations of market size.

Then  $f(a)$  and  $k(c)$  taken together yield a schedule relating the rate of change in the outflow of product to total accumulated outflow  $N$ . And,

(4)  $g(b)$  the rate of creation of product due to production.

It should be noted that a system of this sort is very simple indeed. Two of the primary variables of the system,  $dN/dt$  and  $g(b)$ , are directly measurable by the firm. The remaining variable  $k(c)$  which gives the slope of the sched-

ule relating the frequency of sales as a function of accumulated sales is then derivable by a simple subtraction. The firm may either compare  $k(c)$  for two successive inventory periods and/or it may compare  $k(c)$  and  $g(b)$  in the same period. Either or both calculations provide the firm with a quick and inexpensive reading of market conditions and its efforts relative to those conditions. We can look upon such simple indicators as one of the means by which the firm perceives and learns about its position, and the tendencies of its position, in the broader long period environment.



## CHAPTER 3

### SOME "EXCERCISES" WITH THE SHORT PERIOD MODEL

#### A. Introduction

Under the very constrained conditions outlined above, that is, when firms are restricted to changes in their level of output/sales and are not allowed to consciously mold their evolutionary characteristics to actual or perceived changes in their environment, competitive success or failure is merely a reflection of decisions made prior to the beginning of the short period.

It may be useful to think of the time related aspect of competition somewhat as follows: We think of a 'game' played in successive rounds in which each player, or the management of the firm, is asked to 'fix' the evolutionary characteristics--prices, costs, product characteristics, and so on, everything but level of output--of the firm. Each player is constrained by the results of previous rounds of play in terms of the size and resources of the firm, and accumulated knowledge of consumer demand, relevant technology and input markets--in short, the historical development of the firm. Players are then brought together and firms pitted all against each other. Each round of play is analogous to the short-term competition analyzed here. It takes place over a short period of time during which the 'players' observe the unfolding of the interacting consequences of their previous decisions in terms of changes in the rate of sales of each firm.

At any time any player may call a halt to the process, end the short period and (under constraints discussed later) alter the characteristics of his firm in order also to alter the likely outcome of the game. The process is essentially one in which long period decision making creates continuous short period disequilibrium around continuously changing points of potential equilibrium.

The convenient and probably essential mental crutch of 'holding all other things equal' is not the model's preferred way of looking at the world. Consequently, if one were to hold rigorously to the spirit of the model it would be virtually impossible to simply and easily demonstrate the 'pure' effects of this or that kind of action by any actor within the system. In order to achieve the kind of pedagogical simplicity which is frequently so useful, we depart from our preferred method of treating the short period in this section of the paper. Our departure is very simple and straightforward: We allow the short period to be played out to equilibrium and, for purposes of simplicity, we require that the period be defined in terms of a single decision. Thus each short period is initiated when one firm makes a decision (i.e., changes its relationship to other firms in the economy). This decision causes the parameters of the system to be altered and the system to tend towards a new equilibrium. Neither the firm in question nor other firms are "allowed" to make any other decisions during the movement to equilibrium nor are any other aspects of the environment assumed to change except in passive response to the firm's decision. By carefully and narrowly specifying the nature of the decision and the environment we can compare the old and the new equilibria and isolate the effect of that single decision. This kind of approach allows us to draw some highly conditional conclusions about long period processes in this kind of environment.

In addition, in this section of the paper we also abandon the implicit formulation of the constraints facing the firm in favor of a more explicit formulation which allows the use of simple graphics. We assume here:

- (1) that there are only two firms in the economy, and
- (2) that all the inputs necessary for the firm's operation are purchased internally (i.e. all the off-diagonal elements of the  $b$  matrix are assumed equal to zero). Hence, the equation describing the flows within the firm can be

written as:

$$(1/N_1)(dN_1/dt) = a_1 - b_{11} - c_{11}N_1 - c_{12} \quad (3.1)$$

These simplifying assumptions produce an easy to use linear graphical representation of the resource flows within the firm and reduce the problem of interactions with other firms to the manageable case of only one other firm. Formally we are left with the analysis of duopoly and what might be called duopoly with differentiated products.

The comparative static analysis achieved by modifying the short period model in this way allows one to begin a preliminary analysis of the adaptive phenomenon of long period competition. Some of the results of this analysis are very suggestive; however, they do lack a convincing, consistent theoretical rationale. That is, the decisions analyzed in this way are decisions made without reference to the highly important factors constraining and directing them. The kinds of questions surrounding these matters can only be approached after we have laid out our long period model. (See Boulding [1950] for a similar formal geometric approach. Pielou [1969] is a convenient source for a similar model of biological competition with long term dynamics appropriate to biological, but probably not economic, competition.)

#### B. Short-run Competition in General

In the simple two firm case under these restrictive conditions the model can be represented as:

$$(1/N_1)(dN_1/dt) = a_1 - b_{11} - c_{11}N_1 - c_{12}N_2 \quad (3.2)$$

$$(1/N_2)(dN_2/dt) = a_2 - b_{22} - c_{21}N_1 - c_{22}N_2 \quad (3.3)$$

Consider now the conditions which would result when the relative rate of growth in sales of firm one comes to a halt; that is, when  $a_1 - b_{11} - c_{11}N_1 - c_{12}N_2 = 0$

$$(3.4)$$

It can be readily seen that the size of firm one at a zero

rate of growth of sales depends upon the size of the other firm (i.e. the firm cannot be viewed in isolation). Graphically this may be represented by the locus of points lying on a straight line in the first quadrant (ruling out negative firm size) of a graph with  $N_1$  and  $N_2$  on the vertical and horizontal axes respectively. (See Figure 2.) The slope of the locus is  $c_{12}/c_{11}$  and the intercepts are

$$(a_1 - b_{11}/c_{11}) \text{ for } N_2 = 0 \text{ and}$$

$$(a_1 - b_{11}/c_{12}) \text{ for } N_1 = 0.$$

In other words, the maximum possible size of firm one (when  $N_2 = 0$ ) is seen as strictly a function of its own market and technological characteristics ( $a_1$ ,  $b_{11}$  and  $c_{11}$ ). As the constraints of production,  $b_{11}$ , and limited market size,  $c_{11}$ , become greater relative to its unrestricted growth rate,  $a_1$ , the maximum possible size of the firm declines. Likewise, its minimum possible size ( $N_1 = 0$ ) is the result of the inhibitory effects of the other firm,  $c_{12}$ , and its own costs of production out-weighting its unconstrained growth,  $a_1$ .

If we were to consider the equilibrium tendencies of the firm we would find that for any point lying below the line, i.e.,

$$N_1 < ((a_1 - b_{11}) - c_{12}N_2)/c_{11} \tag{3.5}$$

the combined relative sizes of the two firms is such that firm one will tend to grow taking the size of firm two as given (e.g., point A in Figure 2). The arrow extending from point A and running parallel to the  $N_1$  axis shows the direction of growth of firm one. All points above the line,

$$N_1 > ((a_1 - b_{11}) - c_{12}N_2)/c_{11} \tag{3.6}$$

such as point B in Figure 2, indicate that for a given size of firm two firm one will tend to diminish in size.

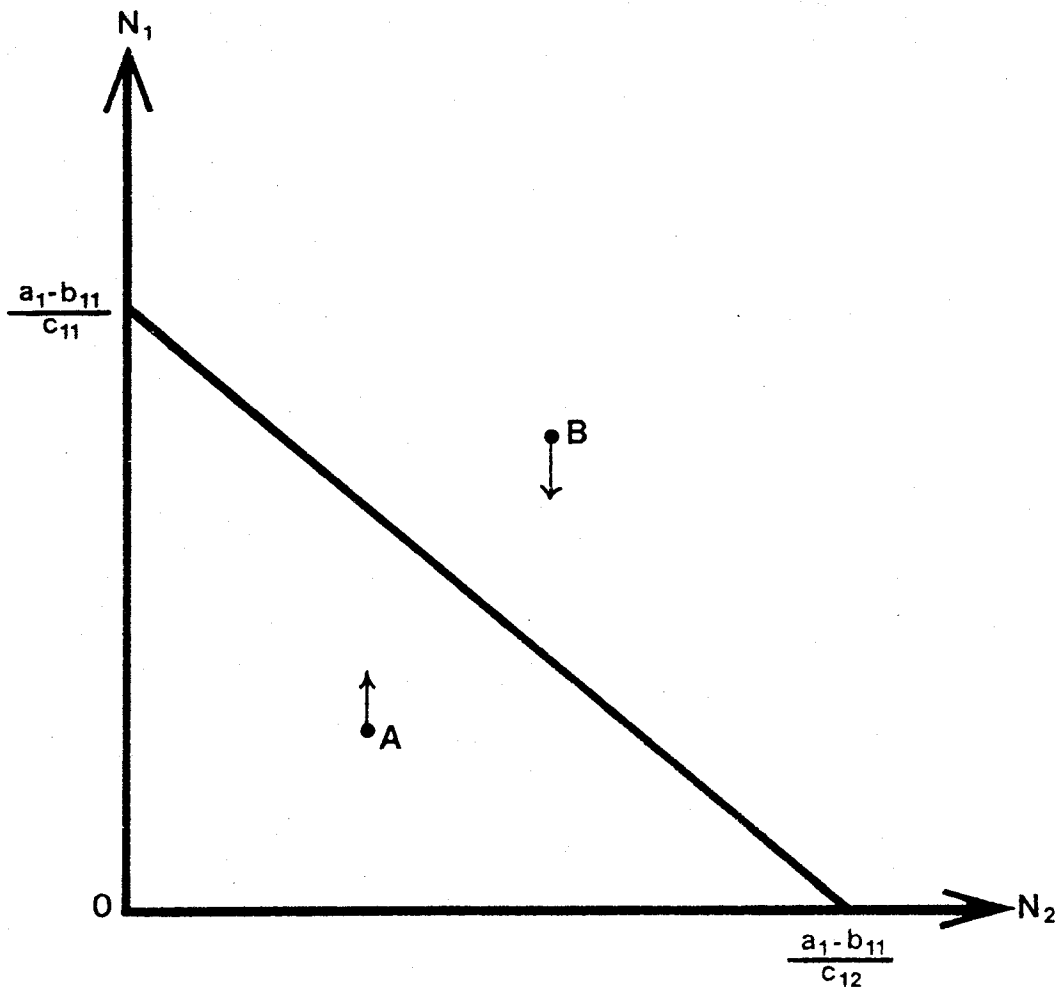
Similarly for firm two its equilibrium size possibilities are given by the locus of points described by

$$a_2 - b_{22} - c_{21}N_1 - c_{22}N_2 = 0 \quad (3.7)$$

where the slope of the line is  $c_{21}/c_{22}$  and its intercepts are  $(a_2 - b_{22})/c_{22}$  and  $(a_2 - b_{22})/c_{21}$  on the  $N_2$  and  $N_1$  axes respectively. For all combinations of firm sizes lying above this line firm two will tend to exhibit negative growth rates and for all combinations lying below the line firm two will tend to show positive growth rates.

FIGURE 2

Short Run Locus of Equilibrium Sizes for Firm One, Seen as a Function of Size of Firm Two



Arrows from non-equilibrium points A and B show direction of change in size of firm one for a given size of firm two.

The simultaneous solution of both these equations reveals no unique properties without knowledge of the values of the various coefficients. However, in general there are four possible solutions as illustrated in Figure 3(a), (b), (c) and (d).

The conditions for stable equilibrium with both firms at a positive size are

$$(a_2 - b_{22})/c_{21} > (a_1 - b_{11})/c_{11} \quad (3.8)$$

and

$$(a_1 - b_{11})/c_{12} > (a_2 - b_{22})/c_{22} \quad (3.9)$$

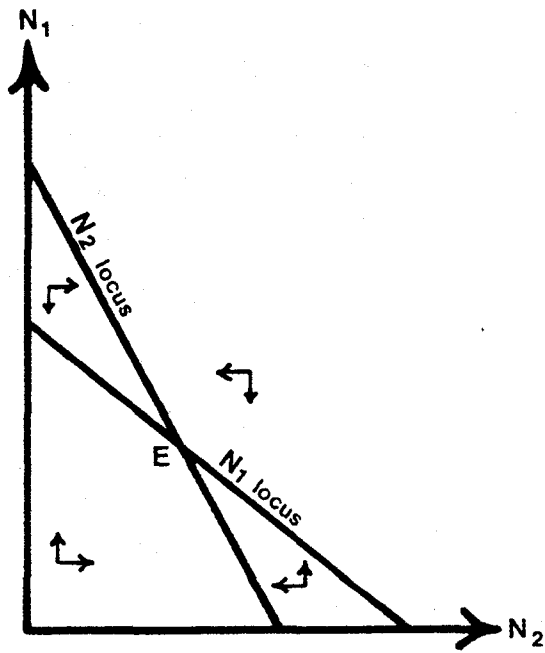
This corresponds with the graphical situation depicted in Figure 3(a) where the slope of the equilibrium locus for  $N_2$  exceeds and intersects that of  $N_1$ . Stable equilibrium occurs at point E. The economic interpretation to be put on these conditions is very straightforward: For a stable equilibrium to exist the constraints on the growth of firm one given a zero size for firm two have to be strong enough to prevent firm one from 'filling' the market. The same has to be true for firm two.

Figures 3(b), 3(c), and 3(d) represent three circumstances of non-stable equilibrium in which complete dominance by one of the two firms is the result. The factors which determine the stability of competition, especially those which can be shown to be of importance in the formation of monopoly or the exercise of market power, are always of interest. Consequently, we now examine the question for two general cases: (1) competition with homogeneous products, and (2) competition with non-homogeneous products.

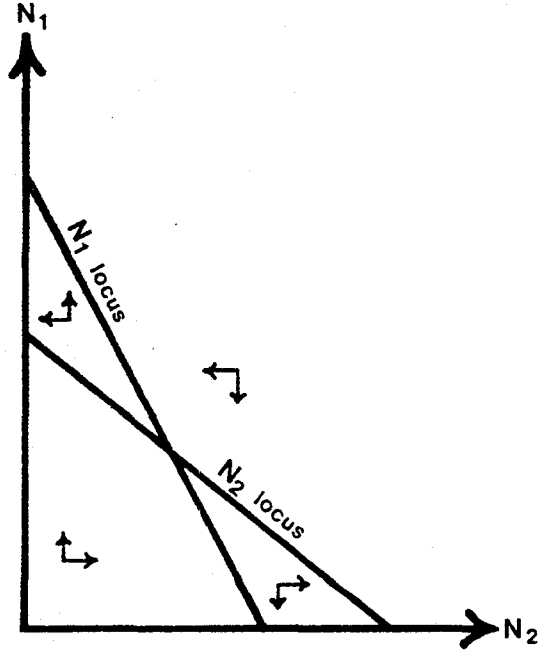
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FIGURE 3

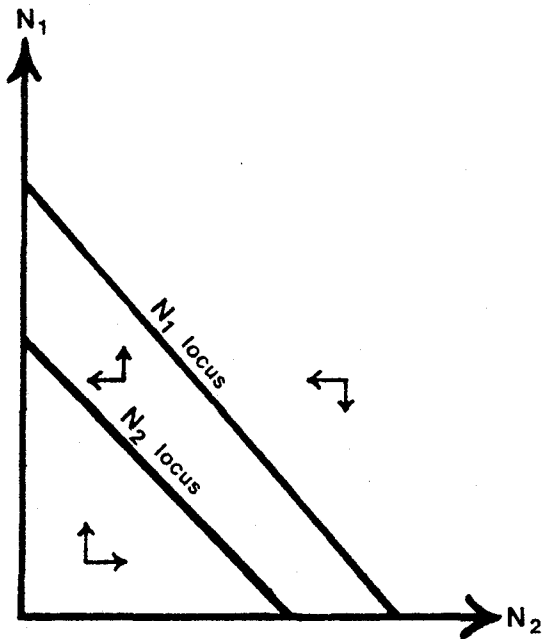
Possible Outcomes of Two Firm Competition



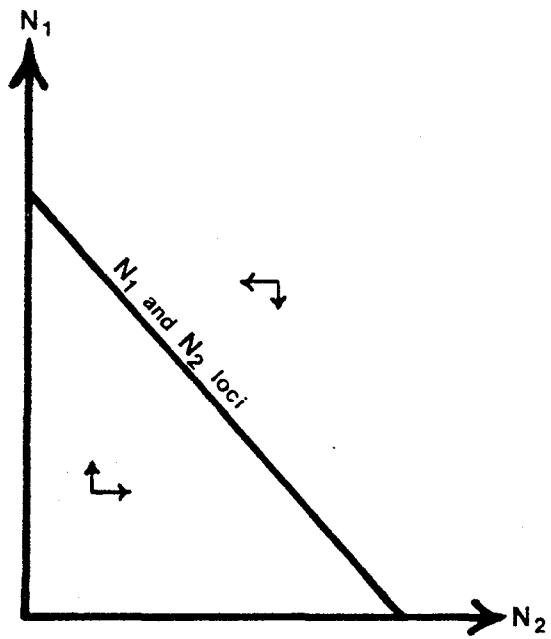
A. Stability with both firms at a positive size



B. Only one firm survives (depending on phase path)



C. Only firm one survives



D. Indeterminant - homogeneous products with constant and identical costs

### C. Competition Through the Sale of a Homogeneous Product

In Chapter 2 we noted that homogeneous product markets give rise to a situation where  $c_{ii} = c_{ij}$  and  $c_{ji} = c_{ij}$ . Referring to the equilibrium conditions stated in equations (3.8 and 3.9) and to the definition of a homogeneous product (equation 2.12) it follows that

$$c_{11} = c_{22} = c_{12} = c_{21} \quad (3.10)$$

therefore, setting (3.10) equal to  $c$ , and substituting into the equations which define a stable equilibrium at a positive size for each firm (equations [3.8] and [3.9]) we derive, for the first firm

$$(a_2 - b_{22})/c > (a_1 - b_{11})/c \quad (3.11)$$

and for the second firm

$$(a_1 - b_{11})/c > (a_2 - b_{22})/c \quad (3.12)$$

Multiplying both equations by  $c$  for the first firm we get

$$a_2 - b_{22} > a_1 - b_{11} \quad (3.13)$$

and, for the second firm

$$a_1 - b_{11} > a_2 - b_{22} \quad (3.14)$$

It is clear that no uniquely defined equilibrium is possible because equations (3.13) and (3.14) cannot be simultaneously fulfilled. One firm or the other, depending on the balance of its revenue and production constraints, will survive. These results conform perfectly with the well known proposition that competition among sellers of homogeneous products under conditions of constant costs will be unstable.

Nevertheless a question arises with regard to the interpretation of the probability of this outcome in the real world. At the crux of the question is the assumption of constant costs. If we were to presume that in the real



world costs might change with respect to the size of the firm or its volume of output, then it would be important to know also the relationship of the size of the market to the size of the firm. It would seem that if size of market is defined so that a market tends to be small then the likelihood of a firm experiencing (long period) decreasing or constant costs at a level of output sufficient to exhaust the market would be rather high. On the other hand, a liberal definition of size of market (one that implicitly arrived at a larger size) might lead one to conclude that the likelihood of competitive exclusion would be small.

It would appear then that one's view of what is meant by 'homogeneous commodity' would strongly color one's view of what economy was like. A strict definition would lead one to see large parts of the economy as consisting of more or less trivial monopolies. Schumpeter has written: "Literally...anyone is a monopolist who sells anything that is not in every respect, wrapping and location and service included, exactly like what other people sell..." (1969). A more relaxed or liberal view of the definition of homogeneous products and markets would lead one to aggregate transactions of many similar but not identical commodities into a single market. The firms in these markets would be characterized, by and large, by an inability to achieve a size sufficient to drive other firms to extinction. This latter view is implicit among most neoclassical economists, and the former is the view of those economists who tend to describe the economy in terms of monopolistic or imperfect competition. Ultimately this question is of importance because of its ramifications for the conduct and performance of the market. That is, competitive exclusion is important because it gives rise to small numbers bargaining situations which affect the efficiency and equity of the market process. This, of course, deserves greater discussion but can only be done in the context of our long period model.

Another question raised by the interpretation of these

stability conditions concerns the relationship of costs and size. In a homogeneous product market characterized by instability, it would appear that the surviving firm not only needs to achieve lower costs than the other firm; it also needs to do this at a scale sufficient to exhaust the market. The other side of this same coin, of course, is that a firm could continue to survive in competition against another firm if it were able to achieve relatively lower costs but at a scale insufficient to exhaust the market. Over time, however, such a firm would be faced with the continuous threat that the other firm might be able to achieve relatively lower costs at a scale sufficient to exhaust the market. Consequently, it would seem reasonable to conclude that there is a continuous requirement placed upon the firm which wishes to survive, and this requirement is to achieve relative efficiency at as large a size as is consistent with the market. In short, under these circumstances the firm's preference for growth, which we have only assumed to this point, may be grounded ultimately in its need to survive. It suggests that in non-homogeneous but highly substitutable product markets the long period competitive process may also drive the firm to adopt a growth for survival strategy.

Still another problem raised here is the competitive meaningfulness of homogeneous products and constant costs in a world where firms are free to alter their product characteristics. On the one hand, it would be reasonable to expect that any trend towards competitive exclusion, based entirely on the homogeneity of products, would give rise to a counter tendency towards product differentiation. But the very possibility of differentiation also carries with it the equally possible convergence of product characteristics. Consequently, the possibility of product convergence induced by a new technology, marketing method, or what have you, would always seem to place the firm, even one with a highly differentiated product, in a potential situation of compet-

itive exclusion. Consequently, it would appear that the firm--even one in a differentiated product market--interested in its own survival should always prefer efficiency at as large a size as is consistent with the size of the market to the same level of efficiency at a smaller size. But efficiency in this context is not simply cost minimizing efficiency. It is also, and more importantly, adaptive efficiency which places the firm in a position where it can avoid, or administer, the coup de grace of competitive exclusion.

#### D. Non-Homogeneous Product Competition

The success or failure of firms competing with one another through the sale of non-homogeneous products depends upon more than relative efficiency in production. The point of this section of the paper is to use the graphics of section Chapter 3 B and a comparative static analysis to illustrate how the firm's relationship to its product market and that of other firm's products could affect its success or failure. The analysis is limited to the two firm case merely to keep things simple. We reserve to a later point in the paper the behavioral analysis of how firms undertake to change their relationship to the broader market. For the moment we merely assume a change in order to illustrate the importance of the firm's relationship to the marketplace.

A particular initial situation is depicted in Figure 4. We have two firms selling two different, but substitutable, goods to consumers. Each good gives rise to different firm characteristics (i.e., the parameters  $a_i$ ,  $b_{ij}$ , and  $c_{ij}$ ). The two firms will experience differences in their inflow of resources (revenue),  $a_i$ , costs of production,  $b_{ij}$ , and reductions in revenue flows due to limited product market size,  $c_{ij}$ , and the inhibitory effect of their competition,  $c_{ij}$ , all simply because they are producing different products. Implicit in the situation depicted in the diagram is the assumption that the initial values of the firms' parameters

FIGURE 4

Firm 1 and 2 in Equilibrium

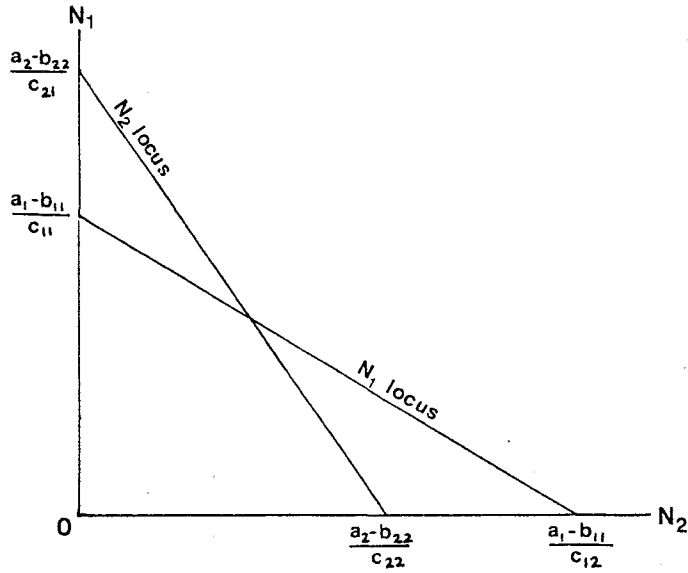
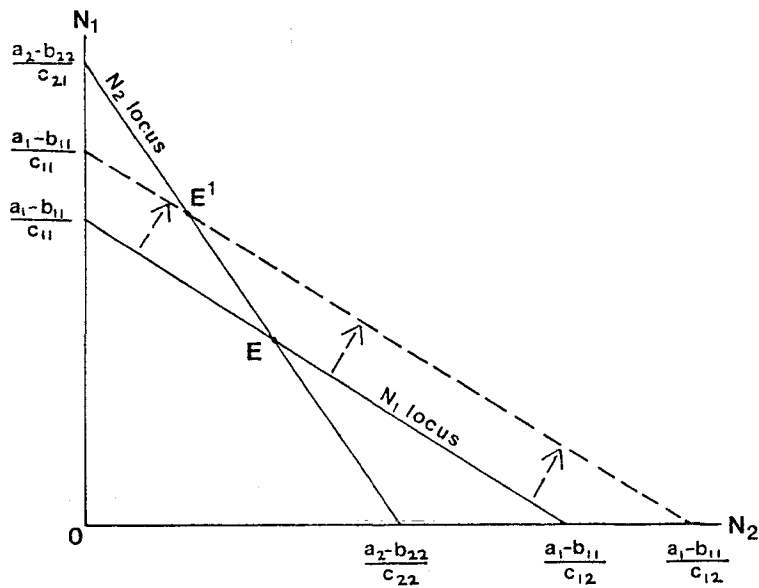


FIGURE 5

The Effect of a Reduction in the Costs of Production ( $b_{11}$ ) for Firm 1



were such that the firms reached a stable equilibrium with both at a positive size.

The comparative static graphical technique which we will use to analyze the effect of decisions on this initial equilibrium is very straightforward: The values of the parameters of the firm's equation are determined to a large degree by decisions made by the firm and its competitors. As decisions are made the equilibrium locus of the firm changes. Depending on the kind of decision made this shows up as an easily illustrated shift or rotation of the firm's equilibrium locus. (If the change occurs in the 'interaction' coefficients in the simplified model used here these are  $c_{12}$  and  $c_{21}$  the locus of both firms shifts or rotates).

#### D.1 Increased Cost Efficiency

We now want to see what would happen if one of the firm's parameters was arbitrarily changed. In the first instance, to go over some ground already covered, consider a case in which firm one's costs of production were lowered through, say, a technological improvement in its production process, that is, in effect, a reduction in the rate of expenditures for inputs,  $b_{11}$ . Referring to the intercept values for firm one's equation we note that graphically this change will cause both intercepts of firm one's equilibrium locus to move outward--the result is a parallel shift of the locus as depicted in Figure 5. This shift produces a new equilibrium at E' which corresponds with (1) an increase in the size of firm one, (2) a decline in firm two's size, but (3) the decline in the size of firm two is more than offset by the increase in size of firm one.

#### D.2 Product Alterations

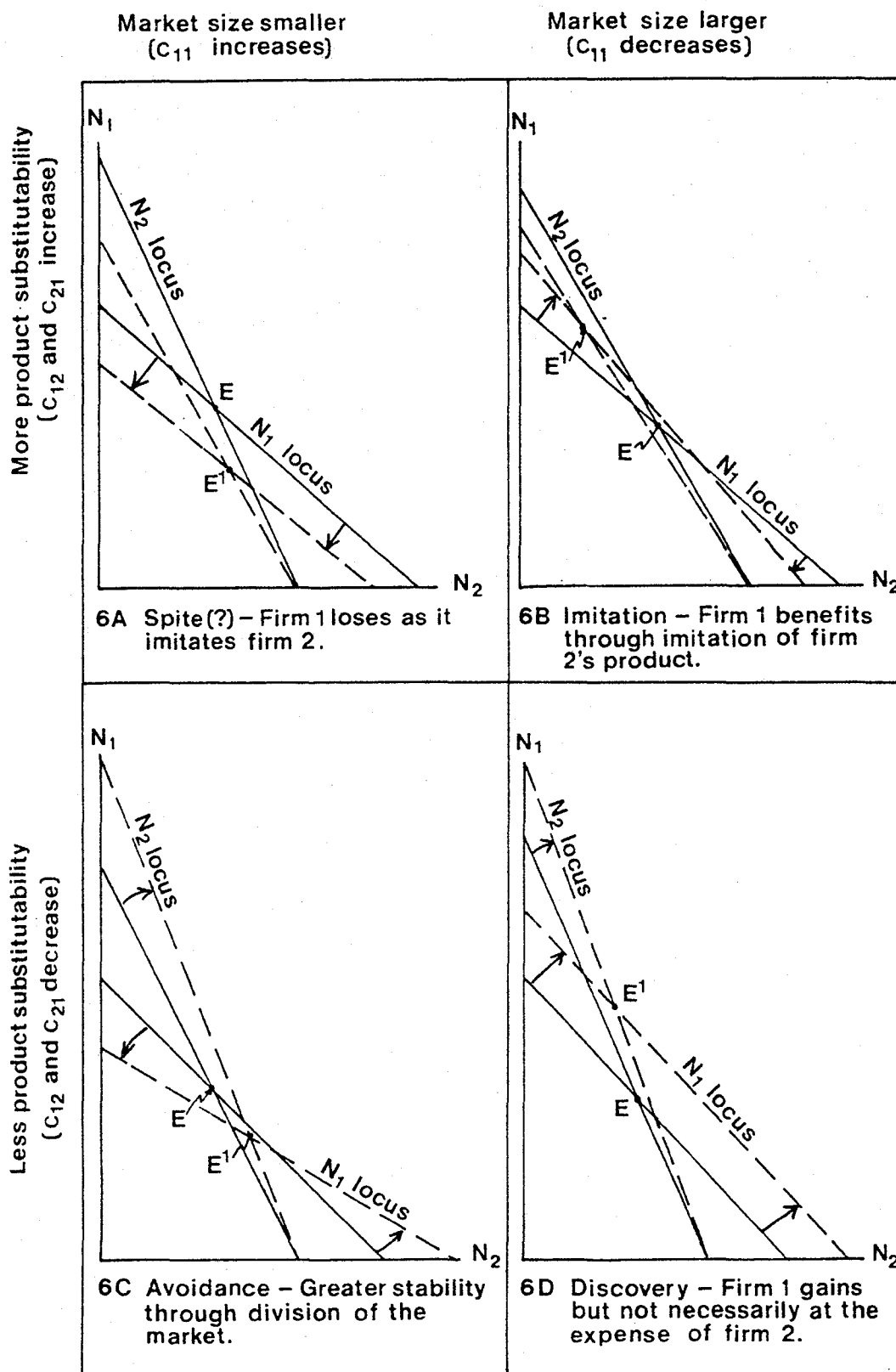
Consider now a case in which firm one decided to alter the characteristics of its product. For simplicity we will assume this can be done without simultaneously altering cost ( $b_{11}$ ) or unconstrained revenue flows ( $a_1$ ). The effect of product differentiation will be observed in changes in the

market parameters of both firms. (1) By changing its product firm one finds the size of its product market is altered and therefore  $c_{11}$  changes. (2) The rate of substitution of its product for firm two's will change and this will be reflected in the value of  $c_{12}$  and  $c_{21}$ . We will assume all relevant market effects on firm two are captured by the substitution effects reflected in the value of  $c_{21}$ . Then, if we are interested only in the direction of change, we have two possible changes (positive or negative) for two variables,  $c_{11}$  and  $c_{12}$ . Firm one moves into either a larger or smaller product market and the substitutability of its product for firm two's either increases or decreases. In addition to changes in firm one's parameters caused by a change in firm one's product, the market interaction between firm one and two changes. This shows up in terms of the substitutability of the two products which affects the value of  $c_{21}$  in firm two's equation. Here we have assumed that substitutability is 'symmetrical'; that is, an increase in the substitutability of firm one's product for firm two's also represents an increased substitutability of firm two's product for firm one's. Thus the interaction terms,  $c_{21}$  and  $c_{12}$ , will always move in the same direction will have the same value and can be treated as one.

In Figure 6 the two possible directions of change in firm one's market size,  $c_{11}$ , are shown across the top, and the two possible directions of change in product substitutability are shown on the left. Figures 6 (a), (b), (c) and (d) show the four possible results of product differentiation.

FIGURE 6

The Effect of Changes in the Characteristics of Firm One's Product



Examination of the graphs leads to the following observations: Firm one is benefited most by product differentiation which tends to move it into a larger market with less product substitutability--i.e., some form of market discovery (6d). However it also seems to receive clear benefits by moving into a larger market with a product more like that of the firm already there--i.e., some form of imitation (6b). In both cases in which the firm moves to relatively smaller markets the results are detrimental, with the exception that in (6c) firm one seems to have achieved a more stable market position by moving to a less substitutable product in a smaller market. This last case is something of a paradox since it suggests that the goals of survival and an increased rate of growth are not always compatible. But as our early discussion has indicated, the possibility of another firm's products converging on that of the firm in question would seem to indicate that this kind of withdrawal from the pressures for competitive growth offers no long term guarantee of survival.



## CHAPTER 4

### THE LONG PERIOD

#### A. Introduction

The representation of the firm in the short period in the previous sections left unstated the reasons why and the conditions under which firms make decisions. No mention whatsoever was made with regard to the conditions circumscribing the scope of alternatives open to the firm. In effect we have yet to lay out a theory of how firms compete--decide what to produce--in the long period. In this section of the paper we discuss the external environment in which firms find themselves. The purpose of this discussion is to define how that environment constrains the decision making behavior and the opportunities of the firm. In terms of the short period model, what is being done here in defining the rules by which the firm can alter those coefficients of its equation which describe its interaction with other firms. In other words, decision making here is viewed as the means by which the firm alters its relationship with its external environment and ultimately competes.

Decision making is retained as the essence of the competitive process (as in neoclassical economics) but is described here in terms of decisions the firm makes with regard to its interaction with other firms in its environment, primarily via its choice of product, rather than in terms of a "given" market (i.e., some aggregate of all other firms selling homogeneous products). The secondary questions the firm is seen as facing are not merely the classical questions about price and quantity, but questions about the terms with which it interacts with its environment. The terms of its interaction are taken to include price and quantity, to

whom and how it chooses to sell, and from whom and how it chooses to buy.

Bound up in these competitive questions faced by the firm are essentially two major theoretical problems: The first requires a simple way of describing a complex environment. From the theoretical point of view this question demands a means for conceptualizing a world in which the characteristics of products are almost infinitely variable. Relative to neoclassical economics it means the abandonment of a theoretical construct which visualizes the product environment in terms of groups of products which, for analytical purposes, can be lumped together into categories whose components can be assumed to be homogeneous. Instead the view propounded here emphasizes the heterogeneity and possibility of continuous change of products. In a sense, this view proceeds from the observation that products are almost always differentiated if it is at all possible, that there must be strong economic reasons for this and that economic theory ought to have a means for describing how the decision to choose a product type is directed and constrained. The theoretical device chosen to conceptualize this kind of material environment is a highly modified version of characteristics or attributes theory of product demand--a theory most thoroughly articulated by K. Lancaster (1971, 1979).

The second major problem has to do with the constraints on the firm's ability to perceive its environment. Put differently, in a complex environment information is scarce and costly. Therefore, the determinants of the relative cost of particular information for each individual firm will strongly affect the nature and effectiveness of the firm's ability to compete. It is this information constraint which is our second major theoretical problem. To approach this problem we develop first a 'taxonomy of knowledge' based on characteristics theory in order to have a vehicle for describing the particularistic nature of knowledge, and sec-

ond, a theory of institutions as information channels or surrogates in order to provide a basis for describing the extent and content of information networks (i.e., the dispersion of collective knowledge).

The major reasons for altering and elaborating the characteristics or attributes theory of demand may be briefly summarized: Our use of this theory is in a form which is very different from that espoused by Lancaster. It is fair to state that Lancaster (1971) went to great pains to show that this form of demand theory was thoroughly consistent with neoclassical theory. This required, among other things, assuming perfect knowledge and a world of a limited number of characteristics in order to make the theory compatible with the long run deterministic world view of the neoclassical doctrine. In effect, in his early work Lancaster purged the theory of its ability to deal with complexity and heterogeneity--the very attributes that make it interesting and important. His later work (1979) takes advantage of these attributes, but because of the methodological approach of carefully specifying the environment, it tends to retain its deterministic character.

Our interest here is not to build a view of the world which is deterministic; rather we wish to emphasize the evolutionary character of the long run economic processes. In short we are interested in the process of learning and adaptation in a complex, changing and heterogeneous environment. Consequently, we depart from Lancaster by assuming information to be costly and the economic environment to be heterogeneous, complex, changing, and, especially, unspecified with regard to particulars.

Characteristics theory is important because it provides a convenient way to reference this kind of world. That is, using characteristics theory one can provide a reasonable concept for dealing with 'closely related' products, a non-existent product, or a million non-existent products. In

this sense it is highly amenable to the treatment of a product environment which is heterogeneous and complex. Because it can describe, or at least conceptualize non-existent products it provides a way to describe change in the product environment. It is not limited as is conventional demand theory to a finite number of unchanging products. Since an outstanding characteristic of modern capitalism is the continuous proliferation and change of products this is an important attribute of characteristics theory. It allows one to conceptualize a heterogeneous demand environment and thereby avoid obfuscating aggregations. For example, the fashion industry, to take an extreme case, is an instance where conventional demand theory provides almost no guide to understanding the competitive structure and performance of the industry. In fact, since it probably would wind up attributing all change to 'shifts in consumer preferences' it probably would do more to mislead than to inform one about the relevant behavior in that industry. To a lesser extent the same is true even in the fishing industry which comes perilously close to the textbook example of a perfectly competitive homogeneous product market at first glance. Characteristics theory, as we hope to point out, can lead to useful conceptualizations of individual and market behavior in these instances.

We also use characteristics theory as a basis for delineating what we call a 'theory of economic knowledge.' In the kind of world which we wish to describe, differentiated knowledge becomes either a very strong constraint on the set of feasible opportunities open to the firm or, viewed from another perspective, a source of competitive advantage. Economic theory, lately, has been concerned with the acquisition of knowledge but mostly as a variant of the generalized investment problem. Only recently has attention been addressed to the broader question of how information and knowledge affect the processes of competition. As a

result there is a very weak theoretical basis for offering some intuitively obvious conclusions about economic phenomena. For example, to take an extreme case, we have no theoretical basis for answering the question: Why don't fishermen consider the production of jet aircraft in their set of feasible alternatives? The answer is intuitively obvious--they don't know how to produce jet aircraft and to learn would take too much time and be too costly--but is not available to us through theory. Although this example may seem trivial in a sense, perhaps because of its extreme conditions, it cannot be denied that the particular forms of knowledge available to the firm strongly circumscribe the set of feasible alternatives before it. The resident knowledge of a firm not only describes what is feasible at the moment, but also the set of knowledge which can be economically acquired. In short, what the firm has learned and is capable of learning are important economic questions. They determine the firm's relationship to its environment and its ability to alter that relationship, in effect, to compete.

In the sections which follow we use characteristics theory as a basis for describing the constraints of knowledge faced by the firm. The approach is rather simple. We assume that for each product the firm currently produces and has produced in the recent past there is a correlated body of financial, market, organizational and technological knowledge necessary for the production and sale of that commodity. To the extent that the firm's product history differs from that of other firms its resident knowledge and, hence, the costs and returns to the acquisition of particular forms of knowledge, will also differ. In other words, the multi-dimensional characteristics space which we use to describe products can also be used to describe the particular forms of knowledge which are correlated with the financing, production and sale of those products. When combined with a "learning approach" this taxonomy of know-

ledge provides the analytical basis for describing the set of feasible alternatives before the firm and how that set differs from the feasible set of other firms. It also provides the basis for a dynamic analysis of the process of competition very different from that of standard theory.

When the notion of the "competitive decision" is altered--away from the "price/quantity" question and towards the "what to produce" question--the non-technological, competitive interactions between firms become much more significant explanators of individual and collective economic behavior than the market interactions--usually labeled pecuniary externalities--of standard theory. When the firm is able to alter the characteristics of what it can produce, the somewhat artificial passivity implied by the whole notion of pecuniary externalities is replaced by (the possibility of) active adaptive behavior in which--using neoclassical language--pecuniary externalities provoke changes in the production function, namely, alterations in product characteristics. In other words, the logical distinction between pecuniary and technological externalities upon which so much of the normative content of neoclassical theory is based breaks down when adaptive, product altering behavior occurs as part of the competitive process. This tends to raise some difficult welfare questions about which we attempt only a very tentative articulation.

Common's (1923) legalistic theory of transactions and (exchange related) institutions is used here because of its appropriateness to a non-deterministic, very imperfect world. Its specific purpose in this theory is to provide a basis for describing the interaction of the firm with its environment under conditions of uncertainty. Characteristics theory provides a convenient basis for describing a complex world which is appropriate to the consideration of uncertainty, but in a sense it provides a view almost without a sense of time. But uncertainty cannot be divorced from the

passage of time. Common's theory on the other hand, not only provides a clear sense of time but also the basis for an institutional interpretation of collective and individual behavior under conditions of uncertainty, especially as it is affected by the flow of collectively generated information.

The purpose of using Common's theory for the long period model is to elaborate further the conditions and constraints which are likely to govern the firm's ability to alter the nature of its interactions with its environment-- i.e., the parameters of its short period equation. The basic behavioral proposition for which Common's theory of transactions and institutions is used may be summarized as follows: when transactions are characterized by poor and/or asymmetrical distributions of information about the current or future environment, institutions arise whose purpose (which is not by any means always fulfilled) is to mitigate the inefficiencies and inequities which could potentially arise under these circumstances. Mitigation takes place through the regularization of behavior upon which relatively firm expectations can be founded. In effect, institutions tend to replace relatively uncertain expectations about the material environment with more certain expectations about human behavior.

Unlike more modern treatments of decision making under uncertainty, the approach suggested by Common's work does not lead one to the "risk equivalent" solution. Rather, there is the notion that uncertainty gives rise to negotiations, deals and, after repeated collective encounters with similar situations of uncertainty, the evolution of a set of working rules or institutions--from the very informal such as reputation to the fully legal such as commercial codes-- whose purpose is to mediate generically similar transactional problems.

Institutions as such are seen as growing out of and

being thoroughly dependent upon the existence of information networks. They are different from information networks to the extent that they provide an interpretation of the world, on the one hand, and a set of rules or expectations of behavior on the other. Both of these functional aspects of institutions can only arise within an information network as a result of repeated interactions under similar circumstances. Broadly speaking, we divide institutions into three categories according to the circumstances governing the interaction: (1) heirarchical institutions governing exchange in a non-market environment, (2) market exchange related institutions, and (3) institutions governing competitive interactions.

#### B. Long Period Assumptions

Our intent in the long period model is to create a theory of economic behavior which can explain economic processes and institutions in a complex, changing environment. The kind of environment which we have in mind can be characterized somewhat as follows:

(1) Heterogeneity: we view the world as one in which products, preferences, markets and so on are variable at any point in time and subject to continuous variation over time. This does not mean that we think of, for example, product space as being completely filled with a set of totally unique products. What it does mean is that we view the product environment as one which is highly variable even though patterns or distributions of products may be readily evident. Put differently, we assume heterogeneity because we feel that this variability in the environment is the basis for a large part of the economic behavior which we term competition, i.e. competition through choice or definition of product rather than through efficiency in the production of a given, non-variable product. Consequently, we do not want to hide this variability by assuming, for ex-



ample, roughly similar products to be members of some aggregate category which is analytically treated as if all its constituent elements were identical.

(2) Complexity: Almost as a corollary to the existence of heterogeneity is complexity. Complexity in a social system is very important because it imposes immense information requirements upon the actors within the system. Since a state of perfect knowledge is never possible and even relatively thorough knowledge of a limited part of the system is very costly, one must view the behavior of individuals and firms in the light of the accommodations they make to contend with their, and other persons, imperfect knowledge. Put differently, 'bounded rationality' is implied by complexity.

(3) Information and knowledge: In this kind of environment information and knowledge are very important resources; likewise learning behavior and the social structures or institutions which facilitate the flow of information become very important factors in the conservation of resources devoted to the acquisition of information and knowledge. Consequently, we will tend to treat information gathering and learning activity as the driving competitive forces in the system according them a role somewhat parallel to that of capital accumulation in the usual economic model.

(4) Time and change: It is hard to think of a static complex world. Without change, complexity disappears as learning accumulates. With change, complexity is maintained and the more rapid the change the more complex is the environment. Consequently, if one is to pretend to investigate behavior in a complex world the rate of change, the timeliness of how things vary in that world is especially important to learning and competitive strategies and costs. Therefore time is treated in terms of its continuous, irreversible passage.

(5) Resource mobility: Part of the complexity we see in the world is associated with the fixity of purpose or non-fungibility of resources, both human and physical. In the case of human resources mobility is seen primarily as a time consuming alteration of the embodied knowledge of the person or firm. In other words, shifting functions in society is seen as a learning problem which is likely to be strongly constrained by the costs and time necessary to acquire new knowledge (new for the person or firm involved). In the case of physical resources, the fixity of their function is seen as more permanent and much more strongly constrained by costs and time in terms of alterations of that function. These attributes of resources, of course, become in and of themselves sources of complexity in the system because they strongly affect the rate at which adaptive behavior and strategies can proceed.

Our assumptions about human behavior in this kind of environment are much less easily summarized. We share the general view of economics that there is a very strong, probably dominating, element of self-interest in economic behavior. On the other hand, in a complex environment in which interactions among individuals are continuous, individual and collective interest often shade into one another. Uncertainty, especially that arising from interactions among individuals, cannot easily be reduced or eliminated without recourse to collective rule making and enforcement. In effect, in this kind of uncertain world we view unbridled self-interest as probably unlikely simply because it is not likely to be serviceable. This point of view or assumption about human behavior does raise, however, the difficult question of how self-interest is constrained. To answer this question we have to go the long way around by first offering up a theory of transactions and institutions in a complex, information poor environment. As mentioned this theory depends heavily upon characteristics theory and upon

our reading of Common's theory of institutions.

### C. Transactions and Characteristics Theory

The crux of Lancaster's version of characteristics theory may be easily stated in terms of its application to consumer demand. Consumers are considered to demand, not goods and services per se, but the characteristics which are embodied in goods and services. For example, the demand for gourmet French dinners may be thought of as arising from consumers' prior demand for nourishment, taste, food texture, status, entertainment and variety of other characteristics which may be embodied in a gourmet French dinner. The demand for housing may be thought of as arising from a prior demand for shelter, convenience, warmth, safety and particular kind of architecture, quiet and many other characteristics which might be associated with housing.

In a world viewed in this manner the consumer (including here the firm as a consumer of intermediate goods) is faced, first, with the need to allocate his budget among those characteristics he demands (much as the consumer in standard theory must allocate his budget among the goods and services he demands), second, with the problem of identifying the characteristics embodied in the array of goods available to him in the market place, and, finally, with the problem of translating his characteristics derived preferences into a set of goods and services which embody the desired characteristics in the desired proportions.

It is assumed that there is a flow of information to the consumer which informs him of the kinds, quality and extent of characteristics as they are embodied in the goods and services available in the market. Lancaster (1971) assumes that this flow is universal in the sense that it is available to all consumers and contains all of the information they require. In his later work, Lancaster (1979) tends to specify carefully the nature of characteristics

preferences (e.g., evenly distributed in characteristics space), the state of consumer information (e.g., half the population fully informed, half fully ignorant) and throughout treats references as exogenous. We depart from Lancaster's methodological approach by assuming there is no a priori basis for specifying the particulars of a complex environment (e.g., the distribution of preferences, etc.). We also depart from Lancaster's version of characteristics theory with regard to the information burden such an environment places upon economic actors--both consumers and sellers. To be specific, we assume both are imperfectly informed about a very complex product and product value environment and about changes in that environment over time. We also assume preferences are subject to an information problem in that they are constrained by what the consumer perceives as feasible in the product environment. But this perception can only be defined in terms of information about that environment. In other words, we take preferences to be endogenous. There are several reasons why these assumptions are made.

First, in a world in which there are many characteristics which may be and, in fact, are embodied in products, and each and every product in the economy is so characterized, the situation arises in which the consumer may not be able to attribute an unambiguous price to each characteristic. Consequently, the consumer's initial problem of allocating his budget among characteristics is not subject to a unique solution because of his inability to assign precise prices to the various characteristics available in goods and services. Additionally, since all consumers are faced with the same problem, that is, the inability to uniquely divorce characteristics from products, competitive bidding is not likely to establish a uniform price for any given characteristic. Needless to say, an impaired bidding process also denies sellers access to unambiguous knowledge of the prices

or the relative value of characteristics.

Second, it typically will be the case that the flow of information to the consumer about the characteristics embodied in products will be a biased and/or incomplete flow. Advertising, the opinions and experiences of other consumers and the consumer's own reading of what characteristics are embodied in products are not likely to provide complete and objective knowledge of the product environment. Consequently, the consumer's decision making process is complicated by making the identification of the quality or quantity of characteristics in products highly uncertain. The seller is faced with a similar problem when he attempts to assess the comparability of his and other products. Additionally, the seller's world is complicated because ultimately the comparability he is interested in is not some sort of objective comparability but the subjective comparability which arises in consumers' minds. Given the information problem faced by consumers and the uniqueness of each of their circumstances, this subjective comparability would be very hard to determine objectively.

Third, products and characteristics are not ageless. They change over time; they deteriorate; and their relative position in the product environment changes as new products are introduced to that environment. In effect, the 'physical' and value characteristics of products are a function of time and thereby require that the assessment of characteristics at the time of the transaction include an often very difficult prediction of the change in the product's relative characteristics over time.

Finally, the very process of entering into an exchange or merely shopping may generate information which alters the product preference structure of the consumer or seller. In other words, search and analysis take time, generate new information and expose both buyer and seller to aspects of the environment they may not have known previously. In and

of itself this process may be sufficient to reshape preferences, which in extreme circumstances might lead to continuous indecision or uncertainty simply because preferences are being altered continuously. In less extreme circumstances this implies simply that preferences are influenced by the product environment and the processes shaping that environment.

The extent to which these problems of a complex economic environment affect the conduct of the transaction depends by and large upon the circumstances of the individuals and the products involved in the exchange. It is most probably the case that relatively standardized products exchanged by individuals on a repetitive basis will give rise to a not overly complex information problem. In other words, in spite of the overall complexity of the environment, circumstances can arise in which exchanges can be conducted under conditions which do not demand a large investment in the acquisition of knowledge for each exchange. On the other hand the confluence of individual circumstances and product characteristics may be such that the information required of parties to each exchange can be rather extensive and expensive to acquire--for example, unique products, works of art, research projects, or whatever. Consequently, in the kind of complex environment with which we are dealing, the nature of the transaction, that is the way in which it is conducted and its outcome, is most probably best analyzed in terms of an information problem whose parameters are defined by the circumstances of the individual parties and potential parties to the exchange, the characteristics of the product involved in the exchange, and the particulars of the market context of the exchange.

#### D. The Transaction as an Information Problem

When the transaction is viewed as an information problem, several variables stand out as important. On one

level of analysis, there is a set of variables determined primarily by the environment external to both parties to the transaction. These variables relate to the alternatives available to each party in the form of other potential transactions of the same or similar goods and services and the alternative historical values placed upon those goods and services by other (third) parties in the market. These variables appear to determine mostly the limiting range of valuations placed upon the exchange during the transactional proceedings, that is, reservation prices. By and large we take these variables to be, first, the frequency with which other exchanges of the same or similar goods and services have taken place recently and, second, the comparability of circumstances including the characteristics of the products in those other exchanges and in the current or proposed exchange.

On the second level of analysis are those variables which affect the relative costs of acquiring information for each party to the transaction. Factors such as the following are likely to be most pertinent here:

(1) The absolute value of the potential gains from trading, defined as the difference between the reservation prices of the buyer and seller, and

(2) the relative costs and benefits to buyer and seller with regard to:

- (a) the terms of exchange applicable to the proposed transaction and to
- (b) other previous transactions of this and comparable products;
- (c) likely changes in the market conditions (e.g., inventories, technological changes) surrounding this and comparable transactions,
- (d) the value other potential sellers and/or buyers have recently attached to exchanges of this and comparable products, and

(e) the particular circumstances of the other trader.

As these factors vary according to the circumstances of each individual transaction, one would expect the particular outcome (i.e., division of the gains from trading) of each transaction to vary. Additionally, one would expect that the repetitive occurrence of generically similar asymmetries in the cost of information between buyer and seller would give rise to institutions which might ameliorate the inefficiencies and inequities that would otherwise result. Less optimistically, one might venture that societies incapable of generating such ameliorating institutions are likely to conform to the archtypical Marxian view of exploitive market processes.

The first of these two sets of information variables (frequency of exchange and comparability) relates essentially to information sources which are collectively generated by all participants in the market. The second set (those determining relative costs and benefits) tends to be more a function of the particular circumstances of the individual traders. In the section which follows we explore the effect of the market determined/or exogenous information costs and benefits on the nature of the transaction with an eye towards those factors which may affect the performance of the market.

#### D.1 Exchange Generated Information

If we consider frequency of exchange alone, we find it to be of interest primarily because the information state surrounding each transaction is very much a function of such frequency. Two reasons can be advanced for believing this to be the case:

(1) Repetitive exchanges lead to learning about the exact characteristics embodied in the good or service and thereby reduce the costs of acquiring information appropri-



ate to each particular transaction.

(2) A large number of recent exchanges by other parties of the same or comparable products generate a greater degree of certainty about the characteristics embodied in and the valuation placed upon or accorded the product by potential parties to similar exchanges--i.e. the costs to each party of learning its reservation price and establishing comparability is lowered the greater the frequency of comparable exchanges.

For example, consider an extreme situation in which exchanges by other parties are strictly comparable because of homogeneous products and homogeneous circumstances of the parties themselves (income, preferences, etc.), there are many buyers and sellers, and the frequency of sales is very high. Under these circumstances the cost to both parties of obtaining information about the characteristics involved in the product and the valuations placed upon those characteristics by others will be minimal. That is, the costs of searching out parties to comparable exchanges will be low as will be the costs of verified (unambiguous) information about prices in those exchanges. There is likely to be a close agreement among the parties about the exact nature of the embodied characteristics and the reservation prices of each are likely to be identical or close to converging (because of an actual or potential many party bidding process). It is likely, in fact, that the only divergence in reservation prices that will arise will be attributable to the need to hold (inventory) offers and bids given that the frequency of exchanges does not produce instantaneous transactions (Demsetz 1968). Since all potential parties will be in this same situation one will find that these conditions will give rise to a 'market price'; that is, one in which all the relevant information about the exchange is provided by other comparable exchanges. No reliance on non-exchange related information (e.g., costs of production, etc.) is pertinent

to the terms of the exchange (although it may determine whether one or the other party is willing to undertake the exchange). Likewise under these circumstances no preference for trading with one or another party will arise on anyone's part.

As these conditions are relaxed so that the frequency of strictly comparable exchanges declines, the cost of information to the individual about the characteristics embedded in the product will rise as will the cost of learning reservation prices. In effect, as the density of information in the environment declines, the searching out of information about the results of other parties' recent exchanges is likely to be less productive. As the frequency of exchanges of comparable products falls two things happen: first, there is a corresponding rise in the uncertainty which becomes attached to information about valuations, in particular reservation prices and product characteristics; and second, there is also a corresponding rise in the amount of substitute information which must be acquired by the individual in order to maintain the same level of certainty.

In other words, because the individual enters the negotiation with implicit predictions of other individuals' behavior bound up in his expectation of his and the other party's reservation price, we essentially take the view that the market is a kind of statistical machine which polls current and past participants on the valuations they place on the product, nothing else held equal. It is extrapolations from the results of these polls that lead to the expectations of other participants' behavior which become embedded in the statement of reservation price. Since information ages in a world in which many other things are likely to be changing, it is the frequency with which the market machine generates information about individual valuations which is of greatest importance in the statistical extrapolation. In short, the market itself is a source or generator of inform-

ation where the quantity of information and the certainty which may be attached to that information is a function of the frequency of exchanges of comparable products.

In a world of less than strictly comparable products (and preferences and circumstances of traders) the information problem becomes very complex. This complexity arises from the ambiguity which is associated with information about historical prices since in the absence of strict comparability of characteristics or combinations of characteristics prices no longer provide the information necessary for a complete or unbiased index of relative value. Traders are therefore forced to rely upon additional information about the non-price characteristics of the product for the establishment of reservation prices. Unfortunately a large part of this additional information about product characteristics is not of the form which is conducive to easy measurement the way money prices are. In and of itself, this increased difficulty of measurement can be expected to lead to higher information costs in the transaction, and, given that parties to the transaction weigh the costs and benefits of information acquisition, there will be as a result less information pertinent to the transaction actually present at the time of execution.

Exactly how much information will be present when products are not comparable will be a function of the costs and benefits of establishing comparability, or on the other side of the same coin, of establishing the significance of differences.

In this instance, one might look at information costs as thoroughly comparable to costs of measurement (measurement being a form of information). For example, for two items that are grossly dissimilar in terms of some given characteristic, say weight, the costs of undertaking the measurements necessary to determine those gross differences are likely to be relatively low when compared with the costs

of measurements necessary to determine minute differences in two items of almost exactly the same weight. As one approaches almost perfect comparability the costs associated with being able to successfully discriminate will tend to rise exponentially. For product characteristics less easily subject to measurement than weight, one would expect correspondingly greater costs associated with successful discrimination among characteristics. In short, one would expect the costs of discriminating or establishing comparability between the circumstances of other exchanges and the characteristics of other products to rise in a very rapid, non-linear fashion as the exchanges and products themselves become more and more similar.

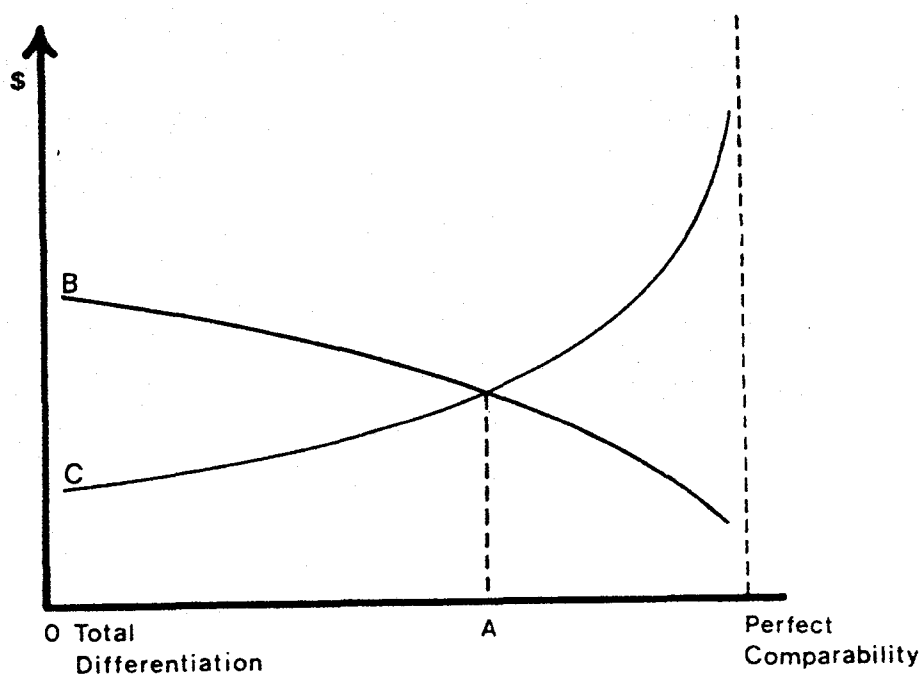
The benefits of successful discrimination, on the other hand, would be expected to be very large for gross differences in the characteristics of two items but to decline to very small levels for highly comparable items--provided the characteristics upon which the discrimination is based are themselves associated with the utility of the decision maker. In other words, so long as we mean by comparability the substitutability of the items in their use, then an unsuccessful discrimination between two highly similar items will not carry a high opportunity cost; whereas the unsuccessful discrimination between two very dissimilar items will carry a high opportunity cost. It is the avoidance of these opportunity costs which constitutes part of the benefits of obtaining information about the comparability of two items. (The other part of the benefits arises as the share of the gains from trading.)

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FIGURE 7

Costs and Benefits of Discerning Product Comparability



B= Benefits of successful discrimination  
C= Cost of information necessary to discriminate

Notes on the graph:

- (1) Comparability axis records 'true' comparability, or comparability after the transaction, of any pair of products.
- (2) Value axis records information costs and utility benefits as perceived or encountered before the transaction.
- (3) A higher frequency of exchange of either product lowers information costs, shifts the cost curve downward and reduces the zone of uncertainty likely to be tolerated by rational individuals.
- (4) Benefits curve is stated in terms of the avoidance of the (utility) opportunity costs of a mistaken decision, and consequently involves the consumer's perception of expected product characteristics.

Hence, when the benefits and costs of the acquisition of information necessary to successfully discriminate between two (or more) items and/or services are graphed against the relative comparability of the items requiring discrimination (as in Figure 7) it becomes apparent that there is a range of comparability over which the decision maker is unlikely to find it worth his while to expend greater resources for the purpose of distinguishing successfully between two items--i.e. the range to the right of the intersection of the marginal costs and benefits curves. That is, it would not be worth his while to allow his marginal information expenditures to exceed a level in excess of OA. This effective limit which rational individuals are likely to place on their acquisition of information requires that all transactions take place under conditions of uncertainty.

#### F. Institutions and Exchange Related Uncertainty

This conclusion raises an interesting problem, namely that the costs and benefits of acquiring exchange related information are such that many exchanges would have to have outcomes viewed as highly random. Not only that, but the highly probable existence of asymmetries in the information of the two parties to the exchange would also indicate the strong possibility of a tendency towards self-interested and collectively degenerative opportunistic behavior. This latter effect, especially, would appear to be large enough to increase the probability of errors, inefficiencies and inequities to the point where the efficacy of exchange would be seriously eroded. This implication, however, appears to be somewhat contrafactual since exchange does not appear to be a fatally flawed or highly randomized form of behavior. Consequently, one is led to the question of whether there exists some mechanism for making exchange tolerably efficient and equitable in spite of the problems posed by uncer-

tainty and/or whether there are social mechanisms which substitute for exchange when conditions surrounding the transaction contribute to excessive uncertainty.

A fundamental view of this paper is that the entities we term institutions operate, on the one hand, to reduce the costs of relevant exchange related information through the substitution of information about expected human behavior for unattainable or overly costly information about the product environment, and on the other hand, to simply replace the process of exchange between independent entities with organizations whose purpose is to supply a set of rules about behavior in order to reduce the inequities and inefficiencies caused by uncertainty. The first of these we will refer to as exchange related institutions and the second as firms or hierarchies. In a sense we are posing an hypothesis similar to that of Coase (1937) but suggest that transactions costs are reduced by rule making which can exist with regard to the market as well as within hierarchies or firms. Our hypothesis suggests a kind of functional substitutability between exchange related institutions and hierarchies. Support for this proposition is found primarily in the legalistic theory of transactions formulated by J. R. Commons.

Common's very difficult book The Legal Foundations Of Capitalism (1923), lays out a complex legal/economic/historical theory of capitalist institutions; the power of his theory ultimately resides in his analysis of the formal and informal institutional constraints surrounding the individual transaction. In the view expressed by Commons the transaction is not a simple exchange of goods or services for money. Rather it is a complex socio-legal act which gives rise to a set of rights and obligations--among the parties to the exchange itself, among third parties who may be contractually bound to one or the other first parties and for the State or whatever collective organization has

assumed police powers. These rights and obligations define a set of conditional, behavioral rules for the parties to the transaction which must be fulfilled during and after the transaction. The specific content and duration of these rights and obligations is a function of the embodied characteristics of the product and the particular circumstances of the parties to the exchange and the market.

When the transaction is viewed as the establishment of a quasi- or fully legal contractual relationship between the two parties, questions about the nature of the rights and obligations of the parties arise more or less automatically. One must define those rights and obligations, the limits to those rights and obligations, the basis for defending rights and enforcing obligations, and, further, what other rights and obligations are likely to be created for other, third parties; for example, the state may have assumed an obligation to enforce and defend rights, obligations may have been incurred through private contract, employees may be bound by the terms of their contract to perform in conformance with a sales contract, etc. In especially complicated transactions the web of rights and obligations and their definition as they relate to all relevant parties can be exceedingly extensive even if incomplete and, when viewed as an outlay for the acquisition of information, exceedingly expensive. Macaulay (1963) cites the instance of the transfer of ownership of the Empire State Building which required millions of dollars for the fees of lawyers and other experts. On the other hand, in a more simple transaction, for example the purchase of a candy bar or cup of coffee, the actual outlay of expenditures on information about rights and obligations may be exceedingly small, although from the legal point of view, thoroughly inadequate for the purposes of defining the rights and obligations created by even this simple transaction. Nevertheless, whether the transaction actually involves the outlay of large or small expenditures for the



definition of rights and obligations, there remains an unequivocal similarity in that all transactions establish a relationship over time between buyer and seller. This relationship defines the conditional behavioral requirements placed upon each party, and, given those conditions, provides an expectation of behavior which, with enforcement of rights and obligations, is more certain in its fulfillment than an expectation regarding the physical performance of an item of exchange, or more importantly, the performance of the other party in the absence of enforced rights and obligations. Put differently, the certainty of one's expectation regarding the results of an exchange can be enhanced considerably if the transaction is accompanied by a set of rights and obligations which require, for example, the seller to assure the expected performance of the item under some reasonable conditions for some reasonable period of time, where what is reasonable is defined, by and large, by the characteristics of the product and the circumstances of the exchange. In effect, the expectations formed by these rights and obligations refer to human, not product, behavior or performance.

At first glance, this legalistic view of the transaction would appear to imply an additional informational requirement for the transaction and the possibility that institutions might actually hinder exchange. But this is not really what is happening. Rather, institutions create a situation in which one form of (relatively) easily available and highly generalized information (about the structure of rights and obligations) can be substituted for other less easily available, highly particularistic and unpredictable information (about the future performance of product characteristics and the other party to the exchange). For example, to take a very simple case, the purchaser of a radio may effectively substitute the implied or formal warranty regarding the performance of the radio after

purchase for other, very extensive and costly information about the engineering and other characteristics of the radio itself. The warranty relates not so much to the radio whose performance may be very hard to predict and impossible to enforce but to the behavior of the seller which is relatively predictable because it is enforceable through custom or law. In effect, the uncertainties of the physical world and the strategic behavior these uncertainties would induce are at least partially replaced by the establishment of an implied or formal relationship between the two parties to the transaction--a situation which is much less demanding of information and much less uncertain.

Another way of looking at this same effect would be to note that the existence of institutions reduces the overall information requirement, thereby presumably reducing the probability of error and inefficiency and increasing the probability of exchange taking place, either in the market or within a hierarchy. This reduction in the overall information requirement is accomplished by (formal and informal) prohibitions against opportunistic behavior based on informational advantages, i.e., the equivalent of the so-called moral hazard insurance problem. A very important economic effect of these prohibitions is, on the one hand, to deny the full benefits of special or particularistic knowledge to the holder of that knowledge through the creation of a kind of social memory and, on the other, to spread the benefits of that knowledge throughout the market or organization. Put in still a different light, the behavioral rules embodied in institutions--especially the prohibitions against opportunistic behavior--tend to create highly beneficial networks of complementary information sources where the networks are composed of strings of transacting partners. To the extent that enforcement of these prohibitions is effective, a 'social memory' is created and allocational efficiency is improved through the

ability to more easily discriminate between correct and incorrect statements about performance--all without the costly need to distribute all knowledge to all possible participants in all transactions. In short, institutions create trust and provide tremendous savings in the cost of acquiring and distributing knowledge about both the products and participants in transactions.

All this is not to say that institutions create perfectly efficient and equitable alternatives to high frequency, homogeneous product markets. There is no reason to believe that there is some invisible hand which automatically creates and modifies behavioral rules as circumstances in the market are altered. There is, in fact, probably much stronger reason to believe that institutions are slow to adapt in the face of changing circumstances, since repeated collective experience under the new circumstances is required before the formation of a consensus, in the case of informal rules, or a law, in the case of formal rules, is possible. There is also little reason to believe that even in the absence of change institutions are likely to arise which will approximate an optimal set of rules (e.g., Arrow's intransitivity problem). Consequently, it is reasonable to proceed on the assumption that institutions facilitate exchange but at the same time may significantly color the process of exchange in a way that impacts upon the performance of the market.

Institutions simplify a complex, heterogeneous environment but at the same time they create a potentially distorted view of that environment. If this view of institutions is correct it implies that a willingness to forego opportunistic and individually advantageous behavior improves the allocative efficiency of exchange and, of course, lowers the social enforcement costs associated with the maintenance of markets in the face of great uncertainty. Whether such individual willingness is encouraged or discouraged is most

probably a function of the information networks established by the market.

The other side of this is that the relative efficiency of exchange related institutions will undoubtedly determine the boundary between the market and hierarchies. To the extent that the information networks established by exchange related institutions are costly vis-a-vis the provision of information, one would expect market mediated exchange to be replaced by planned exchange within hierarchies.

Finally, we should note that an argument similar to that advanced here for exchange related institutions can also be made with respect to competitive interactions. In the kind of environment we have assumed, competitive interactions are the norm and take place under conditions of uncertainty about the environment and other competitors behavior. In these kinds of situations institutions can be expected to arise and function in a manner parallel to that of exchange related institutions.

#### F. 1 Summary of the Argument about Institutions

In summary, in the absence of perfect information in the trading (and for that matter the competitive production) environment individual transactions are viewed as being subject to great uncertainty. This uncertainty, if not resolved, leads to potentially degenerative collective situations. In other words, an environment of imperfect information creates many opportunities for self-interested lying, cheating, stealing, deceiving, misleading and all sorts of other similar behavior. It is the expectation of the possibility of this behavior that leads to foregoing trading and production opportunities to the potential harm of all parties. We hypothesize that the perception of potential collective benefit coupled with repeated encounters under roughly similar conditions leads to the evolution of rules or institutions governing or prohibiting collectively degenerative opportunistic behavior. We expect that these rules

are determined by a consensus of traders or competitors and are tailored to the very specific context of the trading or competitive situation they are meant to govern. The function of these rules is to remove or reduce the uncertainties of potential opportunistic behavior by providing a basis for the fairly certain conditionalized expectations regarding the outcome of individual trading and competitive interactions.

## CHAPTER 5

### THE FIRM IN THE LONG PERIOD

#### A. Introduction

To this point we have outlined what we believe to be the important factors determining the external environment of the firm. We turn now to the question of the individual firm's behavior in this kind of environment. Especially important here is the constraints on that behavior<sup>1</sup> and the implications which flow from those constraints with regard to the firm's choice of product and the effect of similar behavior of all firms on the collective processes and performance of the market.

Throughout this section we assume, as in the short period model, that the objectives of the firm are, first, its own survival as an economic entity and, second, growth. More specifically, we suggest here that the firm will tend to use a relativistic measure of its performance based upon a comparison of its performance with that set of firms currently exercising product alternatives lying within or near the range of the feasible set of alternatives open to the firm itself. Although it might be argued that the firm should have a broader based measure of performance its firm behavior would seem that there is little reason for the firm to judge its own success or failure by that of firms whose circumstances are not closely related to what the firm itself conceives as feasible. Similar firms provide a basis for meaningful comparison resting on the similarity of financial, market, technological and other environmental conditions facing both firms. It is also much less costly

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<sup>1</sup> An important omission in our outline concerns the internal or organizational constraints upon the firm's ability to process information.

information for the firm.

The requirements of meaningfulness also suggest that a primary object of attention of the firm will be the attributes of that same set of firms and the characteristics of their products. Specifically the firm will focus its attention on:

- (1) the relative success or failure of these other firms and
- (2) the relationship of other firms' performance to
  - (a) their product characteristics
  - (b) methods of production
  - (c) the relationship of the other firm's products to all others in the market and
  - (d) the financial practices of the other firms.

The information resulting from this attention to other firms will not only be useful for purposes of judging its performance but will also be a primary source of data for adaptive change by the firm. It will provide the firm with a tolerably accurate approximation of:

- (1) the strength of consumer demand associated with certain product characteristics,  $(c_{11})$ ,
- (2) the extent of competition for particular areas of consumer demand,  $(\text{SUM } c_{11})$ ,
- (3) the existence of potential strong (and weak) areas of demand  $(c_{11} + \text{SUM } c_{ij} = \text{min})$ , and
- (4) if the information is acquired continuously over time, a strong feeling of the dynamic patterns of product design change in the immediate area of its feasible set of alternatives.

Further refinement of these data is open to the firm through a variety of channels such as market surveys and so on.

The firm's response to its perception of its environment is crucial to its success or failure. Depending upon the circumstances postulated one might develop an immense variety of potential actions. Because of the informational

constraints outlined, almost all, however, are reducible to two general modes of response--imitation or innovation. By imitation we merely mean an evolutionary change in product design, production methods, marketing or financing which is predicated on the belief that another firm has located a favorably strong area of consumer demand, production or marketing method, etc. By innovation we refer to an evolutionary change in product design, etc., predicated on the belief that there are unexploited areas of 'potential' consumer demand--i.e. that there are combinations of characteristics for which there is strong potential demand but for which there are no corresponding products on the market. In the case of product innovation, as opposed to (patentable technological) invention, we further conclude that the process of innovation is most likely to be carried out in a process of relatively small changes. The reasoning for this conclusion is based on the costs of acquiring new market information and the difficulty of assigning property rights to such knowledge. This will be elaborated after a necessary prior discussion of the firm's behavior in the long period, especially the constraints on its behavior.

#### B. The Firm in a Complex Environment

In the long period, the firm's decision about what to make or do revolves around two environmentally determined questions: (1) the expected frequency of demand associated with its product alternatives and (2) their respective expected prices. We do not view the firm's choice process as if it can be arrived at through the simultaneous determination of these two variables. Rather, each variable is viewed as encompassing a host of subsidiary, but related, problems as will be elaborated. First we outline the problems of determining the expected frequency of demand and then turn to the question of expected price. Both are dealt with in terms of the institutional theory of Chapter 4.



The problem of choice of product can be approached from one of two angles: we might consider the problem confronting a firm contemplating its initial entry into the market, or we might consider the problem facing an established firm considering the alteration of its product or the production of another. For ease of illustration we have chosen to illustrate the problem of an established firm considering a new product.

It should be emphasized from the outset that we choose to define all the attributes of the firm (the parameters of its short period equation) solely in terms of the product(s) the firm offers in the marketplace. Depending on the characteristics of the firm's product--putting aside consideration of price for the moment--it will find that the competitive impact of other firms will be either greater or less ( $c_{ij}$ ); that the constraint of its own particular product market will be larger or smaller ( $c_{ii}$ ); that its costs of production (as defined by available techniques of production and supply of inputs) will be higher or lower ( $b_{ij}$ ), and that its access to capital (either through retention of surpluses or outside borrowing) will be easier or more difficult ( $a_i$ ). Consequently, the firm's choice of product is exceedingly important.

#### B.1 The Information Requirements for an Optimal Choice of Product

If the firm were to attempt to accomplish an optimal choice of product in the kind of complex environment we have outlined here without regard to the analytical and information costs of the decision it would be faced with a truly formidable problem. The scope of the problem can be outlined as follows:

First the firm requires knowledge of the characteristics preferences of all consumers.

Second, it needs to know the characteristics embodied in all products of all other firms.

Third, it needs to have a means for analyzing the potential market interactive effects of all other firms for all the alternative products it could produce.

Fourth, it requires knowledge of the costs of production for all product alternatives.

Fifth, it must know how each alternative product will affect the conditions under which it could borrow and/or the rate at which it might accumulate surpluses, and,

Finally, it must know the learning costs it would incur for each alternative product.

This partial list of requirements is further complicated by the realization that each requirement for each alternative cannot be determined independently. For example, the firm's access to capital will be strongly influenced by the potential reactive behavior of other firms. And, of course, the firm is faced with its own internal organizational problems which make it difficult for it to perceive, analyze and react to its environment as if it were a single neurophysiological system.

We may illustrate a simplified version of the firm's product choice problem by reference to a heuristic community characteristics preference map. Figure 8 assumes a simplified world of only two characteristics which may be embodied in a product in varying combinatorial quantities. We refer to these characteristics as  $k_1$  and  $k_2$  and for purposes of illustration assume that we may measure these characteristics and arrange them along the axes of the diagram in a way which conveys a meaning of greater or less. For a given level of consumer expenditures and a given state of consumer preferences, we could generate a map of consumer preferences. That is, we ask each consumer to create his 'ideal' (but not necessarily optimal) basket of products given his preferences, perception of the prices of characteristics, products, information, analytical ability, and so on. Then

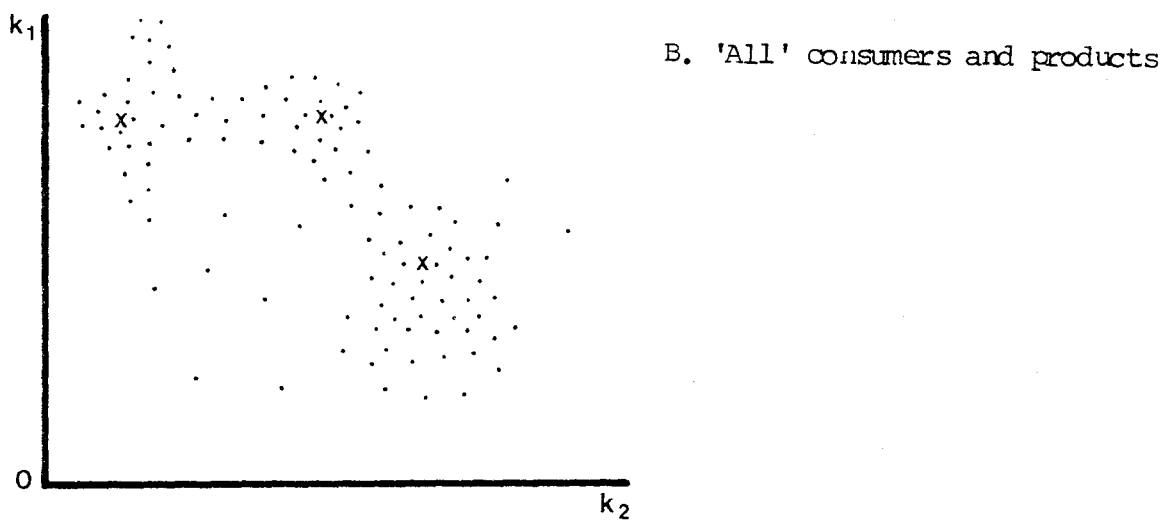
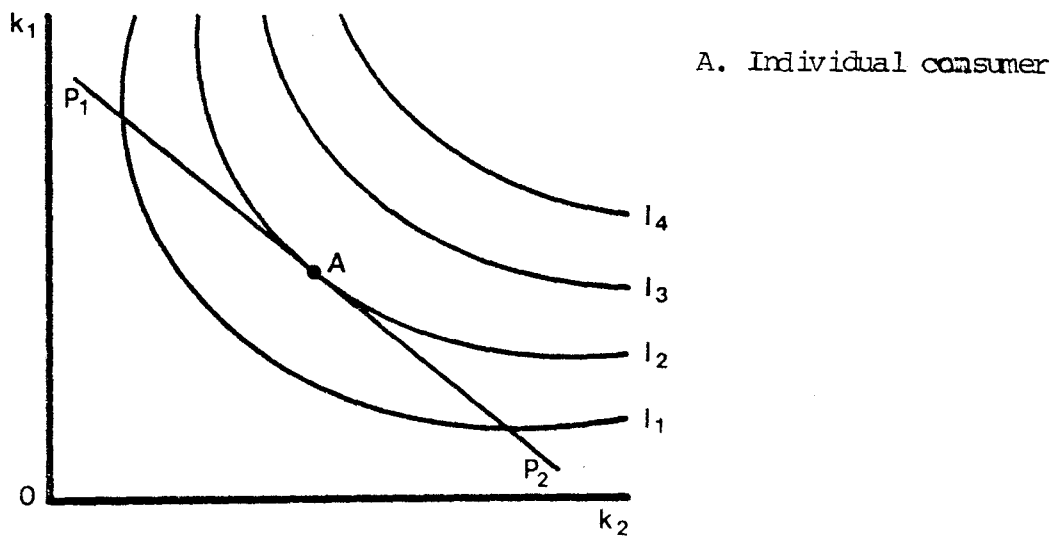
we record on the map that combination of characteristics  $k_1$  and  $k_2$  which defines his and all other consumers' ideal products. By ideal product we mean essentially the constrained preference statement the consumer makes given his knowledge of technologically and socially feasible characteristics, relative characteristic prices, his budget, and so on. The statement need not be limited to points corresponding to existing products simply because only full knowledge of the product environment on the part of consumers would constrain their search so thoroughly. On the other hand, one would expect a passing knowledge of the product environment to constrain the statement of preferences within a range which is reasonably feasible--technologically, socially and economically. In other words, we would expect consumers' product preferences to reflect to a large extent the existing configuration of products in the economy because the information constraints faced by consumers limit their expectations about (technologically determined) feasibility and (socially determined) desirability to a product set corresponding closely to the existing set. Hence, product preferences can be expected to be closely correlated with existing products or product characteristics. It is in this sense that we take preferences to be endogenous to the system.

When this recording of preferences for all consumers is carried out on the heuristic two characteristics diagram we may view the result as a map showing varying densities of 'ideal product points' (Figure 8). We take this map as a summary representation of the characteristics preferences of consumers. Knowledge of this 'map' is the first requirement of the firm's product choice decision.

We may also record on this map the existing products offered by other firms. The cross marks on the map indicate the combinations of characteristics  $k_1$  and  $k_2$  which define the other firms' products.

FIGURE 8

A Heuristic Preference Map with Two Characteristics



The individual consumer: where  $p_1 - p_2$  is a 'partial' budget line resulting from a prior allocation of his total budget among all characteristics whose slope is determined by perceived relative characteristics ( $k_1, k_2$ ) prices.  $I_1$  to  $I_4$  are taken as curves of indifference between the two characteristics and the utility value of  $I_1 < \dots < I_4$ . Given the consumer's budget and perceived relative characteristics prices, point A represents his 'ideal' product or combination of characteristics. Assumes more of a given characteristic is 'better', and the consumer's perfect knowledge of his preferences and the nature of characteristics and characteristics prices. 'All' consumers' ideal product preferences shown as dots. Actual products shown as "x"s.

The importance of the distribution or density of consumer demand around each potential product point is, perhaps, intuitively obvious. Nevertheless, it illustrates one aspect of consumer demand--that consumers may not be able to perfectly match their preferences with products because of incomplete knowledge of the product environment--or, as viewed by the firm--that it is likely that few consumers will have characteristics preferences exactly matching any product offered by the firm. Nevertheless, assume consumer's 'satisficing' behavior will lead them to gravitate to the product whose characteristics most resemble the characteristics they desire. If consumers were possessed of complete knowledge, the firm's product 'location' on the characteristic's map would yield an easily determined number of sales (according to some 'least distance' model). On the other hand, if consumers are less than well informed and subject to the decision 'errors' discussed in Chapter 4 above, then the firm must take into account the effectiveness of the selling or marketing procedure of the other proximate firms. Specifically, the firm needs to weigh the ability of other firms' marketing strategies to alter the informational environment and thereby influence the purchasing decisions of consumers relative to a perfect knowledge situation.

In short, the firm must state for each possible alternative the approximate limits of the specific product market in the absence of competition and how those limits might vary as a function of changes in the firm's costs of selling or marketing effort (via inducement of change in the consumers decision) and similar activity by other firms. In the terminology of the short period model, this is how the firm is viewed as approximating the value of  $c_{ij}$ . When the firm states the proximity of another firm's product and the effectiveness of that firm's marketing efforts it is, in effect, approximating the value of the  $c_{ij}$  parameter of the

short period model, or the other firm's inhibitory effect.

Once the firm has made these assessments with regard all possible market alternatives, it must then turn to a consideration of the likely costs of production and learning and the implications for its access to finance associated with each product alternative. Even greater complications enter when the firm is confronted with the very real possibility that existing (or even other currently non-existent) firms will alter their own product's characteristics or introduce new products in response to any action by the firm.

When all these factors are listed out it would appear that the real world problem faced by the firm is not one which is amenable to a "full information" decision making process simply because the consideration of all alternatives poses an impossibly immense problem for the firm. In short, the decision ability of the firm, like the consumer's, is severely constrained by the availability of information. This is a source of weakness and also competitive strength for the firm.

### C. Determinants of the Firm's Feasible Alternatives

It would appear, then, that when we consider the decision making problem of the firm in this kind of complex environment we must first consider the factors which limit or define its set of feasible alternatives. In effect, we must ask what it is that determines the character and extent of the opportunities which might reasonably be considered by the firm, or put a little differently, the factors which limit the scope of the firm's new product search. On the basis of the discussion to this point it is natural to turn to the question of the kind and quality of information available to the firm. As we noted with the consumer, the problem of the vastness of the economic environment is diminished for those commodities with which the consumer has repeated contact, in other words, for commodities about

which he is knowledgeable. It is reasonable to expect that the firm will also be able to best cope with those regions of the economic environment with which it has the greatest familiarity. In short, we want a convenient way to conceptualize the particularistic forms of resident knowledge and other resources which determine the firm's set of feasible opportunities.

In this matter, we can continue to rely on our characterization of the firm in terms of its financial, technological and market attributes. That is to say, the resident knowledge of the firm is most likely to conform with the subsets of operational knowledge required for the financing, production and marketing of the firm's (current) product. Consequently, we may begin by noting that the set of feasible adaptive alternatives available to the firm at any point in time will be closely related to the current embodiment of knowledge within the firm, while the limits of the feasible set may be considered to be determined by the costs of acquiring new knowledge which, of course, is likely to be relatively ill-defined for the firm.

### C.1 Characteristics Space as a Basis for a Taxonomy of Knowledge

In Chapter 4 we outlined a theory of the market environment in terms of characteristics or product space. One purpose in doing so was to create a conceptual base by which we might be able to systematically identify or describe the forms and types (i.e., a taxonomy) of knowledge the firm possessed of its environment. In terms of the market environment, for example, we assume that the firm would be possessed of particular forms of knowledge appropriate to the area of that environment in which it has been selling its product(s). Its experience is likely to have appraised it of the nature of consumer preferences, the methods necessary for selling to those preferences, and the methods and strategies of competitors in the area of the market adjacent to

that in which it has been selling its product(s). Thus, the realm of its resident knowledge with regard to the market can be described in terms of the correlation of that knowledge with the characteristics which define its product(s). For example, a dress manufacturer may be highly knowledgeable of the market for fashionable women's shoes. In short, the firm's knowledge of the consumer environment is limited not just to the marketing of its particular product, but to a wide but still limited part of the demand environment associated with the characteristics of its products.

In a similar manner, the history of the firm will give rise to particularistic bodies of technological and financial knowledge which will also be closely correlated with the firm's product history and characteristics. These sets of technological and financial knowledge may or may not correspond (in terms or product space) to the set defined by its marketing knowledge or to each other. In the case of the dress manufacturer, for example, it is not likely that the set of feasible alternatives defined by its marketing knowledge (including women's shoes) would overlap the set of feasible opportunities defined by its knowledge of production. Shoe and dress production appear to be rather far removed from one another even though the marketing requirements may be very closely related.

Consequently, in all spheres of its operation--marketing, technological and financial--we would not expect the firm's knowledge to be confined simply to the point(s) in characteristics space defined by its product(s). The firm will have acquired relevant knowledge of the market, technical and financial parameters in adjacent areas of that space. Undoubtedly, the exact boundaries of this knowledge would be difficult to define but perhaps that is unnecessary; what is important for our purposes is that the resident financial, technical and market knowledge of the firm is a limited set of particularistic knowledge whose boundar-



ies, however ill-defined, are determined by the history of the firm's interaction with its environment. We take this body of resident knowledge as a major determinant of the set of the firm's feasible alternatives.

### C. 2 Firm Learning and Characteristics Space

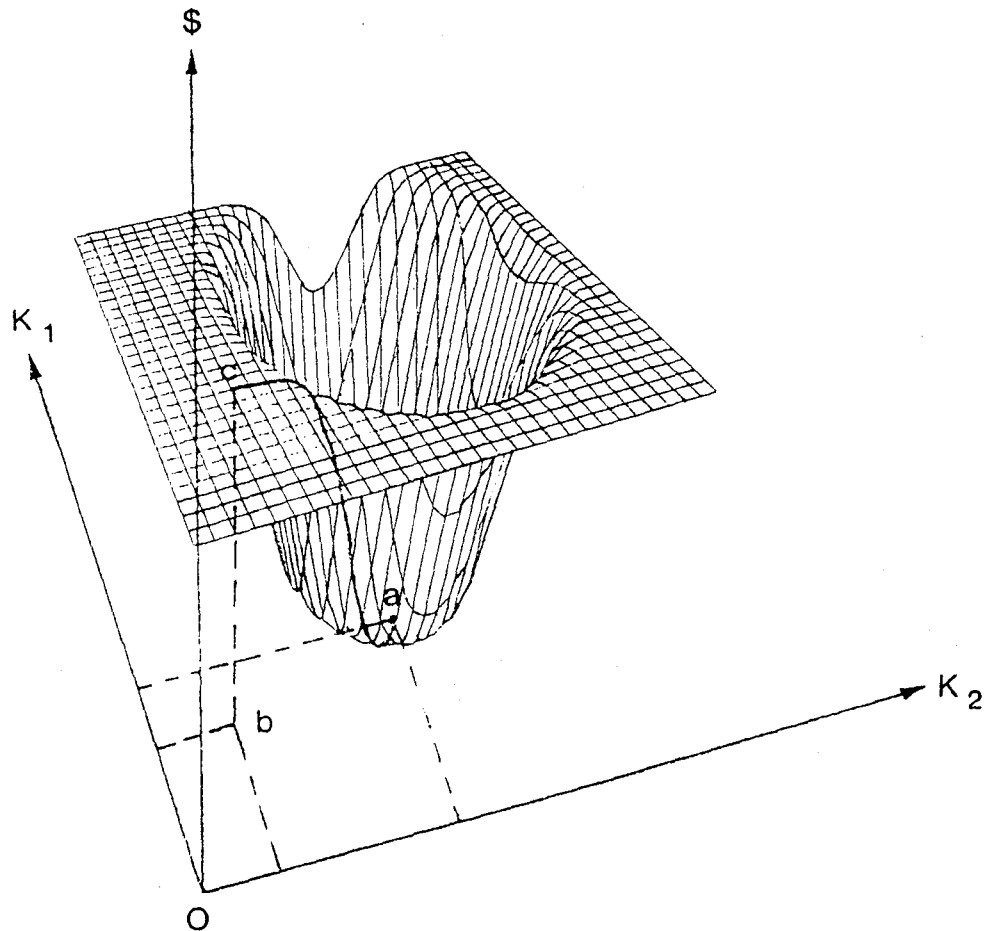
The costs of acquiring knowledge beyond the boundaries of the set determined by the firm's resident knowledge is viewed as entailing an investment expenditure. The cost of this investment will determine to a certain extent the boundaries of the firm's set of feasible alternatives in product space. In particular, the schedule of likely investment/learning costs in each of the firm's spheres of operation--marketing, production, financing--is taken as a function of the distance (in terms of characteristics space) from the existing boundaries of each sphere of the firm's knowledge to the location of the to-be-acquired knowledge.

On the basis of a priori speculation alone we would venture to define the learning cost function in each sphere of operation as conforming to a simple logistics growth or learning curve. That is, for any direction in characteristics space from the current location of the boundaries of the firm's resident knowledge, we postulate that the cost of acquisition of new knowledge will proceed at first at a slowly rising rate, will then begin to grow rapidly, and finally will slow down, asymptotically approaching some finite maximum. Put somewhat differently, we would expect learning costs for the firm to be relatively low in the area immediately adjacent to its current location in product space simply because its observation of its consumers and its interaction with competitors in this area is relatively intense (i.e., knowledge conveyed through experience). Thus we assume the firm to be fairly well informed about the financial, technological and market parameters relevant to products closely related to its own current product. Beyond a certain distance in product space, however, the firm will

find that its resident knowledge in any given sphere of operation becomes increasingly irrelevant and that the costs of learning begin to rise relatively rapidly. Beyond a certain point the firm is likely to find that its resident knowledge has almost no bearing on product choice or possibilities. This area is represented by the asymptotic section of the learning costs curve. In two dimensional characteristics space the entire learning cost schedule for any particular sphere of operation will take on a general shape somewhat like an upside-down hat as illustrated in Figure 9.

FIGURE 9

Product Change Learning Costs in Characteristics Space



The graph illustrates a world of two characteristics,  $k_1$  and  $k_2$ , and the learning cost function of a firm with a current product located at point A in the characteristics plane. Alteration of the firm's product to point B in the characteristics plane requires that the firm 'climb' the learning cost function along the patch A-C. Learning costs associated with the move from product A to product B are given by the vertical distance B-C.

This postulated view of the learning costs function in characteristics space suggests two significant points of view: (1) the feasible product alternatives of the firm tend to be restricted to an area in the immediate vicinity of the boundaries of its current resident knowledge and product(s), but (2) if the proximate feasible set contains no alternatives preferable to the firm's existing product(s) (because of consumer demand conditions or the existence of other firms' products), the firm may find that its resident knowledge confers no special competitive advantage. In this latter kind of situation, the feasibility of choosing an alternative or new product will not be a function of the firm's particularistic current knowledge, but of the resources at its disposal for the acquisition of unrelated knowledge. In other words, beyond the boundaries defined by the maximum learning costs, the firm might just as well consider all alternatives without regard to the costs of learning.<sup>1</sup>

Later we will use this notion of the firm's learning process in characteristics space to describe first, niche seeking behavior in the design and marketing of products and second, a learning theory of integrative and conglomerate firm behavior.

In addition to the current body of resident knowledge of the firm, other aspects of its situation will also serve to constrain the size and attributes of its set of feasible alternatives. We assume that these other aspects of the firm's situation constrain it primarily through their effect on the costs, rate and direction (or biases) of learning of

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<sup>1</sup> It will probably also be the case that the rate of increase of learning costs along each characteristic axis will vary from one characteristic to another. For example, the costs of acquiring knowledge of the market with regard to the characteristic, say, basic nutrition might be considerably lower than the costs of acquiring market knowledge related to the characteristic, say, convenience.

the firm. Its size and consequent access to finances are, for example, likely to close off a great many opportunities for the small firm even if its financial, marketing and production knowledge does not. In short, possible expenditures for learning/investment are positively related to the size of the firm and, therefore, the scope or size of the firm's feasible set is also a positive function of the firm's size. The limit of the firm's feasible set of alternatives will also be determined by the ability or efficiency of the firm to undertake the learning process and the costs associated with that learning. It will be the case that for every new alternative facing the firm a certain amount of learning needs to take place. Firms which, for one reason or another, are able to learn rapidly and at low cost will, of course, always have open to themselves a larger array of alternative products, than will the slow learning firm. When one is concerned with the process of conscious adaptation of a firm's rate of learning, even as it takes place from a constrained base as viewed here, would appear to be one of the more important actors in the evolutionary success or failure of a firm. Not only is learning important with regard to the opportunities open to the firm at a point in time, but the accumulated exercise of those opportunities over the past also defines for the firm the character and size of the base from which feasible new alternatives may be considered.

In summary, we view the firm's set of feasible or possible adaptive actions as a function of its resident knowledge and its costs of learning necessary to alter that body of knowledge. From the point of view of the system as a whole this view of the individual firm should convey a picture of firms, competing with one another--or avoiding or sheltering from competition--on the basis of their unique attributes of knowledge. In short, the competitive process

is seen as one in which relative competitive advantage or disadvantage is conferred through the possession and acquisition of particularistic unique sets of knowledge of the technological, financial and marketing spheres of the environment. The competitively successful firm is one which is able to acquire relative advantage through the efficient acquisition of particularistic knowledge of the economic environment. Viewed dynamically it is the process of economically acquiring and applying knowledge which is of greatest interest in adaptive competition. In the section following immediately we begin to explore this aspect of collective microeconomics behavior in the context of the notions of adaptive competition and efficiency outlined here.

#### D. The Niche

Successful competitive behavior is dependent upon the conservation of resources devoted to the acquisition of particularistic knowledge and the identification of exactly what particularistic knowledge needs to be acquired. Both of these aspects of the firm's behavior are strongly constrained by the attributes of the firm's base of resident knowledge. For each firm the base of resident knowledge is likely to be unique because of differences in its historical experiences. Consequently, at any point in time the feasible opportunity set of each firm will be unique. It is this uniqueness which denies many opportunities to many firms, but at the same time and for the same reasons, confers upon each firm a special competitive position and set of adaptive possibilities. Clearly the results of playing out the competitive game in a changing, complex environment will depend heavily upon the unique starting position or, to borrow a term from biology, the niche of the firm.

The notion of the niche is one which is commonplace among businessmen. It is also a notion which is peculiarly suited to a perspective which views the world as complex and heterogeneous. It is, in short, a concept which is highly

appropriate to the kind of theory we have been describing. Consequently, we turn now to a definition of what is meant by the niche in the context of our theory.

From the outset it should be made clear that we want to define the niche and associated phenomena in such a way that our nomenclature does not unintentionally camouflage some of the very processes in which we are interested. In particular we want to avoid unintentional aggregation. Therefore, we suggest that niche be defined, first, in a static sense, as corresponding with the set of opportunities open to the firm on the basis of its current resident knowledge alone, that is, without any learning taking place. In the more meaningful dynamic sense, we define the firm's niche in terms of the opportunities open to it through the acquisition of knowledge about its environment. This notion of a niche is, in a sense, broadly behavioral, because it includes as important not only the firm's 'starting place' or current body of resident knowledge, but also those aspects of the firm such as hierarchial structure, financial position, and potentially a host of other factors which will affect the extent and efficiency of its acquisition of information about the environment and learning processes in general. This dynamic view of the niche further reinforces the notion of uniqueness. Even though it is not highly likely that two firms' niches would be the same in terms of their current resident knowledge (the static definition), the likelihood is even less if the behavioral learning aspects of adaptive ability are also taken into account (the dynamic definition).

From a competitive point of view what is important about the firm's niche is not so much the particular knowledge and abilities which define it, but more its relationship to the niches of other firms. In other words, the competitive position of the firm, its probability of success, is dependent not only upon its feasible opportuni-

ties but also on the opportunities open to other firms on the basis of their knowledge and ability to learn.

At any point in time the relative position of the firm's niche is clearly important in terms of the inhibitory effect (a revenue reducing effect) of other firms, in terms of the positioning of the firm's product relative to the density of demand, and in terms of its costs of production, i.e., the parameters of its short period equation. For the purposes of discussing long period competitive processes it is convenient at this time to define a few terms which will allow the discussion of relative niche positions, or starting points, to proceed more smoothly.

At a point in time the area or size of the firm's niche can be defined in two ways: as a volume in characteristics space or in terms of value. In terms of a volume in space we may think of the niche as being bounded by the area in space from which the firm is likely to make sales, but the boundary so formed is not likely to be impermeable. That is, the boundaries of the niche will not be such that on one side of the 'line' are found consumers of one product and on the other side are found consumers of another. Rather imperfect and costly information on the part of all actors in the system will cause the boundaries of adjacent niches to overlap. Referring back to the explanation of consumer behavior in Chapter 4 we will find that, compared to a situation of perfect information, many consumers will make erroneous purchases. Towards the extreme outer boundaries of the firm's niche we will find that the probability of a consumer making an erroneous purchase approaches zero because the differences between product characteristics are large and easily discernible. Likewise there is an inner boundary where the probability of a consumer making an erroneous purchase approaches zero for the same reason. (The area enclosed by this boundary may be non-existent when the comparison is between two nearly identical products.)

Between these two areas is the area of niche overlap. The size of this overlapping area will be determined by consumer behavior (cf. the discussion of uncertainty in the transaction in Chapter 4) and by product 'spacing'.

The traditionally defined 'states of competition' may be defined in terms of the degree or nature of niche overlap. The perfectly competitive firm is a special case wherein consumer demand is assumed to exist at a single point in product space; all the firms in the industry are also 'located' at the same point and have completely overlapping niches. For the purpose of individual firm analysis there is no overlap between the niche of the perfectly competitive firm and the niche of firms outside the industry, although when the industry as whole is considered there may be some overlap which is captured as cross elasticity of demand. Oligopolistic competition with homogeneous products is defined similarly, except that the numbers of the occupants of the same niche are assumed to be rather few in number. A pure Marshallian monopoly is simply the situation in which the amount of niche overlap is assumed to be nil.

The case of monopolistic and/or imperfect competition is one in which each firm occupies an identifiable niche but experiences considerable niche overlap. Chamberlain's (1956) group in turn is very similar to the cluster of firms which would be expected to occur in product space as a result of the kind of imitative/innovative strategies discussed in the model just above. Similarly, only the numbers of firms involved separate monopolistic from oligopolistic with differentiated products competition, at least as far as niche overlap is concerned.

Multi-product and conglomerate firms, although not referred to as states of competition generally, are interesting and rather common cases in which the identity of the firm and the niche do not correspond on a one to one



basis. Rather, the firm is a distinct collection of differing niches. The idea of niche overlap is also useful in describing product configuration of these kinds of firms. The literature generally refers to horizontally and vertically integrated firms and to conglomerates. Horizontal integration in our terminology refers to the situation in which the products of the firm are clustered together on the basis of their proximity in product characteristics space. The integration in this case is not so much an internalization of the exchange function of the market but rather the proliferation of similar products for the purpose of capitalizing on the firm's market related knowledge of proximate locations in product space. One might think of this in terms of overlapping niches corresponding to each of the firm's products, where the combined product niches span a large sector of product space. The static competitive significance of this type of firm strategy would not appear to be a function of the extent of the product space spanned by the firm's products, but as in the single product case, a function of the relationship of the overlap with the product niches of other firms. With regard to dynamic competitive processes, however, the broad span of the firm in product space would appear to create significant differences compared with the single product firm situation, especially with regard to information flows in the market. This is a point, however, which cannot be addressed until we first make better sense of the forces sharing those information flows.

Vertical integration like horizontal integration is based on an extension of the firm's activities into new product areas, on the basis of resident knowledge of the firm, in this case, the knowledge related to the markets and technology supplying the initial product of the firm or perhaps even into the products for which the firm was initially a supplier. The significant difference here, of

course, is the absorption within the firm of transactions which previously took place as market exchanges between independent entities. Here also the significance of this behavior for dynamic competition would appear to relate to its effect on the character and quantity of information flows--to the firm and environment in general.

Conglomeration in its pure form is an interesting case of multiproduct 'horizontal' firm growth in which the products of the firm are for all practical purposes without any niche overlap at all. Unlike vertical and horizontal integration, conglomeration is not a multiproduct development of the firm based upon a particularistic advantage of its product history and resulting resident knowledge. However, like horizontal and vertical integration, conglomeration is the result which is likely to be expected from firm growth under particular circumstances. As such they are all examples of what we would call long period processes; presently we will present models of these processes.

An alternative measure of the size of the niche is in terms of value. The importance of distinguishing between niche size and value is clear when one realizes that it is possible for a firm to occupy a relatively large niche and at the same time find that the niche is completely overlapped by the boundaries of other firms' niches or that there is a very low density of consumer demand in the area of characteristics space encompassed by the niche. In short, niche size and the value of a niche need not be at all correlated with one another. The greater the niche overlap the greater the inhibitory constraints of other firms and the lower the rate of net revenue flow for the firm.

When one considers the value aspect of the niche from the point of long term strategies which the firm might pursue, the question of the impact of niche overlap assumes

interesting attributes. From the dynamic point of view the attributes of the niche which are of importance for the firm are those which determine its set of feasible alternatives. Earlier we introduced the idea of the firm's movement in characteristics or product space as a problem in learning. Learning, of course, has costs as well as returns. Niche overlap turns out to be an important determinant of the returns the firm can expect to learning and, as we shall see, the appropriate multiproduct strategy for the firm.

Consider for example a situation in which the firm finds itself in a tightly packed cluster of niches. Although the costs of learning for the firm may be relatively low, it will find that any proximate product location it turns to is already occupied by another firm and consequently, it can expect the returns to learning associated with that kind of product development (i.e. development based upon its particularistic knowledge of the consumer environment) to be relatively low. In short the flow of consumer demand associated with the firm's niche, including its overlap with the niches of other firms, provides a basis for describing the size of the niche in value terms, as well as in terms of its span in product space. It is the value characteristics of the niche which are, of course, likely to be dominant in the firm's choice of long period competitive strategies.

## CHAPTER 6

### DETERMINATION OF EXPECTED PRICE

#### A. Introduction

At the beginning of each short period we consider the firm always to be faced with the need to make a choice among the product alternatives, including its current product, contained within its feasible set. It is this decision which constitutes the basis for long period competition and defines the evolving nature of the firm's niche in the economic environment. In order to make this decision the firm's information about its economic environment must be translated into its implications for the firm's objective--survival and growth. That is, its perception of the density of consumer preferences by characteristics, technology, finances, the costs of learning, and so on, need to be translated into a measure of the prospects offered by any potential product or course of action for the growth and survival of the firm.

In the context of adaptive change by the firm, the meaning and measure of what is meant by 'growth' differs radically from its meaning in a short-run situation. For the short run we have taken net revenue to be an adequate measure of firm growth. In the long run this is an inadequate measure, for in the long run the firm must make choices among a variety of feasible alternatives and must be concerned with the current and future size of the set of its feasible alternatives. There is no easy or unambiguous measure of survival and growth in the long run. At any point in time the firm must follow a strategy, not designed to maximize growth along a known path, but designed to preserve for the firm the greatest flexibility for coping with

an unknown or only partially knowable future.

As Chrysler has recently demonstrated size, *per se*, is an inadequate measure of the probability of survival. What is more important is the firm's "position in the market" -- its set of feasible alternatives. In a complex dynamic economic environment the primary requisite for firm adaptability is the ability to learn about and respond to changes in that environment. The factors influencing the extent of the firm's adaptive ability are undoubtedly complex. Two of the most important are the hierarchical structure of the firm (which we will not deal with here, in spite of its importance) and the resources at the firm's disposal. Hierarchical structure is important since the process of decision making and the rate of learning of the firm involve coordination and communication of a (potentially large) group of people. There are, presumably, better and worse ways of structuring hierarchies for these purposes. Available resources are important primarily because learning consumes resources and the extent of costly learning which can be undertaken is a major determinant of the size of the set of feasible adaptive alternatives. We will consider the quantity of resources available for investments in learning (and complementary physical capital) to be something called surplus--primarily retained earnings and funds obtainable through outside borrowing.

## B. 1 Determinants of Surplus

### B. 1.1 Borrowing

The firm's access to outside funds we will take to be determined by the quantity of assets which the firm can pledge as collateral for its borrowing. At any point in time, then, we would expect the maximum borrowing by the firm to be no greater than some value approximately equal to the liquifiable assets of the firm. Also at any point in time the amount of those potentially borrowable funds available for surplus will be no greater than the difference be-

tween the maximum possible borrowing and the amount the firm has already committed itself to for earlier learning/investment decisions.

#### B. 1.2 Retained Earnings

For the firm faced with the consideration of alternative possible products it will be no easy matter to come to a precise estimate of the retained earnings which might be derivable from each alternative. Among the important factors which would have to be known with regard to each alternative are price, frequency of sales, and costs. The difficulty of estimation arises primarily because these quantities are not necessarily independent of one another and because the data relevant to each alternative are quite likely to be non-existent. The problem is likely to be sufficiently complex that the information and analytical costs to the firm will be enough to foreclose any advantage in calculating or finding a maximum surplus alternative. In other words, the choice problem of firms is viewed as so complex that rationality requires reliance on far from complete information about and analysis of the firm's environment and the use of relatively unsophisticated (in the analytical sense) rule-of-thumb decision making techniques. This is not meant to imply that the process of decision making is considered simple minded; instead this attitude towards decision making tends to emphasize not so much the importance of 'correct' or sophisticated decision making techniques, but rather the importance of learning about the environment and having available relatively better information (relative to one's competitors) and being in a relatively more favorable location in characteristics space at the time when fairly simple decision rules are applied. What is complex and difficult are the long run strategies for learning about and positioning oneself in the economic environment.

In order to support this assertion about the nature of

decision making in a complex environment we offer here, by way of a kind of 'negative proof', the informational requirements of an optimizing approach to the determination of surplus.

#### B. 1.2.1 Information Requirements For the Prediction of Price

For the firm considering the introduction of a new product, different from that of any other firm's, the question of an appropriate price is not only important but also difficult to resolve especially if the problem is approached with optimizing techniques in mind. The extent of the analytical and information problem can be easily illustrated by listing out those factors which would need to be known in order to arrive at, say, the surplus or profit maximizing price. Not only would this information need to be known for a single product possibility but also for all possibilities lying within the firm's feasible set.

- (1) First, the firm must be able to assess the strength of consumer demand in the area of characteristics space appropriate to the contemplated product.
- (2) It must also be able to predict the expected trade-off between price and frequency of sales.
- (3) It must know the effect on the frequency of sales of its product, over a range of relevant prices, of the presence of competing or substitutable products.
- (4) It must know how the information available to consumers from other firms, non-proprietary sources (e.g. other consumers, governments, etc.) and itself will affect frequency of sales and how this effect will vary with price.
  - (a) The firm must know how much and what kind of information needs to be made available to consumers and in what form.
  - (b) It needs to know the costs of conveying this

information and how such expenditures will affect or interact with the frequency of sales and price.

- (5) It needs to know how other firms will react to its initiative in terms of possible changes in price, product or information policies.
- (6) It must be cognizant of macro-economic trends likely to affect disposable income, preferences and so on.
- (7) And finally, this must be done for each possible product alternative.

Obviously the information requirements of this list represent a very large potential cost to the firm. Just as obviously, the requirements on the list can be drastically reduced if the firm is content to undertake a less than completely thorough analysis of its choice problem. The consequences of the uncertainty which arises thereby may represent a cost which is far less than the analytical and information costs--to say nothing of the time--necessary to resolve uncertainty. The burden of this uncertainty will be reduced even further if there are available to the firm institutions which provide substitutes for its 'analytically preferred' information.

#### B. 2 Determinants of Costs

The cost problem of the firm is completely similar to that of price, only the list of information requirements differs. Among the information requirements on the cost side are:

- (1) The firm must know what methods of production exist for each alternative.
- (2) It must know the costs of inputs (including capital investments).
- (3) It must know whether supply and labor contracts can be arranged.
- (4) It must know the effect of its own purchases on



input prices and reliability of supply.

- (5) For each method of production it must know how unit costs vary with the rate of output.
- (6) It must be able to estimate its costs of learning a new (or modified) method of production, marketing and finance.
- (7) It must be able to estimate the cost of selling the product (advertising, distribution, inventories, etc.).
- (8) And finally, it must be prepared to undertake all of the above for all the alternatives within its feasible set.

Here also a 'global' analytical technique is not likely to be feasible because the time and costs for acquiring adequate information and analysis are likely to be so high. The basic question is how the firm goes about conserving on these costs, both those associated with explicit resource expenditures and time.

### C. Pricing Methods in a Complex Environment

The discussion of transactions and institutions in Chapter 4 above made the point that exchange related institutions tend to provide a set of rules which function as substitutes for expensive and perhaps unattainable information about the economic environment. There was little or no discussion of the form or specific content of these institutions. At this point, the discussion of exchange institutions is continued with an eye towards the development of a theory of how and why pricing rules are developed. The aim is to point out that these rules are relatively general, much more reliable, and less expensive than, say, an independent approximation of the traditional profit maximizing approach of theory, and very useful to the firm trying to estimate surplus and arrive at its choice of product.

In any possible and proposed transaction the bottom

line position with regard to price of each party is called the party's reservation price. So long as the seller's reservation price is lower than the buyer's the transaction is possible. For the proposed transaction to become a reality the two parties must agree on the terms of the sale including a final price lying between their two reservation prices. What we are concerned with here are the rules and circumstances which govern the process leading to a final price. As before, we will deal with the transaction as an information problem, but in this case the emphasis is on the asymmetries in the nature and costs of information required by the two parties. What is important here is how variations in the circumstances of the market--which may be described in terms of the inhibitory parameters of the firm's short period equation--are likely to affect each party's relative information requirement and give rise to reasonably predictable patterns, in the rules or (informal) institutions used to arrive at prices. The discussion here is specifically aimed at the pricing process, but the arguments and conclusions apply almost in exactly the same way to the terms other than price which can be expected to be attached to the sale of any feasible product alternative.

The earlier discussion of transactions centered on the importance to a single individual of the informational variables, comparability and frequency of exchange of other products. Both are necessary to arrive at some notion--even one that is relatively uncertain--of reservation price. And both are easily describable for both buyer and seller in terms of the parameters of the firm's (the seller's) short period equation. Comparability, of course, is a function of how closely related other products are and is represented by the ratio of the  $c_{ij}$  and  $c_{ii}$  coefficients in the firm's short period equation. Frequency of sales of the firm's product is captured in terms of its own inhibitory effect upon itself with respect to time,  $c_{ii}/dt$ ; and the frequency

of sales of other firm's products is captured in the relative value of its inhibitory effect with respect to time,  $c_{ij}/dt$ . If it is assumed that the sales of all relevant firms are distributed evenly over time or in the same seasonal cycle, then the relative frequency (relative to each other firm) of a firm's sales is closely approximated by

$$c_{ii}X_i/(c_{ii}X_i + c_{ij}X_j) = c_{ii}^*$$

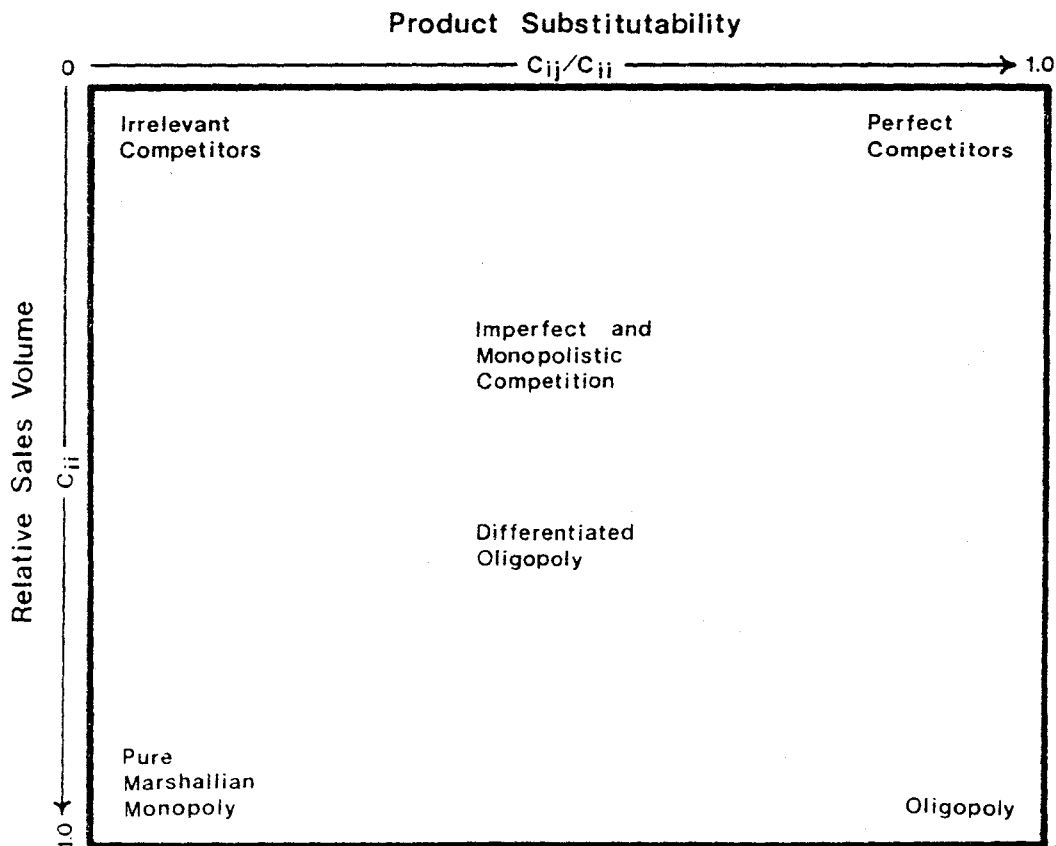
a term which conveys a sense of the relative volume of sales for each relevant competitor.

By arranging the positive values of these two variables-- $c_{ij}/c_{ii}$  and  $c_{ii}^*$ --in a simple table or map it is possible to capture the range of potential product market circumstances which a (single) product firm could face. [A similar map could be produced for complementary product market circumstances by also mapping in the negative values of  $c_{ij}/c_{ii}$ , and a completely analagous map for factor markets also could be produced using the  $b_{ij}$  parameters of the firm's equation.] This map for competitive product markets is shown in Figure 10 and may be explained somewhat as follows: Begin by thinking of the firm's relationship with any other single firm (i.e., any one of the  $j$ th firms) in the economy. This relationship can be plotted as a single point on the map simply by reading off the values of  $c_{ii}^*$  and  $c_{ij}/c_{ii}$  from the firm's short period equation. If the other firm is selling a product which is highly substitutable from the consumer's point of view (i.e.  $c_{ij}/c_{ii}$  tending toward a value of 1.0) the plotted point will lie somewhere in the right hand portion of the map. To the extent that the product is less substitutable the plotted point will lie towards the left hand boundary of the map. The vertical position of the plotted point depends on the  $i$ th firm's inhibitory effect on its own market relative to that of the  $j$ th or other firm, that is, the extent to which the firm itself rather than the other firm is capable of exhausting

its own product market in a given period of time. For firms whose rate of sales is small relative to the rate of creation of demand,  $c_{ij}$ , the plotted points (i.e., the collection for all relevant  $j$ th firms) will tend to lie in the upper part of the map provided that demand is filled by all firms together. For firms with high valued  $c_{ij}$  parameters (1.0) the plotted points will tend to lie towards the bottom of the map. In the case of expanding markets where saturation of demand has not taken place, firms with small inhibitory effects upon their own market will tend to yield plotted points towards the bottom of the map.

FIGURE 10

The Competitive Map of the Firm



If points are plotted for other, irrelevant, firms in the economy, the map will show a very strong concentration of points in the upper left hand corner corresponding to those other firms in the economy whose relative inhibitory effect on the firms in question is practically nil (i.e.  $C_{ii}^*$  approaches zero), firms whose products are, at best, remote substitutes for the firm's.

If the world were neatly arranged so that it corresponded to the traditional analytical constructs of economics the points plotted for the 'relevant' competitors would appear as tight clusters on the map. For example, corresponding to a perfectly competitive market structure one would find in the upper right corner a particularly dense and numerous cluster of points--perfectly substitutable products and, for each other firm, an inhibitory effect which approached zero. Clusters found towards the bottom right corner would still correspond to an analytical world of perfectly substitutable products, but each other firm would tend to have a relatively strong inhibitory effect--in sum, the analytical world of undifferentiated oligopoly. Clusters lying to the left of the right hand boundary correspond with the analytical world of differentiated product competition--towards the top monopolistic and imperfect competition, and towards the bottom differentiated oligopoly. Finally, approaching the left hand boundary of the map, one would find at the very bottom and exactly on the boundary pure Marshallian monopoly. Higher up along and near that boundary one would find an almost unknown analytical world of highly differentiated products in which one firm's competitive success or failure is not likely to affect another's (the arts, crafts, personal services, etc.). In summary, for any given firm whose competitive circumstances corresponded to one of the traditional analytical categories of economics one would find an appropriate clustering of plotted points.

The messy world we are trying to deal with here, of course, would not produce such neat clusterings when a firm's competitors were mapped. It is quite reasonable to expect that a large firm, for example, might face simultaneously homogeneous product competition from other large firms which have a strong inhibitory effect on it, and from small firms with small inhibitory effects, as well as differentiated product competition from both large and small firms all with widely varying inhibitory effects. Potentially, only the diversity of the product environment limits the range and circumstances of competition a firm might face. Its competitors are likely to be a heterogeneous collection of firms whose attributes and potential actions would be almost impossible to portray or predict precisely; put differently, the cost of the information for an analytically accurate description of a firm's competitors is likely to be prohibitively high.

In terms of the conduct of the transaction, this complexity is important because it gives rise first, to exchange situations which are potentially very demanding of information necessary for the establishment of reservation prices (as pointed out in Chapter 4) and, second, to situations in which the relative cost of this information to the two parties to the transaction is likely to be different. If it is assumed that under most conditions these asymmetries in information costs would tend to be correlated with the predominant (i.e., traditional analytical category) market situation of the firm then one would expect these regularities to lead to fairly regular pricing rules or institutions for establishing reservation prices. It would appear that the conditions necessary to produce this kind of regularity are:

- (1) Clustering of competitors at a point on the firm's competitive map similar to the other firm's maps (i.e., relative homogeneity of competitor's circum-

stances).

- (2) A relative lowering of the buyer's cost of information the more homogeneous the product associated with the firm's cluster. And,
- (3) A lowering of the relative cost of information to the seller the fewer the number of firms in the competitive cluster (i.e., towards the bottom of the map).

These conditions would place the greatest asymmetry in costs (favoring the seller) in the lower left corner of the map (pure Marshallian monopoly) and the greatest equality in the upper right corner (perfect competition). Between these polar cases one would expect, under these conditions, gradual and regular changes in information cost asymmetries associated with establishing reservation prices.

For the moment we will assume that the tendency of market institutions to provide simplified and somewhat distorted information and, consequently, perceptions of the environment, leads to a situation in which actors in the system tend to behave as if the regularities represented by the 'institutionalized' information flow accurately represent reality. Then if we were to approach the problem of each transaction as if its outcome were independent of other transactions (i.e., as if neither buyer or seller had yet developed uniformly applied pricing rules of thumb and was more or less attempting to act like a discriminating monopolist or monopsonist but perceived this regularity) and allow both parties to rely upon information from their own previous and other party's transaction we would be likely to find that the circumstances of each party, especially his "degree of presence" in the market, will determine his relative information costs. By "degree of presence" we mean simply the frequency and history of the trader's acquisition of or search for relevant market information. For example, the occasional participant or first time participant in a

market will face higher marginal information costs than the trader who has been continuously in the market. In effect, information acquisition costs are closely analagous to capital costs. Information costs have a high fixed cost component and the value of the accumulated item tends to depreciate over time--not as a function of use but simply because the context which gives it value--the economic environment--changes. In other words, one would expect collective information costs to rise and the value of acquired information to depreciate more rapidly during periods of rapid structural change and inflation, for example, than in more stable situations. Thus, in addition to the competitive circumstances of the particular product market, one would expect total and marginal information costs and, consequently, the asymmetries of costs in the transaction to rise or fall in response to the contextual situation.

Looking only at static competition, those variables which appear to be most important in the creation of asymmetrical information costs (i.e., that are most sensitive to the differing circumstances of buyer and seller) are:

- (1) Comparability of other products ( $c_{ij}/c_{ii}$ )--the less comparable they are the more costly information will be and the more the seller's continuous presence in the market will allow him to distribute these fixed information costs across a large number of transactions. The greater the comparability of other sales, the less costly information is to both parties, but the less the relative cost of information to the buyer is correspondingly. If buyer and seller are both continuously present in the market, these asymmetries in information cost with greater or less comparability should not occur.
- (2) Frequency of sales of this and comparable products --the lower the frequency of sales, the more costly



is information about the terms, circumstances and characteristics of other sales, and again the seller's continuous presence in the market reduces his relative information cost per transaction. The higher the frequency the lower the fixed information cost to both parties and the lower is the relative disadvantage of the buyer (unless, of course, the buyer is also continuously in the market).

- (3) Homogeneity or regularity of preferences and attributes of buyer--that is, a firm selling to a group of buyers whose circumstances and information sources are relatively uniform and/or regularly distributed will find its information costs regarding buyers' reservation prices lower than otherwise. With a decrease in the homogeneity of consumer attributes one would expect the total information cost to the firm to rise while that of consumers should not rise so rapidly since other product prices, not the attributes of other consumers, is more relevant to the buyer.
- (4) Homogeneity of attributes of other sellers of comparable products--the more other firms' circumstances (costs, inventories, etc.) are uniform or regularly distributed the lower will be the costs to the firm of learning buyers' likely reservation prices. However, as the circumstances of other firms become more dissimilar there is likely to be a greater variance in buyers' likely reservation prices and the cost of information to both seller and buyer; and information cost per transaction should begin to favor the seller because of the fixed cost aspect of information.

But relative costs are not the only factors likely to affect informational asymmetries. The benefits of information acquisition are of crucial importance, as pointed out

in Chapter 4, because together with costs they will determine actual information acquisition--or uncertainty tolerance--by either of the two parties. If we view the process of shopping or searching for market information as a series of paired comparisons of potential exchange alternatives, the variables which would appear to stand out as important are:

- (1) The proximity in characteristics space of either of the two alternative products to 'ideal' preferences, or put somewhat differently, the comparability of product and preference characteristics. One would expect that the closer the two products are in characteristics space the lower would be the benefits of successfully discriminating between the two and the lower would be the probability that rational behavior would lead to the actual acquisition of the information necessary to discriminate. One would also expect that the benefits effect would be similar for buyers and sellers, but that the greater presence of the seller in the market and consequently his lower information costs would lead to a greater likelihood of the seller entering the transaction with more adequate information than the buyer, unless of course, both were equally present in the market or the buyer more so than the seller.
- (2) The absolute value of the potential gains from trading or put differently, the potential losses from trading, place an upper limit on benefits and the rational expenditure of resources for information acquisition. Again 'presence in the market' would appear to determine the direction of informational asymmetries in the actual transaction. For example, it would be reasonable to expect that sales of high volume (from the seller's point of view), cheap and differentiated products would be charact-

erized by strong asymmetries favoring the seller. It is simply not worthwhile for the buyer to carefully acquire all relevant information when the benefits involved are so paltry. For the seller this is hardly the case.

- (3) Finally, when potential bargaining costs exceed potential gains, one would expect simple rules to develop for the establishment of price. The more comparable the products, the more these rules will reflect reservation (market) prices; the less, the more reliance will be placed on substitute information.

In short, the circumstances of the market and the characteristics of products tend to give rise to fairly predictable patterns of informational asymmetries. It is reasonable to expect that the information networks in the market will begin to codify and simplify data on the environment according to these perceived regularities. But one would expect that the categories, or instances, of these perceived regularities would far exceed in number the traditional competitive analytic categories of economics. In effect a kind of conventional wisdom might be expected to grow up. One would expect the growth of informal and perhaps formal exchange institutions, related to collective experience, which would tend to set standards regarding the terms and conditions of generically similar transactions according to the peculiar or particularistic attributes surrounding broadly defined product areas.

In other words, most of the conditions affecting the outcomes of transactions are determined primarily by circumstances external to the individual transaction. For any particular product grouping the similarity of conditions will tend to yield relatively similar outcomes which, over time, will become fairly well known. In a like manner the terms, or the set of rights and obligations, attached to

similar transactions will tend to approximate one another. Finally, the formation of expectations centered around these historical outcomes will tend to drive actual (current) outcomes into the mold of historical experience. This would happen because the institutional codification and simplification of historical experience would tend to deprive the market of information about unexpected or surprising results, i.e. those at variance with the expectations of the conventional wisdom. It is, quite simply, this process of converging expectations which produces for the firm relatively inexpensive and fairly accurate information about price and other transactional terms for products in its feasible set. In effect, what are called hunches or informed guesses are most probably extrapolations of these perceived regularities to new but still roughly similar conditions--product characteristics, location, and so on.

What is interesting about this process, if indeed it is what is going on, is that it would appear to create very strong forces limiting the perception of what is in fact feasible. For example, if consumer's product preferences (in this case formed from expectations regarding the performance or availability of characteristic) began to consolidate around the characteristics of the existing set of products, one might very easily conceive of a situation in which firms' fairly accurate perception of consumer preferences would lead them to believe that only small or perhaps even no changes in product characteristics would pass the test of the market. The often stated 'truth' of the sixties and early seventies to the effect that Americans would never buy small cars would appear, in retrospect, to be an example of this kind of informational phenomenon in the market.

But as this example perhaps points up, a significant alteration in the conditions of the market or the overall economic environment, probably usually coming from outside the system, can alter the substance of the surrogate inform-

ation provided by exchange related institutions. Because of the historical nature of this surrogate information, however, such alterations undoubtedly create a transitional period during which new surrogate information has not been codified, leading to a rise in the costs of exchange related information, uncertainty, and most probably, informational asymmetries.

Another very important aspect of this institutionally generated information is that its suppression of outlying possibilities, even though expectations may converge around its representation of reality, always leaves open the possibility that competitive advantage may be gained through access to a more accurate depiction of reality. In other words, the tendency of market institutions to simplify and distort reality would tend to always create 'vacant niches' ready for exploitation by some capitalist entrepreneur. Both this tendency and that for external change would tend to off-set the stabilizing effects of surrogate information and converging expectations.

## CHAPTER 7

### CHOICE OF PRODUCT

#### A. Introduction

To this point we have sketched out a view of long period environmental conditions--the nature of demand, the relationship of institutions to uncertainty, the flow of information, and so on--and factors contributing to the formation of expectations regarding price and other terms of potential transactions. We turn now to the overall question we have set out to answer: How does the firm go about choosing what to produce or do given relatively confident expectations about prices? Alternatively, in the context of an informational problem we can rephrase the question in a somewhat more operational manner as follows: How does the firm come to form its expectations about the potential density of consumer demand associated with all the product points in its feasible set? This rephrasing takes for granted the firm's ability to identify a product conforming with its own best interests (i.e., its ability to carry out the traditional analytical choice problem of economic theory, given a set of information) and shifts the center of attention to the firm's problem of acquiring information. It suggests that the flow of information to the firm may limit or bias its perception of the size and extent of its feasible set of opportunities and of the costs and benefits associated with each alternative in that set. It also suggests that competitive processes and outcomes may be viewed as being determined primarily by the collective, institutional mechanisms which give particular form to the flow of information and distribution of knowledge in the economy. It should not be surprising to the reader that our

approach to answering this question will tend to rely heavily on the theory of institutional information networks developed during our analysis of price expectations in the previous section of the paper.

## B. Assumptions

Our approach to the problem assumes:

(1) that actors in the system or market put primary informational reliance upon the 'regularities' in the environment as represented to them through the filtering mechanism of institutions. But

(2) in spite of these regularities it is assumed that technical change generated by new products, extra-market institutions or international trade, and a continuing process of distribution of information tend to cause a continuous alteration in the characteristics structure of consumer preferences. And

(3) firms are assumed to respond in a not entirely passive way (i.e., they may deliberately seek to reinforce or impede the flow of market information leading to changes in preference structure). They do so through the modification of old and creation of new products, or, described simply, through changes in the characteristics of their products. (As advertisements for the "all new" this or that demonstrate, it is sometimes hard to distinguish between modifications of old and creation of new products--'changes in product characteristics' may be a simple and easy way to avoid what may be an unnecessary definitional problem.)

Finally, we want to emphasize the need to cast the product choice problem in terms of a dynamic information acquisition problem which is overlaid with the firm's inability to permanently withhold the fruits of its informational search from its competitors. In other words, the problem is not a simple one of the costs of searching for and acquiring information; it is also a time dependent problem in

which the economic value of knowledge is a function of the duration of its relative scarcity. The duration of scarcity, in turn, depends upon the learning behavior of competitors.

### C. Imitation, Innovation and Product Niches

New knowledge of the demand environment is costly to obtain and difficult to retain for exclusive use. In effect, knowledge of the market has the attributes of a common property resource. On the surface this would seem to indicate that there is little or no incentive for the development of new knowledge about the market. But this is not the case if one takes into account the unique competitive position of each firm, especially as that position affects the firm's relative costs and the time required for acquiring any particular body of knowledge. What one finds is that an environment of this sort places a premium on a particular kind of innovation, namely an incremental change in product characteristics emphasizing relatively low learning costs and early returns.

This proposition may be explained somewhat as follows: in any common property resource where the characteristics or location of the resource are subject to frequent and more or less unpredictable change, an ephemeral 'property' right of a sort (i.e., an exclusive ability to exploit) accrue to the person or firm which discovers any changed or newly perceived characteristics of the resource. This ephemeral 'right' lasts only so long as other persons or firms are denied access to the relevant knowledge of the resource. Once the existence of that knowledge is recognized by others--which is usually soon after the discoverer begins exploitation of the new knowledge--it is only a matter of time and the learning costs faced by competitors before the process of imitation takes place. In effect, the innovator may count on only a short time during which he might exclus-



ively exploit the value of his newly acquired knowledge. As might be expected, these attributes of knowledge, combined with the relative competitive position of each firm (especially with regard to the unique characteristics of its body of resident knowledge) strongly influence the direction and extent of the search for new knowledge.

In Chapter 5 we discussed the firm's internal constraints vis-a-vis its new product search. In the collective process of competition, however, the firm also is constrained strongly by the current and potential activities of other firms, especially their ability to undertake adaptive change which might increase their inhibitory effects. Illustration of this process is most easily addressed from the point of view of a firm considering a change in product characteristics, and is most easily cast in terms of the problem of potential imitation by competitors.

At first glance, factors governing the rate of imitation with no real property rights seem likely to be determined by the manner in which the body of knowledge which constitutes the innovation is acquired and the relative position of the firms in product space vis-a-vis the costs of learning for imitators. In general, there would appear to be two polar or extreme imitative learning patterns: one is when the new knowledge is conveyed simply through its use (for example, search that results in the discovery of a good fishing spot or area of consumer demand is knowledge conveyed completely through observation). The second is new knowledge which only can be acquired through experience (for example, how to make an internal combustion engine is not easily conveyed through observation of an engine).

In the kind of 'knowledge' environment postulated here, however, these two means by which imitators can acquire knowledge tend to shade into one another, since the difference between the two forms of imitation are most clearly a function of the relative positions of the resident knowledge

of imitator and innovator. That is, the unique body of resident knowledge of each firm tends to dictate its relative costs of learning (ignoring here the potential for large differences in the relative efficiencies of the group learning process in each firm). For the imitating firm say, firm B, whose resident knowledge closely approximates that of an innovating firm, A, the amount of learning required may be so small that observation of the innovation may be all that is required to understand it. For a firm C whose body of resident knowledge is far removed from the innovating firm, comprehension of the innovation may require the acquisition of related knowledge in order to provide the context for understanding comparable to that of firm B. In short, we may look upon the costs of imitative learning as most closely approximated by distance in 'knowledge space', or, without the jargon, by the similarity in the competitive positions and histories of innovator and imitator.

This view of the imitative process suggests three rather elementary aspects of long period competition: (1) that imitators are likely to be found among firms most similar to innovators; (2) that the costs of 'contextual' information are likely to limit or constrain firms' search for information to nearby locations; or put somewhat differently, that the information flows or networks are likely to be denser the more similar the sets of resident knowledge; and (3) that the rate of imitation is likely to be correlated with the proximity of competitors' resident knowledge--the more similarity the more rapid the imitation.

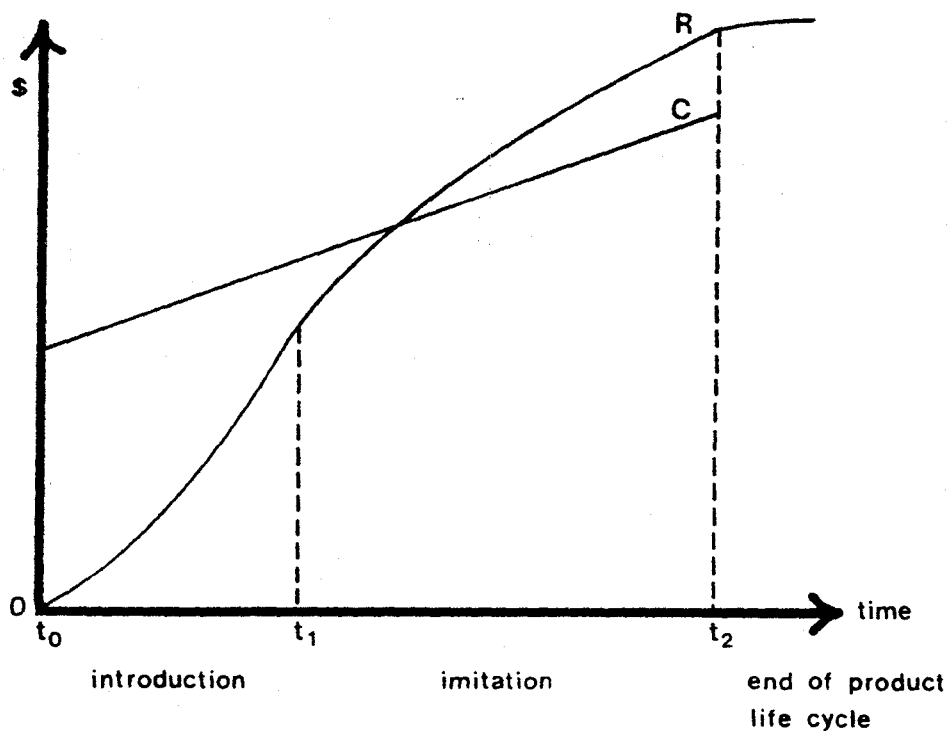
#### D. The Timing of Imitation

Given these aspects of imitative learning, a general question about the external competitive constraints facing the firm is whether they give rise to regular patterns of behavior likely to alter or impact upon the firm's choice of product. A relatively straight-forward graphical model,

emphasizing solely the innovating firm's problem of timeliness, provides an initial exploration of the problem. Figure 11 is used for illustration. Costs and benefits of product change are measured on the vertical axis and time on the horizontal. For simplicity it is assumed that investment in and introduction of the new product occur simultaneously at time  $t_0$ .

FIGURE 11

Costs and Benefits of Innovation



Let the period between  $t_0$  and  $t_1$  be the short period during which the innovator has de facto property rights due to the lagged response of imitators. The duration of this response is assumed to be determined by the proximity of other firms' resident knowledge. Curve c-c is taken as the cost over time of the investment in the acquisition of the innovator's new knowledge. C-c rises at a rate equal to the going rate of interest or opportunity returns plus the costs of production over time (assumed constant) from a level equal to the initial cost of the firm's investment expenditure. Curve O-R is taken as the gross returns associated with the innovation. It is further assumed that the effects of market saturation by the innovating firm do not begin before imitation takes place.

As drawn, the curve O-R reflects the innovator's rapid penetration of the market ( $t_0-t_1$ ), a decline in his rate of sales beginning at  $t_1$ , and around  $t_2$  a settling down to a rather constant rate of sales, followed by a decline which might be attributable to shifts in consumer preferences, the introduction of product change by a competitor or even the firm itself or any one of numerous factors which seem to contribute to the declining stages of a particular product's life cycle. Among other things, the curve assumes that imitative product change has purely inhibitory effects on the innovating firm, that is, that the proliferation of similar products does not alter the information environment of consumers in such a way as to lower their search costs or alter their preferences in a way that is favorable to the innovator.

Whether the product change yields a positive net return can be seen to depend crucially on (1) the initial cost of the product change, (2) the rapidity of spread and inhibitory effect of imitation, (3) the lifetime of the product and, of course, (4) the density over time of consumer demand. It can be expected that the firm will tend

to orient its assessment of feasible alternatives, or its preferences with regard to product change, in directions which will tend to minimize the net inhibitory effect of these four factors.

All other things equal, the firm would prefer:

- (1) incremental changes closely related to its current product--a lower value for OC in Figure 11
- (2) changes which tend to capitalize on its areas of relative advantage as conferred by its base of resident knowledge in order to prolong the imitation lag and minimize the probability of overly close competition by a firm with similar product change preferences (i.e., (1) above)-- a slower rate of decline in OR after time  $t_1$
- (3) relatively long product life--a longer period between  $t_1$  and  $t_2$ --and
- (4) of course, a product conforming to a relatively dense area of consumer demand--a proportionately more rapid rise in OR than OC. (Ignoring the opportunity cost of investment, there would tend to be a proportionate, and favorable, rise in both OR and CC.)

There is no reason to believe that all four preference factors will consistently point the firm's search in the same direction; rather it would appear, for reasons which we hope become clear, that the competitive process itself is likely to impose conflicting directional indicators.

#### E. Product Space and Imitation

To illustrate that process still further we turn our attention to the nature of imitative behavior in terms of product space movements, or put differently, in terms of the factors likely to affect the degree of product differentiation in the market.

If firm one chooses to imitate the product of firm two

(and provided product differences are the only significant ones between the firms) on the grounds that firm two's product characteristics correspond to an area of stronger consumer demand ( $c_{22} < c_{11}$ ), it could expect two effects to dominate its assessment of less or more completely imitative product alternatives. First, if its perception of a dense area of consumer demand arising from observation of the strong, or anticipated strong, performance of firm two is indeed correct, imitation will lead it into an area where the limitations of the market for its product alone will lessen (i.e.,  $c_{11}$  will fall). But, imitation will produce a second effect, that is, increasing competition arising from the greater proximity of firm two's product (i.e.,  $c_{12}$  will rise). The first effect will tend to enhance the growth of firm one; the second will tend to retard it. One would expect the favorable effects to be relatively stronger in the initial stages of imitation and the deleterious effects to become relatively more dominant as imitation proceeded to the ultimate of identical products. Firm two, of course, will be affected by the imitation of firm one. Throughout the process of imitation, assuming no response by firm two, the inhibitory effect of firm one on firm two ( $c_{12}$ ) will grow, probably at an increasing rate. This will tend to reduce the surplus of firm two as its sales decline.

One would expect that the two opposing effects of the imitation process would combine to yield a product equilibrium of sorts before firm one evolved to a product identical to firm two's. In other words, to the extent that the firm can anticipate these conflicting inhibitory effects, the process of imitation would stop when the beneficial effects of entering an area of greater consumer demand began to be outweighed by the greater inhibitions of more proximate competition. In the language of our short period model we would expect  $c_{12}/c_{11}$  to stop growing some time before the stage of perfect product homogeneity was reached

( $c_{12}/c_{11} = 1$ ). In effect, each firm will find its market position to be a niche, perhaps constantly changing as other firms' products and consumer demand change, which will place each firm apart from yet in close relation to other firms. Viewed from a slightly different prospective one would conclude that these same effects would combine to cause homogeneous product markets to disintegrate into differentiated product markets if it is technologically or legally possible. In effect, this process will tend to define the firm's niche and reinforce the uniqueness of its position in the environment.

#### F. The Cluster

If we were to apply this view of the imitative process with two firms to a multifirm situation, some interesting results emerge concerning the competitive process. Earlier we discussed the costs to the firm of simply perceiving the state of its environment, the relationship of these costs to its current body of resident knowledge, and the tendency to rely upon surrogate information from collectively or institutionally filtered perceptions of regularity. All these factors tend to constrain the scope of the firm's knowledge of its environment and limit the direction and extent of its search for new knowledge. The dependence upon surrogate information especially tends to restrict the firm's sense of what is feasible to the limited set of opportunities (or variants of them) represented by other relevant firms. In effect, costly information imposes a kind of conservatism on the product choice process.

In this context, then, what can be expected of a multifirm process? Basically, one would expect a form of product clustering to take place; that is, the relative commonality of information available to all relevant firms would tend to create similar, but not identical (given the uniqueness of the niche), perceptions of economically feasible products.

Furthermore, recalling the discussion of endogenous consumer preferences, one would expect similar informational processes to give rise to a set of consumer product preferences closely approximating the existing set of products. This will tend to reinforce the firms' perceptions of what is feasible, as well as reinforcing the tendency of products to cluster into groups of differentiated, but similar, products.

In a competitive environment, we should expect that multifirm processes will be based on the response to the unique contextual circumstances surrounding each individual competitive cluster. The current competitive position of any firm in the cluster and the source of any perceived competitive advantage for that firm can only be described in terms of the very context specific position it holds relative to all other firms. Consequently, there is little reason to expect to find generically similar long period processes, beyond niche and cluster formation, common to all clusters. What appears to be most pertinent to the analysis of long period processes are those variables which define the competitive situation of the cluster, especially the informational situation.

By the informational situations of the cluster we refer, on the one hand, to the factors influencing the flow of information within the cluster and on the other, to the actual information itself--namely, information about the product related spheres of knowledge of the market, technology and finances. The latter, of course, are particularistic to the cluster. The factors influencing the flow of information, however, can be described most easily in terms of the attributes of the cluster itself.

Our earlier discussions have brought out some of these factors which are worth reviewing here or perhaps restating as long period hypotheses:

- (1) Cluster packing--the preference for incremental



innovation has been described as a function of the expected rapidity of imitation or, what is virtually the same thing, the similarities of the resident knowledge of the firm and that of its competitors. Following this line of thinking we can think of tightly or loosely packed clusters according to the similarity of product histories, current products and resident knowledge bases of the firms in the cluster. Among tightly packed clusters, we would expect a relatively strong preference for fairly small changes, simply because firms in a tightly packed cluster would have reason to expect relatively easy and rapid imitation. The opposite might be expected of loosely packed clusters.

(2) The reasons why clusters might be loosely or tightly packed are:

(2a) Technological age--one would expect that knowledge of a new technology would create the potential of a large number of economically feasible products. In the early stages of the technology one would expect relatively few specific products, mostly those which would readily substitute for existing products (with a different technological base). But with the demand shifts arising from broader recognition of the feasibilities of the new technology and the refinement of the technology itself, one would expect the product possibilities inherent in the technology to become more fully utilized. This utilization can be expected both in terms of the range of products in characteristics space (as a result of technological learning) and in terms of a finer differentiation or variation in product types (as a result of learning about the character-

istics preferences of consumers when tied to the technology). In effect, technological aging can be expected to lead to tighter clusters and rationally more conservative attitudes toward changes.

- (2b) An enlarged span of a cluster in product spaces, even if the cluster is tightly packed, will bring greater diversity to the firms in the cluster. Basically, products combine characteristics; characteristics are likely to have differing technological, market or financial bases. In effect, clusters can overlap much like niches. The result is the infusion of new information in the clusters, a kind of synergy, more favorable from an informational point of view to some of the firms in the cluster.
- (3) The number of firms in the clusters relative to the number of products also should affect the information state of the cluster if the source of performance information sought by other firms is overall firms' performance. In this case, the performance of multiproduct firms conveys ambiguous information. However, if individual product sales rates provide sufficient information, the ratio of firms to products in a competitive cluster may be irrelevant from the point of view of information flows about the consumer environment. On the other hand, if a single firm occupies a large number of adjacent niches for technological, marketing or other reasons the total inhibitory effect of other firms may be significantly diminished, leading to a variation of the monopoly problem (see Lancaster 1979).

## CHAPTER 8

### NOTES ON WELFARE IMPLICATIONS

The theory presented here stipulates conditions in the economic environment and reaches tentative conclusions about competitive processes which are significantly different from those of the neoclassical theory of welfare. As might be expected, this theory also implies significantly different and, at this stage of the development of the theory, less easily specified welfare conclusions. This section of the paper attempts to sketch out the tentative welfare implications or questions about welfare problems raised in the theory.

In general we consider welfare theory to be concerned with the 'adequacy' of economic processes regarding the fulfillment of the collective welfare. Central to the traditional welfare problem is the 'macroeconomic' trade-offs which arise between efficiency and equity--the growth/distribution problem--on the one hand, and the proper means or criteria for defining and resolving 'microeconomic' conflicts between private and collective interests--the externality problem--on the other. The analysis of these problems in the neoclassical system is firmly grounded in the explicit propositions (1) that both social and private efficiency can be equated with cost minimizing behavior given proper accounting of costs and (2) that it is possible to identify or specify an exogenous aggregate welfare function. The conclusions of our theory are compatible with neither of these basic propositions.

Regarding the question of efficiency, this theory suggests that adaptive efficiency arising from the decision about what to produce or do, although not the exclusive basis for efficiency, will tend to dominate the competitive

process. (In an unchanging environment, however, it would be reasonable on the basis of this theory to expect cost minimizing efficiency to become dominant.) It is not immediately apparent that private adaptive efficiency corresponds in all circumstances to what might be termed 'social efficiency' since any notion of social efficiency depends upon a definition of aggregate welfare. Put somewhat differently, the notion of adaptive competition introduces the problem of variety into the social calculus (e.g. Lancaster 1979) and suggests a three way trade-off among equity, efficiency (in its traditional sense), and variety. Is variety in some sense a 'good thing' in the way that more of any given material 'good' is taken to be? What is the basis for preferring more variety to a greater quantity of a given set of limited goods? Is the proliferation of variety in market economics a response of the market to unique, niche-like, attributes of consumers, or merely the result of playing out competitive strategies, or perhaps the result of market created differences in consumer situations and hence preferences? This theory would find it rather difficult to conceive of an aggregate welfare function, given its assumptions of endogenously or environmentally influenced individual welfare functions and of scarce and costly information. Basically the 'transactions' cost of specifying such a function make it extremely improbable, and the endogeneity of preferences (which can be expected to change over time) would confer upon it only ephemeral usefulness.

This is not to say that the idea of such a function cannot be useful for certain analytical purposes. Rather, the point is that the behavioral improbability of such a function being employed by society suggests that the actual decision mechanisms and criteria used are subject to significantly different constraints and, hence, are likely to be much different than welfare theory envisions. We have tried to point out that the firm is strongly constrained by in-

formation costs. The welfare problem for society is one which is much more massively constrained by this same factor. We should expect the informational constraint as such to exert a strong influence on the process and choice of criteria with regard to social welfare questions.

Endogeneity of preferences, as assumed here, raises particularly difficult welfare problems. We have not tried to claim that tastes are fully endogenous, but simply that their expression in terms of product preferences is strongly influenced by the information available to consumers. This does not amount to an assumption of full producers' sovereignty (in the sense used by some of the critical caricatures of Galbraith's writings); but rather, it simply tries to point out that the strong informational influence of the material and cultural environment limits the potential range of consumer product preferences and, if firms are responsive to their perception of these preferences, the range of outcomes that can be considered if society's choices are dependent on market processes. This is not necessarily a question of the individual firm's ability to influence the preferences of potential consumers of its products, but rather it is a collective informational problem brought about by the limited capacity of informational networks--specifically their tendency to homogenize preferences through reliance upon surrogate and simplified rather than direct information about the environment.

In effect, we see the information problem as affecting a kind of collective reinforcement of current product types or trends to the exclusion of alternatives which might be open, or might have been open, to society had not the conservatism of the informational problem been imposed upon the product search and choice process. Given this, the general problem of the adequacy of economic activity can be solved either through what would appear to be a rather hopeless global search for and assessment of alternatives

not exercised, or through an assessment of the adequacy, or, perhaps it would be appropriate to say, the efficiency of the informational-institutional structure of the economy. Put another way, we may ask: are there other collective mechanisms or alterations of current mechanisms which are likely to constrain or limit individual and social choice processes less than the existing ones would? This latter approach to the 'adequacy' problem would necessarily direct one's research and policy approach towards the question of institutional function and structure as well as actual outcomes.

Endogeneity of preferences and adaptive efficiency together raise difficult questions about the so-called efficiency/equity trade-off. Perhaps the most fundamental problem here revolves around the inability, with endogenous preferences, to make unambiguous statements of social preference between one or another outcome of economic activity (product mix); in other words, taking an extreme view, if the constraints of information cause a perfect convergence of preferences around the current product mix, then any welfare criteria which mistakenly relied upon the exogeneity of preferences and was somehow able to assess those preferences would always pronounce the current state of the world to be the best of all possible worlds since any other conceivable outcome would not correspond to or match up as well with 'revealed' preferences. A less extreme view of the extent of endogeneity is one which admits information sources external to the current product environment into the process of product preference formation (i.e., new learning in the sciences, technology, the arts, and so on). Such a view introduces the possibility that alternatives other than the current might be perceived as 'better'. But the question of how this perception comes about, of how the judgement is made, cannot be determined independently or unambiguously so long as preferences are a function of the

collectively generated information network. Put as simply as possible, the relationship between human happiness or the human condition and any given economic outcome is likely to be very uncertain to the extent that product preferences are an endogenous function of the cultural and material environment. Consequently, to the extent that unambiguous rankings of alternative outcomes ~~cannot~~ be made, the theory suggests there is no efficiency/equity trade-off as such; there is simply an equity problem.

What is suggested by this theory as a more relevant welfare question, given the uncertainty of comparing alternative outcomes, is basically the collective problem of the consequences of economic growth. One is led to the suspicion, if the competitive processes outlined here are accepted, that the traditional welfare theory (and societal) emphasis on the importance of growth confuses the competitive requirements of individual firms (for whom continuous growth increases the probability of survival) with the collective welfare. Put differently, one is led to the strong suspicion that a very real welfare problem may be present in the possibly conflicting private and social interests generated by competitive growth processes. This is a possibility which is clearly raised in an environment of strictly limited, non-renewable resources; but our theory would seem to suggest that the problem is not simply limited to this kind of situation. There are costs to economic growth. The problem of the costs of growth has generally been looked upon as a problem of unaccounted for costs arising from deficiencies in the market mechanism. Implicit in this view (depending upon the proponent) is the proposition that 'internalization' or full and appropriate accounting of these costs through the extension or simulation of a property rights regime will resolve the problem. Market processes will then accurately reflect desired social outcomes. The suggestion put forward here is, in a sense,

more fundamental since it questions whether the competitive requirements for growth coupled with endogenous preferences so constrain society's perceived set of feasible alternatives that we could perpetually chase an illusory goal of 'more is better.'

In the context of a resource limited world the theory suggests that there is a possibility that a 'fully endogenized' market economy could go highballing along a particular high risk, resource intensive path without price or other informational mechanisms signaling other equally preferable, but less risky alternatives. If the answer to this proposition is yes, or possibly yes, then the operational welfare question would once again seem to be directed towards the design and functioning of institutional-informational mechanisms, in this case those that are, strictly speaking, outside the market but still relevant to its functioning--namely institutions whose information networks are not constrained by the process of converging preferences. There is no doubt that such institutions/information networks exist. The question is: what is their relevance and impact on economic processes?

The emphasis on growth may also be confused with the fact that growth makes the resolution of equity issues much easier than they might otherwise be. In short, many of the distributional problems in a resource scarce situation (i.e., all situations) can be avoided through the creation of a bigger pie. There is no doubt that continued growth has had the effect of reducing or eliminating serious social conflict, at least domestically. But if there is the potential that other aspects of growth are becoming more costly, then the relevant question once again appears to be an institutional/informational one--in this instance relating to the mechanisms for the resolution of conflict and their possible application to the equity problems we have tended to avoid through growth. Undoubtedly these



problems cannot be addressed without simultaneous reference to the accessibility of extra-market information (i.e., how do we avoid the pitfalls of 'endogeneity'?) and without some reference to the competitive structure itself which, through its requirement for growth, may exacerbate so much of what we call the equity or distributional problem.

The question of appropriate criteria for the judgement of equity has always been a painful matter for economic theory. The implication of the theory offered here is simply that equity criteria, or the design of such criteria, is not a matter for theory. For example, the Pareto criteria and its variants are explicitly formulated on the basis of exogenous individual preference functions and the assumed omniscience required to aggregate individual preferences. This is necessary if one is to make abstract judgements about the social preferability of one state of affairs relative to another. But this or any other possible universal criterion is clearly not appropriate to the kind of environment discussed here simply because such criteria do not take into account the effects of the information constraint. It is the information constraint which gives rise to the endogeneity of preferences and the inability to make unambiguous comparisons between one state of the economy and another. Hence the information constraint also indicates the probable inappropriateness of an aggregate welfare function.

What seems to be more appropriate in the consideration of equity is the informational/institutional constrained processes which tend to provide the particularistic, context relevant criterion upon which equity judgements are based (e.g., Wilson 1980). One might expect to find criteria of equity highly variable depending on the informational context and also relative to the market or cluster in question. In other words, one would expect, in the presence of choice, a kind of selection mechanism favorable to firms or individuals who traded under conditions perceived to be 'fair',

however inarticulate the sense of fairness might be. This selection mechanism should give substantive particularistic form--in terms of more and less acceptable ways of doing business--to the incoherent sense of equity contained in the community. Hence, to the extent that the institutional/informational state and other characteristics of the market or cluster provide the basis for reasonably informed choice of trading partners, more favorable economic circumstances ought to evolve for the firms and individuals who conform to the more acceptable trading practices. Nevertheless, at no time in this evolutionary process are the equity criteria themselves likely to be articulated; rather they will probably remain embedded in the process in the form of relatively particularistic laws or informal rules. From the research and policy point of view the interesting questions ought to revolve around the economic 'adequacy' of laws and informal rules especially given the constraints of their evolution and operation. Alternatively, the conditions under which such choices can realistically take place ought to be a matter of concern.

Another interesting welfare problem which is brought up by the whole question of imperfect information is the problem of lying deception. If exchange and competition were characterized by universal intents to be truthful, the uncertainties of economic interactions, although certainly not eliminated, would be reduced considerably and one would expect the organization and outcome of economic activity to be considerably different from what is observed. What appears to be a very interesting question in this regard is the characteristics of institutional structures which give rise to circumstances in which the intent to be truthful is reinforced or not. In other words, the problem with lying and deception is that it increases uncertainty and leads to more inefficient and inequitable outcomes. In effect, individual gains from opportunistic behavior are clearly not in the in-

terest of society; undoubtedly there are institutional arrangements which tend to reduce or minimize these problems. Hierarchical structures would seem, for example, to encourage the intent to be truthful and this may, in fact, be one of the sources of the relative economic advantage of such structures. But if this is so then the structure of markets with regard to their propensity to encourage credibility of statements is very important when considering the question of the extent to which economic activity requires that people subject themselves to hierarchical control. In effect, the entire question of the impersonalization of economic activity because of the growth of government and business hierarchies may be related, to a surprising degree, to the potential for opportunistic behavior in many market situations (for example see Williamson 1978).

The externalities problem as stated by neoclassical theory is also difficult to rationalize in terms of our theory, also because of the assumption of endogenous preferences and our differing conclusion with regard to the nature of competitive efficiency. Without doing too much violence to neoclassical theory, it seems fair to state that pecuniary externalities operating on the behavior of the individual firm through price signals are viewed as a desirable and, fortunately, normal state of affairs; but technological externalities operating outside the price mechanism are viewed as undesirable and, fortunately, exceptional. To give this a somewhat broader normative interpretation, we might say that neoclassical theory finds any interactions which are arrived at through mutual agreement of the relevant parties as desirable and finds interactions initiated and completed through unilateral action as the source of many economic and social problems. This broader interpretation is a reasonable normative statement which does not present problems for our theory. On the other hand the first, more technically specific statement with regard

to pecuniary and technological externalities is one which attempts the marriage of a normative statement (i.e., the immediately preceding) with a statement on the nature of competitive behavior (that unilateral action must be extra-market, i.e., circumvent the market; and that it is an exceptional occurrence) in a way that is incompatible with the assumptions and conclusions of our theory.

Basically, the argument here is that in a world such as we have outlined, adaptive competition involves strategies and responses to unilaterally initiated actions which may not be consistent with greater social efficiency. For example, there is the frequently made assertion that advertising can produce strategic situations analogous to the prisoner's dilemma in which the firm is "damned if it does and damned if it doesn't" respond to a competitor's initiative. In other words, in information poor environments there is an invitation to pursue strategic behavior from which there is always a possibility that all relevant parties may be worse off. From the normative point of view there is little or no reason to disagree with the broadly defined neoclassical position on the undesirability of unilateral action. From a positive point of view, however, there is strong reason to suspect that a complex, information poor environment will be rife with these kinds of problems. Perhaps the only thing which might constrain or limit this kind of competitive behavior is the existence of informal prohibitory agreements or rules, that is, institutions, within markets and competitive clusters. In other words, the theory leads to the hypothesis that there are indeed a great many possible and socially undesirable interactions among competitors which, if carried out, would seriously erode the performance of the market and possibly the interests of each competitor, unless the experience accumulated within the relevant institutional/informational network served to create behaviorally constraining rules.

Situations of common property exploitation--fishing, hunting, grazing--provide some interesting historical examples of the effects of these kinds of rules, on what is assumed to be the classical, or archtypical, technological externality (Acheson 1975a, Hardin 1976, Wilson 1977). Similarly, ordinary competitive situations abound with informal competitive rules (business ethics) and formal rules (commercial codes).

The importance of the institutional/informational factors in the so-called externalities problems is perhaps underlined by the fact that the most glaring of these problems, for example, pollution, occur across the boundaries of the informational networks created by markets and competitive clusters. In these instances, there is an absence of informal institutional structures necessary for the formulation of limiting rules, that is, there are no competitive clusters nor any relevant markets. Consequently, the lack of direct competitive interactions and the inability to withdraw from (non-existent) exchange or exert other forms of strategic leverage increases the probability that unilateral strategic behavior will be perceived as, and will actually be, unilaterally beneficial. Put somewhat differently, since the unilateral action is directed across cluster boundaries there is little likelihood of a competitive response which could escalate into a mutually degenerative situation. Furthermore, since the unilateral action is not related to an on-going series of transactions there is little likelihood that potential trading partners will withdraw from exchange which is beneficial to the party initiating the unilateral action.

The neoclassical school tends to divide into two points of view on this matter of across cluster unilateral action. First, there is the Pigovian view which adheres rather strongly to the notion that appropriate changes in relative prices can be devised and applied in such a way as to

produce socially desirable behavior. Second, we have the property rights view which argues that the full extension of property rights to all valuable resources will transform all interactions into voluntary market interactions and thereby solve the problem. Both these lines of thought share the same basic premise with regard to the costliness of information--basically that it is not costly, a premise which is strongly at variance with our theory. The Pigovian view tends to attribute almost omniscient powers to the government which can ostensibly set the appropriate taxes, subsidies and what have you required to alter relative prices appropriately, dynamically and in a manner which will actually improve allocative efficiency. The property rights school tends to attribute a similar omniscience to individual actors in the market while at the same time denying the potential opportunity for strategic unilateral actions within a market context. One is tempted to see the differences in the assumptions of the two views as reflecting not so much a perception of the reality of the information constraint, but rather an ideological predilection for or against government action. It seems strange to attribute imperfect knowledge to one, but not another, sector of the economy.

From the policy point of view, then, our theory tends towards a somewhat eclectic view on the appropriate basis for ameliorative action. On the one hand, there is a strong presumption that the informational cost burden necessary to simulate the appropriate price mechanism for across cluster strategic actions (for example, concerning pollution) would be excessive given the particularistic and changing aspects of the relevant technology and markets. The results of such Pigovian policies might just as easily decrease allocative efficiency and equity as improve them. On the other hand, there is a strong presumption that property rights alone are not likely to improve either the efficiency or equity of the

market. They may be inappropriate to the circumstances and/or they may involve such high social costs with regard to their definition and enforcement that they represent a net deterioration, rather than improvement of the situation.

Collective, institutional action (beyond the minimal one of maintaining order) is necessary for the proper functioning of any market. But there is an informational cost associated with collective action also. What is suggested and what is the source of the eclectic view of our theory is that from a policy perspective problems arising from across cluster unilateral actions should be subject to a wide range of ameliorative sets of differing rights and obligations. In other words, solutions to these problems are not necessarily limited to either "no rights and obligations" or "property rights" (or the simulation of their effects). There may be, in fact, many potential solutions falling short of the creation of property rights but still more constraining than the ones currently prevailing. Each of these alternative sets can be expected to alter behavior and give rise to costs of defining, defending and enforcing rights and obligations. Depending upon the particularistic circumstances, the social benefits of the induced behavioral change and the social costs of any given institutional structure will vary. However, the policy problem is not simply to choose the institutional variant with the most favorable benefit/cost ratio. It would also appear to require an institutional variant capable of generating a collective sense of what constitutes social benefits and costs--in other words, the choice of institution is probably best made in terms of the process it creates.

PART III

APPLICATION OF THE MODEL TO THE NEW ENGLAND FISHERIES



MEMORANDUM

## CHAPTER 1

### THE SOCIAL AND ECONOMIC ENVIRONMENT OF FISHING

Facts do not speak for themselves. They make sense only within the context of a theory. Indeed, what the facts are depends on the theoretical point of view involved. That is, no scientist reports all of the phenomena under study. What data are selected and the way they are organized depends on the set of theoretical glasses worn at the time. In short, any statement of facts and any description has embedded in it a model (Hospers 1946:69-79; Beattie 1959:118-123).

The adaptive model described in the last section is particularly useful when applied to the fishing industry of New England. Not only does it allow us to account for a very high percentage of the phenomena observed; but it has allowed us to see certain facts about the industry which have not been reported previously. The result is, we believe, a unique and more comprehensive picture of the fishing industry and fishing behavior.

First, the environment within which fishing takes place is very similar to the one assumed in this model. (See Chapter 4, Part II.) At first glance, it might appear that fishing is a relatively simple, traditional, and uncomplicated industry where change comes slowly if at all and where physical strength is at a premium rather than skill and knowledge. To those not familiar with the industry, it appears that there is only one product--namely fish--which are caught with boats equipped with a technology (i.e. nets) which has remained essentially the same for decades.

In reality, fishing is a highly heterogeneous industry operating in a very complex and changing biological and economic environment. There are a number of different species caught in New England, each of which is associated with dif-

ferent technologies, marketing arrangements, processing techniques, annual rounds, and legal requirements. In fact, one could easily make the case that fishing is several different industries. Fishermen are constantly changing and innovating. In all cases, business success is strongly influenced by skill and knowledge. Indeed, fishing is such a competitive, changing industry, demanding such diverse sets of skills, that a stupid, inflexible person can succeed, if at all, only with enormous effort.

In New England the boats in use range all the way from 12 foot outboard-powered skiffs costing only a few hundred dollars, to 150 foot vessels equipped with the most sophisticated electronic gear involving investments in excess of two million dollars. The smaller boats carry a single man and go day tripping only a few miles from shore; the largest vessels have crews of more than a dozen men and operate all over the Gulf of Maine and Georges Bank for days and weeks on end. There are at least 19 major types of fishing gear in common use, which involve different levels of skill and capital investment, and which are used for different species (Acheson 1980b). For example, a lobster trap costs only \$35 and is used to catch only lobsters and crabs; a 60 foot (a common size) bottom trawl net costs about \$8000 (including the doors and cable), and commonly catches six to ten species per tow. A clam rake can be used effectively with only a few days practice, assuming one knows where to find the clams; a purse seine requires at least five years experience to use effectively.

The boats, gear and skill are matched to the species sought. The habits of these various species and their life cycles differ widely and have a marked impact on the behavior and decisions of fishermen. For example, all species caught show different migration patterns. Lobsters remain generally in the same area throughout the year, but migrate inshore in the spring and out in the deep water in the fall. Thus, in

the summer, fishermen place their traps close to shore; in the winter, they are fishing as much as 20 miles from their home harbors. Herring have markedly different patterns. Marketable-sized herring come ashore to spawn in the warm months of the year--between April and October--in the central and eastern part of Maine where they can be caught in the bays and estuaries in stop seines and weirs. In the late fall, the larger herring migrate southward and are caught in mid-winter by purse seiners and pair trawlers in the deep waters of Massachusetts Bay or south of Cape Cod. Scallops show still other patterns. They migrate or travel only in the larval stage and land on the bottom in dense clusters depending on tide and currents. Thus, first one area of the Gulf of Maine has large beds of scallops and then another.<sup>1</sup> Besides lobster, herring and scallops there are at least 29 other species commonly caught in commercial quantities in the Gulf of Maine.<sup>2</sup> The habits and habitats of all these species are different enough so that each requires something different of the men who would harvest them.

There are three very distinct marketing arrangements used in the area. Every harbor in northern New England has one or more lobster dealers or a cooperative which sells bait, gas, and other supplies and which buys lobsters from the fishermen who regularly do business there. Such dealers or cooperatives buy lobsters from "their" fishermen daily, and then resell them to restaurants, pound operators, large lobster shippers in Boston or New York, and so on. Groundfishermen, in Maine and New Hampshire, however, generally ship their fish to Boston or New York where they are sold by a

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<sup>1</sup>The habits and life cycles of various species and the technology used to capture them have been described in some detail in another volume. See Acheson et al. (1980).

<sup>2</sup>Maine Landings 1979 (Department of Marine Resources)

broker. These fishermen own their own fish until they are sold. Increasingly, groundfish are sold to local processors and dealers with whom the fisherman has a long-term arrangement (Wilson 1980). Herring fishermen are ordinarily obligated to sell their catch to one or another of the herring processing firms in the central or eastern part of Maine. Usually these processors loan fishermen money for fishing gear with the stipulation that their firm has "first refusal" on the herring caught.

While fishermen and processors have an intimate knowledge of the laws affecting the species they handle, the legal situation appears very complicated to one not familiar with the industry. Not only do the laws vary for each species within each jurisdiction, but the regulations on a single species vary considerably from state to state. Maine, for example, makes it illegal to take lobsters over 5 inches on the carapace or under 3 and 3/16 inches. In New Hampshire, lobsters must be 3 and 1/8 inches to be legal; in Massachusetts the legal size is 3 and 3/16 inches, and in Rhode Island 3 and 1/4 inches. In New Hampshire, Massachusetts and Rhode Island there is no prohibition on the landing of lobsters over 5 inches long. Differences of this type can be seen in the states' laws regarding most other species as well.

Since 1976, when the Fisheries Management and Conservation Act (PL94-265) was passed, the regulatory picture in New England has become increasingly complex as first one species and then another has come under Federal regulation. In this process, the rules and regulations governing the exploitation of a single species have changed very rapidly depending on the scientific information available and the political pressures engendered (Acheson 1980c).

New England exhibits a good deal of geographical variation as well. The southern part of the region (i.e. from Portland, Maine south) is heavily urbanized and industrialized. Wages are high and unemployment is relatively low. Groundfish

are the primary species available. A high percentage of these fish are caught by large boats operating far offshore. As one moves further east along the Maine coast, population density decreases and the area becomes increasingly rural. In the central part of Maine, groundfishing is far less important than either lobstering or herring fishing. The eastern part of Maine is very rural, isolated and impoverished. In this area, inshore herring, lobster and scallops are the fisheries of paramount importance. Very little groundfishing is done. Wages are low, job opportunities are very poor, and the area has had an unemployment rate not exceeded by most other places in the eastern United States since the depression of the 1930's (Acheson et al. 1980:246).

Some fishermen in New England fish for one type of species throughout the year with one type of gear. This is particularly true in the southern region, where a good many large boats do nothing but fish for groundfish or scallops in the offshore regions of the Gulf of Maine (for example, Georges Bank, the Great South Channel). As one moves further north and east, an increasing number of fishermen fish for multiple species over the annual round (Acheson et al. 1980: 253-255). In eastern Maine, for example, it is common for fishermen to seek lobsters in the summer and fall and go scalloping in the winter and spring. In this same area, a large percentage of the stop seiners and weir fishermen are also lobstermen. In the central part of the Maine coast, many fishermen tend to combine lobster fishing with gillnetting for groundfish. Moreover, in this area the boats which fish for herring with purse seines and gillnets often go bottom (otter) trawling for groundfish during part of the season.

Not only are there regular, patterned changes over the annual round as first one species and then another becomes more plentiful; fishermen are also making a good many permanent changes in fishing gear. In New England as a whole, the boats in use are unquestionably becoming larger and the

gear in use is becoming more versatile. Thus, in the region an increasing proportion of the fleet can fish in a larger number of locations for a larger number of species (Acheson 1980c).

The enormous technical, biological and geographic variation in the New England coastal area introduces a good deal of uncertainty into the decision-making process of fishermen. After all, a strategy which may work well for a fisherman with one type of boat, fishing for one species in a given season and area may spell financial disaster for a man with different equipment fishing in a different area. Even two men fishing from the same harbor at the same time with the same gear may have very different incomes if the range of their boats or other factors differ.

There are four additional factors which introduce a good deal of uncertainty into fishing. First, the price of fish fluctuates seasonally. The price of lobster, for example, normally reaches its annual high sometime in February or March when catches are very poor, and is at its lowest point early in the fall when catches are at their highest. In 1979 the low point was \$1.10/pound in late July, while the highest price paid was \$3.65 late in March. While this general pattern has prevailed in the past few years, no one can predict how high or low the price will go, nor what the price is apt to be on any given day. Moreover, within any given season, the price paid to fishermen can jump very suddenly with little or no warning. For example, the price of lobster at the New Harbor, Maine Cooperative was \$3.25 on April 30, 1980; \$2.50 on May 1; \$2.25 on May 2, and \$2.00 on May 3. Prices paid for finfish are even more volatile. There are so many fishermen in New England that there is nothing any one fisherman can do to affect the price paid for a given species at any single time. Prices are influenced by such factors as demand nationally and internationally, the volume of Canadian imports, and so on.

While the general patterns of fish movements are well known, there are such a large number of factors influencing fish behavior that it is very difficult to predict exactly where concentrations of fish of different species will be at any given time. It is not enough to know that herring generally move toward shore in the spring and out to sea in the fall; a purse seiner has to locate schools of herring within a hundred yards. The lobster fisherman needs to know when lobsters can be caught off a particular shoal. The groundfisherman when he leaves shore in the morning will do much better if he knows that incoming cod can be caught in 30 fathoms of water rather than 50 fathom water five miles away. The fact that no two seasons are exactly alike makes it very difficult to accumulate information on fish locations. Sometimes concentrations of fish show up in very different places from year to year. In 1978, for example, great schools of herring were found in the easternmost area of Maine; the year before, large schools were caught in the Penobscot Bay area--100 miles to the west. While such year to year differences in fish concentrations are unusually pronounced in the case of herring, the same phenomena can be seen with other species to a lesser degree.

Another factor influencing the economic success of fishing vessels is the psychological make-up of individual crew members--particularly the way that the captain and mate complement each other regarding their willingness to take risks (Roberts and Acheson n.d.). While a captain may know what to expect from his crew after they have been together for a while, the composition of fishing crews typically changes frequently. This clearly introduces an element of uncertainty, and one that has a significant effect on the performance of the boat as a whole.

Last, the catch of any boat depends on the behavior of other captains and boats. The catches a lobster fisherman will obtain from traps placed in a given location will vary



significantly depending on whether he is the only fisherman who has placed traps there or whether other fishermen are competing for a limited number of lobsters. Much the same situation is true in herring fishing and groundfishing. The first boat to drag a particular piece of bottom on a given day or put a net around a given school of fish has a definite advantage. Latecomers are faced with bottom which has been partially swept clean of fish, or schools which are dispersed.

In summary, the environment within which fishermen operate is very complicated, heterogenous, and introduces a high degree of uncertainty into the fishing business. This uncertainty is increased by the fact that many factors on which fishing success depends vary considerably from one time to another. This is particularly true of the stocks of fish, their locations, and the prices paid for them.

In the face of all this uncertainty, the fisherman makes two fundamental sets of decisions: (1) what species to produce, and (2) how to catch them. In the short run, he may have very little choice in even these matters, given the boat and gear he currently possesses. A man who has only a small boat and a few hundred lobster traps cannot possibly go swordfishing in the Gulf Stream without making a large investment in a new boat and equipment. Even if a man has a versatile boat and set of fishing gear, it may be difficult to change to a different species. It takes two months to repair and prepare the number of lobster traps required to make a living in lobstering on a minimal level. Once a man has committed his time and has a gang of traps in the water, it is very difficult for him to go groundfishing without a major financial sacrifice. In a similar vein, once a boat is equipped to go offshore scalloping, it generally remains in the scallop fishery for a long time since expensive and permanent modifications of the hull have to be made for a boat to enter the scallop fishery. In the long run, fishermen can

and do make major changes in gear, boats and species sought. This is not to suggest that fishermen have no flexibility in the short run. Fishermen are constantly making changes in fishing strategies, that is, in locations, species mix, and market. The changes that fishermen can make in the long and short run will be analyzed in great detail in our discussions of clusters and niches below. At this point, it is crucial to realize that fishermen do not make decisions concerning either the quantity of fish to be caught or the price charged. Fishermen will catch all of the fish of a given species they are able to catch, given the time and equipment available. How much fishermen should catch from a given set of lobster traps or purse seine sets is not the issue. They keep all of the fish or lobsters caught. Moreover, the fisherman has no control over price. They are generally price takers (Wilson 1980).<sup>1</sup> Sometimes they do not even know what the price will be until they have landed. Maine groundfishermen may not know for ten days or two weeks. When a fisherman feels the price is too low, his only recourse is to stop fishing temporarily, or switch to some other species.

To say that fishermen concentrate on only two types of decisions (i.e. what to fish for and how to catch those fish) is not to indicate that fishing is a simple, uncomplicated industry in which few decisions need to be made. Quite the contrary: the environment in which the fishermen operates is so complex and heterogenous and marked by so much uncertainty that a good deal of skill and knowledge is required.

The skills and knowledge involved in fishing are not ordinarily learned in school; moreover, formal education does not facilitate learning fishing skills. A stepwise multiple

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<sup>1</sup>The single exception to this rule may be the large offshore finfishing boats operating out of the large ports in Massachusetts. When three or four of these boats land in close sequence, the price of fish can be reduced (Wilson 1980).

linear regression run on data collected in a sample of 190 groundfishermen and herring fishermen showed no significant correlation between years of formal education and level of fishing success (Acheson 1980i; Acheson and Reidman 1980a). An earlier study on lobster fishermen also demonstrated that number of years of education plays little role in influencing catch or income in this fishery (Acheson 1977a:114). Fishermen are very aware that formal education is no guarantee of success, although some very successful fishermen have college educations. These data suggest that there is more than a grain of truth in the apocriphal stories fishermen tell about "the educated fool," "the college boy who couldn't catch fish to save his soul," and so on.

However, it is very clear that skill and knowledge are strongly linked to fishing success--even though those skills are not learned in school. The evidence comes from a variety of sources. Fishermen themselves are fully aware that technical skills are of critical importance, and are constantly comparing the skills and strategies of various men. Differences in skill have shown up in several studies carried out by one of the authors. A study of fishing effectiveness in the Maine lobster industry turned up the fact that the skill of the individual fisherman was one of the most significant variables affecting catch. A regression analysis on these variables (i.e., fishing area, head type, type of bait used, depth, type of bottom, and so on) indicated that there were only two variables that had more influence on catches than skill--namely the season of the year and length of the trap (Acheson 1980e). Still another study of the Maine lobster industry pointed out that skilled fishermen caught more pounds of lobster per trap, and had higher gross incomes than unskilled men (Acheson 1977a:130).

Skill can also produce wide disparities in the income of lobster fishermen. One of the authors knows two men who go lobster fishing out of the same harbor. The younger, who had

only five years experience in 1973, used 900 traps and a thirty six foot boat. The older man, with some thirty-six years experience in the business, used only 300 traps, which he fished from a boat twenty-eight feet long. In spite of these differences in equipment, the older man had a net income of \$21,000 from lobstering in 1973, while the younger man netted only \$12,800.

Skill and knowledge are important in other fisheries as well. A regression analysis on a large sample of groundfishermen revealed a significant relationship between level of fishing skill and indicators of fishing success (Acheson and Reidman 1980a).

While it is obvious that skill and knowledge are important for fishing success, it is less clear what these skills are and what knowledge fishermen have to have to be successful. Direct, formal interviewing techniques are not effective in studying skills. Questions designed to elicit data on skills were often only successful in eliciting instances of fisherman's humor or open resistance. Much of the secrecy surrounding the subject of skills stems from the fact that this information is so critical for success. As one fisherman phrased it when he was asked about skills, "You are asking the secret of how I earn my living." He clearly was not interested in talking about the subject. Under these conditions, more indirect methods, including participant observation and intensive but open-ended interviewing, proved far more successful in obtaining information on these topics.

The study that produced the most detailed information on fishing skills and knowledge used a very indirect approach. In this study, some 18 highline lobster fishermen and four biologists were shown a set of eleven tables on lobster catches in their area and asked to interpret the results. (These tables contained information on such matters as pounds of lobsters caught per trap in different locations, in different seasons at different depths, on different bottom types,

and so on.) The Rohrschach-like technique produced excellent results. The average interview lasted some three and a half hours, and revealed a whole world view of fishermen concerning the life cycle of the lobster, physical features of the ocean bottom and technology--especially as these factors influenced lobster catches. Interestingly enough, there was no difference in the perceptions of the biologists and fishermen on virtually all issues (Acheson 1980d). Unfortunately, similar studies have not been done in other fisheries. Thus, our information on knowledge and skills in the herring industry, groundfishery, and so on are far more impressionistic.

After several years of contact with the fishing industry, we have been able to come to several major conclusions concerning fishing skills and knowledge. First, there are several different kinds of skills involved in fishing; the kinds of skills and knowledge with which novice fishermen are most concerned are different from those that are of concern to experienced fishermen. Men with under five years experience are most concerned with learning to navigate and to maintain their boats and equipment, and with how to operate their gear without undue financial losses due to accident and breakdown. They are more interested in avoiding disaster rather than maximizing profits (Acheson 1977a:121). These are, of course, skills and knowledge that are of concern to any fisherman, and which anyone going into the business would have to learn. The more experienced fishermen, by way of contrast, are most concerned with learning "the bottom." When fishermen talk about "bottom" they are speaking very literally. The tourist or amateur fishermen looking at the ocean sees waves and water; the experienced fisherman sees humps, ridges, edge, mud-covered channels, rocky shoals, steep dropoffs and a hundred other specific features that can only be memorized after years of experience. The knowledge experienced fishermen have of "the bottom" are legendary. Not only can they locate specific very small features (for example, a wreck, a

rocky outcropping, a small hole) miles from shore; they also can navigate from one location to another in a thick fog simply by looking at the changes in the contours of the bottom on electronic sounding machines. There are two basic reasons fishermen pay such attention to the details of the ocean bottom. First, it helps them to find fish, since concentrations of fish are located at different times of year on bottom with different characteristics (Acheson et al. 1980:Chapter 2). Thus, when fishermen speak of knowing the "bottom" they are talking not only about the physical features of the ocean floor, but about a whole theory of fish movements and behavior as well. Second, a knowledge of the bottom is necessary if one is to operate fishing gear successfully and without damage. This is particularly true of dredges and bottom trawls that can be completely destroyed if dragged over rocky bottom.

Second, there are very substantial differences in the specific kinds of knowledge about the "bottom" and fish that are required by each industry. In the lobster industry, the most critical skills involve trap placement. The overall pattern of such placement is relatively simple. Men place traps with three factors in mind: concentrations of lobsters, avoiding the destruction of traps from storms, and competition from other fishermen in any given area (Acheson 1977a). This means that traps generally are moved into deeper water in the winter and back in shallower water in the warmer months of the year to follow lobster migrations, always with an eye to the depth of water to avoid storm losses. The subtleties of trap placement are very complicated indeed, and take a good deal of time to acquire. Some men never do learn them. They simply memorize a set of "moves" and mechanically change the position of the traps seasonally without understanding any of the factors involved. Highline fishermen, however, have a large body of knowledge about the microecology of the ocean bottom and the way that affects the behavior of the lobster.

They try to place traps with pinpoint precision to "hit" the specific types of bottom which they know have characteristics which will be productive of lobsters. The specific skills and knowledge of lobster fishermen have been described in some detail in two articles (Acheson 1977a;1980d).

In the groundfishery, the critical set of skills involves a knowledge of the "tows" or flat areas where bottom trawls may be used without becoming entangled. One also has to know the "snags," the piles of rock, the sunken boats, and other obstacles which can destroy a set worth several thousand dollars in a matter of seconds, and put one out of business for a matter of hours or days. Groundfishermen must not only be able to read electronic devices giving information concerning position and characteristics of the bottom, but must also have some system of recording and recalling a very large number of details about the bottom over wide areas. Some fishermen record details in books. The "tow and snag books" of experienced, successful fishermen are reputedly sold for many thousands of dollars on retirement.

Herring fishing requires still a different set of skills and knowledge. The most important skill in weir fishing concerns the spot to build the weir in the first place. This involves primarily a knowledge of the places which herring schools have frequented over the course of many years. Stop seiners not only have to know how to pick seining locations (i.e. "berths") but also have to master techniques to know when fish have entered a particular cove which can be shut off. For herring fishermen exploiting schools in open ocean (purse seiners and pair trawlers) the primary problem is to locate concentrations of fish. This not only involves a knowledge of fish movements and habits, but also the ability to use the most advanced electronic gear.

Third, the degree of technical knowledge and skill required varies enormously from fishery to fishery. Operating and maintaining a clam hoe takes very little skill. More

skill and knowledge is required for success in lobster fishing, although again the degree of technical knowledge is relatively low. It takes relatively little skill to pull lobster traps with a hydraulic hauler, and boat maintenance skills are minimal as well. Bottom trawling for groundfish requires far more technical knowledge. Learning to put gear overboard and retrieve it takes only a few weeks to learn, but learning to rig and mend a net is another matter entirely. A poorly rigged net (for example, doors improperly attached, head rope too long) simply will not fish right. Purse seining is even more difficult. It takes, we estimate, some five years to learn to be proficient in this technique. Very large offshore draggers and pair trawlers clearly take the most technical knowledge to operate. Not only are the maintenance and operation of the equipment so specialized that such boats have an engineer aboard, but a high degree of skill is required to operate the fishing gear on such vessels.

One of the important things that fishermen have to know is what other fishermen know. Since knowledge and skill are so closely linked to fishing success, the knowledge of the men with whom one is competing is one of the factors influencing fishing strategy. Novice lobster fishermen, for example, will often put traps where older, more experienced fishermen do. Naturally, this is greatly resented by the more experienced fishermen because the traps of the novice will not only become entangled with his own but will also reduce the catch of all other traps in the area. Often the novice fisherman does not know what factors have influenced the trap placement strategy of the more experienced fisherman. All he knows is that the more experienced man knows where to place traps. In other instances, what other fishermen know influences fishing strategy in more subtle ways. In the groundfishery, for example, fishermen are often attracted to or dissuaded from fishing in particular locations depending on the success of fishermen of different levels of skill.



Skilled fishermen sometimes will deliberately stay away from areas where other skilled men have fished on the ground that if there were any fish there, the competition has caught them. In a similar vein, one older fishermen was overheard to say, "I know that kid has been fishing on the Kettle (a piece of bottom) and caught nothing; but I'm going to fish there anyway. If Roger (a highline fisherman) had been there for three days and come up empty, I'd know the cod hadn't moved that far north yet. But that kid going broke don't mean a thing." Statements of this kind indicate that fishermen use their understanding of what each other know about fishing to aid in their own search. We will return to this point later. It also means--and this we would like to stress--that differential fishing knowledge is another element increasing the complexity of the fishing scene and one strongly influencing the fishing strategies of individual fishermen.

Timing plays such an important role in fishing success that knowing when to do something is as important as knowing how to do it. Concentrations of all species of fish are not found in the same location permanently. Thus, if one wants to succeed as a fisherman, one must be in the right spot at the right time. Some species migrate over the annual round (for example, lobster, adult herring, swordfish) and there are general rules concerning where they will be at any given time of year. But being exactly where the fish are at any given time takes a lot of knowledge and some luck. Other species have cycles which are many years long. Scallop larvae tend to settle in huge concentrations first in one location and then in another. Several years after such a concentration has landed in an area, there will be good scallop fishing (if the bed is found) until the scallops are fished out. Then fishermen have to locate other beds in other areas.

Large numbers of fishermen exploit more than one species over the annual round depending on the availability of the species, ex-vessel prices paid, and the equipment at their

disposal. Knowing when to switch from one species to another involves some very complicated rules, and a good deal of judgement. Sometimes, fishermen will switch gear in great haste to be the first boat to exploit a particular species. Some large boats, for example, fish for groundfish with otter trawls part of the year and go purse seining for herring part of the year. When they are dragging (otter trawling) and spot a school of herring, they head back to port and spend a frantic day taking off their dragging gear and putting the purse seine gear on board. They do not want to be the second boat to reach that school. At times, men will deliberately seek to be second. Several excellent fishermen in the eastern part of Maine will continue scalloping until they are absolutely certain groundfish are in the area in numbers sufficient to warrant changing to gillnetting. It takes a week to rig a boat for gillnetting, and often the first boats to make this switch find nothing to catch for several weeks.

Timing is also very important if one is to be successful in marketing one's fish. This is especially true in the offshore finfishery of southern New England. These boats carry such large loads of fish, that sometimes when several boats land in close sequence, the warehouses and processing plants can be so packed with fish that the price drops very low (Wilson 1980). It does not pay to land fish on a day when so many other boats have landed that the warehouses are full. By way of contrast, it can pay very handsomely to be the first boat to go to sea after a long storm. At that time, warehouses are apt to be empty, and the first boat to leave port is apt to be the first boat back and be able to sell its fish at a high price.

For most species, there is also a weekly market cycle. Demand is apt to be strongest on Wednesday and Thursday because the fish-on-Friday habit has not died out by any means. This means that one should try to land fish if at all possible

so they reach the Boston and New York markets at the end of the week, and arrange one's days in port accordingly.

In summary, the fishing industry in New England certainly does not operate under the conditions assumed by the textbook model of fisheries in economics. The environment within which fishermen work is very complicated. Fish are not a single homogenous product; each species or set of species is a different product which is associated with a distinct marketing structure, technology, and annual round. Fishermen do not have perfect knowledge; great uncertainty is the rule. The critical decisions fishermen make do not involve price and quantity as much as what to produce and how to catch it. Decisions of fishermen are not made solely with information about their own firm in mind. Information about competing firms is critical since the costs and benefits to one's own boat are strongly influenced by what competing firms do. In an ever-changing environment, where ocean resources are not private property, success depends primarily on knowledge and timing.

## CHAPTER 2

### FISHING CLUSTERS AND NICHES

#### A. Introduction

As has been pointed out in Part II, firms operating under conditions of uncertainty are faced essentially with an information problem. We have hypothesized that much if not all of the essential information they need is obtained from other firms producing similar goods or operating in similar markets. In contrast to the text-book model of economic behavior which assumes that firms make decisions independently of competitors, our model assumes that some of the critical decisions are made on the basis of information obtained from other firms producing similar goods, and that ties between such firms are critical for success. Such units we have termed "clusters" (see Part II, Chapter 5 ). Moreover, if our model is correct, a great deal of the behavior of firms depends on the characteristics of the cluster to which the firm belongs.

The key issue then is: Do such "clusters" exist in the New England fishing industry? Are the decisions of the firm influenced by "cluster behavior" in ways that would be predicted on the basis of this model? Our observations of the fishing industry strongly indicate that "clusters" do indeed exist, and that the type of cluster has a strong impact on the decisions fishermen make. In this chapter we describe a variety of fishing clusters, stressing differences in social ties, and information flow among and between them. In Chapter 3, we describe the way different clusters influence the behavior of fishermen--especially the way fishermen search for fish, and their innovative behavior. Next, we present two different patterns of transactions we observe within and between various fishing clusters. In

Chapter 4, we focus on several different kinds of institutional arrangements associated with various clusters, the way they lower uncertainty for fishermen, and the manner in which they influence exploitation rates.

#### B. General Characteristics of Niches and Clusters

How do fishermen operate in the heterogenous and uncertain world in which they find themselves? The answer to this question, we believe, lies in the fact that fishermen do not operate as isolated units. They have adapted to this uncertainty by forming "clusters." While the concept of "clusters" requires extensive elaboration as it is applied to the fisheries of New England, it should be noted that fishing clusters have social, economic and technical aspects. However, fishing clusters have very different characteristics and involve different kinds of transactions and institutions.

Sociologists have long noted that the critical social units and social ties in the lives of many Americans are not confined to a geographical location or physical community, but rather involve ties to those who do the same kind of job. Salaman, among others, has identified three characteristics of these so-called "occupational communities" (1974: 18-29). Members of these communities identify with their occupation and have a shared occupational label. They share with people in the same occupation a set of values, norms, and ideals which define goals and proper behavior. The norms and goals of those occupational reference groups extend beyond the place of work. Last, members tend to interact with and form social bonds with people in the same occupational groups far more than with people in unrelated occupations.

All of this is certainly true of the kinds of groupings formed by fishermen (Miller and Van Maanen 1979; 1980).

However, fishermen's occupational units have other traits which are not approached in the literature on occupational community. Fishermen are organized into firms. A large number of the most important decisions they make are economic in nature. More important, there is a technical and biological dimension to the groups formed by fishermen. The relevant social unit for most fishermen is not fishermen as a whole, but the men fishing the same species with the same gear in the same area. To a very large extent, what they share is a common set of knowledge and skills concerning the ways to effectively exploit certain species and market them. When fishermen meet, much of the conversation revolves around such things.

The linkage between the type of fishing gear men use and the crucial social units they belong to shows in any number of ways--particularly in some of the quantitative information we obtained through interviews during 1977 and 1978. One of the questions we asked 153 New England fishermen was: "What other captain do you talk with most about fishing?" The answers received indicate a strong relationship between the primary type of fishing gear used by the men involved. These results are summarized in Table 1. In a significant number of cases, the primary gear of our informants was the same as that of the men they spoke to most often about fishing. For example, of the 61 lobster fishermen interviewed, 49 said they talked most with another lobster fisherman; of the 33 men who have bottom (otter) trawls as their primary gear, 26 talked to other men operating otter trawls the most, while five spoke to gillnetters, who are also groundfishermen. The same is true with virtually every other kind of gear. A log-likelihood ratio run on these data demonstrate these results are highly significant statistically. There is, in fact, under one chance in 1000 that the strong relationship between the gear type of our informants and the gear type of men they talked

TABLE 1  
 Gear Types of the Fisherman Captains Communicated With Most  
 Primary Gear of Other Captain

	Lobster	Scallop	Longline	Gillnet	Otter Trawl	Weir & Stop Seine	Pair Trawl/ Purse Seine	N.I.	Totals
Lobster	49	2		3	1	2	1	3	61
Scallop		3							3
Longline			3						3
Gillnet	1			15	7			3	26
Otter Trawl		1		5	26			1	33
Weir & Stop Seine	2					9	1	7	19
Purse Seine/ Pair Trawl					2		5	1	8
Totals	52	6	3	23	36	11	7	15	153

Results of Log Likelihood Test G = 239

R < = .001

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Weir & Stop Seine	2					9	1	7	19
Purse Seine/ Pair Trawl					2		5	1	8
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Results of Log Likelihood Test G = 239

R<sub>s</sub> = .001





with most often could have occurred by chance alone.

Moreover, men tend to identify with other men using the same gear type and to compare themselves with them. This came out in many aspects of our data--perhaps most clearly in the results obtained on the question: "Who is the best fisherman in your section of the fishing industry?" The results are summarized in Table 2.

Here again, there is a very strong relationship between the primary gear type of the informant and the primary gear type of the men identified as the "best fisherman." For example, of the 61 men whose primary gear is lobster traps, 49 identified a man who also used lobster traps as the "best fisherman." In the case of other gear types also, the men who were identified as "best fisherman" used the same type of gear as the informant in a significant number of cases. Two aspects of these data should be noted. First, men had no difficulty identifying their "section of the industry." The term "section" caused some confusion because this term is not used by the fishermen themselves. Most, however, were very quick to interpret the question in ways which made it clear that the fishing industry is not an undifferentiated whole. No one said "the fishing industry has no section," or "We are all fishermen." Second, these responses indicate that fishermen compare themselves and identify, in the main, with other men using the same kind of fishing gear. A man is a good fisherman or a bad fisherman only in comparison with other men in the same part of the industry. To these men it is almost inconceivable that one could compare the captain of an offshore scalloper with a lobster fisherman. They are simply playing two very different games with different standards. For the men in the New England fishing industry, meaningful sets of social units are defined by the technology in use.

The geographic range of social contacts fishermen have varies widely, depending on the kind of gear in use. This

TABLE 2  
Gear Type of Men Identified as "Best Fishermen."

Who is the best fisherman in your section of the industry?  
What does he do or know that makes him a superior fisherman?

	Lobster	Scallop	Longline	Gillnet	Otter Trawl	Weir & Stop Seine	Pair Trawl/Purse Seine	N.I.	Totals
Lobster	49	1		2	2	1		6	61
Scallop		2						1	3
Longline			3						3
Gillnet	2			15	6			3	26
Otter Trawl					29		2	2	33
Weir & Stop Seine					1	7	2	9	19
Pair Trawl/Purse Seine					2		4	2	8
Totals	51	3	3	17	40	8	8	23	153

Results of Log Likelihood Test G = 209  
P < .001

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Results of Log Likelihood Test G = 209  
 P < .001



shows very clearly in the information we gathered on radio contact between captains who use different types of gear. When we asked captains what three boats they contacted most on their radios, and then obtained the mean distance between the homes of the men involved, it became apparent that men using certain kinds of gear had a very restricted range of social contacts, while those using other kinds of gear are part of much more dispersed networks and social groups.

As can be seen in Table 3, the lobster fishermen interviewed contacted other fishermen who live within 1.4 miles of each other's homes. Most of these men lived in the same town. From this it is obvious that the contacts of lobster fishermen are very local. By way of contrast, those men using otter trawls, purse seines, and pair trawls most often contacted captains whose homes were much further away. The men using these types of gear have direct network ties which spread over a much wider area, as does their range of operation.

From these data, it is apparent that the relevant social unit for these men is not the fishing industry as a whole or all men involved in fishing, but the men fishing with the same type of gear. In addition, the size of these social units varies considerably depending on the type of gear being used.

The literature on occupational communities contains a very inadequate set of analytical tools for describing the relevant units in the fishing industry since it orients one toward thinking in terms of an industry as a whole, and contains no hint that the technical base (in this case gear type) is connected in some important way with critical social units among fishermen.

Moreover, the concept of "cluster" is far more inclusive than "community," since it emphasizes that relationships between fishermen have not only a social component, but an important economic and technical aspect

TABLE 3  
 Mean Distance Between Homes of  
 Captains Contacting Each Other by Radio

Primary Gear Used	N (boats contacted)	Mean Distance Between Homes of Captains
Lobster	155	1.4 miles *
Scallop	6	24.1 miles
Longline **	6	95 miles
Gillnet	55	7.6 miles *
Otter Trawl	75	17.4 miles *
Weir & Stop Seine	33	6.5 miles *
Pair Trawl/ Purse Seine	18	32 miles *

\* A series of t-tests was run on these results to ascertain if the differences in these mean mileages were statistically significant or not. The differences in mean mileage were significant at at least the .05 level for all those means marked by the asterisk. This is true for virtually all combinations tested. Thus, there is, for example, a significant difference between the mean distance between captain of lobster boats and the mean distances of the homes of captains of gillnetters, otter trawlers, weirs and stop seiners, and purse seiners and pair trawlers. There is one exception; there is no significant difference in the mean distance between homes of captains of gillnetters and those of weirs and stop seiners.

\*\* These longline boats were engaged in swordfishing and follow schools of fish along the entire Atlantic coast of the U.S.

as well. As we shall see, in the fishing industry of northern New England, men with similar sets of technical and economic options not only interact, but influence each other regarding choice of technology, fishing strategies, marketing choices, and other decisions.

The various clusters operating in the fishing industry need to be examined in some detail. Before this can be done, however, some information is needed on the concepts of "niche" and "cluster" as those terms apply to the fishing industry.

In the fishing industry, it is almost inconceivable that two boats would occupy the same niche. A "niche," as we have defined the term, refers to a feasible set of options defined by a single point in characteristics space (See Part II, Chapter 5). It is almost impossible for two fishing firms to have the exact same set of options. If the boats, gear inventory, crew size, market, species sought, annual round, wharfing capability, and so on are exactly the same, the owners of the businesses will differ in age, experience or some other characteristic. The historical record of each firm is likely to be unique as well. Since knowledge and skill are so critical in fishing, differences in the traits of the men themselves may well open opportunities for one fishing firm which are closed to the other. This is true even when the technology is the same. In one harbor, for example there are two 42 foot Bruno-Stillman boats which are used for dragging groundfish in the spring and for lobstering in the summer and fall. The firms are, however, scarcely the same. The owner of one of these boats grosses at least \$5000 per year more than the other man. While he is slightly younger, he also has more lobster traps, more experience in dragging some of the offshore fishing grounds, and has far more experience with the complicated electronic gear. These, and perhaps other advantages, result in a significant difference in gross income.



While fishing firms are virtually never identical, large numbers of boats do have approximately the same or overlapping feasible sets of opportunities so that they are in what we have called the same "cluster" of firms. In some fisheries, firms have such closely identical sets of feasible options that they meet the requirements of a "closely packed" cluster (See Part II, Chapter 5). Such fishing firms use virtually the same boats and techniques to catch the same species, in the same area, at the same time for the same market. Other clusters, where opportunities are not so nearly identical, are "loosely packed." Where fisheries are concerned, it is important to stress that the packing of a cluster refers the degree to which feasible sets overlap in characteristics space. The concept of "packing" as applied to the fisheries does not refer to the number of boats fishing in an area, the degree of competition for a given species, or the saturation of a market. It refers merely to similarity of options. For all practical purposes, the best index of cluster packing in the fishing industry is the ability to use the same fishing gear or sets of gear within the same geographical area at the same time. If boats operating in the same area can make the same gear switches and thus make the same decisions concerning what they are going to produce and how they will produce it, they are likely to be in a tightly packed cluster. If they cannot make simultaneous gear changes, they are in a less tightly packed cluster. If they do not use any of the same gears over the course of the year, they are obviously in a different cluster altogether. The ability to make simultaneous gear changes is a good index of the degree of cluster packing because so many other traits are usually associated with it. Two firms using the same gear in the same area are ordinarily exploiting the same species or set of species, have crews which share similar sets of knowledge, and usually have boats approximately the same size with much

the same equipment.

The boundaries of a firm's feasible set are influenced by such a large number of factors that it is difficult to label clusters. An accurate description of a firm or cluster of firms would take literally many pages if we wanted to include all of the features influencing the feasible set of options. Clearly some kind of shorthand way of labelling clusters is necessary. The fishermen themselves sometimes speak of the various kinds of subunits of their industry in terms of the primary species they fish (for example, "lobsterman"), but more usually by the primary gear they use ("gillnetter," "stop seiner," "purse seiner"). They are fully aware that the target species is closely correlated with annual round, boat size, fishing gear, electronic gear, crew size, and to a large extent, knowledge. Thus, when a fisherman talks about a "stop seiner" or "lobsterman" he is making a summary statement about a whole constellation of traits. He is also fully aware that some fishermen have many more options than others in that they can fish for multiple species over the annual round, but there is no accepted set of terms in his lexicon to describe these firms with multiple options. When he is describing firms which can exploit multiple species, the lack of terminology forces a fisherman to use whole sentences. He says something like "some of the boys go for lobster most of the year, but some of them are starting to switch off on scallops in the winter."

In general, we will use the terminology of the fishermen in describing various niches and clusters. That is, we will normally use primary species and principal gear as a means of labelling these units. There are two caveats, however:

- (1) In some cases, firms or clusters exploit two or more species. In such cases, we will use multiple species names as a label for example, "lobster-stop seine" or "pair trawl-dragger."
- (2) The boats of some clusters range the

length of the coast; others are highly localized. In the latter cases, the range of options is influenced by the place the firm is located. In these cases, some kind of location indicator will be used in describing the cluster. Thus, we will speak of units such as "lobster fishermen of Port Clyde" or the "Portland redfish fleet" or the "Passamaquoddy Bay weir fishermen." Such a system is awkward and perhaps incomplete, but preferable to the other options (such as a number system).

Fishing clusters have five characteristics, which have been touched on briefly. First, fishing firms in the same cluster use the same technology and have boats that are approximately the same size. Boats which are markedly different in size are not generally considered to be in the same cluster since the feasible set of options is normally quite different. For example, boats that are appreciably larger than others can sometimes be equipped with larger scale equipment (for example, bigger nets), can have more versatile gear, have a wider range, can stay out in rougher weather, can carry a larger load of fish, and may have a larger crew. In addition, boats in a cluster normally carry the same fishing equipment, and have much the same type of electronic gear. Again, boats that have a larger set of fishing gear have a different set of options, and those with appreciably more invested in electronic gear have an edge in searching for fish.

Second, boats in a cluster exploit the same geographical range. In some cases (for example, the lobster industry) that range is very small; in others, like the purse seiners, the area exploited includes the whole inshore area of the Gulf of Maine. But whether the range is large or small, the important point is that firms which fish very different areas do not have the same options.

Third, markets are an important defining feature of clusters, since they strongly influence opportunities. In

some fisheries, catches are bought immediately when they are landed, so that the buyer incurs the costs of transportation and all marketing risks. In other cases, the fish are the property of the fisherman until they are sold in distant markets. In these cases, it is the fisherman who incurs the costs and risks. In some instances fisherman can obtain sizeable loans from the people to whom they sell fish; in other cases no such credit is available. As we shall see, marketing ties vary enormously in other respects as well--particularly in the way they can be used to convey information to fishermen and the way they affect uncertainty.

Fourth, men in the same cluster form a reference group. These are the men one compares one's self with. They are the yardstick by which one judges one's own behavior. It is the cluster--operating as a reference group--that imposes a degree of social control on members of that cluster. A swordfisherman does not judge his own success or failure by comparing himself with lobster fishermen, but rather by his relative standing among other swordfishermen. The standard of conduct for a gillnetter derives from that of other gillnetters in his immediate area. The captain of a scallop dragger might earn much more income, but that is irrelevant as far as a gillnetter is concerned. He is competing with other gillnetters; and it is the gillnetting game which is the focal point of his attention, at least in the short period.

Fifth, firms in the same cluster are an important source of information for each other. However, the flow of information through the cluster is complicated by the fact that if the men who are fishing for the same species, in the same area with the same techniques have information which would be helpful to each other, they are also competitors. At times fishermen openly exchange information in face to face encounters. In other instances, they withhold information from each other and deliberately mislead each other.

In many circumstances, they obtain information from each other primarily by observation. The extent to which information is exchanged and the mechanism used to transmit it varies from cluster to cluster. Some clusters contain long-established groups whose members have interacted over a long period of time and who have definite, established rules concerning competition and proper ways to fish. The firms of other clusters are linked by only the loosest network ties. In some clusters, fishermen find it advantageous to exchange information with each other; in others they do their best to obtain information about the activities of other fishermen while deceiving them about their own. In many clusters one can observe open exchange and deception in the same conversation.

It should be noted that a change in any one of the factors defining a cluster, that is, technology, geographical areas exploited, markets, sources of information and reference group) influences the feasible set of options for a firm. Thus, these factors affect the degree of cluster packing and membership in a cluster.

In the following sections, we will describe all of the kinds of clusters in Maine and New Hampshire, stressing those in the lobster industry, groundfish industry and herring fishery, since these are the largest and most important in the area.<sup>1</sup> The clusters in the southern part of New England will not be described since the authors do not have extensive first hand experience with them. Some information on fisheries in those areas will be used in the next chapter to buttress certain aspects of the argument.

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<sup>1</sup>Some of the information in this section is drawn from Acheson et al. (1980: Chapter 2).

## C. Lobster Fishing Clusters

### C.1 Technology

The American lobster (Homarus Americanus) is found in the waters off the Atlantic coast of North America from Newfoundland to Virginia. However, Maine consistently produces far more lobsters than any other state, and the lobster industry is the biggest fishery in Maine and New Hampshire in both numbers of men employed and in gross revenue produced.

The technology employed by lobstermen along the entire length of the coast of northern New England is relatively uniform. Lobsters are caught in traps or "pots" three to four feet long, made either of oak frames covered with hardwood lathes or of wire. The lathes and wire allow free circulation of sea water while retaining the larger, legal-sized lobsters.<sup>1</sup> The open end of the trap is fitted with a funnel-shaped nylon net, or "head" which lets lobsters climb in easily but makes it difficult for them to escape. The traps are attached to a small styrofoam buoy via a "warp" (rope made of hemp or polyethylene). The buoys belonging to a lobsterman are marked with distinctive sets of colors, registered with the state. These traps are baited with fish remnants obtained from nearby processing plants. The traps are usually placed in the water in "strings," or long rows, so that a man can see from one buoy to another in a fog or bad weather. In most of the region, fishermen have about 350 to 500 traps. In some

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<sup>1</sup>To be legal in Maine a lobster must be between 3 3/16 inches and 5 inches measured on the carapace. In New Hampshire the legal minimum size is 3 1/8 inches; there is no maximum size.

areas 6 to 10 traps are tied on a long "warp" so that all are placed and pulled together. In these areas, larger groups of traps are the rule.

Two different kinds of boats are used in the lobster fishery. Outboard powered skiffs, between 14 and 18 feet, are used to fish very near shore in the summer. Most of the so-called "skiff-fishermen" are part-timers who have very small numbers of traps which they pull by hand.

Virtually all of the full-time fishermen fish alone from gasoline or diesel-powered boats 30 to 36 feet long, equipped with a depth sounder, hydraulic "trap-hauler," ship-to-shore radio and compass. In the island areas, boats may be somewhat larger, more often diesel-powered, and also equipped with radar to cope with the more violent offshore seas and the fog. In the Casco Bay region of Maine, where men pull larger gangs of traps, large, diesel-powered boats and two-man crews are the rule.

In addition, virtually all lobster fishermen have a pick-up truck to transport traps and equipment and a workshop where they store fishing gear and build traps. A large number of fishermen, but not all, own their own small docks.

There is very little variation in the basic equipment used in lobstering. All full-time fishermen use hydraulic haulers, save for a tiny handful of older fishermen who still use winches. All lobster boats have the same configuration, with the engine mounted forward and housed in the cabin, while the fisherman works behind a house with a glass windscreen and a roof, open on both sides and the back. Almost all lobster boats are made of wood or fiberglass.

Virtually all lobster boats owned by full-time fishermen are between 25 and 40 feet long. Boats under 28 feet are too small to be used from November to March, a season when there are many storms and high winds, and they cannot carry enough traps. Boats over 38 feet have

higher costs per unit of output than smaller boats. After all, there is a maximum number of traps that can be pulled by a fisherman in a day; and increasing boat size will not increase that number. Moreover, larger boats cost a good deal more than smaller boats, have larger maintenance costs and use more fuel--increasingly an important consideration. In the past year (1979-80) two of our key informants have sold boats in the 38 to 40 foot range to buy craft 35 feet long, which they both regard as ideal for lobster fishing. From the point of view of the available and known technology, all lobstering clusters are very tightly packed, with approximately the same set of feasible options open to all full-time fishermen. Financial, skill and other factors, however, tend to differentiate the feasible sets to a certain degree.

## C.2 Geographical Range

When fishing inshore, lobstermen rarely go more than a few miles from their home harbors due to the territorial system in the industry. From the legal view, anyone who has a state license can go lobster fishing anywhere. In reality, far more is required. To go lobster fishing at all, one needs to be accepted by the men fishing out of one harbor, and once one has gained admission to a "harbor gang," one is ordinarily allowed to go fishing only in the traditional territory of that harbor. Interlopers are strongly sanctioned, sometimes verbally, but more often by the surreptitious destruction of lobstering gear. This territorial system is entirely the result of political competition between groups of lobstermen. It contains no "legal" elements.

Violation of territorial boundaries meets with no set response. An older, well-established man from a large family might infringe upon the territorial rights of others



almost indefinitely, whereas a new man or a "part-timer" would quickly lose a lot of fishing gear. Ordinarily trap cutting involves only one or two men from competing areas. However, perhaps once a decade, a series of small incidents will escalate into a full-fledged "lobster war" involving dozens of men and resulting in widespread destruction of lobster gear. However, all conflicts are kept very quiet, since trap cutting is illegal, and silence reduces the chances for a victim to retaliate. As a result, the public knows very little about the territorial system, or the political mechanisms that maintain it.

There are some very important local differences in the territorial system which have been described in detail in an earlier paper. However, in all cases, lobstermen are restricted to fishing no more than 15 miles from their home harbor, and most of the time they are far closer than that. As a result, lobster fishing is highly localized. Fishermen spend their whole lives literally crossing and recrossing one very small piece of water. This geographical limitation limits social contact as well. Thus, lobster fishing clusters are very small, and involve usually only the men fishing from one harbor or two or three adjacent harbors.

It is important to note that territoriality exists only in inshore fishing areas where the vast majority of boats fish. A few boats are fishing for lobster offshore where no territoriality exists.

### C.3 Marketing

Any sizeable harbor has at least one lobster dealer or a cooperative which buys directly from local lobstermen and sells to tourists or to one or more of the large wholesale firms distributing lobsters in Maine and the nation. Typically, fishermen sell their catch to dealers every day or every few days so all of the costs and risks

associated with storing and transporting lobsters are assumed by the dealer or wholesaler--not the fisherman. While the prices lobstermen receive do fluctuate seasonally, there is little price competition in the Maine lobster industry. On any given day, all the dealers and cooperatives are paying approximately the same exvessel price for lobsters. Dealers compete for a supply of lobsters by attempting to attach as many lobstermen to themselves as possible. They supply "their fishermen" with gas, oil, and bait at low margins of profit, allow them to use their wharfs free of charge, and supply them with large amounts of credit. A few fishermen sell to two or more dealers or cooperatives, and periodically a man will change from one dealer or cooperative to another in rapid succession. But typically a lobster fisherman maintains a longstanding relationship with only one dealer and sells his catch exclusively to that dealer.

The location of dealerships is not connected to lobster fishing areas. A lobsterman usually sells to a dealer in his own home harbor, but he may sell to any dealer--regardless of location.

#### C.4 Reference Groups and Information

The men who fish out of one harbor share far more than common "ownership" of a lobster fishing territory. They are informal groups of great importance. The men of a harbor gang interact a great deal. They meet on the docks and typically talk and joke with each other before they leave for their day's fishing. On days when the weather is bad, groups of fisherman can be seen hanging around the dealer's dock or cooperative for several hours on end. Once or twice a day, lobster fishermen will stop their boats to talk to their friends in between pulling strings of traps. Virtually all full-time lobstermen have CB radios on board.

Most of these conversations take place between men in the same harbor gang. In fact, it is customary for the men from each harbor to use one or two channels. (Men from other harbors tend to use other channels.)

Even ashore, interaction between lobster fishermen in the same harbor gang is very intense. In one community studied extensively, a large sample of fishermen were asked to name their best friends. Of the 113 lobster fishermen interviewed, 87 named another fisherman in the same "harbor gang" or "gang" fishing from a harbor no more than 10 miles away. In this community, there are an estimated 750 adult men and only 113 skippers of fishing boats so that there is only a small probability that these data on the tendency of fishermen to select other lobstermen as friends could have occurred by chance.<sup>1</sup>

Lobster fishermen in the same harbor gang ordinarily have long-term, multistranded ties with each other. They usually live in the community where the harbor is located. Only rarely are fishermen who live in one town admitted to "harbor gangs" located in other towns (Acheson 1975a:187). Most of the men admitted to harbor gangs are members of long established families who have a history of involvement in the fishing industry. The men of a harbor gang share a good many kinship ties as well. The fishermen in the same generation have literally grown up together, and members of their families have known each other and intermarried for generations.

Membership in a harbor gang strongly influences many aspects of a lobster fisherman's career. It is the men from

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<sup>1</sup>A Chi Square test run of these results was significant at the .05 level, indicating that there is only one chance in twenty that these results could have occurred by chance.

one's harbor gang that one can count on in an emergency. Members of a gang will often get together to perform certain tasks, such as building traps or painting boats. They generally share a common set of traits, attitudes and techniques that mark them off as slightly different from the men of other harbors.

Perhaps most important, harbor gangs are reference groups. They provide a yardstick for a man to use in measuring his success and skill. They are the primary people with whom a lobsterman competes; they are the people whose opinion counts. Such gangs look inward on themselves. They are the most important unit in a lobster fisherman's life beyond his family and the community in which he lives (Lazarowitz and Acheson 1980).

In some of the smaller harbors, the degree of interaction has been of such intensity that one can consider the entire "gang" as a group, with all that indicates about common norms, sentiments and activities. In the larger harbor gangs, there may be many cliques and several different groups of fishermen. If lobstermen typically interact a good deal with the fishermen operating out of their own harbor, they have little contact with lobster fishermen in other harbors--even harbors only a few miles away. It is quite common to meet fishermen who have not visited harbors within 10 miles of their home port for years. To some extent, the geography of the coastal region of Maine, with its long peninsulas, does not facilitate contact. Moreover, the members of other harbor gangs are "enemies" in the competition for lobster fishing territory. Virtually every member of a harbor gang has had some conflict with members of adjacent gangs concerning placement or destruction of fishing gear. If he has not, he knows a lot of friends and relatives who have.

The lack of interaction and the slight enmity between members of different harbor gangs has a significant influence

on the transmission of information. In one set of towns studied intensively, it is rare for a lobster fisherman to be able to name more than ten men who fish from another town on the same peninsula only nine miles away. Highline fishermen are the exception to this rule. Most of them know the four or five most successful fishermen in most harbors within a 20 mile radius. At times, such men will exchange information, and even form friendship ties. When new techniques and innovations are transmitted between harbor gangs, usually the network ties between "highliners" are involved.

Despite the network ties between "highliners," information and innovations are transmitted very slowly between harbor gangs. For example, there is clear evidence that lobster traps made from aluminum and vinyl wire catch significantly more lobsters than the old style oak traps. In 1974, such metal traps were well established in Bremen, Maine. It was only in 1977 that fishermen in New Harbor (a few miles away) even began experimenting with such traps. In 1978, a good many men in New Harbor had begun to build these traps, but no one in Round Pond, two miles away, was even interested (Acheson 1980a: 429-440). This means that most of the information lobster fishermen obtain comes from other members of their own harbor gang, and even within gangs men do not gladly share information. As we shall see, the reason that information in the lobster industry travels so glacially relates both to the territorial system and to the duration of the economic value of the knowledge involved.

Clusters in the lobster industry are numerous, small, and tightly packed. Given the fact that lobster fishermen are restricted to fishing in small harbor territories and that interaction among lobster fishermen is largely restricted to the men who jointly own those territories (i.e. a harbor gang), virtually every single harbor in

Maine and New Hampshire can be considered as an independent cluster. Men from two harbors have slightly different sets of feasible options, since they must exploit different areas, which are differentially productive of lobsters. However, virtually all lobster fishing clusters are tightly packed from the technical point of view. There is very little variation in the boats, traps, gear, and so on used in the industry throughout the entire region.

#### D. The Groundfishery

In fishing circles it is common to speak of the groundfishery, since haddock, cod, hake, flatfish, pollock, cusk, and other species inhabit the same general ecozones, are caught in the same gear, and are marketed in a similar fashion. However, fishermen also distinguish between various segments of the groundfishing fleet in terms of the gear they use and the areas they fish. The two most common techniques used to take groundfish are gillnetting and bottom (otter) trawling; fishermen speak of "gillnetters" and "draggers" or "trawlers." A further distinction is made between the small inshore boats, sometimes called "day-trippers," and the large boats exploiting the offshore fishing grounds of the Gulf of Maine (i.e. the offshore fleet). These verbal distinctions underline the fact that although there are similarities among all the boats and people exploiting groundfish, there are some very important differences as well. For our purposes, it is useful to distinguish between five different kinds of groundfishing clusters, based on both the kind of gear used and the areas exploited: gillnetters, inshore draggers or trawlers, offshore draggers, handliners, and tub trawlers. The feasible sets people in these categories have are very different despite the fact they catch the same species of fish and market them in roughly similar ways.

## D.1 Technology

D.1.1 Gillnetting is a small boat, inshore fishery. Virtually all the boats in this fleet are between 36 and 62 feet and venture no more than 30 miles from shore. Gillnets are a type of fixed gear, consisting of very long, narrow nets with weights on the bottom, and floats on the top which float up vertically from the bottom of the water. Fish are caught by the gills when they try to force their heads through the mesh. Individual gillnets are often linked together to stretch a quarter of a mile or more across the bottom. Gillnets are usually left in the water no more than two days to minimize predation on fish that have been caught and to maintain some semblance of quality. The nets are retrieved by pulling one end of a string of gillnets into the boat by winding in the rope attached to the buoy that marks the location of the net. Power is generally provided by a gillnet hauler--essentially a hydraulically-powered drum. As the net is hauled in, the fish are disentangled from the net ("picked out") by a crew of two to five men. When the net is empty, it is played over the side again.

D.1.2 Trawling or dragging. There is tremendous variation in the size and capacity of the boats engaged in trawling, which is currently the most important technique used to catch groundfish. The smallest boats are about 38 feet long; the largest are 120 feet, and still larger boats are being added to the fleet. The small boats fish inshore waters exclusively, while the large boats range the entire Gulf of Maine, concentrating on Georges Bank. Regardless of boat size, all trawlers catch fish by towing a cone-shaped net through the water. The sides of the net are held open by doors attached to the sides of the net. The nets are towed by long wire cables attached to a winch

used to retrieve the net.

Trawling may be done from the side of the vessel, called an eastern rig, or from the stern, called western rig. Both types have advantages and disadvantages. (See Acheson et al. 1980: 20.)

D.1.3 Handlines and longlines (tub trawls). Longlining and handlining are relatively old and primitive techniques. Handlining refers to fishing with two or three lines over the side of a boat on which one or more baited hooks are attached. A longline, or line trawl, is a horizontal line with a series of shorter lines with hooks hanging from it. The use of these techniques to catch groundfish is concentrated mainly in a few harbors in eastern Maine. In the main, longlining and handlining are done from very small boats (under 25 feet), although a few lobstermen, who have larger boats do a little tub trawling (i.e. longlining) in the spring when lobsters are scarce. Given the size of the boats involved, it is not surprising that "hook fishing" is done mainly in the summer by part-time fishermen.

## D.2 Geographic Range

Unlike the lobster industry, there is no territoriality in any section of the groundfishery. Owners of boats are free to go anywhere they can find fish and still avoid conflicting with other fishermen. They are limited only by the range of the boats. The large vessels generally take trips of from four to ten days and exploit fishing grounds far out in the Gulf of Maine--particularly Georges Bank, the Northeast Channel, the Great South Channel, and in the past Browns Bank and Le Haves Bank. Moreover, there is little tendency for boats fishing these offshore areas to come from specific ports. In recent years, the northeast peak of Georges Bank was fished by boats from Maine, Massachusetts



and Nova Scotia. The inshore fishing areas, such as Jeffreys Bank, the Kettle Bottom, Jeffrey's Ledges, and Fipennies Ledge, are fished by both small and large boats. Since the range of small boats is restricted, these inshore grounds are exploited generally by boats from relatively nearby harbors. Cashes Ledge, for example, is fished mainly by boats from southern Maine and New Hampshire. These small draggers and gillnetters concentrate on nearby fishing grounds because it is dangerous and expensive for them to go too far offshore--not because they have any kind of exclusive rights to these grounds.

In Maine, the majority of the boats that have groundfish as their major fishery are located in only 18 of the state's 82 harbors. In addition, most of these boats are concentrated in the southern part of the region. (See Acheson et al. 1980: Table 2.) There are two factors clearly involved in influencing the concentration of these groundfishing boats: marketing outlets and availability of fish. It is simply much more convenient to moor one's boat in a harbor with an established groundfish dealer rather than going to the trouble of arranging to transport and market catches oneself. The role of species availability is equally obvious. More groundfishing boats are located in the southern part of this two state region since there are more groundfish available over a longer period of the seasonal cycle there.

To some extent, the choice of fishing gear is related to the seasonal cycle of groundfish and the type of bottom that predominates in various areas. Handlining predominates in the easternmost parts of Maine (for example, Lubec and Eastport) because groundfish are available in quantity only a few months a year. In addition, the very high tides characteristic of the region set up such fast currents that use of fixed gear (gillnets) is difficult, and the rocky bottom means that there is little opportunity to use otter trawls.

### D.3 Marketing

All groundfish landed in Maine and New Hampshire ports is marketed through the same kinds of channels. Most commonly, fish are shipped to either Boston or New York where it is sold through a broker. A truck picks up the fisherman's catch, and transports it to the broker who sells it on consignment and then sends the fisherman a check. Thus, the fish is owned by the fisherman until it is sold on the market, and all the risks and costs of transportation are borne by him. There are obviously a good many opportunities for inequities and misunderstanding in a system where the fisherman does not even know what he has been paid for a given load of fish until many days after he has shipped it (Wilson 1980:11 f.f.). In some harbors (for example, Prospect Harbor, Rockland, and Portland) some groundfish are bought by processing firms which pay the fisherman for his catch immediately upon landing. In the future, local outlets for Maine and New Hampshire fish will probably increase. Some fishermen have long-term established relationships with local dealers to whom they sell their fish. This is the more common method in southern New England and has been described in detail in another volume (Wilson 1980). For the present, most of the fish is sold through the trucker-broker system.

### D.4 Reference Groups and Information

Groundfishermen have a great deal of contact with each other. At sea, the captains of both inshore and offshore dragnets spend an enormous amount of time talking with each other on the radio. For example, on one daytripper which made three three-hour tows, the captain was on the radio a total of six hours and five minutes. This is far from unusual. The frequency of radio contact with other boats

depends on the type of gear being used. Captains of gillnetting boats use the radio far less frequently than captains of draggers since they spend a great deal of their time helping the crew "pick fish" out of the net. In part this use of the radio helps to pass long and boring hours. But far more than entertainment is involved, because groundfishermen only talk to other groundfishermen. They rarely talk on the radio to lobster fishermen from their home harbors, even though they might be fishing within sight of each other. They never talk to men who fish exclusively for herring or dig clams either. Most important, most radio communication takes place between captains of boats who have information of use to each other. The vast majority of the messages sent and received are between boats that are directly competing with each other. Captains of offshore fishing boats tend to talk to captains of other boats fishing offshore waters. The captains of inshore boats talk to skippers of vessels who are fishing or usually fish in the same area.

Periodically, fishermen will talk about women, liquor, parties, sports, or gossip directly about each other, but such conversations are in a distinct minority. Most radio communication concerns fishing. Markets and fish prices are a favorite topic, along with discussions on catches and locations where fish are found. Most of the information transmitted is surprisingly frank and honest, given the fact that the captains involved are competitors. When a fisherman asks how large a catch another man got on his last tow, he will very likely be told with reasonable accuracy. It is very rare that fishermen will tell each other lies of such proportions that they will be damaging. It is considered extremely bad form, for example, to tell another man a certain place is safe to fish, and avoid mentioning dangerous snags. However, fishermen characteristically will try to minimize the amount of information they give out about their

own boat and its operation while trying to gain as much information as possible about other boats. It is also common for fishermen to exaggerate or underestimate fish catches to lure a competing boat into changing fishing grounds so that it will lose valuable fishing time. For these reasons, fishermen carefully assess the information they receive. Often the information sought can best be obtained by direct observation or by listening in on the conversations of others.

Interest in catches and prices received by other boats is also stimulated by the fact that it is these competing boats, crews and captains which are the reference group for groundfisherman. One's success and standing are measured in terms of the catches and income one has relative to these boats. It is, however, far more difficult to identify the boundaries of the reference groups in the groundfishery than it is in lobstering. Fishermen on large offshore vessels assess themselves against the record of those on other large offshore vessels. Those on inshore vessels compare themselves with each other. But geographical and technical factors play a role as well. At times gillnetters and small draggermen constitute a single reference group. In other cases, gillnetters and draggermen measure success relative to other men using the same kind of gear. In addition the reference group for groundfishermen almost always extends beyond the home port, but the relevant audience is not the entire ground-fishing fleet either. Men compare themselves and obtain information from others who own similar groundfishing boats in their own harbor and a few adjacent harbors. As one moves up the coast, the composition of reference groups changes depending on the contacts of the individual fishermen involved. The kind of sliding scale used by fishermen in forming reference groups could be seen in the responses of a sample of fishermen to questions such as: "Who are the best inshore groundfishermen?" and "What three boats do you

call on the radio most often?" In the answers to these questions, it became apparent that the boundaries of the reference group used by the men in any harbor were not exactly the same as those used by the men in adjacent harbors, even though they might overlap considerably. For example, in an area of where five harbors are located, called A, B, C, D, and E groundfishermen in Harbor B might communicate and compare themselves with men in their own harbor and harbors A and C; men in harbor C would have a reference group composed of fishermen in harbors B, C, and D but not those in A.

It is much more difficult to delineate clusters in groundfishing than in lobstering. The shifting nature of reference group boundaries is one complicating factor. Geographical factors also have to be taken into account since the species mix that is available in any one area at any given time differs from that in other areas, and the costs of transporting fish to market increase as one moves eastward along the coast. In the groundfishery, the technology in use is very different, so that men using different kinds of gear (i.e. longlines, handlines, gillnets or otter trawls) and different-sized boats obviously occupy different niches. All these factors make it difficult to decide whether particular groundfishing vessels are part of the same loosely packed cluster or a different cluster completely. The difficulties become most apparent when specific situations are considered. The groundfishermen from South Bristol and New Harbor, for example, use boats that are approximately the same size. They fish the same grounds for the most part, and communicate with each other a good deal. Many fishermen from these two harbors know each other quite well. However fish from South Bristol is sold to a private dealer in Maryland, while fish from New Harbor boats is sold via the usual trucker-broker arrangement. In addition, all the New Harbor groundfishermen

use otter trawls, while many South Bristol men use gillnets. Are groundfishermen from these two harbors from one cluster or two?

In the case of the groundfishery, it is impossible to distinguish between all clusters--particularly in the inshore fishery--without being very arbitrary. It is possible however, to delineate some of the more important and obvious clusters. In these cases, differences in feasible sets of options are so obvious that the clusters involved stand out. These clusters are listed below:

(1) The 11 large vessels of the redfish fleet which fish far out in the Gulf of Maine are a single cluster. This is true despite the fact that they belong to two vertically integrated firms, one in Rockland, the other in Portland.

(2) The small boats that are used for handlining in Passamaquoddy Bay, stationed at Eastport and Lubec.

(3) The gillnetters and draggers of Jonesport, Maine have a single marketing outlet and fish the same grounds. They are so isolated geographically and socially that they constitute a single reference group.

(4) The gillnetters of Stonington have approximately the same size boats, use the same marketing outlets, and constitute a closely-knit social group which interacts frequently at sea and ashore. They also have the same annual round, combining gillnetting with fall lobstering and winter scalloping.

(5) Vinalhaven Island reportedly has two distinct groundfishing clusters, although we know little about them.

(6) The small dragger captains of Tenants Harbor and Port Clyde are a cluster. These men have similar size boats, use the same marketing outlets, fish the same grounds, and clearly form a distinct reference group.

(7) The fin-fishermen of Boothbay and Boothbay Harbor constitute a cluster. While their boats vary from 42 to 65

feet, they use the same type of gear, fish in many of the same places, and all sell to the Boothbay Fish and Cold Storage Corporation of which they are all members. They also interact a good deal with each other and constitute a reference group.

(8) The dragger fishermen of Cundy's Harbor, Bailey's Island, and South Harpswell are a cluster. Although there is some variation in the size of the boats used, these men sell through the same two or three marketing outlets, interact a good deal with each other, and use the same gear in many of the same locations.

(9) Portland has at least two groundfish clusters: the redfish boats already mentioned, and the inshore dragger/gillnet fleet.

(10) The gillnetters of Kennebunkport. These men sell through the same marketing outlet, and fish many of the same grounds with similar gear and similar sized boats. They also constitute a clear reference group.

## E. The Herring Industry

### E.1 Technology

Herring are caught by four very different types of fishing gear: weirs, stop seines, purse seines and pair trawls. Weirs and stop seines are types of fixed gear; purse seines and pair trawls are mobile and used on large boats. These four different techniques involve different levels of investment and skill.

All weirs are made from a series of long stakes or poles driven into the bottom of a bay or inlet; and all have a round pound or enclosure to hold the captured fish and a single or double leader extending outward from the "pound" to guide the schools of herring into it. The walls of the weir are composed of brush or netting hung between the poles.

Stop seining, like weir fishing, involves trapping juvenile herring when they enter a bay. The fish are caught by hauling a long net across the mouth of the cove after the school of fish have entered.

In purse seining a very long net (up to 1000 feet) is set in a circle around a school of herring. When the circle is complete, a rope or "purse line" is drawn to close or purse up the bottom of the net. The top of the net is then pulled in to compress the school of fish to the point where they can be "brailed" into the boat or sucked up with a fish pump.

Pair trawlers catch herring by towing a very large net between them. This is a more advanced technique than purse seining, since such boats can catch long narrow schools strung out over a mile or more, and can take fish anywhere in the water column. Purse seiners, by way of contrast, can only approach schools where fish are on the surface and concentrated into a compact mass.

The primary skill in weir fishing and stop seining involves a knowledge of where to place the gear (that is, where to build the weir and which coves to reserve for stop seining). Again this involves a knowledge of where fish have been historically. Much more is involved in pair trawling and purse seining. Men using these techniques must know how to locate schools of herring in the open ocean, and must coordinate a large crew (four to ten men) to operate very large nets and fishing gear. Extensive electronic gear and sometimes spotter planes are used to locate schools of herring.

Weirs and stop seine operations are relatively uniform although some weirs are larger than others, and some stop seine operations involve longer nets to stop off bigger coves. In addition, some weir and stop seine operators have inboard-powered boats equipped with hydraulic net haulers to tend their herring gear, while other men simply use small



skiffs.

There is, however, a tremendous difference among various purse seiners and pair trawlers. The boats that do purse seining vary in size from 42 feet with a three man crew to 90 feet with a seven man crew. There are variations as well in the type of electronic gear used, marketing deals with processing firms, and the amount of involvement in other fisheries. The pair trawlers are more uniform, although they range in length from 70 feet to 90 feet.

## E.2 Geographical Range

There is great variation in the mobility of herring fishermen using different types of gear. Physical and social factors make owners of stop seines and weirs highly immobile. Weirs are obviously permanent fixtures in the localities where they are built. They could not be moved even if the owner wanted to move them. It is physically possible to move seine dories from one cove to another, but few stop seiners move their operations much. Most of these men have one or two coves or "berths" which they fish exclusively. A few stop seiners move their operations several times over the course of the season, but they are in a distinct minority. The relative lack of mobility in stop seining can be explained in part by the fact that there are a limited number of places where herring can be caught by stop seines, and most of these have already been taken. Moreover, there is a strong sense of territoriality in the fixed gear herring fishery. Men who place their seine dories in a cove have exclusive rights to fish that cove as long as they are tending the gear. In many instances, these rights have been claimed by family members in the past and have been handed down from one generation to another. This sense of territoriality also operates in the weir fishery. It has long been considered unfair for a

fisherman to set up a weir or seine near another man's weir. This norm has been formalized into a law which makes it illegal for a person to go herring fishing within 1000 feet of another's weir.

By way of contrast, the purse seiners and pair trawlers are among the most mobile fishing boats operating in New England. Between May and November, they congregate in the inshore waters of Maine to fish for juvenile herring; in the middle of the winter, they travel to Massachusetts Bay and the waters south of Cape Cod to fish for adult fish. At times these mobile boats are highly dispersed over wide areas of the Gulf of Maine. However, since herring tend to concentrate in very large schools, the boats following them tend to concentrate as well.

### E.3 Marketing

All of the herring caught in New England waters are processed in one of the 15 plants owned by the herring processing companies. These companies pack the juvenile sardines into cans, which are sold primarily in the United States. The adult herring are filleted, frozen and shipped to European markets.

These herring packing firms are vertically integrated. They not only own the packing plants themselves, but also very large warehouses where boxes of fish are stored before being shipped to wholesalers. In addition, these firms own the herring "smacks," which transport fish from seines, weirs, and boats to the plant. They also own and operate two of the six pair trawlers as well as some of the purse seiners. However, most of the herring are caught by fishermen who operate their own boats, weirs and seines. The owners of these plants loan large amounts of money to these operators with the understanding that their plant will have first refusal on the fish caught. Thus, these

fishermen are closely tied to herring processors although they are not employees. In many respects, this system of financing is comparable to sharecropping, especially since the company takes a share of the fisherman's catch rather than a flat amount of money.

#### E.4 Reference Groups and Information

Given the relatively small size of the herring industry in New England and the fact that all herring is sold to a small number of processing plants, anyone in the herring business is tied into a network that covers the entire industry and a large geographic area. The stop seiners and weir operators have some information on purse seiners and pair trawlers and vice versa. When large schools of herring are located and large catches are made, everyone in the industry knows about it, although the amount of specific information they have might be relatively small if they are not personally involved in exploiting those schools. The flow of information within the industry is facilitated by the herring carriers which range the length of the coast, picking up fish and gossip from fixed gear operations and boats alike. However, the information networks and reference groups in the herring industry vary with the gear being used. The weir operators and stop seiners have detailed information on herring operations only in their local area--usually within a 20 mile radius. For example, the men operating weirs and stop seines in Passamaquoddy Bay know a good deal about each other's catches, but they have only the vaguest idea about the relative success of fixed gear operations in the Jonesport area or in the Milbridge-Stuben area. The men operating stop seines in the bays along Penobscot Bay have a lot of information about each other, but little indication of catches in the Mount Desert Island area to the east or

Boothbay to the west.

However, it is difficult to argue that the fixed gear operators in any given area really constitute a reference group in any meaningful sense. Virtually all of the men using this gear are part-time herring fishermen. Most of their income comes either from some other kind of fishery, from another job ashore, or from a pension. With the exception of three men who own more than one weir or stop seine operation, everyone in the industry can be considered a part-time fisherman. In addition, the information these men exchange appears to be more ephemeral than that exchanged between other kinds of fishermen. Once a man has built a weir or has taken over the family stop seine berth, the amount of fish he catches depends largely on the vagaries of herring movements and his own willingness to tend his gear rather than on strategic information from or about other fishermen. As a result, the owners of fixed gear herring operations can be considered a reference group--if at all--only in the herring season and only within a restricted local area.

The men manning the six pair trawlers and twenty purse seiners from Maine ports, by way of contrast, maintain a very dense communications network, despite their mobility. Boats like "Rodine," "Candy B II," "Dutchess II" and "Western Wave" are well known the length of the coast among men who fish for herring. Very often a high percentage of these boats are concentrated in one place fishing on the same schools--regardless of where their home ports might be. Their crews interact a great deal with each other. Every night there are a good many radio conversations between herring boat crews fishing in the same area. They tend to tie up their boats at the same docks between trips. In addition, the men of this mobile herring fleet constantly monitor and watch each other's movements. Information on the location of herring schools is obtained not only from

watching one's own electronic gear and spotter plane (if any), but also from observations of the movements of other boats. Even when these boats are fishing in different places, news of the activities of other boats is obtained via VHF radio or through contacts with the plants and their carriers. Given the small size of the fleet, and the density of the communications network, it is possible for a skipper in this fleet to have an idea about the general area where every other herring boat is fishing at any given time.

All the boats in this mobile herring fleet can be said to form a single cluster. All fish for herring throughout their migratory range, and although there are differences in the sizes of these boats, they are all able to fish in the same locations under the same conditions. The men in this fleet are a single reference group and maintain a dense set of network ties over which a great deal of information flows constantly. All of the skippers know each other and know each other's reputation for skill and fishing effectiveness. In addition, all of the boats in this fleet sell their catches to the same small number of processing firms under similar agreements.

The techniques used by purse seiners and pair trawlers differ, however. Purse seiners have a slight advantage very near shore, since they can "set on" schools of herring in small bays and in shallow water. The pair trawlers, however can take long ribbon-like schools of herring on the surface or deep in the water column. They also carry two nets--one on each boat--so that they may begin another tow as soon as the first net is back on board which gives them a distinct advantage if there are a lot of fish. Given the differences in technology employed, one might want to argue that there are two clusters in the mobile herring fleet: the pair trawlers and the purse seiners. It would, however, be very difficult to claim that there were any more than two.

## F. Summary

### F.1 Boundaries

Four important points need to be made concerning clusters in the fisheries of northern New England. Clusters are groups of firms with the same set of feasible options. While all clusters in the fishing industry of northern New England have social, geographical, economic, and technical aspects, some of these aspects are more important than others in defining the limits of clusters in the various fisheries. The boundaries of lobstering clusters are determined socially. The range of the species and the technology play little role in influencing the formation of clusters. Lobsters are found all the way from Newfoundland to Virginia, and lobster fishermen have very similar fishing boats which are capable of travelling fairly long distances. No inshore lobsterman travels long distances, however. In fact, they confine their fishing activities to very small territories and interact almost exclusively with men in their own harbor gangs or men in very nearby harbors. It is this system of territoriality and the associated involvement of social contacts that makes every lobster fishing harbor a separate cluster. Technological and biological differences have no bearing in cluster boundaries.

In the groundfishery, the boundaries of clusters are determined by a combination of the technology in use and the geographic area fished. These clusters are defined first by the type of gear (that is, gillnets, otter trawl, handline, longline) and second by the area in which that gear is used. Thus, all the men using a certain type of groundfishing gear on the same fishing grounds are generally in the same cluster. They know each other and constitute a reference group. However, in the groundfishery the boundaries of clusters are very difficult to delineate because the reference groups

of groundfishermen and their sets of contacts differ from harbor to harbor.

In the herring industry, the clusters are most strongly influenced by technological factors. There is a sharp distinction between the fixed gear herring fishermen and the mobile gear fishermen. The owners of weirs and stop seines constitute clusters only in restricted local areas. The skippers of purse seiners and pair trawlers fish together throughout the entire range of the species, clearly have dense network ties, and constitute a reference group. Despite the technological superiority of the pair trawlers, it is best to regard this mobile fleet as a single cluster.

## F.2 Cluster Packing

The degree of cluster packing varies considerably from one fishery to another. In the lobster industry, the feasible sets of options open to lobster boats in the same cluster are nearly identical. The men in a cluster are fishing from the same harbor, exploiting the same commonly owned territory with boats and fishing equipment that are very similar technically, and selling their catch to the same one or two outlets. There is some variation in the sizes of the boats full-time lobster fishermen use, the age of those boats, the numbers of lobster traps fished, the electronic gear employed and the skill of the fishermen. These differences mean that some fishermen from a given harbor have slightly different options than others. Nevertheless, such differences have such small effects on feasible options that one can regard all lobstering clusters as being relatively closely packed.

There is far more variation in the degree of cluster packing in the groundfishery. Gillnetting boats in any given area range from 35 to 65 feet. The smaller size

boats are restricted to day-tripping near shore. The larger boats can fish up to a hundred mile radius of their home harbors; make trips several days in length; and commonly land their fish in several different harbors. Much the same is true for the inshore draggers. Some of the smaller draggers are restricted to day-tripping in local waters, while some of the boats fifty feet long and larger take trips of several days duration along the coast. In both the gillnetting fleet and the inshore dragging fleet, there are also considerable differences in the kinds of electronic equipment in use. Some boats have little more than a compass, radio, and recorder. Others have this equipment in addition to Loran, radar, scanners, fish scopes, Loran C. plotters and in many instances more than one of these kinds of gear. There are even greater distinctions in the options open to boats in the offshore fleet. These boats range from 70 to 150 feet long. Some haul over the side; others over the stern. Again, there is considerable variation in the amount of electronic gear employed, as well as in the refrigeration equipment.

The boats in the herring industry exhibit the same kind of variation. Some of the smallest purse seiners are 45 feet long; others are over 90. There are variations in auxiliary boats, men in the crews, electronic equipment, and so on.

In summary, then, all three kinds of clusters of firms exploiting groundfish must be considered relatively loosely packed in comparison with lobstering clusters. The mobile herring fleet forms a loosely packed cluster as well.

### F.3 Reference Groups and Clusters

In all fisheries, the size of reference groups appears to be a constant and has some bearing on the size of clusters. Men do not compare themselves with one or two other boats but



with seven to twenty. Thus, the fewer boats there are in one's own home harbor similar to one's own in size and gear type, the larger and more heterogenous the reference group will be. If there are no other gillnetters in one's own harbor, one may seek ties, contacts, and comparison with small draggers in the immediate area and gillnetters in harbors in the next county. On the other hand, if one comes from a harbor where there are at least six or seven other gillnetters in the same size range, the reference group will likely consist largely of gillnet fishermen in one's own harbor. The same principle is applicable to the offshore fleet. However, there are so few large offshore vessels in northern New England that a reference group is apt to encompass a large geographic area. The Maine redfish fleet is composed of boats between 90 and 110 feet long which fish far out in the Gulf of Maine. The men on these boats know a good many details about each other despite the fact that six of these boats come from Rockland, and the other five from Portland, over two hours away by car. The cluster in this case includes the entire Maine fleet.

Lobstering clusters, by way of contrast, are very restricted geographically--usually to the men fishing from one harbor. The number of boats in the small harbors is generally between seven and twenty. In harbors where there are very large numbers of boats (for example, Vinalhaven, Friendship, Jonesport-Beals, Stonington), lobstermen are divided into smaller units, which even have their own sub-territories.

#### F.4 Clusters and Fishery Switching

So far we have talked about clusters as if all fishermen use only one kind of gear and fish for one species over the annual round. Most fishermen in Maine and New Hampshire in fact do exactly this. However, a fairly large number of

fishermen are involved in multiple fisheries over the annual round and use two or more different kinds of gear. The number of fishermen who are using multiple types of gear is clearly increasing (Acheson 1980b). In 1978, of the 579 Maine and New Hampshire fishermen who pursued groundfish as their major fishery, 80, or 13.8 percent went after other species over some part of the annual round (Acheson et al. 1980: Tables 8 and 10). The largest number of these men went purse seining for herring, using the same boats they used for groundfishing. In the same year, there were 2205 men who were full time lobster fishermen in Maine, of whom 541 or 24.5 percent fished for other species over the year. Of these 541 lobster fishermen, 277 or 51.2 percent fished for scallops; 156 or 28.8 percent did some groundfishing; while 79 or 12.9 percent fished for herring (Acheson et al. 1980: Table 12). Virtually all of these men use their lobster boats while engaging in these other fisheries. It should be noted that most of the lobster fishermen who go scalloping and stop seining for herring are from the eastern part of Maine. Most of the lobster fishermen who go groundfishing are from the central part of the Maine coast. Very few lobster fishermen in the southern part of Maine fish for other species, and none of the lobster fishermen in New Hampshire did anything other than lobstering over the annual round. In 1978 a total of 484 men fished for herring. Three hundred seventeen of these men were full-time fishermen while 167 were part-time fishermen. Of the 317 full-time fishermen, about 210 had herring as their major fishery (Acheson et al. 1980: 262). Virtually all of the stop seine and weir operators are among the part-time fishermen or are full-time fishermen who have another species as their primary one. Virtually no fishermen make most of their incomes from stop seines or weirs. However, the vast majority of the men whose major fishery is herring do not

switch onto any other species. Of the 210 men in this category, only 45 or 21.4 percent went after other species, over half (57.8 percent) for groundfish. Almost all of these men were on pair trawlers or purse seiners.

The phenomenon of fishery switching causes problems in delineating clusters and analyzing the degree of cluster packing. When a fisherman switches species, he becomes, temporarily at least, part of another industry. The marketing outlets change, along with the gear used, the men with whom one competes, and the norms one is expected to obey. A fisherman who fishes for lobster and stop seines for herring must obey the rules concerning territoriality in his area and sell to a lobster dealer when he fishes for lobster. When he switches to herring fishing, he does far more than cut down on the number of lobster traps he fishes and put out his seine boat. He is now part of the herring industry and is expected to operate as a herring fisherman. He must have a berth for his seine dory; he normally has a deal with a herring processing firm, and gets large amounts of credit in exchange for rights to the fish caught. It should be made clear that there is no conflict between these two industries. Men can pull lobster traps in the morning and tend their stop seine in the evening. In the morning, they are operating as full-fledged lobster fishermen; in the evening as herring fishermen. The same is true in other fisheries. The skipper of a large boat can make a tow with an otter trawl and be operating completely as a groundfisherman. In the afternoon, he can spot a school of herring; go home and change his dragging gear for a purse seine; and be a herring fisherman by nightfall. Such men are really members of two industries at once. Their set of feasible options is such that they lie somewhere between clusters composed of fishermen who fish only one species. They may be primarily a member of one cluster, but they have wider sets

of contacts and different skills than men who fish for only one species.

The men who are engaged in more than one fishery obviously have different sets of options than men catching one species exclusively. Since clusters reflect the sets of options available to firms, fishery switching must be taken into account in delineating clusters. There are two ways men who fish for multiple species can be assigned membership in clusters. First, we might regard all the men in a given area who combine fisheries as being members of a different cluster than the men from that area who fish a single species. That is, we might say that the lobstermen fishing from a harbor were one cluster; the stop seiners in the area were another cluster; and the men who combined lobster fishing with stop seining a third. In the short run, at least, each of these three sets of men produce different products. Second, we could classify fishermen into clusters based on their majority fishery. On the whole, the second approach appears to be most applicable to most situations. In the long run, these men have much the same opportunity set. Moreover, clusters are reference groups, and involve network ties between fishermen. Simply because a fisherman fishes for two species over the annual round does not mean that he has a vastly different reference group from the men who fish only one. A man who goes for lobster most of the year is still a member of the harbor gang operating out of his lobstering harbor; and he does not give up these contacts during the few months he goes stop seining. For this reason, it is best to regard the men who switch fisheries as in the cluster of their major fishery, even though they have a larger set of feasible options than most other fishermen in that cluster. Clusters that have many such men are not as tightly packed as those in which men fish only one species. The amount of fishery switching and the effect it has on cluster packing is an

empirical matter that differs from place to place. For example, virtually all of the lobster fishermen in New Harbor, Round Pond and Pemaquid are engaged in lobstering all year: few do anything else. On Swans Island, by way of contrast, a very high percentage of the lobster fishermen engage in inshore scalloping during the winter months. In this case the New Harbor lobstering cluster is more tightly packed than that of Swans Island. However, there are few generalizations that can be made concerning cluster packing as it relates to changing fishing gears. In discussing the effect of gear switching on cluster packing in other chapters, each case must be decided on its own merits.

## CHAPTER 3

### FISHING CLUSTERS: THE SHORT RUN INFORMATION PROBLEM

#### A. Introduction

Clusters in the fishing industry exist primarily to solve the problem of obtaining information in a very uncertain environment. As we have seen, fishing is a highly heterogeneous industry, in which the location of the species sought, the market, the activities of other fishermen and what they know, and, increasingly, the government are all in constant flux so that fishermen are constantly faced with situations of uncertainty. A strategy which may work in one week or in one season may doom one to failure if tried the next. The response of fishermen to this situation is literally to imitate each other. Those who are imitated most are men who have adapted successfully to changing circumstances. This imitative behavior, we argue, takes place in both the long and short run. In the short run, men imitate the strategies of more successful fishermen in their search for fish. In the long run, this imitation takes the form of adoption of innovations.

Our adaptive model suggests that the full value of property rights over innovations lasts only as long as other firms are denied access to the relevant knowledge of innovations (See Part II, Chapter 7). This suggests that the secret of success for innovators is to maintain exclusive control over the knowledge and skill involved in innovations. Conversely, other firms should be willing to expend great effort in obtaining that information about those innovations. In addition, the model indicates that the innovations firms accept will be influenced by the nature of the competition they face-- specifically the degree of cluster packing. Indeed, this is exactly what we find in the fishing industry in northern New

England. Success, as we have seen, is achieved largely by skill and knowledge. Successful fishermen go to great lengths to maintain exclusive control over the innovations they make, and the knowledge congruent with them. Moreover, cluster packing does influence the adoption of innovations. In this chapter, we discuss short run imitation and the way it influences the behavior of fishermen on a daily basis. In Chapter 4, we discuss long run innovative behavior and the way the characteristics of clusters and innovative behavior are systematically interconnected over the course of time.

#### B. Searching for Fish

There are two sets of decisions every fishermen has to make concerning every fishing trip. The first is whether he is going to go fishing at all on a particular day or week. This decision is influenced largely by the weather, the price of fish, the activities of other fishermen, maintenance problems he may be having with his boat, and problems he may be having with his crew, if any. In any fishery, the most common reason to stay home is the weather. But one might also decide not to go fishing if essential gear needs to be repaired or if one is having trouble getting essential crew members. In the groundfishery and scallop fishery, one might postpone a fishing trip if the price falls too low, or if going fishing would result in one reaching port at a time when a large number of other boats landed so that the price would be depressed.

Once having decided to go fishing, the most essential question that a fishermen asks is where to fish. This question is far more critical for our purposes since fishermen have to make such decisions every day and sometimes several times a day. This question: "Where to go fishing?" or "Am I fishing in the right place?" is a constant preoccupation of the captains of fishing boats, and the answers they give to them strongly influence their behavior and ultimately their economic success.

There are two sources of information fishermen have concerning locations where concentrations of fish might be located. First, they can draw on their own experience and the information they can gather themselves from their own electronic equipment and their own catches. As we have seen, some men have the knowledge and skill to be able to find fish concentrations with much greater success than others. This unquestionably involves detailed information on the habits of the species involved and the microecology of the ocean floor (Acheson 1977a; 1980). Second, fishermen can obtain information from other fishermen and gain the benefit of their experience. It is important to note that the amount of information that can be obtained from other fishermen, and the means by which it is obtained, differs dramatically depending on the type of cluster. This, in turn, depends on the habits of the species being sought. Specifically, there is a great difference in the way information is gained depending on whether a migratory or a sedentary species is sought.

In the case of lobsters, clams and other sedentary species, the knowledge one might obtain about fish concentrations lasts a long time. If one locates a good bed of clams, one might be able to come back and dig them with great success for a period of weeks or even months, if they are not all dug by other diggers. The same is true for lobster fishermen, since lobsters remain in the same locations for a period of days or even weeks at certain times of the year. Given the value of such knowledge, men fishing such species are very secretive about their fishing activities. Periodically, clambers and lobster fishermen will discuss catches and the locations of fishing grounds with other fishermen. But they are usually careful to discuss such matters only after the fish concentrations have all been caught or only with other close family members who they want to help, or with men who might have equivalent valuable information to exchange. Under no circumstances do they broadcast their successes. Quite the con-



trary, they are very apt to play down their catches and even deliberately understate them. In fact, the secretiveness of lobstermen and clammers is legend all along the coast. As one coastal resident phrased it: "They are the dogdamdest bunch of liars you have ever seen. They are always crying about something. The price of bait is always driving them out of business, their boats always have worms, their traps--what few have survived the last storm--never hardly catch anything. They never admit when they are into the lobsters. They're making lot more than you or I, but to hear them talk you would think they were all eligible for food stamps." The same pattern is observable in the clamming industry. There is a state law in Maine that all clam dealers have to record the number of men from whom they purchase clams every day and the location where those clams were dug. One dealer confided: "I just put down any old thing for the location. No clammer is going to tell where he dug clams--especially if the digging is good." State officials are fully aware that the information on places where clammers are digging is notoriously inaccurate. As a result of this secrecy, the most important way that men in clusters exploiting sedentary species obtain information about fishing locations is by direct observation. They watch each other very carefully. Since there is so much to be learned by observing where other men are clamming or lobstering and correlating this data with catches, many men are very wary of anyone hanging around a dealer's establishment, keeping close tab on catches. One man, who was notorious for loitering around a dealer's establishment picking up catch details, stirred up such hostility that he was known as the "CIA clammer." There is no logic in the name, but the spirit of the emotions he stirred up is evident. Most experienced fishermen are far more circumspect in observing each other's fishing behavior.

While all men in such fisheries learn a good deal by observing each other, and by their own direct experience (i.e.

electronic instruments, fishing success, and so on), the degree of dependence on these sources of information differs markedly with experience and knowledge. Many very experienced fishermen rely primarily on their own experience and detailed knowledge of the bottom and habits of the fish. Some of the "highline" fishermen state that they almost ignore what others are doing. One very successful lobster fisherman, with perverse pleasure, put it in the following terms: "There's no sense fishing with all those dubs; the only thing they are good at is getting the gear all tangled to hell up." For the novice fisherman the ratio is almost reversed. He has little experience to draw on and only the vaguest idea about the bottom and fish movements. Many of them have little choice between simply trying to learn where fish are through their own experimentation (not usually very successful) or to follow around an older, more knowledgeable fishermen. Inexperienced clammers will sometimes dig within a few feet of experienced men. In the lobster fishery, inexperienced fishermen often put their traps in the same place experienced men have theirs. Naturally, the experienced fishermen greatly resent this kind of behavior. Sometimes they will rid themselves of the pests by violent means. One of the authors has seen one older clammer threaten a man who was going to dig in the exact same location with a clam rake. On another occasion, we witnessed an incident in which an older fisherman flattened the tires on the pick-up truck of a man who was following him. In the lobster fishery, experienced fishermen will sometimes simply "cut off" or destroy the traps of the men who have "dumped (their traps) on top of him."

Ordinarily, however, more subtle means are used by experienced fishermen to discourage their shadows. Deceptive tactics are relatively easy for those involved in the clam fishery. Inexperienced fishermen locate more experienced men by seeing them on particular clam flats, asking them or trusted

acquaintances where they are digging, noting where their pick-up truck or automobiles are parked, or literally following them as they leave their houses to dig clams. As a result, experienced clammers who are having too much unwelcome company on the flats are very reticent to tell anyone where they are currently digging, take pains to park their trucks and cars in out of the way places, and go in the dark to places they feel will be especially productive. They are also very careful not to visit places they are planning to dig until they are ready to harvest the clams there. One of the authors spent a day with a very experienced clammer, who had been plagued by what he called "admirers." At least three hours of the day was taken up with ploys that could have come from a spy thriller. Throughout the day, we went through a whole series of diversionary tactics designed to confuse and confound the competition. The truck was pulled off to the side of the road to see if we were being followed; the truck was carefully hidden while we were actually digging clams; the best clamming spots were actually dug before daylight and after dark when we could not be observed easily. At the end of the day we sold our clams to this fisherman's "regular dealer" who he said he trusted. He told the dealer's assistant a baldfaced lie when the topic of digging location was broached, misrepresenting our actual location by a good sixty miles. On the way home, I was sworn to secrecy and pointedly told I would never have been brought along if I had not had the reputation of keeping my mouth shut.

Nor was this highline clammer being unduly suspicious and secretive. On two occasions, one of the authors has heard young local boys with an obvious penchant for trouble describe how they waited in their car outside the home of a very good clammer and followed him everywhere he went for the entire day. Apparently, this resulted in several shouting matches, with the parties almost coming to blows at one point.

In the lobster fishery, other ploys are used to mislead novices and others. There are well-verified stories of experienced men anchoring buoys on pieces of concrete blocks to simulate a string of traps. Often men will put actual traps in places they know are not productive of lobsters as a disguise. One knows where a fisherman has placed his traps from the location of the buoys, but there is no way one can tell which of these traps are producing. By deliberately putting a few traps in "poor spots," highline fishermen hope to confuse the issue even further. On several occasions, we have heard of "highline" lobster fishermen putting strings of traps dangerously close to shore when a storm was brewing, and moving them into deeper water at the last minute. Any novices lured into the shallow water by these tactics are almost certain to lose a few traps. Nor are raw novices the only victims. On one offshore island, one moderately good lobster fisherman who was being accompanied by one of the authors lost a string of 17 traps by "dumping on" a highline fisherman just before a gale. Still, the rewards of following a highline fisherman are high enough so that most novices and even more experienced fishermen are guilty of the practice at one time or another.

Some of the other elaborate ploys lobster fishermen use to confuse other fishermen need to be mentioned. One Casco Bay fishermen both authors know well discovered that there were still good catches of lobsters to be had on mud bottom, in deep water, some 10 to 15 miles offshore in the summer. All of the other fishermen in the region concentrated their traps close inshore since it is widely known in the entire industry that lobsters migrate toward shore in the summer. This fishermen knew there were no great numbers of lobsters offshore, but there were enough still there to make fishing very profitable if there were no competition for them. In order to keep his find secret, he bought an extra colored

sail for his lobster boat.<sup>1</sup> In the morning, he would hoist his ordinary white sail on his boat, and fish strings of traps placed inshore, talking constantly on the radio to call attention to himself and the location he was fishing. In the afternoon, he would separate himself from any boats in the immediate area, raise the colored sail, and go fishing far outside in deep water all afternoon. Late in the afternoon, he would come back inshore, raise his white sail and come into the dock to sell his large catch, pretending he had been fishing inshore waters all day long.<sup>2</sup> The secret of this location was also maintained by deceptive banter at the buyer's dock. At last report, his ploy still had not been discovered, and he was enjoying the best summer and fall fishing he had ever had. This fisherman gleefully told one of the authors that other fishermen used to watch him very carefully and even pull some of his inshore traps, to see if the secret of his inshore traps could not be accounted for in terms of a different kind of bait or different heads, or some change in trap construction.

All of this is not to indicate that fishermen exploiting sedentary species never exchange information verbally. Older fishermen will openly instruct their sons and younger kinsmen in fishing techniques, and fishermen when they meet together

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<sup>1</sup>On lobster boats a small sail is usually raised on a small mast mounted on the stern of the vessel to steady the boat in a wind. It is usually obvious at a distance to a couple of miles or even more.

<sup>2</sup>To those unfamiliar with the sea, it might seem difficult for a boat to slip away from others and remain hidden on the open ocean. Lobster boats, however, are so small that they are usually difficult to spot with the naked eye from sea level when they are more than two miles away. Even on a good day in summer there is usually enough haze to make them difficult to see as little as a mile and a half away. Sometimes in rough weather, fog, or rain these small boats can be difficult to locate a few hundred yards away.

talk about only one thing: fishing. But fishermen will exchange information about catches, income, and currently productive locations only with a selected few people, and then only in a very guarded manner, usually holding back some of the critical details. Despite the fact that many lobstermen, wormers and clammers are friendly, deception and secrecy mark relationships between men in such clusters. Men exploiting sedentary species gain a great deal of information on their own or by direct observation of others.

In the herring fishery and swordfishery, by way of contrast, the duration of knowledge is very short. Since its value is much less, a great deal of information is openly exchanged. Schools of fish which are in one place in the early morning may be completely dispersed and in other locations by noon. In a day's time, such fish can often be dozens of miles away from the place they were originally spotted. The problem is to locate schools, and once located to stay with them. In such fisheries, much of the time at sea is spent searching for fish. There is little sense keeping the existence of such schools secret, because they will not be in the same place long. In these pelagic fisheries, there are no fishing locations or "sweet spots," but merely places where fish happened to be when one caught them. As a result, boats in such fleets actively aid each other in their search for fish. They tend to fan out over a wide area and when fish are found, inform at least some other members of the fleet. They might not call other boats until they have a full load of fish or are sure they have located more fish than they can possibly exploit themselves, but they would certainly tell other boats in a matter of a few hours. Moreover, such fishermen would never remain completely mum about the places they caught fish, or the fact that they caught them. Anyone who has spent a couple of nights with the herring fleet is certain to observe at least one or two instances when boats help each other in search

operations. Most often, communication concerning search behavior involves laconic comments on places where no fish have been found. Of course, such information is very valuable in that it makes it unnecessary for other boats to search in the same place. When fish are found, boats will go out of their way to inform other vessels about the location of schools. Most inform other vessels about fish locations in the hope that they will reciprocate some time in the future. Herring fishermen often help each other to keep track of schools. Manville Davis of New Harbor, Maine recalls one day when four seiners kept track of a huge school of herring by such cooperation. In his own words: "When those Gloucestermen were coming in with a load of herring, they would come on over and meet us and point to where the school was and shout the distance; when we were coming in with a load, and they were coming back out again, we would do the same for them. That school zigzagged a good hundred miles, but between the bunch of us we managed to keep on them for three days. After that, they (the fish) just seemed to peter out. They (the fishermen on the other boats) was all Portogees you know, but they was nice fellows."

Purse seiners have also been known to give each other part of their catch when they caught more than they could handle. In purse seining, one does not know exactly how many tons of fish have been caught until one pulls in the seine and "dries up" the fish. "Dried up" fish have to be pumped or brailed into the boat or carrier quickly because they quickly die for lack of oxygen when they are packed together in the water. Eventually they sink, taking the net to the bottom with them. Thus, when a purse seiner has caught more fish than it can handle, it will usually give another nearby boat the excess fish. In fact, in the herring industry it is considered very bad form not to give excess catches to other vessels. Not only are such fish wasted, but herring men say that if the bottom is littered with tons of dead fish, other

schools of herring will stay away from the area permanently. It is also considered an unfriendly and selfish act, and even evidence of hostility. Of course, altruism and friendliness are not the only reasons to give away such excess fish. The men who do so obviously hope the beneficiaries of their largeness will reciprocate in the future.

There can be little question that the cooperation between herring fishing boats contributes to the total success of the boats in this fleet. Certainly they are able to search a far wider area than would be possible alone. In addition, they are able to exert far more exploitive effort on schools of herring by operating in this manner. The area that cooperating boats can search is enormous. In February 1978, one of the authors accompanied four pair trawlers for a day. These boats left Gloucester in the afternoon. One pair of boats went south and systematically searched around Marblehead and Boston Harbor. Late at night they had covered Massachusetts Bay down as far as Plymouth, and by the middle of the night had searched the entire shore as far south as the Cape Cod canal. The other pair of trawlers went first to Provincetown, and through the afternoon and night worked their way down the inside shore of Cape Cod. The search areas of these two sets of boats was sometimes no more than two or three miles apart, as they zigzagged out from shore to search in the middle of the Bay. Between the four boats, they made an effective search of the whole Massachusetts Bay. During this entire period, they only communicated by radio three or four times. Nevertheless, each set of boats kept careful tabs on the activities of the other, primarily by watching the boat lights. Around midnight our electronic gear indicated a school of herring, and we made an eleven minute tow, catching 12,000 pounds of fish. Within 25 minutes of taking the fish aboard, the other set of pair trawlers arrived on the scene from the other side of the Bay to see what we had found. They made a tow on the same school and caught a few thousand pounds



of fish which they never would have obtained had they not been able to observe us towing from a distance of several miles.

It should be noted that these two sets of pair trawlers were competitors. One pair was owned by one of the Maine herring processing companies, the other privately by a father and son team. If one of these sets of boats located a school, it was going to fish it first, with very little thought about the welfare of the other. Some vessels are far more successful in this overall competition. From the limited data at our disposal on catches, it is clear that some pair trawlers and purse seiners catch 500 percent more than other comparable boats in a season. Wadel has observed even greater disparities in the North Sea herring fishery. Here a "single purse seiner may catch as much as five or ten others put together" (Wadel 1972:107). Thus, the kind of cooperation observed between such herring vessels does not necessarily operate to distribute the catch evenly. However, there is enough communication that such boats are able to search very wide areas and focus fishing effort on the herring schools when they are found. Thus, this kind of competitive cooperation increases the total effectiveness of the fleet, if not the short term success of every boat in it. In the herring fishery, adding boats to the fleet fishing in a given area may be an economy for boats which have been fishing there for some time. Although we do not have solid quantitative data on the matter, we suspect that removing boats from the fleet fishing particular areas would often result in a more than proportional decrease in the total number of fish caught.

Captains of fishing boats contribute to each other's success--and the success of the total fleet--primarily in the area of search behavior. The phenomenon of boats sharing excess fish with less fortunate boats is far rarer, but such events occur often enough to cause no great stir among herring fishermen. In the herring fishery, it should be noted that

there is a good deal of open communication among fishermen not only when they are searching for fish at sea, but also when they are ashore. As a result, information about catches and relative economic success are widely known among the men of the herring fleet. Even ashore, the men chasing the highly mobile herring have few secrets from each other.

While no member of our research team spent any time on swordfishing boats, information from key informants indicates that this fishery is similar to the herring industry. Swordfish are, of course, highly mobile. In the winter, they are found in the waters off Florida. In the early summer they appear in the Gulf Stream, off southern New England, and by early fall, they have migrated north to Newfoundland. Late in the fall, as the water cools, they migrate further south again. Many New England boats rig up for swordfishing only in the summer months; others follow concentrations of swordfish throughout their range. In either case, the problem is again to locate schools of fish. Most of the hours spent on swordfishing boats are spent in dull search for fish, punctuated by a few minutes or hours of intense activity when fish are harpooned. As in the herring industry, swordfishermen communicate a great deal about locations of schools of fish. Here again, there is very little to be gained by keeping fish locations secret and a great deal to be gained by sharing information. Information concerning fish locations may have value for only a few hours at the most; by sharing information, the search net of the entire fleet is greatly increased.

Boats of the swordfishing fleet do not ordinarily communicate fish sightings when they occur. They may, in fact, keep their good fortune to themselves as long as they are killing fish. However, the men of this fleet (in a given range) are constantly in touch with each other and much information about fish locations is passed via radio. More important, groups of these vessels meet every evening; tie their

boats together; and engage in what has been variously described as an "offshore convention" or "party" complete with singing, drinking, storytelling, and a constant exchange of serious information about the job at hand. Much of the talk is, of course, about catches, places where fish were harpooned and speculation about places where they will be found on the morrow.

Despite the fact that groundfish are a migratory species, found offshore in the deep waters of the Gulf of Maine in the winter and inshore in the northern part of the Gulf in the summer, groundfishermen are relatively secretive. They learn about fish locations primarily from their own experience and from observation rather than from open verbal communication with others. In this sense, the groundfishery is more like the lobster industry than the herring or swordfishery. This pattern of secrecy stems from the fact that while the fish are migratory, the tows and places one can safely fish without destroying one's dragging gear are fixed. Since the duration of this essential knowledge is so long, information about such fishing locations is a jealously guarded secret.

However, groundfishermen are not as secretive and uncommunicative as lobster fishermen and clammers. While such fishing boats are at sea, their captains are constantly on the radio to each other, and some accurate information about catches and fishing locations are communicated. However, such fishermen rarely actively help each other either, and as Andersen and Stiles have noted (Andersen 1972:121-128; Stiles 1972:40-48), a good many radio messages are artfully designed to deceive the listener about one's degree of fishing success.

Several variations in the pattern of secrecy and communication should be noted in the groundfishery. There is more verbal communication of information of catches and fishing locations in the inshore fishery, primarily because tows are relatively well known and because information on catches is

relatively easily checked. A man who lies about catches over the radio may very well find the man he attempted to deceive on the dock in a few hours watching him unload. In such fisheries, men often do not keep elaborate records on tows and snags. Some even have small pencilled maps of the tows they commonly exploit drawn on the walls of the pilot house where any crewman or visitor can see them.

Ordinarily, the boats fishing inshore go day-tripping within 25 miles of their home harbors. Since there are only a few tows in any given inshore area, many of the draggers from the harbors in an entire section of the coast have each other in view during much of the day.

Unquestionably the information skippers of inshore groundfishing boats gain from talking to other skippers in their cluster or observing them has a strong influence not only on decisions concerning where to fish, but what to fish for. In Stonington, Maine, for example, the groundfishing vessels fish in different locations for different kinds of groundfish during the spring, summer and fall. In the winter several shift to dragging scallops. These men take their cues concerning switching species and fishing gears from two or three highline fishermen, who are always the first to seek out information on species arriving in the area, and the first to change gears. These two or three men will switch gear and fishing grounds ahead of everyone else, and once the majority of fishermen is convinced they have found concentrations of a new species, they will shift onto that species as well. This pattern shows up clearly in the catch records of the local fishing cooperative.<sup>1</sup> During a period when one species is plentiful, all boats will be exploiting this species exclusively. The first sign of change occurs when the two or

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<sup>1</sup>The figures themselves have not been made available to our research team. A skilled observer of the industry, who has access to the figures, has described this pattern to us.

three "experimenters" show no landings for a period of several days. It is in this period that they are switching gears and/or searching new locations for new species. Then, one can see a period when the "experimenters" are landing a new species, while the majority of fishermen are still landing the "older" one. Gradually the landings of the new species increase while the older species landings decrease. In this period, the majority of the groundfishermen in the harbor are switching to the new species. The exact same pattern is apparent several different times a year--every time there are marked changes in target species, to be exact.

At times, the "experimenters" gain substantially by being the first to switch species. Other times they do not. If the "experimenters" can find concentrations of a new species quickly, and the price is good, their willingness to invest their time in searching out a new species pays handsomely. Sometimes the men who deliberately wait before making a switch are the winners. They are letting the "experimenters" pick up all the costs of finding new species. Those search costs can be very substantial if it takes two or three weeks to locate concentrations of newly arrived species while the older species are still plentiful.

In the offshore groundfisheries, where boats range hundreds of miles, knowledge of fishing grounds is far more differential and fishermen more secretive. Here, the areas exploited are so vast that fishermen ordinarily do not know the details of the bottom in all offshore areas, but rather tend to have a thorough knowledge of some, and be completely ignorant of others. Here, knowledge of the bottom depends primarily on the amount of experimenting and exploiting that one has been able to do, so that older, more experienced men are apt to have a wider knowledge of more fishing grounds than younger ones. It should be noted that a detailed knowledge of these offshore grounds is very costly to obtain and that there are social

barriers to obtaining it. Since economic success depends primarily on a knowledge of the bottom (that is, places one can tow safely and which are productive of fish), experienced fishermen will rarely divulge such knowledge. They will talk in generalities about fishing grounds, but critical details about snags and productive locations are rarely fully revealed. Knowledge of fishing grounds is something learned only through direct experience, and it is difficult to obtain this experience with strange fishing grounds.

Many of the offshore groundfish vessels are owned by large, vertically integrated companies whose owners expect their captains to be able to produce fish on a reasonably steady schedule. This is especially true of the redfish fleet. Moreover, the crews of such boats want to make as much money as possible in as few days at sea as possible. Thus, both owners and crews judge captains by their ability to catch a load of fish in a minimum amount of time. Captains of these vessels are very often on the horns of a dilemma. If they spend too much time experimenting and learning about new fishing grounds, their catches are sure to suffer in the short run, and they may lose valuable crewmen and perhaps even their jobs. On the other hand, a captain's ability to produce good catches consistently in reasonable time periods depends largely on his knowledge of a large number of fishing grounds. Thus, an offshore captain, if he is to become a highliner, somehow has to increase his repertoire of possible fishing grounds despite the obstacles to gaining that experience. The usual ploy captains use is to fish in locations they know most of the time, and then make a few experimental tows in strange areas, all the while pretending they are fully knowledgeable for the benefit of the crew. In the case of company-owned boats, the home office is ordinarily kept fully ignorant of such forays.

There is a marked difference in the way owners of ground-fishing boats learn about the bottom as they move from one

part of New England to another. Some boats from the eastern and central ports of Maine move temporarily to ports in southern Maine, New Hampshire and northern Massachusetts in the late winter and early spring when groundfishing is very bad near their home harbors. Conversely, some inshore groundfishing vessels move to the eastward in the summer and unload much of their fish in ports in eastern Maine. When these boats are fishing in central and eastern Maine, the areas they can fish are very circumscribed since there is a great deal of rocky, uneven bottom in the area. The primary problem here is to locate the holes or tows where one can safely fish. In the southern part of Maine, New Hampshire, and off Massachusetts, there is a great deal more sandy and gravel bottom. Here, the problem is largely one of locating concentrations of fish--locations of tows are far less of a problem. This situation markedly affects the way fishermen obtain information about fishing locales. In the eastern part of Maine, where critical knowledge about tows has long duration, men are much more secretive so that a good deal of data about fishing locales is obtained through observation. In the southern part of this region, where the problem is to locate fish concentrations on wide expanses of useable bottom, the duration of knowledge is relatively short since the fish are constantly moving. Here, there is a great deal of verbal contact between skippers of boats, and an active exchange of information concerning fishing locations. So marked is the difference in attitudes and cooperation that two owners of inshore draggers, who live in different ports in central Maine, have said they were seriously thinking of moving to southern Maine because fishermen there were so much friendlier.

Others have remarked on the situational aspects of this difference in willingness to communicate accurate information about groundfish locations. The exact same men, they say, are much more open and friendly when they are fishing out of

ports in the southern part of the Gulf of Maine than they are when fishing in the more central and northern areas. Some men have not only noted the phenomenon, but have also pinpointed the cause. "When we fish out of Portsmouth and York (southern region), we all swap information. Sometimes Cashes will outfish Jeffreys' and at times you can do as well at Boone Island and other inshore grounds as anywhere else. Up here (New Harbor) everyone has his favorite fishing hole and he wants to keep it secret. The same man who will tell you anything when we are down south, won't give you the time of day up here."

In summary, then, in all fisheries in northern New England, fishermen learn a great deal about fish locations from other fishermen. It is the men with whom one is competing for the same species in the same area who are the best source of information on the locations of concentrations of fish. The men in the same cluster use each other in much the same way they do electronic gear--as extensions of their own senses in searching for fish. Moreover, in all fisheries, captains obtain information from other fishermen concerning fishing locations both by direct verbal contact and by observation. The proportion of information they obtain from each source differs according to the duration of knowledge, which ultimately is related to the mobility of the species being hunted. Among men fishing for lobsters, clams and marine worms, which are highly sedentary, knowledge of the locations of concentrations lasts a long while so that it is in the best interests of a fisherman to be very secretive. The fish he does not talk about today, he can come back to fish tomorrow. Much the same pattern is true in the groundfishery--especially in the offshore areas of the Gulf of Maine and the more eastern areas of Maine where a knowledge of fixed tows is crucial. In the herring industry and swordfishery, more information is exchanged verbally about concentrations of fish. Here the problem is to find the moving fish. Once con-



centrations are found, there is little sense keeping locations secret since the fish are not likely to be in the same place again. As a result, men in these fisheries are more prone to exchange information about fish concentrations in the hope others will reciprocate.

Whether fishermen obtain information about fish concentrations actively or passively (observation, eavesdropping on radio conversations) information from other skippers greatly enhances one's ability to find fish. A man cut off from contact with other vessels has far less chance of finding fish than if he were part of a widespread search net. It is the utility of the information from other vessels fishing for the same species that makes it highly desirable to form the kinds of networks, friendship ties, and reference groups that characterize all clusters.

## CHAPTER 4

### INNOVATIVE BEHAVIOR IN FISHING CLUSTERS

#### A. Introduction

Fishermen imitate the behavior of other men in ways which have long-term implications for the formation and characteristics of clusters. The most important long run imitative behavior relates to the adoption of innovations. We argue that in the face of tremendous heterogeneity and uncertainty, fishermen adopt innovations which they have seen other men use with obvious success. If the external environment is stable for a long period, this tendency to adopt successful innovations results in a relatively uniform technology being used by all of the men fishing a particular species. Conversely, we argue that the characteristics of the innovations adopted will vary considerably with the traits of the cluster involved. In short, clusters and technology are actually mutually interrelated, with cluster characteristics influenced by the technology adopted; and the responsiveness to innovations influenced by the cluster characteristics, especially the degree of cluster packing. In this section, we will first examine the role of cluster membership in the adoption of innovations. Second, we will discuss the effect of cluster packing on the adoption of innovations.

In the past 40 years an enormous body of literature has been published concerning the social, economic and cultural factors influencing the diffusion of innovations. It is, in fact, one of the few topics that has been studied by people trained in every social science. In all these different disciplines, students of innovation have been struck by the fact that in any culture, the adoption of innovations is highly differential, with some people

adopting them ahead of others (Rogers and Shoemaker 1971: 176ff). Correspondingly, certain kinds of innovations are adopted relatively speedily in comparison with others. Until very recently, the social scientists interested in innovation have asked two key questions: (1) What kinds of innovations are apt to be adopted faster than others? (2) What kinds of people are more likely to adopt innovations? Several studies have demonstrated that innovations which are "advantageous," "uncomplicated," "triable," or "observable" will be adopted at a faster rate than those which do not have these characteristics (Rogers and Burdge 1972:353-354). Others have pointed out that rate of diffusion is related to profitability (Mansfield 1961). The people who are said to be more likely to adopt innovations--regardless of type--were younger, better educated, more cosmopolitan than those who were slower to adopt innovations (Rogers and Shoemaker 1971:176-191).

In the past few years, however, this approach to the study of innovation has seemed more like a blind alley than an avenue to the truth. Certainly social scientists taking this approach have produced very contradictory results, and few generalizations which are universally verifiable. The problem, it is increasingly recognized, lies in the fact that this approach to the study of innovation treats innovator and innovation as separate phenomena, and considers adoption of innovations out of any cultural context. Recently, a number of researchers have come to the conclusion that a far more fruitful approach to the study of innovation is to consider the "match" between the innovation and the needs of the individual adopting it. That is, innovations are adopted most quickly when they solve some problem for the individual considering their adoption. This adaptive approach to the study of innovation appears as if it will be very fruitful (Downs and Mohr 1976:700-714). Certainly many fishing innovations

are adopted because they are matched to the needs of individual fishermen. Indeed, much of the data we have collected concerning technical change in the New England fishing industry makes very little sense in any other context (Acheson and Reidman 1980a).

However, all students of innovation have noted that the diffusion of innovations is a very complicated phenomenon in which a large number of social and economic variables must be considered. Those students who want to investigate the match between an innovation and its adopters have been forced to consider an even larger number of variables. Recently, several studies have appeared in which dozens of variables of all kinds have been treated by advanced statistical techniques in an attempt to account for the adoption of innovation. In such studies personal variables on the adopter such as age, education, experience, marital status, and so on are included, along with information on the innovation and data on the firms doing the adopting (that is, firm size, total assets, and so on).

However, in the entire literature on innovation little attention has been given to two sets of variables which are critical for understanding the adoption of fishing gear in northern New England. First, very little has been said concerning the kind of industrial groupings that owners of firms belong to--especially the kind of competition firms are facing in their decision to adopt innovations, and the kind of information they obtain from those competing firms. In many studies it is assumed that information about innovations comes primarily from change agents (for example, extension agents), or from the mass media (Rogers and Shoemaker 1971). But to the best of our knowledge, there has been no study of industrial social units such as the ones we call "clusters" and their effect on the adoption process. Our model suggests that the competition a firm faces from firms producing similar products

influences the innovation adopted. The data on the fishing industry of northern New England support this contention. Second, little attention has been paid to the kinds of knowledge needed for successful adoption of innovations. Many studies mention concepts such as "contact" with an innovation or the "early knowers" or "late knowers" as if simple awareness alone is the key to adoption (Rogers and Shoemaker 1971:107ff). Certainly some students of innovation have recognized that there are different kinds of knowledge that are involved in the adoption process. Rogers and Schoemaker make a distinction between three different kinds of knowledge: "awareness," "how-to knowledge," and "principles knowledge" (1971:106-197). This distinction is also made by Arrow (1962). "How-to knowledge" is defined as the information necessary to use an innovation properly; while "principles knowledge" involves an understanding of the axioms underlying the innovation. However, Rogers and Shoemaker do very little by way of linking this classification to the adoption of different kinds of innovations. As we shall see, the type of knowledge involved and the factors influencing access to this knowledge play a critical role in influencing decisions concerning the adoption or non-adoption of innovations.

B. The Influences of Cluster Membership on the Adoption of Fishing Innovations

During the course of the past two years, we have gathered and analyzed data on some 20 technical innovations currently being adopted by members of the fishing industry in New England. We deliberately picked innovations requiring different amounts of capital to ascertain the effect of investment requirements on investment behavior. Specifically, we studied the factors influencing the adoption of metal lobster traps--a type of technology which is inexpensive enough that anyone wanting to experiment with

this gear is able to do so. We also studied 18 moderately expensive innovations, such as Loran C, gillnets, radar, scanning sonar, otter trawls, and VHF radio, which generally cost several thousand dollars. We also studied, at the other extreme, the adoption of pair trawlers, which cost more than \$500,000 each. Both quantitative and qualitative information were gathered on the factors influencing the adoption of all of these types of innovations. We framed a series of hypotheses concerning the adoption of these innovations, and used standard statistical techniques to analyze them. In all cases, our sample was large enough so that the results were highly significant statistically. The single exception was the pair trawlers. Since only 16 of these large vessels have been adopted in all parts of New England we did not have a large enough sample to even attempt a statistical analysis. The specific results of our findings are contained in two articles (see Acheson and Reidman 1980a; Acheson 1978).

The factors explaining the adoption of all of these innovations are complicated indeed. Several are associated with the adoption of each innovation studied. In fact, no two innovations in the entire study could be explained by the exact same set of variables. This strongly reinforces the point made in some of the newest studies of innovation--namely, that different innovations are accepted by different people to solve different problems (Acheson and Reidman 1980a; Duchesneau, Cohn and Dutton 1980). However, there are some factors that are connected to the adoption of most of the innovations studied. Some variables point up the importance of clusters on the decision to adopt new technology. In order to demonstrate the importance of cluster behavior in the mix of facets influencing adoption decisions, we will discuss several innovations, beginning with lobster traps, the most inexpensive, and ending with the most costly and complicated.

### B.1 Metal Lobster Traps

In 1977 and 1978, there was little question that lobster traps made of aluminized wire and vinyl-coated wire were superior to the old style oak lobster traps. Even though the metal traps cost more to buy, and last a shorter length of time, they increase physical productivity sufficiently to be a sound investment (Acheson 1978:24). Nevertheless, only certain men in certain harbors adopted large numbers of these traps at a rapid rate. A detailed study of the diffusion of metal traps revealed that two factors were of overriding importance in their adoption: career cycle of fishermen, and the cluster from which they came. In the area where this study was carried out, there are substantial differences in the personal characteristics of early vs. late adopters of metal traps. The men who adopted metal traps early are more committed to the industry, and certainly have more invested. Their average age is 41.3 years--in the height of their career. Lobstering for them is an occupation, not a hobby. They are constantly experimenting with techniques to increase production.

There is a bimodal distribution of the age frequencies of the late adopters; many are young men in the early years of their career, while others are relatively old. The reasons these classes of men have little interest in the adoption of metal traps differ substantially. The older men are in the process of retracting their fishing operations and retiring. They want to depreciate their gear and get out of business. The young men are more interested in purchasing wooden traps, both because they consider them less risky and because they can get more of the cheaper wooden traps. Since they have limited capital, and want to build up their operations as quickly as possible, wooden traps seem the better buy (Acheson 1978:32).

However, it should be noted that the adoption of metal

traps was very spotty, with the men from some harbors taking on this gear long before others. The concepts of "early adopter" and "late adopter" have meaning only within the context of a given harbor. Specifically, the adoption of metal gear was studied in five harbors in the Muscongus Bay area of Maine: Friendship, Bremen, New Harbor, Round Pond and Pemaquid. In this area, metal traps were first used in Bremen in 1974, and by 1976, some lobster fishermen in that town had converted completely to metal traps, and all fishermen had some of them. However, the diffusion of these traps to fishermen in other nearby towns was very slow. By January 1977, only two men from New Harbor had any metal traps and they had only a few. None of the men in Round Pond or Pemaquid--only a few miles from Bremen--were even experimenting with such traps. By this time, however, a number of men in Friendship (across Muscongus Bay from the Pemaquid Peninsula) had adopted large numbers. By 1978, when our study was completed, at least half of the men in New Harbor had some metal traps, and four men from Pemaquid were experimenting with them. None of the men in Round Pond was interested, despite the fact that Round Pond is only four miles from New Harbor in one direction and six miles from Bremen in the other. In short, the social units involved (that is, harbors, which are clusters in the case of the lobster industry) played an important role in the diffusion of metal traps. Once traps were established in a particular harbor, they diffused throughout the "harbor gang" relatively quickly. However, diffusion of such traps between clusters or harbor gangs occurred very slowly.

This diffusion pattern is related to the network ties and sources of knowledge available to lobster fishermen. The reason metal traps and other innovations diffuse slowly between harbors is because of the lack of communication and hostility between members of different harbor gangs. Within



a harbor gang these are dense network ties so that knowledge of innovations spreads rapidly. Successful lobster fishermen do not give others information about fishing locations, or much of anything else for that matter. However, once an innovation has been adopted by some members of the gang, it can be observed and its relative efficiency can be more easily judged. Once metal traps had been introduced into particular harbors, it became apparent that they were relatively more efficient, and they spread very quickly.

The question remains, given the relative lack of interaction and the distrust existing between members of different harbor gangs, how does information about innovations cross boundaries of these clusters? The data we have gathered on the diffusion of metal traps indicates that certain highline fishermen who have wide-ranging social ties play an essential role in the transmission of information about innovations. The vast majority of the fishermen in Pemaquid, New Harbor, and Round Pond said they obtained information about metal traps from men in their own harbors. Several highline fishermen, by way of contrast, said they heard about such traps and were convinced to buy them by talking with friends from Bremen--the town where metal traps were first adopted. Despite this evidence that ideas and awareness of innovations can be transmitted between "clusters" there are clearly impediments to the transmission of information from one cluster to another. This means that cluster membership is a key factor in the diffusion of innovations in the lobster industry. Whether one hears about an innovation or not, and one's ability to observe it in operation, depends on whether one comes from a cluster where the innovation is established.

## B.2 Innovations in the Fin-Fishery

Cluster membership is also important in the adoption of

the intermediate cost innovations, although the importance of clusters in the adoption process varies considerably depending on the particular innovation. Information on the factors influencing the adoption of 18 intermediate cost innovations was collected by a team of interviewers in the summer of 1978 from captains of 190 fin-fishing boats in every major harbor in Maine and New Hampshire.<sup>1</sup> These vessels represent approximately 65 percent of all year-round fin-fishing boats in this area. Information was collected by personal interviews on the boats and docks where the boat, equipment and crew could be observed.

Two kinds of informations were recorded on the interview form: (1) information on the individual and his personal history in fishing (education, marital status, experience in fishing, and soon), and (2) information on fishing operations and equipment. The average interview took about an hour and a half; a few lasted far longer. Thus, this study provided a great deal of information on the kinds of changes occurring in the fishing industry and the traits of the men making them. Special attention was paid to changes in boats, electronic gear, and fishing gear.

Specifically, we studied the adoption of boats that were significantly larger than the boat the fisherman previously owned; a larger boat is an innovation, since its adoption requires quantum increases in skill levels. There were four kinds of fishing gear studied: gillnets, otter trawls, pair trawls and longlining gear. Last, we

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<sup>1</sup>Our study of these innovations was completely separate from the study of the factors influencing the diffusion of metal lobster traps. The trap study was done in the summer and fall of 1977 and the winter of 1978; it involved only lobstermen from four adjacent harbors in central Maine.

studied the adoption of the following kinds of electronic gear: depth finders, depth recorders, scanning sonar, radar, automatic pilot, CB radio, VHF radio (Very High Frequency), Loran A, Loran C, and Loran C plotter.

These electronic devices fall into three functional categories. The CB radio and VHF radio are obviously used for communication. Radar and auto pilot are essentially aids to navigation. Depth finders, depth recorders, and scanning sonar are used fundamentally to locate fish. These fish finding devices operate by projecting a sound wave outward from the boat. The bottom of the ocean or schools of fish register as flashes of light on cathode ray tubes, in the case of depth finders and scanning sonar, and as graphs drawn on paper in the case of depth recorders. Loran A and Loran C allow the fisherman to locate the position of his boat with extreme accuracy.<sup>1</sup>

They are used not only as navigational devices, but also in finding fishing locations and in locating fixed gear. The Loran C plotter which graphically indicates on a chart where the vessel has been has many uses in the search for fish (for example, helping draggers avoid going over the bottom twice, aiding pair trawlers in finding schools of herring).

The data from this study were coded by the interviewers who collected the information, keypunched, and compiled at the University of Maine computer center. These data were

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<sup>1</sup>The location is determined by the intersection of radio beams emanating from fixed stations. The fisherman notes the number of microseconds it takes for the beam to reach a station, and finds his position on specially prepared maps.

\*At present, the older Loran A system is being replaced by Loran C. The Loran A stations are scheduled to be closed completely in the next few years.

then analyzed by a linear probability model to examine relationships between socio-economic variables and the adoption of various innovations. In this analysis, we attempted to account for 18 dependent variables, which measured innovation, by regressing each definition of innovation on a subset of 39 independent variables. Three different kinds of dependent variables were used in this study: (1) those representing the adoption or non-adoption of a single gear type (for example, Loran C, otter trawl), (2) more complex definitions of innovation involving the adoption or non-adoption of any innovation out of a group of innovations (for example, making any major changes in primary fishing gear), and (3) the number of types of major changes in gear or technique the fishermen made. It should be noted that 14 of the 18 dependent variables involve a simple definition of innovation--namely the adoption of a single type of equipment.

Some of the independent variables investigated are relatively standard in studies of innovation; others were selected to test hypotheses concerning unique features of the fishing industry. The dependent variables used in this study are listed in Table 4; the independent variables in Table 5. The regression statistics for these innovations are summarized in Table 6.

Table 6 contains only information on the regression coefficients for each independent variable in all 18 regression equations. We have not put in this table the value of the regression coefficient or the level of statistical significance. This table contains only the signs of the coefficients if they were significant at least at the .10 level. Results above the .10 level were ignored as statistically insignificant. We have simplified our regression results in this way to

TABLE 4

Definitions of Dependent Variables Used in  
Regression Analysis of Innovation in  
the Fin-Fishery of Maine and New Hampshire

Simple Variables

1. Adoption/Nonadoption of Depth Finder
2. Adoption/Nonadoption of Depth Recorder
3. Adoption/Nonadoption of Scanning Sonar
4. Adoption/Nonadoption of Radar
5. Adoption/Nonadoption of CB Radio
6. Adoption/Nonadoption of VHF Radio
7. Adoption/Nonadoption of Auto Pilot
8. Adoption/Nonadoption of Loran A
9. Adoption/Nonadoption of Loran C
10. Adoption/Nonadoption of Bottom Trawl
11. Adoption/Nonadoption of Gillnets
12. Adoption of Bottom Trawl after having lobster traps
13. Adoption of Gillnets after having lobster traps
14. Adopting a new boat which is a least seven feet larger than past boat

Complex Variables

15. Adoption of a new Primary Gear Type (e.g., changing from bottom trawl to gillnets)
16. Making a major change in Primary Fishing Gear (e.g., change to midwater trawl, pair trawl or scottish seine from any other gear type)
17. Adopting any major piece of electronic gear (i.e., Loran A, Loran C, Fish Scope, Scanning Sonar)
18. Number of major types of innovations adopted. (The value of this variable could range between 0 and 3 depending on whether the person adopted a larger boat, a major piece of electronic gear, or made a major change in primary fishing gear).

Source: Acheson and Reidman (1980a:Table 2)

TABLE 5

Definitions of Independent Variables Used in  
Regression Analysis of Innovation in the  
Fin-Fishery of Maine and New Hampshire

<u>Type of Independent Variable</u>	<u>Number</u>	<u>Definition of Variables</u>
Age	1	Fishermen's age
	2	Fishermen's age squared
Education	3	Number of years of formal education
	4	Special formal education in fishing*
Size of Firm*	5	Over 1 million dollars in assets*
	6	\$150,000 to \$1,000,000 in assets*
	7	\$30,000 to \$150,000 in assets*
	8	Over \$30,000 in assets*
		(Note: Variables 5 to 8 compare size of firm to firms under \$30,000 in assets.)
Fishing Success	9	"Highliner"-Highly successful fisherman*
	10	Average*
	11	"Highliner or Average"*
		(Note: variables 9 to 11 compare fishing success with novice fishermen.)
Wife's Income	12	Wife of fishermen had steady, secure, well paying job*
Information and Cluster Variables	13	Number of ports visited in past year
	14	Member of fishermen's cooperative*
	15	Member of fisherman's political organization*
	16	Attended major fishing exposition in past year*
	17	Total number of kinsmen fishing
	18	Total number of kinsmen fishing in home port
Expectations and Opportunities	19	Optimistic about opportunities now*
	20	Optimistic about fishing opportunities five years in future*
Fishing Status	21	Full-time or part-time fisherman*

TABLE 5 (CONTINUED)

<u>Type of Independent Variable</u>	<u>Number</u>	<u>Definition of Variables</u>
Fishing Experience	22	Number of years in fishing
	23	Fishing 0 to 5 years*
	24	Fishing 6 to 15 years*
	25	Fishing 16 to 25 years*
		(Note: Variables 23 to 25 compare years fishing to men fishing over 25 years.)
Primary Species (sub industry)	26	Other industry (non-lobster, non-herring, non-groundfish)*
	27	Groundfish*
	28	Herring*
		(Note: Variables 26 to 28 are all being compared with the lobster industry.)
Geographic Region	29	West of Penobscot Bay*
	30	East of Penobscot Bay*
		(Note: Variables 29 and 30 are compared with the large urban ports of Portland and Rockland.)
Market Access	31	Groundfish dealer, processor or broker in home port*
Possession of Superior Gear Types	32	Fishermen and depth recorder on past or present boat*
	33	Fishermen does not have any groundfish or herring gear*
	34	Has VHF on past boat*
	35	Has VHF on present boat*
	36	Does not have boat capable of fishing offshore*
	37	Has Loran C or Loran C plotter on past boat*
	38	Has Loran C or Loran C plotter on present boat*
39	Has stop seine or weir*	

\*Indicates a binary variable.

Source: Acheson and Reidman (1980a:Table 3)

TABLE 6

Summary of Significant Independent Variables on 18 Innovation Definitions in the Maine/New Hampshire Fin-Fishing Industry

Indep. Var. (See Table 5 for Labels)	Dependent Variable (See Table 5 for labels)																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0	+	0	0			0	+	0	0	0	0		0	0	0	0	0
2	0	0	0	0	0		+			0	0			0		0	0	0
3	0	-	0	0	0	+	0	+	0	0	0	0	0	-	0	0	0	0
4	0	0	0	0	+	0	0	0	-	0	0			0	0	0	0	0
5		0		+		+	0	0		0	+			-	+	0		0
6		0		+		+	0	+		+		0		+	0	0	+	+
7		+		+		+	0	+		+	+		+		0	0	0	0
8	0		0						0									
9				-	0		+		+	0	+		0	0		0		0
10				-	-		0		+	0	+	0		-		0		0
11	0	0	+			0		0							0			
12	+	0	0	+	+	0	0	+	0	0	-			0	0	0	0	+
13	0	0	0	0	0	-	0	0		+			0	0		0	0	0
14	0	-	0	0	-		0	0	+	0	0			-	+	0	0	-
15	0	+	+	0	+	-	0	0	0	+	+	+		+	-	0	0	+
16	0		0	0	0	0	0	-	0	0	-		0	+	-	0	0	0
17	0	0	-	-	-	-	0	-	+	0	0	0		0	0	0	0	0
18	0	0	+	+	0	+	0	+	-	0	0	0		0	0	0	0	0
19	0	0	-	0	-	0	0		-	0	0		0		0	0	0	0
20	+	0	+	-	+	0	0	+	0	0	0			+	0	0	0	0
21	0	0	0	0	0		0	0	0	0	-			0	0	0	0	0
22																0	0	0
23		0	-	0	0	0	+	0	+	0	+		0	+	0			
24	0	0	0	0	0	0	0	+	0	0	0			+	+			
25	0	0	0	0	-	0	+	0	+	-	+	-	0	+	0			
26	0	0	+	0	-	0	0	-	+	-	+	-	0	+	0			
27	0	-	+	-	-	-	+	-	0	-	-	-	-	-	-			
28	0	-	0	0	0	-	0	-		0	-			0				
29	-	0	+	0	-	+	0	0	0	0	0			-	-	0		
30	0	-	0	0	-	0	-	-	0	0				-	0			
31	+	0	+	0	+	0	0	-	0	0	0		+	0	+			
32	0																	
33			-	0														
34						-												
35					0													
36							0											
37								-										
38								-										
39																0	+	

If a regression coefficient is significant at the .10 level, then its sign (+ or -) is entered in the table. Those independent variables having insignificant regression coefficients are designated by zeros. Variables not included in an equation are indicated by blank spaces in the appropriate column.

Source: Acheson and Reidman (1980a:Table 5)



allow us to compare the variables associated with the adoption or non-adoption of these innovations, unencumbered by a welter of statistical details.

It took many months to collect, code, and analyze the data summarized in Table 6. It would take a good many pages to explain fully all of these data and the ethnography of the fishing industry which they illuminate. This is not necessary for our purposes. It is, however, critical to notice two aspects of this information.

First, the information in Table 6 demonstrates that the social and economic variables explaining the adoption of one innovation are very different from those associated with the adoption of others. For example, the adoption of gillnets is positively associated with moderate-sized firms and having a groundfish dealer in the home port, negatively associated with having groundfish as a major target species, and the area of the coast west of Penobscot Bay. To pick another example, adoption of scanning sonar is positively linked to a high level of fishing success, membership in a fisherman's political organization, number of kinsmen in one's home port, optimism about the future of fishing, groundfish as a primary target species, the area west of Penobscot Bay, and having a groundfish dealer in one's home port. It is negatively associated with the total number of kinsmen fishing, optimism about fishing, present fishing conditions, under five years experience in fishing, and a lack of groundfish and herring gear. Very different sets of variables are linked to still other innovations listed in Table 6. This indicates that these different innovations are adopted by men with different characteristics to solve distinct sets of problems. The different reasons that these innovations were adopted and the theoretical implications of this behavior have been discussed in detail in another paper (Acheson and Reidman 1980a).

Second, although different sets of variables are associated with the adoption of different innovations, there are certain variables which show consistent patterns for large numbers of the innovations studied. Some of these patterns can be explained by reference to the general social science literature, but most require consideration of conditions specific in the fishing industry--particularly the types of clusters involved.

In the literature on innovation, age and education are often thought to be important determinations of innovation (Mansfield 1971:198-199; Rogers and Shoemaker 1971:186). Neither of these variables is significant in explaining the adoption of most of the innovations we studied in the fin-fishery of Maine and New Hampshire. The data in Table 6 indicate that education played a role in the adoption of only Loran A and VHF Radio, and had a negative correlation with the adoption of depth recorders and a significantly larger boat. However, years of formal education had no significant impact, either positive or negative, on the response to the other 14 innovations studied. Fishermen themselves often state that formal education bears little relationship to fishing success and the ability to expand one's fishing business. These statistics indicate that such stories have a solid basis in fact.

While age was a critical element in the adoption of metal lobster traps, it played very little role in the decision to adopt these other innovations. In the entire set of equations represented in Table 6, the variables on age and age squared were significant in only three cases.

In almost all economic studies of innovation, firm size is identified as a critical variable (for example, Mansfield 1968a:107-108). In 11 of the 18 equations, the variable on the size of the firm was positively associated with the adoption of innovations of all kinds, indicating that larger firms had a stronger tendency to adopt

innovations in comparison with the smallest firms (less than \$30,000 in assets). The intermediate sized firms (\$30,000 to \$1,000,000) were the most likely to adopt innovations. There is little surprising in this pattern. The smallest firms in the sample were owned by men who fished for lobster most of the time, or who had small stop seine operations. Many do not have either the financial resources to purchase a lot of equipment or the need, since lobster fishing requires only a moderate-size boat and very little electronic gear. The largest sized firms are also less likely to take on larger boats or additional fishing gear, doubtless because they already have some of the biggest, most well equipped boats in the fleet.

In the literature on innovation, there is strong evidence that an entrepreneur's perceptions concerning future earnings play a very important role in influencing adoption of innovations--especially innovations requiring substantial investment (Mansfield 1963:290-311; 1968b:4-5). However, in our data, variables on perception of present and future fishing opportunities were positively associated with the adoption of only six of the innovations studied. In essence, these psychological variables were relatively unimportant in explaining the total set of innovations.

Two of the most interesting variables are membership in a fishermen's political association and number of kinsmen in the local area in fishing. Both of these variables were positively associated with the adoption of a large number of innovations studied, and both are indicative of the important role which clusters play in the adoption of such innovations.

Those who were the adopters of Sonar, Radar, VFH Radio and Loran A had a large number of kinsmen who were fishermen operating from their own home ports, and a lower than average number of kinsmen in fishing in other

ports. Clearly, in these cases, local kinship ties were used as a means of obtaining accurate information and experience necessary to adopt these innovations successfully. In this regard, it should be noted that all of these innovations are relatively expensive, and all require skill and "hands on" experience to use effectively. The U.S. Navy and Coast Guard require radar and sonar operators to go to school for a period of several months before they are allowed to stand a shipboard watch, and even then they are under the command of a petty officer with several years experience. While the radar and sonar type equipment used on fishing boats to navigate and find fish are not as complicated as the equipment used by the military, it takes some experience to be able to interpret the lines and blips appearing on these scopes and graphs. Naturally, before one invests thousands of dollars in one type of electronic equipment as opposed to another, one wants to be able to see it in operation and preferably to use a boat equipped with the kind of electronic gear one is thinking of buying. A good many fishermen report that only their kinsmen or close friends can be counted on to give them accurate information consistently and let them experiment using their own boats. Fishing, after all, is a highly competitive business, and one in which training and informing the competition is seldom advantageous. As one fisherman put it, "There is only one person who is going to let you experiment with his boat, nets and fishing gear--your father." Thus, people who have ready contacts with a large local network of kin who are in fishing are more likely than others to have had a chance to learn about and try these sophisticated pieces of electronic gear.

The question needs to be asked, "Why can't fishermen obtain the same kind of information on these kinds of electronic devices from more geographically distant

kinsmen?" Distance itself is part of the answer, since it tends to inhibit the flow of information and limit the opportunities to observe gear in operation. However, another set of factors is also important here. There is substantial evidence that the operating kinship unit is the kinsmen living in the same town or within about ten miles of each other. Kinsmen who move away from the local area rarely interact, and within a generation are quickly forgotten (Acheson and Lazarowitz 1980). Having a large number of kinsmen outside the area of one's home town has no bearing on the adoption of innovations. For all practical purposes these people do not exist. The information on these kinship variables not only points up that family ties are used as a means of obtaining information about innovations, but also points to the importance of clusters. After all, it is kinsmen in the same area who are using the same kind of gear one wants to purchase who are valuable. Most of the relatives who have such gear are fishing for the same species in the same area. They are members of the same cluster.

The variable on membership in political organization also indicates the importance of cluster behavior. This variable played a significant role in the adoption of a large number of innovations studied--including depth recorder, scanning sonar, CB radio, bottom trawl, gillnets, larger boats and the number of major innovations adopted. A few of the men who said they were members of fishermen's political organizations were members of the Maine Lobstermen's Association, but most were members of the Maine Fishermen's Cooperative Association, which is based in Portland and operates as a lobbying group to influence state and federal fisheries legislation. An intensive study of this group indicates that most of the members of this association live within 25 miles of Portland and are successful draggers and gillnetters in the prime years

of their careers (Acheson and Lello 1980). These men are doing well in fishing and want to stay in the industry. They are willing to donate their time to this organization to foster a political and legal environment which will ensure their continued success. In short, this organization is composed of the committed highline groundfishermen from the Portland and Harpswell areas. Most of its members are the best and most influential fishermen in the unit we have identified as the Portland groundfishing cluster. Given our intensive study of this cluster, there is no doubt that a good deal of technical information is obtained through this organization. At some meetings, more time is taken up with discussions of fishing locations, catches, boats, and equipment than with matters concerning fisheries legislation.

The regression analysis of factors influencing the adoption of innovations in the fin-fishing industry in Maine and New Hampshire contains still additional evidence that clusters play an important role in the adoption of innovations. The region variables (independent variables 29 and 30) demonstrate that men in Portland and Rockland, the fourth and fifth largest ports in New England, are more likely to adopt large numbers of innovations than fishermen in other areas.<sup>1</sup> Specifically, men from these two ports were more likely to adopt depth finders, CB radios, gillnets, and new boats than fishermen in harbors west of Penobscot Bay. And they were more likely to adopt depth recorders, CB radios, Auto Pilots, Loran C and new boats than the men in harbors east of Penobscot Bay.

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<sup>1</sup>In actuality, most of these innovative fishermen are from Portland. Rockland has very few groundfishermen, save for those involved in the redfish fleet. It was an error to have aggregated together the data on Portland and Rockland in this regression analysis.

The reasons that men in these two ports are prone to adopt so many innovations can undoubtedly be explained in terms of the information available to them. Portland has the largest number of fin-fishermen in the state. Moreover, Portland and Rockland also have a lot of firms involved in marketing and processing fish, shipyards, and firms selling marine hardware, supplies, electronic gear, nets, and so on. These two ports have the largest repositories of fishing expertise and infrastructure in the region. Virtually all fishermen in Maine go either to Portland or Rockland regularly to buy various supplies, have their gear repaired, or market their fish. Fishermen operating out of those two towns are part of clusters whose members have an unusual advantage in observing and obtaining information on the entire fishing scene. It is not just that these men are passively exposed to more gossip and data about fishing; they also have a clear advantage in obtaining jobs on vessels of various types, and in observing a large number of different kinds of vessels and equipment in action. In short, fishermen from Portland (and, secondarily, from Rockland) have an opportunity to get more "hands on" experience with more gear than men from smaller, more isolated harbors.

In the case of innovations studied in the fin-fishery, it is critical to note that the opportunity to observe the innovation, or better still, to experiment with it on a working boat, is much more important than merely being aware of the innovation. If merely being aware of an innovation were an important prerequisite to adopting it, we would expect that fishermen who had attended a major fishing exposition would have adopted more innovations. This is not true in general. In fact, attendance at an exposition is positively related only to the adoption of a larger boat (see independent variable 16). Exposition attendance actually "retards" the adoption of Loran A,

gillnets and a new primary gear, for reasons discussed in another article (Acheson and Reidman:1980a). Certainly men who are adopting these innovations have obtained information on them, but that information is obtained from men in their own local cluster--not at a major exposition in a large urban cluster.

The strongest evidence concerning the link between clusters and the adoption of innovation is provided by information fishermen gave concerning the source of information about innovations they adopted, and the people who influenced these adoption decisions. In all of our studies of the diffusion of innovations in the fishing industry (i.e. metal lobster traps, pair trawlers and the 18 types of electronic devices and fishing gear in the fin-fishery) we attempted to obtain information on the source of the information. Very often, fishermen were unable to identify the factors or people who influenced their decision or were unwilling to admit they had been influenced. Our questions on this topic often resulted in indeterminate answers such as: "I just heard about it somewhere" or "Some of the boys were talking about it." However, if we aggregate the information we do have on the source of information about innovations, a very distinct pattern emerges. In our study of 20 innovations of all types combined, only a handful of men said they were primarily convinced to acquire an innovation from newspapers, advertisements or other written sources. Moreover, change agents (i.e. marine extension agents) were instrumental only in diffusing one of the innovations studied--namely pair trawlers (Bort 1980). Change agents were not mentioned by the adopters of any other innovations. Most of the information concerning innovations came from other fishermen.

The quantitative data we have gathered strongly demonstrate that the men who influenced others to adopt



the innovations studied were in the same cluster. In this regard, it should be noted that a very high percentage of the men who adopted one or more of these 20 innovations were influenced, directly or indirectly, by men who use the same type of fishing gear. This can be seen in Table 7 which contains data on the primary gear of adopters of these innovations and the men influencing them. There were 14 instances of innovations adopted by men who fished with purse seines and pair trawls in which we had information on the gear type of both the adopter and the men who influenced them. In 12 or 86 percent of these cases both the adopter and the fishermen who was his source of information used the same gear type. Another 80 innovations were adopted by men using otter trawls as their primary gear. In 56 or 70 percent of these cases men were influenced by other men using otter trawls. Seventy nine percent of the men using lobster traps as a primary gear were influenced in their decision to adopt innovations by other lobster fishermen. The same strong pattern can be seen in the case of men using gillnets. A log likelihood ratio demonstrates that these results are highly significant statistically.

The distance between the home of the men who adopted innovations and those of the men who influenced them varies enormously depending on the primary gear type used. As can be seen in Table 8, the vast majority of lobster fishermen were influenced in their decision to acquire innovations by men who lived very nearby. Of the 142 cases of innovations adopted by lobstermen on which we have data, in 106 instances (75 percent), the adopter of those innovations lived within three miles of the men who influenced him. In the case of groundfishermen, the men who adopted innovations and those who influenced them lived further apart. We had information on 63 cases of innovations adopted by gillnetters, and in only 24 instances (or 38 percent of

TABLE 7

Primary Gear Type of Men Adopting Innovations and  
Those Giving Information on Those Innovations

Primary Gear of Adopters of Innovation

Primary Gear of Men Giving Information on Major Innovations	Purse Seine/ Pair Trawls	Otter Trawls	Gillnets	Lobster Traps	Total # of Innovations
	Purse Seine/ Pair Trawls	12	2		
Otter Trawls	4	56	23	2	85
Gill-net	2	18	36	11	67
Lobster Traps	6	4	18	108	136
Total of Primary Types of Adopters	24	80	77	121	302

Log likelihood ratio results:

$$G = 59.8$$

$$DF = 9$$

$$P < .001$$

the cases) did the adopter and the men who influenced the adoption decision live within three miles apart. In the vast majority of cases, men who used otter trawls as a primary gear live over three miles away from the men who influenced them to buy the innovation. Furthermore, most of the men using purse seines and pair trawls were influenced in their decisions concerning innovations by men who lived very far away. There were 36 cases of innovations adopted by these herring fishermen on which we have data. In 31 cases (86 percent) the adopter of the innovations and the men who influenced their decisions lived over 15 miles apart.

The results presented in Table 8 are also highly significant statistically.

TABLE 8

Distance Between the Homes of Adopters of Innovations and Those Giving Information on Innovations, by Primary Gear Type

Primary Gear Type of Adopter of Innovation

Distance Between Homes of Adopters of Innovations and Men Giving Information on Those Innovations

	Purse Seine and Pair Trawl	Otter Trawl	Gillnets	Lobster Traps	Total
Under 3 miles	1	22	24	106	153
3-15 miles	4	51	29	26	110
over 15 miles	31	45	10	10	96
Total	36	118	63	142	359

Log likelihood ratio results:

G = 59.1

DF = 9

P < .001

The data in Tables 7 and 8 indicate that men using the same gear in the same geographic range imitate each other and influence the kinds of innovations each other adopt. Lobster fishermen tend to have been influenced by men living very near by; groundfishermen by men living further away; and owners of pair trawlers and purse seiners by men living outside their own local area. This pattern is to be expected, given the range of social contacts men using these different kinds of gear have. From this it is clear that fishermen are influenced in their innovation decisions by men in their own clusters. Clusters, after all, are technical and social units. They are composed of a network of fishermen using the same gear in the same geographic range.

The reasons for this kind of imitative behavior are not difficult to discern. The fisherman, faced with great heterogeneity and uncertainty, attempts to solve his problems and increase his fishing effectiveness simply by copying the strategies of other fishermen which he perceives to be effective. There is strong evidence from the social psychological literature that people seeking information do not search very far. From this point of view, it is not surprising that when fishermen seek information, they seek no further than men in the same fishery operating in the same geographical range.

### C. Cluster Packing and Its Effect on Innovation

This pattern of imitation of innovations in turn has enormous long-run implications for the formation and evolution of clusters. The fact that men in the same cluster influence each other to adopt similar innovations means that over the course of time, the technology used by the men of a given cluster becomes increasingly uniform. This assumes, of course, that the external environment (i.e. the laws, availability of species, markets, and so on)

do not change greatly. If there are great alterations in the environment, different fishermen will attempt to cope by trying a variety of different strategies and adopting different kinds of innovations. Thus, a rapidly changing environment will result in great diversity in the technology and strategies used by the fishermen of a cluster. If this occurs, loosely packed clusters result. By way of contrast, a slowly changing environment, will result in more and more uniformity in the technology employed and in the development of "tightly packed" clusters.

The degree of cluster packing then is the result of both time and changes in the environment. This means that the degree of cluster packing can differ substantially not only from cluster to cluster, but even within the same cluster over the course of time.

Conversely, the degree of cluster packing has a strong influence on the type of innovations adopted by fishermen. This means not only that the degree of cluster packing is the result of the number of common innovations that a cluster of fishermen have adopted over the course of time but also that the type of innovations they adopt is, in great part, a function of the degree of packing. In short, there is feedback in the system.

Our adaptive model suggests many hypothesis concerning the adoption of innovations and the degree of cluster packing. Where the fisheries are concerned, the two most important are:

- (1) Fishermen in tightly packed fishing clusters will be more likely to adopt small, incremental innovations. Large radical innovations are not likely to be adopted

in such fishing clusters.<sup>1</sup>

(2) Fishermen in loosely packed clusters are more likely to adopt more radical innovations.

There are two reasons for this pattern. First, tightly packed clusters are the result of men innovating and imitating each other over a long period of time in a relatively stable environment. These men have had time to experiment to achieve an optimal solution to the problems they face. All of the more radical innovations which are advantageous have been adopted long ago. Given the stable environment in which these clusters operate, the only innovations left to adopt are those which will make small, marginal improvements. The men of less tightly packed clusters operate in a more heterogenous, changing environment. They have not had time to explore the full range of optimal solutions. It is a type of environment in which the possibility for more radical solutions still exists.

Second, and more important, in tightly packed clusters, the feasible set of opportunities is similar for everyone, by definition. In this situation, any innovation made by one member of a cluster can easily be copied by another member. Why then should a fisherman make a radical innovation? He takes enormous risk, and if he succeeds, he will be unable to capture the benefits for very long. His competitors (i.e. the men in the same cluster) are in position to be able to copy any innovation he adopts and will do so the moment he proves to be successful. Any advantage accruing to an adopter of a radical innovation

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<sup>1</sup>"Radical innovation" is a misnomer. As we pointed out in Part II, Chapter 4, all innovative change is cumulative. Major change is produced by the adoption of several cumulative incremental innovations. The term "radical innovation" is used because it is less awkward than "cumulative incremental" innovation.

is not likely to be his alone for very long. Thus, where the feasible set of options is similar for everyone in the cluster (i.e. tightly packed clusters) the innovations adopted are apt to be small and incremental in nature. Conversely, in loosely packed clusters fishermen may have options open to them that others cannot imitate easily. In these circumstances, the benefits of innovating will accrue to those who can make the innovation. Under these conditions, a radical innovation is apt to pay.

These hypotheses explain several patterns of innovations that can be observed in various segments of the fishing industry in New England--particularly when we compare the pattern of innovation in the lobster industry with that in the mobile herring fleet.

Lobster fishing clusters, as we have seen, are very tightly packed. The geographical distance boats from a particular harbor can exploit is limited by the territorial system. The technology is very uniform. The vast majority of boats are between 28 and 37 feet, and are equipped with an inboard gasoline or diesel engine. There is very little variation in the electronic gear used on these boats. Only C.B. radios and either depth recorders or depth sounders are standard equipment on these boats, and very few lobster fishing boats have any other kind of electronic equipment. All boats are now equipped with hydraulic trap haulers made by the same company. In addition, lobsters are caught in traps. While there is some variation in the trap construction material (i.e. metal vs wood) and the type of heads (netting to stop the lobsters from escaping) used, these factors have relatively little effect on productivity in comparison with variables such as season of the year. There is some variation from one geographic area to another. In the Casco Bay area, men tend to fish larger gangs of traps, with relatively big boats (i.e. 38 to 40 feet), and usually have a sternman to help them. In

other parts of Maine and New Hampshire, men fish alone much of the year and use smaller gangs of traps and smaller boats. But within any given cluster, the equipment and practices of lobster fishermen are remarkably similar.

This uniformity in technology and fishing practices is due to a long period of stability in the lobster fishing industry, which has given fishermen ample time to assess various different kinds of fishing techniques and strategies and adopt the ones that have proven satisfactory. The lobster catch, for example, in Maine has varied between 16.6 million and 22.1 million pounds for the past 20 years (Thomas 1980). The territorial system has been in effect and has changed little in the past several decades. Lobsters have been caught with standard lobster traps, which have varied very little, for well over 100 years. And lobster boats have been powered by gas or diesel engines since the 1920's.

Despite the passage of the Fisheries Management and Conservation Act of 1976, no Federal regulations have been promulgated to date which affect the lobster industry. Moreover, there have been no great changes in the state laws either. The most important laws are those aimed at protecting the breeding stock. The law prohibiting catching females with eggs was enacted in the 1930s. The rule prohibiting taking lobsters over 5 inches (measured on the carapace), and under  $3\frac{3}{8}$  inches were passed decades ago. The marketing system has remained relatively stable as well. Lobster fishermen have long sold their catches to local dealers with whom they have close ties, who then sell the lobsters to wholesale dealers or lobster



pound operations.<sup>1</sup>

As a result of this relative stability and the closely packed clusters which resulted, very few innovations have been adopted by lobster fishermen in the past 25 years, and those can scarcely be called radical ones by any means. The early 1960s saw the adoption of the hydraulic trap hauler, and a little later electronic depth finders came into general use. In the late 1940's, fishermen began to knit lobster pot heats out of nylon string rather than knit them from sisal. In the late 1960s and early 1970's polyurethane lobster trap warp was introduced and the use of C.B. radios became widespread. In the mid 1970's metal traps came into use in a few areas. All of these innovations made only the most marginal improvements, since they all had close antecedents. Fishermen had been hauling traps with the aid of winches since the 1930's; some boats were equipped with single side band radios as far back as the early 1940's. Traps had been equipped with warps and woven heads for many many decades. The use of synthetic rope and twine merely lengthened the useful life-span of these trap parts. Of course, the use of metal wire on the outside of a trap simply is a substitute for wood lathes. The only really new innovation was the introduction of electronic depth finders. Before the advent of these machines fishermen could only learn what was on the bottom by using a lead line.

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<sup>1</sup>There have been some recent changes in the lobster fishing industry. One notable change has been the spread of cooperatives. The first one was started in 1947 and there are fifteen at this writing. In the past four years (since 1976) the price of lobsters has not risen as rapidly as costs--especially the costs of fuel, bait, and boat replacement costs. As a result, increasing numbers of lobster fishermen have begun to fish for groundfish at certain seasons for the year or have moved entirely into other kinds of fishing. (Acheson 1980b).

It is important to note that none of these innovations is particularly difficult to learn to use, nor were lobster fishermen barred from adopting these innovations by unusually high capital requirements. Nylon rope and twine cost more than hemp, but then again, they last longer too. Any lobster fishermen can afford to experiment with metal lobster traps. Several firms are making them and they only cost \$35.00 each (Acheson 1980a). C.B. radios can be purchased in any moderately large city and models run as low as \$60.00. Hydraulic trap haulers and depth recorders (and flashers) cost far more, but even these kinds of equipment can be purchased for under \$1000.00. It should be noted that depth recorders and depth finders are an exception to the rule that most innovations in the lobster industry are easy to learn to use. It is relatively easy to read the depth by using these machines. However, learning how to use information about depth to increase catches takes a good deal of experience and knowledge. For a man who has already acquired an understanding of the movements of lobsters and a knowledge of the bottom, the use of a depth finder can speed up his fishing operation. A depth finder in the hands of an amateur will do little by way of increasing output, since he has only the most general idea what depth means. Thus, the time it takes to learn to use a depth finder or depth recorder effectively depends very much on one's prior state of knowledge.

Since all of these innovations are relatively inexpensive and easy to learn to use, they diffused throughout the entire lobster industry relatively rapidly. It is true that the men of some clusters adopted these innovations before others. Certainly there has been some secrecy concerning the effectiveness of these innovations so that much information about them was transmitted via direct observation. Nevertheless, from the time each of these

innovations were adopted by the earliest adopters until the time they became generally used throughout all clusters in the industry was less than 10 years. The earliest hydraulic trap haulers were introduced about 1958; and it was a rare full-time lobster fisherman who did not have one by 1968. Electronic depth finders were first used on lobster boats about 1959. By 1967 or 1968, they had become standard equipment. Nylon twine to make heads started to be used about 1945, and by 1955 it was general throughout the industry.

During this entire time period, there were no radical innovations introduced into the lobster industry, much less experimentation with any radically new lobster fishing system. Given the stable legal, biological, social and economic environment in which the lobster industry has operated, only incremental innovations were made and are currently being made.

In the herring industry, the opposite situation prevails. As we have seen the mobile herring fleet is a single cluster, and one that is very loosely packed. These boats range in size from 42 feet to over 90 feet, and a boat 150 feet long will soon join the Maine fleet. Most of these vessels fish within a few miles of shore most of the time; the larger boats have the capacity to fish the offshore herring grounds, but the smallest purse seiners do not. There is a notable difference in electronic equipment in use too. The largest vessels in this fleet are equipped with radar, depth recorders, fish scopes, Loran C, Loran C plotter, scanning sonar, VHF radios, and scrambler phones. The vast majority of these vessels go dragging for groundfish part of the year, and six of the largest boats are now equipped to go pair trawling for herring. Some of these vessels, in recent years, have done pair trawling for such long periods of time that their primary gear has probably ceased to be purse seines

and is now pair trawls. In any case, vessels equipped with both pair trawls and purse seines have a larger set of feasible options than those with only purse seines.

While the lobster catch has been relatively stable, herring are notoriously unpredictable. In some years, schools will concentrate in the bays and estuaries of one part of the coast; in other years they will be in other areas dozens of miles away. From year to year, herring catches have fluctuated wildly. In 1951, for example, the Maine catch was 22 million pounds; the next year it was 57 million. In 1974, it was 2 million pounds; in 1957 6 million pounds; in 1976, it had increased to 20 million pounds. In the late 1970's, herring fishermen have done well, but this has not always been the case. Herring fishing is always a high risk option. Moreover, catches for various types of herring fishing gear have varied considerably as well. In general when the mobile herring fleet (purse seiners and pair trawlers) has done well, the fixed gear fishermen (weir operators and stop seiners) have done poorly, and vice-versa. For example, in 1969 the purse seiners caught 59.11 percent of the sardines packed in Maine, while the fixed gear operators only got 40.89 percent. In 1977, however, the fixed gear operators caught 77.69 percent of the sardines while the mobile fleet caught only 22.31 percent. The same pattern can be seen in the statistics for a period of decades (Maine Sardine Council 1979).

Since the early 1970's, the marketing and processing of herring has altered considerably as well. Prior to that time, all herring were canned and sold here in the United States. In the past 10 years, the Baltic and North Sea herring catches have fallen drastically, creating a huge market for filleted adult herring. As of late in 1978, six plants in Maine were equipped with automated filleting equipment manufactured in Europe, and were

shipping large quantities of frozen herring fillets to the European market.

The legal environment has changed too. In 1978, Maine, in coordination with the Federal government put into effect a new herring regulatory plan called for closed seasons, quotas, and restrictions on the size of the herring that could be caught. It is the first fisheries management plan that has been put into effect in New England under the new Federal Fisheries Conservation and Management Act of 1976 and one that constitutes a radical departure from the regulatory environment that existed before.

Finally, the feasible set of options among vessels in this fleet differs due to the relation they have with the processing companies. Some boats in this fleet are owned by the processing firms; many others are privately owned by men who have various different kinds of agreements with herring processing firms.

As a result of the rapid changes the herring industry is currently undergoing, in combination with the differences in feasible options open to different fishermen, a variety of incremental and radical innovations are being adopted at the present. Men in the herring fleet are purchasing larger boats; they are equipping those boats with vastly more expensive and complicated electronic gear; and the gear they are using on those vessels is becoming more versatile (Acheson 1980c).

Specifically, between 1973 and 1978, our innovation survey in Maine and New Hampshire showed that of the 13 purse seine captains in our sample, all but two had purchased a boat over six feet longer than their previous boat. Three owners of herring boats had purchased boats that were over 20 feet longer than the one they had previously owned. Such increases in vessel size constitute the adoption of a radical innovation, since a much larger boat automatically means a difference in crew size and an

increase in the range that can be fished; it necessitates a good deal more knowledge concerning maintenance, ship handling, fishing locations, and so on.

In our sample of 13 herring boats, nine had adopted scanning sonar. This is not only an expensive piece of equipment, costing in the range of \$9000, but one which allows the fishermen to do something he could never do before--namely get information on schools of herring far ahead and on the sides of his boat. Another six have adopted Loran C plotters which allow a herring fisherman to find and map out the location of very large and dispersed herring schools. Another four boats have adopted scrambler phones, and more will certainly do so in the future. Six additional boats during these years have adopted pair trawling--a radically different innovation involving two vessels working in tandem (Bort 1980). Furthermore, the new boats in the herring fleet are western rigged vessels, which involve a radically different configuration of engine, wheel house, and hold, which strongly affects the comfort of the vessel, the net towing characteristics, and the entire procedure for hauling back the net (Acheson et al. 1980). None of these innovations is inexpensive. Scrambler phones cost \$15,000 per set, while scanning sonar and Loran C plotter sets cost about \$5,600 and \$10,000 respectively. The most expensive and radical innovations are, of course, the adoption of the western rigged vessel and pair trawls. These innovations are associated with whole different systems of fishing. None of these innovations mentioned can be considered minor. Loran C and scanning sonar allow fishermen to obtain information they could not get before by any means. Scrambler phones allow them to exchange information without informing the fleet. In an industry where a good deal of information about fishing locations is obtained directly or by observing other vessels, the use of phones has important

implications.

There are two reasons for the number of radical innovations being adopted in the mobile herring fleet at present. First, the expansion of the market, and Federal fisheries conservation efforts, in combination with the advent of a good many different kinds of new types of equipment, have increased the economic opportunities available to the industry (Acheson 1980c).

Second, it is very difficult to imitate such innovations and thus the men who have successfully adopted these new types of equipment and techniques will gain the benefit of them. Several things should be noted in this regard. The fact that the mobile herring fleet constitutes a loosely packed cluster means that most men have dissimilar sets of feasible options. What may be possible for the owner of a large 90 foot vessel may be out of the question for a man with a 45 foot boat. In addition, much of the capital to finance new boats and equipment is obtained through loans from the processing companies. The amount of money these companies will lend is strictly limited. They will not finance superfluous weirs and boats. Last, and most important, the kind of knowledge one needs to operate this sophisticated electronic and fishing gear can only be obtained by personal experience. Since the herring fleet is so heterogenous, there are very few boats on which one might gain that "hands on" experience, and even fewer boats one can observe which are directly comparable to the boat any given captain owns or is contemplating buying.

There are several different factors stimulating investment in the herring industry at present. The fleet is very old and due for replacement. Catches and prices for herring have been very high (Acheson 1980b and 1980c). The uncertainty generated by the quickly changing Federal regulatory system has clearly stimulated men to purchase new kinds of fishing gear so they can fish for

multiple species in case one fishery or another is "closed."

However, this situation does not explain why these fishermen are willing to purchase such radically different kinds of boats and equipment--especially since they entail such high learning costs. Why don't these men simply buy the same kind of boat and fishing gear when their old boat and equipment needs to be replaced? Why the headlong rush for new, complicated innovations? These men are not late adopters who need to adopt these innovations to remain competitive. They are the early adopters. The willingness of these men to adopt radical innovations, we believe, can be traced to the fact that these innovations cannot be easily imitated. The time, effort, and money they invest in purchasing such gear and learning how to use it will ultimately benefit them, and give them an edge over their competitors. They will not be experimenting with fishing gear only to educate their competitors. Some fishermen are very aware of this situation. When one of the owners of a large pair trawler was asked what made him decide to invest over a million dollars in a new technology he would have to learn how to use by experimentation, he answered: "We were willing to take the risk. We knew we would lose money until we fooled around and learned to catch fish with this rig, but after that the whole lake (i.e. part of the ocean) would be ours." He made it clear that he expected very few others to enter pair trawling to compete with him.



## CHAPTER 5

### INSTITUTIONS AND TRANSACTIONS

#### A. Introduction

So far we have concentrated on clusters--the loose networks between men using essentially the same technology in the same area to exploit the same species. These amorphous social units composed of people who are essentially competitors play a critical role in solving the information problem faced by fishermen in both the short run and the long run. Clusters, in short, are the primary social mechanism fishermen use in coping with uncertainty. There is another mechanism, however. Under certain circumstances, fishermen form institutions, which allow them to cope with uncertainty in a different way.

In forming institutions, fishermen enter into special agreements with each other to obtain some end that neither could obtain alone. These agreements, which are governed by formal or informal rules, structure the relationships between individuals in a fishing industry. Some of these agreements, or institutions as we call them, operate to reduce financial costs to the fishermen involved, others to increase revenues from the sale of fish, and still others function to limit competition and conflict. Only a few, for reasons that need to be discussed in detail, reduce exploitation rates on resources. The latter are of particular interest since they are an indigenous--if informal--kind of fisheries management.

In this chapter, we will first describe institutions we have noted among fishermen in various parts of New England. Second, we will make certain generalizations about the exchanges and transactions involved in many of these institutions. Third, we will discuss the degree to which these institutions can be explained in terms of the model presented

in Part II. Last, we will consider the conditions under which such institutions come into being. In the last part of the volume (Part IV) special emphasis will be placed on developing a tentative hypothesis concerning the factors generating those institutions which conserve resources.

While little of a general nature can be said about institutions and the transactions underlying them until some of them are described, two things need to be pointed out immediately.

First, clusters and institutions are not mutually exclusive kinds of organizations or behavior. The vast majority of the institutions recorded are formed by men in the same cluster. Clusters are loose networks of men with the same opportunity set, which serve as reference groups for the members and as sources of information. Under certain conditions, men in certain clusters will enter into one kind of agreement or another, concerning some kind of fishing practice or practices.

Second, both clusters and institutions are responses to the information problem continually facing fishermen. Men in the same clusters find each other the best source of information on both fishing locations and the efficacy of various kinds of technical innovations. Institutions are, in effect, substitutes for accurate information. The future is impossible to predict, but one can reduce uncertainty by having agreements specifying what actions will be undertaken and who will bear the costs if misfortune strikes. In essence, clusters provide (1) an information network which reduces each individual's costs of information, and (2) the basis for institutional formation and evolution. Institutions reduce uncertainty by assigning risk and thus providing a kind of insurance.

We have gathered information on ten instances where fishermen have formed "institutions." Two of these (i.e. lobster fishing territories and cooperatives) have been

studied extensively and a small literature has been written on them. While the other eight cases have not been studied in great detail and little or nothing has been written about them, we have been able to gather sufficient data through interviewing to come to several important conclusions concerning them. We will describe the features of these institutions critical for our purpose, beginning with those on which we have the most data and progressing to those where very little data is available.

#### B. Lobster Fishing Territories

Earlier in this section, it was mentioned that lobster fishermen are allowed to place traps only in the area jointly owned by the "harbor gang" of which they are a member. Territories are defended against the incursions of men who are not members of the "gang" by the surreptitious destruction of lobstering gear (Acheson 1972).

Several additional facts need to be mentioned about this territorial system. First, there are two different kinds of boundaries that can be observed, which are linked in important ways with the ease of entry into harbor gangs and the informal agreements to limit fishing effort. In most areas, a nucleated territoriality is the rule (Acheson 1975a). That is, the area close to the harbor mouth is reserved for the exclusive use of members of the harbor gang, and incursions into this area are swiftly sanctioned. Further from the harbor mouth, feelings of ownership decrease markedly. Far from the mouth of such harbors, "mixed fishing" is allowed. That is, in the middle of large bays or in areas several miles from the mouths of harbors, men from three to five harbors can often be found fishing together. Perimeter defended areas are characteristic of certain islands--particularly in the Penobscot Bay region--which have been the private property of certain established families for generations. The boundaries of these fishing territories are known to the yard and

are strongly defended. In these areas, little mixed fishing is allowed; the entire area out to the periphery is exploited exclusively by members of these harbor gangs (Acheson 1975a; 1980g).

It is relatively easy to gain entry into harbor gangs with nucleated territoriality. In such harbors, a young man who begins fishing at an early age has no difficulty gaining acceptance. This is particularly true if he is a member of an established family whose members have long been involved in the fishing industry. Perimeter defended areas are reserved exclusively for members of the family owning the island, or members of a few families they have allowed to go fishing in their waters. Thus, without the proper kinship ties, it is impossible to go fishing in these areas. The reason for this pattern is fairly clear. Perimeter defended areas exist to guarantee that the entire lobster catch from a given body of water will be shared by only a few select men. There is no sense spending great effort defending the boundaries of these fishing areas if one is going to let a large number of people join one's own harbor gang (Acheson 1975a).

Most important for our perspective here, differences in the system of territoriality affect fishing effort, which, in turn affects not only the size of the lobsters caught, but also the breeding stock. In the perimeter defended areas, there is less fishing effort on the lobster not only because there are fewer fishermen per square mile of ocean area, but also because the men in those areas have been able to agree to and enforce certain conservation rules. For example, the men fishing the areas around two such islands have agreed to fish a limited number of lobster traps. While this does not limit the lobster catch over the annual cycle, it does reduce the cost of trap maintenance and bait. It also reduces mortality on the lobster by minimizing the number of "ghost traps"<sup>1</sup> in

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<sup>1</sup>Lost traps which continue to fish.

the water. In addition, the fishermen on Monhegan Island have agreed to go fishing only from January to June and have persuaded the State Legislature to pass a law forbidding fishing in their waters the other six months of the year. Thus, these fishermen are catching only the more valuable hardshell lobster and selling their catch at the time of the year when the price is at its annual high. In the summer, when they are working in the local tourist industry, the state fishery wardens are protecting their exclusive fishing grounds. As a result of these practices, the fishermen in perimeter defended areas not only have higher incomes, but catch lobsters that are slightly larger (and hence more valuable). Moreover, the size of the breeding stock is clearly larger because the reduction in fishing effort has resulted in a higher percentage of lobsters which have been allowed to attain the size where they can bear eggs (Acheson 1975a). Thus, the system of territoriality--especially in the perimeter defended areas--has not only resulted in increased income for fishermen, but has had favorable biological benefits as well.

### C. Cooperatives

While the anthropological literature on fishermen's cooperatives in the world as a whole has recorded far more instances of failure than success, a number of very successful fishermen's cooperatives have been formed in various parts of New England in the past two or three decades. The largest and most successful cooperative in New England is the one at Point Judith, Rhode Island. Fifteen smaller cooperatives have been formed in various Maine ports, and four more have been formed in other ports of Massachusetts and New Hampshire.

The first of these cooperatives were formed in the years immediately following World War II by veterans who were determined to end the exploitation they had experienced at the hands

of fish buyers, and obtain fuel, bait and supplies at reasonable prices. The Point Judith, Rhode Island cooperative was formed at this time with these ends in mind (Poggie 1980:22), along with the cooperatives at Pemaquid Harbor, Maine and Boothbay Harbor, Maine. In the early 1970's another set of cooperatives was formed in Maine. Again one of the primary reasons to form cooperatives was a desire to escape the real or perceived abuses of fish dealers. Both in the 1940's and the 1970's the formation of cooperatives involved direct and bitter confrontations between private dealers and fishermen.

In the typical cooperative, members are required to purchase stock at the time they join. Basic management decisions are made by a board of directors and officers who are elected by the cooperative membership at large; the day to day operations of the cooperative are in the hands of a hired manager. The services cooperatives provide for their members vary somewhat. Usually, however, cooperatives market fish and/or lobsters for their members and sell fuel, ice, bait, and so on to them at reduced costs. In most cases, the profits of the cooperative are divided among the members and paid to them once a year in the form of a "dividend." The Point Judith, Rhode Island, cooperative provides its members with ice, group insurance, and cold storage facilities. The smallest and newest cooperatives have none of these services.

In all cases, however, men who decide to join a cooperative gain a secure market for their fish at fair prices, and can buy services and supplies at good prices. They are expected to obey the cooperative's rules, sell their fish to the cooperative, and must get along with the manager and other members--sometimes a difficult, frustrating and time consuming job. They forfeit the flexibility of being able to deal with several buyers, some independence and a good deal of time.

In the eyes of many fishermen, the primary advantages of cooperatives are the fact that they will buy the fish of

their members at fair prices. The fact that they provide an alternative to private dealers is far more important than the services and annual bonus.

#### D. Dragger Information Exchange

The captains of four draggers from Maine have agreed to exchange accurate information on catches and fishing locations. This is not the kind of periodic casual kind of exchange all fishermen indulge in from time to time, but a conscious agreement to exchange accurate information consistently throughout the year and record that pooled information for future reference. Some of the information on fishing locations is exchanged at sea via radio in a combination of straight English and private code. Such guarded conversations are typical among fin-fishermen (Orbach 1977: 104-131; Anderson 1972:104-139). More detailed information--especially on catches--is obtained over the phone or in person when the crews are ashore. The existence of this "ring" as it is known to its members is a carefully kept secret. As one member explained it, "if all the dubs knew what we were doing, they might be able to get a good deal from some of our conversations with a little practice. They just think we are just passing the time like everyone else." The ring members have toyed with the idea of using scrambler phones to communicate vital information, but so far have not purchased them because the mere existence of such phones would indicate they "were passing information to someone that we didn't want public."

Ring members stress that there are two different kinds of information obtained. It gives each of them a data base on concentrations of fish over a wide area. In short, it broadens their total search pattern. It is also information on long term aggregate behavior. As one man phrased it, "When your own catch goes up in a certain area, you always wonder if it is a fluke. If you see all four boats doing the

same thing, you know it isn't an accident."

The ring is the result of several fortuitous long term associations. Two of the members are close kinsmen. Three of the ring members have worked on the same boat. And two of these men served as captain and mate on a single boat for a period of years. Two other members were best friends in high school. No crisis or conflict helped to generate the ring. One senior member of the ring helped his kinsmen get started in fishing. He also used to talk very openly to the man who served as his mate. When the mate got his own boat, they continued to exchange information. The fourth man was a friend and associate of the other two men (i.e. the mate and kinsman).

It is important to note that all of these men are excellent fishermen operating comparable boats in the same general area. The information they exchange is essentially equivalent in value.

#### E. The Northeast-Southwest Trawl Rule in Casco Bay

The lobster fishermen of Casco Bay (Maine) have long used "trawls" composed of 5 to 20 lobster traps attached to a single long line, marked with a buoy at either end. This system allows these fishermen to fish a very large number of traps, and yet minimize the number of buoys congesting the surface. In the late 1950s and early 1960s, the number of lobster traps in the area escalated rapidly as first one lobster fisherman sought to improve his competitive position by increasing the number of traps he fished, and others quickly built more traps to remain in a competitive position. As the numbers of traps increased, the number of gear tangles went up rapidly. Tensions due to trap congestion were already high when one man began to fish "squares." That is, he placed some 15 to 18 long trawls with over 15 traps each in several parallel rows in an attempt to reserve a large area of prime fishing ground for himself. Additional men took up the practice of "fishing



squares" with the result that the remaining fishermen were forced off a large percentage of available summer fishing ground. Several others who refused to be pushed out of areas they had always fished, placed trawls in the area where "squares" had been placed. As a result, massive numbers of traps quickly became entangled with each other; men began to cut off each other's fishing gear; and tempers flared. For a period of several months in 1965 and 1966, there was a great deal of open conflict, with hundreds of traps destroyed, several fist fights and even a few shooting incidents. Most of the conflict involved men from different harbors, but there were also numerous incidents of conflict between men from the same harbor gang. After a period of several months, a nucleus of men, who had remained relatively uninvolved in the fray, proposed a solution--namely, that everyone in the area would refrain from fishing squares and would place their "trawls" in a northeast to southwest direction. This would allow all men to fish large areas and prevent the development of "private fishing grounds," and yet prevent the severe gear tangles that resulted when men placed their gear in any direction they chose. These men began to fish their own gear in a northeast to southwest direction and were able to persuade many other of the more active combatants to join them. Complete tranquility was a long time in coming, however, as several militant men continued to insist on their right to "fish squares." By the mid 1970s, however, everyone in the area was fishing according to the northeast-southwest rule as increasing numbers of fishermen were convinced of the wisdom of this rule and grew tired of conflict and trap losses.

#### F. Lobster Trap Limit and Limited Entry Legislation

In the early 1970's, the lobster fishermen of Great Chebeague Island and Cliff Island in Casco Bay agreed to limit the number of traps they fished and limit entry into lobster fishing. Thus, they organized themselves in much the same way

as the fishermen in the perimeter defended areas discussed above. In 1973, one of the authors was approached by a group of those fishermen who wanted to formalize this system by having the legislature pass laws to: define a boundary around their islands, limit entry into this fishery, and limit the number of traps. The Southern Maine Lobstermen's Association, to which many of these island fishermen belonged, became interested in promoting this management plan for the lobster fishery in the state of Maine as a whole. Between 1973 and 1975 the Association lobbied to limit the number of entrants into the lobster fishery by controlling the number of licenses. The licenses, according to the proposed plan, could have been sold on the open market so that men could enter the industry only as older men left or retired. It also prohibited fishermen from using more than 600 traps. This proposed legislation gained the approval of many members of the Maine Legislature's Committee on Marine Resources. It was finally defeated in the Maine House of Representatives after fishermen from Vinalhaven hired an effective lobbyist, who argued that aspects of the bill were unconstitutional.

What is of primary interest to us is not the ultimate fate of the proposed legislation, but that dozens of top lobster fishermen from some eleven harbors could form an association, agree on legislation to limit their own fishing effort, and support that legislation for the two years it took to get a formal vote in the legislature. Several facts about this effort stand out. First, a great deal of trap congestion was being experienced in southern Maine. This was especially true in the Casco Bay region, due to the escalation in the number of traps individual fishermen purchased as well as to a large number of entrants into the fishing industry, many of whom were part-time fishermen. There was general agreement that there were too many traps in the water and too many fishermen.

Second, it is important to note that a limit of 600 traps

will not cut individual catches or total catches. There are a fixed number of lobsters of legal size in a given area and virtually all of them are being caught within a year after they molt into legal size. Fishermen will catch the same number of lobsters--all other factors being equal--if they all have 1000 traps or 600 traps. It may simply take them a little longer. It would take an enormous reduction in the total number of traps fished to reduce the catch. Of course, if one fisherman has more traps than others, he will catch more lobsters. Thus, it is important to restrict all fishermen to the same number of traps or trap escalation will occur as fishermen try to improve their competitive position by fishing more traps. A trap limit, then, reduces costs for individual fishermen by reducing the number of traps that have to be built, maintained, baited, and tended. It is thus an economic measure, not a conservation measure.

Third, the limited entry rules were written in such a way that no established fisherman would be removed from the industry. Most of the men prohibited from fishing would have been part-time fishermen, who are generally disliked by full-time fishermen (Acheson 1975b). In time, however, this provision of the bill would have resulted in a reduction in fishing effort.

Fourth, it was generally conceded that the licenses, which would be the private property of the fishermen, would quickly gain a great deal of value as their price was bid up by would-be entrants. Thus, the legislation would have transferred property rights to the established fishermen worth several thousand dollars (Acheson 1975b).

In short, the legislation was written in such a way that it would have clearly benefitted the existing fishermen by reducing their operating costs, reducing the competition they faced from new entrants into the industry, and by giving them a license of great value. Thus, the critical question is not why the men of the Southern Maine Lobstermen's Associa-

tion favored such legislation, but why men from other regions, such as Vinalhaven, opposed it so violently. The reactions of fishermen to limited entry legislation are very complicated and have been analyzed in two articles (Acheson 1975b and 1980f).

With the defeat of this bill in 1975, the Southern Maine Lobstermen's Association has not attempted to establish any kind of limited entry or trap limit rules on either a formal or informal basis. While the membership of the Association, which includes some of the very best lobster fishermen in this part of state, is still overwhelmingly in favor of such legislation, they recognize that only the state can limit the number of licenses and only the state wardends could enforce a trap limit. Informal agreements, they believe, are not likely to work in a wide area since they can not be enforced.

#### G. Herring Stop Seine Berths and Weir Regulations

Fixed gear herring fishermen have long had a system of established ownership rights over the coves where their gear is located. It is not just that a man who "has a weir" or a stop seine berth has a right to operate that gear without physical interference from others; he also has "rights" over an entire stretch of water, and by implication, rights to catch any fish that may enter the cove or harbor.

Ownership rights are signalled and maintained primarily by locating one's fishing gear in a cove. In the case of a weir operation, ownership rights are established by building a weir in the cove; in the case of a stop seine operation, by anchoring a seine dory containing a seine net in the cove.

These ownership rights are usufructory rights in every sense. A man has the fishing rights to a cove only as long as he is actively maintaining his gear and tending it properly. When the weir falls apart or is otherwise obviously not tended, or the seine dory is removed, then others are free to "take over the berth." In the past, other herring fishermen would not

move into a cove if someone merely had his fishing gear there. Increasingly, active attention to the gear is necessary to maintain full fishing rights. In recent years, there are cases where men have stopped off coves when herring entered, even though others had seine dories stationed there, because the cove was not being properly tended. In one instance, the man who had the berth had taken a vacation; in another, he was engaged in other fishing activities. In still another case, a fisherman takes over the cove after the "berth owner," an older fisherman, goes home for the night.

The duration of these ownership rights varies enormously. There are instances where men have maintained weirs in coves for 15 to 20 years. In other cases, men have built weirs in poor locations and abandoned them after a season or two. Some stop seine operations have been fished for generations by members of the same family. The stop seine berth at Tenants Harbor, Maine is currently "owned" by a man who inherited it from his father and grandfather. On the other hand, certain stop seiners move their gear from one cove to another--sometimes several times in a single season. In these cases, their ownership rights last no longer than the amount of time they have a seine dory anchored in the harbor.

Two factors clearly play a role in establishing long term fishing rights in a cove. First, being the first to establish one's fishing gear in the cove is of critical importance. As one man phrased it, "If no one else is in a cove and you are the first to put a dory there, you have won ninety-nine percent of the battle." Second, legal ownership of the land surrounding the cove gives some herring fishing rights in that cove. Legally, the oceans are the property of the state and federal government, and ownership of land does not convey any rights to any adjacent waterways. But in the informal normative system, a man who owns property on a cove has a far better claim to the local fishing rights than someone who does not. Should a conflict arise, there is no question that owner-

ship of land helps one to maintain a claim to fishing rights.

The more critical questions is: What motivates fishermen to want such a system of usufructory rights over herring fishing sites? Part of the answer lies in the fact that herring are a very skittish fish and easily frightened. In cases where there are too many boats and too much activity in a small area, the chances of catching herring are greatly reduced.

If two fixed gear operations are located in the same location, only one is apt to catch any herring. If there is any gear conflict, neither may catch anything. At best, placing two sets of gear in a single cove is a zero sum strategy. It is very likely to be a negative game.

Feelings of ownership of stop seine berths and weir sites are strong enough so that a man who places his gear in areas where others are fishing is very apt to have it molested or destroyed or be forced to guard its continuously. Guarding gear is very difficult, since virtually all fixed gear herring fishermen have other jobs or businesses. Of course, one can retaliate if one's fishing gear is destroyed, but this situation, in the words of one fisherman, "means two fishermen put each other out of business."

Last, virtually all herring fishermen receive large loans from processing companies to help buy their weirs or stop seine gear. The processors make these loans to men in scattered locations to ensure a steady supply of herring. If a man from one harbor does not catch fish, one from another harbor will. A man who deliberately places his gear in the exact same location other fishermen have staked out is operating to defeat the general strategy of the processors. Such a person is also likely to come into conflict with other herring fishermen, in which case the processing companies' investments would be jeopardized. Thus, it is very unlikely that a herring fisherman who made a practice of trying to fish in areas others had reserved would continue to obtain

loans for very long.

There are, in short, a number of factors inherent in the nature of herring fishing and in the kind of marketing ties involved that strongly buttress the system of "ownership" rights characteristic of fixed gear herring operations. These factors make it logical or rational for those involved in the industry to promote such a system of ownership. The system has lasted as long as anyone in the industry can recall. The men in this section of the industry are so well socialized to the norms concerning "ownership" of weir sites and stop seine berths that there are very few instances of conflict and violation in any given season. In fact, these norms are so strong that the weir fishermen successfully petitioned the legislature to pass a law prohibiting herring fishing within 1000 feet of a weir. This law merely formalizes a long-existing norm.

#### H. The New Bedford Scallop Agreement

Price instability has been one of the problems in the scallop industry in New England. In this industry, ex-vessel prices have risen and fallen so drastically and suddenly that fishermen are never certain when they leave the dock whether they will make or lose money on the trip. Many scallop fishermen are convinced that this price instability is the result of price fixing by scallop buyers. The basic cause of this phenomenon is traceable to the fact that the demand for scallops is price inelastic, while supply fluctuates greatly depending on fishing conditions. Over 80 percent of the scallops landed are purchased by institutions and restaurants, which order approximately the same amounts of scallops with little regard for the price charged. As one restaurant owner phrased it, "I can't afford to print new menus every week when the price of meat and fish change. When scallops cost a lot, I make a little less; when scallops cost a little less, I make a little more. I always order about 40 pounds

per week." The scallop catch, by way of contrast, varies wildly. When the weather is bad, boats stay ashore. When it improves, large numbers of them put to sea together. The result is either scarcity or oversupply. The scallop buyers react to this situation by bidding the price up when scallops are scarce and refusing to buy when storage facilities are full. They do not refuse to buy openly, but rather lower the price offered drastically. Thus, despite the suspicions of fishermen, collusion among buyers is probably not the cause of the great price fluctuations observed in the scallop market. Fishermen, however, are correct in believing that this situation in the market is hurting them more than it is buyers, truckers, or consumers, and that all of the risk is being passed on to them.

Several times in the past, there have been confrontations between buyers and fishermen, who have demanded higher price for the scallops landed. On many occasions when the price was very low, fishermen have refused to go fishing until prices improved. These work stoppages have had little lasting effect because they were not organized. However, in the summer of 1980, a set of events occurred in New Bedford which might alter the scallop market permanently.

Early in 1980, prices for scallops had averaged about \$.50/pound. In May and June, prices had fallen to \$.15 to \$.20/pound. In June, there were several acrimonious meetings between groups of buyers and scallop fishermen. When the buyers refused the demands of fishermen for a \$.30/pound minimum ex-vessel price, scallop fishermen refused to go fishing. By July, the entire New Bedford scallop fleet was "tied up." During the three week "tie up," the scallop fishermen as a whole formed an "ad-hoc fishermen's committee" and agreed that boats will spend a maximum of nine days at sea with a four day layover, and that only 11 boats, out of the 135 vessels in the fleet, will be permitted to leave port in a day, on a schedule set up by the "Committee." This, they hoped,



would even out the supply of scallops and prevent the kind of glutted market which has resulted in abnormally low prices.

Whether this fishermen's committee and set of rules will last for long is uncertain at this writing. At present, fishermen in New Bedford are determined to continue the rules for at least two or three months to see whether scallop prices will rise sufficiently. If the plan appears to be working, an effort will be made to continue. If prices remain low, undoubtedly they will be dropped or altered in some way. The plan may very well have favorable results if the rules can be enforced, since it seeks to remedy what is most likely the basic cause of price instability--namely fluctuations in supply. Moreover, New Bedford is the largest scallop port in New England by a very large margin. A very high proportion of all the scallops caught in the entire region are marketed through this city. Any scheme which can affect the New Bedford market will certainly affect scallop prices in the entire region.

#### I. Rhode Island Offshore Lobstering Lanes

In recent years the offshore lobster fishermen from ports in Rhode Island and southern Massachusetts have lost a great deal of their fishing gear, first to the foreign fleet before 1967 and then to local scallopers and draggers in the past few years. In 1977, the Atlantic Offshore Lobstermen's Association with headquarters in Westport, Massachusetts, proposed to solve this gear conflict problem by establishing a series of "lanes," 100 microseconds apart on Loran C, each of which would be used alternately by lobster fishermen and then by mobile gear fishermen. With this system, all fishermen would be allowed to fish the entire bottom, but at different times to avoid gear conflicts. One of these lanes running east and west and marked by a series of large bell buoys has worked out reasonably well, according to informants. But, on the whole, the system has failed. Local dragger fish-

ermen have tried to avoid lobster fishermen's gear, but they have entered "forbidden lanes" when they knew there were concentrations of finfish moving through the area. The worst offenders have apparently been the scallopers--especially scallop boats from other parts of the Atlantic coast--who have not only ignored the whole lane system, but have deliberately destroyed lobster gear. Sometimes they have run their boats through areas where concentrations of traps were placed; at other times they have sunk the marking buoys with gunfire.

At present, most of the lobster fishermen are attempting to protect their gear by making sure it is well marked and by spacing it far enough apart so that draggers can work in between the lobster pots if the skippers of those boats really want to avoid entanglements. At this writing, the "lane system" is still in effect, but it is clearly not working well and may be abandoned soon.

#### J. Relationships Between Fishermen and Dealers

So far we have considered only relationships involving fishermen and the kinds of institutions that sometimes evolve from transactions between fishermen. Fishermen, of course, have some very important ties with people who supply ancillary services for the fishing industry (i.e. boat builders, marine supply houses, shipyards, and fish dealers). The relationship between fishermen and the dealers they sell to is particularly important, because a man's economic success depends in large measure on his ability to form and manipulate such ties. These relationships are particularly important to understand since they exhibit some very different characteristics than the ties between sets of fishermen and shed some light on the nature of the transactions and institutions in the fishing industry as a whole.

Some fishermen characteristically sell to a number of dealers, or change dealers within a short period of time. The

vast majority of fishermen, however, sell their fish to one dealer with whom they have a long-standing bilateral arrangement. The relationship between fishermen and dealers characteristically involves far more than an exchange of money for fish. Dealers will supply fishermen with whom they are acquainted with large loans; financial backing for repairs or new equipment; preferential prices for fish; supplies, bait, and paint at wholesale prices; free use of wharves and docks; and so on. Most important, the fisherman usually obtains a great deal of information about the market from the dealer and can count on the dealer to treat him fairly in evaluating the worth of his catch. The fisherman, for his part, is ordinarily expected to sell all of his catch to the dealer, or at least give him first refusal on the catch. The value of such arrangements to the fisherman is obvious, but the dealer gains something of critical importance too--namely the steady, secure supply of fish he needs if he is to keep his fish processing plant operating and/or keep his own customers.

The terms of these agreements are rarely written down or legally enforceable. Under such conditions, it is not surprising that misunderstandings are relatively frequent, and periodically the relationship between a buyer and a fisherman will break down completely. However, such bilateral arrangements are so advantageous for both parties that men are reluctant to break a long-standing relationship if at all possible.

The ties between fishermen and dealers is an institution since there are a set of informal rules structuring the relationships between the parties involved. However, there is tremendous variation in the expectations between fishermen and the men to whom they sell their catches. Two kinds of variations can be observed. First, a dealer has a unique and individually negotiated relationship with every fisherman with whom he does business, depending on the length of the relationship, the amount of fish the fisherman can deliver, the amount

of time the fisherman can afford to invest in the relationship, and the degree of trust the two men have built up over time.

A successful sale of fish lays the groundwork for future transactions involving more complicated exchanges; and a history of successful exchanges can lead to a relationship involving loans, information, and preferential treatment. On the other hand, the suspicion that one has been cheated or is giving more than he is receiving can lead to a loss of trust, fewer exchanges, and, ultimately, disintegration of the relationship. In this sense, the relationship between fisherman and dealer resembles Foster's dyadic pairs rather than an institution in which all the rights and obligations are the same for all people occupying similar statuses (Wilson 1980).

Second, the content of a relationship between a fisherman and his dealer depends on the relative leverage the two can bring to bear during the negotiating process. The dealer or processor has two assets: superior knowledge of the markets, and the ability to give loans, supplies at wholesale costs, free wharfage, and so on. The fisherman, for his part, can withhold his supply of fish. Fishing risk, size of catch, and ability to store fish all play a role.

On the whole, men who bring in large catches are in a better negotiating position. Such men can do far more to threaten a dealer's supply of fish than a small fisherman. Fishermen in high risk areas of the industry and men who hold other non-fishing jobs are in a similarly favorable position vis-á-vis the dealers. After all, if they go out of business the dealer's supply of fish is cut off. The ability to store the catch is of critical importance; a fisherman who has a hold full of two week old fish is in little position to bargain .

In the major fishing industries in New England, these factors combine in different ways to effect: the negotiating

process, the transactions between fishermen, and the dealers to whom they sell their catches. At one extreme is the herring industry in which it is standard for dealers (i.e. fish processors) and fishermen to have very close, long-term arrangements in which fishermen receive very large, interest-free loans from dealers for boats and equipment which will be paid out of the catch. In this industry, the fisherman has a guaranteed market for his fish at the going rate. In addition, these processors go out of their way to treat fishermen fairly, inform them of pending changes in the price of herring, and will even make loans to tide fishermen over in poor years. Such loans and agreements make the processor a virtual partner in the herring fisherman's business.

At the other extreme are the Maine and New Hampshire groundfishermen who have very few close ties with their dealers and are constantly being taken advantage of by dealers. The majority of these men sell their fish on consignment so they do not even know what they will be paid until their check arrives in the mail. They get little or no financial support from the dealers they do business with, very little accurate information about fish prices, and no services (i.e. wharfage, low priced bait, gas, ice, or whatever). Thus, the groundfisherman in northern New England is on his own and must sell his fish to a distant dealer who often acts more like an enemy than a source of support.

The lobster industry presents still another marketing pattern. In this industry, dealers attempt to ensure a large and steady supply of lobsters by attaching as many fishermen to themselves as possible. Usually a dealer attempts to "keep his fishermen" by giving them free wharf space, bait, gas and paint at low prices. In addition, he provides a secure and steady market for "his fishermen." Dealers in this industry buy all the lobsters caught by their fishermen at the end of the day and pay them immediately. Lobster dealers do make some loans to fishermen, but these are characteristically for

small amounts. It is important to note that in many Maine harbors, lobster dealers have failed in their attempts to "keep their fishermen," as the rapid formation of cooperatives attests.

In summary, in these three different fishing industries, there are three very distinct sets of relationships between fishermen and the dealers to whom they sell their fish. At first glance, it might appear that fishermen and dealers in these industries are operating within three distinct institutional frames. This is not true. The basic social structural principles in all three markets are the same. The observed differences in these industries are due to relative leverage of dealers and fishermen in negotiating long-term agreements with each other.

The position of the Maine and New Hampshire groundfishermen is relatively weak. They have a perishable product that cannot be stored for more than a few days. Moreover, Maine fishermen cannot possibly keep track of the market situation personally. There are some 72 species of marketable groundfish and these fishermen live several hours away from the markets. Last, Maine fishermen have small boats and small catches. All of these factors strengthen the hand of the dealers. A Boston broker trading with a Maine groundfisherman knows he is dealing with a man who cannot withhold his catch, has little knowledge of the various groundfish markets, and cannot supervise the sale of his own fish personally. Under these circumstances, the temptation to cheat must be overwhelming. Even if the fisherman gets angry and takes his business elsewhere, he has such small catches that he has not hurt the original dealer's business much. Moreover, there is no guarantee that he can find any other dealer who will treat him any better. Under these conditions, it is scarcely surprising that over the course of time the transactions between these fishermen and distant dealers have resulted in a situation in which the fishermen is on his own and is pro-

vided with very little in the way of loans or services.

The lobster fishermen is in a far better position. He catches one species which can easily be stored live in lobster "cars" for months at a time. He sells his catch every afternoon personally and receives his money immediately. While any single lobsterman's catch is never more than a few hundred pounds at the most (a 500 pound daily catch is very large), groups of fishermen, often kinsmen, can pool their catches which they sell to a single dealer. Moreover, every small harbor has at least one lobster dealer. Thus, the position of lobster dealers is much weaker than that of groundfish dealers since they are doing business with men who can easily keep track of the market and who personally supervise the sale of their catch. If they are displeased, it is relatively easy to sell to another dealer or to hold their catch off the market altogether.

The relative bargaining position of herring fishermen is very strong for a different set of reasons. Herring fishermen catch one species of fish so that it is easy to keep track of the market. Sometimes their catches can be very large. It is not uncommon for seiners to stop off 10,000 bushels in a night. But the most important factor increasing the negotiating position of herring fishermen is the risky--boom or bust--nature of herring fishing itself, which makes it difficult for processing firms to ensure a steady supply. As a result, the herring processing firms extend loans and financial aid to fishermen in harbors up and down the coast. If one of the fishermen to whom they have made loans does not have herring, another one will. These firms are really assuming part of the risk of the individual fishermen in an effort to ensure a steady supply of fish. Failure to financially buttress herring fishermen would almost certainly result in vastly increased variations in supply of herring for the processors. Herring fishing is such a risky operation that none of the stop seine operators and weir

operators can earn a living in herring fishing. All of them have another job. Moreover, virtually all of the purse seiners fish for other species during one season of the year. Were it not for the aid of the processors, a very large number of these fishermen would abandon herring fishing completely during dry years, leaving the processors without fish. Thus, the success the herring fishermen have had in negotiating very large loans from processors lies in their vulnerability in combination with their ability to quickly switch to some other occupation.

In summary, one of the most important institutions in the New England fishing industry are the long-term bilateral relationships between fishermen and dealers. The content of the contract between any given dealer and fisherman depends on the history of the relationship between them, and the leverage each can bring to bear in the process of negotiations. The conditions in the lobster industry, herring industry and groundfish industry are so different that very different kinds of transactions are typical of each industry.

#### K. New England Herring Management Plan Agreement

One of the situations we know least about, and one of the most interesting, is the circumstances surrounding the promulgation and acceptance of the New England Herring Management Plan. In 1977, after PL 94-265 was passed, it became apparent to the herring processors that Atlantic herring would soon come under Federal regulation. They decided that these regulations should reflect the long-term biological and economic interests of the herring industry. Consequently, spokesmen for the five largest processors of herring in Maine got together with representatives of the herring industry in southern New England, the state fisheries management agencies, the National Marine Fisheries Service, the Maine Sardine Council, and a few highline herring fishermen. The representatives of these organizations reached a consensus rather



quickly, which is reflected in both the Maine State Herring Plan and the Federal Herring Plan. Both have already gone into effect. Basically, they decided to continue quota regulations on herring, specifying the total amount of herring in each size category that could be taken. These herring quota were phrased in terms of the so called "nine-inch-rule" which in essence limits the amount of adult herring (i.e. over nine inches) that can be taken as well as the amount of "juvenile herring" that can be caught. In addition, there is a rule specifying the amount of herring that can be caught above a line drawn from Cape Elizabeth (Maine) to Georges Bank. Above that line, herring can be caught essentially in the summer months; below that line is the winter herring grounds.

The major bone of contention in the negotiations was the nine inch herring rule. Basically, the processors in Massachusetts and southern New England are currently packing and freezing frozen herring fillets, which can only be made from herring eight and a half inches long. In Maine, there is much more interest in the small-sized herring since the sardine plants require such a large number of these small fish. The industry and government representatives were able to agree on the "nine-inch-rule" which defined adult herring as those which are over nine inches. This rule basically allocated the amount of adult as opposed to juvenile herring that could be caught and thus reflected the needs of both kinds of producers (filleters vs. sardine canners). Once the industry and governmental representatives agreed on the phrasology of the ruling, the New England Regional Fisheries Management Council and the Maine state legislature were able to go forward with the regulations with little difficulty.

It should be noted that this agreement on herring regulations was not easily reached. The herring processors in New England, particularly in Maine, are very competitive and there is a good deal of animosity between them.

## L. Exchanges and Transactions in Clusters and Institutions

### L.1 Institutions and Uncertainty

Given the information on fishing clusters which we have presented in the last chapter, and the data on institutions among fishermen which have been briefly described in this section, certain generalizations can be made on the exchanges and transactions which occur in both types of relationships among and between fishermen.

First, in the introduction to this chapter it was asserted that institutions are essentially surrogates for accurate information. They are agreements stemming from long-term transactions and exchanges, which assign risks and thus reduce uncertainty. The kinds of transactions that are involved in institutions and the way they operate to reduce uncertainty was left purposely vague. Moreover, no mention was made of the fact that these transactional rules have to be enforced to be effective. Both of these issues can now be addressed.

Lobster territories essentially involve agreements among the men fishing from particular harbors to limit the number of men who can fish for lobsters in a given area, thus reserving the catch for the group from that harbor. Harbor gang members not only keep others out of the area by trap cutting and harassment but prevent other men from joining their own harbor gang. After all, a new man in the area has the same effect on their own aggregate catches as the incursion of a man from another harbor. If this does not guarantee all of the men in the harbor a certain catch, it at least reduces the uncertainty of the catch of available lobsters being taken by someone else. The transaction that is involved is basically one in which men from a harbor agree to defend a jointly owned area. The sacrifice is emotional energy and periodically traps which are destroyed in the fray.

What happens when a fisherman who has derived the benefits of a harbor gang refuses to defend the gang's territory? Such cases happen fairly frequently. In many instances other mem-

bers of the gang defend the boundaries of the territory, take their losses, and do little more than grumble. Sometimes the recalcitrant are sanctioned by having a few traps cut off. In these cases the men who have defended the territory make sure everyone incurs the same losses they have. In many cases those men who want to avoid conflict place their traps well inside the area owned by their own harbor gang. If they do not incur the trap losses associated with defense of the perimeters of an area, they do not receive the rewards of being able to fish the whole area either.

Cooperatives involve at least two different kinds of transactions. In the lobstering cooperatives of Maine, fishermen agree to sell their catch to one outlet in exchange for a better price on fish and the inconvenience of working through a cooperative. They are essentially swapping independence for extra income. To many, the gain is not worth the cost. Fin-fishing cooperatives in southern New England involve a second kind of transaction. In these cases, fishermen are exchanging a steady supply of fish for information, loans, favorable prices and an assured marketing outlet. In all cases, cooperative membership reduces uncertainty for the fisherman. Lobstering cooperatives cannot guarantee a given fixed price, but they can guarantee that the fisherman will receive the best price for his catch possible. Fin-fish cooperatives help to reduce uncertainty by giving an assured market, favorable prices and accurate information. Again, enforcement is a problem. When fishermen who are members of the cooperative sell part or all of their catch elsewhere, they are not sanctioned for a time. Repeated offenses however usually result in their being maneuvered out of the cooperative.

In the case of the four dragger captains who have agreed to secretly pool data on catches, information is basically being exchanged for information. These men are exchanging time and confidential information about their own catches and

fishing grounds for information about fishing conditions over a very wide area. All four men agree that this is a very favorable exchange since it greatly increases the certainty of finding concentrations of fish. The terms of these transactions have not been violated yet by any of the four fishermen involved, but if a violation were to occur that person would almost certainly be denied information in the future. Violation would almost certainly mean an end of the institution, since many kinship and friendship ties are involved.

The rules concerning stop seining berths and weirs are essentially agreements giving exclusive fishing rights in certain coves in exchange for agreements to stay out of other coves and fishing areas. This institution does not guarantee a certain catch, but it does guarantee that a man will have no competition if fish do enter the cove where he has the "berth." The institution cannot make the behavior of herring any more certain; but it can reduce uncertainty concerning the behavior of other fishermen. Enforcement of the rules concerning weir and stop seine berths proved to be very difficult. The industry solved the problem by petitioning the Maine legislature to have the informal rules formalized into law, which transferred problems of enforcement from the members of the industry to officials of the Department of Marine Resources.

In Casco Bay, the fishermen who agree to place their trap trawls in a northeast to southwest direction are essentially exchanging the right to place traps anarchically for more fishing time which would have otherwise been used building new traps and untangling fouled gear. The rule reduces the uncertainty concerning the number of traps one will have producing on any given day and the amount of time one will spend at sea. The northeast-southwest rule proved difficult to enforce although it appears to be generally workable.

The New Bedford scallopers are essentially exchanging

freedom of movement to get higher prices. The entire strike effort was explicitly aimed at reducing the uncertainty associated with rapidly fluctuating prices for scallops. However, it is very difficult to say what would happen if one or more of the scallop boats involved in the New Bedford strike decided to ignore the rules concerning trip length and staggering of trips.

In summary then, in every case, these institutions involve exchanges and transactions which operate to reduce one or another kinds of uncertainty connected with fishing. In all cases, enforcement is a problem. In some cases violation of transactional agreements is characteristically ignored; in other cases fishermen themselves attempt to enforce them; in still other cases, the enforcement problem is passed over to state officials through the expedient of passing a law.

#### L.2 Exchange and Information Flow in Institutions and Clusters

Exchanges occur in both institutions and clusters. However, institutions and clusters are very different not only in what is exchanged, but more importantly in the rules surrounding the exchanges.

In institutions there are a set of rules (i.e. transactions) surrounding the whole process by which the exchange takes place which insure that the bilateral agreement is kept, and usually insure that the parties involved obtain something of equal value. As we have seen, enforcement of these agreements always poses problems, but enforceable rules are present nevertheless. Exchanges in clusters are essentially uneven and nontransactional. In exchanges within clusters, one person is giving more than he receives. This is true regardless of whether information is swapped for information; information for favors; labor for instructions in running new electronic gear, or whatever. In addition, there are no rules surrounding the exchanges in clusters, and there are neither implicit nor explicit agreements between the parties

which can be enforced. A herring fishermen, for example, who catches more fish than he can carry may give the excess herring to another boat fishing nearby rather than have them wasted. But there is no hard and fast obligation on the part of the captain of the other boat to reciprocate in kind or to reciprocate at all.

This difference in institutions and clusters has a strong effect on information flow. When people involved in institutions exchange information, something of equal value is given in return, whether that be information, loans, material goods, or what have you. Fishermen obtain a great deal of information about catches, fishing locations and equipment from other men in the same cluster. However, in clusters there are no enforceable rules surrounding the exchange of this information, so that poor fishermen obtain more from skilled fishermen than the "highline" fishermen obtain from them. As a result, information flows from the most highly skilled fishermen to the least skilled men in the cluster. Under these conditions, it is not surprising that relations between fishermen are marked by secrecy-- especially in those fisheries where the duration of the value of knowledge is long.

There is a marked difference in the proportion of goods and services which have an explicit economic value which are exchanged within clusters (or institutions in that cluster) as opposed to exchanges between men who are not in the same cluster. Within clusters, a very high percentage of the exchanges involve goods or services with only an implicit value (i.e. information, favors, instruction, and so on). Sometimes men who fish for the same species in the same area with the same gear sell each other fish and gear, but for the most part they exchange favors and information. Exchanges between men in different clusters involve primarily goods and services which have a more explicit economic valuation. For example, when exchanges between a fisherman and his dealer

do involve exchanges of favors, information, and so on, the most important exchanges are money for fish, or loans for an assured future supply of fish. Here, the most important things exchanged are easily measured in monetary terms. In short, the exchanges between men in the same cluster have a very high ratio of implicit to explicit exchanges; while men who are not in the same cluster have a high ratio of explicit to implicit exchanges.

### L.3 Types of Fishing Institutions and Fishing Effort

Theoretically, two different kinds of institutions can exist in any industry: hierarchical institutions and market institutions. The market institutions we subdivided into exchange institutions and production institutions (See Part II, Chapter 4). However, both of these types of institutions are not represented in the fishing industry of northern New England by any means. We have discovered no hierarchical institutions. If the industry were dominated by large, vertically integrated firms, some instances of hierarchical institutions would undoubtedly exist. But fishermen in northern New England simply do not work for anyone, and thus these institutions, which are typical of relationships within a firm, do not exist. (The single exception may be the Maine redfish fleet, which is dominated by two firms which own all the vessels and which have hired captains and crews.) Even in the herring industry, where fishermen typically have close financial ties with one or more processing companies, transactions are still voluntary. Thus, even in this industry, it would be very difficult to make the case that hierarchical institutions exist, at least where the fishermen are concerned.

All fishermen are involved in at least one exchange institution--namely with their dealer or broker. Relationships between dealer and fishermen are open, voluntary and involve a quid pro quo transaction. However, there are no other institutions we have discovered which meet these criteria.

Virtually all of the institutions we have discovered are competitive or production institutions. That is, they are essentially agreements to minimize conflict, competition, and reduce costs. This is true of the cooperatives, the lobster fishing territories, the northeast-southwest lobster trawl rule, the lobster trap limit bill, the stop seine and weir regulations, the Rhode Island offshore lobster lanes, the New Bedford scallop agreement, and the New England Herring Management Plan. The aim of these agreements is to benefit the fishermen involved--not society as a whole. There is nothing fishermen can do to reduce the uncertainty they face due to natural factors, but they can reduce uncertainty by controlling other fishermen and themselves through bilateral agreements. If there is nothing one can do to ensure fish, one can enter into agreements to reduce the uncertainty about the actions of one's competitors. In Heath's terms, rules have "the function of introducing predictability and regularity into the relationship" (1976:64).

Several of the institutions described influence fishing effort and one increases fishing effectiveness. Institutions reducing fishing effort include: lobster fishing territories, the northeast-southwest lobster trawl rule in Casco Bay, the lobster trap limit, the stop seine berth and weir regulation, the New Bedford scallop agreement, Rhode Island offshore lobstering lanes, and the New England Herring Management Plan. In all of these cases, fishermen agreed to place restrictions on the gear they used, the time they spent fishing, or the location where they fished. A reduction or increase in fishing effort is not the avowed purpose of these agreements, but it is certainly their effect. These agreements are enforced in different ways and in different degrees. It is critically important to note that in most of these instances, there is no evidence that these institutions actually cut fishing mortality or operated to conserve the fish resources. In only one case (i.e. the lobster fishing territories), do we have



solid evidence that this did, in fact, occur. It is critical to note that entry into perimeter defended areas is much more difficult than in nucleated areas (see section on lobster territories in this chapter). As a result, there are fewer fishermen per square nautical mile of fishing grounds in perimeter defended areas (Acheson 1975a:196). This reduction in fishing effort has three biological and economic benefits. First, lobsters caught in perimeter defended areas are larger. This means that the percentage of female lobsters which are sexually mature and capable of extruding eggs is much larger in perimeter defended areas than in nucleated areas (Acheson 1975a:200). Second, the reduction in fishing effort has resulted in higher stock densities in perimeter defended areas. Third, fishermen in perimeter defended areas catch larger lobsters and more pounds of lobsters with less effort. Thus, the average gross incomes of men fishing in perimeter defended areas is significantly higher than those of men in adjacent nucleated territories (Acheson 1975a:203). Thus, the system of territoriality found in the Maine lobster fishing industry--a kind of spontaneous limited entry system--clearly has beneficial effects for both the lobster and the men fishing for them. We suspect that other institutions we have described in the New England fishing industry might have the same kind of beneficial effects. At this writing, we have no evidence of this, however.

Institutions among fishermen can function to increase fishing effort of fishing efficiency. Certainly the dragger information exchange has increased the effectiveness and incomes of the fishermen who participate in it. If the entire groundfish fleet were involved in such exchanges, there would clearly be much more pressure on the resource. Again if these institutions between fishermen conserve fish stocks, they do so only as an accidental aftereffect. The more crucial question is: Why don't fishermen form institutions whose aim is the reduction of fishing effort and the conservation of the

stocks? Management, after all, presumably benefits everyone--including fishermen (Acheson 1980f). This question is addressed in the last part of this volume.

#### L.4 Formation of Institutions and Fisheries Management

Most of the social behavior of fishermen is essentially cluster behavior. That is, when fishermen interact with each other, the most important ties are within the loose networks of men who have the same feasible set of opportunities. Under certain circumstances, however, fishermen form institutions in which there are a set of formal or informal rules structuring transactions between people. The formation of these kinds of institutions is of critical importance for purposes of fisheries management since some of these structured arrangements involve agreements between fishermen to limit fishing activities. If one could pinpoint the factors associated with the evolution of such institutions, it might be possible to introduce policies which would encourage the formation of similar institutions which would limit fishing pressure. In addition, it would hopefully give some insights into the kinds of regulations that fishermen would accept with relatively little political opposition. Presumably, fishermen would have far less objections to the same kinds of regulations they impose on themselves than to regulations which are not matched to the existing normative system and social structure.

Institutions of all kinds are relatively rare among fishermen, and we do not have good historical evidence on the evolution of most of them. Some are so new that they have no history (e.g. the New Bedford scallop agreement, the Rhode Island lobstering lanes); others are so old that their origins have been lost in time (e.g. the lobstering territories, and arrangements between fishermen and dealers).

Nevertheless, we have enough information on these cases to come to some tentative conclusions about the conditions under which fishermen form them.

(A) The formation of institutions is clearly structural; they cannot be explained in terms of personality or friendship. In many cases, fishermen can be reasonably friendly with other fishermen in their cluster, but not form any kind of institution. In other instances, there can be a good deal of hostility and suspicion and yet the individuals concerned are still able to agree on a set of rules structuring their relationships and achieve a set of mutually desired ends. There is, for example, no love lost between several of the herring processors, or between many of the lobstermen fishing from the same harbor. Yet the former were able to cooperate to formulate a herring management plan agreeable to all; while the latter are able to successfully defend their fishing territories. Clearly, far more is involved besides goodwill.

(B) Gear conflict and market forces operate to produce an element of cooperation among fishermen. As the discussions of the formation of cooperatives and the New Bedford scallop agreement point out, one needs volume to get a market. Fishermen who can agree to aggregate their catches are in a better position vis-á-vis the market than those who operate alone. Moreover, in situations of gear conflict all fishermen are losers and no one can be said to gain anything. In these cases, fishermen can obtain something by working together that they could not achieve alone. Much of the cooperation we see in the fishing industry has as its goal either avoidance of gear conflict or more favorable marketing situations. Again, most of the institutions noted are production institutions. The role of conflict and "unfair treatment" in the formation of institutions has been noted by several social scientists (Blau 1964:231).

(C) One of the primary traits of market institutions is that they involve transactions in which the exchanges are equal or relatively equal. We suspect that institutions do not evolve unless the parties involved do obtain something of

equivalent value. As a corollary, it appears that the institutions which are the most stable are those in which there is a quid-pro-quo exchange, and those that are the least stable involve exchanges that are unequal. This finding is in accordance with those of Thibault and Kelley (1959) and Homans (1961), who stress that rules (i.e. norms) are the result of bargaining and strategic interaction. In this regard, it should be noted that the institution which is most likely to fail is the Rhode Island offshore lobstering lane agreement. It may have failed already. The reason is simply that the lobster fishermen obtain a great deal from the arrangement; the groundfishermen obtain far less. The arrangement allows lobster fishermen to save many thousands of dollars a year in gear that otherwise would have been destroyed. Dragger fishermen lose a lot of flexibility by adhering to the agreement, and do not really lose much gear because of lobster traps when they do not. They can, in fact, usually fish in and around strings of traps so that they can get the fish from areas where there are lobster traps, and avoid destroying their own gear at the same time. The inequality takes another form too. Lobster fishing traps are impossible to guard continuously and thus are very vulnerable. Groundfishing or scalloping gear is easily guarded against depredations by other fishermen since it is on the boat. Thus, dragger fishermen can easily sanction lobster fishermen through the surreptitious destruction of their fishing gear. The reverse is not true, however. As a result, many scallopers and some dragger fishermen fish anywhere they want in violation of the "lanes agreement." There is very little that lobster fishermen can do to sanction the violators. Under these circumstances, it is scarcely surprising that the whole institution is in jeopardy.

(D) Institutions are most easily formed by small groups of people who are able to communicate with each other relatively frequently. Every single institution studied involved under

fifty people and in some of these cases far fewer people are party to the agreement. The New England Herring Management Plan was essentially put through by eight to ten people, and the "dragger information exchange" included only four. In the vast majority of cases, those involved in these various institutions live and fish in one harbor, or two or three adjacent ports. Lobster fishing territories and cooperatives are essentially agreements between men fishing from one harbor. The dragger information exchange, the northeast-southwest lobster trawl rule, the lobster trap limit, and the Rhode Island lobstering lanes included men from two or three harbors in the same general area. In only one case--the New England Herring Management Plan--did the participants live in widely scattered parts of New England. Most of the men involved were processors who keep in very close touch with each other. This situation is not surprising. There is, after all, a massive literature in sociology concerning small groups, attesting to the fact that small groups are able to reach decisions and coordinate efforts faster and more easily than large groups. Another body of literature stresses that rules (norms) are likely to be evolved in situations in which the participants can interact on a face to face basis. This is one of the essential points of Homans' The Human Group.

(E) In all of the cases where men have formed institutions the participants to these agreements receive the benefits in the short run. Lobster fishermen who defend fishing territories and restrict entry into local harbor gangs receive not only short-term rewards in the form of less competition, but also long-term rewards through increased recruitment. Herring fishermen who obey local rules concerning stop seine operations receive benefits in the form of exclusive fishing rights in one cove or estuary. It is important to note that several fishermen mentioned during interviews concerning institutions that the geographic range of the species

played a critical role in influencing willingness to enter into transactions which restricted their fishing operation. That is, they were more willing to restrict their fishing operations when they could exploit fish throughout the entire range of the species. Lobster fishermen who enter into territorial agreements know that lobsters are relatively immobile, so that the lobsters they conserve in one year will be available to them in another. Herring processors are willing to divide the spoils so to speak, since they know that vessel operators obligated to them can exploit herring anywhere in the Gulf of Maine. Thus, these men know that they will not restrict their own fishing efforts only to see the benefits of their sacrifice go to some other fisherman.

(F) Last and most important, fishermen who enter into institutional agreements in which their own fishing operations are restricted are involved in tightly packed clusters. Eight of the ten cases of institutions noted involved men in the lobster industry, the fixed gear herring industry or in scalloping. In all of these cases, fishermen have very similar sets of options, and these are all industries which are difficult to switch out of. Lobster boats, as we have seen, are specialized for lobster fishing and cannot be easily altered for any other fishing. Offshore scallop boats require permanent, expensive hull modification if they are to fish for anything but scallops. There is nothing that owners of stop seines and weirs can do with their gear except fish for herring, and moreover the number of locations where they can use that gear is very limited as well. The herring processors who were so instrumental in producing the New England Herring Management Plan are not fishermen, but their set of feasible options is very restricted. There is only one thing they can do with a herring processing plant without the expenditure of a large amount of money. They, too, are in a closely packed cluster. None of the institutions we have

found involve fishermen from loosely packed clusters save for the men who organized the Point Judith Fishermen's Cooperative.

There are two reasons men from closely packed clusters are more prone to restrict the use of fishing gear. First, men from these clusters have few other feasible options. It is not easy for them to switch to fishing other species. Since they are so dependent on one type of gear and one species, they are apparently more willing to enter into exchanges which minimize the costs of gear conflict and conserve the species.

Second, the costs of violating formal or informal institutional rules are far higher for men from tightly packed clusters than for fishermen in loosely packed clusters. Fishermen in all clusters obtain a good deal of valuable information from each other which strongly affects their economic success. No fisherman can afford to alienate a large number of other men in his own cluster for fear of reducing the amount of information to which he has access. The costs of alienating other cluster members are much higher for men in tightly packed clusters, however. They are not only dependent on one species, but on other men in their own area fishing for that species. For these men, violation of institutional rules may bring not only physical sanctions (i.e. destruction of fishing gear), but also an end to many network ties through which essential information is obtained.

In this part of the volume, we have described the way fishing clusters and institutions actually operate. In Part IV, we explore how a knowledge of these fishing institutions and clusters, in combination with biological and economic information, might be used in the formation of fisheries management plans.

PART IV

TOWARD A BEHAVIORAL THEORY OF THE MANAGEMENT OF COMPLEX FISHERIES



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## A. Introduction

With the implementation of the 200-mile fisheries limit (PL 94-265) in March of 1977, the U. S. embarked on the management of relatively complex fisheries systems. Unlike the relatively stable single species systems described in accepted economic theory, these systems tend to be highly variable, multiple species systems whose dynamics are very imperfectly understood. Additionally, these fisheries exist in a social and political context which not only limits the choice of management policies, but also, and more importantly, significantly affects the real (enforcement, administrative, and so on) costs of policy alternatives. The purpose of this section is to begin the development of a socio-economic theory of greater relevance to these complex systems. The argument put forth here is predicated to a certain extent upon the imperfections in our biological knowledge of these complex fisheries. Nevertheless, much more fundamental to the argument is the notion that the social costs of rule making and enforcement (i.e., the institutional transaction costs) are high in a complex, uncertain, and highly variable environment. Our approach to the argument is, first, to define the pertinent biological and economic attributes of the fishery environment. We then introduce some propositions about the formation and operation of institutions under conditions of uncertainty and, in the light of these propositions, ask the time worn question of why the market has not given rise to "conserving" institutions in fisheries. On the basis of our answer to this question, we then turn to an analysis of the North Atlantic demersal (groundfish) fishery.<sup>1</sup> Needless to say, we consider these arguments as "exploratory."

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<sup>1</sup>We concentrate on the demersal fishery because it allows us to bring out many points concerning complex fisheries. In addition, management plans for these species are currently being developed by the New England Regional Fisheries Management Council. Management plans for herring and lobster have already been formulated or are in the final stages of preparation.

## B. Biological and Economic Assumptions About the Fishery

The experience of the past four years (1977-1980), especially in New England, provides a strong rationale for altering the basic assumptions of the accepted economic theory of fisheries. The accepted body of theory makes two fundamental assumptions about the biological environment: (1) that biological processes relevant to the fishery are well known, and (2) that the characteristics of these processes are such that it is possible to exercise considerable control over potential biological outcomes in the fishery. Both of these assumptions are built into a typical specification of the biological production function, found, for example, in Clark (1976) and Andersen (1977). On the economic side, accepted theory tends to rely exclusively upon the standard neoclassical model of microeconomics which assumes that the decision maker has perfect knowledge about the environment and that the key to economic success is the ability to minimize costs.

The theory we are proposing here alters these basic biological and economic assumptions about the fisheries environment. The basis for altering the biological assumptions rests upon what appears to be a consensus emerging among biologists with regard to the state of our knowledge regarding the dynamics of fish populations. These considerations lead to the following major assumptions about the biological state of the fisheries environment; those which appear most germane to the management problem are:

(1) Each of the many harvested species of fish has differing population characteristics.

(2) The relative abundance of any species over time in the fishery is generally subject to wide variations which are most pronounced when viewed in terms of the strengths of successive year classes.

(3) The state of our knowledge makes it difficult to determine the cause of these variations in year class strengths.

Put differently, standard theory assumes that man, through control of his own exploitive efforts, can also control future sizes of exploitable stocks. However, experience in the North Atlantic and apparently elsewhere lends little support to this crucial assumption. There is little evidence that there is a relationship between current stock size, fishing effort, and future population sizes. However, when stock sizes are driven to very low levels as a result of fishing pressure there appears to be a reduced probability of good recruitment. Specifically, for each species, we assume that recruitment is a highly variable stochastic function of spawning stock size. Below some critical spawning stock size, which is difficult to specify, the expected value of the distribution of variation in recruitment as a function of spawning stock size is reduced sharply. Above it, we assume that for all practical purposes, the expected value of the distribution of variation in recruitment is independent of spawning stock size.

In addition to these assumptions about the biological environment, we have made five other assumptions about the factors influencing economic competition. All of these assumptions are at variance with the standard theory, although they are reasonable given our model and the data presented on competition among fishermen in Part III of this volume.

(1) We assume that demersal fish neither school in the manner of pelagic fish such as herring and menhaden nor distribute themselves randomly as in theory. Rather, we assume that fish move relatively slowly in fairly dense aggregations and that their movements are influenced by bottom types, currents, water temperatures, and a variety of other physical factors.

(2) We assume that the locations where concentrations of individual species may be found is very difficult to predict in a way which is meaningful for the immediate competitive purposes of individual fishermen.

(3) We assume that the primary costs of fishing are related to the costs of acquiring knowledge about the location of fish at any particular point in time. By primary cost, we mean simply that the efficient acquisition of knowledge about the location, density, and movements of fish is the overriding determinant of competitive success or failure.

(4) Furthermore, we assume that the individual fisherman's costs of acquiring information about fish is a function of the multivessel competitive information networks developed as a result of both competitive and cooperative behavior of other fishermen as well as his own searching behavior.

(5) Finally, we assume that fishermen are not technologically bound to the pursuit of a single species, but may easily and freely alter the species direction of their fishing effort (within the limits of a relatively large set of demersal species).<sup>1</sup>

These economic and biological circumstances cast the collective production problem in a different light than that assumed by standard theory. Most important, the biomass of the system as a whole, as opposed to the individual species within the system, appears to exhibit marked stability over time. If one can speak of recruitment to a biomass it would appear that biomass size is not a function of factors related to exploitation rates, but is perhaps more closely related to overall energy inputs to the system which appears to be relatively stable over time. (Again, this appears to be true over wide, but not extreme, ranges.)

Although the biomass of individual species varies considerably from year to year, season to season, and location to location, the relative stability of the overall biomass is extremely important to the competitive strategies

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<sup>1</sup>This is not to suggest it is easy to change from one fishery to another if that means a major change in boats, gear type, or skill. (See Acheson 1980b.)

of individual fishermen. Although these variations are predictable to a certain degree, the precision of these predictions in terms of time and location is insufficient to be relevant to the competitive problem faced by the fisherman. Consequently, the problem for fishermen is not how to trawl vast areas of ocean for randomly or predictably distributed fish; rather, it is to obtain information on changes in the location and availability of non-randomly distributed fish. In multispecies fisheries, the rapidly changing external environment places a premium on the ability to adapt rapidly. Given the rapid changes in availability of these species, a social network is critical for success.

This view of the biological situation has implications that are very different from those stemming from the standard bio-economic models concerning fisheries. First and most important, it suggests that the possibility and feasibility of controlling fish population size appears to be substantially reduced and, consequently, that the social benefits of exercising controls (e.g., on fishing effort) should be much more modest except for those controls necessary to maintain a safe minimum population size. Second, these circumstances imply that the most beneficial kinds of policies are those designed to control the timing of the exploitation of the already-recruited population in the short run. The question of how that control may be economically exercised we address through our theory of institutions.

### C. A Basic Institutional Proposition

Accepted economic theory of wild fisheries is based on the fundamental observation that market processes provide only a very imperfect collective mechanism for the conservation of wild resources. Fisheries are the classic case of market failure. There is nothing in our theoretical view or experience which would lead us to disagree with this observation. However, accepted theory suggests that the reason market forces

are ineffective in stemming over-exploitation is due solely to the absence of well defined property rights or a mechanism for simulating their effects. This deduction, we believe, is not wrong. However, the common property resource argument has been so compelling that it has closed off consideration of many other reasonable policy alternatives.

Our theory of adaptive behavior suggests several other policy alternatives which should be considered. The model suggests that the organization of economic activity for the exploitation of wild fisheries is a collective problem just like any other economic activity. As such, it requires the establishment of rules for the avoidance of strategic interactions which have the potential of destroying the possibilities for collective betterment through exchange and/or production. In non-fisheries markets, for example, the absence of such rules can lead to situations in which the uncertainty of another party's potential strategic behavior is so large that exchange or production is not feasible. It is the opportunity cost of this foregone exchange or production which makes the establishment of rules (or sets of rules, which we call institutions) economic. But to be economic, it is clear that the costs of these rules themselves cannot exceed the opportunity costs of the potentially foregone exchange or production. Furthermore, there is often more than one set of rules which will produce the desired social benefits. The problem lies in choosing the most economical set of rules from among a larger set of feasible rules.<sup>1</sup>

Commons (1923) looked upon these rules as reciprocal sets of rights and obligations. It is the assignment and enforcement of these rights and obligations to particular individuals or collections of individuals which has the effect of altering

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<sup>1</sup>The idea that social forms are selected with costs and benefits in mind has been clearly recognized by Barth, among others (1966:4).

behavior in the direction desired by policy.<sup>1</sup> But to be feasible (i.e., capable of preventing undesirable strategic behavior) whatever rules are chosen must be tailored to the context of the social problem. For example, rules or regulations well suited to sedentary creatures would probably be very inappropriate for highly migratory species.

In this light then, our dissatisfaction with the standard economic theory of fisheries lies primarily in the fact that these theorists consider only two institutional alternatives with regard to fisheries policy: namely, one may either abolish the root of the problem through the establishment of resource property rights or one may simulate the market result of resource property rights through the appropriate application of taxes and subsidies. From our point of view, these policy suggestions are not "wrong" per se, but have the effect of ignoring the crucial question and that is the choice of the most effective and economic sets of rules. In effect, standard theory poses the policy problem in terms of a choice between "no rules" and one of two very limited sets of rules. It is not surprising, given this artificial choice, that most economists automatically assume that the theory defined set of rules--called "limited entry" in the trade--is socially superior to no rules at all.

Actually, standard theory is very unclear as to what it means by resource property rights and, in particular, provides little or no guidance for the specification of these rights. We might suggest that what is implied but never articulated

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<sup>1</sup>In most situations, rules are not assigned to individuals. Rather the rules or social forms are generated through a process in which individuals change their strategies of interaction in response to the ploys of other individuals. The individuals involved, in other words, construct the rules of the games they play through repeated transactions over the course of time (see Barth 1966; Heath 1976: 64). In this sense, fisheries regulation involves a different process. Here, legislators and management agencies do play a large role in selecting rules (i.e. laws) constraining the choices of individuals in the fishing industry.



is simply a situation in which individual fishermen are constrained to behave in a way that is consistent with the socially efficient harvest of the resource. There is nothing at all wrong with this implied objective. What is problematical about it is that the vagueness or lack of definition of the term "resource property rights" obfuscates the economic policy problem. Generally it places economists in the position of not being able to recognize the very wide range of potential constraining rules capable of achieving a socially efficient solution to "overfishing." The exact rules or regulations formulated will vary from fishery to fishery.

In summary, accepted theory does not consider what might be termed "intermediate" systems of rights and obligations nor does it seriously consider the basic economic question of the social costs and benefits of any particular system of rights, duties, and obligations. Given the dichotomous policy choice presented by the theory, there is an almost universal presumption among economists that the social benefit/cost ratio of a property rights system or its simulation through taxes and subsidies will be relatively favorable. This appears to be the correct answer to an irrelevant question. A more fruitful question is: which of the potential sets of rules and regulations will produce the best social benefit/cost ratio?

#### D. Restatement of the Fisheries Problem

It should be noted that most current wild fisheries are not conducted in the absence of institutions which define and enforce rights and obligations. Observation of communities exploiting wild resources turns up many examples of "spontaneous" (i.e. market, not governmentally imposed) institutions whose purpose of to govern certain collective aspects of the activity. We have documented ten such instances in the New England fishery in the previous part of this volume (Part III, Chapter 5). Few, if any, of these institutions, however, are

explicitly designed for the purpose of conserving the resource. We are aware of a few instances--hunting and trapping in the Northern Maine woods, pre-colonial grazing practices in the Sahel (Hardin 1976), lobstering around certain Maine islands (Acheson 1975a; Wilson 1976)--in which institutions function to conserve resources and the people involved recognize this. Nevertheless, the much more prevalent situation is characterized by the absence of resource conserving institutions; it is the prevalence of these situations which has given rise to the perception of an endemic problem. However, the existence of institutions for the collective solution of other economic problems (and, in a few instances, conservation problems) suggests a refinement of the fundamental question about over-fishing: since fisheries resource conservation is so clearly a collective problem and since the groups engaged in the exploitation of these resources have shown the ability to create institutions for the solution of other collective problems, why is it that there are so few resource conserving institutions?

Our general model (see Part II) and the data on New England fisheries (Part III) suggest that several factors are involved in the formation of resource conserving institutions. First, we may note that institutions arise when the informational costs or uncertainties in the trading or competitive environment are too high to make exchange or production feasible. Second, we suggest that the particular institutional form chosen or evolved to facilitate exchange or production is determined by consensus (non-articulated) that arises among traders or competitors who confront similar types of uncertainty. Third, we suggest that the function of these institutions is to remove or reduce the uncertainties of trading or competition through the creation of behavioral rules which make the outcomes of individual transactions more predictable. Institutions also must involve a mechanism for the enforcement of

these behavioral rules. As we saw in the last chapter, enforcement is constantly a problem.

These four factors are suggested by our general model (Part II). Our analysis of ten existing fishing institutions (see Part III, Chapter 5) suggests that institutions will arise when transactions involve swapping entities of equal value, and when the people who bear the transaction costs reap the benefits. In addition, the span of the crucially necessary information network must encompass, at the least, all the individuals affected by or affecting the collective problem.

These notions about the necessary evolutionary conditions for the formation of institutions suggest several explanations why resource conserving institutions have not arisen in fisheries.

First, the span of the relevant information networks created by trading and competition, especially the latter, is typically not large enough to encompass the span of users of the resource itself.

Our second hypothesis is that conserving market institutions have not evolved because the requirement for repeated encounters with uncertainty under similar conditions is not easily met, given the complex biological nature of the fishery. Put differently, we have mentioned previously the great difficulty there is in determining causality in variations in the relative abundance of any given species of fish. This difficulty is encountered by scientists using the best data, theory and analytical techniques available. The relatively few instances of overfishing or dramatic declines in abundance which have been observed in any given fishery have been insufficient to give rise to a clear sense of causality among fishermen--much less a clear sense of what might be done to remedy the situation (Acheson 1980f). In the absence of any consensus about whether any overfishing problem even exists, it is

senseless to expect fishermen to evolve norms and institutions to solve such problems. The evolution of institutional structures takes time. The rate of evolution is probably closely related to the frequency with which very similar situations are encountered and a fishery does not give rise to frequent overfishing situations. It is only recently that we have become conscious of anything more than isolated instances of what appears to be overfishing.

Last, fisheries management involves foregoing present catches in the hope that future catches and incomes will be improved. It involves investment. The problem is that the rewards of management come, if at all, only years in the future. Under these circumstances, it is scarcely surprising that fishermen do not support rules to conserve the fisheries. The costs of such rules will be borne by them. The benefits will be shared with new entrants. They may even come at a time when current fishermen have left the fishery completely. Fishermen are acutely aware of these limitations (Acheson 1980f: 784 ).

#### E. Market Impairment in Complex Fisheries

Given these hypotheses about institutional evolution, what can be said about the nature of the market impairment in the fisheries? Traditionally, economists have tended to emphasize the impairment arising from potential reductions in stock which result from intergenerational effects of fishing activity (i.e., the so-called stock/recruitment problem). In addition to this longer term impairment, the literature also mentions the impairments that arise from short term competitive interactions (i.e., "crowding effects" and age of capture effects). In each case, what is meant by the impairment is an opportunity cost imposed upon society as a result of strategic behavior on the part of fishermen. The term impairment implies that there are opportunity costs that need not be borne by

society, provided better rules for the governance of fisheries can be found. In the immediately following section, we discuss the particular nature of these impairments with special reference to the Atlantic demersal fishery and the institutional policies implied by the peculiar nature of the impairments in the context of the unique circumstances of the fishery. The analysis treats these impairments as if they were inseparable, even though in an unregulated fishery, all these impairments are simply different manifestations of the same problem. However, from the point of view of ameliorative policy, it is possible to find rules which can solve one and not the other impairment. Also it should be noted that the reason for our use of the term impairment instead of externality, as is more common in the literature, is that the meaning of the term externality is derived from the notion that normal competitive behavior is not characterized by strategizing (i.e. the model of perfect competition). It should be clear from the preceding sections of this book that we consider strategizing, potentially degenerative competitive behavior, to be normal. Hence, the different term.

### E.1 Short-Term Competitive Interactions

The impairments arising from short-term strategic behavior by fishermen can generally be said to occur in two very distinct circumstances. On the one hand, there are gear conflicts or other forms of physical interference which arise because fishermen often find it advantageous to fish in very close proximity to one another. These conflicts can be seen most clearly, for example, when fixed gear (gillnet, longline, etc.) is used in the fishing operation. Often, the close proximity of one fisherman to another is an attempt by one to take advantage of the presumed greater knowledge of another regarding the location of fish. When this kind of imitative strategic behavior is carried to an extreme, the chances for physical

entanglement of the gear are high. This can mean loss of the gear of both fishermen, or, at the least, loss of time spent untangling the gear. It is rare for gear conflicts to arise except in cases where fixed gear is employed, and even in those instances the very nature of the problem--the close proximity of competitors, the clear losses in terms of gear or time, and the relatively straight-forward solution rules--is such that impairments of this sort can generally be solved by consensus of the involved parties. The northeast/southwest trap placement rule in the Casco Bay lobster fishery, the Rhode Island lobster lanes, and the weir-stop seine rules cited in the previous chapter are good examples of this kind of spontaneous institution. In short, problems of physical interference generally do not appear to be critical management problems because the conditions of their occurrence are generally sufficient for the evolution of "spontaneous" solution rules.

The other short-term competitive impairment ( "crowding" in the literature) concerns the reduced catch of one fisherman due to another fisherman's success. The range or span of this particular impairment would appear to depend in large part upon the mobility characteristics of the resource. For completely sedentary animals, the span of the problem is apparently relatively localized; a fisherman's activity in one location is not likely to affect the activity of a fisherman located elsewhere. One would expect this localization of the impairment to facilitate the growth of rules whenever it was felt that the opportunity costs of the impairment exceeded the cost of potential rules. This appears to be the case in the lobster fishery in which the territorial system operates to reduce entry and thus crowding (Acheson 1972, 1975a, 1980g; Wilson 1977).

In the case of the more mobile animals, however, one would expect the range of affected parties to exceed the span of

information networks created by competitive interactions. For example, mackerel fishermen who exploit the same stock of fish in the Mid-Atlantic Bight and off the Nova Scotia coast are unaware of each others' effects on the stock. They also have no information networks of the kind necessary for the establishment of ameliorating rules. The less mobile demersal fish probably present a case intermediate between the sedentary and highly mobile species.

Another aspect of the crowding impairment which may help explain the relative absence of spontaneous rules for its amelioration has to do with the severity of the social opportunity costs. This may be explained by reference to the differences between social and private efficiency caused by this competitive interaction (where we are using a very narrow definition of efficiency--catch per unit effort). For any particular boat, the most efficient situation is one in which there are no other boats in the fishery. Densities of fish would be greatest and catch per unit effort at a maximum in this circumstance. Nevertheless, this single boat will find that its own efficiency is affected by its own actions--the more it catches, the more it reduces the density of fish in the ocean and the lower will be its own efficiency. The addition of other vessels to the fishery will, of course, reduce the efficiency of the first and subsequent vessels. In fact, for any given rate of total catch, the same reduction in efficiency will take place regardless of the rules or institutions in place. The question, then, is where is the impairment? If this impairment is purely a physical phenomenon, no rule would appear to be able to ameliorate its effects.

The idea that there is an impairment lies in the presumption that rules can be devised to alter the total catch and thereby affect the extent to which these efficiency reductions take place. Traditional theory, in fact, proposes that the major difference between free entry and sole ownership is in

terms of differences in total output. The reason offered for this is that the sole owner is assumed able to perceive and react to the marginal efficiency effects of additional fishing units. Given prices in the market, he is then also assumed capable of equating marginal costs and revenues. This profit maximizing decision rule results in fewer boats and greater efficiency of each remaining boat. Whether this decision rule is capable of generating a net social gain or not depends, among other factors, upon the nature of the overall supply function in the fishery. Traditional theory assumes that at levels of exploitation at or beyond MSY (Maximum Sustainable Yield) the industry supply curve is vertical or backward bending. In these circumstances, the marginal value of the product of an additional vessel is not actually zero or negative. In effect, the opportunity cost to society arises when the value of the net addition to total catch of a new boat does not equal or exceed the value placed upon that additional catch by society (i.e. units of effort greater than that consistent with maximum economic yield).

In the kind of complex fishery we are concerned with, it is unlikely that limited entry rules can be developed which are economic from the point of view of the society as a whole. There are three reasons for this skepticism: First, the opportunity cost borne by society depends to a large extent upon the nature of the supply curve. The traditional presumption that this function is vertical or backward bending (and hence that there is a high social opportunity cost) is based upon a long run concept of equilibrium in which supply becomes a function of the stock/recruitment relationship in the fishery. Given the nature of the stock/recruitment relationships that appear to be found in complex fisheries, there is reason to doubt the validity of this presumption, at least above safe minimum population levels. Also, there is the question of whether it is the short or the long run supply function which



is pertinent to the determination of social opportunity costs. In the short run the fishery will always show an upward sloping supply function. So long as the choice of output in the short run does not impact upon output in the long run, the opportunity cost of crowding would be entirely short run and would not appear excessive. Hence, there is strong reason to believe that so long as safe minimum population levels are maintained or exceeded, there is little or no social cost in this respect to free entry.

Second, the economic value of the "marginal decision rule" must be judged not only in terms of its potential for reducing social opportunity costs, but also in terms of the costs of the rule itself. In this respect, those promoting the traditional argument are guilty of attributing costless omniscience to either the sole owner or the management authority which might be attempting to simulate the effects of sole ownership. Given the tremendous variation in the species composition from location to location, season to season, and year to year, highly variable species prices, and long lived capital equipment, the practical informational requirements facing the sole owner or management authority would appear to be extremely costly. Put differently, the ability to discern the marginal effect of an additional harvesting unit in these circumstances would be very low or exceedingly costly. In addition, one must also take into account the social costs incurred in the establishment of the institutional structure (e.g. limited entry) necessary for the implementation of the decision rule. Limited entry, after all, is not popular with the majority of fishermen (Acheson 1980f: 775ff).

Third, each additional vessel increases the efficiency of other vessels because it reduces the collective search costs. Knowledge of the locations of fish concentrations cannot be acquired by an individual acting entirely on his own. The

ocean is rather large, the distribution of fish very uneven, and the width of the search path of any single vessel is very narrow. Consequently, fishermen tend to rely upon one another for information about the results of each others' searches. As we have pointed out, there are basically two ways that search information flows through the fleet: (1) information is gained by observing fishing locations and catches; (2) information is exchanged verbally. The public reluctance of fishermen to discuss the success of their fishing operations gives the impression that involuntary information flows dominate because of the apparent barriers to the flow of information. This is only partially true. Most fishermen--especially those seeking mobile species--exchange a good deal of information with each other. In these arrangements with family members, close relatives, and good friends, fishermen share fairly detailed information about where the fish are, where the most promising search areas might be, and so on. The basis for the voluntary provision of competitively valuable information is the expectation of reciprocation at some time in the future. In the literature, there are numerous examples of such information-sharing agreements (e.g. Acheson 1980a: 442ff; Acheson and Lello 1980: 374; Wilson 1980; Orbach 1977: 104-133; Bort 1980; Andersen 1972).

From the economic point of view, these arrangements are significant not only because they offset the inefficiencies of greater numbers but also because admission to one of these information-sharing groups constitutes a significant barrier to successful entry into the fishery. That is, unless a fisherman can gain entry into an information-sharing arrangement, his chances of competitive success are considerably diminished. From the point of view of the magnitude of social opportunity costs, one is led to conclude that the existence of these arrangements would lead to fewer but more efficient boats than would otherwise be the case. In short, these practices of fishermen are entirely in accord with the policy direction implied by theory.

In summary, under the circumstances we assume are characteristic of a complex fishery, there does not appear to be a strong, a priori case for the existence of large, net, social opportunity costs arising from the strategic interactions among fishermen. (This stands in contrast with traditional fisheries theory.) Three factors lead us to this conclusion. First, costs to management of discovering and preventing the dis-economic impact of the marginal vessel are apt to be high. Second, the collective search arrangements among fishermen create barriers to entry and important economizing effects. Third, the crowding opportunity costs are likely to be limited to the short run, assuming that the current stock size does not fall below the safe minimum level.

In effect, complex fisheries do not appear, on their face, to present an instance of a highly impaired market. It is not at all clear that establishing property rights or its bureaucratic simulation would give rise to greater net social benefits than the current system of institutions. The practical management problem would appear to be whether the benefit-cost ratio of these rules devised by fishermen can be improved upon by the imposition of sole ownership or its bureaucratic simulation.

#### F. Age of Capture Impairments

In a sense, the age of capture impairment is a result of short-term competitive interaction also. Traditionally, however, it has been treated quite separately from the so-called "crowding problem."

The age of capture impairment stems from the fact that fish grow rapidly when young and slowly when old so that the biomass of any given year class of a species exhibits the same general growth patterns modified by the age specific mortality rate of the class. Given these differences in biomass growth

rates over time, it is felt that there should be an economically optimal time of harvest. A first approximation to the determination of this optimal time states that harvest should take place when the costs of waiting are no longer offset by the more rapid growth of the biomass (Clark 1976). As a practical matter, this notion of optimality has to be modified to take into account the imperfect mobility of capital and labor resources employed in the harvest, the imperfections in our knowledge of the location of the fish, our imperfect knowledge of actual growth rates which may vary by location and so forth, the presence of predators and prey, and finally, the fact that our technological ability to selectively harvest fish of only a certain given size is very limited. All these factors make it very difficult to identify the optimal period of harvest, as well as make it difficult to harvest the class in that period.

In a multiple species context, further complications enter regarding the actual or expected availability of substitute species. Put simply, the problem here is that the market exhibits a strong preference for stability of supply but tolerates some substitution among species. If no substitution were possible, the preference for stability of supply would cause the optimal period of harvest to become crucially dependent upon expectations regarding the time of arrival and size of new year classes in the fishery. Given the extreme variability in the strength of successive year classes, which appears to characterize most marine fish species, and the relatively short prediction horizon which is possible, an unambiguous analytical determination of the optimal timing of harvest in a single species context becomes virtually uneconomical not because the analytical technique is necessarily difficult, but because the cost of analytically relevant information is likely to be so high. In a multiple species fishery, the nature of both the analytical and

practical problem is changed markedly. At any given time there is always a greater expected probability of "good" year class among a number of species than there would be for a single species. This can be taken as simply a normal statistical phenomenon or, alternatively, as a result of the relative stability of the total system biomass noted earlier. Whatever the case may be, the result from the practical point of view is that the timing of the exploitation of a year class of any given species is less dependent upon expectations regarding the arrival of a new year class.

What species may happen to have good year classes and the relative prices of those species is another question, however. This aspect of a multiple fishery causes the analytical problem of the optimal economic timing of harvest to become exceedingly complex. On the other hand, given substitution in the market, the social opportunity costs of not achieving that optimum are minimal.

In spite of these problems with the determination of the optimal timing of harvests, one may logically argue that a formal set of rules cannot lead to timing the harvest for any defined optimum. This argument is very simple: in the absence of any rules, each fisherman has the incentive to catch fish before the other. This leads to harvesting the fish as early in their life as possible consistent with what is saleable in the market, with unfortunate results for the stocks and society as a whole. Consequently, the social opportunity cost of the "age of capture" impairment is the difference between the value of fish harvested under the "as early as possible" strategy and the value which could be obtained if formal rules were instituted to force fishermen to harvest the fish at some more optimal age. In sum, the management question is whether or not there exist economical rules for the reduction of this opportunity cost.

As mentioned, the feasible set of rules will depend upon the particular biological, technological, social, and economic context of the fishery. In a net fishery, such as the New England groundfishery, biological and technological factors severely limit the feasible techniques (and hence possible rules) which might be used to selectively harvest fish by size or age. Fish cannot be caught indiscriminately and then sorted by sizes after they are brought on board the vessel without creating extremely high mortality rates among the smaller fish.

Consequently, the size selection needs to take place while the fish are still in the water. There are basically only two imperfect ways in which this can be accomplished. First, the mesh size of nets (or hook size on a longline) can be chosen so that smaller fish stand a lower probability of capture. This is a far from foolproof technique. The greatest problem is that no small fish are released from otter trawls when the mesh of the net is already plugged by larger fish. In a multiple species fishery in which the optimal size of each species differs, it also requires a compromise mesh size based, for example, on the relative value of allowing each species to grow to a given size. Needless to say, the technological limitations of this method of size selection in a multiple species fishery considerably magnify the analytical problem of determining the optimal period of harvest. In a sense, mesh size is a relatively crude tool for influencing the timing of harvests. Consequently, not only is the cost of the analytical problem increased, but the practical ability to approximate the solution to the analytical problem is reduced by the technological attributes of the mesh size technique. From the point of view of management policy, these limitations reduce the potential benefits of using mesh size to regulate the timing of harvest. Whether the technique is capable of yielding a net gain from the fishery is likely to depend entirely upon how the particularistic aspects of the fishery

influence the benefits and costs of a mesh size rule.

The second way to size select fish is through the avoidance of congregations of small fish. In a multiple species fishery, this may be a very difficult procedure to follow because of the intermingling of small and large fish of the same and different species. With intermingling, an avoidance strategy--closing a geographical portion of the fishery--always carries with it a difficult problem: namely, when does the cost of foregoing the availability of large fish outweigh the benefit of avoiding small fish? Analytically, this is not a difficult problem. Given the relative price of the fish, expected growth and mortality rates, interest rates and catch per unit effort, a breakeven ratio of small and large fish can be calculated. The real problem is the informational one--what is the extent of intermingling? How does it vary as one moves across the bottom of the ocean? How does the mixing vary by species? Here again, feasible solution rules are likely to be totally dominated by the idiosyncratic characteristics of the resource. If, for some reason, small fish tend to congregate more or less separately from large fish and in relatively stable locations, the information problem is minimized and avoidance is clearly a viable means for size selections. To the extent that such clear size separations do not occur, the usefulness of area prohibitions for size selection is diminished. As with mesh size, the very particular attributes of the resource and the harvesting methods dominate the choice of appropriate rules for putting into effect an avoidance strategy (i.e., when, where, and for how long is avoidance appropriate?).

No matter what the institutional structure--sole ownership or government management--attempts to solve the age of capture problem will depend upon the implementation and enforcement of rules-of-thumb, based on compromise and imperfect information. The relevant policy problem lies in devising an appropriate

institutional structure which is capable of assimilating the idiosyncratic information about the fishery and reaching or deciding upon the relevant compromise rules-of-thumb.

An interesting question that occurs here is whether or not the appropriate rules need to be directed at the act of selection itself--i.e., specifying a particular mesh size or closed area--or whether rules can be devised which encourage individual fishermen to adopt the selection techniques most appropriate to the idiosyncratic conditions they happen to encounter in the process of harvesting. For example, what would be the effect of a simple "minimum size of landing" rule for each species? Is it possible that fishermen can devise their own selection techniques which at the same time do not confound the intent of the size rule? Would fishermen operating under this kind of regulation tend to fish indiscriminately, discarding under-sized (and dead) fish? Might they, for example, find that a large mesh size caught more larger fish and fewer smaller fish than a small mesh? This kind of "indirect" rule appears to have the advantage of simplicity and also maintains the fisherman's ability to adapt to resource idiosyncracies more than would a direct rule which specified a certain mesh size or closed area.

Whatever rule approach is eventually taken, the process of developing regulations is not likely to be analytically elegant but must be steeped in the very particularistic aspects of the fishery. This is absolutely crucial if anything near an optimum rule is to be implemented. In any case, it requires solid scientific work, especially on the more behavioral aspects of fish stocks, the fishermen, and the knowledge of fishermen regarding the stocks. In effect, the complexity of the fishery and the limitations in the feasible set of rules would appear to require an equally complex and diverse collective information and decision network.



### G. The Recruitment Impairment

The recruitment impairment arises from the possibility that fishing activity will lead to declines in the size of future generations (or year classes) of exploitable fish. This possibility is most easily illustrated in terms of the models that posit a continuous relationship between fishing effort and fish population size. The implied view of these models is that changes in current population size caused by fishing effort give rise to changes in egg production, and, depending upon food or some other limiting factor, an increase or decrease in the rate of recruitment or future population sizes. In the view of these models, a potentially large opportunity cost to society arises when current fishing effort is large enough to cause a decline in recruitment. The source of this opportunity cost, of course, is levels of fishing effort great than that necessary to maintain the population at a level consistent with maximum economic sustained yield from the fishery. In short, the models conclude that careful regulation of fishing effort is necessary to maintain populations at the level consistent with maximum economic yields.

In the kind of complex fishery we are dealing with, there is little, if any, evidence to demonstrate the existence of biological processes similar to those assumed by standard economic theory. (See, for example, Hennemuth 1979; Cushing 1977.) Biologists are beginning to suspect that there is almost no causal relationship (at least for practical purposes) between current fishing effort and future stock sizes except perhaps when fishing proceeds to the point where the current spawning population is driven to very low levels. This threshold level is currently not known. Above this minimum safe population level, the probability of spawning leading to a 'good' year class appears more or less independent of spawning population size; below, it appears that there is a reduced probability of a good year class. The management

implications of this kind of biological production function are important, especially when compared with the traditionally held view.

In terms of the potential social opportunity cost which might be borne in a completely unregulated fishery, this non-traditional view of the effort/recruitment relationship suggests that there is essentially no opportunity cost so long as current spawning populations are not fished to a point below the (uncertain) safe minimum level. In other words, above the safe minimum level we may still observe highly variable recruitment, but this variation is probably not due to factors related to the current size of the population. There is, in effect, no ability to exercise control over this variability (at least not through controls on fishing effort) and, hence, there is no rule which can be devised to achieve a better result. Below the safe minimum population size, however, there is clearly an opportunity cost related to the level of fishing effort; and an impairment exists. A set of rules to prevent this situation from arising could theoretically be developed. The biological production function assumed by most biologists suggests that the appropriate rules need to be directed at spawning as opposed to total stock size. Given the relationship between size of individual fish and maturity, the attainment of minimum safe spawning populations at the least requires size selectivity in harvest.<sup>1</sup>

The relevant management question here, as in all other cases, is whether or not an economical rule or set of rules from the social standpoint can be developed. The answer to this question depends upon the particular bioeconomic context of the fishery and the existing normative structure.

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<sup>1</sup>In this case, however, the objective of size selectivity is not some economically optimal timing of harvest, but rather the preservation of minimum spawning stock size.

## H. Application to the Atlantic Demersal Fishery

In this section, we outline the bioeconomic context relevant to the Atlantic demersal (i.e. groundfish) fishery and then discuss the set of formal and informal rules regulating relationships between fishermen and influencing their fishing effort.

From the viewpoint of management, the spawning stock/recruitment relationships cause a good deal of uncertainty--most importantly in the magnitude of the safe minimum population size. Because of this uncertainty, one of the first questions that needs to be asked is whether or not there are any existing mechanisms or rules that tend to divert effort away from or towards populations where spawning size is declining toward the safe minimum. The answer to this question is that few such rules exist in this fishery in contrast to the herring and lobster industries. In this regard, two separate points need to be made.

(1) The structure of the market itself could operate to limit effort on over-exploited species. It does not do so, however. The traditional economic argument is that below some 'unspecified' population size, effort targeted at a given species becomes uneconomic (except for a continuing by-catch). There is no a priori basis for determining whether this economic minimum population exceeds or is exceeded by the safe minimum spawning population size. Nevertheless, it is of some interest to consider those factors which might affect the level of the economic minimum.

In a multiple species context, the most important factor would appear to be the substitutability (i.e., price elasticity) of each species in the market. The importance of substitutability for management is illustrated most easily by reference to an extreme condition. Suppose, for example, that all species in the fishery were perfectly substitutable for one another in the market. Under these circumstances the species targeting of fishing effort would be purely according

to availability, which, presumably, would be strongly correlated with species abundance. In the best of all possible markets one would find that market forces effectively constrain fishing activity to maintain population above the safe minimum level. Unfortunately, the actual market for the fishery hardly behaves in this way. Price elasticities appear to be fairly high for some traditional white meat species, at least on an annual or longer term basis. However, there is only a very limited market for large numbers of species composing a significant proportion of the biomass (e.g. squid, whiting, etc.).

These problems appear to derive from the market structure (see Wilson 1980) which tends to restrict the geographical range of final consumption. This has the effect of closing off demand for many species regularly consumed outside this restricted geographical district. Needless to say, this lowers species substitutability at the ex-vessel level, which, in turn, exacerbates the long-term management problem. These same structural aspects of the market also tend to give rise to a relatively rigid (in terms of individual species) supply contract structure. The result is a relatively marked price inelasticity and highly volatile prices for almost all species in the short run. This contractual phenomenon presumably has the effect of retarding the fishery's response to the declining abundance of a given species, and, consequently, increasing the probability that any given species might be driven below safe minimum population levels.

Since these structural aspects of the market are themselves the result of significant impairments (Wilson 1980), the strong implication is that fisheries management problems may derive significantly not from behavioral impairments in the fishery itself, but from impairments in its associated markets. In other words, policy directed towards the removal of market impairments may have the effect of reducing the

opportunity costs of reduced recruitment.

(2) Size selectivity regulations and the competitive impediments to a free flow of search information could aid in maintaining safe minimum stock sizes. The size selectivity rules can increase the probability that each year class has a chance to spawn at least once. On the other hand, such rules would appear to be of reduced benefit if they do not also contribute to a higher probability of survival for fish above the mean age of selectivity. In other words, if the throw of the dice is such that the fishery experiences several successive poor year classes, recruitment becomes heavily dependent upon spawners from relatively old year classes. These fish have been vulnerable to fishing mortality over a long period of time. And it is reasonable to expect that in the absence of an intentional or unintentional mechanism for reserving a part of this population, it could become dangerously small. This outcome is likely to occur regardless of whether traditional regulatory mechanisms (i.e. quotas, mesh sizes, etc.) are in place or not.

This potential outcome suggests the need for a new rule or set of rules which would operate in such a way as to selectively maintain a small but significant population of older fish, more or less as a spawning stock reserve in the eventuality of successive poor or disastrous year classes. Other than the market induced tendencies to avoid the targeting of effort on small populations, there would appear to be few or no traditional rules appropriate to this particular problem. Two kinds of possible regulations which might achieve this end are permanent sanctuaries, and rules to protect very large fish. (The latter would be analagous to the law protecting lobsters in Maine over 5 inches on the carapace.)

The institutional structure of the fishery--and this we stress--is such that no rules to beneficially affect recruitment have had a chance to develop. The rules governments have employed or suggested--basically quotas and limitation

of effort--are the product of theoretical structures (i.e., dealing with the biological production function) which appear to be inconsistent with the statistical record of the fishery. The new theoretical structures that are emerging cast the recruitment problem in a slightly different light. They suggest that the most economical regulations from the standpoint of the society are those which can maintain a small, mature population distributed over several year classes.

### I. Conclusion

We have attempted in Part IV to outline what we feel is a relatively simple, socially economic approach to fisheries management. Our institutional or behavioral approach differs from the standard bio-economic approach in several important aspects. We do not see the fishing problem as different from any other problem of socio-economic organization. In all cases, human interactions in either exchange or production are subject to opportunities for individual gain which, in the absence of prohibitive rules, threaten to destroy the circumstances which give rise to the collective benefits of trade and specialization. "Overfishing" is clearly a collective problem of this sort. We propose that solutions are to be found in the application of rules which are closely tailored to the particular context of the problem. Furthermore, these rules are themselves costly, and in order for any rules to be socially economic, their cost must not exceed the social opportunity cost of the problem. In strong contrast to standard theory, there is no reason to believe on the basis of this approach that fisheries resource property rights, or their bureaucratic simulation, provide a clearly superior and socially economical institutional context for the management of fisheries.

The need to manage fisheries is scarcely new. The same problems and the same solutions have been discussed for close

to three centuries with little to show for it. In 1759, Hederström wrote:

"I wish to believe that with an increased knowledge about these matters [the growth rates of fish] at least some more reflecting husbandmen will be more prepared to spare the young fish until it has reached its full size. To these will belong especially those who are the owners of lakes and thus sole beneficiaries of their good economy. Also all persons who own shares in the same lakes and fishing waters ought to agree on the same economy with the small fish, both for their own and for society's common and great advantage in times to come. If this had been the case in the past, we would not now suffer from such a deficiency of fish and the lakes which otherwise might be such excellent, rich, and secure storerooms would not be empty." (Hederström 1759:229.)

If our work does nothing more than orient fisheries management efforts from focusing solely on property rights toward an analysis of all of the social and cultural forces that might be used in an effort to conserve fish stocks, it will have been of some use.

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