AN ABSTRACT OF THE THESIS OF

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Title: Strategy Selection in the Oregon Trawl Fisheries

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The ocean fishery is an example of a common property resource industry. Behavior of commercial fishermen is determined by a complex set of economic, environmental and social factors. All of these factors contribute to the individual fisherman's success.

Fishermen learn to cope with the variability inherent to their occupation. Two strategies are observed in fishing behavior: The specialist who operates exclusively in one fishery and the generalist who readily switches fisheries according to market, social or management considerations.

Traditional fishery models formulated to predict the behavior of fishermen have focused on the specialist. Smith and McKelvey (1986) and McKelvey (1983, 1987) have provided analyses to suggest these two fishing strategies may co-exist in a fluctuating environment.

The purpose of this study is to analyze the Oregon trawl fisheries for the presence of diversification in strategy selection.

To gather the data necessary for testing the hypotheses, interviews were conducted in the trawl fisheries of Oregon, June through December 1985. Three groups of fishermen are identified according to strategy selection. Nominal effort differences and capital-to-income ratios are examined for each strategy type.

Additional analysis is done to look at the components of income determination through regression analysis. Discriminant analysis is used to examine the fishermen's attitudes toward switching, risk and management concerns.

Among the findings of this research is that specialists and generalists do exist but they cannot adequately characterized by exclusively economic measures.

Attitudes shown on the part of the fishermen indicate they feel that management is a significant factor contributing to income variability and strategy selection.

Strategy Selection in the Oregon Trawl Fisheries

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CHAPTER I

INTRODUCTION

Behavior of commercial fishermen is determined by a complex set of economic, environmental and social factors. All of these factors contribute to the individual fisherman's success. Overuse and overcapitalization are often cited as the general trend in fisheries, primarily attributed to the unconstrained access to fishing opportunities. The ocean fishery as a common property resource is frequently cited as an example of economic inefficiency in production.

Insight and understanding of the incentives and motivational factors behind fishing behavior will enhance management decisions. Economic analysis has traditionally assumed homogeneous behavior of fishermen. A more thorough understanding of common property resources enhances management decisions and therefore benefits society in general.

Common property resources exist when conditions are such that private ownership is impractical, impossible or is not implemented. Traditional economic analysis suggests privatization as a solution to common property problems. Private ownership is not always a viable solution. Alternate ways of looking at and defining economic efficiency are necessary in the common property context.

The first major effort focusing on the construction of a bioeconomic model of the fishery was done by H. Scott Gordon (1954). Gordon asserts "proof" that the level of fishing effort which would maximize "net economic yield" was always less than that which would maximize sustained yield. Since this article appeared, much economic literature has appeared, expanding and enhancing his ideas. These ideas are the foundation of fisheries management today.

In addition to Gordon's "proof", traditional fishery literature states the consequences of open access to be (Carter, 1981):

1. A possible reduction of numbers of fish harvested on a sustained basis;

2. The possible deviation in length, weight and quality from the socially preferred characteristics.

3. The lack of cost effectiveness for any given level of harvest;

4. Potentially turbulent conflict among user groups;

5. Undesirable impacts on ecologically related species.

Additionally, it has been stated by economists, under conditions of open access, the rent will be totally dissipated. This is attributed to the renewing nature of the fish stock. More and more fishermen enter to capture a share of the rent until it is totally dissipated.

Inherent Variability and Strategy Selection

Because fishing is a precarious business, fishermen have had to learn how to cope with the variability inherent to the occupation. Two strategies have been observed in fishing behavior. The specialist who exclusively operates in one fishery and the generalist who readily switches fisheries according to market, social or management considerations. In reality one observes a graduation of the behavior.

Traditional fishery models formulated to predict the behavior of fishermen have focused on the specialist. Smith and McKelvey (1986) and McKelvey (1983, 1987) have provided an analysis suggesting these two fishing strategies may coexist in a fluctuating environment. McKelvey states:

> Traditionally fishing vessels have harvested a single species or aggregation, but now powerful multipurpose vessels have been introduced which switch targets as opportunities arise. These vessels represent an adaptation to the fluctuating environment: They give up efficiency of specialized operation for flexibility under changing conditions (McKelvey 1983).

This is consistent with theories of optimal foraging strategies in ecology and analogous to consumer behavior in neoclassical microeconomic theory (Rapport and Turner 1977).

Cody (1974) developed an ecological model focusing on the generalist versus specialist foraging strategies. A generalist is willing to consume all prey species encountered, with no preferences. The specialist consumes only maximum fitness-bearing prey. This theory additionally hypothesizes that as preferred prey decline relative to the predator population, the generalist strategy becomes more profitable. This is attributable to the increased costs associated with specialist behavior such as waiting time and search information.

In economics the issue of portfolio investment diversification is addressed by Samuelson (1967) and Levy (1979). Samuelson developed a general mathematical model in which he shows that portfolio diversification can yield a higher payoff. Through empirical studies, Levy has shown that diversification almost always pays, but the longer the time horizon the smaller is the merit of diversification. It is assumed that investors are risk averters. If investment is assumed to be for a short period of time (one year) the conclusions were reached that diversification does pay. For periods of longer than five years the results were not clear-cut. Analogous behavior in fishing strategies may occur when the choice is made between fisheries (diversification) or remaining a specialist, fishing only one fishery.

Objectives

The primary objective of this work is to enhance the understanding of the behavior of fishermen in the Oregon ground and shrimp fisheries. To fulfill this objective several hypotheses are presented for testing based on data gathered from the Oregon shrimp and ground fisheries.

These hypothesis follow from the McKelvey-Smith hypothesis that in strategy selection some fishermen select a single fishery while others prefer the flexibility of a diversified choice. The McKelvey-Smith model attempts to link the question of fishermen's behavior in coping with stochastic variation to an economic model for determining optimal effort in the exploitation of ocean fisheries.

The first task is to determine if there is a specialist-generalist dichotomy in the Oregon trawl fleet. After this determination is made, strategy-related differences in income-to-capital ratios are examined. Additionally this research looks to see if different strategies show differences in levels of nominal effort and if there are different factors contributing to the make-up of income.

The final task is to examine the possible attitudinal differences between groups.

Procedure

To accomplish the objectives set forth, this work will be divided into six additional chapters. Chapter II gives an overview of the commercial fishing industry in Oregon.

Chapter III looks at traditional fisheries economics and briefly discuss biological models. A section on the uncertainty in fisheries economics is include here.

Chapter IV presents the McKelvey-Smith model.

Chapter V examines the presence of specialists and generalists in the Oregon trawl fisheries. Nominal effort differences and income-to-capital ratios are also presented in this chapter.

Chapter VI presents the results of income determination in strategy selection and attitudinal differences.

The final chapter, Chapter VII, presents the summary and conclusions related to this thesis.

CHAPTER II

COMMERCIAL FISHING IN OREGON

The trawl fishermen interviewed need to be put in the context of Oregon commercial fisheries. Background on the range of commercial fishing activities and the alternatives of the trawlers show that trawling requires large vessels and investment. An overview of all major commercial fishing activities in Oregon is presented followed by a section on the history of the trawl and shrimp fisheries in Oregon. Detailed information on the fisheries can be found in the Fishery Management Plans of the Pacific Fishery Management Council.

The Interview: Gathering Data

A sample was selected from the population of Oregon trawl fishermen. Approximately 300 vessels participated in these fisheries during 1985. The objective of this procedure was to create a sample that reflected the composition of these fisheries in Oregon. The data gathered were cross sectional.

The initial draw consisted of 81 vessel owners. Of this sample, 52 interviews were completed or 64 percent of the original draw. Of the 29 vessels not interviewed, ten were untraceable with no information available. Two of the vessels had sunk within the previous year, five had been sold and were no longer in the area. Six vessels were deleted because they were unavailable. Six owners refused to be interviewed. An additional 16 replacement interviews were conducted for a total of 68 interviews.

The interviews were conducted in July through December 1986. The interview consisted of 17 questions, each with multiple parts. The interview form is found in Appendix A.

The Commercial Fishing Industry of Oregon: A Composite

The rugged coastline of Oregon spans nearly 300 miles. The mountains of the Coast Range end where the beaches begin. Much of the range is made up of dense temperate rainforest. The ocean floor off the coast of Oregon tends to be flat with a narrow continental shelf. Many of the harbors are bar harbors. Most of the potential dangers inherent to bar harbors have been reduced by modifications of the natural configuration of the harbors through jetty construction and channeling (Stephenson 1980).

Between 75 and 88 percent of all Oregon fish landings in the period between 1975 and 1981 came from the ports of Astoria, Newport, and Coos Bay. Brookings, Garibaldi, Port Orford, and Winchester Bay account for the remaining percentage (Hanna 1987).

Salmon, Dungeness crab, albacore, shrimp, groundfish and the widow rockfish trawl fisheries are the major fisheries in Oregon.

The Dungeness crab fishery is currently in operation from December 1 through August 14. Regulations restrict gear usage to pots. Most crabs are captured in the ocean, in December and January. A small scale fishery exists in some of the larger bays.

The salmon fishery is characterized by diversity in gear types and extensive regulations. Chinook and coho salmon are the predominant species caught, though chum, pink and sockeye salmon have been commercially fished in the past (Carter 1981).

The albacore fishery in Oregon has declined significantly since the late 1970s. Albacore is a highly migratory, pelagic species of fish appearing off the Oregon coast for several months beginning in the late summer.

The groundfish complex along with the roundfish complex are comprised of a significant number of species. A data base of 78 species is recorded by the Oregon Department of Fish and Wildlife (Hanna 1987). Table 1 shows the most heavily fished species. A diversity of gear is used in this fishery. The predominant gear type found is otter trawl nets. In addition pots, jig gear and longlines are used.

Table 1. Common and Scientific Names of the More Frequently Exploited Fish in Oregon.[a]

Roundfish	
Lingcod	Ophiodon elongatus
Pacific cod	Gadus macrocephalus
Sablefish (Black cod)	Anoplopoma fimbria
Rockfish	
Pacific ocean perch (POP)	Sebastes alutus
Rockfish (Sebastes, all but POP)	Sebastes complex
Flatfish	
Dover sole	Microstomus pacificus
English sole	Parophrys vetelus
Pacific sanddab	Citharichthys sordidus
Petrale sole	Eopsetta jordani
Rex sole	Glyptocephalus zachirus
Sand sole	Psettichthys melanostictus
Starry flounder	Plafichthys stellatus
Ocean pink shrimp	Pandalus jordani

a/ Adapted from Hanna 1987.

The shrimp fishery is the most recent established fishery in Oregon (1957). Trawl nets are used in this fishery and the boats are either single or double rigged. A system of permits was established in 1980. At the time the system was instituted anyone who had landed at least 5000 pounds of shrimp in Oregon between January of 1974 and January of 1979 was eligible to buy a permit. If a boat was under construction during 1978-79 for the purpose of shrimping, this vessel was also eligible to purchase a permit. Currently a moratorium exists on the issuance of shrimp permits in Oregon.

Table 2 shows the numbers of licensed fishermen operating in Oregon in the years 1976 through 1986.

The Oregon Trawl Fleet

The first recorded attempt at trawling in Oregon was over 100 years ago. In 1884 through 1886 and again in 1888 several boats successfully used the beam trawl. Due to the lack of markets and the loss of one of the vessels none of these ventures proved successful (Harry and Morgan 1963).

Otter trawl nets were introduced to fishermen in Oregon in 1908 (Pacific Fisherman, June 1908). In September of the same year the magazine devoted space to this new gear type. This is currently the only type of trawl used in Oregon. The other two types of trawl gear previously used in Oregon waters are the paranzella and beam trawls.

Table 2. Type and Number of Commercial Fishing Licenses Issued, 1976-86.[a]

Type	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Albacore Tuna Landing	202	164	179	147	134	223	87	105	81	51	
Bait Fishing	39	52	64	55	72	112	91	96	97	117	
Boat	3452	4095	4359	4263	4928	4575	4231	3966	2078	3072	3072[c]
Individual Fishing	5990	7980	8566	8258	8383	8008	7449	6853	3946	5982	6330[c]
Single Delivery	88	66	77	55	224	196	109	85	113	165	
Gillnet	--	--	730	815	571[b]	534[b]	511[b]	475[b]	436[b]	370[b]	
Scallop Permit	--	--	--	--	--	196	164	144	134	101	
Shrimp Permit	--	--	--	--	373	295	268	234	209	173	
Troll Permit	--	--	--	--	4311	3926	3646	3439	3203	2735	

a/ Oregon Department of Fish and Wildlife Summary files.

b/ Gillnet permit.

c/ Preliminary.

The paranzella net, bag shaped, is pulled through the water by two vessels. The beam trawl is pulled by a single fishing boat where a rigid horizontal beam holds open the mouth of the trawl. In contrast the otter trawl net is held open by two boards at the mouth of the net which flare out as the vessel pulls the net through the water.

Unsuccessful attempts at establishing a trawl fishery in Oregon continued through the 1930s. The lack of a substantial market was the primary cause of the failure coupled with the decline in the stock of sardines on the west coast.

The true beginning of the trawl fleet in Oregon came as a result of the demand for vitamin A. The Booth Fisheries, in Washington, bought halibut livers for the pharmaceutical companies of Abbott and Parke-Davis at 12 cents per pound (Pacific Fisherman, August 1952). Supplies had been cut off because of the war in Europe. Prior to World War II the United States had been supplied with cheaper foreign fish livers and oils. Both dogfish shark and soupfin shark were found in abundance off the Oregon coast, a ready source for vitamin A.

About two million pounds of dogfish shark were landed at Astoria in 1940. This came from approximately 20 boats. In 1945, 73 trawlers landed about 26 million pounds of bottomfish to Oregon ports. This included all bottom fish landings (Harry and Morgan 1963).

The end of the war, coupled with synthetic processing of Vitamin A, brought about a significant decline in the fleet. In 1953 only 44 vessels trawled, landing 15 million pounds of groundfish. Approximately ten million pounds of this was for human consumption with the remaining five million pounds used for animal (primarily mink) feed. Many of the vessels that had previously been part of the groundfisheries fleet during the war converted to the crab, salmon, and tuna fisheries.

It was not until 1960 that quantities of fish landed for human consumption reached the levels that had existed during WWII. More than half of the total catch of bottom fish in 1957 was bought for mink feed (Jones and Harry 1961). Table 3 shows the groundfish and shrimp landings since 1956.

Technological progress has continued to occur in the trawl fleet since the introduction of the otter trawl in 1908. In an attempt to make the trawler more efficient, more instrumentation has been added. Among these are sonars, radios, fathometers, lorans, and various types of fish finders.

Various types of trawl nets are now used according to what type of species is being targeted. Combination trawls are now commonly found on vessels so a switch can be readily made from flatfish gear to roller gear while at sea (Carter 1982). The flatfish gear is used for species that

Table 3. Groundfish and Shrimp Landings in Oregon, 1955-1986.[a]

Year	Groundfish (pounds)	Shrimp (pounds)
1986	54,869,748	33,857,467
1985	64,693,503	14,855,247
1984	63,245,014	4,843,571
1983	78,151,779	6,547,073
1982	90,690,217	18,461,988
1981	82,502,220	25,923,589
1980	63,661,111	30,152,030
1979	64,383,974	29,586,586
1978	37,056,208	56,666,109
1977	23,365,634	48,580,070
1976	26,929,976	25.456,007
1975	21,023,739	24,083,568
1974	22,097,723	20,313,760
1973	21,944,140	24,517,194
1972	22,801,367	20,731,151
1971	22,039,881	9,075,006
1970	21,392,381	13,572,174
1969	23,243,151	10,268,433
1968	22,436,252	10,858,975
1967	22,381,920	10,155,251
1966	26,757,968	4,684,548
1965	33,320,192	1,575,152
1964	31,972,035	5,279,494
1963	31,353,101	3,027,746
1962	32,929,371	2,777,023
1961	27,781,671	1,452,099
1960	27,378,424	1,148,797
1959	25,398,092	2,734,193
1958	23,161,126	1,751,618
1957	26,980,622	495,388
1956	26,720,563	6,320
1955	21,224,013	----

a/ Oregon Department of Fish and Wildlife.

are commonly found close to sandy smooth bottoms. Roller gear is used for fish found among rocker bottoms.

As a result of technological innovation, midwater trawling was introduced in Oregon waters ten years ago. According to Pacific Fishing magazine (August 1987):

> The big breakthrough came with the invention of the net sounder. An echosounder transducer was mounted in the center of the headrope and connected to the boat via a long electric cable. The pulse of sound from the transducer would first echo back from any fish under the head rope then echo back from the footrope and finally from the seabed. The accurate measurements obtained allowed the skipper to fly the net at an exact depth above the bottom, and to check net performance from the headrope and the footrope. Catch rates could be estimated from the number of fish echoes in the net mouth (pp. 33-34).

A significant financial outlay is necessary for conversion to midwater trawl. Typically this involves the purchase of new sonars, netsounder, and hydraulic auto tension winches along with a number of trawls at $20,000 each. Conversions of this type typically cost upwards of one-half million dollars (Pacific Fishing, August 1987).

With the arrival of midwater trawling gear came the entrance into the market of the widow rock fish. This new gear type coupled with the new electronics, essentially created a new fishery. "Brownies," as widows are commonly called, are part of the Sebastes complex. The scientific name is *Sebastes entomelas*. This species is the primary target of midwater trawls. Between 1979 and 1981 an increase of 30 percent occurred in total trawl landings on the west coast, largely as a result of the strength of widow rock fish landings (Pacific Fishing, November 1982). Figure 1 graphically illustrates both total groundfish and shrimp landings between 1955 and 1986.

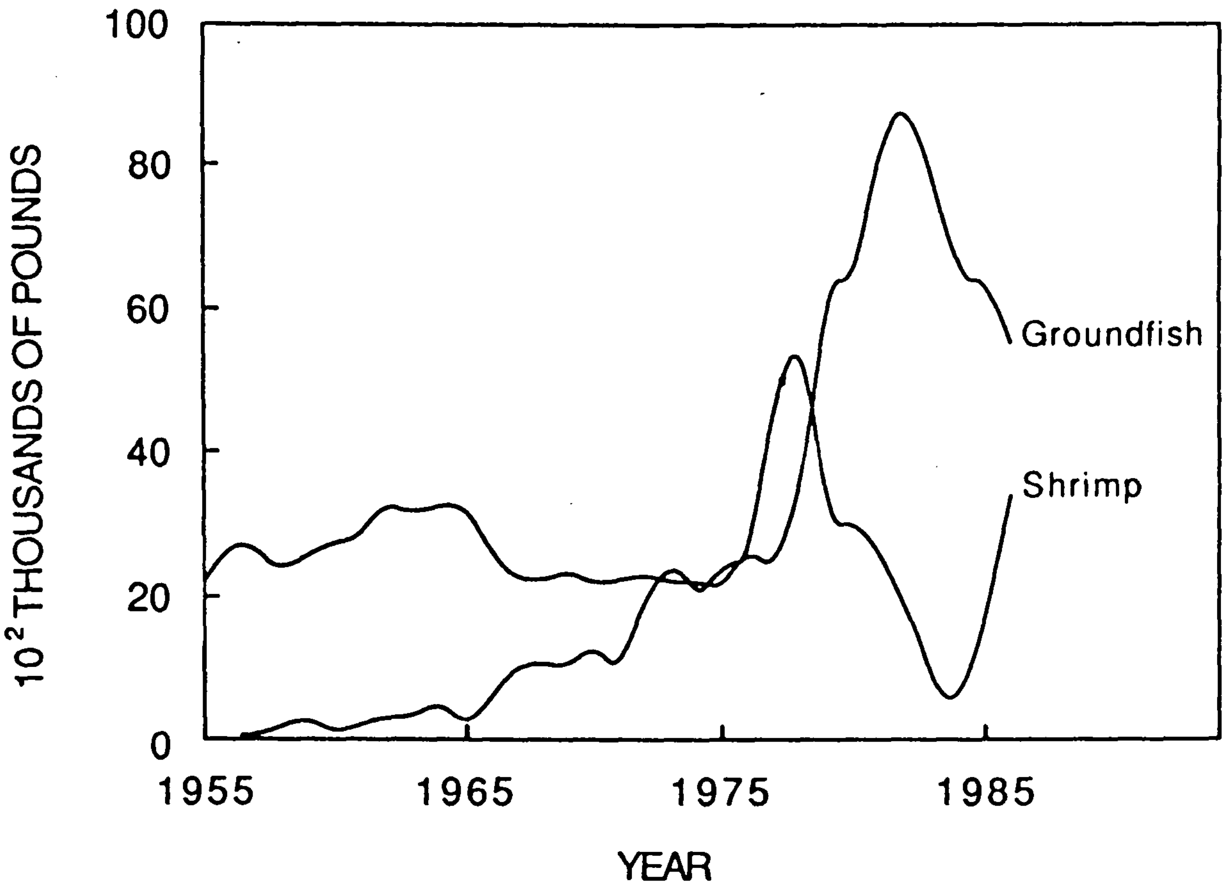
Growing concern for this resource, which was virtually untouched until the late 1970s, caused the Pacific Fishery Management Council to cut the optimum yield (OY) over several years. The acceptable biological catch (ABC) for 1987 is 12,500 metric tons (MT), down from a high in 1981 of 27,691 MT. The acceptable biological catch is determined by a regulating group to be the amount of fish landings that will maintain the optimum yield. This will vary from species to species.

In 1981 midwater trawlers landed 41 percent of the groundfish catch, 23 percent in 1982 and only five percent in 1983. In 1981 an average of $10,675 was made per trip. This decreased to $8,000 in 1982 and was only $4,500 in 1983 (Pacific Fishing, 1984 Yearbook). These are gross earnings.

At the peak of widow rockfish fishing, 70 percent of the landings came from the large midwater trawlers. Seventy percent of the fish landed by these vessels were brownies.

Due to the decreasing size of trip limits many of these large midwater trawl vessels were effectively barred

FIGURE 1
OREGON SHRIMP AND GROUND FISH
1955 - 1986



Source: Data from ODF&W summary files

from fishing in the Oregon trawl fishery. As an alternative, many of these fishing boats turned to joint venture (JV) fishing operations. The joint venture fishery is a domestic fishery in which U.S. trawl vessels deliver their catch to foreign processing vessels at sea. Currently some of these vessels engage in joint venture contracting in the Bering Sea for six months out of the year then will fish in Oregon waters several of the remaining months.

Pacific whiting, or more commonly called hake, is the primary species caught in joint venture operations. According to the Pacific Fishery Management Council (1986) just over half of the total whiting quota between 1978-85 has been landed. In a very limited way joint venture operations began in 1978 in conjunction with Soviet and Korean partners. In the December 1985 issue of Pacific Fishing, 16 joint venture companies were listed and it was noted that two additional companies declined inclusion in the directory. In an earlier article (Pacific Fishing, 1982) it was stated:

> The joint venture argument has an irrefutable logic. There is an excess of modern, high priced and often heavily mortgaged fishing vessels on the coast, along with a growing constituency of loudly complaining fishermen who can't find room in the traditional fisheries. The nation controls millions of tons of fish it can neither process nor consume. The rest of the world, meanwhile, had an insatiable appetite for fish and a surfeit of floating fish factories that have been idled by the advent of the 200-mile limits (p. 33).

Despite its potential, the joint venture fishery has been plagued by political, economic, and factional obstacles (Pacific Fishing, January 1982). More recently (Pacific Fishing, December 1985) it was stated that the outlook for joint ventures is "confused".

Currently the outlook for the Oregon groundfisheries is one of stability. Fewer vessel foreclosures have occurred in the past two years than in the previous four years. Fuel prices have dropped and there have been no significant cuts in quotas. Marketing by fish associations has been strong and has supported increases in ex-vessel prices (Pacific Fishing, 1987 Yearbook).

The Shrimp Fleet

A few small scale shrimp fishing operations existed along the western coast of the United States prior to 1957 but none existed in Oregon. The breakthrough in price and production came with the introduction of an automatic peeler (Pacific Fishing, May 1981). The first shrimp processing plant in Oregon was located in Warrenton.

Though somewhat less than one-half million pounds of shrimp was landed in 1957, 1958 marked the true beginning of the shrimp fishery in Oregon. Initially no seasonal regulations were imposed but gear was restricted to the beam trawl in an attempt to minimize incidental catch. This restriction was rescinded in late 1957. Effective beginning in 1965, the Oregon Fish Commission (currently the Oregon Department of Fish and Wildlife) established an open season from March 1 to October 31. In 1972 the season was changed to April 1 to October 15 and again in 1980 was changed to run from April 1 to October 31.

Improved technology has contributed to the shrimp fishery. The introduction of double-rigged vessels to the Oregon shrimp fleet in 1969 gave added flexibility in seeking shrimp. In 1966 new processing plants facilitated increased landings (Zirges and Robinson 1980; Pacific Fishing, May 1981). Table 3 shows shrimp landings since the beginning of the shrimp fishery in 1956 through 1986.

The period from 1981 through 1984 showed serious declines in landings each year (see Table 3). Multiple factors are cited for this decline. Poor predicted survival of the 1981 and 1982 year classes, poor upwelling and an abundance of hake all seem to have contributed to the decline in landings. The effects of the El Nino of 1983 cannot be separated out, but there is no doubt it was an additional factor. In 1983 along with the sharp drop in landings came an small price increase which meant a 45 percent decline in total ex-vessel value on the west coast (Pacific Fishing, April 1984).

Recovery began in the Oregon shrimp fishery in 1985 with increased ex-vessel prices and an increase in landings of almost ten million pounds. This trend continued into the 1986 season where total landing in Oregon more than doubled to 34 million pounds. The 1987 season began with an ex-vessel price higher than the ending price of the 1986 season and continued high landings. While the ex-vessel price has since dropped, continued availability of stock off the Oregon coast will help to insure a reasonable season for 1987.

Characteristics of Fishermen Surveyed

The fishermen interviewed in this sample are a young group. Sixty-nine percent are under the age of 45. Twenty-one percent are between the age of 46 and 55, 10 percent are between the age of 56 and 65. No one surveyed was older than 65. The average years of experience for this group is 19.2 years. Forty-seven percent of this group had either a father or a step father who fished. An additional three percent had another family member who fished.

A range of educational backgrounds is characteristic of this group. Ten percent of the fishermen surveyed had a bachelors degree or above. Only two of the fishermen had not completed high school and both of these individuals were in the highest age group. Twenty-six percent of the group had had some college education and another 18 percent had some vocational, technical or community college training. Forty-seven percent had completed high school.

There is a strong commitment to fishing among this group. Forty-three percent said they would continue fishing "till I die" or "forever". Forty-four said they would continue until retirement.

The responses to two additional questions asked in the interview process support this commitment. When asked, "If fishing is bad, what do you do to make up lost income?", 68 percent responded either "nothing" or "fish harder". Only two (four percent) responded "go to the bank". Only seven percent said they would try another fishery or cut costs (nine percent).

When asked, "What would you do if you could no longer work as a commercial fisherman?", 43 percent said they had never thought about it. Thirty-eight percent of the fishermen did mention an alternate occupation but not all of them were trained in the occupation mentioned. Three percent said they would retire and 16 percent said they would engage in a fishing related occupation.

Sampling Similarities

A study conducted on technical innovation in the Pacific coast trawl fleet through the Sea Grant extension program at the University of California-Davis, indicates similar responses to some of the questions asked of the Oregon fishermen (Dewees 1987).

For this study a sample of 150 owners of trawl vessels was selected from fishery management agency license lists with home ports between Santa Barbara, California, and Newport, Oregon. Eighty-three fishermen were surveyed.

A comparison of some of the personal characteristics found in both surveys shows some similarity. It is difficult to present an exact comparison because measurement was done in different ways. A range estimate was used for age and education in Oregon. The Pacific coast survey asked for point information.

The average years of education in the Pacific coast survey was 12.46 years. In Oregon 44 percent of the fishermen surveyed had completed high school, three percent had not completed high school and the remaining 53 percent had education past the high school level.

Experience and familial ties were quite similar between the two groups. Thirty-nine percent of the Pacific coast fishermen had fathers who fished. In Oregon it was 43 percent. The Pacific coast fishermen showed just over 18 years of experience; Oregon fishermen had just over 19 years of experience. The average age of the fishermen in the Pacific coast survey was 46.43 years. In the group of Oregon fishermen the modal age group was between 35 and 44 years of age.

A distinct difference between the two groups is in the market value of the vessels. The average value of the

Oregon vessels is 66 percent of the Pacific coast vessels. The Pacific coast survey was done in 1984 and the Oregon survey was done in 1986. This may account for some of the difference in the market value of the vessels. Fleet expansion had been encouraged through the easy availability of federal loans during the late 1970s (Dewees 1987). It may be that an excess supply of boats contributed to lower boat values after the fleet size began to decline.

A second possible explanation is that California boats are included in the Pacific coast survey. A higher cost of living may be reflected in the higher boat values. Higher labor and materials costs could be reflected through the manufacturing process and reflected in a higher selling price.

The comparison of some of the characteristics of the fishermen surveyed in these two studies gives some insight into the validity of the sampling procedure used in the Oregon study.

CHAPTER III

FISHERIES ECONOMICS

This chapter summarizes economic theory as applied to fisheries. It is not an exhaustive presentation of all fisheries models, but is intended to set the stage for use of the questionnaire data to test some of these ideas.

The static model will be presented in some detail in the first section. This model was first presented by H. Scott Gordon in 1954.

The second section of this chapter presents some of the literature on dynamic models of fisheries economics. The final section of this chapter as a natural extension will present a brief review of uncertainty as it is related to the fishery.

The Static Model: H. Scott Gordon

H. Scott Gordon's (1954) economic model of the fishery is the base from which most economic analysis begins. Gordon's model combines the equilibrium yield concept with an economic theory of competitive fishing. This follows from the neoclassical theory of the firm.

In this model, price is assumed to be fixed and the cost of fishing is assumed to be proportional to fishing effort. This yields:

$$TR = P * Y = P * L(f)$$

where L(f) is the aggregate yield of the fishery. P is the selling or ex-vessel price and is assumed to be constant. TR is the total revenue. The total cost equation is:

$$TC = C * L(f)$$

where effort is assumed to be proportional to the number of fishermen and vessels operating in the fishery. The cost curve is a straight line indicating that the cost for the entire fishery increases in direct proportion to the effort.

The concept of effort is not clear cut. Gordon summarily speaks of it as fishing intensity or "fishing effort". In actuality fishing effort is an aggregate or index of many different inputs: time, different types of capital, skill, fishing power, etc. Given these different inputs it is easy to see that effort is difficult to both observe and quantify.

One way to look at effort is to think of it as the effect of the factors of production that are applied to a given stock of fish. The exact formulation will depend upon the inherent biological and economic characteristic of each fishery.

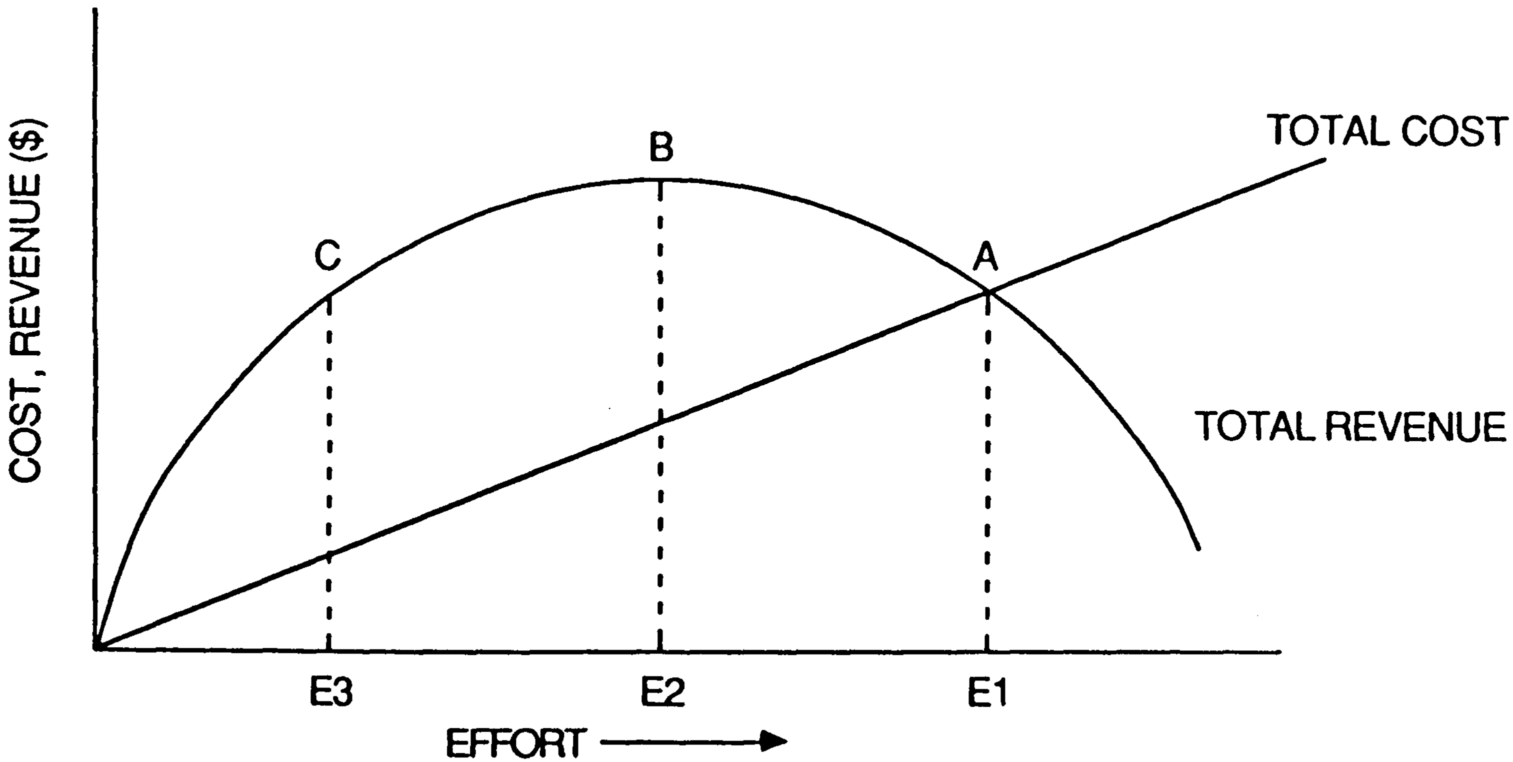
The constant cost per unit of effort includes the opportunity cost of labor and capital along with the cost of all other inputs. The profit or the equilibrium net revenue generated by any given level of effort is equal to the vertical distance between the total revenue and total cost curves.

An industry, using the usual neoclassical assumptions, will expand or contract until the long run equilibrium profits are zero. This follows from the point at which the intersection of the demand curve and the long-run supply curve occur. If this occurs at a point (price) where capital and labor are earning returns in excess of normal profits new fishermen may be induced to enter. The assumption of free entry or exit in the neoclassical model guarantees this. The quantity supplied by the new fishermen will add to the already existing quantity supplied, resulting in a shift out in the long run supply curve. This will drive long-run profits to zero. In turn, the industry will contract if returns are less than the opportunity costs associated with the employed capital and labor. It is at point A in Figure 2, (adapted from Gordon), that the returns are equal to the opportunity costs associated with the employed labor and capital. This is attributed to the open access or common property nature of the fishery.1/

1/ When a common property resource exists, the interest of the private individual is not the same as the interest of society. The private cost incurred by the individual fisherman is less than the social cost. The cost to catch another fish is the amount of effort used in the current period. This is the opportunity cost of his effort. The loss to future generations is not considered because a fish was caught today. The cost to society is both the opportunity cost of the effort used in the current period and the present value of the loss to any future generations. Private and social costs are not equal. This is why the common property resource must be managed (Fisher 1981, Tietenberg 1984).

FIGURE 2

STATIC OPTIMIZATION



A: BIONOMIC EQUILIBRIUM

B: MAXIMUM SUSTAINABLE YIELD

C: MAXIMUM ECONOMIC YIELD

The optimal level of fishing effort is at point B where sustainable resource rent is maximized.

Two extreme examples, where no industry would exist, are in the case where the costs are so high as to prevent the total cost curve from intersecting the total revenue curve. No fishing effort would be expended at this point. The only place an intersection would occur, in this case, is at the origin. The second extreme case, where no industry would exist, is where the price of fish is so low that it causes the the total revenue curve to be entirely below the total cost curve.

An alternative explanation is shown in Figure 3. In this figure, adapted from Gordon, it can be seen that the average revenue earned per unit effort declines as the effort increases. Another way of stating this is that the catch per effort declines as the effort increases. This is represented by U. U is the aggregate yield divided by effort.

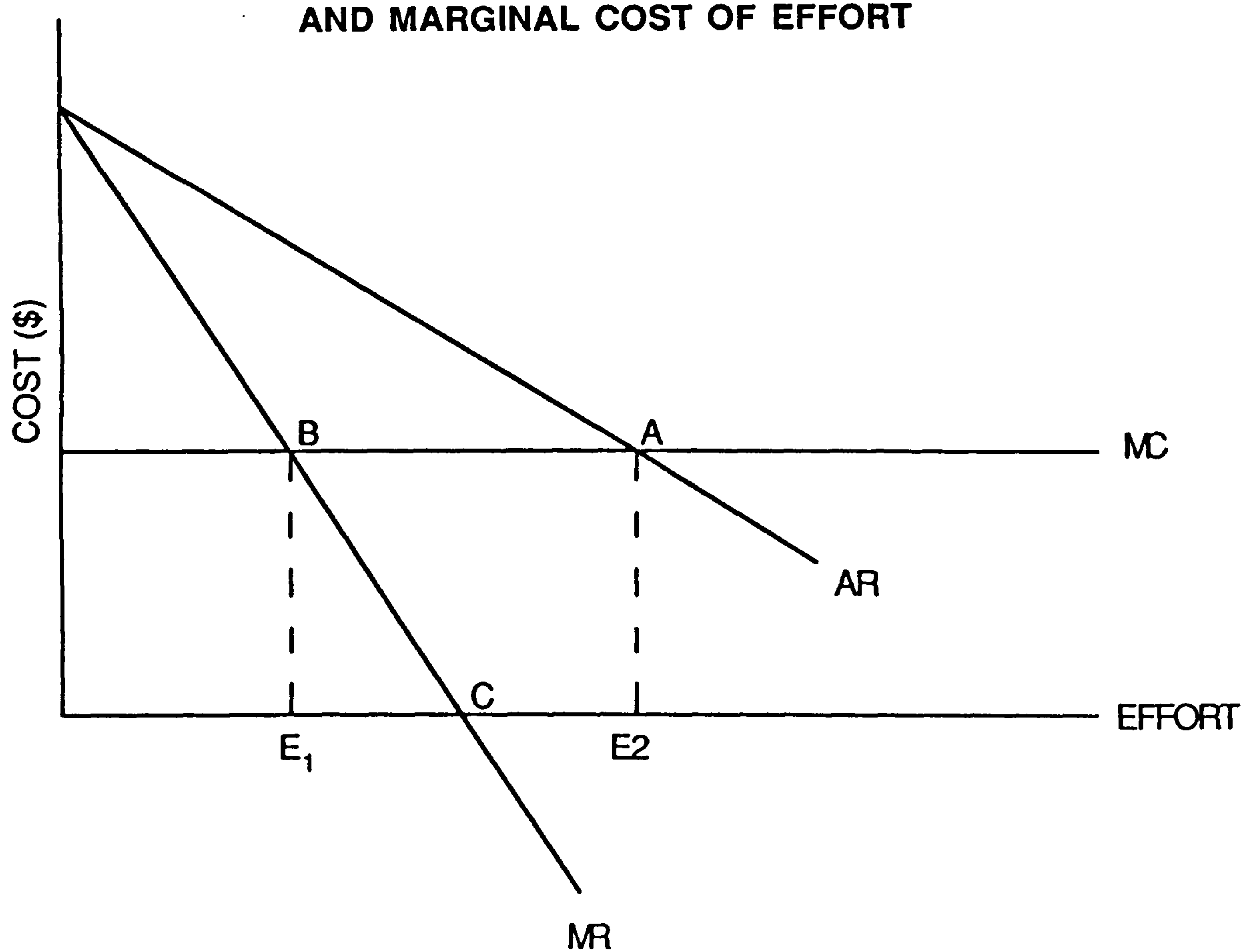
$$AR = P * U = P * L(f)/f$$

and where the marginal revenue of effort is given as:

$$MR = dTR/df = P * L'(f)$$

As the effort is increased, shown along the horizontal axis, the MR declines continuously becoming negative after C.

FIGURE 3
AVERAGE REVENUE, MARGINAL REVENUE AND MARGINAL COST OF EFFORT



The competitive industry will expand to E2 where average revenue just covers marginal cost per unit of effort which is equal to average cost. The point at which the sustainable resource rent will be maximized, analogous to point C in Figure 2, is at point E1.

This model has been used extensively to explain the effects of commercial utilization of the fishery. More complex models have been developed to describe optimal harvest policies under biologically and economically dynamic conditions. After a brief digression to present some aspects of the physical basis of a fishery, extensions of the Gordon model will be discussed.

The Physical Basis of a Fishery: Biological Yield Functions

M. B. Schaefer (1957) developed a biological yield function following a sigmoid curve relationship. This yield-effort function is the basis of the preceding economic analysis. This model is static in nature and based on the assumption that for each level of fishing effort the size of the fish population and the output will tend toward a stable equilibrium. This biological model is adequate for explanatory purposes, but the long run economic characteristics do not address the diversity of different ecological systems that fish inhabit.

The steady-state yields of a fish stock are determined by four factors: individual growth rates; recruitment of new individuals to the fishable stock; natural environment mortality; and fishing mortality (Cruthchfield and Pontecorvo 1969).

The point where marginal increments from growth and recruitment are precisely offset by the decline in the population due to natural mortality and human predation is the point at which the long term equilibrium will be reached. Schaefer states:

> An outstanding characteristic of populations of fishes and other natural populations of organisms is that they tend to remain in dynamic balance. When, however, the percentage rate of loss is increased, decreasing the size of the population from whatever cause, the percentage rate of renewal must increase also so that the population again comes into balance (1957, p. 672).

From this, it then follow that there will be a schedule of fishing yields related to each level of the population from zero to an environmental maximum. Equilibrium is reached where the catch equals the rate of natural increase in biomass. It is from these relationships that Schaefer derived this yield function.

$$L = k_2 E (M - k_2/k_1 E)$$

where L is landings, E is fishing effort, M is maximum population, and k_1 and k_2 are constants.

The model is shown graphically in Figure 4. The sustained yield curve has the same shape as the total revenue curve because, as assumed above, the fish price is constant. Total revenue therefore varies directly with catch.

Because any point on the sustained yield curve is a biological equilibrium, any given yield is an equilibrium in both the economic and biological sense and can be called a bionomic equilibrium. Unless the circumstance arises where price or cost changes occur, the level of effort will not change, and with effort held constant the fish population will remain unchanged.

An alternative biological model, the eumetric yield curve, is a curve drawn to reflect empirical work done by Beverton and Holt (1957). These curves reflect the fact that as the minimum fish size is increased toward the largest year-class size, the maximum sustained yield increases. In this case the downward sloping segments of the sigmoid curve disappear. It is the optimal combination of gear selectivity and fishing effort. Figure 5 is an example of the Beaverton-Holt model in static optimization. This model incorporates more fully some of the biological characteristics found in the trawl fisheries.

The above models, while useful for static analysis and theoretical construct do not address the year-to-year environmental changes found in most fisheries. The next

FIGURE 4

SUSTAINED YIELD CURVE

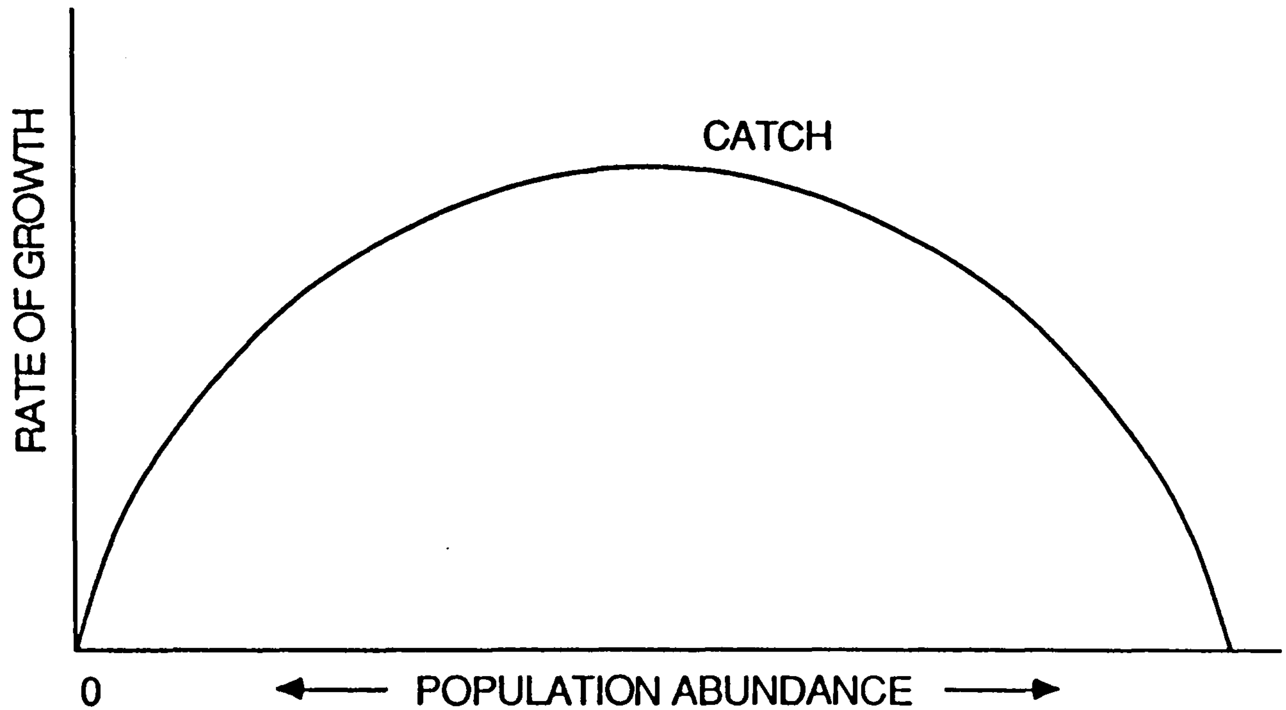
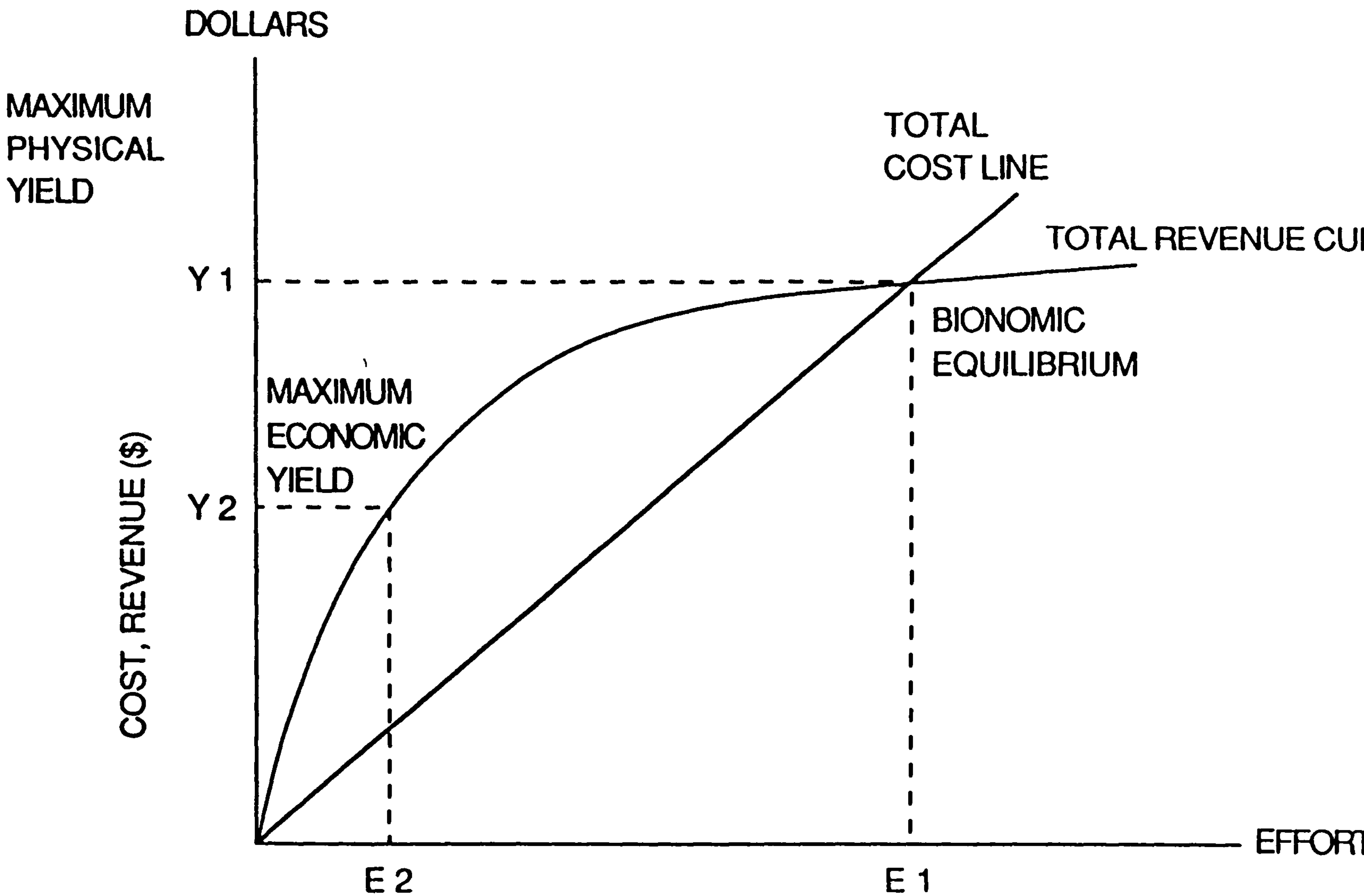


FIGURE 5

STATIC OPTIMIZATION FOR THE BEVERTON-HOLT MODEL



section of this chapter will present aspects of the non-linear models of fishery economics.

Dynamic Models of the Fishery

The first attempt to develop a dynamic framework in fisheries economics based on the Gordon model was made by Anthony Scott (1955). Scott both utilized and criticized the Gordon article. His intent in the paper is to show that "private property in fishing boats is not a sufficient condition for efficiency; sole ownership of the fishery is also necessary" (Scott 1955, p. 116). One of the assumptions of the Gordon model is that there are no diminishing returns in fishing. This in turn means there are no incentives to stop fishing short of the point where total costs are equal to the total value of the landings. Scott points out that in the short run with equipment and fish population fixed, each fishing boat will experience increasing costs as it attempts to increase landings. Each fisherman will produce or capture fish until its supply price (marginal cost) is equal to the price of fish. Under competitive fishing conditions the tendency will be to maximize net returns from the fishery by producing at the point where marginal cost equals marginal revenue. In perfect competition this will equal price. According to Scott this holds only in the short run. Because the catch today will influence the catch tomorrow, the sole owner will be interested in the optimal series of landings over time. Put differently, the fisherman wants to maximize the expected present value of his property. This will be done by determining the effect of his marginal output on this present value and by adjusting current output where marginal current net revenue is equal to marginal user cost. He thus succeeds in keeping the future returns from the fishery as high as possible while still maximizing current income (Scott 1955, pp. 122-123).

Scott concludes the article by stating that the equilibrium position of the sole owner who maximizes the expected present value to the fishery corresponds more closely to the social optimum than to the competitive equilibrium.

Though some attempts were made to develop dynamic models of the fisheries throughout the 1960s, static analysis remained dominant. Crutchfield and Zellner (1962) did some extension of the Gordon (1954) and Scott (1955) models.

The first successful dynamic models of the fisheries began to appear in the early 1970s (cf. Hanna 1983). The application of optimal control theory is the central focus of these models. Plourde (1970, 1971) and Quirk and Smith (1970) were among the initiators.

These models explain the process of how population size and the level of effort change through time and what conditions are necessary to achieve equilibrium under the open-access situation. The formal dynamic model uses a set of two differential equations. The equations specify the rates of change of population and effort. Changes in both are treated explicitly and describe their interrelationship.

According to Clark, Munro, and Charles (1985):

> The chief benefit of the dynamic model is not that it allows us to correct the static model's mis-specification of the optimal biomass level; it is rather that it compels us to recognize what we noted earlier, namely that achieving the optimum may well require a lengthy and difficult period of adjustment. It is not merely a matter of restricting the level of fishing effort (p. 105).

An implicit assumption of most dynamic models is is assumption that capital in the form of vessels and gear, processing plants and human capital is perfectly malleable. The advantage of this assumption is that nonresource capital can be treated as a flow variable and in terms of optimal control theory only a one-state-variable, one-control-variable exists. The disadvantage is that in real world fisheries, more often than not, capital is not entirely malleable.

Clark, Clarke, and Munro (1979) developed a dynamic model in which the nonmalleability assumption is incorporated. In this analysis, due to the nonmalleability of capital, they have concluded that extreme policies of stock rehabilitation may be unwarranted unless stocks become radically depleted.

Uncertainty in Fisheries Economics

In the models discussed above the approach was either static or deterministic. By nature, both types preclude the incorporation of uncertainty into the analysis. The remarkably high level of uncertainty inherent in fisheries has long been observed. The intent of this final section is to present a cursory review of literature on uncertainty in fisheries economics with a focus on the relationship of uncertainty to fishermen and management.

In fisheries management, three general classes of uncertainty have been cited by Walters and Hilborn (1978):

1. Random effects, whose future frequency of occurrence can be determined from past experience;

2. Parameter uncertainty, which can be reduced by research and acquisition of information through future experience;

3. Ignorance about the appropriate variables to consider and the appropriate form of the model.

The emphasis has been on the first category, where, characteristically the appropriate deterministic dynamics of the fishery are transformed into a set of mathematical equations. Dynamic linear programming is then used to analyze the resulting stochastic optimization problem.

Stochastic effects may enter in a number of ways. Environmental fluctuations affecting the population dynamics is the most common source of uncertainty cited in the literature.

Andersen (1982) incorporates price uncertainty and risk aversion to extend the traditional model. In this article he proves that in the open access fishery both the total fishing effort and the number of fishing units are reduced as the variance of the price increases. Additionally it is shown that the total fishing effort may be smaller in the open access fishery than in the optimal fishery at a high variance and/or at a high degree of risk aversion.

Sissenwine (1984) addresses the deterministic orientation of most biological models. Production of fish populations is stochastic and fishery biologists need to use models and methods which are less dependent on precise estimation of population size and focus on the uncertainty of all parameters involved in estimation of stock size.

Bockstael and Opaluch (1983 and 1984) incorporate uncertainty into behavioral modeling. A discrete choice model is presented. This model is designed to predict fishermen's supply response. A change in the focus of fisheries management away from bioeconomic optimization is advocated. A satisficing approach to management is proposed. Attempts are made to reallocate some proportion of effort from overutilized to underutilized fisheries. No attempt is made to determine the optimum.

An increasing amount of literature is available on fleet behavior. Huppert (1979) addresses the lack of focus by management on problems associated with mixed biological stocks and multipurposed vessels. A linear model is developed to demonstrate how the multipupose fleet can be a part of rational management.

Beddington and Clark (1984) consider the allocation of rights to exploit fish resources between domestic and foreign fisheries. Various optimal allocation policies are derived under differing biological and economic situations. Results imply that agreements between foreign and domestic countries may be beneficial for domestic fisheries.

McKelvey (1983) presents a mathematical model that incorporates the operation of a mixed fleet of fishing vessels. The generalist, who readily switches fisheries according to the fluctuating environment and the specialist who fishes in only one fishery are analyzed from the point of view of economic efficiency. A more extensive presentation is given in the following chapter.

Efficiency is the goal the traditional economist has sought. The current economist also practicing traditional economics continues to focus on the efficient solution.

Sole ownership of the resource with centralized decision making has been alleged as the only way to eliminate the "inefficiencies" present in a common property fishery.

Because of the ubiquitous nature of uncertainty in the fisheries, alternative ways of looking at what is efficient needs to be considered. The static model does not incorporate any elements of uncertainty into the possible outcomes of this model. Increasing theoretical work is being done in this area. Creating new models of the fishery incorporating uncertainty will enhance the understanding of all aspects of the fishery.

The following chapter presents the model constructed by McKelvey. The model is an extension of the static model presented in this chapter. Work done by McKelvey and Smith is the foundation for the analytics of this thesis presented in Chapters V and VI.

CHAPTER IV

STRATEGY SELECTION

Traditional analysis of fishing behavior treats the population of fishermen as homogeneous in decision making behavior (Anderson 1986; Clark 1976; Crutchfield and Pontecorvo 1969; Gordon 1953). However, observation in the Oregon ground and shrimp fisheries does not support this assumption.

This chapter provides the framework for the presentation of the empirical results of fishermen surveyed. Work done by McKelvey (1983, 1986) and Smith and McKelvey (1986) is the basis for the analytics of this thesis. An initial survey of the work done by McKelvey and Smith is followed by the presentation of the results and discussion of this research.

McKelvey and Smith

The McKelvey-Smith hypothesis set forth in these works is that adjustments in the mix of specialists and generalists are part of the process by which society copes with variability. Variability refers to both market and natural variability. A specialist is defined in this model as one who operates exclusively in one fishery and the generalist as one who has alternate fishery options and or nonfishery options.

Because the specialist operates in only one fishery, the effort invested in this one fishery makes the cost of changing to a new fishery very high. The specialist has a long term perspective and would only switch when there is a high profit potential for the alternative. The opportunity cost of continuing to fish in a single fishery would be very low for the specialist.

The opportunity cost is the net benefit forgone because the factors of production utilized in the fishery can no longer be utilized in their next most beneficial use. This can be either another fishery or any other occupation or profession.

The specialist will average returns over time and prefers the stability and consistency of a single fishery. Additionally it is assumed behaviorally that an attempt is made to minimize objective risk through attaining some degree of technological control over the fisherman's environment.

The generalist, on the other hand, switches readily, has a short term perspective and economic decisions center on minimizing total variable costs. The objective of the generalist is to have alternatives. By maintaining a range of options the generalist will accept a riskier environment but as a result is able to hedge his income. The generalist strategy selection has not been widely addressed in fishery economics. The distinction between the specialist-generalist mode needs to be incorporated into a multifishery model. Table 4 summarizes the different characteristics of the specialist and the generalist presented in the Smith-McKelvey model.

The Analytical Model

McKelvey (1983) constructed a mathematical model incorporating the effects of both natural and market variability using the distinction of the specialist and the generalist. This model is an extension of the bioeconomic models of Gordon (1954), Crutchfield and Zellner (1962), and Clark (1976) and incorporates ecological theory on specialist-generalist adaptive strategies.

The assumption is made that fishermen are motivated by profit maximizing goals but that due to the classical behavioral assumptions attributed to common property resources, the aggregate of their private decision making, in the absence of management intervention, will not achieve the socially desirable Pareto optimum.

This model focuses on a single species fishery with a fleet of specialists operating in the fishery. These specialists are backed up by a fleet of general-purpose vessels, operated by the generalists who characteristi-

Table 4. Differential Characteristics of Specialists and Generalists.a/

Characteristic	Specialist		Generalist
Activities, occupations, fisheries	Few		Many
Income averaged over	Time		Opportunities
Variable costs	Operating costs	<	Operating costs + opportunity costs
Fixed costs	Capital costs	>	Switching cost
Time perspective	Long-term		Short-term

a/ C.L. Smith and R. McKelvy, 1986.

cally harvest in another fishery. The generalists will be attracted into the fishery only in a good year.

The dominant stochastic elements of the fishery are taken to be the annual recruitment variation and the market price. The model also includes an additional source of variation for the generalist. This is the opportunity cost of foregoing his alternative fishery. It is assumed that the opportunity costs of the alternative fishery will change as prices and stock levels change.

The within-season operation of the fishery is modeled in a deterministic manner after the operating and opportunity costs have been set at the beginning of the season. The biomass of the fishery will decline according to the intensity of effort, determined by the behavioral response of the fishermen to current prices, costs, and stock levels.

At the beginning of the season the size of the specialist fleet (alpha) is assumed to be fixed with capital costs being treated as fixed. Because of start up costs, in a particularly poor season, part of the alpha fleet may choose to remain idle. Those who do enter will fish until the marginal returns from the harvest are equated to the marginal costs. This is a reflection on the efficiency attributed to the specialist in the model. The generalists (beta), however, upon entering will balance their average net returns against the alternative fishery.

This is the classical behavioral assumption attributed to behavior in a common property resource.

Fleet Efficiencies

In this model C_a and C_b represent the unit operating costs of the Alpha and Beta fleets within the season. The start up costs are represented as K_a and K_b. In combination with T for season length the total cost for the fishery will be

$$C_aT + K_a; \; C_bT + K_b \tag{1}$$

The assumption is made that operating costs are less, on average, for the specialists. Start-up costs are assumed to be less for the generalist:

$$C_a < C_b; \quad K_a > K_b \tag{2}$$

Reflected in the first inequality is the greater efficiency of the specialist and the opportunity cost to the generalist of forgoing the alternative fishery. The second inequality illustrates that start-up costs for the generalist are only switching costs because the generalist is currently fishing.

Outcomes

Different fleet mixtures will result according to ownership and management. This section presents the varying outcomes.

Sole Ownership

Under optimal management fleet start-up costs are minimized by utilizing the the smallest fleet capable of taking the maximum harvest possible. The assumption has been made that the total cost per unit time of specialist effort is less for the specialist than for the generalist, or,

$$(C_a + K_a/T) < (C_b + K_b/T). \qquad (3)$$

This reflects the greater efficiency of the specialist over the generalist. The point where marginal revenue is equal to marginal costs is the most efficient level of operation. Only when the specialist fleet is used to capacity will the supplementary or generalist fleet be called upon to harvest the remaining stock.

Common Property/Open Access

This model predicts a different outcome under common property ownership. Excessive levels of effort are assumed with open access in comparison to the efficiency attributed to sole ownership. This results in a shortened season from biological, economic or imposed administrative constraints. Because of the second inequality above, if a sufficiently shortened season is imposed the direction of the third inequality will reverse direction. The generalist will become relatively more competitive because the total cost of operations for either group will be higher but the impact will be greater for the specialist.

This model predicts that the generalist will enter the specialist's fishery at the beginning of the season in a good year and eventually exit, having diluted the returns-to-effort for the specialist. If the fishery, over a period of time, shows increased profitability, the generalist will begin to dominate the fishery. It will be the generalist who will fish the abundance over the base line stocks fished by the specialist. The entrance and exit of the generalist will be highly variable year to year and will be dependent on all possible stochastic variations in the alpha fishery and the opportunity cost forgone elsewhere.

An interesting outcome of this trend will be the reduction of financial risk for the remaining specialists. The generalist assumes a greater amount of this risk with enhanced stocks or increasing prices. It is the enhanced stocks or increasing prices that induce the generalist to enter the specialist's fishery. In the model this is considered to be the riskiest part of the harvest. The specialist continues to fish the base load and the generalist enters to harvest the stock over the base load.

It is in this sense that the financial risk is reduced for the specialist.

If there is a decline in harvest the generalist will leave the fishery in greater numbers than the specialist because of alternate possibilities.

This model determines the generalist fleet exogenously. This is to say that on average, the generalist is able to maintain a profitable operation without ever entering the specialist's fishery at all. The model assumes that the generalist does not have to rely on the main fishery. This follows the critical assumption that the generalist has a positive, expected opportunity cost of foregoing an alternate fishery. By choosing to fish in the alpha fishery the generalist is able to increase his profits.

If these assumptions fail, for example if the generalist must fish in the alpha fishery to survive, the model fails. Recognizing this, McKelvey (1987) extends the model to include less restrictive assumptions.

In this second model, as with the initial model, the boats are distinguished by relative intensities in the utilization of the factors of production, capital, and effort. Specialists are seen to be capital intensive and the generalist more effort intensive. Vessel economics are modeled less restrictively and the harvest function is density dependent unlike the initial model where a frequency dependent structure is used.

The hypothesis set forth is also somewhat different: In order to coexist, the two vessel types must adopt quite different strategies of response to their fluctuating environments. McKelvey states:

> In the density dependent, open access case, either vessel type can exclude the other under favorable circumstances. However it is also possible for the vessel types to coexist, provided that the advantage of alpha vessels, with their generally lower operating costs, is balanced by a compensating advantage for beta vessels in fixed costs. These compensating relations are generally statements of relative efficiency, as expressed in terms of cost-price ratios under respective modes of operation.
>
> The prices and costs that enter here are from the per-spective of the main fishery, with alternatives represented through opportunity costs and net capital costs. It is only with this understanding that the lower alpha-vessel operating costs $C_a < C_b$ cause them to be dominant in the main fishery, and thus take the role of the specialist there when the vessel type co-exist.
>
> Unlike the situation for a frequency-dependent model, the vessel types' distinctive roles as specialist and generalist are not fundamentally different under open access conditions from what they would be under cooperative management. Of course, open access does imply excessive effort and excessive capital capacity in both subfleets (McKelvey 1987 pp. 16-17).

It is with the background of these two models that the data gathered in the Oregon trawl fleet is presented and tested against four hypothesis in the following two chapters.

CHAPTER V

STRATEGY SELECTION IN THE OREGON GROUND AND SHRIMP FISHERIES

This chapter presents both qualitative and quantitative results of the survey. Additional quantitative analysis is presented in Chapter VI.

Classification

The initial task set forth in Chapter I is to determine if there is a specialist-generalist dichotomy in the Oregon trawl fleet. The hypothesis being examined is: A specialist-generalist dichotomy exists in the Oregon trawl fisheries.

In order to test this hypothesis it is necessary to determine a classification scheme. The criteria chosen for classification is the summation of four factors taken from the survey.

One of the questions asked in the survey determined what species or group of species was fished during the previous twelve months. The Oregon Department of Fish and Wildlife's species codes were used to assign a value for each of the 12 months. These codes were grouped by similar species, generally caught by the same or similar gear type. This enabled a way to assign consistent values for the range of fisheries the fishermen participated in during the

12 month period. The standard deviation across the 12 month period was determined. The mean for all 68 participants was calculated and divided into each individual standard deviation. This is the coefficient of variation.

The coefficient of variation is a relative measure of variation. This is in contrast to the standard deviation which is in the same units as the observations. The coefficient of variation is the ratio of two averages and is independent of the unit of measurement used, enabling comparison between groups.

The coefficient of variation of species fished was the first factor. The second and third factors are a ranking of 0, 1, or 2 according to changes or lack of changes in the seasonal pattern during the last five years. Zero was assigned if no changes had occurred or were anticipated, one for some changes and two if significant changes had or were going to be made. The final factor, also a ranking of 0, 1, or 2, pertains to additional income generating occupations. This was ranked according to the time spent on the alternate occupation rather than an income percentage. This gives a better indication of time away from fishing.

Using this classification scheme the minimum possible sum of the four factors is zero. The maximum possible is six plus the highest value of the coefficient of variation calculated for this sample. For this sample the highest coefficient of variation is 4.95. This means there is a possible range between zero and 10.95.

Rejection of the hypothesis occurs if less than 95 percent of the sample have a sum of the four factors greater than zero. If less than 95 percent of the sample have a sum of the four factors greater than zero this would indicate a lack of diversification in the Oregon trawl fisheries.

Results

The results indicate the presence of diversification in the Oregon trawl fisheries. The hypothesis is not rejected. At least ninety-five percent of the sample have a sum of greater than zero. Four percent of the sample have a sum of the four factors equal to zero. This means that the specialist-generalist dichotomy does exist in the Oregon trawl fisheries.

In the sample the range of the sum of the four factors was from 0 to 6.99. Through inspection, a natural break occurred at 1.47 and again at 3.5 creating three groups. These three groups of fishermen are the subject of further analysis.

Twenty-three (34 percent) fishermen fall into the most specialized group, 26 (38 percent) in the second group and 19 (28 percent) in the most diversified group. Figure 6 illustrates the pattern of the summation of the factors used for testing the hypothesis and the breaks in the pattern.

Out of the entire group, 16 (24 percent) fishermen fished only one fishery. The maximum number was four fisheries during the 12 month period. Nine (13 percent) in the sample had the factor of "additional" income added. Of these nine, as a result of the added factor, the classification was changed by one group. None were changed by two groups and three did not change at all. Throughout the remainder of this thesis the most specialized group is referred to as Group 1, the intermediate group as Group 2 and the most diversified as Group 3.

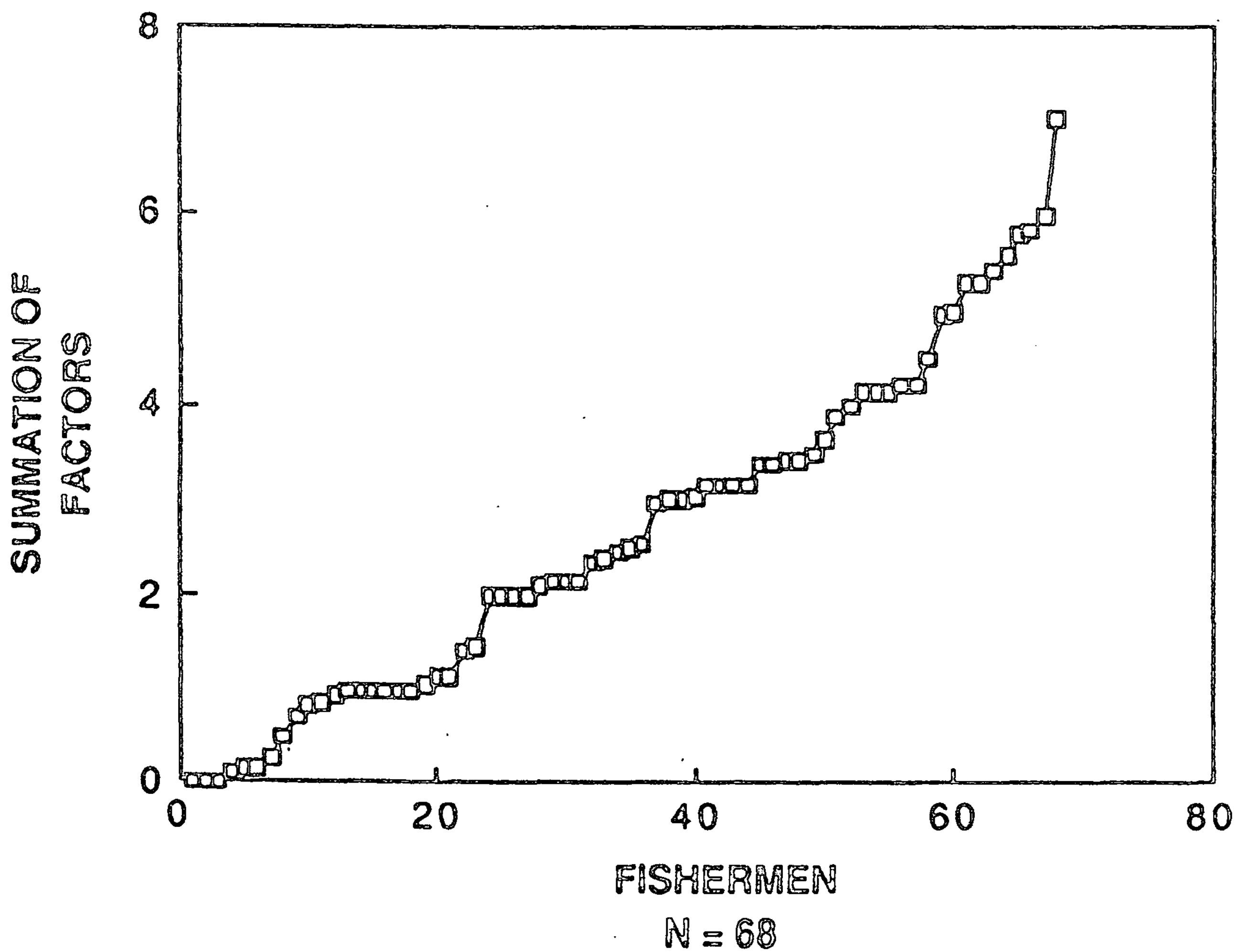
Group Comparisons and Outcome

Data gathered from the survey allow a comparison of the three groups and enable a discussion of the McKelvey-Smith model as it relates to the ground and shrimp fisheries of Oregon. In this section the second and third tasks presented in Chapter I are fulfilled.

A net income determination was made. The total variable costs (TVC) are average variable costs (AVC) multiplied by days fished per year. The AVC is a combination of fuel, oil, food, supplies, ice, bait, transportation and crew expenses. Total fixed costs (TFC) are composed of

FIGURE 6

CLASSIFICATION DETERMINATION



insurance, moorage fees, license costs, professional expenses, and mortgage payment. The combination of TVC and TFC give the total costs (TC). The net income is estimated by subtracting TC from the estimated total revenue (TR). The TR is calculated by multiplying the days fished per year by $/day to continue. The $/day to continue is the amount of money the fisherman felt was necessary, as a minimum amount, to continue fishing in a particular fishery per day for his operation.

This net income cannot be taken as the final income of a given fishermen because taxes have not been accounted for. Additionally, other expenses may have been either overlooked on the survey or forgotten on the part of the fishermen during the interview. This does not make this information any less valid but it must be seen as a proxy for income based on the estimates from the survey information. In certain cases not all of the information was complete. This accounts for an N of less than 68 at different points in the analysis. Table 5 gives a summary of the calculations used in this discussion. They are presented as a ratio of the total group average.

Coexistence

The focus of this analysis is on the coexistence of vessels rather than exclusion or dominance of one group over the other. This is what is empirically observed from

Table 5. Computational Results of Income Components Presented in Ratios to Average Totals.

	Minimum Gross $/Day to Continue	AVC	TVC	TFC	NET	Capital to Income Ratio	Days Fished Per Year	HP	NT	Boat Market Value (thousands of dollars)
Group 1.[a]	1271	.81	.80	.78	.57	3.19	142	297	43	.67
Group 2.[b]	1733	1.12	1.16	1.24	1.21	2.7	148	428	58	1.1942
Group 3.[c]	1782	1.08	1.10	1.03	1.62	2.0	171	446	56	1.1906

a/ N = 17.

b/ N = 15.

c/ N = 9.

the data. There is no one specialization in the Oregon trawl fleet. There are specialized bottom trawlers, mid-water trawlers and shrimpers. The initial model determined the generalist fleet exogenously on the assumption that the generalist has an alternate fishery and need never enter the specialist's fishery at all.

One of the survey questions asked what was perceived to be the best alternative fishing activity or target species other than what was currently fished. Sixty-two percent of the respondents (N=60) felt their best alternative would either decrease their income or make no change in income. Eight percent felt no alternative existed to switch into, while the remaining 30 percent said the alternative would bring an income increase. Only nine percent (N=68) anticipated significant changes in the future.

The data gathered from the survey do not readily lend themselves to determining accurate opportunity costs. After the response to "the best alternate fishery" was given the interviewer asked what percentage or amount of income change would occur if the switch were made? The responses appeared to be made in terms of gross revenues rather than net revenues. Consideration of the the opportunity cost of remaining in the current fishery did not appear to be included.

When a fisherman indicated the alternate fishery would bring an income increase and yet was not at that time planning to switch, two possibilities for interpretation exist. The first possibility is that this individual may not be a profit maximizer. The second consideration is an extension of the first possibility. The perceived personal cost may be so negative to a fisherman that this will overcome the desire to increase profits. While this is nonquantifiable, this "psychic" opportunity cost appears to be a part of the decision making process in strategy selection among some of the fishermen who were surveyed.

There are some additional factors to consider when examining the data gathered from the surveys. Because the data are cross sectional in nature the results may be affected by the conditions of the fisheries in this particular year. In 1986 there was a resurgence of the shrimp fishery and landings in the other fisheries were strong.

Factors of Production: Capital and Effort

Relative intensities in the factors of production, capital and effort are the factors these models examine in relation to strategy selection. A greater effort intensity is attributed to the generalist where greater capitalization is seen as the dominant characteristic of the specialist. As previously mentioned the components of effort are very complex and difficult to measure. For purposes of this study nominal effort is used. Effort in this case is measured as days fished per year.

Given that the specialist-generalist dichotomy does exist in the Oregon trawl fisheries it is hypothesized that no differences exist in nominal effort between groups. The critical test for this hypothesis will be a 10 percent difference in the nominal effort expended.

Effort, taken as days fished this year, is highest for the most diversified group, Group 3, at 171 days. The Group 2 generalists follow with 23 days fewer. The difference between Group 2 and Group 1 is less marked at 148 and 142 respectively.

Conclusions are difficult to draw based on these measurements. There is only a 4 percent difference between the specialist group and the Group 2 generalists. In this case the hypothesis is not rejected. The difference between the specialist group and the most diversified group, Group 3 is more significant at 17 percent. In this case the hypothesis is rejected.

Capitalization

The market value of the vessels, used as a measure of capital, shows the most specialized group to be the least capitalized. Group 2 and Group 3 have virtually identical capital values. This is not consistent, however, with the income-to-capital ratio. The income-to-capital ratio is the net income divided by the market value of the vessel multiplied by 1000. This ratio is the highest for the specialist group and the lowest for the Group 3 generalists. This measurement as an indicator of efficiency shows the Group 1 specialists to be the most efficient. This is one of the assumptions of the McKelvey-Smith model. The income-to-capital ratios of the Oregon trawl fisheries support this assumption.

Examining each group separately and as a whole will give additional insight into strategy selection.

Fleet Strategy Selection and the Shrimp Fishery

Fishermen in all three categories participated in the shrimp fishery. This fishery is a limited entry fishery. It is, however, possible to land shrimp without a license. If a boat holds a California or Washington vessel license, single deliveries are permitted for a fee of $75. The summary files of the Oregon Department of Fish and Wildlife show 165 single deliveries for 1986. This gives a margin of flexibility to a fishermen who wishes to shrimp but does not hold a shrimp permit.

Thirty-seven vessels (N=68) shrimped some part of the seven month season, while 20 fished the full season. Only five fishermen participated in this fishery to the exclusion of any other fishing related activity. This does not clearly indicate an exclusive fishery with well defined participants.

Additional Species

An additional 11 fishermen used only one gear type through out the 12 month period. These were predominantly for the sole and flounder species.

All three groups had participants in the crab fishery. A total of 16 boats crabbed and nine boats shrimped then crabbed. The seasons are somewhat complimentary and lend themselves to this mix.

Three more species of fish showed up in the sample. Albacore in conjunction with black cod and crab was one of the more unusual mixtures. Herring, a bay fishery, was noted by a Group 3 fisherman. Thresher shark is perhaps the most unique species mentioned by one of the fishermen surveyed. Currently no one in Oregon is processing this edible shark. In the 1986 season approximately six boats from California fished this species in Oregon waters and trucked the landings to California where a market has emerged. The fishermen surveyed was fishing in southern California.

Joint Venture Vessels and Mid-Water Trawling

Mid-water trawling came to Oregon in the late 1970s with larger and more powerful vessels. Rockfish species were heavily exploited. This continued until regulations were implemented, severely limiting possibilities for this category of vessel. Survival dictated finding alternatives for these fishermen. The joint venture operations both in Alaska and off the coasts of Washington and Oregon offered a workable alternative.

Nine vessels of this type were drawn in the sample. Six of these are classified in Group 2 with the remaining three in Group 3. Days fished per year in this group is over 200. Two of these fishermen said any alternative fishery would cause their income to decrease enough that they would loose their boats. Three said they could shrimp but the income decrease would be very serious. The remaining fishermen saw alternatives only with in terms of increasing or decreasing joint venture contracting. Alternatives were not seen as being viable when substantial gear change was required.

Group Differences and Similarities

The Group 1 fishermen by definition are the most set in their strategy selection and the least likely to change. Within certain boundaries this is also the case for Group 3 fishermen. This is the largest and most capitalized group. Choices are restricted for this category according to management regulations more than the other two categories. It is possible for many of the boats in this group to catch the weekly limit in one day in Oregon waters. As a result, a combination of fishing closer to home part of the year is often used in conjunction with contracts further away, in order to stay financially solvent.

It is the Group 2 fishermen who as a group have the least restrictive number of choices and more readily switch. This is because fewer of the management restrictions severely limit choices in this group. This group is not as heavily capitalized as the Group 3 generalists. It is for this reason this group more closely resembles the generalist pattern presented in the models. The income-to-capital ratio is less in this group than the first. The vessel operating expenses are also greater for the Group 2 generalist than the Group 1 specialist.

Additional Considerations and Implications

The first model presented is not really testable in the Oregon trawl fisheries. The exogenous modeling of the generalist fleet is not valid for this group of fishermen. The shrimp fishery in Oregon is not composed exclusively of vessels who only shrimp. Furthermore while every fisherman has what he probably considers a "reference" fishery or gear type, fewer than 25 percent of those interviewed had exclusively fished one fishery or gear type in the pervious 12 months of fishing. This does not support the assumption that on average, the generalist is able to maintain a profitable operation without entering the specialist's fishery at all.

The second model is not as restrictive in the assumptions. The specialist exists in the "main" fishery and as opportunity arises the generalist will enter. As stated previously the hypothesis is: In order to coexist, the two vessel types must adopt quite different strategies of response to their fluctuating environment. While this hypothesis was not testable it was possible to test for the presence of the general-specialist dichotomy in the Oregon trawl fisheries.

While this research cannot test the hypothesis presented in the McKelvey-Smith models, it is able to support assumptions contained in the models. The capital is less for the Group 1 specialist, however variable costs are not less in either of the generalist groups than they are for the specialist. The nominal effort as assumed, is greater in both generalist groups. However it was not possible to reject the hypothesis that no differences exist in nominal effort between the Group 1 specialists and the Group 2 generalists.

Different strategies do exist for the three different groups. Though on average the Group 2 and Group 3 generalist have a higher income, the Group 1 specialist has a higher income-to-capital ratio. This is indicative of the greater efficiency of the specialist.

Realities, Fleet Behavior, and the Model: Consideration for Future Research

These models are based on situations that do not exist. Open access in the Oregon waters is not a reality. Every species of fish cited by the fishermen in this survey is under some type of restriction. Either in the form of limited entry as in the shrimp fishery or in the form of trip limits or weekly aggregate totals as in the case of rockfish species. The bottom fish fisheries have gear restriction.

The models under consideration in this thesis do not implicitly consider management regulations as a source of variability. Throughout the interviewing process many comments made by the fishermen indicated the fishermen felt as if this was the greatest source of variation.

Many of the fishermen interviewed did not feel as if they had any way to participate in management meetings to enable their input. The expense of travel and time away from fishing deters participation. The feeling that regulations are set independently of the fishermen's knowledge or lack of consideration of existing fleet capabilities creates animosity and adversarial relations between management and fishermen. Fishermen feel as if choices are too severely limited by management and not necessarily for the good of the fishery. This qualitative assessment comes from many hours spent by the author listening to fishermen discuss the Oregon fisheries. Switching behavior does not seem to be independent of regulations but more specifically in response to regulations relative to capital constraints.

This research has shown quantitatively how and what differences exist in this segment of the Oregon fisheries. This study was cross sectional in nature. Only one 12 month period was looked at, with additional information given through other survey questions. Time series analysis with this same orientation can potentially give conclusive evidence as to why a fisherman feels a need or desire to switch.

CHAPTER VI

ADDITIONAL ANALYSIS AND RESULTS

To further understand differences and similarities between the subgroups in the trawl fisheries, econometric analysis was used to look at the components of income determination and discriminant analysis was used to look at three attitudinal questions included in the survey. This part of the analysis is independent of the model testing but enhances the understanding of the three groups of fishermen.

Econometric Analysis

Income was used as the dependent variable in these equations. The estimated gross income presented in Chapter V was used. Income was taken to be a function of effort, experience, and vessel characteristics.

Through information gathered from the survey, data were available on vessel and owner characteristics. Initial considerations were horse power, net tonnage, effort, years experience, age, and education. Because of the small data set the independent variables were narrowed down to horsepower, net tons, experience and effort.

Experience was measured as the total number of years an individual had fished. Effort was taken to be the number of days fished per year. This is a measure of nominal rather than actual effort. Real fisheries effort measures the actual impact on the stocks of fish (Rothchild 1972).

It has been hypothesized that components of income are the same for all three groups of fishermen. Another way of stating the hypothesis is that the same regression models can be used for all three groups. The critical test used for this hypothesis was the Chow test (Kmenta 1986). In all three cases the the hypothesis cannot be rejected.

Ordinary least squares was used. Linearity in the parameters as well as the variables was assumed. This is a weak assumption because real effort is typically not linear. The results are as follows:

<u>**All groups:**</u>

$$\underset{}{INC} = \underset{(-3.94)}{-227195} + \underset{(-5.30)}{443\ HP} + \underset{(1.40)}{683\ NT} + \underset{(6.60)}{2030\ EFF} - \underset{(-.80)}{1178\ Years}$$

(t values in parentheses)

n = 55

R^2 = .72

where HP is horse power

NT is net tons

EFF is effort

YEARS is years of experience

<u>**Group 1:**</u>

$$INC = \underset{(-1.23)}{-156879} + \underset{(1.87)}{386\ HP} + \underset{(1.93)}{1189\ NT} - \underset{(-1.25)}{2986\ YEARS} + \underset{(2.67)}{1627\ EFF}$$

n = 21

R^2 = .646

Group 2:

$$INC = -112791 + 552\ HP + 1422\ NT + 798\ EFF - 2485\ YEARS$$
$$(-1.52) \quad (2.7) \quad (1.55) \quad (1.61) \quad (-1.24)$$

n = 23

$R^2 = .84$

Group 3:

$$INC = -354573 + 611\ HP - 2398\ NT + 3301\ EFF - 180\ Years$$
$$(-2.35) \quad (2.11) \quad (-1.3) \quad (5.34) \quad (-.04)$$

n = 12

$R^2 = .85$

Not all of the t values are significant at the five percent level. Because of this and due to relatively high correlation between the independent variables, the variance inflation factor was examined.

The inverse of the correlation matrix can also be used to examine the severity of multicollinearity. The diagonal elements of the matrix are called variance inflation factors, VIF. In all cases the VIF was found to be less than ten indicating that the influence of collinearity is not harmful (Kennedy 1985).

This also is an indication that the t values are greater than indicated because of the inflated standard error. This follows from the fact that the standard error is the square root of the variance. If the variance is inflated the t value will be computed smaller than is really the case. This is because the t value is calculated by dividing the standard error into the estimators. F tests at the five percent level indicate that the independent variables are jointly significant in explaining the variation in the dependent variable.

The influence of effort as a contributing factor to income is the strongest in the first and third group.

The predictive power of experience (YEARS) in the All groups and Group 3 regression was negligible, even taking into account the VIF. The signs of the coefficients were as anticipated with the exception of the sign of NT in the Group 3 regression. The negative sign on YEARS is expected to be negative because of age-earnings profiles. It is assumed that income will increase with experience then at some point, level off and begin to decline.

The least clear result is the sign of NT (net tons) in the Group 3 equations. This could be attributed to having a small data set with four parameters or it could be a true characteristic of this group. Conclusions are difficult to draw in this case. This may indicate these boats have become too capital intensive for the Oregon fisheries.

Discriminant Analysis

Discriminant analysis is a statistical technique used to identify distinguishing characteristics among mutually exclusive groups. Linear combinations of the predictor variable are formed as the basis for classifying cases into one or more groups. Three survey questions asked perceptions on specific topics related to fishing. Discriminant analysis was used to look at the group differences.

The hypothesis in each case is: In the populations from which the samples are drawn there is no difference between the group means.

The critical test is based on Wilks' lambda (this is sometimes referred to as the U statistic). Wilks' lambda is the ratio of the within-groups sum of squares to the total sum of squares. It is the proportion of the total variance in the discriminant scores not explained by differences among groups. A small value of lambda is associated with functions that have much variability between groups and little variability within groups. When lambda is equal to one, there is no between-group variability and all scores are equal (Norusis 1986).

Wilks' lambda is transformed to a variable that has approximately a chi-square distribution. It is on this basis that the hypotheses is either rejected or fails to be rejected (Norusis 1986). When the computed chi-square value is greater than the table value, the hypothesis is rejected.

Question 6

This question asked for responses based on the alternative fishery mentioned in the previous question. The question was: Thinking of the activity or target mentioned in #5, how important are each of the following in switching to the best alternative? In question 5 the fishermen were asked to give what they thought was the best alternative fishing activity or target species other than the one currently being fished. Thirteen items were mentioned. Then the fisherman was asked to rank each of these in one of the four following categories: Very important, somewhat important, neither important nor not important or not important at all (Appendix A, p. 4).

The final predictor variables remaining were; season of the year, time required to make the switch and fish prices. The function coefficients are given below. The signs of the coefficients are arbitrary. Since the variables are correlated, it is not possible to distinguish the importance of one variable over another variable.

Canonical Discriminant Functions Evaluated at Group Means (Group Centroids)

Group	FUNC 1	FUNC 2	
1	-.45944	-.22392	fish price
2	-.04436	.32243	season of the year
3	.61687	-.17016	time rqd to make switch

Classification Results:

Actual Group	No. of Cases	Predicted Group Membership 1	2	3
Group 1	23	14 60.9%	6 26.1%	3 13.0%
Group 2	26	7 26.9%	15 57.7%	4 15.4%
Group 3	19	4 21.1%	8 42.1%	7 36.8%

Percent of "grouped" cases correctly classified: 52.94%

Eigenvalue	.18 .06				
Wilks' Lambda:	.78 .93	Chi-square :	15.1 4.2	Significance:	.01 .12

On the basis of Wilks' Lambda, transformed to a variable that has approximately a chi-square distribution, the hypothesis that the means of both functions are equal in all three groups can be rejected at the five percent level of significance. The computed chi-square value is larger than the table value.

It is necessary to note that even though Wilks' lambda may be statistically significant, it is not informative about the effectiveness of the discriminant function in classification. If the means are equal, discrimination is not possible. In the case where small differences exist, they may be statistically significant but nonetheless, not allow good discrimination among groups.

The eigenvalue is the ratio of the between-groups to within-groups sums of squares. Large eigenvalues are associated with good functions. A good discriminant function is one that has more between-group variability than within-group variability.

The percentage of correctly classified cases gives additional insight into the effectiveness of the discriminant function. The prior probabilities of .34, .38 and .28 mean that a classification rate higher than this indicate that the discriminant function is performing better than chance.

The Group 3 generalists have a lower percentage of correct group classification than either the Group 2 generalists or the Group 1 specialists. This may be reflective of the previously mentioned characteristic of large boat size and restricted choices placed upon these fishermen. It may be that the attitudes toward switching behavior are more closely related to the Group 1 specialists.

Throughout the interview process the responses to this question were not particularly strong and lacked much discussion. The Group 1 fishermen were often reluctant to answer at all. Satisfied with their choices of fisheries, responses were generally straight forward with little comment. The answers given by the Group 2 and Group 3 generalists were somewhat more talkative in their responses. One Group 2 fisherman said, "Knowledge is the whole business in fishing," another fisherman of the same group was a little more expansive in saying that "the amount of new knowledge in very important if you haven't fished a particular fishery before, otherwise not very important at all.

Several fishermen in generalist groups made careful distinctions between the importance of having a market versus having a market order.

Question 7

Question 7 asked for a ranking of nine factors towards risk as a business. The ranking scale as well as the prior probabilities are the same for all three questions. The final predictor variables were; what other fishermen are doing, processor limits, insurance costs and fish prices. The results are as follows:

Canonical Discriminant Functions Evaluated at Group Means (Group Centroids)

Group	FUNC 1	FUNC 2
1	.19394	.36432
2	.31848	-.28170
3	-.67057	-.05553

Classification Results:

Actual Group	No. of Cases	Predicted Group Membership 1	2	3
Group 1	23	10 43.5%	6 26.1%	7 30.4%
Group 2	26	5 19.2%	17 65.4%	4 15.4%
Group 3	19	3 15.8%	5 26.3%	11 57.9%

Percent of "grouped" cases correctly classified: 55.88%

Eigenvalue	.18 .07				
Wilks Lambda:	.78 .92	Chi-square :	15.6 4.8	Significance:	.04 .18

On the basis of Wilks' Lambda transformed to a variable that has approximately a chi-square distribution, the hypothesis that the means of both functions are equal in all three groups can be rejected at the five percent level of significance. The computed value of chi-square is larger than the table value.

The results in this case show better predictive power in the second and third groups. Attitudes toward the risk of fishing may not be so readily grouped according to strategy selection but grounded in different personal factors across all fisheries and fishermen.

The responses and feelings toward the factors included in this question were stronger than in the previous question. The attitudes toward management began to come through.

"What other fishermen are doing" was one of the final factors selected as a predictor variable. This factor almost always, after the response was given, was punctuated with a comment. One fisherman said, "What other fishermen are doing is the least of my worries." He did add however, "The more boats fishing, the thinner the slice of pie". This analogy was used repeatedly by fishermen during the survey. Another fishermen said that he paid attention to what other fishermen were doing but did not let this affect him. This characterizes fairly well the typical response. The individual fishermen seemed to be well aware of what was going on with other fishermen and aware of the activity in fisheries other than their own. They did not feel influenced in decision making as a result of this knowledge.

Another factor, which was not in the final predictive group of factors, was cause for many comments. This was "number of boats fishing". This also ties in with the comments made on the "pie slices". Limited entry frequently entered in the discussion at this point. A large range of attitudes was presented. A number of fishermen were adamantly opposed to the idea, but others felt there was an increasing need for it. One fisherman said that limited entry came too late. He did not specify for what fishery but additionally said, "One good thing about regs is that the limits have held the market. Because the government gave loans we have big boats causing overfishing, now they have to go to Alaska or JV."

"Insurance costs" was one of the predictor variables. Consistently the cost of insurance was cited as a problem and "getting worse". Several fishermen mentioned that if the price of fuel had not decreased and if the fishing had not been good this year, they aren't sure they would be able to pay the premiums.

Both processor limits and fish prices were typically cited as being important or very important because of their direct relationship with income.

Question 10

This question asked which fishery management problems are the most serious. The final factors left in the analysis were; stock levels, access to fishing opportunities and gear regulations.

Canonical Discriminant Functions Evaluated at Group Means (Group Centroids)

Group	FUNC 1	FUNC 2
1	.14591	-.30311
2	-.46613	.09117
3	.46123	.24216

Classification Results:

Actual Group	No. of Cases	Predicted Group Membership 1	2	3
Group 1	23	10 43.5%	10 43.5%	3 13.0%
Group 2	26	6 23.1%	19 73.1%	1 3.8%
Group 3	19	7 36.8%	6 31.6%	6 31.6%

Percent of "grouped" cases correctly classified: 51.47

Eigen value	.22 .00				
Wilks' Lambda:	.82 .99	Chi-square:	12.90 .19	Significance:	.01 .66

On the basis of Wilks' Lambda, transformed to a variable that has approximately the chi-square distribution, the hypothesis that the means of both functions are equal in all three groups can be rejected at the five percent level. The compute chi-square value is greater than the table value.

The percentage of correctly classified groups was the lowest of the three questions. It is complicated to analyze these results. There was a serious reluctance on the part of the fishermen to respond to this question. The overwhelming feeling was that management had or should have no bearing on any of these factors. While this does not invalidate these results, it does complicate the interpretation.

The predictor variables selected in this question are "stock levels", "access to opportunities" and "gear regulation". These were the three most heavily discussed and commented on by the fishermen. Generally feelings were strong and even if an individual refused to directly answer the question this did not preclude a discussion of the subject.

The attitudes of the biologists are a source of frustration to many of the fishermen who participated in the survey. One fishermen said, "The attitudes of the biologists changed, and not for the better, after the 200 mile limit went into effect. Their jobs went from meaningless to power positions. And they like their power". Stock level assessments are not felt to be accurate by the fishermen. One fishermen said, "you may as well roll the dice". Another said, "guesses on guesses, educated or not. Management shows lack of concern for people who are in day to day contact with the resource and their input". "Management procedures are lousy....Stock levels are not as serious (low) as they make then out to be. Too many ding-a-lings. The whole thing needs to be changed".

There is also a greater concern for the resource than fishermen feel they are credited with. During one interview a fisherman said that a biologist had approached him one day dockside and asked him if he didn't think that it would be wonderful if he "could fish the last fish in the ocean?". The fisherman's response to the biologist was that it would be to expensive and too stupid a thing to do. The fisherman said he was astounded not only that the biologist asked the question to begin with, but could not comprehend why he wouldn't want to fish the last fish.

A number of individuals said that it was management who caused waste. Because of incidental catch regulations many feel as if they are given no choice but to waste fish. One fisherman said he found it really painful to dump fish but because of the regulations he was required to. "It is a pathetic waste". Another comment was, "waste is ridiculous and throwing away fish is just plain stupid.

Because of strong feelings on improper stock level assessment, the fishermen feel as if access to opportunities are also not properly regulated. One fisherman said that each change in a regulation has its own set of situations: With brownie limits the change will cause someone to go into a storm. He also said, "quotas kill people" and that management has caused the death of a lot of people off this coast. Another fisherman said, "management should regulate the fish, not the fishermen".

Though there are fishermen who strongly feel that no regulations should exist, a larger group of the individuals surveyed felt that greater communication between management and fishermen would be beneficial to everyone. One fisherman said, "fishermen who complain need to fish more".

Conclusions

The use of discriminant analysis has given additional insight into the validity of the classification of the three groups. Knowing the prior probabilities based on the analytical classification in Chapter V allows a quantitative reference point. Classification related to these three questions was shown to be better than random chance.

None of the eigenvalues were high. As previously mentioned high eigenvalues are an indication of good discriminate functions. The values for the Wilks' lambda were also all high. This indicates that there is not a lot of between group variability.

These results suggest there are group similarities in attitudes but that there are other factors which probably influence the choices and decisions of the fishermen who were interviewed.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

This research demonstrates that a mix of specialist and generalist behavior does coexist in the trawl fisheries of Oregon.

Limitations arise when using or testing a model. This is the case with the McKelvey-Smith model. While none of the situations proposed by these models exist, namely open access, sole ownership or cooperative management, the analysis of this mix of vessels allows greater insight into characteristics of each group. Income-to-capital ratios were found to be different for each group. The most specialized group of fishermen were found to have the highest ratio. This supports one of the assumptions of the model.

From the data collected it was not possible to determine accurate opportunity costs nor possible to separate out the switching costs for the generalist. This analysis reveals that not all of the fishermen surveyed are profit maximizers.

Additional analysis was done to give further insight into the three groups of fishermen. Estimated regression equations revealed differences in the influence of horsepower, net tonnage and nominal effort on income for each group. However it was found that the parameters are the same for each group.

The negative sign on the independent variable for net tons indicates the possibility that the Group 3 vessels may have become too large and overcapitalized to fish exclusively in the Oregon fisheries.

The discriminant analysis showed that according to the classification scheme used, a better than random grouping was done. This gives insight into the fact that the specialist-generalist selection cannot be adequately characterized by using only economic measures.

The optimal mix of strategy selection in any fishery will be determined by the variability in both natural and market influences. Until the decisions made by management are more fully understood by the fishermen who are affected by the regulations, the influence of these management decisions will be perceived as more variable and difficult to cope with than variability in fish populations and price. The McKelvey model suggests that the profit maximizing behavior of the specialist is desirable. However this research suggests that management variability may stimulate fishermen to adapt to this uncertainty by using a generalist strategy.

With this in mind, further research into how management decisions affect long run strategy selection would be beneficial. The effects of traditional regulations are not fully understood. Attempts to control effort through limited entry, catch quotas and shortened seasons discriminate against one strategy or the other. The influence of regulations on a given fishery does not just affect that particular fishery.

Single fishery, single species models do not encompass all of the variables necessary to obtain optimal management of this resource. Multi-species models need to be developed to include the aspect of the multi-user. Two additional suggestions arise from the research contained in this thesis. As the joint venture fisheries continue to expand with more of the large vessels participating in both the Oregon trawl fisheries and JV contracting, a greater understanding through research into this particular mix of fisheries will help management understand the particular characteristics of this vessel type.

The final suggestion is oriented toward the fisheries managers. Partipation in the decision making process is not felt to be accessible by the majority of the fishermen interviewed. A study to find ways to increase this participation will be beneficial to everyone involved in any aspect of commercial fishing.

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APPENDIX

APPENDIX A

THE SURVEY

APPENDIX A

FISHING PATTERNS QUESTIONNAIRE

Questionnaire Rationale:

Your help is needed to determine how different fishing patterns combine in the operation of a fishery. Many fishery science and management approaches assume most fishermen are pretty much the same. These approaches fail to consider the professional fishermen's needs for handling risks and for coping with changing fishing conditions and markets.

The objectives of this study are primarily educational. First, the study seeks to describe the diversity of fishing patterns and to explain why a mix of activities copes with changing conditions. Second is the education of students. Graduate students are learning research techniques and the findings will increase all students' background on one of Oregon's primary industries. Third, knowing how a fishery operates helps identify the effects of resource management.

Your participation is voluntary. Your responses are are confidential. Grouping results assures your anonymity.

This research is a joint project with cooperating investigators from the University of Oregon and Oregon State University. For further information contact:

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Revised 8/4/86US

Date / / Time : Interviewer Initials _______

To begin with, we want to know the pattern of your fishing seasons for the past several years.

1. Seasonal Pattern: Please provide season-by-season summary of target species, area fished, the minimum amount needed to continue fishing the species, and the maximum likely catch. This is to provide the range of variability experienced. If species change within a season, indicate the month and nature of these changes. Be sure to cover each month of every season. If not fishing during a month or season, indicate the nonfishing activity.

Month	Target Species or Other Activity (Other occup. or vac) (#/day or trip)	Area	Min Catch Needed to Continue	Max Catch Likely
Spring (April May, June)				
Summer				
(July, August,				
September)				
Fall				
(October, November,				
December)				
Winter				
(January, February				
March				

Date / / Time : Interviewer Initials ______

2. In terms of time fished, target species, gear, and area fished, is this basically the same or substantially different from your fishing pattern over the last several years?

   Basically the same ______, or if substantially different indicate the change in target species ____________________

   gear____

   area____

   time fished_____________________________________

3. Will this seasonal pattern continue for the next year?

Now we need to know the alternatives you **consider when making decisions about fishing.**

4. Thinking about planning your next fishing year what is the minimum level of catch you need in order to fish? Answer for each of the major target species or activities in 1.

Target species	Amount
____________________	: ____________________
____________________	: ____________________
____________________	: ____________________
____________________	: ____________________

5. What do you think is the best alternative fishing activity or target species other than the one you currently fish?

   Activity or Target
   Species________________________

   Percentage or Amount of
   Income Change________________________

   Explanation____________________________________

Date / / Time : Interviewer Initials______

6. Thinking of the activity or target species mentioned in #5, how important are each of the following in switching to the best alternative?

	Very Important	Somewhat Important	Neither Important	Not Important At All	Comment
having the right gear	____	____	____	____	
estimate of likely catch	____	____	____	____	
amount of new knowledge required	____	____	____	____	
the fish price	____	____	____	____	
having a market order	____	____	____	____	
regulations limiting catch	____	____	____	____	
previous experience with the alternative	____	____	____	____	
season of the year	____	____	____	____	
distance to travel	____	____	____	____	
cost to switch	____	____	____	____	
time required to make the switch	____	____	____	____	
weather conditions	____	____	____	____	
(Other, Specify)	____	____	____	____	

Date / / Time : Interviewer Initials______

In the following questions, we'd like to ask your opinion about several topics related to fishing.

7. Please tells us the importance of these factors in contributing to the risk of fishing as a business.

	Very Important	Somewhat Important	Neither Important	Not Important	Comments
weather	____	____	____	____	
changes in fish availability	____	____	____	____	
number of boats fishing	____	____	____	____	
fish prices	____	____	____	____	
insurance costs	____	____	____	____	
processor limits	____	____	____	____	
regulation changes	____	____	____	____	
uncertainty about future earnings	____	____	____	____	
what other fishermen are doing	____	____	____	____	

8. What factors create the greatest risk in fishing? (Try to obtain at least three)

____
____
____

9. What things make fishing most rewarding? (Try to obtain at least three)

____
____
____

Date / / Time : Interviewer Initials_______

10. We want to know which fishery management problems are most serious. Please rank the following problems in terms of their seriousness.

	Very Serious	Somewhat Serious	Neither Serious	Not Serious	Comment
stock levels	____	____	____	____	
number of fishermen	____	____	____	____	
gear regulations	____	____	____	____	
management procedures	____	____	____	____	
profitability of fishing	____	____	____	____	
access to fishing opportunities	____	____	____	____	
ability to make a decent living	____	____	____	____	
variability in income	____	____	____	____	

Are there any other problems that need attention?

Now we'd like to know about choices you might make regarding your future in fishing.

11. How long do you expect to continue fishing?

12. If something happened so that you could no longer work as a commercial fisherman what occupation would you pursue?

____

Why this occupation?

Date / / Time : Interviewer Initials_____

13. If fishing is bad, what do you do to make-up lost income?

Thinking of your most recent fishing trip.

14. What did you need to gross for the trip to be successful? Be sure to indicate both the value of the fish and a time period, e.g. dollars per fishing day, dollars per trip, or dollars per year.

15. Thinking of your most recent trip, would you characterize this as very successful____, average____, or not successful at all____.

16. Which of the following was most responsible for ending the trip? Purpose: To establish factors limiting the trip length.

Weather______	Gear Damage_____	Time Away from Home_____
Reached Desired Weight_______	Legal Limit Reached_________	Reached Trip Income Goal______
Completed Trip as Planned_____	Injury_______	Other (please specify) ____________________

17. What were your operating costs for the most recent trip? If annual totals are easier, this is acceptable. Be sure to indicate the time period for which the information applies.

Engine Maintenance ____________________

Gear Repair ____________________

Gear Change ____________________

Fuel and Oil ____________________

Food and Supplies ____________________

Crew Expenses ____________________

Ice and Bait ____________________

Transportation ____________________

Other Expenses ____________________

Date / / Time : Interviewer Initials_____

Background Data: In order to be sure we have adequate coverage of the fishery, we need some background information about you and the vessel you fish.

Length of Time Fishing:

fishery	years crew	years captain	years owner
______________	____	____	____
______________	____	____	____
______________	____	____	____
______________	____	____	____
______________	____	____	____
______________	____	____	____

Currently Own Shares in How Many Boats______

No. of Different Boats Fished Last Year_____

Boat HP____:____:_____ Net Tons_____:_____:___
Crew Size____:____:_____

For the newest boat:

Loran C Plotter__________ Year Installed________

Type of Refrigeration_______________ Year Installed______

List Fish Detection Equipment:

____

____

____

____

____

How Many Trips Do You Make in an Average Year_______

Date / / Time : Interviewer Initials_____

Do you have any income generating occupations other than commercial fishing? ______ If yes, what are they and how do they contribute to your income?

Occupation	Percent of Time	Percent of Income

Which of the following best describes your educational background?

grade school_____
vocational, technical, or community college_____
high school_____
college graduate_____
some college_____
college beyond a bachelor's degree_____

What is your age group?

under 25______ 45-54______

25-34__________ 55-64______

35-44________ 65 and over ______

Is or was your father a professional fisherman? __________

Date / / Time : Interviewer Initials_______

We need information on the boat you fish and annual costs of fishing. You may want to take this sheet with you and return it in this envelope.

Value of Boat: Replacement__________ Market__________ Insured_________

Percent Mortaged__________

How many processors do you work with each year?_________

Crew Share Formula (including captain)__________________

What are your annual costs for

insurance: hull & machinery________,

insurance: protection & indemnity__________

moorage__________

professional services______________

mortgage payment___________

depreciation allowance___________

licenses_____________

association or professional organization dues______________

other expenses (please specify)_______________

Do you calculate returns on investment? Yes No

THANK YOU FOR YOUR HELP AND TIME