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An Evaluation of the Effectiveness of Trip Limits as a Management Tool

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NOTICE

An Evaluation of the Effectiveness of Trip Limits as a Management Tool

by

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TABLE OF CONTENTS

PREFACE

This report was prepared at the request of staff of the Pacific Fishery Management Council and several of its advisory bodies in order to provide timely information to the Council on the effectiveness of past management practices. The results reported are preliminary and subject to change, and focus on one aspect of an ongoing comprehensive bioeconomic study of the west coast trawl fishery. A more detailed final report is being prepared for distribution at a later date.

INTRODUCTION

The U.S. West Coast groundfish fishery off California, Oregon and Washington is a mixed-species fishery, with landings obtained primarily by trawl gear. The fishery expanded greatly during the late 1970's following enactment of the Magnuson Fishery Conservation and Management Act, and a stringent management regime was put into effect during the early 1980's. There were two major objectives of this new regime: to prevent overharvest of individual species, and to maintain a year-round fishery.

Annual landing limits (OY's or ABC's) were determined for many species. For some species these limits were treated as absolute quotas, with landings of the species becoming prohibited once the quota had been reached. In other cases, annual limits served as harvest guidelines. The number of vessels that could participate in the fishery was not restricted. However, regulations that limited the amount of fish that could be landed per fishing trip, and the number of trips that could be conducted per time period by each vessel in the fishery were implemented. The primary purpose of these trip quotas was to slow the rate of landings to enable the fishery to proceed year-round. Given the harvesting capacity of the fleet, it was apparent that without such limits, the annual quotas would be reached rather early in the year.

Because the trip limits applied only to landings (not catch) of particular species, fishing could continue (presumably directed at other species) after trip limits for one or more species were reached. Any catch in excess of the trip limit would be discarded; for temperate water trawl fisheries it is likely that few, if any, of the discarded fish survive. In order to examine the degree to which the regulatory regime promoted discard, an at-sea sampling program of the trawl fishery was conducted from 1985 through 1987. In this report we present preliminary estimates of discard rates for species managed by trip quotas by the Pacific Fishery Management Council based on the results of the field study. In addition, the

effectiveness of the management regime in maintaining a year-round fishery and conserving fish stocks is evaluated. Finally, we briefly discuss possible alternatives to the current form of management.

METHODS

Field Study

Data were collected aboard commercial groundfish trawl vessels operating out of the ports of Newport, Astoria, and Coos Bay, Oregon from June 1985 through December 1987. Participation in the study by vessel skippers and owners was voluntary. An observer was stationed aboard each vessel for the duration of each trip sampled. Trips were conducted under normal production fishing conditions; the skipper determined the fishing activities undertaken by the vessel and crew. In selecting vessels for sampling trips we attempted to obtain a representative, random sample of the fishing activities that occurred out of each study port during each quarter.

For each trip sampled, the observer recorded information on start date, end date, activities undertaken (eg. fishing, handling and sorting catch, drifting, running to grounds), gear on board, trip expenses, and processor limitations on catch by species. The beginning and ending locations, bottom depth, gear depth, gear characteristics, target species, and tow speed were recorded for each tow. Based on these characteristics, each tow was assigned to one of five fishing strategy categories. When the total catch weight of a tow was small the entire catch was sampled. Otherwise, total catch weight was estimated visually, and a random sample of the catch was taken. The sample was then sorted and the total weight and number of individuals in the sample were recorded by species. Each species sample was further sorted into utilized (landed), and discarded portions, and each of these portions were weighed and enumerated. Length measurements were also taken for some species to the extent permitted by the time available between tows.

Total numbers and weight caught were estimated by multiplying the number or weight, respectively, of each species in the sample by the ratio of total tow weight to total

sample weight. For discarded portions of the catch, the reason for discarding was determined in consultation with the crew.

Data Analysis

Analyses were performed on an individual species basis because of differences among species in the magnitude, duration and applicable area of trip quotas. Data were further partitioned by time periods corresponding to different trip limits, by fishing strategy or gear type, and by area when appropriate.

In order to estimate total catch and discard of each species, data from the field study and commercial landings records obtained from the PacFIN data base[1] were examined. Stratification of data was limited by the level of resolution of the PacFIN data base which contains daily aggregate catch by gear type, date and location. Gear types included in the PacFIN data base were non-trawl, midwater trawl, shrimp trawl and bottom groundfish trawl. The field study data base distinguished several types of groundfish bottom trawls but did not include information for non-trawl gear. Thus, in the analyses performed data from all groundfish bottom trawl tows were combined and it was assumed that no discard occurred for non-trawl gear types.

For time periods during which landings of a species were permitted, the total catch, C, for each gear type was estimated as $C = L/(1-p)$ where p = fraction of the catch discarded (from the field study), and L = landings from the PacFIN database. For time periods during which landings of a species were prohibited, catch was estimated as the product of the number of groundfish deliveries during the time period (from PacFIN) and the average catch of the species per trip (from the field study). Total annual catch was estimated by summing catches for each gear type and time period.

1PacFIN (Pacific Fisheries Information Network) data were obtained from W. Daspit, Pacific Marine Fisheries Commission, 7600 Sand Point Way, NE, Seattle, WA 98115

RESULTS

Management Restrictions

From 1985 through 1987 landings of five species and/or species groups were subject to trip limit restrictions (Table 1). These were Pacific ocean perch (*Sebastes alutus*), yellowtail rockfish (*Sebastes flavidus*), widow rockfish (*Sebastes entomelas*), sablefish (*Anoplopoma fimbria*) and the Sebastes complex. The Sebastes complex includes all rockfish except widow rockfish, Pacific ocean perch, thornyheads (*Sebastolobus* spp.) and shortbelly rockfish (*Sebastes jordani*). Because yellowtail rockfish were considered part of the Sebastes complex, landings of that species counted towards both yellowtail and Sebastes complex trip quotas.

During the course of the study the Pacific Fishery Management Council adjusted trip quotas at various times in an attempt to maintain a year-round fishery. When cumulative landings significantly exceeded projected landings at a given time of year, trip quotas were adjusted downward, and vice versa. Generally, trip quotas were adjusted downwards within each year, with some notable exceptions seen for Sebastes complex and yellowtail rockfish. Widow rockfish trip quotas varied by an order of magnitude (from 30,000 lbs/trip to 3,000 lbs/trip) within each year. The lower (3,000 lb.) limit was intended to be an "incidental" catch allowance, to prevent waste of widow rockfish during trawling directed at other species. Pacific ocean perch has been considered a severely depleted species, thus the low trip limits in force for this species during all three years were also intended as incidental catch allowances.

There were three occasions when landings of a species were prohibited. In December of 1985 and November-December of 1987, landings of sablefish were prohibited coastwide following attainment of annual quotas. Similarly, widow rockfish became a prohibited species near the end of 1987. Thus, while some trawling activity was permitted year-round during the three year period, the regime was not successful in maintaining a year round fishing season for all species regulated by trip quotas. In addition, seasonal adjustments

made to trip limits led to very uneven levels of allowable fishing activity within years, with incidental catch levels prevailing for several important species during a significant part of each year.

Sampling Coverage

Forty commercial fishing vessels participated in the field study. A total of 1470 tows were sampled during 139 trips conducted between June 1985 and December 1987 (Table 2). Sampling was concentrated off Oregon but also included much of the area off the Washington coast (Figure 1).

Five major fishing strategies, distinguished by gear used, target species, and depth of fishing, were observed. These were: 1) Bottom rockfish trawling (BRF); tows conducted using roller gear on the ocean bottom, with the primary target of the tows being one or more species of rockfish. 2) Midwater trawling (MID); tows conducted using midwater trawl gear above bottom; primary target species are widow rockfish and Pacific hake (*Merluccius productus*). 3) Deepwater Dover sole trawling (DWD); tows conducted on bottom in areas generally exceeding 100 fathoms depth, using mud-gear, roller gear or mud-roller combination gear. An important target species of the fishing strategy was Dover sole, (*Microstomus pacificus*), but sablefish and *Sebastolobus* spp. were also important components of the catch. 4) Nearshore mixed-species trawling (NSM); tows conducted using mud gear on bottom in areas generally less than 100 fathoms depth; primary target species were a mixture of flatfish. 5) Shrimp trawling (SHR); tows conducted using shrimp trawls, targeting primarily on pink shrimp (*Pandalus jordani*).

Catch Composition

For all fishing strategies combined almost 50% of the total catch weight sampled was comprised of species regulated by trip limits (Figure 2). However, the relative importance of regulated species differed among fishing strategies. About 80% of the catches of the BRF

and MID strategies consisted of species regulated by trip quotas, whereas such species comprised only a minor portion of the catches of the NSM and SHR strategies. Trip landings restrictions applied to almost 40% of the catch weight obtained by the DWD strategy.

The strategies differed in the species composition of the catch. Widow rockfish predominated in the catch of the MID strategy, and formed a significant share of the catch of the BRF strategy. Sablefish was an important component of the catch of the DWD strategy, but formed a relatively small portion of the catch of the other strategies. Of the species regulated by trip quotas, those in the Sebastes complex ranked first in importance in the BRF strategy and second in importance for the DWD strategy. Yellowtail rockfish comprised a large share of the catch of the BRF strategy, but was relatively unimportant for the other strategies. Pacific ocean perch comprised less than 5% of the catch for each of the strategies, but was most commonly encountered in the BRF and DWD strategies.

Discard Rates

Some discard of catch was observed for each of the species managed by trip quotas but the magnitude of discard varied by species, gear type, and time period (Table 3). Discard rates were highest for Sebastes complex, sablefish, and widow rockfish, and relatively low for Pacific ocean perch and yellowtail rockfish. For shrimp trawls, although the percent of the catch discarded was relatively high (Table 3), overall discard was small because species regulated by trip quotas comprised a small percentage of the shrimp fishery catch (Figure 2).

For each species, the rate of discard varied inversely with the magnitude of the trip limit. In some cases the change in discard rates observed during different time periods was quite large. For example, for widow rockfish caught by groundfish bottom trawls only 5.7% of the catch was discarded when landing limits were 30,000 lbs/week, whereas 52.3% of the catch was discarded during 3,000 lb trip limit periods. Under a minimally restrictive limit (no more than 5,000 lbs of fish under 22" length; essentially a size limit restriction) 15.3% of the catch of sablefish was discarded, compared to a 20.4% discard rate during times when

landings of sablefish were limited to between 6,000 and 12,000 lbs per trip. As expected, 100% of the catches of widow rockfish and sablefish were discarded during times when landings of these species were prohibited.

Reasons for Discard

Fishermen attributed the discard of fish to one of five reasons: 1) market; the species being discarded had a limited market and the processor would not purchase the fish; 2) size; the species was marketable but the particular fish being discarded were below the minimum acceptable market size and would not be purchased; 3) highgrading; the fish being discarded were of a marketable species and of adequate size for purchase; however, their per-unit weight ex-vessel value was not as great as that of other fish. 4) regulation; the landing quota for the species was previously met, thus landing of the fish would be illegal, despite the fact that they were fully marketable. 5) other; discards were rarely attributed to causes other than 1)-4) above. Miscellaneous reasons for discards included attaining full hold capacity; all miscellaneous reasons were combined into a single category.

For the five species groups discussed in this report, which are all managed by trip quotas, the majority of the discard was attributed to regulations (Figure 3). Virtually all of the widow and yellowtail rockfish discard, and about 75% of the Pacific ocean perch discard was regulation-induced. The only species group for which regulations did not account for the majority of the discard was the Sebastes complex.

Sablefish was the only species for which processors commonly paid a higher price per-unit weight for larger fish than for smaller fish, and consequently it was the only species for which a significant fraction of the total discard was attributed to highgrading. The restrictive landing limits in effect for sablefish during much of the three year period increased pressure to maximize the value of the landed catch, which in essence, increased the probability of highgrading of the catch. Thus, highgrading could be considered one manifestation of the effects of trip quotas. Combining the discard attributed to the regulation

and highgrade categories, more than 60% of the discard of sablefish were a result of trip quotas.

The size of the fish caught was another important factor in causing discard. Most of the discard of the Sebastes complex was attributed to fish size, as was approximately 25% and 38%, respectively, of the discard of Pacific ocean perch and sablefish. Market limitations were not a significant factor in causing discard of species regulated by trip quotas.

Estimates of Total Catch

Total catch was estimated for each year for each the two species managed by annual quotas: widow rockfish and sablefish. For both species reported landings were close to annual quotas in each year (Figures 4 and 5). However, total catch consistently exceeded both landed catch and annual harvest goals.

For widow rockfish, the ratio of estimated total catch to landed catch was 1.19, 1.13, and 1.15, for 1985, 1986 and 1987, respectively (Figure 4). The ratio of total catch to annual quota ranged from 1.06 to 1.16 among years. The discard of widow rockfish was greatest in 1987, the only year during which landings of widow rockfish were prohibited for some time. The ex-vessel value of the discarded widow rockfish averaged approximately one million dollars per year. Non-trawl landings of widow rockfish were small in comparison with trawl landings. Thus, failure to account for discard by non-trawl fisheries is unlikely to have had a major influence on these results.

Both trawl and non-trawl landings contributed significantly to the total catch of sablefish (Figure 5). The ratio of total catch to landed catch ranged from 1.11 to 1.20, and the ratio of total catch to annual quota was 1.24, 1.07 and 1.28 in 1985, 1986, and 1987, respectively. Discard of sablefish was higher in 1985 and 1987 (the two years when landings were prohibited at year-end) relative to 1986. Of particular interest are the patterns of catch and discard seen between 1986 and 1987. Although the annual quota was reduced in 1987, the catch in that year actually exceeded that of the previous year (Figure 5). The ex-vessel value of the marketable sablefish discarded averaged approximately $800,000 per year. This

excludes the potential market value of the fish discarded because of size, some of which would have survived to contribute to the fishery at a later time had their capture been avoided.

Association of sablefish and Dover sole

The association of Dover sole and sablefish provides one example of the problems that can arise when single species trip quotas are applied in a mixed species fishery. Figure 6 illustrates the catch rate of sablefish relative to that of Dover sole in bottom groundfish trawls for various time periods. In each case there is a significant positive association between catch rates of the two species, but also a great deal of variability. The regression lines for the different time periods are very similar, even when landings of sablefish were prohibited.

The deepwater Dover sole fishery accounted for the majority of the trawl catch of sablefish. The strong association between sablefish and Dover sole was clearly evident for this strategy, however, the catch rate of sablefish relative to that of Dover sole was significantly lower when landings of sablefish were prohibited compared to other time periods (Figure 7). The average catch of sablefish (in pounds per trawling hour) declined from 143.6 under a size regulation (no more than 5,000 lbs. of fish under 22" total length) to 94.9 when landings of sablefish were prohibited. Interestingly, catch rates were highest when trip limits were between 6,000-12,000 lbs/trip. The differences in catch rates observed may not be directly attributable to changes in regulations. For example, some of the variation may have been caused by the time of year different regulations were in place and changes in the spatial overlap of the species among seasons and years. Generally trip limits decreased within years, and prohibited time periods always occurred at year-end.

While catch rates of sablefish were lowest when landings were prohibited, it is clear that significant quantities of sablefish were still being caught (and discarded) during those times, despite the fact that there was no incentive for fishermen to catch them. These results

demonstrate that it is not possible to limit the catch of sablefish independent of the catch of Dover sole.

DISCUSSION

The estimates of catch and discard presented in this report were based on data obtained from a sample of trips made by a sample of vessels in the west coast trawl fleet. The accuracy of these estimates depends upon how representative the trips sampled were of the total fleet activity. As of this date no formal analysis of this question has been performed. The geographic extent of the study was limited to the area off the Oregon and Washington coasts, with a focus on the Oregon-based fishery. However, within the areas sampled, coverage was rather extensive. At present, there is no reason to suspect that the activities of the vessels observed differed significantly from others in the area studied. Confidentiality of individual vessel activities, and the fact that discard of fish is legal under the present management system are factors that tend to promote integrity of the data.

There are several inferences that can be drawn from the results regardless of the precise relationship of the data obtained to that of the fishery at large. It is clear that significant quantities of fish are being discarded at sea, and that for species examined in this report, the majority of the discard was attributed by fishermen to trip limit restrictions. The magnitude of discard observed differed among species and among time periods for individual species. There was a strong tendency for the magnitude of discard to increase as regulations became more restrictive. Because the majority of the fish discarded were of marketable quality, and because few of the discarded fish can be expected to survive, these discards represent a significant economic loss.

Effectiveness of Trip Limits in meeting management goals

Trip limits were intended to maintain a year-round fishing season while avoiding overharvest of key species. The results presented here indicate that the actual performance of the management regime from 1985 through 1987 fell short of these objectives. While

some groundfish fishing was permitted year round, there were several months during which landings of one or more species were prohibited, and large portions of all years during which landings of key species were severely restricted. Our results also indicate that while landings of sablefish and widow rockfish (the two species managed by annual quotas (OY's) in addition to trip limits) were close to annual harvest goals, the estimated total catch exceeded the annual quota in every year examined. In 1987 the ratio of total catch to annual catch quota was 1.16 for widow rockfish and 1.28 for sablefish.

The long-term consequences of this management scheme are difficult to predict. Trip limits may vary greatly both within and between years due to changes in annual quotas and variation in the number of vessels participating in the fishery. For a given annual quota, an increase in the number of participants would likely result in lower trip limits, and vice versa. Currently, fleet size is not restricted and varies, in part, with changes in accessibility and profitability of alternative fishing opportunities. During the course of the study the shrimp fishery was particularly profitable, which may have diverted effort away from the groundfish fishery. Were shrimping to decline in importance, increased pressure on groundfish resources might result, along with lower trip limits and greater quantities of waste.

The results reported here also raise a concern about the ability to monitor the effectiveness of the management regime in the future. The observer study was a limited duration research project, and there are no plans at present to continue monitoring catch in this fishery. While the study results may have some value for predicting the impacts of future trip quotas, the variability seen during the study period indicates that considerable uncertainty might apply to such predictions.

Experience with the current management system of trip and annual single-species quotas indicates that it has been unsuccessful in meeting conservation goals and maintaining a year-round fishery, and has led to a significant waste of fish. Because most of the stock assessments rely on catch data, regulation-induced discard may also have introduced errors in abundance estimates for those species managed by trip quotas. Because of the limited

ability to monitor the catch, the effectiveness of the regime will be difficult to evaluate in the future. For these reasons it is important to consider alternative forms of management.

Alternatives to the current system of management

The following is intended to be a brief discussion of some alternatives that may warrant further exploration. Some of these alternatives are currently being investigated, and there may be other promising techniques not included here. We present these in order to indicate some of the possibilities and their potential advantages and disadvantages, and not to advocate one or another.

1. Maintain the present system of trip quotas, but develop more appropriate quotas (for example, based on a predictive model of catch rates and discards). This approach would not eliminate waste and would also have the disadvantage of being difficult to evaluate without direct monitoring of catch. Prediction of discard rates has the advantage of allowing estimates to be incorporated into stock assessments, and would be least disruptive of current practices.

2. Establish quarterly or trimesterly quotas and eliminate trip quotas; shut down the fishery once quotas for a time period have been reached. Annual quotas could be allocated among time periods in whatever manner seemed most appropriate. This method has the advantage of reducing discard and maintaining groundfish fishing throughout the year. Disadvantages are that landings would need to be tracked more carefully, and that the seasonal quotas could be depleted rapidly if a "race for fish" results.

3. Replace trip *poundage* limits with trip *time* limits. This method has the advantage of reducing catch rates and maintaining a year-round fishery without promoting discard. It also eliminates the "race for fish" that could occur with option 2. Biweekly and twice-weekly time limits could be established, similar to those that have been in effect for poundage limits. Because options 2 and 3 both reduce discard, the ability to evaluate their effectiveness is greater than that of option 1. A disadvantage is that neither of these alternatives provides a disincentive for targeting on key species groups.

4. Make greater use of gear restrictions. Possibilities include prohibiting use of particular gear types at certain times of year, and changing the minimum legal mesh size. Mesh size regulations could be used in two different ways: a change in mesh size could increase sustainable yields, thus permitting higher trip and annual quotas to be established. Changes in mesh size can also be used as an alternative to trip quotas to reduce catch rates and spread fishing effort throughout the year. Work in progress is examining these options in greater detail.

5. Restrict the number of participants in the fishery. Limiting fleet size could reduce the need to restrict the activities of the participants. Given current fleet size, this option could be highly disruptive. In addition, the issue of meeting conservation goals for individual species would still need to be addressed.

6. Change the objectives of management. Present management objectives implicitly include obtaining MSY for each species. One alternative objective would be to manage the multispecies complex for MSY, which could result in reducing some stocks below MSY levels, while maintaining others above MSY. Implementation of this approach would require a change in the way assessments were performed. In contrast to an independent series of single species assessments, a multispecies assessment could account for technological interactions among species (ie. the fact that some species are caught together). Another objective that could be reconsidered is that of maintaining a year-round fishery.

7. Combination of 1-6 above, and/or other alternatives. It is clear that both the fishery and the management problem being faced are complex. The alternatives listed above are not a complete set, nor are they mutually exclusive. Combinations of the above alternatives may offer the most appropriate solution to management concerns.

CONCLUSIONS

A three year study that included at-sea observations aboard commercial trawl vessels indicates that significant quantities of fish were discarded between 1985 and 1987 as a result of single species trip quotas. The rate of discard varied among species and time periods, and tended to increase as trip regulations became more restrictive. The discards represent a significant economic loss, and also a loss of information. Most stock assessments rely importantly on catch data, and when discards occur and are not accounted for, errors may ensue. While the observer study provided estimates of total catch and discard for the three year period, no long-term monitoring program is in force to provide such estimates for future years.

During the three years of observation, the management regime failed to meet its two major goals: to conserve key species and to maintain a year-round groundfish fishery. For sablefish and widow rockfish, the catch significantly exceeded annual quotas despite the fact that landings were similar to quota levels. While some groundfish fishing was permitted year-round, there were several instances when landings of key species were prohibited, and large portions of all years when landings were severely restricted. Future performance of this management regime is difficult to predict and will be difficult to evaluate.

Given the failure of the current system to meet management goals it would appear warranted to explore some alternatives. Seven alternatives were briefly discussed in this report including: 1) modification of the trip poundage quota system, 2) elimination of trip quotas and establishment of quarterly or trimesterly quotas, 3) replacement of trip poundage limits with trip time limits, 4) greater reliance on gear regulations in management, 5) limitation of the number of participants in the fishery, 6) modification of the objectives of management, (for example, from a single-species to a multispecies perspective), 7) some combination of the above alternatives. Both the fishery and the management problems it faces are complex, and further work on the advantages and disadvantages of these and other alternatives is needed.

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LIST OF TABLES

Table 1.--Trip limit restrictions pertaining to west coast groundfish vessels in the Columbia Area from July 21, 1985 through December 31, 1987. On some occassions biweekly and twice-weekly landing options were available, and trip limits for these options were generally twice and one-half, respectively the weekly trip limit. For simplicity, only limits for weekly options are shown.

Species or Species Group	Effective Dates	Regulation
Pacific Ocean Perch	1/1/85 - 4/27/85	20% of the catch
	4/28/85 - 12/31/85	5,000 lbs. or 20% of the catch, whichever is less
	1/1/86 - 12/31/86	10,000 lbs. or 20% of the catch, whichever is less
	1/1/87 - 12/31/87	5,000 lbs. or 20% of the catch, whichever is less
Sebastes Complex	1/1/85 - 4/27/85	30,000 lbs./week
	4/28/85 - 10/3/85	15,000 lbs./week
	10/4/85 - 12/31/85	20,000 lbs./week
	1/1/86 - 8/28/86	25,000 lbs./week
	8/29/86 - 12/31/86	30,000 lbs./week
	1/1/87 - 12/31/87	25,000 lbs./week
Yellowtail rockfish	1/1/85 - 4/27/85	10,000 lbs./week
	4/28/85 - 10/3/85	5,000 lbs./week (15,000 lbs. Sebastes)
	10/4/85 - 12/31/85	5,000 lbs./week (20,000 lbs. Sebastes)
	1/1/86 - 8/28/86	10,000 lbs./week
	8/29/86 - 12/31/86	12,500 lbs./week
	1/1/87 - 7/21/87	10,000 lbs./week
	7/22/87 - 12/31/87	7,500 lbs./week

Table 1. continued

Species or Species Group	Effective Dates	Regulation
Widow rockfish	1/1/85 - 7/24/85	30,000 lbs./trip
	7/25/85 - 12/31/85	3,000 lbs./trip
	1/1/86 - 9/27/86	30,000 lbs./week
	9/28/86 - 12/31/86	3,000 lbs./week
	1/1/87 -10/13/87	30,000 lbs./week
	10/14/87 - 11/24/87	5,000 lbs./week
	11/25/87 - 12/31/87	prohibited
Sablefish	1/1/85 - 11/24/85	22" size limit with an incidental allowance of 5,000 lbs. of fish under 22" length
	11/25/85 - 12/5/85	13% of catch
	12/6/85 - 12/31/85	prohibited
	1/1/86 - 8/21/86	22" size limit with an incidental allowance of 5,000 lbs. of fish under 22" length
	8/22/86 - 10/22/86	8,000 lb./trip
	10/23/86 - 12/31/86	12,000 lb/trip
	1/1/87 -10/1/87	22" size limit with an incidental allowance of 5,000 lbs. of fish under 22" length
	10/2/87 - 11/4/87	6,000 lb. or 20% of the catch, whichever is greater
	11/5/87 - 12/31/87	prohibited

Table 2.--Number of tows and trips sampled throughout the study (from June 1985 through December 1987) by port and fishing strategy (BRF = bottom rockfish trawling, DWD = deep water Dover sole trawling, MID = midwater trawl, NSM = nearshore mixed-species trawl, SHR = shrimp trawl).

Port	No. of Tows by Fishing Strategy						No. of Trips
	BRF	DWD	MID	NSM	SHR	ALL	
Astoria	114	109	10	118	60	411	38
Newport	125	233	24	124	63	569	58
Coos Bay	137	160	6	57	130	490	43
Total	376	502	40	299	253	1470	139

Table 3.--Percent of the catch (in weight) discarded during different trip limit regimes.

Species	Gear Type	Time Period	% Discard
Widow rockfish	Bottom groundfish trawl	30,000 lb. limit	5.7%
		3,000 lb. limit	52.3%
		Prohibited	100.0%
	Midwater Trawl	30,000 lb. limit	17.6%
Sablefish	Bottom groundfish trawl	no more than 5,000 lb. of fish < 22" length	15.3%
		6-12,000 lb./trip	20.4%
		Prohibited	100.0%
	Shrimp Trawl	all	75.5%
Pacific ocean perch	Bottom groundfish trawl	10,000 lb.	0.6%
		5,000 lb.	7.6%
	Shrimp Trawl	10,000 lb.	37.9%
		5,000 lb.	95.7%
Sebastes complex	Bottom groundfish trawl	25,000 lbs or greater	12.4%
		20,000 lbs or less	42.5%
	Midwater trawl	all	8.4%
	Shrimp trawl	all	46.1%
Yellowtail rockfish	Bottom groundfish trawl	less than 10,000 lbs.	9.1%
		10,000 lbs. or greater	6.1%
	Midwater trawl	all	0.1%
	Shrimp trawl	all	0.4%

LIST OF FIGURES

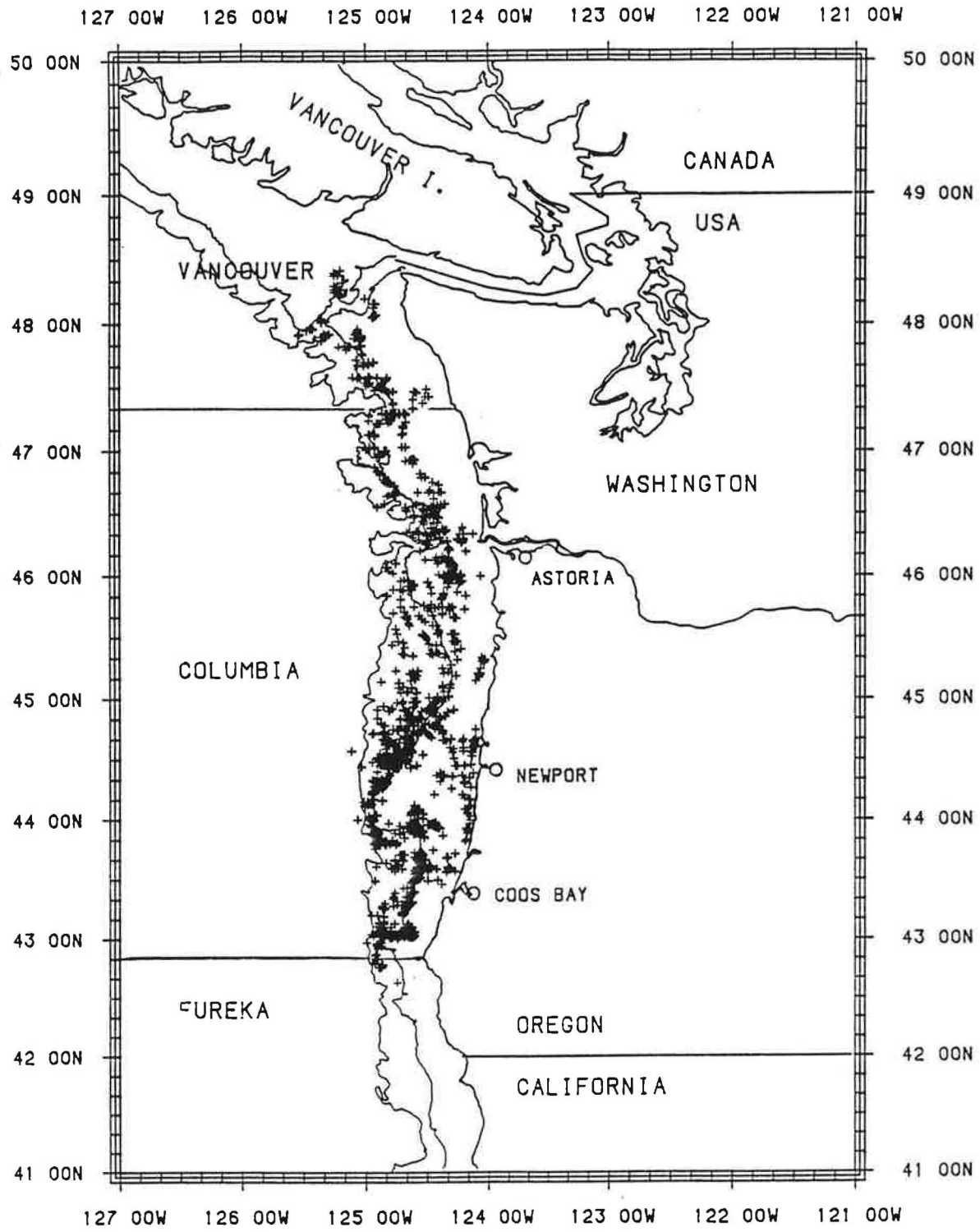

Figure 1.--Locations sampled from 1985 through 1987. Both 100 fathom (inner) and 500 fathom (outer) contour lines are shown for perspective.

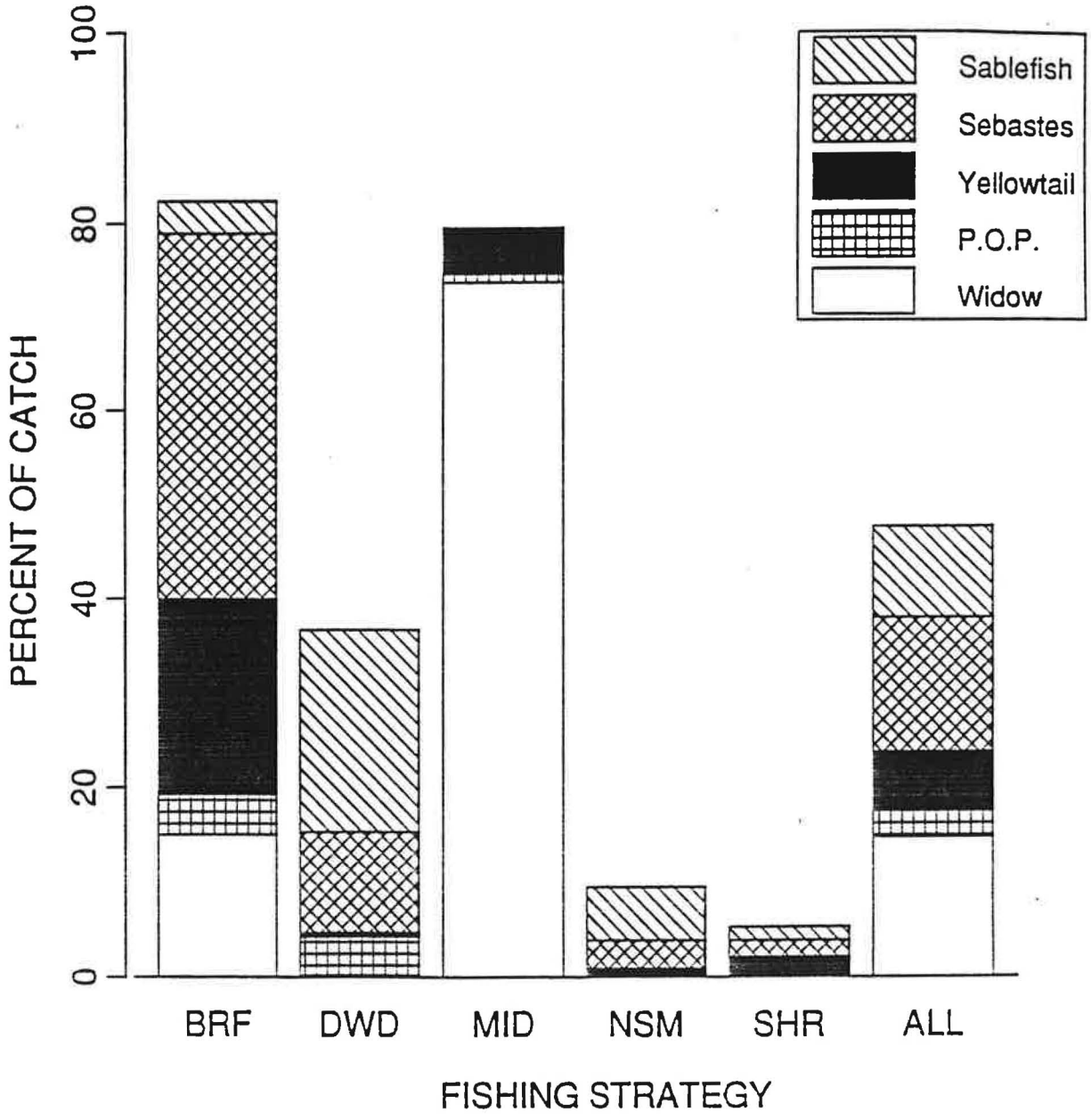

Figure 2.--Percent of the catch composed of species regulated by trip quotas for different fishing strategies (BRF = bottom rockfish strategy, DWD = deepwater Dover sole trawling; MID = midwater trawling; NSM = nearshore mixed species trawling; SHR = shrimp trawling; ALL = all fishing strategies combined). See text for further explanation

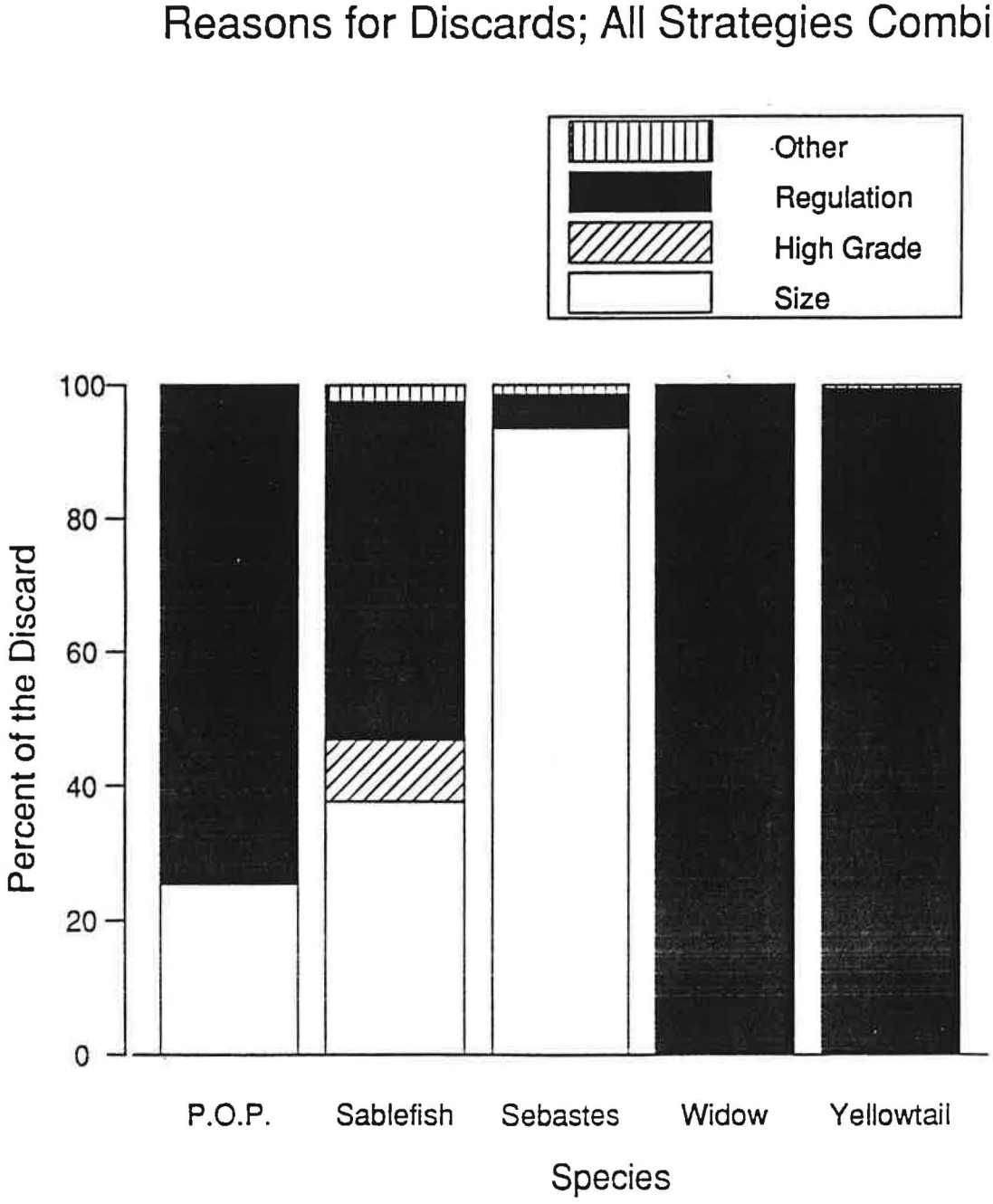

Figure 3.--Percent of the discarded catch (by weight) attributed to various causes by fishermen (Reasons: REGULATION = trip limit for species previously reached; HIGHGRADE = fish have lesser value per unit weight than other individuals, but are marketable; SIZE = fish are below the minimum acceptable market size; OTHER = other reason for discard/ Species: P.O.P. = Pacific ocean perch; SEBASTES = Sebastes complex; WIDOW = widow rockfish; YELLOWTAIL = yellowtail rockfish).

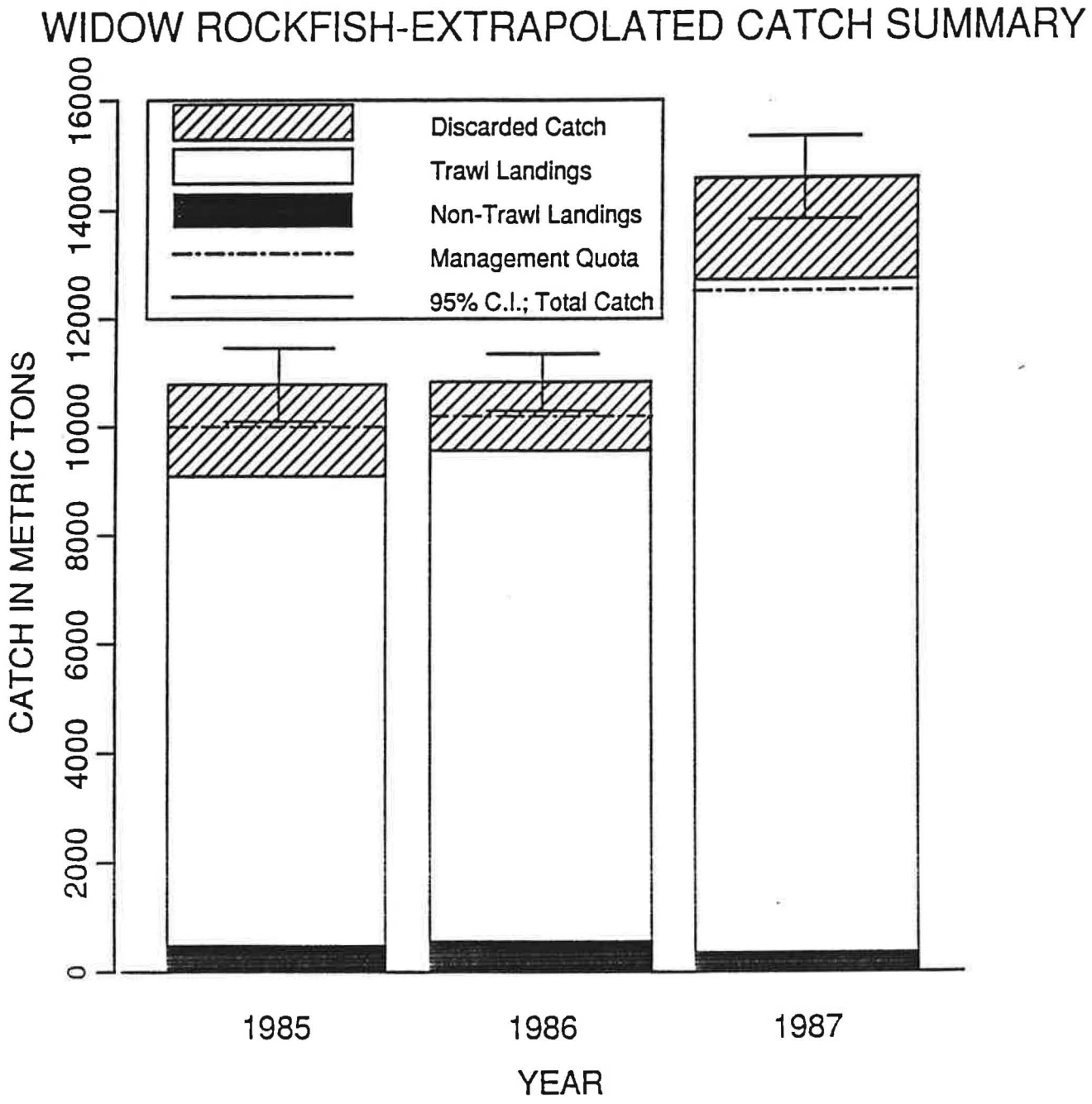

Figure 4.--Estimated coastwide catch (non-trawl catch = black, trawl landings = white, trawl discard catch = hatched) of widow rockfish and annual management quota (OY, dashed line), for each of the years 1985-1987. Landings data are from the PacFIN data base, discarded catch was estimated for the trawl fishery based on data from both the observer study and the PacFIN data base (see text). No information on non-trawl discard was available; thus the above figures do not reflect any discard that may occur in this portion of the fishery.

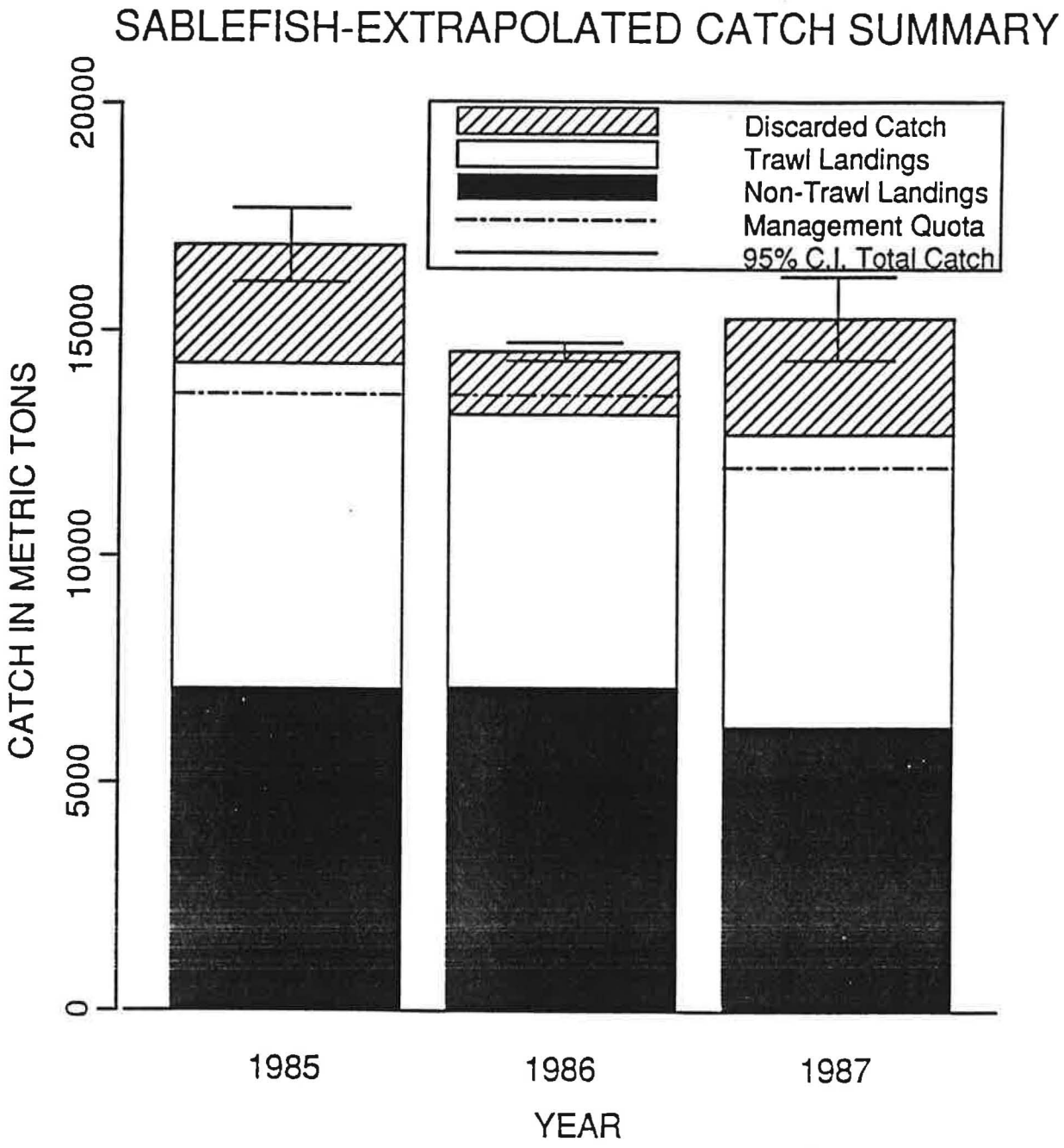

Figure 5.--Estimated coastwide catch (non-trawl catch = black, trawl landings = white, trawl discard catch = hatched) of sablefish and annual management quota (OY, dashed line), for each of the years 1985-1987. Landings data are from the PacFIN data base, discarded catch was estimated for the trawl fishery based on data from both the observer study and the PacFIN data base (see text). No information on non-trawl discard was available; thus the above figures do not reflect any discard that may occur in this portion of the fishery.

Figure 6.--Plot of $\log_e$(catch of sablefish/trawling hour) versus $\log_e$(catch of Dover sole/trawling hour) by tow, and regression lines for bottom groundfish trawl tows during different management periods (A = 22" size limit for sablefish with an incidental allowance of 5,000 lbs of fish less than 22" total length; B = landing limit of between 6,000 and 12,000 lbs per trip; C = landings of sablefish prohibited; D = regression lines for all time periods.

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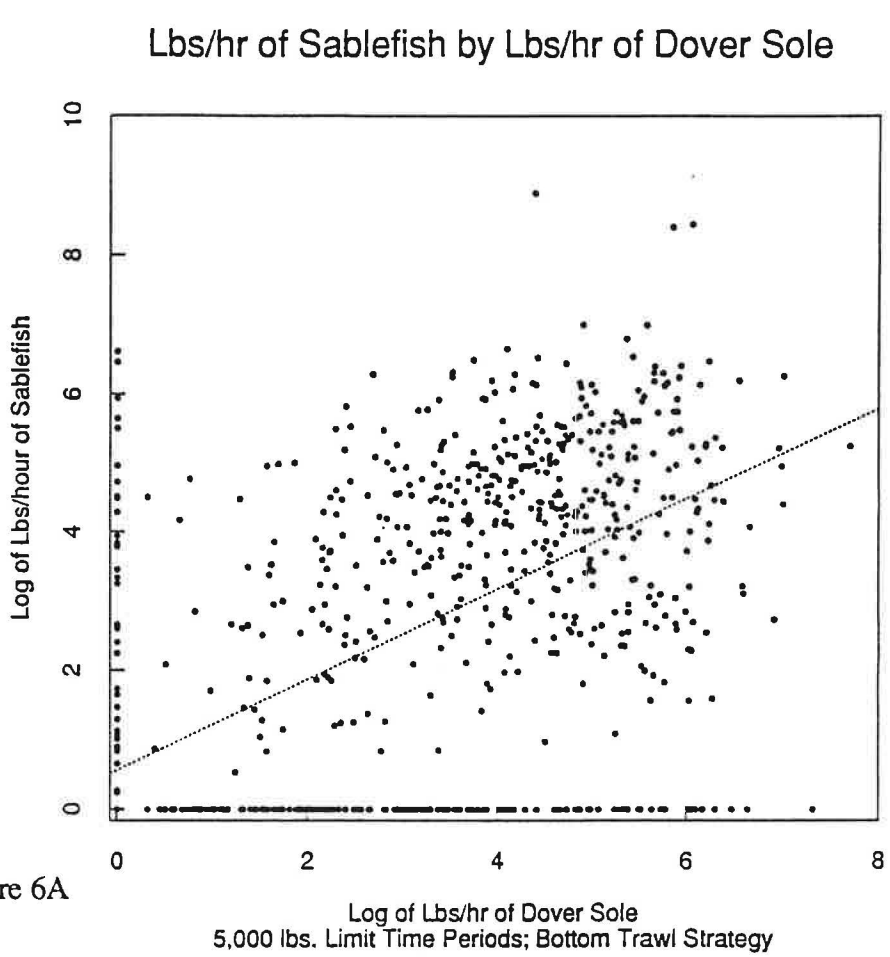

Figure 6A

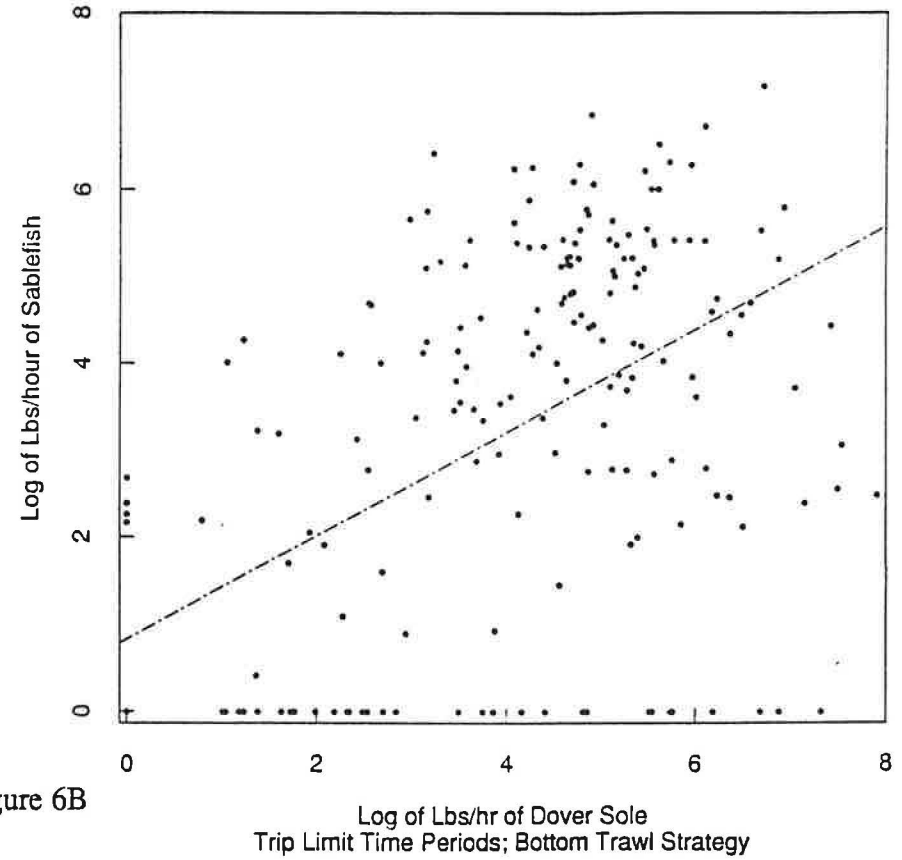

Figure 6B

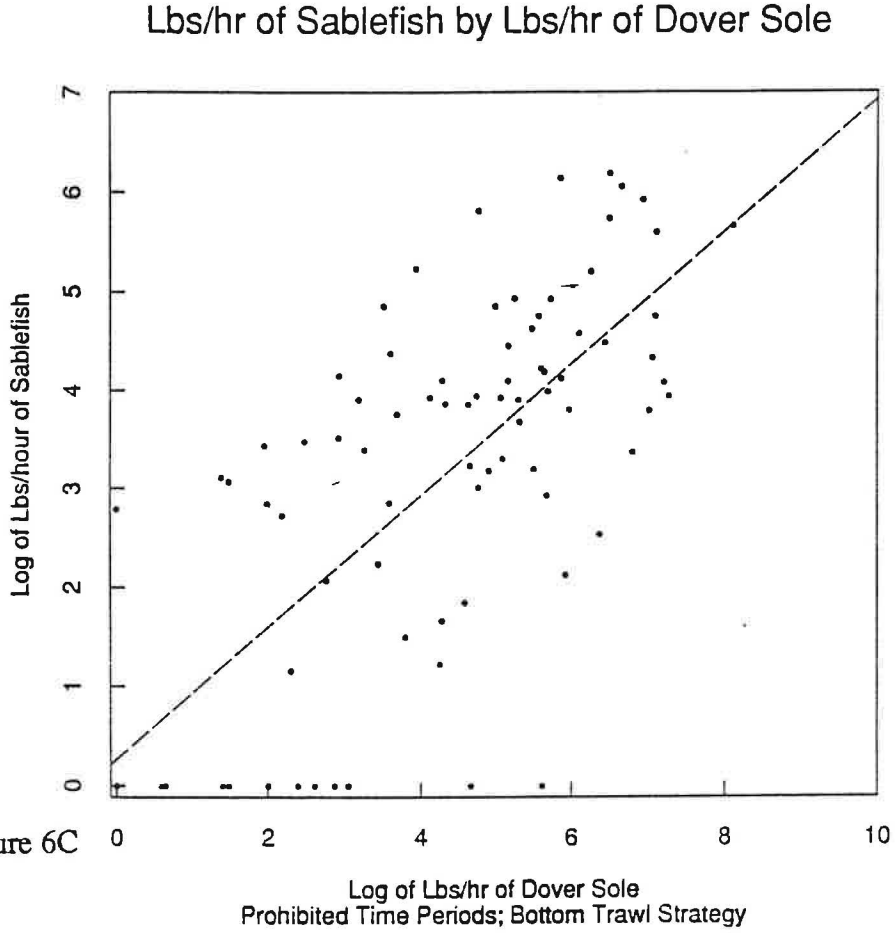

Figure 6C

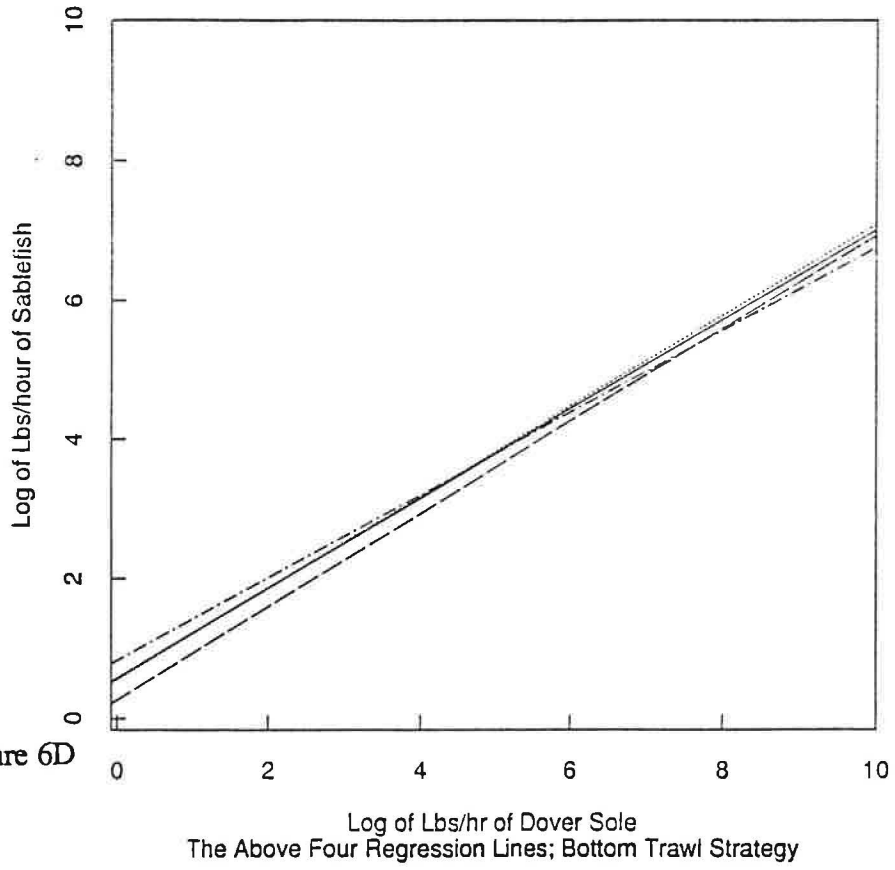

Figure 6D

Figure 7.--Plot of $\log_e$(catch of sablefish/trawling hour) versus $\log_e$(catch of Dover sole/trawling hour) by tow, and regression lines for deepwater Dover sole trawl tows during different management periods (A = 22" size limit for sablefish with an incidental allowance of 5,000 lbs of fish less than 22" total length; B = landing limit of between 6,000 and 12,000 lbs per trip; C = landings of sablefish prohibited; D = regression lines for all time periods.

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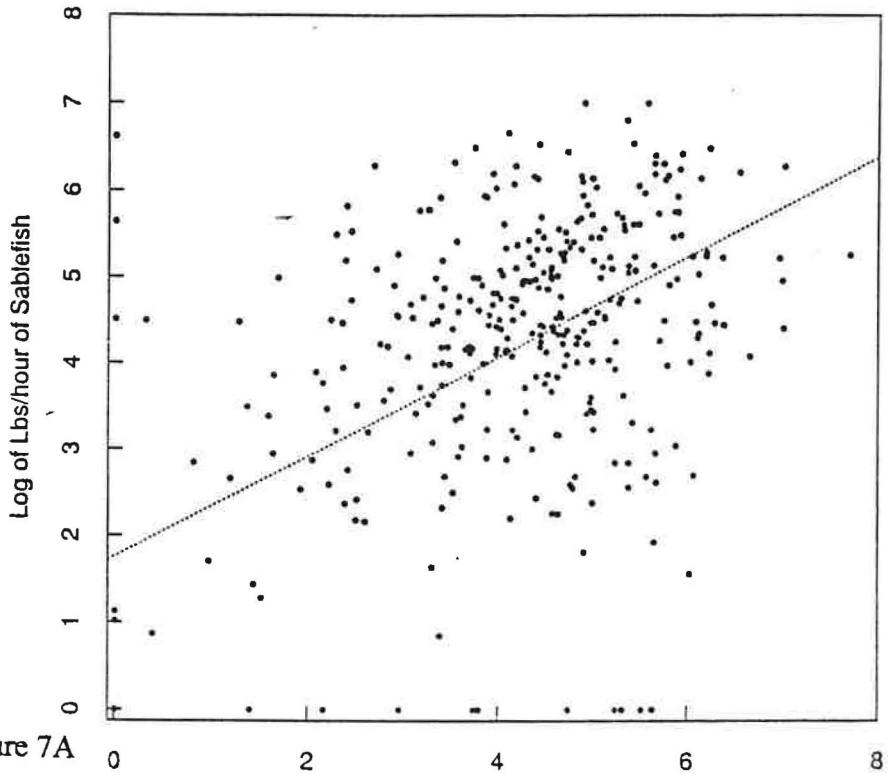

Figure 7A

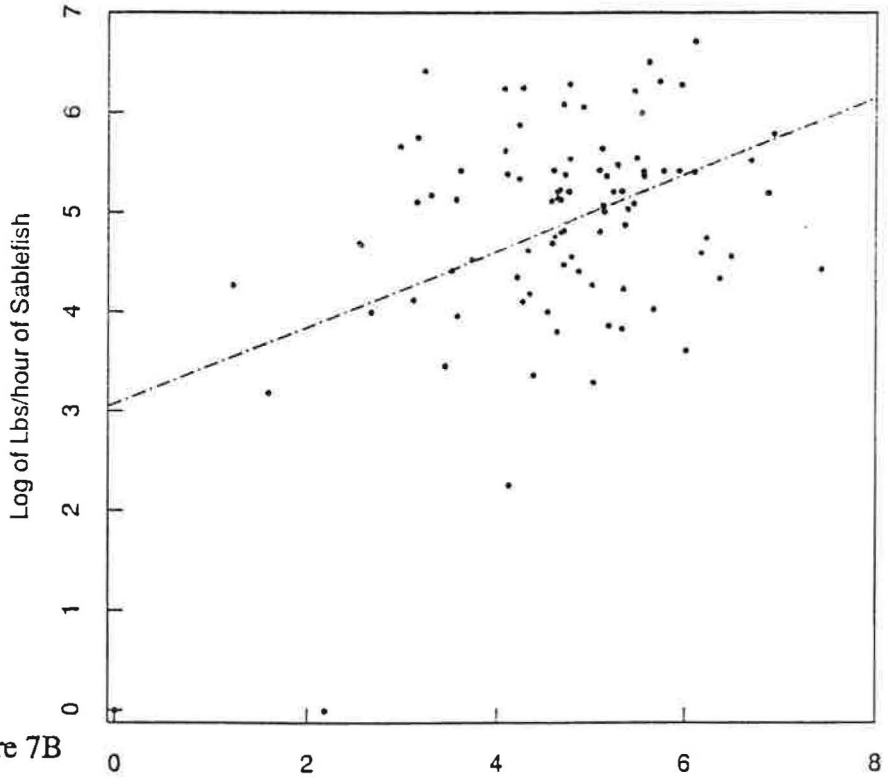

Figure 7B

Lbs/hr of Sablefish by Lbs/hr of Dover Sole

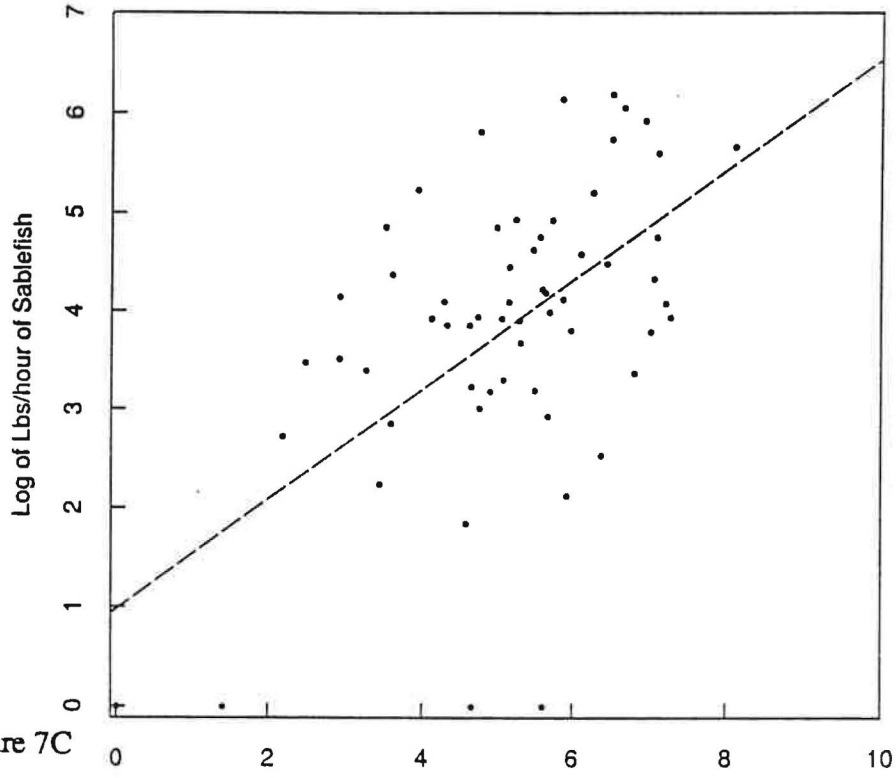

Figure 7C

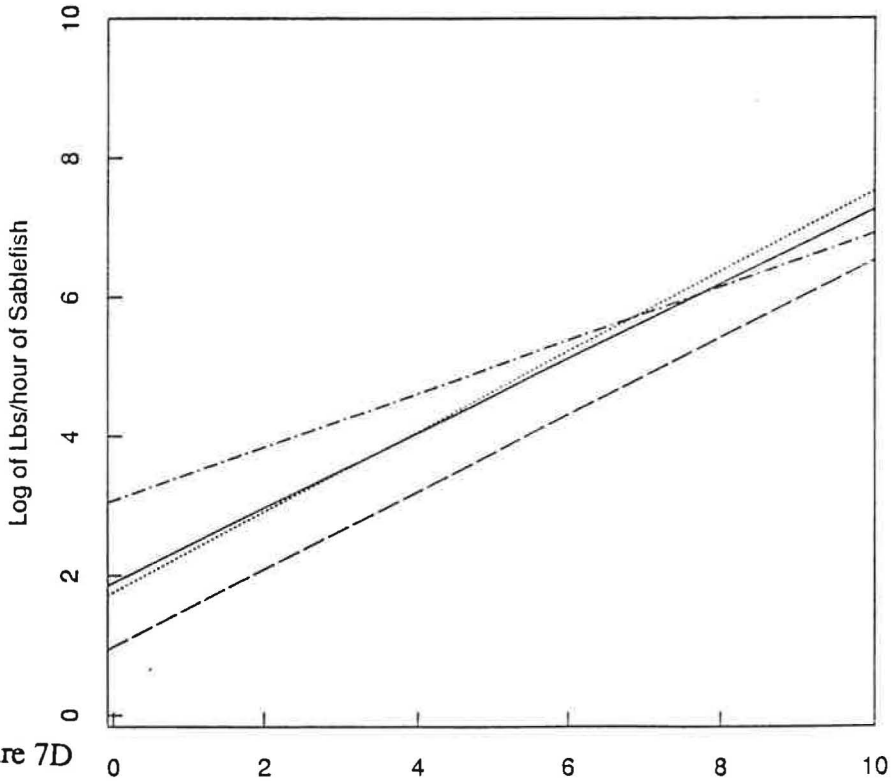

Figure 7D