ENVIRONMENTAL ASSESSMENT/REGULATORY IMPACT REVIEW/

FINAL REGULATORY FLEXIBILITY ANALYSIS

OF

HALIBUT BYCATCH LIMITS FOR THE TRAWL AND NON-TRAWL FISHERIES

AMENDMENT 21

TO THE FISHERY MANAGEMENT PLAN FOR

THE GROUNDFISH FISHERY OF THE BERING SEA AND ALEUTIAN ISLANDS

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1.0 INTRODUCTION

1.1 Management Background

The eastern Bering Sea groundfish fisheries in the U.S. exclusive economic zone (EEZ) are managed under the Fishery Management Plan of the groundfish fisheries in the Bering Sea/Aleutian Islands (BSAI) Area. The fishery management plan (FMP) was developed by the North Pacific Fishery Management Council (Council) under the Magnuson Fishery Conservation and Management Act (Magnuson Act). The BSAI FMP was approved by the Secretary of Commerce and became effective in 1982.

This amendment package was developed as part of the Council's annual amendment cycle which began with the Council's solicitation for proposed changes to the groundfish management regime. Amendment proposals and appropriate alternatives accepted by the Council were analyzed by the Groundfish Plan Teams or other staff analytical teams for their efficacy and for their potential biological and socioeconomic impacts. After reviewing this analysis, the Council, Advisory Panel (AP), and Scientific and Statistical Committee (SSC) made recommendations concerning how the amendment alternatives should be changed and how the analysis should be refined before the amendment package was released for general public review and comment. The AP, SSC, and the Council then considered subsequent public comments before selecting a preferred alternative and deciding to submit it to the Secretary of Commerce for approval and implementation.

Initially, Amendment 21 addressed three priority bycatch issues established by the Council during its January 1992 meeting. These were: (1) halibut bycatch limits for the trawl and non-trawl fisheries, (2) chinook salmon bycatch limits for the trawl fisheries, and (3) trawl closures around the Pribilof Islands.

After reviewing the draft amendment package at its April 1992 meeting, the Council voted to release the amendment package for public review after specific changes were made. The most substantive change was the removal of the options that addressed the second and third issues. The Council determined that additional options and analysis should be developed for these two issues. Therefore, the draft EA/RIR/IRFA for Amendment 21 to the BSAI groundfish FMP that was released for public review on May 26, 1992 addressed only halibut bycatch limits for the trawl and non-trawl fisheries.

The Council identified its preferred alternative at its June 1992 meeting. If the Council's preferred alternative is approved by the Secretary, the implementing regulations should be in place for the start of the 1993 fishery.

1.2 Purpose of the Document

This document provides background information and assessments necessary for the Secretary of Commerce to determine if the Amendment is consistent with the Magnuson Act and other applicable law. It also provides the public with information to assess the alternatives that the Council considered and to comment on the Council's preferred alternative. These comments will enable the Secretary to make a more informed decision concerning the resolution of the management problems being addressed.

1.2.1 Environmental Assessment

One part of the package is the environmental assessment (EA) that is required by NOAA in

compliance with the National Environmental Policy Act of 1969 (NEPA). The purpose of the EA is to analyze the impacts of major federal actions on the quality of the human environment. The EA serves as a means of determining if significant environmental impacts could result from a proposed action. If the action is determined not to be significant, the EA and resulting finding of no significant impact (FONSI) would be the final environmental documents required by NEPA. An environmental impact statement (EIS) must be prepared if the proposed action may be reasonably expected: (1) to jeopardize the productive capability of the target resource species or any related stocks that may be affected by the action; (2) to allow substantial damage to the ocean and coastal habitats; (3) to have a substantial adverse impact on public health or safety; (4) to affect adversely an endangered or threatened species or a marine mammal population; or (5) to result in cumulative effects that could have a substantial adverse effect on the target resource species or any related stocks that may be affected by the action. Following the end of the public review period, the Council could determine that the proposed changes will have significant impacts on the human environment and proceed directly with preparation of an EIS.

1.2.2 Regulatory Impact Review

Another part of the package is the Regulatory Impact Review (RIR) that is required by the National Marine Fisheries Service (NMFS) for all regulatory actions or for significant Department of Commerce or NOAA policy changes that are of significant public interest. The RIR: (1) provides a comprehensive review of the level and incidence of impacts associated with a proposed or final regulatory action; (2) provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to solve the problems; and (3) ensures that the regulatory agency systematically and comprehensively considers all available alternatives so that the public welfare can be enhanced in the most efficient and cost effective way.

The RIR also serves as the basis for determining whether any proposed regulations are major under criteria provided in Executive Order 12291 and whether or not proposed regulations will have a significant economic impact on a substantial number of small entities in compliance with the Regulatory Flexibility Act (P.L. 96-354, RFA). The primary purpose of the RFA is to relieve small businesses, small organizations, and small governmental jurisdictions (collectively, "small entities") of burdensome regulatory and record-keeping requirements. This Act requires that the head of an agency must certify that the regulatory and record-keeping requirements, if promulgated, will not have a significant effect on a substantial number of small entities or provide sufficient justification to receive a waiver.

This RIR analyzes the impacts of proposed changes to the BSAI bycatch management regime. The SAFE document and its appendix provide a description of and an estimate of the number of vessels and processors (small entities) to which regulations implementing these amendments would apply.

1.3 Purpose of and Need for the Proposed Action

Because groundfish fisheries use non-selective harvesting techniques, incidental catches (bycatches) are taken as a byproduct of the groundfish catch. The bycatch species include crab, halibut, salmon, and herring. A conflict occurs when bycatch is thought to impact measurably the resources available to another fishery. Bycatch management attempts to balance the effects of various fisheries on each other. This is particularly contentious because fishermen value these alternative uses of crab, halibut, salmon, or herring very differently, depending on the fishery they pursue.

The current halibut prohibited species catch (PSC) limits and associated regulations were established principally by Amendments 16, 16a, and 19 and revised Amendment 16. The following discussion of these amendments is limited to the parts of the amendments that addressed halibut PSC limits. Amendment 16 extended beyond 1991 the previously established PSC limits for the trawl fisheries. Amendment 16 also established procedures: (1) to apportion PSC limits to specified trawl fishery categories as prohibited species bycatch allowances and (2) to divide the allowances into seasonal fishery bycatch apportionments. The attainment of a prohibited species bycatch allowance or seasonal apportionment triggers a fishery specific time/area closure. Amendment 16a modified the authority to apportion PSC limits among trawl fisheries. Revised Amendment 16 implemented a vessel incentive program to reduce prohibited species bycatch rates in specified groundfish trawl fisheries. The incentive program was implemented on May 6, 1991.

Amendment 19 is was approved by the Secretary on July 24, 1992, this amendment establish a 750 mt halibut PSC mortality limit for the non-trawl fisheries and reduce the PSC limit for the trawl fisheries from 5,333 mt to 5,033 mt. An associated regulatory amendment change the PSC limit allowance groups for the trawl fisheries.

Three problems are being addressed by this amendment package. First, under Amendment 19, the establishment of the halibut PSC limit for the non-trawl fisheries and the associated change in the limit for the trawl fisheries are just for 1992. Therefore, unless action is taken, halibut bycatch would not be limited in the rapidly expanding non-trawl fisheries and the halibut PSC limit for the trawl fisheries may be higher than appropriate. This will tend to result in higher levels of halibut bycatch in the groundfish fisheries and larger adverse effects on halibut fishermen and others because the halibut fishery quotas are reduced to compensate for bycatch in the groundfish fisheries.

Second, the trawl PSC limit is in terms of bycatch, not bycatch mortality. Therefore, it does not address directly the management goal of controlling bycatch mortality and it limits the methods available to fishermen to meet that goal.

Third, the PSC limits can only be changed with a FMP amendment. This can be a cumbersome and lengthy process and may prevent timely and efficient changes to the PSC limits as the biological, economic, and social factors that determine the appropriate PSC limits change.

1.4 Alternatives

Two alternatives are being considered for the halibut bycatch limits for the trawl and non-trawl fisheries. One is the status quo. The other includes three options with respect to the PSC limit for each of these two types of fisheries.

Alternative 1: If no action is taken with respect to the halibut PSC limits, the trawl limit for 1993 and beyond will be 5,333 mt of bycatch and there will be no limit for the non-trawl fishery.

Alternative 2.1: Halibut PSC limits will be specified in the FMP for both the trawl and non-trawl fisheries. Three PSC limits options are being considered for each fishery. They are as follows:

Trawl fisheries bycatch limits

1. 2,516 mt
2. 5,033 mt
3. 7,550 mt

Non-trawl fisheries bycatch mortality limits

1. 375 mt
2. 750 mt
3. 1,125 mt.

These are 50%, 100%, and 150% of the limits established for 1992.

Alternative 2.2 (change to bycatch mortality) The trawl fishery bycatch limit would be replaced with an equivalent bycatch mortality limit. Based on the current estimate that the discard mortality rate is 75%, the three equivalent limits are:

Trawl fisheries bycatch mortality limits

1. 1,887 mt
2. 3,775 mt
3. 5,662 mt.

Alternative 2.3 This alternative is the same as Alternative 2.1 except that the halibut PSC limits would be specified in the regulations, not in the FMP. Therefore, because the halibut PSC limits could be changed with a regulatory amendment, an FMP amendment would not be required.

Alternative 2.4 This alternative is the same as Alternative 2.2 except that the halibut PSC mortality limits would be specified in the regulations, not in the FMP.

When initiating a regulatory amendment to change a halibut PSC limit under Alternatives 2.3 or 2.4, the Secretary, in consultation with the Council, would consider information that includes:

1. Estimated change in halibut biomass and stock condition;
2. Potential impact on halibut stocks and fisheries;
3. Potential impacts on groundfish fisheries;
4. Estimated bycatch mortality in prior years;
5. Expected halibut bycatch mortality;
6. Methods available to reduce halibut bycatch mortality;
7. The cost of reducing halibut bycatch mortality; and
8. Other biological and socioeconomic factors that affect the appropriateness of a specific PSC limit in terms of FMP objectives.

Alternatives 2.1 - 2.4 would also establish procedures to:

(1) apportion the non-trawl PSC limit to specified non-trawl fishery categories as prohibited species bycatch allowances;

(2) permit the PSC limit or allowances to be further allocated into seasonal apportionments; and

(3) permit exemptions for some non-trawl fisheries.

The first two procedures would be similar to those established previously for the trawl fisheries. Once the categories are defined in regulations, the Regional Director, in consultation with the Council, may apportion the non-trawl halibut PSC limit among non-trawl fishery categories and seasons during the annual September through December specification process.

The third procedure would allow the Regional Director, in consultation with the Council, to determine annually which non-trawl fisheries would be exempt from the non-trawl PSC limit or allowances. In making this annual determination, the Regional Director and Council will consider information that includes:

1. Estimated change in halibut biomass and stock condition;

2. Potential impact on halibut stocks and fisheries;

3. Potential impacts on the specific non-trawl fishery;

4. Estimated bycatch mortality of the specific fishery in prior years;

5. Expected halibut bycatch mortality in the specific fishery;

6. Methods available to reduce halibut bycatch mortality in the specific fishery;

7. The cost of reducing halibut bycatch mortality in that fishery; and

8. Other biological and socioeconomic factors that affect the appropriateness of an exemption in terms of FMP objectives.

Alternative 2.5 (preferred alternative) This alternative is the same as Alternative 2.4 except that the halibut PSC limit for the non-trawl fisheries was not identified. This alternative would:

1. amend the FMP to allow the trawl and non-trawl PSC limits to be changed by regulatory amendment;

2. amend the FMP to establish procedures that would allow the Regional Director, in consultation with the Council to annually: (a) apportion the non-trawl PSC limit to specified non-trawl fishery categories as prohibited species bycatch allowances; (b) allocate PSC limit or allowances into seasonal apportionments; and (c) exempt some non-trawl fisheries from the non-trawl PSC limits;

3. amend the FMP so that the trawl limit is also in terms of halibut bycatch mortality; and

4. set the halibut PSC limit for the trawl fisheries at 3,775 mt of bycatch mortality until changed by a regulatory amendment.

The Council also voted to exempt pot gear from the non-trawl halibut PSC limit for 1993. Because the preferred alternative includes a procedure for determining annually which if any exemptions will be made with respect to the non-trawl limit, that vote reflects the Council's intentions for 1993 but is not part of the amendment itself.

The Council also voted not to establish the halibut PSC limit for the non-trawl fisheries for 1993 and beyond until the September 1992 meeting. Once it is established, it can be changed by a regulatory amendment.

1.5 Treatment of Inshore/Offshore Apportionments of Pollock TACs

The effects of possible inshore/offshore apportionment of pollock TACs were not considered. There are two reason for this.

1. The inshore/offshore apportionments have not been established for 1993.

2. It was unclear how or if PSC limits would be apportioned as the result of any TAC apportionment. The apportionments of the pollock TACs and PSC limits will be addressed in separate amendments.

1.6 Explicit Allocation of the Cod TAC between the Trawl and Fixed Gear Fisheries

The explicit allocation of the Pacific cod TAC between the trawl and fixed gear fisheries is the subject of a separate amendment that the Council will consider during 1992. The analysis of Amendment 21 does not attempt to determine whether a decrease in the percentage of the cod TAC taken with trawl gear would provide positive or negative net benefits to the nation. Such a determination is beyond the scope of the current analysis. However, effects of alternative halibut PSC limits for the trawl fisheries and for the non-trawl fisheries are estimated.

1.7 Bycatch in the Groundfish Fisheries

Table 1.1 lists the PSC limit induced closures for 1990, 1991, and first quarter 1992. Tables 1.2 - 1.5 summarize domestic (DAP) bycatch and catch data by fishery for 1990 and 1991 and for the first quarter of 1990, 1991, and 1992. Respectively, the tables include estimates of: (1) prohibited species bycatch for BSAI domestic (DAP) groundfish fisheries by species and fishery, (2) the percent of the estimated bycatch of each bycatch species accounted for by each groundfish fishery, (3) bycatch rates, and (4) groundfish catch and wholesale value by fishery.

The halibut bycatch and bycatch rate estimates used in this report have been adjusted to reflect assumed discard mortality rates of 75% in the BSAI trawl fisheries, 16% in all hook-and-line fisheries, and 10% in all pot gear fisheries. These discard mortality rates were recommended by International Pacific Halibut Commission (IPHC) staff and the BSAI Groundfish Plan Team in late 1991 and they were used by the IPHC in establishing halibut quotas for 1992.

Catch in the non-trawl fisheries has expanded rapidly. For example, its first quarter catch increased from about 9,000 mt in 1990 to 14,300 mt in 1991 and to 30,200 mt in 1992. In the first quarter of 1992, groundfish catch in the longline cod fishery was about 30,100 mt compared to 31,000 mt in the trawl cod fishery. This is a substantial change, for 1990 and 1991 combined the annual catch in the longline cod fishery was less than half of that in the trawl cod fishery.

1.8 Description of the Groundfish Fisheries

The most recent description of the groundfish fishery is contained in the Draft Economic Status of the Groundfish Fisheries off Alaska, 1991, an appendix to the Draft SAFE documents for the BSAI and GOA groundfish fisheries for 1992. The draft includes information on the catch and value of the fisheries, the numbers and sizes of fishing vessels and processing plants, and other economic variables that describe or affect the performance of the fisheries.

1.9 Organization of the Document

The biology of halibut, historical bycatch levels, and the biological effects of halibut bycatch mortality are discussed in Chapter 2. Chapter 3 contains an evaluation of the alternative halibut PSC limits. Chapter 4 is a summary of the biological and economic effects of the alternatives and Chapters 5 through 8 address specific requirements for a FMP amendment.

Table 1.1 BSAI fishery closures in 1990 and 1991 due to prohibited species bycatch.

FISHERY	AREA	DATE	CAUSE
1990			
JV Flatfish	Zone 1	01/25 - 12/31	PSC - RKC
JV Flatfish	Zone 2H	02/27 - 12/31	PSC - HALIBUT
DAP Flatfish	Zone 1	02/27 - 03/01	PSC - BAIRDI
JV Flatfish	BSAI	03/05 - 06/24	PSC - HALIBUT
DAP Flatfish	Zone 1/2H	03/14 - 12/31	PSC - HALIBUT
DAP Flatfish	BSAI	03/19 - 08/04	PSC - HALIBUT
DAP plck/cod	Zone 1/2H	05/30 - 12/31	PSC - HALIBUT
DAP plck/cod	BSAI	06/30 - 12/31	PSC - HALIBUT
JVP Flatfish	BSAI	07/01 - 12/31	PSC - HALIBUT
DAP Flatfish	BSAI	11/16 - 12/31	PSC - HALIBUT
1991			
Plck/cod	Zone 1/2H	02/17 - 03/31	PSC - HALIBUT
Plck/cod	BSAI	03/08 - 03/31	PSC - HALIBUT
Rock sole	Zone 1/2H	03/15 - 12/31	PSC - HALIBUT
Plck/cod	Zone 1/2H	04/19 - 05/03	PSC - HALIBUT
Plck/cod	Zone 1/2H	05/03 - 12/31	PSC - HALIBUT
Plck/cod	BSAI	05/08 - 07/01	PSC - HALIBUT
Rock sole	BSAI	06/06 - 12/31	PSC - HALIBUT
Plck/cod	BSAI	07/08 - 12/31	PSC - HALIBUT
Flatfish	HSA 2	07/14 - 08/15	PSC - HERRING
Flatfish	HSA 3	09/01 - 3/1/92	PSC - HERRING
Flatfish	Zone 1/2H	09/16 - 12/31	PSC - HALIBUT
Pollock	HSA 3	09/21 - 3/1/92	PSC - HERRING
Flatfish	BSAI	10/15 - 12/31	PSC - HALIBUT
Gturb/arrowth	BSAI	10/21 - 12/31	PSC - HALIBUT
1992			
Rocksole	HSA 1	06/01 - 07/01	PSC - HERRING
Rocksole	HSA 2	07/01 - 08/15	PSC - HERRING
Rocksole	HSA 3	09/01 - 03/01/93	PSC - HERRING
Pollock/P.cod	Zone 1	02/15 - 12/31	PSC - BARIDI
P.cod	BSAI	02/16 - 03/07	PSC - HALIBUT
Pollock	BSAI	02/16 - 03/07	PSC - HALIBUT
Rocksole	BSAI	02/23 - 03/29	PSC - HALIBUT
Rocksole/other flat.	BSAI	04/04 - 06/29	PSC - HALIBUT
Rockfish	BSAI	04/26 - 06/29	PSC - HALIBUT

Table 1.2 Estimated prohibited species bycatch for BS/AI groundfish fisheries by species and fishery, 1990, 1991 and first quarters 1990-1992.

Fishery	1990 Halibut	Bairdi	Red King	Chinook	O. Salmon
Longline					
Pacific Cod	280.7	1,528	2	4	22
Sablefish	53.6	22	0	0	0
All targets	337.4	1,576	2	4	22
Pot					
Pacific Cod	2.1	19,770	8,673	0	0
Trawl					
Atka Mackerel	119.8	353	110	93	200
Pollock	622.5	362,756	6,999	1,282	1,055
Pacific Cod	1,936.4	724,241	20,412	4,552	140
Rockfish	166.3	9,879	300	87	148
Pel pollock	150.8	98,983	3,319	7,586	14,183
Rock sole	273.0	448,818	62,103	142	12
Sablefish	20.9	332	88	2	0
Turbot	544.5	4,947	1,722	45	0
Arrowtooth	9.9	7,674	46	0	0
Y. Sole	40.9	115,970	933	19	0
All targets	3,892.3	1,780,498	96,592	13,815	15,742
All gears/targets	4,231.9	1,801,845	105,267	13,819	15,764

Fishery	1991 Halibut	Bairdi	Red King	Chinook	O Salmon	Herring
Longline						
Pacific Cod	421.5	8,300	78	41	54	0.0
Sablefish	38.0	8	61	0	0	0.0
All targets	462.9	8,363	139	41	54	0.0
Pot						
All targets	3.9	52,482	2,714	0	0	0.0
Trawl						
Atka Mackerel	46.6	15	134	124	15	0.0
Pollock	433.3	486,228	1,419	2,896	3,399	30.2
Pacific Cod	1,731.0	527,854	1,006	6,336	51	.7
Rockfish	129.3	4,984	196	753	7	.2
Pel pollock	437.8	304,639	648	24,013	26,986	706.8
Rock sole	882.3	718,243	89,379	825	611	33.9
Sablefish	32.0	729	3	1	1	.0
Turbot	290.9	15,874	1,492	38	5	.1
Arrowtooth	46.5	1,585	0	1	88	.0
Y. Sole	501.4	752,531	18,538	398	763	509.8
All targets	4,594.8	3,019,193	114,356	35,441	31,992	1,288.7
All gears/targets	5,061.5	3,080,038	117,208	35,482	32,046	1,288.7

Table 1.2 continued

First Quarter 1990

Fishery	Halibut	Bairdi	Red King	Chinook	O. Salmon
Longline					
Pacific Cod	14.0	37	0	4	0
Sablefish	23.9	0	0	0	0
All targets	37.9	37	0	4	0
Trawl					
Atka Mackerel	43.1	310	28	23	0
Pollock	354.8	209,789	4,920	986	2
Pacific Cod	1,121.5	463,360	16,583	3,438	19
Flatfish	1.2	45	0	5	0
Rockfish	1.8	43	0	4	0
Other	.5	351	75	0	0
Pel pollock	43.1	9,716	2,219	5,937	0
Rock sole	264.1	334,457	61,971	109	0
Sablefish	18.7	271	86	2	0
Turbot	503.8	1,015	294	43	0
All targets	2,352.6	1,019,357	86,178	10,547	22
All gears/targets	2,390.5	1,019,394	86,178	10,552	22

First Quarter 1991

Fishery	Halibut	Bairdi	Red King	Chinook	O Salmon	Herring
Longline						
Pacific Cod	41.8	2,999	0	4	0	0.0
Rockfish	.3	0	0	0	0	0.0
Other	.1	2	0	0	0	0.0
Sablefish	7.0	0	4	0	0	0.0
All targets	49.2	3,001	4	4	0	0.0
Pot						
Pacific Cod	.0	163	23	0	0	0.0
Trawl						
Atka Mackerel	46.6	15	134	124	15	0.0
Pollock	201.5	58,279	874	2,654	3	.1
Pacific Cod	919.9	377,888	814	3,057	6	.1
Flatfish	4.1	2,388	66	0	0	0.0
Rockfish	22.2	1,306	0	327	0	0.0
Other	1.1	313	25	0	0	.0
Pel pollock	46.6	26,350	36	22,156	1,156	7.2
Rock sole	686.9	643,745	79,111	811	465	.1
Sablefish	6.8	640	2	1	1	.0
Arrowtooth	.4	360	0	0	0	0.0
All targets	1,936.0	1,111,284	81,062	29,130	1,647	7.6
All gears/targets	1,985.3	1,114,449	81,090	29,135	1,647	7.6

Table 1.2 continued

Fishery	First Quarter 1992 Halibut	Bairdi	Red King	Chinook	O Salmon	Herring
Longline						
Pacific Cod	89.5	5,429	95	8	0	0.0
Other	.0	0	0	0	0	0.0
Sablefish	8.2	0	0	0	0	0.0
All targets	97.7	5,429	95	8	0	0.0
Trawl						
Atka Mackerel	47.9	1	66	17	1	0.0
Pollock	389.4	192,799	25,911	3,326	350	2.8
Pacific Cod	471.1	146,617	151	3,024	44	.2
Flatfish	11.0	11,087	104	0	0	0.0
Rockfish	32.1	815	0	369	0	0.0
Other	1.0	1,470	23	29	0	0.0
Pel pollock	487.1	297,547	5,249	15,186	1,097	2.9
Rock sole	474.5	456,405	40,453	0	35	0.0
All targets	1,914.2	1,106,740	71,958	21,951	1,528	5.9
All gears/targets	2,011.8	1,112,169	72,053	21,959	1,528	5.9

Notes: Halibut and herring are expressed in mt; bairdi and red king crab and chinook and other salmon are expressed in numbers. The halibut bycatch estimates have been adjusted to reflect assumed discard mortality rates of 75% in the trawl fisheries, 16% in the hook & line fisheries, and 10% in the pot gear fisheries. These estimates are based on data provided by the Alaska Region. The totals include bycatches for some fisheries with such low levels of bycatch that they are not reported separately. Estimates of BSAI herring for 1990 were not available for the Region.

Table 1.3 Estimated percentage of prohibited bycatch species accounted for by each BS/AI groundfish fishery in 1990, 1991 and first quarters of 1990-1992.

1990	Halibut	Bairdi	Red King	Chinook	O.Salmon
Longline					
P.cod and other	6.6%	.1%	.0%	.0%	.1%
Sablefish	1.3%	.0%	.0%	.0%	.0%
All targets	7.9%	.1%	.0%	.0%	.1%
Pot					
P.cod and other	.1%	1.1%	8.2%	.0%	.0%
Trawl					
Atka Mackerel	2.8%	.0%	.1%	.7%	1.3%
Pollock	14.7%	20.1%	6.6%	9.3%	6.7%
P.cod and other	45.8%	40.2%	19.4%	32.9%	.9%
Rockfish	3.9%	.5%	.3%	.6%	.9%
Pel pollock	3.6%	5.5%	3.2%	54.9%	90.0%
Rock sole	6.5%	24.9%	59.0%	1.1%	.1%
Sablefish	.5%	.0%	.1%	.0%	.0%
Turbot	12.9%	.3%	1.6%	.3%	.0%
Arrowtooth	.2%	.4%	.0%	.0%	.0%
Y sole	1.0%	6.4%	.9%	.1%	.0%
All targets	92.0%	98.8%	91.8%	100.0%	99.9%

1991	Halibut	Bairdi	Red King	Chinook	O.Salmon	Herring
Longline						
Pacific cod	8.3%	.3%	.1%	.1%	.2%	.0%
Sablefish	.8%	.0%	.1%	.0%	.0%	.0%
All targets	9.1%	.3%	.1%	.1%	.2%	.0%
Pot						
Pacific cod	.1%	1.7%	2.3%	.0%	.0%	.0%
All targets	.1%	1.7%	2.3%	.0%	.0%	.0%
Trawl						
Atka Mackerel	.9%	.0%	.1%	.4%	.0%	.0%
Pollock	8.6%	15.8%	1.2%	8.2%	10.6%	2.3%
Pacific cod	34.2%	17.1%	.9%	17.9%	.2%	.1%
Flatfish	1.1%	6.6%	1.2%	.1%	.2%	.5%
Rockfish	2.6%	.2%	.2%	2.1%	.0%	.0%
Pel pollock	8.6%	9.9%	.6%	67.7%	84.2%	54.9%
Rock sole	17.4%	23.3%	76.3%	2.3%	1.9%	2.6%
Sablefish	.6%	.0%	.0%	.0%	.0%	.0%
Turbot	5.7%	.5%	1.3%	.1%	.0%	.0%
Arrowtooth	.9%	.1%	.0%	.0%	.3%	.0%
Y sole	9.9%	24.4%	15.8%	1.1%	2.4%	39.6%
All targets	90.8%	98.0%	97.6%	99.9%	99.8%	100.0%

Table 1.3 continued

	1990-91 Halibut	Bairdi	Red King	Chinook	O.Salmon
Longline					
P.cod and other	7.6%	.2%	.0%	.1%	.2%
Sablefish	1.0%	.0%	.0%	.0%	.0%
All targets	8.6%	.2%	.1%	.1%	.2%
Pot					
All targets	.1%	1.5%	5.1%	.0%	.0%
Trawl					
Atka Mackerel	1.8%	.0%	.1%	.4%	.5%
Pollock	11.4%	17.4%	3.8%	8.5%	9.3%
P.cod and other	39.5%	25.6%	9.6%	22.1%	.4%
Flatfish	.6%	4.3%	.9%	.1%	.1%
Rockfish	3.2%	.3%	.2%	1.7%	.3%
Pel pollock	6.3%	8.3%	1.8%	64.1%	86.1%
Rock sole	12.4%	23.9%	68.1%	2.0%	1.3%
Sablefish	.6%	.0%	.0%	.0%	.0%
Turbot	9.0%	.4%	1.4%	.2%	.0%
Arrowtooth	.6%	.2%	.0%	.0%	.2%
Y sole	5.8%	17.8%	8.8%	.8%	1.6%
All targets	91.3%	98.3%	94.8%	99.9%	99.8%

	First Quarter 1990 Halibut	Bairdi	Red King	Chinook	O.Salmon
Longline					
P.cod and other	6.6%	.1%	.0%	.0%	.1%
Sablefish	1.3%	.0%	.0%	.0%	.0%
All targets	7.9%	.1%	.0%	.0%	.1%
Pot					
P.cod and other	.1%	1.1%	8.2%	.0%	.0%
Trawl					
Atka Mackerel	2.8%	.0%	.1%	.7%	1.3%
Pollock	14.7%	20.1%	6.6%	9.3%	6.7%
P.cod and other	45.8%	40.2%	19.4%	32.9%	.9%
Rockfish	3.9%	.5%	.3%	.6%	.9%
Pel pollock	3.6%	5.5%	3.2%	54.9%	90.0%
Rock sole	6.5%	24.9%	59.0%	1.1%	.1%
Sablefish	.5%	.0%	.1%	.0%	.0%
Turbot	12.9%	.3%	1.6%	.3%	.0%
Arrowtooth	.2%	.4%	.0%	.0%	.0%
Y sole	1.0%	6.4%	.9%	.1%	.0%
All targets	92.0%	98.8%	91.8%	100.0%	99.9%

Table 1.3 continued

First Quarter 1991

	Halibut	Bairdi	Red King	Chinook	O.Salmon	Herring
Longline						
Pacific cod	2.1%	.3%	.0%	.0%	.0%	.0%
Sablefish	.4%	.0%	.0%	.0%	.0%	.0%
All targets	2.5%	.3%	.0%	.0%	.0%	.0%
Pot						
All targets	.0%	.0%	.0%	.0%	.0%	.0%
Trawl						
Atka Mackerel	2.3%	.0%	.2%	.4%	.9%	.0%
Pollock	10.1%	5.2%	1.1%	9.1%	.2%	1.6%
Pacific cod	46.3%	33.9%	1.0%	10.5%	.4%	1.7%
Rockfish	1.1%	.1%	.0%	1.1%	.0%	.0%
Pel pollock	2.3%	2.4%	.0%	76.0%	70.2%	94.8%
Rock sole	34.6%	57.8%	97.6%	2.8%	28.3%	1.3%
Sablefish	.3%	.1%	.0%	.0%	.1%	.4%
Arrowtooth	.0%	.0%	.0%	.0%	.0%	.0%
All targets	97.5%	99.7%	100.0%	100.0%	100.0%	100.0%

First Quarter 1992

	Halibut	Bairdi	Red King	Chinook	O.Salmon	Herring
Longline						
Pacific cod	4.4%	.5%	.1%	.0%	.0%	.0%
Sablefish	.4%	.0%	.0%	.0%	.0%	.0%
All targets	4.9%	.5%	.1%	.0%	.0%	.0%
Pot						
All targets	.0%	.0%	.0%	.0%	.0%	.0%
Trawl						
Atka Mackerel	2.4%	.0%	.1%	.1%	.1%	.0%
Pollock	19.4%	17.3%	36.0%	15.1%	22.9%	47.7%
Pacific cod	23.4%	13.2%	.2%	13.8%	2.9%	3.8%
Rockfish	1.6%	.1%	.0%	1.7%	.0%	.0%
Pel pollock	24.2%	26.8%	7.3%	69.2%	71.8%	48.5%
Rock sole	23.6%	41.0%	56.1%	.0%	2.3%	.0%
All targets	95.1%	99.5%	99.9%	100.0%	100.0%	100.0%

Note: The estimates in this table were calculated using the data in Table 1.2. Therefore, the notes for that table also apply to these estimates.

Table 1.4 Estimated prohibited species bycatch rates for BS/AI groundfish fisheries by species and fishery in 1990, 1991 and first quarters of 1990-1992.

1990

Fishery	Halibut	Bairdi	Red King	Chinook	O. Salmon
Longline					
Pacific Cod	.55%	.03	.00	.00	.00
Sablefish	1.38%	.01	0.00	0.00	.00
All targets	.60%	.03	.00	.00	.00
Pot					
Pacific Cod	.15%	13.94	6.12	0.00	0.00
Trawl					
Atka Mackerel	.37%	.01	.00	.00	.01
Pollock	.35%	2.01	.04	.01	.01
Pacific Cod	1.43%	5.36	.15	.03	.00
Rockfish	.52%	.31	.01	.00	.00
Pel pollock	.01%	.08	.00	.01	.01
Rock sole	.85%	13.98	1.93	.00	.00
Sablefish	3.03%	.48	.13	.00	.00
Turbot	4.18%	.38	.13	.00	.00
Arrowtooth	.61%	4.68	.03	0.00	0.00
Y. Sole	.23%	6.40	.05	.00	.00
All targets	.24%	1.08	.06	.01	.01
All gears/targets	.25%	1.06	.06	.01	.01

1991

Fishery	Halibut	Bairdi	Red King	Chinook	O. Salmon	Herring
Longline						
Pacific Cod	.60%	.12	.00	.00	.00	0.00
Sablefish	1.07%	.00	.02	0.00	0.00	0.00
All targets	.62%	.11	.00	.00	.00	0.00
Pot						
All targets	.09%	12.01	.62	0.00	0.00	0.00
Trawl						
Atka Mackerel	.17%	.00	.00	.00	.00	0.00
Pollock	.28%	3.15	.01	.02	.02	.02%
Pacific Cod	1.47%	4.47	.01	.05	.00	.00%
Rockfish	1.52%	.59	.02	.09	.00	.00%
Pel pollock	.04%	.26	.00	.02	.02	.06%
Rock sole	1.30%	10.59	1.32	.01	.01	.05%
Sablefish	6.08%	1.38	.00	.00	.00	.01%
Turbot	3.83%	2.09	.20	.01	.00	.00%
Arrowtooth	2.37%	.81	0.00	.00	.04	.00%
Y. Sole	.42%	6.37	.16	.00	.01	.43%
All targets	.27%	1.78	.07	.02	.02	.08%
All gears/targets	.28%	1.73	.07	.02	.02	.07%

Table 1.4 continued

1990-91

Fishery	Halibut	Bairdi	Red King	Chinook	O. Salmon
Longline					
Pacific Cod	.58%	.08	.00	.00	.00
Sablefish	1.23%	.00	.01	0.00	.00
All targets	.61%	.08	.00	.00	.00
Pot					
All targets	.10%	12.48	1.97	0.00	0.00
Trawl					
Atka Mackerel	.28%	.01	.00	.00	.00
Pollock	.32%	2.54	.03	.01	.01
Pacific Cod	1.45%	4.94	.08	.04	.00
Rockfish	.73%	.37	.01	.02	.00
Pel pollock	.02%	.17	.00	.01	.02
Rock sole	1.16%	11.68	1.52	.01	.01
Sablefish	4.35%	.87	.07	.00	.00
Turbot	4.05%	1.01	.16	.00	.00
Arrowtooth	1.57%	2.57	.01	.00	.02
Y. Sole	.40%	6.37	.14	.00	.01
All targets	.25%	1.43	.06	.01	.01
All gears/targets	.27%	1.40	.06	.01	.01

First Quarter 1990

Fishery	Halibut	Bairdi	Red King	Chinook	O. Salmon
Longline					
Pacific Cod	.17%	.00	0.00	.00	0.00
Sablefish	3.22%	0.00	0.00	0.00	0.00
All targets	.42%	.00	0.00	.00	0.00
Trawl					
Atka Mackerel	3.92%	.28	.03	.02	0.00
Pollock	.77%	4.55	.11	.02	.00
Pacific Cod	1.53%	6.31	.23	.05	.00
Rockfish	.39%	.09	.00	.01	0.00
Pel pollock	.02%	.03	.01	.02	.00
Rock sole	.98%	12.41	2.30	.00	0.00
Sablefish	6.72%	.97	.31	.01	0.00
Turbot	9.22%	.19	.05	.01	0.00
All targets	.54%	2.33	.20	.02	.00
All gears/targets	.54%	2.28	.19	.02	.00

Table 1.4 continued

Fishery	First Quarter 1991 Halibut	Bairdi	Red King	Chinook	O. Salmon	Herring
Longline						
Pacific Cod	.31%	.22	0.00	.00	0.00	0.00
Sablefish	.93%	.00	.01	0.00	0.00	0.00
All targets	.34%	.21	.00	.00	0.00	0.00
Pot						
Pacific Cod	.10%	8.56	1.21	0.00	0.00	0.00
Trawl						
Atka Mackerel	.17%	.00	.00	.00	.00	0.00
Pollock	.34%	.99	.01	.05	.00	.00%
Pacific Cod	1.80%	7.39	.02	.06	.00	.00%
Rockfish	1.42%	.84	.00	.21	0.00	0.00
Pel pollock	.01%	.06	.00	.05	.00	.00%
Rock sole	1.27%	11.90	1.46	.01	.01	.00%
Sablefish	3.62%	3.40	.01	.00	.01	.02%
Arrowtooth	1.61%	15.68	0.00	0.00	0.00	0.00
All targets	.29%	1.67	.12	.04	.00	.00%
All gears/targets	.29%	1.64	.12	.04	.00	.00%

Fishery	First Quarter 1992 Halibut	Bairdi	Red King	Chinook	O. Salmon	Herring
Longline						
Pacific Cod	.30%	.18	.00	.00	0.00	0.00
Sablefish	1.68%	0.00	0.00	0.00	0.00	0.00
All targets	.32%	.18	.00	.00	0.00	0.00
Pot						
Pacific Cod	0.00	0.00	0.00	0.00	0.00	0.00
Trawl						
Atka Mackerel	.17%	.00	.00	.00	.00	0.00
Pollock	.46%	2.28	.31	.04	.00	.00%
Pacific Cod	1.52%	4.74	.00	.10	.00	.00%
Rockfish	.77%	.20	0.00	.09	0.00	0.00
Pel pollock	.12%	.76	.01	.04	.00	.00%
Rock sole	1.33%	12.79	1.13	0.00	.00	0.00
All targets	.33%	1.92	.12	.04	.00	.00%
All gears/targets	.33%	1.84	.12	.04	.00	.00%

Notes: Halibut and herring bycatch rates are expressed as percentages (bycatch/groundfish catch). Crab and salmon bycatch rates are expressed in terms of number of crab or salmon per 1 mt of groundfish catch. The halibut bycatch estimates have been adjusted to reflect assumed discard mortality rates of 75% in the trawl fisheries, 16% in the hook & line fisheries, and 10% in the pot gear fisheries. These estimates are based on data provided by the Alaska Region. Estimates of BSAI herring for 1990 were not available for the Region.

Table 1.5 Estimated BS/AI groundfish catch and wholesale value by fishery in 1990, 1991 and first quarters of 1990-1992.

1990

GEAR	TARGET	TONS	VALUE
Longline	Pacific Cod	51,211	63,894,673
	Rockfish	41	79,935
	Other	208	324,057
	Sablefish	3,897	12,290,698
	Turbot	423	595,993
	All targets	55,781	77,185,356
Pot	Pacific Cod	1,418	1,829,457
Trawl	Atka Mackerel	32,091	28,256,045
	Pollock	180,116	151,564,606
	Pacific Cod	135,193	133,534,807
	Flatfish	773	1,026,412
	Rockfish	31,742	23,830,807
	Other	534	2,708,598
	Pel pollock	1,200,826	925,560,650
	Rock sole	32,106	31,695,260
	Sablefish	690	597,287
	Turbot	13,022	12,259,672
	Arrowtooth	1,639	736,575
	Y. Sole	18,124	7,433,842
	All targets	1,646,857	1,319,204,562
Unknown	Unknown	2,268	1,727,674
TOTAL		1,706,324	1,399,947,049

1991

GEAR	TARGET	TONS	VALUE
Longline	Pacific Cod	70,416	103,883,553
	Rockfish	30	43,369
	Other	153	110,529
	Sablefish	3,565	9,845,543
	Turbot	9	15,373
	All targets	74,172	113,898,368
Pot	Pacific Cod	4,361	6,411,326
	Other	9	362
	Sablefish	0	175
	All targets	4,370	6,411,863
Trawl	Atka Mackerel	27,917	20,968,078
	Pollock	154,216	110,506,616
	Pacific Cod	118,154	131,341,358
	Flatfish	13,080	7,699,337
	Rockfish	8,489	5,853,534
	Other	635	87,474
	Pel pollock	1,182,073	898,643,007
	Rock sole	67,794	54,627,407
	Sablefish	527	501,947
	Turbot	7,593	7,313,794
	Arrowtooth	1,961	841,684
	Y. Sole	118,124	53,765,233
	All targets	1,700,563	1,292,149,468
Unknown	All targets	345	198,463
All gears/targets		1,779,450	1,412,658,162

Table 1.5 continued

1990-91

GEAR	TARGET	TONS	VALUE
Longline	Pacific Cod	121,626	167,778,226
	Rockfish	71	123,304
	Other	361	434,586
	Sablefish	7,462	22,136,241
	Turbot	432	611,366
	All targets	129,953	191,083,724
Pot	Pacific Cod	5,779	8,240,783
	Other	9	362
	Sablefish	0	175
	All targets	5,788	8,241,320
Trawl	Atka Mackerel	60,008	49,224,123
	Pollock	334,333	262,071,222
	Pacific Cod	253,347	264,876,164
	Flatfish	13,853	8,725,749
	Rockfish	40,232	29,684,341
	Other	1,169	2,796,072
	Pel pollock	2,382,900	1,824,203,657
	Rock sole	99,899	86,322,667
	Sablefish	1,217	1,099,234
	Turbot	20,615	19,573,466
	Arrowtooth	3,600	1,578,260
	Y. Sole	136,248	61,199,074
	All targets	3,347,419	2,611,354,030
Unknown	Unknown	2,613	1,926,137
All gears/targets		3,485,774	2,812,605,210

First Quarter 1990

GEAR	TARGET	TONS	VALUE
Longline	Pacific Cod	8,227	11,448,387
	Sablefish	742	2,449,033
	All targets	8,970	13,897,420
Trawl	Atka Mackerel	1,100	1,138,486
	Pollock	46,070	42,660,786
	Pacific Cod	73,382	81,529,008
	Flatfish	25	28,691
	Rockfish	467	432,214
	Other	149	0
	Pel pollock	283,737	278415461
	Rock sole	26,951	28,273,250
	Sablefish	278	444,027
	Turbot	5,468	5,315,571
	All targets	437,626	438,237,493
All gears/targets		446,596	452,134,914

Table 1.5 continued

First Quarter 1991

GEAR	TARGET	TONS	VALUE
Longline	Pacific Cod	13,478	20,812,761
	Rockfish	20	30,554
	Other	23	5,402
	Sablefish	758	2,073,620
	All targets	14,279	22,922,337
Pot	Pacific Cod	19	24,500
Trawl	Atka Mackerel	27,917	20,968,078
	Pollock	58,696	47,130,424
	Pacific Cod	51,142	64,902,651
	Flatfish	165	211,550
	Rockfish	1,561	767,639
	Other	97	2,692
	Pel pollock	472,363	472,779,623
	Rock sole	54,095	45,112,556
	Sablefish	188	253,245
	Arrowtooth	23	22,132
	All targets	666,248	652,150,590
All targets		680,546	675,097,427

First Quarter 1992

GEAR	TARGET	TONS	VALUE
Longline	Pacific Cod	29,640	36,851,702
	Other	3	0
	Sablefish	486	1,442,664
	All targets	30,129	38,294,366
Pot	Pacific Cod	50	87,052
Trawl	Atka Mackerel	28,029	21,820,455
	Pollock	84,527	79,587,633
	Pacific Cod	30,951	32,708,641
	Flatfish	593	450,207
	Rockfish	4,161	3,072,771
	Other	365	1,454,928
	Pel pollock	391,513	323,817,854
	Rock sole	35,679	35,967,405
	All targets	575,818	498,879,894
All gears/targets		605,996	537,261,313

Note: 1991 prices were used for both 1990 and 1991.

2.0 HALIBUT BIOLOGY AND BYCATCH

The biology of halibut, historical bycatch levels, and the biological effects of bycatch are the topics of this chapter. Information for the Bering Sea-Aleutian Islands and the Gulf of Alaska are included because of stock interchange between management regions. Egg and larval drift and counter-migration by juvenile fish apparently create a homogeneous resource and prevent the development of separate populations. The IPHC manages halibut by regulatory area, but considers the resource as a single population.

2.1 Biology

Spawning occurs primarily during winter from northern British Columbia through the Gulf of Alaska into the Bering Sea, at depths of 150-250 fathoms. Eggs and larvae at depth drift passively with the ocean currents and gradually rise toward the ocean surface. Prevailing currents at spawning depth and near the surface tend to flow counterclockwise, paralleling the British Columbia and Alaska coastline. Eggs and larvae drift for hundreds or thousands of miles before reaching shallow water where the larvae can settle to the bottom. Continuity of the halibut resource requires that the progeny move back to the east and south at some stage in the life history (Figure 2.1) to counter the drift of eggs and larvae. Under this hypothesis, virtually all halibut off the coast of British Columbia and Washington, Oregon, and California migrate through Alaska. No young-of-the-year halibut have been documented south of southeast Alaska, and the average age of juvenile halibut in survey catches increases from youngest in the Bering Sea and western Gulf of Alaska to oldest off British Columbia. IPHC documents present evidence that the counter-migration occurs primarily during the juvenile stage, and that most juveniles migrate while 2 through 6-years of age. Most counter-migration takes place by fish smaller than 65 cm.

Adult halibut undertake a seasonal migration from winter spawning grounds in deeper water to summer feeding grounds on the continental shelf. This is a separate migration pattern from the counter-migration noted for juveniles.

The Pacific halibut stock assessment is a catch-at-age analysis conducted by IPHC regulatory area. Information is gathered from catch, catch per unit effort (CPUE), age composition, and average weight data. These data are used to estimate the exploitable biomass. Available harvest is based on constant exploitation yield (CEY), by applying an optimum harvest rate of 0.35 to the exploitable biomass. Catch limit recommendations are determined by subtracting removals from other sources (bycatch, sport, waste, and subsistence) from the available harvest (Table 2.1). In 1991, for the first time, the IPHC subtracted an additional 2 million pounds for personal use/subsistence.

The estimated coast-wide exploitable biomass of Pacific halibut peaked in 1988 at approximately 200,000 mt round weight (332 million pounds dressed weight) and has declined to approximately 160,000 mt (263 million pounds) in 1991 (Table 2.2). The decline is about 5-10 percent per year, and is expected to continue for several more years. The overall biomass, however, has remained above sustainable biomass. Since 1974, the recent low biomass level, the exploitable biomass has more than doubled. In IPHC Regulatory Area 4 (similar to the Bering Sea-Aleutian Islands area), exploitable biomass increased from about 13,000 mt (21 million pounds) in 1977 to about 18,000 mt (30 million pounds in 1985. Biomass declined since to about 15,000 mt (24 million pounds) in 1991.

The pattern of increasing and decreasing biomass is consistent with long term cycles observed in the past. Recruitment of halibut to the exploitable biomass, measured as abundance of 8-year old halibut, has fluctuated in a cyclic pattern for 60 years. Biomass and recruitment since 1974 are presented in Figure 2.2.

The IPHC staff, in cooperation with NMFS staff, has reported on the changes in bottom trawl estimates of juvenile and adult abundance in the Bering Sea (Clark and Bakkala 1992). Clark and Bakkala estimated halibut abundance in numbers and biomass, which show different patterns. Numbers of halibut (Figure 2.3) increased in the late 1970s (from the 1977 year class) and in the late 1980s and early 1990s (from the 1987 year class), with low values in between. Small halibut (< 65 cm) showed the same pattern as all sizes combined. Biomass of total halibut (Figure 2.3) increased slightly over the time period, without significant peaks or valleys (NMFS considers the 1988 value, in parentheses, unreliable, so a mid-point value from adjacent points is included). Small halibut varied without apparent trend, which suggests that the 1987 year class has not contributed to high bycatch in the Bering Sea in recent years, and should contribute only moderately in future years.

The numerical peaks demonstrate that more halibut are present in the Bering Sea, and more numbers of halibut are likely to be caught as bycatch compared to periods of low numerical abundance. However, increased numerical abundance does not necessarily mean increased weight of bycatch. In the case of the Bering Sea, the numerical peaks are composed of halibut aged 2 to 6-years. The individual weight of these small halibut is very small compared to older fish, so the aggregate weight of the cohorts during the first several years is very small.

The numerical peak associated with the 1977 year class, as estimated by the trawl surveys, occurred in 1979. Neither total biomass nor biomass of small halibut increased much during the period that the 1977 cohort was dominant (Figure 2.3). During the first three years that the 1987 year class has been present (1989-1991), an upturn in biomass of small halibut occurred in 1991. However, the 1991 value is within the range of historical values. To date the 1987 year class has caused no significant change in bycatch, because the biomass of small fish (all halibut in the 1987 year class are smaller than 65 cm) has not changed very much since the entry of the 1987 year class.

The change in halibut biomass in the Bering Sea is buffered by multiple year classes and migration. A strong cohort cannot add much biomass in the early years because of the low weight of individuals. Multiple year classes reduce the effect of biomass change within a single cohort. The IPHC believes that a substantial proportion of young halibut migrate out of the Bering Sea during the ages of 2 to 6-years, so that when the halibut reach maximum cohort biomass (within the small halibut group) many are no longer in the survey area.

2.2 Bycatch

Pacific halibut are caught inadvertently by fisheries targeting on other species. Regulations require returning halibut to the sea in as good a condition as possible. The survival of discarded halibut varies from near zero to over 90 percent, depending on the type of fishery and the handling provided by fishermen. Coast-wide halibut bycatch mortality was relatively small until the early 1960's, when it increased rapidly due to development of foreign trawl fisheries off the North American coast. Total bycatch mortality (Figure 2.4), including several years of Japanese directed harvest authorized by the International North Pacific Fisheries Commission, peaked in 1962 at over 15,000 mt (25 million pounds). Bycatch mortality generally declined from 1962 through 1985, with temporary increases in the early 1970's and late 1970's. Estimated bycatch mortality was lower in 1985 than it had been since before 1960. Since then, it has increased to near the temporarily high level experienced in 1980.

Bering Sea bycatch mortality followed a pattern similar to that of coast-wide mortality (Table 2.3).

It is very difficult to make precise estimates of the effects of bycatch on the commercial-sized component of the halibut stocks because bycatch is largely made up of younger migrating halibut. Growth, mortality, and migration greatly complicate the estimation procedures. If the same age composition occurred in both fisheries one could consider the bycatch removals as merely increasing the directed removals. Migration rates of juvenile halibut are not well known, so the impact of bycatch of juvenile halibut from specific areas on adult populations in those or other areas must be estimated indirectly.

Bycaught halibut are generally smaller than those harvested by the directed fishery. Consequently, factors such as maturity, reproductive capacity, survivorship, and growth substantially affect stock productivity. By allowing small halibut to remain at large for a longer period of time, a net gain in stock biomass occurs due to the greater cumulative gain in individual weight relative to losses incurred due to mortality. Smaller fish are less likely to be reproductively mature, and have less reproductive capacity. Those harvested earlier in their life history not only contribute less in terms of short term yield, but they also contribute less to the maintenance of future stock biomass or to future yields. Bycatch losses affect recruitment, future catch, and future reproductive potential of the stock.

The IPHC staff currently recommends catch limits for Pacific halibut based on limiting total annual removals to 35 percent of the exploitable biomass, which provides relatively high long term yields, yet does not force the spawning stock to low levels that may be risky to the resource. Bycatch is one of the sources of mortality that must be accounted for within the 35 percent rate. Since bycaught halibut are generally smaller, younger, and located in areas different from where they would reside as adults, the IPHC must account for their loss through a series of computations that reflect these factors.

IPHC's approach for compensating the stock for bycatch losses is designed to leave the same reproductive potential (e.g. equivalent number of eggs produced) in the spawning stock as if bycatch had not occurred. The compensation results in a forfeiture of allowable directed harvest. The compensation factor was determined to be one mt of catch limit reduction for each mt of bycatch mortality.

The impact on the halibut fishery consists of two parts: (1) the catch limit reduction to maintain reproduction, and (2) reduced recruitment to the directed halibut fishery from bycatch of pre-recruits.

(1) Reproductive compensation for bycatch immediately deprives the directed fishery of one mt of yield for each mt of bycatch the previous year. But this amounts to leaving fish in the stock rather than catching them right away, and some are caught later. On the average, about 0.6 mt of the one mt bycatch compensation is eventually caught, so the net impact of reproductive compensation is 0.4 mt per mt of bycatch.

(2) Bycatch eventually reduces recruitment to the directed fishery, and amounts to 1.2 mt of lost yield for each mt of bycatch.

The combined effects of reproductive compensation and lost recruitment shows a net loss to the directed fishery of 1.6 mt for each mt of bycatch: 0.4 mt from reproduction compensation and 1.2 mt from reduced recruitment.

If the reproductive compensation is done correctly and if the bycatch is estimated correctly, the halibut spawning stock size will remain in the same condition whether bycatch occurs or not. The directed halibut fishery pays for maintenance of the resource through lower catches. Therefore, changes of $\pm$ 50 percent in the bycatch limits will be felt in the directed halibut fishery, but should not affect the condition of the resource.

The estimated 1991 coast-wide bycatch mortality of 10,000 mt (16.9 million pounds) represents about 16,000 mt (27 million pounds) of lost yield to the halibut fishery. About 9,700 mt (16.1 million pounds) of the bycatch mortality occurred in Alaska, and resulted in 14,000 mt (24.2 million pounds) of lost yield. Of the lost yield caused by bycatch in Alaska, the IPHC estimates that approximately 2,000 mt (3.25 million pounds) were lost to the Canadian halibut fishery. The loss is caused by interception of juvenile halibut migrating from Alaska to Canada.

2.3 Summary

1. The IPHC manages halibut by regulatory area, but considers the resource as a single population.

2. Due to the process used to set halibut quotas, bycatch mortality decreases catch in the halibut fishery but does not decrease the long-term productivity of the halibut stocks. Therefore, within the range of halibut PSC limits being considered, the issue is principally one of allocating halibut between the halibut and groundfish fisheries.

3. Neither an increase nor a decrease in the halibut PSC limits can be justified by recent or expected changes in the total biomass of halibut in the BSAI. The same may not be true for the age groups of halibut that comprise most of the bycatch in the groundfish fisheries.

Table 2.1 Total removals of Pacific halibut in metric tons (round weight).

Year	Comm. Catch	Bycatch Mort.	Sport	Waste	Total
1980	13.2	11.0	0.5	0.0	24.7
1981	15.5	8.7	0.7	0.0	24.9
1982	17.5	7.2	0.8	0.0	25.5
1983	23.2	6.3	1.0	0.0	30.5
1984	27.1	5.9	1.1	0.5	34.6
1985	33.8	4.4	1.6	1.0	40.7
1986	42.0	5.0	2.0	1.9	50.9
1987	41.9	6.5	2.2	1.6	52.2
1988	45.0	8.6	3.1	1.2	57.8
1989	40.2	7.9	3.3	1.2	52.7
1990	37.2	10.6	3.6	1.2	52.6
1991	34.0	10.1	3.9	1.5	49.5

Source: IPHC, personal communication.

Note: In 1991, for the first time, the IPHC estimated that an additional 2 million pounds of removals occurred for personal use/subsistence.

Table 2.2 Exploitable biomass of Pacific halibut estimated by IPHC stock assessment, in millions of pounds (net weight).

	Area						
YEAR	**2A**	**2B**	**2C**	**3A**	**3B**	**4**	**TOTAL**
1974	1.71	30.76	31.00	55.55	9.04	24.01	152.08
1975	1.73	32.43	30.65	60.92	9.90	23.09	158.72
1976	1.55	31.89	29.88	64.75	10.24	21.84	160.14
1977	1.40	31.01	30.34	69.12	10.74	21.40	164.01
1978	1.24	31.17	33.66	75.76	11.14	21.56	174.53
1979	1.27	30.90	36.48	80.20	13.10	22.01	183.96
1980	1.33	30.51	39.83	85.55	16.86	22.60	196.67
1981	1.38	30.72	44.87	93.68	22.50	25.40	218.56
1982	1.37	32.10	51.75	104.07	29.37	28.00	246.67
1983	1.33	35.12	59.84	118.22	33.87	30.46	278.84
1984	1.57	38.90	64.60	133.04	35.90	29.56	303.58
1985	1.80	42.26	68.25	145.83	38.19	30.02	326.35
1986	1.93	43.38	67.17	153.90	34.65	29.96	331.00
1987	1.96	43.69	65.48	156.07	34.66	29.70	331.56
1988	1.85	42.53	63.60	161.93	34.79	27.39	332.10
1989	1.97	38.92	60.51	155.46	33.59	27.33	317.78
1990	2.31	34.99	57.12	141.64	29.64	26.03	291.73
1991	2.33	32.58	53.82	126.38	23.39	24.15	262.65

Source: IPHC, Pat Sullivan

Table 2.3 Bycatch mortality of Pacific halibut in Bering Sea fisheries in metric tons (round weight).

Year	Byc. Mort.	Year	Byc. Mort.	Year	Byc. Mort.
1977	1,758	1983	2,575	1988	5,344
1978	3,029	1984	2,830	1989	4,393
1979	3,269	1985	2,538	1990	5,140
1981	5,570	1986	3,363	1991	5,303
1982	3,865	1987	3,461		

Source: IPHC, personal communication.

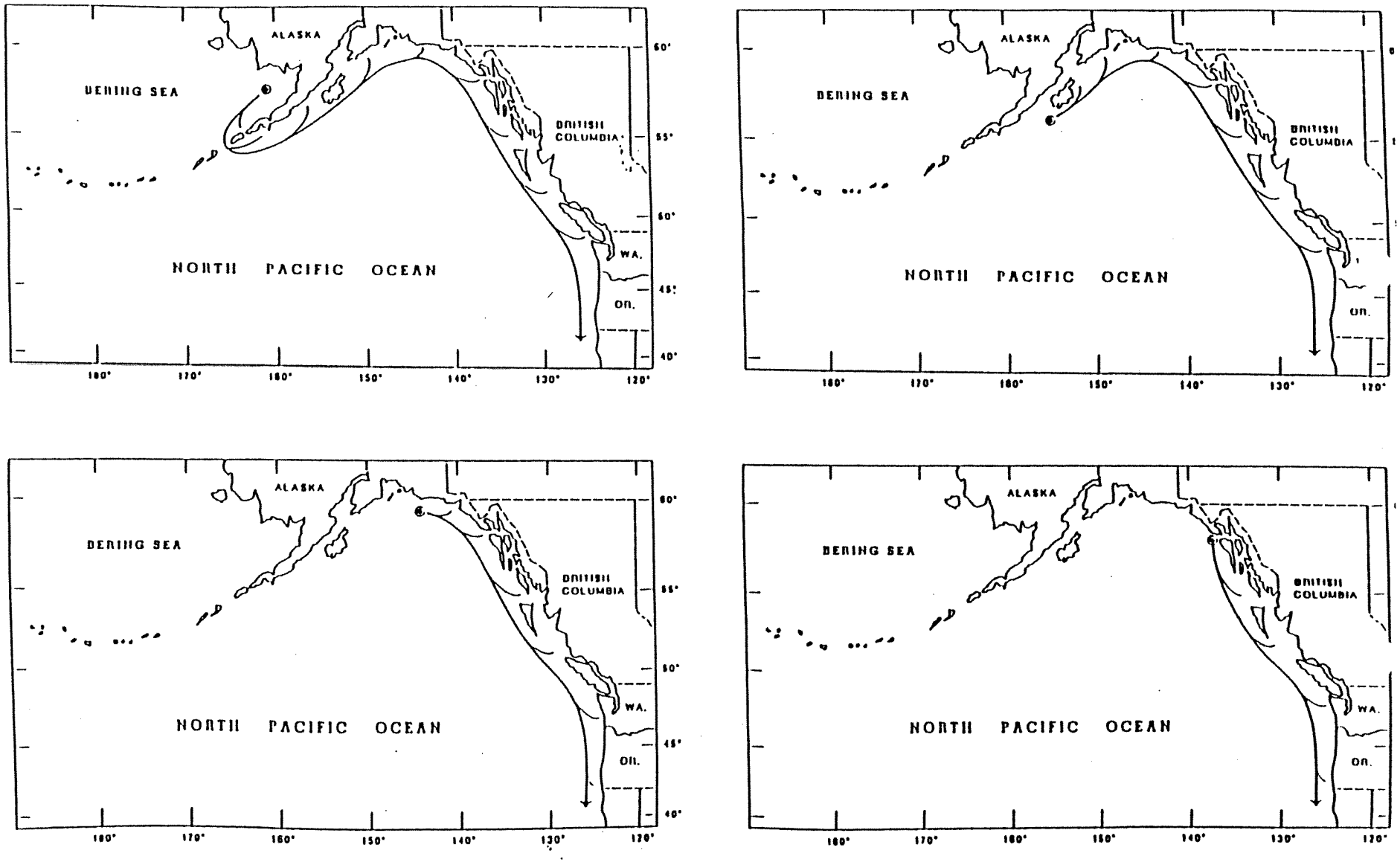


Figure 2.1. Migratory patterns of Pacific halibut from different sites.

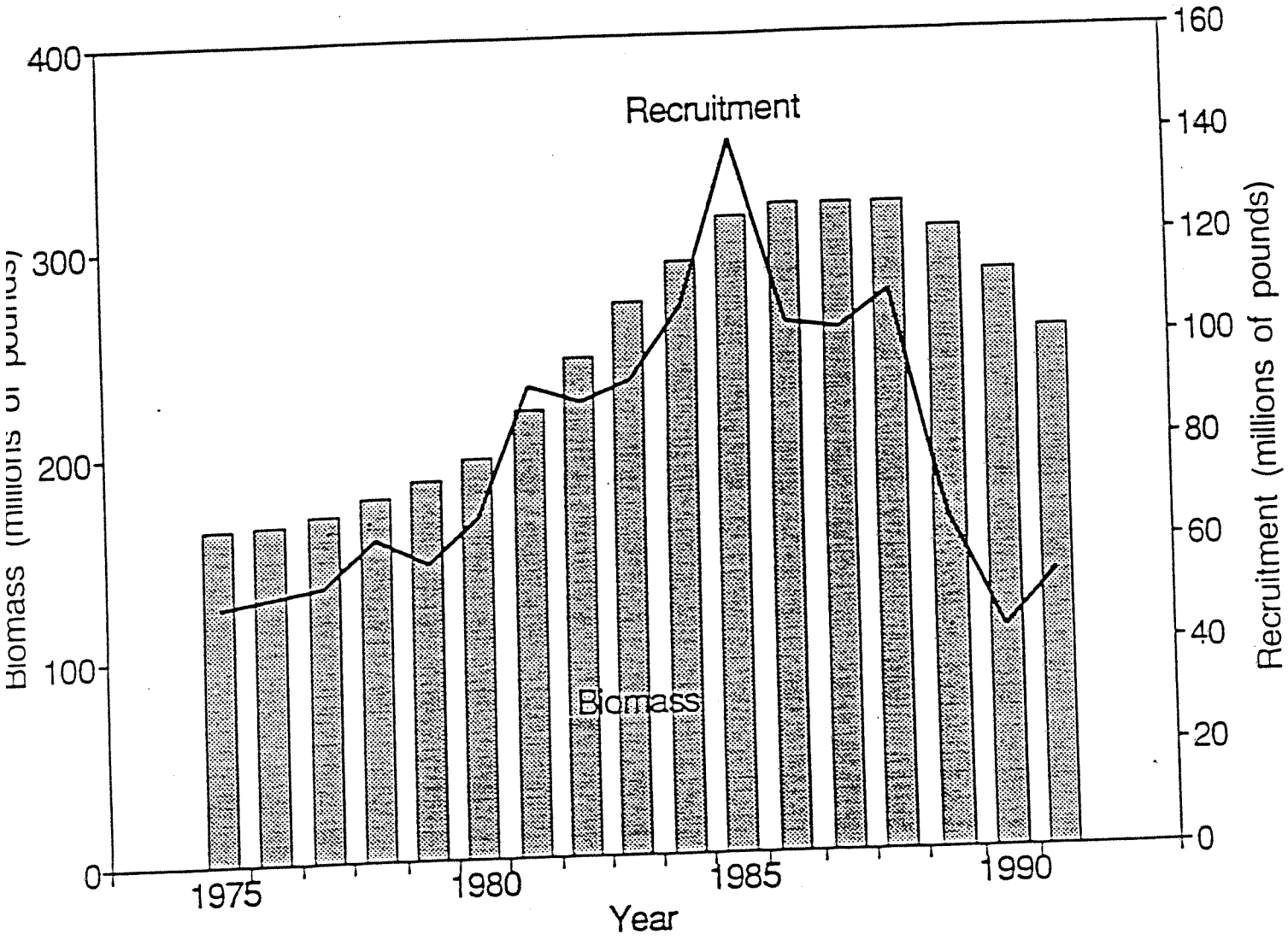


Figure 2.2. Recruitment of 8-year old halibut and halibut exploitable biomass, 1975-1991.

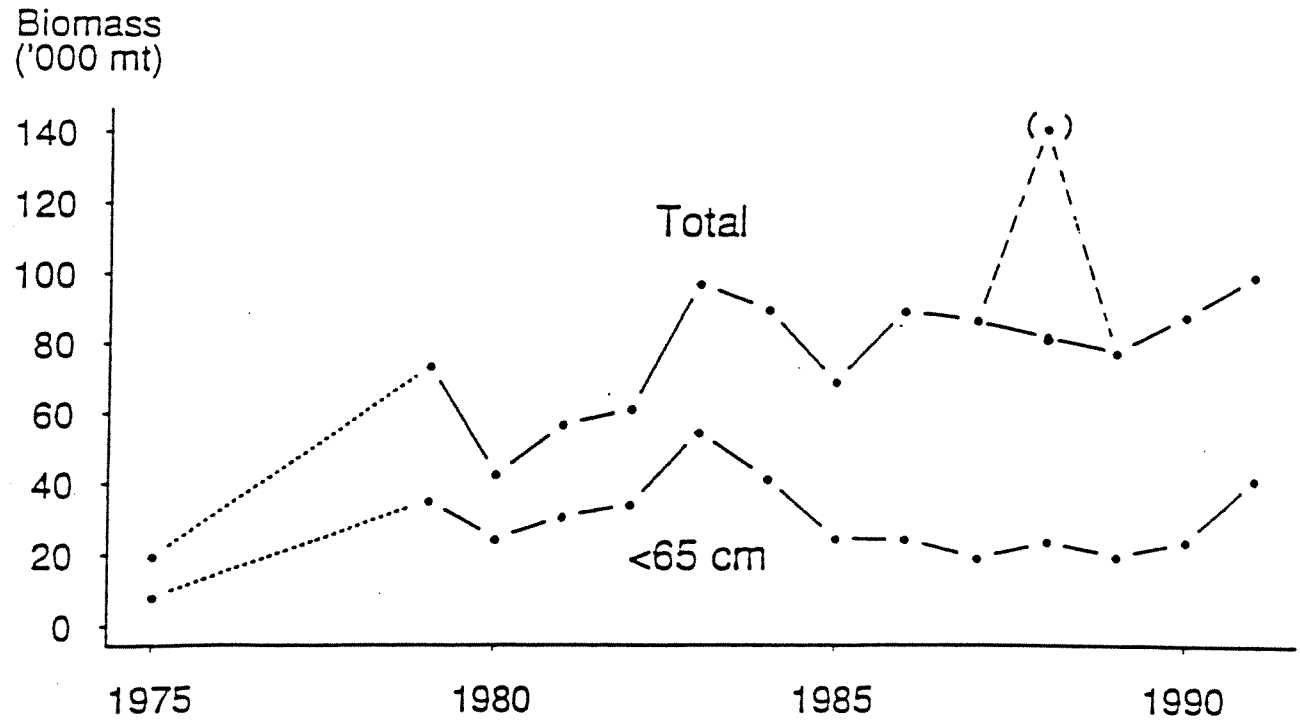


Figure 2.3a. Halibut biomass in the Bering Sea estimated by the NMFS trawl survey.

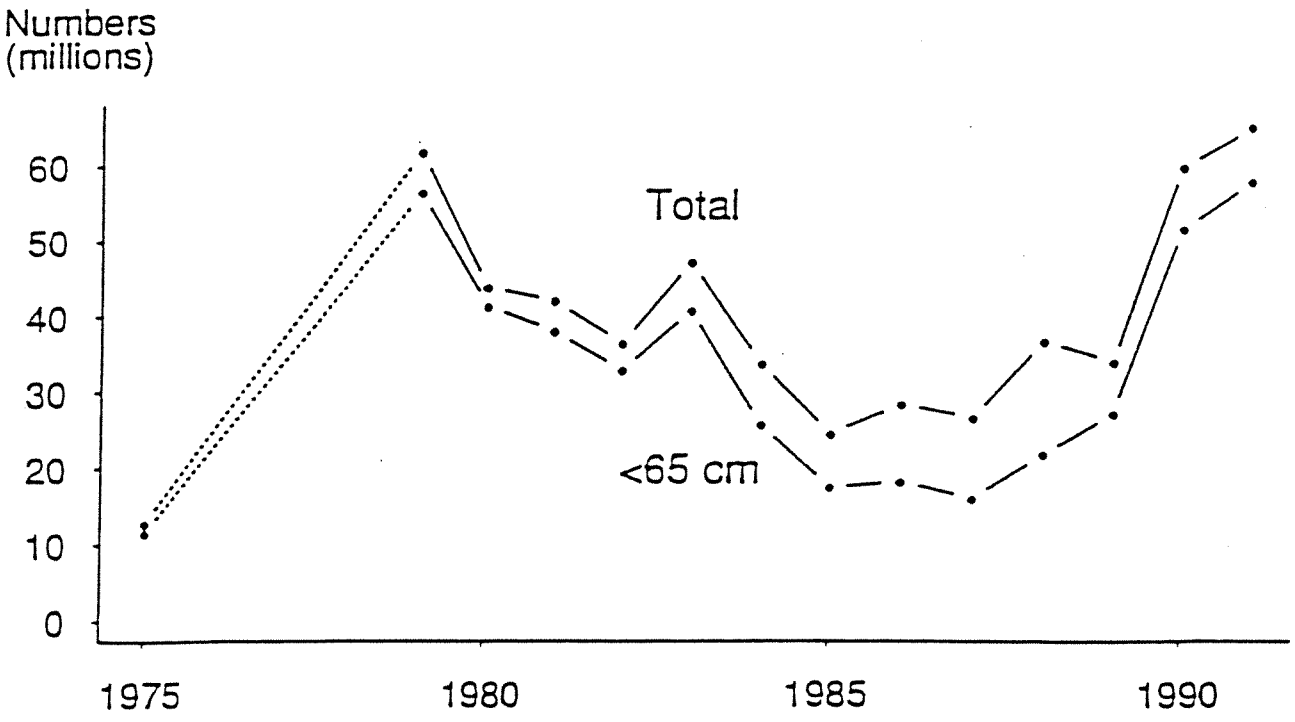


Figure 2.3b. Halibut numbers in the Bering Sea estimated by the NMFS trawl survey.

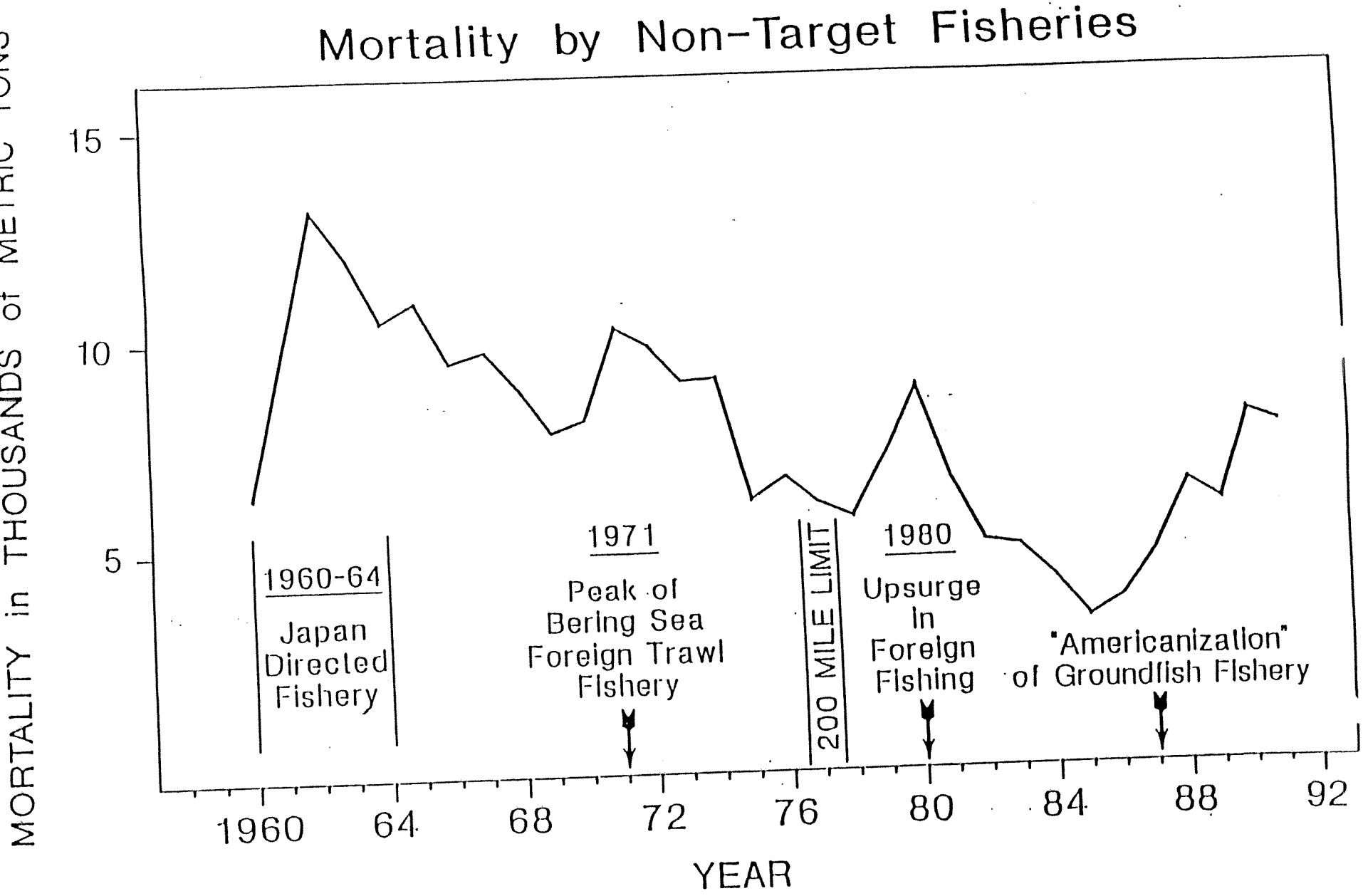


Figure 2.4. Pacific halibut bycatch mortality from 1962-1991.

3.0 ANALYSIS OF THE ALTERNATIVES

The alternatives being considered address three issues:

1. the trawl and non-trawl halibut PSC limits beginning in 1993,

2. the use of a bycatch mortality limit as opposed to a bycatch limit for the trawl fisheries, and

3. the authority to change PSC limits with a regulatory amendment as opposed to an FMP amendment.

Each of these issues is discussed separately.

3.1 Analysis of Alternative Halibut PSC Limits for the Trawl and Non-Trawl Fisheries

Two methods are used to evaluate the alternative PSC limits for the trawl and non-trawl fisheries. First, a bycatch simulation model is used to estimate the effects of the alternative halibut PSC limits. Second, estimates are made of the tradeoffs that result if bycatch is reduced by reducing groundfish catch.

3.1.1 Analysis Based on the Bycatch Simulation Model

A bycatch simulation model was used to estimate many of the effects of alternative halibut PSC limits for the trawl and non-trawl fisheries. The model uses 1990 and 1991 domestic fishery (DAP) data to predict:

1. the pattern of groundfish fishing,

2. expected bycatch,

3. the value of the groundfish fisheries, and

4. the foregone value of other fisheries due to bycatch in the groundfish fisheries.

The values of groundfish and bycatch are measured in terms of both gross and net wholesale value, where the latter is gross value net of variable costs. Wholesale prices for 1991 were used for all species.

The model's estimates of the effects of the alternative PSC limits are based on estimated bycatch rates for 1990 and 1991. These bycatch rates reflect the current management regime for the groundfish fishery. For example, these bycatch rates are higher than they would be expected to be either if each fishing operation were accountable for its bycatch or if the race to catch fish before a PSC limit or TAC is taken were eliminated.

Model Deficiencies The ability of the model to accurately predict the effects of alternative PSC limits for the trawl or non-trawl fisheries is severely limited because the actual effects of a specific PSC limit will depend on:

(1) economic and biological variables which are not static and

(2) the responses of fishing operations to PSC limits, PSC limit induced closures, and the vessel incentive program.

The simulation model uses historical data in a logical and explicit manner to predict many but not all of the effects of alternative PSC limits. The data sets and the response assumptions are described in the Appendix.

Model Runs Model runs were made to provide comparisons of four alternative PSC limits for the trawl fisheries and four alternative PSC limits for the non-trawl fisheries for two alternative assumptions concerning the effectiveness of the trawl vessel incentive programs and for three historical data sets.

The alternative assumptions concerning the halibut and king crab bycatch vessel incentive program for the trawl fisheries are that:

(1) it is effective as defined in the report and

(2) it has no effects on bycatch rates.

The three historical data sets are:

(1) 1990 and 1991 combined,

(2) 1990, and

(3) 1991.

The PSC limits considered are as follows:

Trawl fisheries bycatch limits

1. 5,333 mt bycatch (4,000 mt bycatch mortality)
2. 2,516 mt bycatch (1,887 mt bycatch mortality)
3. 5,033 mt bycatch (3,775 mt bycatch mortality)
4. 7,550 mt bycatch (5,663 mt bycatch mortality)

Non-trawl fisheries bycatch mortality limits

1. no limit
2. 375 mt
3. 750 mt
4. 1,125 mt.

3.1.1.1 Estimated Effects of Alternative Non-Trawl Limits

The model's estimates of the effects of the alternative halibut PSC limits for the non-trawl fisheries are presented in Table 3.1 and Figures 3.1 - 3.4. The differences for the alternatives are summarized below.

The projected halibut bycatch mortality ranged from 328 mt (with the 150% limit, 1990 and 1991 data combined, and an ineffective vessel incentive program) to 393 mt (with the 150% limit, 1991 data, and an ineffective vessel incentive program). Therefore, the 375 mt limit had a small effect on projected non-trawl catch and bycatch and the other limits had not effects.

The difference in the projections for the status quo (no limit), a 750 mt limit (100%), and a 1,125 mt limit (150%) are due to the modeled interactions between the trawl and non-trawl fisheries and due to the fact that each non-trawl limit was run with the same trawl limit (for example, the 50% non-trawl limit was run only with the 50% trawl limit). Therefore, the trawl limit, which affected the trawl closures, determined how much of the Pacific cod TAC was available to the non-trawl fisheries after the trawl closure.

The simulation model results indicate that, unless the bycatch mortality rate increases, the 1990 or 1991 levels of catch in the non-trawl fisheries could occur with a bycatch limit of less than 400 mt and that a 100% increase in catch could occur with a limit of less than 800 mt.

It is not known how rapidly catch in these non-trawl fisheries will increase or how bycatch rates would naturally tend to change. Therefore, it is difficult to estimate what PSC limit would constrain and impose cost on these fisheries.

If the average non-trawl halibut bycatch mortality rate remains at its 1991 level:

1. the 375 mt (50%) limit would reduce catch by about 20% (total catch of 62,900 mt),
2. the 750 mt (100%) limit would allow catch to increase by 60% (total catch of 126,000 mt),
3. the 1,125 mt (150%) limit would allow catch to increase by 140% (total catch of 189,000 mt), and
4. a limit of about 1,000 mt would be necessary to allow the non-trawl catch to increase by the amount equal to the 1991 cod catch in the trawl cod fishery (total catch of 167,000 mt).

The following changes would tend to increase the average bycatch mortality rate:

1. the entry of new participants in the fishery,
2. the expansion of the fishery into new areas and periods,
3. an increase in the pace of the fishery, and
4. decreased cod abundance which will tend to decrease catch per unit of effort.

It is not known to what extent these factors will tend to increase the average rate. The fact that first quarter catch increased by more than 100% in 1992 compared to 1991 while the average bycatch

mortality rate decreased from 0.34% to 0.32%, indicates that such changes do not necessarily increase the rate. However, beginning late in April , 1992, the bycatch mortality rate increased dramatically in the longline cod fishery. This probably was due, at least in part, to new entrants and changes in fishing areas.

Other potential changes would tend to decrease the average bycatch mortality rate, for example:

1. if longline fishermen were required to cut gangions to release halibut before they came aboard the vessel, IPHC staff has tentatively recommended assuming that the discard mortality rate would be reduced by 50% and

2. if soft hooks that automatically release halibut are used, IPHC staff has tentatively recommended assuming that the discard mortality rate would be reduced by 100%.

The list of what catch could occur for different halibut PSC limits if the average bycatch rate does not increase is also valid with a 100% increase in the bycatch rate if the discard mortality rate is reduced by 50%.

Actions to reduce discard mortality rates can be justified if the cost of doing so is less than the benefits associated with the resulting reduction in bycatch mortality. Very preliminary discussions with individuals associated with the longline fishery indicate that the cost of cutting gangions would be relatively low. The cost effectiveness of using hooks that do not retain halibut is more uncertain.

In the absence of bycatch accountability by each fishing operation, individual operations probably do not have an adequate incentive to voluntarily take actions to reduce discard mortality unless the costs of doing so are insignificant. Therefore, mandatory programs may be necessary. Such programs could be justified if they provided a low cost method for reducing bycatch mortality.

The fact that bycatch mortality rates are lower in the non-trawl fishery does not eliminate the possibility that the most cost effective method for reducing bycatch is to have that fishery further reduce its bycatch mortality rate. That is, bycatch rate parity cannot be justified in terms of minimizing the total cost of bycatch.

3.1.1.2 Estimated Effects of Alternative Trawl Limits

The model's estimates of the effects of the alternative halibut PSC limits for the trawl fisheries are presented in Table 3.2 and Figures 3.5 - 3.14. The differences for the alternatives are summarized below for each of two alternative assumptions concerning the effectiveness of the vessel incentive program.

Estimated Effects If the Vessel Incentive Programs Are Effective

The estimates of bycatch for each of the four trawl PSC limits demonstrate that actions taken to decrease the bycatch of one species can increase that of another. The lowest Halibut PSC limit results in the lowest halibut and crab bycatch but the highest herring bycatch for the 1990, 1991, or combined data set. The lowest halibut limit results in the lowest chinook salmon bycatch for the 1990 or 1991 data set, but the highest chinook bycatch for the combined data set.

Total groundfish catch is estimated to be about the same for all except the 50% limit. For the 50% limit, total groundfish catch is approximately 1.55 million mt, 1.60 million mt, and 1,61 million mt,

respectively, for the 1990, 1991, and the combined data sets compared to 1.61-1.62 million mt, 1.69-1.74 million mt, and 1.68-1.69 million mt for the other limits.

The estimates of gross wholesale value of trawl groundfish catch net of variable costs are also quite similar for all but the 50% limit. For the 50% limit, it is approximately $464 million, $418 million, and $447 million, respectively, for the 1990, 1991, and the combined data sets compared to $490-498 million, $455-467 million, and $474-478 million for the other limits.

The estimates of the net value of bycatch are also relatively close except for the 50% trawl limit. For the 50% limit, it is approximately $7.3 million, $9.3 million, and $9.2 million, respectively, for the 1990, 1991, and the combined data sets compared to $10.5-10.8 million, $13.5-14.8 million, and $12.3-12.6 million for the other limits.

The bottom line estimates are provided by the estimates of the wholesale value of the trawl fishery catch minus trawl fishery variable cost and minus the net wholesale value of the bycatch. Using the 1990 data set, compared to the status quo, the 50% limit would reduce the annual net benefit by $26 million, the 100% limit would reduce it by $2 million, and the 150% limit would increase it by $6 million. When the 1991 data set is used, the 50% limit reduces it by $36 million, the 100% limit reduces it by $3 million, and the 150% limit increases it by $8 million. Finally, when the combined 1990 and 1991 data set is used, the 50% limit reduces it by $26 million, the 100% limit reduces it by $1 million, and the 150% limit increases it by $2 million.

Trawl Summary These estimates indicate that the overall effects of the four alternative sets of PSC limits are about the same with the exception of the 50% limits which result in lower estimates of halibut and crab bycatch, groundfish catch and value, bycatch value, and groundfish value minus bycatch value. Therefore, in terms of these estimates, the 50% limits provide the lowest net benefits and there is not much difference among the other three alternatives. These results do not justify a decrease in the trawl fishery halibut PSC limit compared to the status quo and provide at least a weak justification for an increase.

If there are factors that are expected to increase bycatch rates, there would be increased justification for increasing the halibut PSC limit for the trawl fisheries. The factors could include:

1. the entry of new participants in the non-pollock fisheries due to a compressed pollock fishery,

2. decreases in groundfish biomass,

3. changes in fishing periods and areas due to changes in regulations including the allocation of pollock among inshore, offshore, and community development quota (CDQ) operations, and

4. decreased expectations concerning the effectiveness of the vessel incentive programs.

Other potential justifications for an increase in the halibut PSC limit for the trawl fisheries are:

1. the fact that the trawl limit has reduced trawl catch and the associated net revenue in 1990 and 1991 and is expected to do so in 1992 and

2. the tendency of the bycatch model to understate the benefits of relaxing a bycatch constraint.

If non-trawl catch is constrained by competition of the trawl fishery for TACs, at least some of the

catch foregone in the trawl fishery due to a PSC limit induced trawl closure will be offset by increased catch in the non-trawl fishery. To some extent, this is captured by summing the model's estimates of the effects in these two groups of fisheries (see Figures 3.15 - 3.20). Because the model only allows a partial redistribution of catch between these two fisheries, foregone groundfish catch and bycatch savings are understated as are the associated costs and benefits, respectively. The net effect is that the cost of decreasing trawl catch to reduce bycatch is overstated.

Estimated Effects If the Vessel Incentive Programs are Not Effective

The comparisons among the four sets of PSC limits are about the same if it is assumed that the vessel incentive programs for halibut and crab have no effects. In summary, these estimates indicate that the overall effects of the four alternative sets of PSC limits are about the same with the exception of the 50% limits which result in lower estimates of halibut and crab bycatch, groundfish catch and value, bycatch value, and groundfish value minus bycatch value. Therefore, in terms of these estimates, the 50% limits provide the lowest net benefits and there is not much difference among the other three alternatives.

3.1.2 Analysis of Tradeoffs If Bycatch Is Reduced by Reducing Groundfish Catch

The appropriate halibut PSC limit for either the trawl or non-trawl fisheries is determined by the broadly defined benefits and costs of each limit. The benefits of a limit are derived principally from any resulting decrease in halibut mortality and the associated future increases in benefits from the halibut fishery. The costs include those associated with the constraints placed on fishing operations or catch in the groundfish fisheries. There are also management agency costs.

Experience with PSC limits in the trawl fishery has demonstrated that the establishment of PSC limits does not necessarily provide individual fishing operations with an incentive to reduce bycatch rates even though it may be in the best interest of the fleet to do so. As a result, the halibut PSC limits for the trawl fisheries, which close the entire BSAI, have reduced trawl groundfish catch. Similarly, the trawl and fixed gear PSC limits in the Gulf of Alaska have reduced groundfish catch in the Gulf. When this occurs, the cost of a PSC limit includes the net benefits that are foregone due to the reduced catch and there is a tradeoff between groundfish catch and future catch in the halibut fishery. This section provides estimates of the tradeoffs when halibut bycatch mortality is decreased by reducing groundfish catch.

The analysis of tradeoffs that is presented below is based on estimated bycatch rates for 1991. These bycatch rates reflect the current management regime for the groundfish fishery. For example, these bycatch rates are higher than they would be expected to be either if each fishing operation were accountable for its bycatch or if the race to catch fish before a PSC limit or TAC is taken were eliminated.

3.1.2.1 Tradeoffs for the Non-Trawl Fisheries

It is estimated that in 1991 the BSAI longline and pot fisheries had halibut bycatch mortality of about 467 mt and groundfish catch of 78,542 mt. The resulting bycatch mortality rate of 0.59% and a foregone growth factor of 1.6 indicate that the tradeoff is 0.95 mt of future halibut catch per 100 mt of groundfish catch or, equivalently, 105 mt of groundfish per mt of halibut. Unless the benefits of 1 mt (round weight) of halibut catch are at least 105 times the benefits of 1 mt of groundfish taken in the non-trawl groundfish fisheries, a PSC limit that reduces groundfish catch results in marginal costs exceeding marginal benefits. Note that because the growth factor of 1.6 is for the groundfish

fishery as a whole and because the non-trawl fishery typically takes larger halibut than does the trawl fishery, a lower factor probably should be used for this fishery. If a lower factor had been used, the tradeoff would have been more than 105 mt of groundfish catch per 1 mt of catch in the halibut fishery. The tradeoff also would have been larger if a discount rate had been used. For the Pacific cod longline fishery, the corresponding tradeoff in 1991 was about 104 mt of groundfish catch per 1 mt of catch in the halibut fishery.

The tradeoff between using halibut in the halibut fishery and using it in the non-trawl fishery can be analyzed in terms of both net national benefits and changes in regional economic activity. Estimates of the former are presented in Table 3.3. The tradeoffs are based on estimates of bycatch rates, discard rates, gross and net wholesale value per metric ton of groundfish catch, and gross and net bycatch impact costs. Estimated benefit-cost ratios of reducing groundfish catch by 1 mt to decrease bycatch are also reported in Table 3.3. The gross and net wholesale values per metric ton of groundfish catch are used to estimate the cost per metric ton of groundfish catch foregone due to a PSC limit that reduces catch. Similarly, the gross and net wholesale values of the bycatch species foregone per metric ton of groundfish catch are used to estimate the benefits of the reduction in bycatch associated with a 1 metric ton reduction in groundfish catch.

The wholesale prices for 1991 are used. Based on data used in the bycatch simulation model, the net wholesale value of groundfish was calculated by taking 38% of its gross wholesale value. For both groundfish and the bycatch species, the net value account for only variable costs, not fixed costs. This definition of net value was used because fixed costs do not affect the marginal benefits or costs of reducing groundfish catch to reduce bycatch. The basis of the estimates of value for the groundfish and bycatch species are presented in the Appendix.

Based on wholesale values net of variable costs, the estimated benefit-cost ratios of decreasing non-trawl groundfish catch to decrease bycatch for 1991 was 0.03 for both the cod and sablefish fisheries. This means that a decrease in groundfish catch that would reduce the net value of the groundfish fisheries by $1 would provide increases in the combined net value of the halibut, crab, salmon, and herring fisheries by $0.03 for a net loss of $0.97.

Although this is only a rough approximation of the actual benefit-cost ratio, it suggests that, subject to very large errors in these estimates, reducing non-trawl groundfish catch to reduce bycatch probably will result in greater costs than benefits. Future bycatch management research is expected to provide improved measures of net values and a more comprehensive measure of the benefits and costs of reducing bycatch by reducing groundfish catch.

Estimates of the tradeoffs in terms of regional economic activity are available from the Alaska Fishery Economic Assessment Model that was used to estimate the regional impacts of the inshore/offshore allocation alternatives. The estimated tradeoffs of 104 mt groundfish for 1 mt of halibut in the 1991 longline cod fishery are summarized in Table 3.4.

The estimates indicate that if 104 mt of longline groundfish catch are foregone to increase catch in the halibut fishery by 1 mt, household income and total regional economic activity would be reduced substantially for Alaska alone and for the combined region of Alaska and the Pacific Northwest. For Alaska, the estimated income associated with 104 mt of cod catch is almost 800% greater than that of 1 mt of halibut catch and the total community impact is almost 1,400% greater. For Alaska, Washington, and Oregon combined, the income is more than 1,900% greater and the total community impact is 2,400% greater.

This suggests that a halibut PSC limit for non-trawl fisheries that actually reduces halibut bycatch probably will result in larger costs than benefits. This is not because halibut bycatch should not be regulated in these fisheries. It is because regulating bycatch solely with bycatch limits for a fishery as a whole tends to reduce groundfish catch and, therefore, is an expensive way to control bycatch.

The ability to justify a specific PSC limit is in part determined by the cost of reducing bycatch to that level. Therefore, if only high cost methods of reducing bycatch are available, the PSC limits that can be justified are higher than if lower cost methods are available. For example, if the bycatch management regime included effective individual accountability and if the race for fish were eliminated, the cost of reducing bycatch would be expected to be substantially lower for the groundfish fishery and the PSC limits being considered would be justified more easily or the need for PSC limits could be eliminated.

3.1.2.2 Tradeoffs for the Trawl Fisheries

The arguments that are made above concerning the cost effectiveness of controlling non-trawl halibut bycatch with a PSC limit also apply to the trawl fisheries. However, due to the higher bycatch mortality rate for the bottom trawl fishery as a whole, the potential disparity between costs and benefits may not be as large. It is estimated that the 1991 BSAI bottom trawl fisheries had halibut bycatch mortality of 4,157 mt, assuming 75% discard mortality, and groundfish catch of about 518,490 mt. The resulting bycatch mortality rate of 0.8% and the foregone growth factor of 1.6 indicate that the tradeoff is 1.28 mt of future halibut catch per 100 mt of groundfish catch or, equivalently, 78 mt of groundfish per mt of catch in the halibut fishery. Although this is substantially lower than the 105 mt to 1 mt tradeoff for non-trawl gear, it is still quite likely that a reduction in trawl catch to reduce bycatch would result in greater costs than benefits. For the Pacific cod trawl fishery, the corresponding tradeoff in 1991 was about 43 mt of groundfish catch per 1 mt of catch in the halibut fishery.

The tradeoff between using halibut in the halibut fishery and using it in the trawl fishery can be analyzed in terms of both net national benefits and changes in regional economic activity. As noted previously, estimates for these to measures of tradeoffs are presented in Tables 3.3 and 3.4. The basis for each set of estimates was discussed more fully in Section 3.1.2.1.

Based on wholesale values net of variable costs, the estimated benefit-cost ratios of decreasing groundfish catch to decrease bycatch for 1991 ranged from 0.01 for the mid-water pollock fisheries to 0.49 for the sablefish fishery. Excluding the sablefish, turbot, and arrowtooth flounder fisheries which were eliminated for 1992, the largest ratio was 0.19 for the rock sole fishery. This means that in the case of the mid-water pollock fishery and the rock sole fishery, respectively, a decrease in groundfish catch that would reduce the net value of the groundfish fisheries by $1 would provide increases in the combined net value of the halibut, crab, salmon, and herring fisheries of $0.01 and $0.19.

Although these are only rough approximations of the actual benefit-cost ratios, they suggest that, subject to very large errors in these estimates, reducing groundfish catch to reduce bycatch probably will result in greater costs than benefits. Future bycatch management research is expected to provide improved measures of net values and a more comprehensive measure of the benefits and costs of reducing bycatch by reducing groundfish catch.

The estimated regional economic activity tradeoffs of 43 mt of groundfish in the cod trawl fishery for 1 mt of catch in the halibut fishery are summarized in Table 3.4. The estimates indicate that if 43 t

of trawl groundfish catch are foregone to increase catch in the halibut fishery by 1 mt, household income and total regional economic activity would be decreased somewhat for Alaska alone and decreased substantially for the combined region of Alaska and the Pacific Northwest. For Alaska, the estimated income associated with 43 mt of catch in the cod fishery is 187% greater than that of 1 mt of halibut catch and the total community impact is 208% greater. For Alaska, Washington, and Oregon combined, the income is about 600% greater and the total community impact is almost 700% greater. The tradeoffs for Alaska alone would have been greater if it had not been assumed that all of the groundfish would be processed at sea and all of the halibut would be processed in Alaska.

As with the non-trawl fisheries, the conclusion is not that halibut bycatch should not be regulated, it is that regulating bycatch with bycatch limits for a fishery as a whole tends to be an expensive way to control bycatch. As noted in Section 3.1.2.1, if only high cost methods of reducing bycatch are available, the PSC limits that can be justified are higher than if lower cost methods are available. Therefore, the PSC limits being considered could be justified more easily if the bycatch management regime resulted in lower cost methods of reducing bycatch.

If non-trawl catch is constrained by competition of the trawl fishery for TACs, at least some of the catch foregone in the trawl fishery due to a PSC limit induced trawl closure will be offset by increased catch in the non-trawl fishery. The preceding discussion of the tradeoffs for the trawl fishery does not account for the increase in catch and bycatch by the non-trawl fishery. The net effect is that the cost of a halibut PSC limit that reduces trawl catch is overstated.

Concluding Remarks Concerning the Estimated Tradeoffs

The two methods used to estimate the tradeoffs between groundfish catch and future catch in the halibut, crab, salmon, and herring fisheries are based on the assumption that the level of the halibut PSC limit will not result in fishermen changing their behavior intentionally to reduce bycatch rates. Therefore, the cost of a reduction in a PSC limit results from a reduction in groundfish catch that is calculated by dividing the reduction in the PSC limit by the average bycatch rate.

If a lower PSC limit results in intentional and successful efforts by groundfish fishermen to reduce their bycatch rates, the estimates presented in this report tend to over state the cost of reducing the PSC limits. However, because neither the cost nor the effectiveness of such efforts can be estimated accurately, better estimates of the actual costs are not available. Experience with PSC limits for the BSAI and GOA trawl fisheries and the GOA longline fisheries indicates that the assumption that a fleet will take the necessary actions to prevent PSC induced closures is not valid. Even if a PSC limit did result in intentional and successful efforts to decrease bycatch rates, the costs of such efforts would have to be substantially less than the cost of the foregone groundfish catch for a PSC limit to generate net benefits for the nation.

If the cost of a limit is greater than its benefit, there are two possible outcomes. Either a limit is set low enough to have an effect and, therefore, decrease net benefits to the nation or a limit is set high enough that it has no effect and results in no benefits or costs other than the costs associated with setting the limit. The latter would result in at least a small net cost to the nation.

3.2 Replacing The Trawl Fishery Bycatch Limit With A Bycatch Mortality Limit

The current regulation limits the amount of halibut caught by trawl fishermen and has been in this form since Amendment 12a was implemented in 1989. Regulations dictate that all halibut be returned to the sea as quickly as possible, thus encouraging survival of some fish. Since only a

portion of the halibut die and it is this amount that impacts the halibut fishery, it has been proposed that the limit be formulated in terms of dead halibut, i.e., a mortality limit. The options being considered for a trawl fishery bycatch mortality limit are based on: (1) the discard mortality rate of 75%, and (2) the bycatch limit options specified in Alternative 2.1 (2,517 mt, 5,033 mt, and 7,550 mt of halibut bycatch). The resulting options for a bycatch mortality limit are 1,887 mt, 3,775 mt, and 5,662 mt.

The problem is that the current limit for trawls is in terms of bycatch, but the impact on halibut fishermen is measured in terms of bycatch mortality. A goal to address the impact of bycatch on halibut and groundfish fishermen would be most effectively met by defining the bycatch limit in terms of mortality. BSAI trawl fishermen currently have little incentive to reduce the bycatch mortality of halibut, especially if such efforts impose additional cost to their operation.

There are several reasons to have a bycatch mortality limit, rather than a bycatch limit. The main concern of fishery managers is the amount of halibut which is killed through bycatch. First, this is the quantity which impacts halibut fishermen and bycatch mortality is most effectively controlled if the management measures are defined in the same context, thereby allowing managers to manage for the appropriate amount. Second, trawl fishermen have many more factors within their control to reduce the amount of bycatch mortality. They can reduce the initial amount of bycatch through changes in fishing strategy, techniques, and gear or they can reduce discard mortality rates. All other limits on halibut bycatch in Alaskan groundfish fisheries are in terms of mortality: GOA trawl (in 1986), GOA longline (1990), and BSAI non-trawl gear (1992).

One drawback of switching to a bycatch mortality limit has been identified. It has to with the initial translation of bycatch limits to bycatch mortality limits. If the intention is to establish a bycatch mortality limit that is initially equivalent to a specific bycatch limit, the discard mortality rate that is used to make that translation is critical. If it is later found that the wrong rate was used, the change to a bycatch mortality limit will have unexpected effects.

For the purpose of identifying equivalent bycatch mortality limits, it was assumed that the discard mortality rate is 75%. This is the rate currently being used by the IPHC. If this is the actual rate, then bycatch limits of:

1. 5,333 mt,
2. 2,516 mt,
3. 5,033 mt, and
4. 7,550 mt

are, respectively, equivalent to bycatch mortality limits of:

1. 4,000 mt,
2. 1,887 mt,
3. 3,775 mt, and
4. 5,662 mt.

Over time the discard mortality rate may change principally due to actions taken by fishermen. Such changes will affect the amount of groundfish that can be taken for a given bycatch rate and bycatch mortality limit, but they will not affect the initial equivalency between a specific bycatch limit and bycatch mortality limit. However, if it is determined that the rate that was used in establishing the equivalency was incorrect, the limits listed above would not be equivalent. If, for example, it is later

determined that a rate of 90% should have been used, the equivalent bycatch mortality limits would have been 20% higher. Or if the rate should have been 60%, the equivalent bycatch mortality limits would have been 20% lower. The former type of error would impose a cost on the trawl fleet by imposing an actual decrease in the bycatch limit. With this hypothetical example, the bycatch limit associated with a 4,000 mt bycatch morality limit would be reduced from 5,333 mt to 4,444 mt, this is a 16.7% reduction. Conversely, the latter type of error would provide a benefit to the trawl fleet by imposing an actual increase in the bycatch limit. With this hypothetical example, the bycatch limit associated with a 4,000 mt bycatch morality limit would be increased from 5,333 mt to 6,667 mt, this is a 25% increase. Naturally, the former type of error that imposes a cost on the trawl fleet provides benefits to halibut fishermen and the latter type of error that benefits groundfish fishermen imposes a cost on halibut fishermen. Estimates of tradeoffs between benefits and costs for groundfish and halibut fishermen were discussed above.

There are three peripheral issues that may surface if bycatch mortality limits replace bycatch limits. First, the estimates of discard mortality rates will become more controversial because they will be used in determining when a limit has been taken and, therefore, when some groundfish fisheries will be closed. Due to the increased controversy, more accurate estimates of the discard mortality will be required. Efforts are currently being made by NMFS observers to collect additional information on factors contributing to halibut mortality and the discard mortality rate, ensuring that future analyses will be using the best available data for the best estimates of the discard mortality rate.

Second, research has indicated that "small" halibut are more vulnerable to injuries than larger halibut and may possess a higher discard mortality rate. Therefore, a change in the age composition of halibut in favor of smaller fish could increase the discard mortality rate and decrease the amount of groundfish that can be harvested before the bycatch mortality limit is taken. The following explains why this is not expected to be a problem. Small halibut are considered to be fish less than 80 cm in length. Almost all of the halibut taken in BSAI trawl fisheries are less than 80 cm: 1990 observer data indicated that 89-97% of the halibut taken were less than 80 cm (Williams and Wilderbuer 1991). Thus, small halibut already make up most of the trawl bycatch and a large year class would be expected to have little effect on the overall discard mortality rate. By the time they reach 80 cm, most halibut will have emigrated from the BSAI to the GOA and areas further south. Also, 80+ cm halibut have grown beyond the selectivity of most groundfish trawls.

Third, the incentive to reduce the amount of dead halibut may increase on-deck sorting on factory trawl vessels. Observers stationed in a factory below deck may need to adjust sampling procedures in order to ensure that accurate halibut catch and viability data continue to be collected.

3.3 Amend the BSAI FMP to Authorize the Establishment of Halibut PSC Limits by Regulatory Amendment

Under the current FMP, PSC limits for halibut are established in the FMP and cannot be changed except through an FMP amendment. Amending the FMP to change halibut PSC limits can be a lengthy process that normally takes up to a year to accomplish. It is possible that changes could be made more quickly, but with no decrease in the rigor of the analyses, via a regulatory amendment.

Once FMP amendments are submitted for Secretarial review, the Magnuson Act requires the Secretary to take action on the proposed amendment by day 95 of the amendment review schedule, or the proposed amendment is automatically approved. A statutory review schedule does not exist for regulatory amendments submitted for Secretarial review and some regulatory amendments have

languished in the Federal review process for months, particularly if the proposed action is not associated with an urgent issue. Given the priority nature of PSC limits within the bycatch management program, however, regulatory amendments to change PSC limits would likely be reviewed and, if approved, implemented in a timely manner.

Table 3.1 Bycatch Simula Model Projections for BS/AI Non-Trawl Fishe 'or Three Data Sets
1990 DATA

	Status Quo (No Limit)	50% 375 mt	100% 750 mt	150% 1125 mt
BYCATCH AMOUNTS				
Halibut mortality (mt)	370	361	370	328
Herring (mt)	0	0	0	0
Red king crab (no.)	10,288	10,288	10,288	10,288
C. bairdi (no.)	25,289	25,204	25,289	25,057
Chinook (no.)	5	5	5	5
GROUNDFISH CATCH (mt)				
Fixed gear cod and sablefish	64,475	64,427	64,475	57,190
Pollock	0	0	0	0
Cod, Atka mackerel - fillet	0	0	0	0
All other - H & G	0	0	0	0
TOTAL	64,475	64,427	64,475	57,190
GROSS REVENUE ($1,000s)				
Fixed gear cod and sablefish	$91,768	$91,800	$91,768	$82,699
Pollock	$0	$0	$0	$0
Cod, Atka mackerel - fillet	$0	$0	$0	$0
All other - H & G	$0	$0	$0	$0
TOTAL	$91,768	$91,800	$91,768	$82,699
TOTAL VARIABLE COSTS ($1,000s)				
Fixed gear cod and sablefish	$66,073	$66,096	$66,073	$59,543
Pollock	$0	$0	$0	$0
Cod, Atka mackerel - fillet	$0	$0	$0	$0
All other - H & G	$0	$0	$0	$0
TOTAL	$66,073	$66,096	$66,073	$59,543
NET REVENUES (Gross revenue - Total variable cost, $1,000s)				
Fixed gear cod and sablefish	$25,695	$25,704	$25,695	$23,156
Pollock	$0	$0	$0	$0
Cod, Atka mackerel - fillet	$0	$0	$0	$0
All other - H & G	$0	$0	$0	$0
TOTAL	$25,695	$25,704	$25,695	$23,156
PRESENT GROSS VALUE OF BYCATCH ($1,000s)				
Halibut (all fisheries)	$2,035	$1,986	$2,035	$1,804
Pacific herring (all fisheries)	$0	$0	$0	$0
Red king crab (all fisheries)	$223	$223	$223	$223
Bairdi crab (all fisheries)	$45	$44	$45	$44
Chinook salmon (all fisheries)	$0	$0	$0	$0
TOTAL	$2,302	$2,253	$2,302	$2,071
PRESENT NET VALUE OF BYCATCH ($1,000s)				
Halibut (all fisheries)	$1,079	$1,052	$1,079	$956
Pacific herring (all fisheries)	$0	$0	$0	$0
Red king crab (all fisheries)	$102	$102	$102	$102
Bairdi crab (all fisheries)	$17	$17	$17	$17
Chinook salmon (all fisheries)	$0	$0	$0	$0
TOTAL	$1,198	$1,172	$1,198	$1,076
Gross Groundfish Revenue - Gross Bycatch Value	$89,466	$89,548	$89,466	$80,628
Net Groundfish Revenue - Net Bycatch Value	$24,497	$24,532	$24,497	$22,080

Table 3.1 Bycatch [illegible] Simulation Model Projections for BSAI Non-Pelagic Fisheries Continued

1991 DATA

	Status Quo (No Limit)	50% 375 mt	100% 750 mt	150% 1125 mt
BYCATCH AMOUNTS				
Halibut mortality (mt)	380	381	393	373
Herring (mt)	0	0	0	0
Red king crab (no.)	1,775	961	2,067	1,339
C. bairdi (no.)	36,016	17,009	44,102	26,699
Chinook (no.)	47	47	47	47
GROUNDFISH CATCH (mt)				
Fixed gear cod and sablefish	72,464	72,611	74,195	71,538
Pollock	0	0	0	0
Cod, Atka mackerel - fillet	0	0	0	0
All other - H & G	0	0	0	0
TOTAL	72,464	72,611	74,195	71,538
GROSS REVENUE ($1,000s)				
Fixed gear cod and sablefish	$117,766	$117,240	$120,294	$116,395
Pollock	$0	$0	$0	$0
Cod, Atka mackerel - fillet	$0	$0	$0	$0
All other - H & G	$0	$0	$0	$0
TOTAL	$117,766	$117,240	$120,294	$116,395
TOTAL VARIABLE COSTS ($1,000s)				
Fixed gear cod and sablefish	$84,792	$84,413	$86,612	$83,804
Pollock	$0	$0	$0	$0
Cod, Atka mackerel - fillet	$0	$0	$0	$0
All other - H & G	$0	$0	$0	$0
TOTAL	$84,792	$84,413	$86,612	$83,804
NET REVENUES (Gross revenue - Total variable cost, $1,000s)				
Fixed gear cod and sablefish	$32,975	$32,827	$33,682	$32,591
Pollock	$0	$0	$0	$0
Cod, Atka mackerel - fillet	$0	$0	$0	$0
All other - H & G	$0	$0	$0	$0
TOTAL	$32,975	$32,827	$33,682	$32,591
PRESENT GROSS VALUE OF BYCATCH ($1,000s)				
Halibut (all fisheries)	$2,090	$2,096	$2,162	$2,052
Pacific herring (all fisheries)	$0	$0	$0	$0
Red king crab (all fisheries)	$38	$21	$45	$29
Bairdi crab (all fisheries)	$63	$30	$78	$47
Chinook salmon (all fisheries)	$2	$2	$2	$2
TOTAL	$2,193	$2,148	$2,286	$2,129
PRESENT NET VALUE OF BYCATCH ($1,000s)				
Halibut (all fisheries)	$1,108	$1,111	$1,146	$1,087
Pacific herring (all fisheries)	$0	$0	$0	$0
Red king crab (all fisheries)	$18	$10	$21	$13
Bairdi crab (all fisheries)	$24	$12	$30	$18
Chinook salmon (all fisheries)	$1	$1	$1	$1
TOTAL	$1,151	$1,133	$1,197	$1,120
Gross Groundfish Revenue - Gross Bycatch Value	$115,573	$115,092	$118,009	$114,266
Net Groundfish Revenue - Net Bycatch Value	$31,824	$31,694	$32,485	$31,471

Table 3.1 Bycatch Simulr Model Projections for BS/AI Non-Trawl Fishr · Continued
1990 and 1991 DATA

	Status Quo (No Limit)	50% 375 mt	100% 750 mt	150% 1125 mt
BYCATCH AMOUNTS				
Halibut mortality (mt)	380	368	380	380
Herring (mt)	0	0	0	0
Red king crab (no.)	6,303	6,090	6,303	6,303
C. bairdi (no.)	55,063	49,454	55,063	55,063
Chinook (no.)	21	21	21	21
GROUNDFISH CATCH (mt)				
Fixed gear cod and sablefish	63,782	63,707	63,782	63,782
Pollock	0	0	0	0
Cod, Atka mackerel - fillet	0	0	0	0
All other - H & G	0	0	0	0
TOTAL	63,782	63,707	63,782	63,782
GROSS REVENUE ($1,000s)				
Fixed gear cod and sablefish	$98,764	$98,805	$98,764	$98,764
Pollock	$0	$0	$0	$0
Cod, Atka mackerel - fillet	$0	$0	$0	$0
All other - H & G	$0	$0	$0	$0
TOTAL	$98,764	$98,805	$98,764	$98,764
TOTAL VARIABLE COSTS ($1,000s)				
Fixed gear cod and sablefish	$71,110	$71,139	$71,110	$71,110
Pollock	$0	$0	$0	$0
Cod, Atka mackerel - fillet	$0	$0	$0	$0
All other - H & G	$0	$0	$0	$0
TOTAL	$71,110	$71,139	$71,110	$71,110
NET REVENUES (Gross revenue - Total variable cost, $1,000s)				
Fixed gear cod and sablefish	$27,654	$27,665	$27,654	$27,654
Pollock	$0	$0	$0	$0
Cod, Atka mackerel - fillet	$0	$0	$0	$0
All other - H & G	$0	$0	$0	$0
TOTAL	$27,654	$27,665	$27,654	$27,654
PRESENT GROSS VALUE OF BYCATCH ($1,000s)				
Halibut (all fisheries)	$2,090	$2,024	$2,090	$2,090
Pacific herring (all fisheries)	$0	$0	$0	$0
Red king crab (all fisheries)	$136	$132	$136	$136
Bairdi crab (all fisheries)	$97	$87	$97	$97
Chinook salmon (all fisheries)	$1	$1	$1	$1
TOTAL	$2,324	$2,244	$2,324	$2,324
PRESENT NET VALUE OF BYCATCH ($1,000s)				
Halibut (all fisheries)	$1,108	$1,073	$1,108	$1,108
Pacific herring (all fisheries)	$0	$0	$0	$0
Red king crab (all fisheries)	$63	$61	$63	$63
Bairdi crab (all fisheries)	$37	$34	$37	$37
Chinook salmon (all fisheries)	$0	$0	$0	$0
TOTAL	$1,208	$1,167	$1,208	$1,208
Gross Groundfish Revenue - Gross Bycatch Value	$96,440	$96,561	$96,440	$96,440
Net Groundfish Revenue - Net Bycatch Value	$26,446	$26,498	$26,446	$26,446

Table 3.2 Bycatch Simulation Model Projections for BS/AI Trawl Fisheries for Three Data Sets
1990 DATA

	With Halibut and Crab Vessel Incentive Program				Without Halibut and Crab Vessel Incentive Program			
	Status Quo	50%	100%	150%	Status Quo	50%	100%	150%
BYCATCH AMOUNTS								
Halibut mortality (mt)	2,849	1,754	2,807	2,911	2,941	1,777	2,831	3,1
Herring (mt)	801	913	796	664	902	1,072	896	7
Red king crab (no.)	59,749	52,670	58,302	61,085	57,580	53,852	56,270	6
C. bairdi (no.)	1,161,712	941,214	1,136,192	1,261,834	1,122,886	919,797	1,108,480	1,25
Chinook (no.)	18,886	17,787	18,880	18,784	18,716	16,218	18,642	18,6
GROUNDFISH CATCH (mt)								
Fixed gear cod and sablefish	0	0	0	0	0	0	0	
Pollock	1,363,440	1,351,888	1,357,990	1,377,811	1,354,571	1,346,621	1,353,258	1,371,0
Cod, Atka mackerel - fillet	177,719	114,248	175,665	176,092	158,396	99,351	153,392	178,6
All other - H & G	81,053	80,373	81,053	80,298	81,560	79,791	81,560	79,6
TOTAL	1,622,212	1,546,509	1,614,708	1,634,201	1,594,527	1,525,763	1,588,210	1,629,3
GROSS REVENUE ($1,000s)								
Fixed gear cod and sablefish	$0	$0	$0	$0	$0	$0	$0	
Pollock	$1,044,378	$1,028,542	$1,039,316	$1,061,819	$1,040,337	$1,025,583	$1,038,892	$1,060,0
Cod, Atka mackerel - fillet	$180,633	$121,764	$178,778	$178,684	$165,239	$107,861	$160,919	$182.9
All other - H & G	$65,849	$65,312	$65,849	$65,339	$66,600	$65,231	$66,600	$6
TOTAL	$1,290,860	$1,215,619	$1,283,943	$1,305,842	$1,272,176	$1,198,675	$1,266,411	$1,308,1
TOTAL VARIABLE COSTS ($1,000s)								
Fixed gear cod and sablefish	$0	$0	$0	$0	$0	$0	$0	
Pollock	$645,426	$635,639	$642,297	$656,204	$642,928	$633,811	$642,035	$655,1
Cod, Atka mackerel - fillet	$110,728	$74,642	$109,591	$109,533	$101,292	$66,119	$98,643	$112,1
All other - H & G	$42,011	$41,669	$42,011	$41,687	$42,491	$41,618	$42,491	$41,6
TOTAL	$798,165	$751,950	$793,900	$807,424	$786,710	$741,547	$783,169	$808,8

Table 3.2 continued (1990 data)

	With Halibut and Crab Vessel Incentive Program				Without Halibut and Crab Vessel Incentive Program			
	Status Quo	50%	100%	150%	Status Quo	50%	100%	150%
NET REVENUES (Gross revenue - Total variable cost, $1,000s)								
Fixed gear cod and sablefish	$0	$0	$0	$0	$0	$0	$0	$
Pollock	$398,952	$392,903	$397,019	$405,615	$397,409	$391,773	$396,857	$404,9
Cod, Atka mackerel - fillet	$69,905	$47,123	$69,187	$69,151	$63,948	$41,742	$62,276	$70,7
All other - H & G	$23,837	$23,643	$23,837	$23,653	$24,109	$23,614	$24,109	$23,6
TOTAL	$492,695	$463,669	$490,043	$498,418	$485,465	$457,129	$483,242	$499,3
PRESENT GROSS VALUE OF BYCATCH ($1,000s)								
Halibut (all fisheries)	$15,667	$9,648	$15,440	$16,009	$16,174	$9,772	$15,568	$17,2
Pacific herring (all fisheries)	$1,165	$1,328	$1,158	$966	$1,312	$1,560	$1,304	$1,1
Red king crab (all fisheries)	$1,293	$1,140	$1,262	$1,322	$1,246	$1,165	$1,218	$1,3
Bairdi crab (all fisheries)	$2,045	$1,657	$2,000	$2,221	$1,976	$1,619	$1,951	$2,2
Chinook salmon (all fisheries)	$668	$629	$667	$664	$662	$573	$659	$6
TOTAL	$20,837	$14,402	$20,527	$21,182	$21,370	$14,689	$20,699	$22,5
PRESENT NET VALUE OF BYCATCH ($1,000s)								
Halibut (all fisheries)	$8,303	$5,114	$8,183	$8,485	$8,572	$5,179	$8,251	$9,1
Pacific herring (all fisheries)	$594	$677	$591	$493	$669	$795	$665	$5
Red king crab (all fisheries)	$595	$525	$581	$608	$573	$536	$560	$6
Bairdi crab (all fisheries)	$790	$640	$773	$858	$764	$625	$754	$8
Chinook salmon (all fisheries)	$387	$365	$387	$385	$384	$332	$382	$3
TOTAL	$10,670	$7,320	$10,514	$10,829	$10,962	$7,469	$10,612	$1
Gross Groundfish Revenue - Gross Bycatch Value	$1,270,023	$1,201,217	$1,263,417	$1,284,660	$1,250,805	$1,183,986	$1,245,712	$1,285,5
Net Groundfish Revenue - Net Bycatch Value	$482,025	$456,349	$479,529	$487,589	$474,503	$449,660	$472,629	$487,7

Table 3.2 Bycatch Model Projections for BS/AI Trawl Fisheries
1991 DATA

	With Halibut and Crab Vessel Incentive Program				Without Halibut and Crab Vessel Incentive Program			
	Status Quo	50%	100%	150%	Status Quo	50%	100%	150%
BYCATCH AMOUNTS								
Halibut mortality (mt)	3,491	2,070	3,354	3,719	4,090	2,441	3,977	4,385
Herring (mt)	1,195	1,349	1,190	1,127	1,375	1,435	1,376	1,296
Red king crab (no.)	49,263	43,494	47,850	56,061	86,603	60,157	86,562	92,9[illegible]
C. bairdi (no.)	2,580,625	1,871,342	2,501,205	2,957,188	2,637,853	1,238,718	2,588,879	2,882,2[illegible]
Chinook (no.)	29,385	25,857	29,877	29,294	32,139	24,109	33,206	28,145
GROUNDFISH CATCH (mt)								
Fixed gear cod and sablefish	0	0	0	0	0	0	0	0
Pollock	1,353,180	1,347,783	1,345,651	1,364,148	1,339,840	1,337,903	1,342,247	1,341,556
Cod, Atka mackerel - fillet	167,111	91,342	163,975	167,305	160,645	82,340	158,140	160,853
All other - H & G	187,622	164,745	184,552	210,843	202,013	127,203	198,780	214,752
TOTAL	1,707,913	1,603,870	1,694,178	1,742,296	1,702,498	1,547,446	1,699,167	1,717,161
GROSS REVENUE ($1,000s)								
Fixed gear cod and sablefish	$0	$0	$0	$0	$0	$0	$0	$0
Pollock	$914,288	$904,967	$909,259	$924,609	$898,797	$893,010	$900,399	$902,342
Cod, Atka mackerel - fillet	$180,238	$101,647	$177,472	$178,648	$173,633	$92,254	$171,561	$172,005
All other - H & G	$110,512	$92,558	$108,257	$125,122	$114,901	$73,864	$111,937	$126,674
TOTAL	$1,205,038	$1,099,172	$1,194,988	$1,228,379	$1,187,332	$1,059,127	$1,183,897	$1,201,0[illegible]
TOTAL VARIABLE COSTS ($1,000s)								
Fixed gear cod and sablefish	$0	$0	$0	$0	$0	$0	$0	$0
Pollock	$565,030	$559,270	$561,922	$571,408	$555,457	$551,880	$556,446	$557,647
Cod, Atka mackerel - fillet	$110,486	$62,310	$108,790	$109,511	$106,437	$56,552	$105,167	$105,439
All other - H & G	$70,507	$59,052	$69,068	$79,828	$73,307	$47,125	$71,416	$80,818
TOTAL	$746,022	$680,631	$739,780	$760,748	$735,201	$655,557	$733,029	$743,904

Table 3.2 continued (1991 data)

	With Halibut and Crab Vessel Incentive Program				Without Halibut and Crab Vessel Incentive Program			
	Status Quo	50%	100%	150%	Status Quo	50%	100%	150%
NET REVENUES (Gross revenue - Total variable cost, $1,000s)								
Fixed gear cod and sablefish	$0	$0	$0	$0	$0	$0	$0	$0
Pollock	$349,258	$345,697	$347,337	$353,201	$343,341	$341,130	$343,952	$344,694
Cod, Atka mackerel - fillet	$69,752	$39,338	$68,682	$69,137	$67,196	$35,702	$66,394	$66,566
All other - H & G	$40,005	$33,506	$39,189	$45,294	$41,594	$26,739	$40,521	$45,856
TOTAL	$459,015	$418,541	$455,208	$467,632	$452,131	$403,571	$450,868	$457,117
PRESENT GROSS VALUE OF BYCATCH ($1,000s)								
Halibut (all fisheries)	$19,198	$11,385	$18,447	$20,452	$22,494	$13,423	$21,871	$24,11>
Pacific herring (all fisheries)	$1,739	$1,963	$1,731	$1,640	$2,001	$2,088	$2,002	$1,886
Red king crab (all fisheries)	$1,066	$941	$1,035	$1,213	$1,874	$1,302	$1,873	$2,012
Bairdi crab (all fisheries)	$4,542	$3,294	$4,402	$5,205	$4,643	$2,180	$4,556	$5,073
Chinook salmon (all fisheries)	$1,039	$914	$1,056	$1,036	$1,136	$852	$1,174	$995
TOTAL	$27,583	$18,497	$26,672	$29,545	$32,147	$19,845	$31,476	$34,084
PRESENT NET VALUE OF BYCATCH ($1,000s)								
Halibut (all fisheries)	$10,175	$6,034	$9,777	$10,839	$11,922	$7,114	$11,591	$12,783
Pacific herring (all fisheries)	$887	$1,001	$883	$836	$1,020	$1,065	$1,021	$962
Red king crab (all fisheries)	$491	$433	$477	$558	$863	$599	$862	$926
Bairdi crab (all fisheries)	$1,755	$1,273	$1,701	$2,011	$1,794	$842	$1,760	$1,960
Chinook salmon (all fisheries)	$602	$530	$612	$601	$659	$494	$681	$577
TOTAL	$13,909	$9,271	$13,450	$14,845	$16,257	$10,115	$15,916	$17,208
Gross Groundfish Revenue - Gross Bycatch Vi	$1,177,455	$1,080,675	$1,168,316	$1,198,835	$1,155,185	$1,039,283	$1,152,420	$1,166,93.
Net Groundfish Revenue - Net Bycatch Value	$445,106	$409,270	$441,758	$452,786	$435,874	$393,456	$434,952	$439,909

Table 3.2 Bycatch Model Projections for BS/AI Trawl Fisheries
DATA FROM 1990 AND 1991

	With Halibut and Crab Vessel Incentive Program				Without Halibut and Crab Vessel Incentive Program			
	Status Quo	50%	100%	150%	Status Quo	50%	100%	150%
BYCATCH AMOUNTS								
Halibut mortality (mt)	3,071	2,048	3,056	3,180	3,559	2,278	3,500	3,680
Herring (mt)	1,436	1,703	1,436	1,114	1,629	1,907	1,629	1,422
Red king crab (no.)	63,209	51,510	62,948	63,789	87,730	70,394	85,848	89,161
C. bairdi (no.)	1,874,838	1,383,057	1,861,083	2,065,393	1,839,534	1,226,548	1,738,497	2,135,
Chinook (no.)	21,852	22,987	21,841	21,539	21,512	21,912	21,479	21,379
GROUNDFISH CATCH (mt)								
Fixed gear cod and sablefish	0	0	0	0	0	0	0	0
Pollock	1,341,084	1,349,706	1,336,862	1,343,481	1,340,852	1,352,023	1,337,028	1,337,198
Cod, Atka mackerel - fillet	166,634	115,195	166,581	166,634	166,413	108,479	166,049	166,465
All other - H & G	176,667	145,765	176,667	176,061	176,888	132,951	173,414	191,524
TOTAL	1,684,385	1,610,666	1,680,110	1,686,176	1,684,153	1,593,453	1,676,491	1,695,187
GROSS REVENUE ($1,000s)								
Fixed gear cod and sablefish	$0	$0	$0	$0	$0	$0	$0	$0
Pollock	$967,717	$961,331	$963,737	$973,590	$965,753	$961,987	$962,053	$966,166
Cod, Atka mackerel - fillet	$169,042	$120,730	$169,123	$169,042	$169,744	$114,929	$169,543	$169,663
All other - H & G	$112,063	$89,982	$112,063	$111,744	$112,867	$80,700	$110,469	$121,742
TOTAL	$1,248,821	$1,172,042	$1,244,922	$1,254,376	$1,248,364	$1,157,616	$1,242,065	$1,257,5
TOTAL VARIABLE COSTS ($1,000s)								
Fixed gear cod and sablefish	$0	$0	$0	$0	$0	$0	$0	$0
Pollock	$598,049	$594,102	$595,589	$601,679	$596,836	$594,508	$594,549	$597,091
Cod, Atka mackerel - fillet	$103,623	$74,007	$103,672	$103,623	$104,053	$70,451	$103,930	$104,004
All other - H & G	$71,496	$57,408	$71,496	$71,293	$72,009	$51,487	$70,480	$77,672
TOTAL	$773,167	$725,518	$770,758	$776,594	$772,897	$716,446	$768,958	$778,766

Table 3.2 continued (1990 & 1991 data)

	With Halibut and Crab Vessel Incentive Program				Without Halibut and Crab Vessel Incentive Program			
	Status Quo	50%	100%	150%	Status Quo	50%	100%	150%
NET REVENUES (Gross revenue - Total variable cost, $1,000s)								
Fixed gear cod and sablefish	$0	$0	$0	$0	$0	$0	$0	$0
Pollock	$369,668	$367,228	$368,147	$371,911	$368,918	$367,479	$367,504	$369,076
Cod, Atka mackerel - fillet	$65,419	$46,722	$65,451	$65,419	$65,691	$44,477	$65,613	$65,660
All other - H & G	$40,567	$32,573	$40,567	$40,451	$40,858	$29,214	$39,990	$44,071
TOTAL	$475,654	$446,524	$474,165	$477,782	$475,466	$441,170	$473,107	$478,806
PRESENT GROSS VALUE OF BYCATCH ($1,000s)								
Halibut (all fisheries)	$16,892	$11,261	$16,809	$17,490	$19,573	$12,528	$19,247	$20,241
Pacific herring (all fisheries)	$2,089	$2,478	$2,089	$1,621	$2,370	$2,775	$2,370	$2,069
Red king crab (all fisheries)	$1,368	$1,115	$1,362	$1,380	$1,898	$1,523	$1,858	$1,929
Bairdi crab (all fisheries)	$3,300	$2,434	$3,276	$3,635	$3,238	$2,159	$3,060	$3,759
Chinook salmon (all fisheries)	$772	$813	$772	$761	$760	$775	$759	$756
TOTAL	$24,421	$18,101	$24,309	$24,888	$27,840	$19,759	$27,294	$28,754
PRESENT NET VALUE OF BYCATCH ($1,000s)								
Halibut (all fisheries)	$8,953	$5,968	$8,909	$9,270	$10,374	$6,640	$10,201	$10,728
Pacific herring (all fisheries)	$1,066	$1,264	$1,066	$827	$1,209	$1,415	$1,209	$1,055
Red king crab (all fisheries)	$630	$513	$627	$635	$874	$701	$855	$888
Bairdi crab (all fisheries)	$1,275	$940	$1,266	$1,404	$1,251	$834	$1,182	$1,452
Chinook salmon (all fisheries)	$448	$471	$448	$442	$441	$449	$440	$438
TOTAL	$12,371	$9,157	$12,315	$12,578	$14,148	$10,039	$13,887	$14,562
Gross Groundfish Revenue - Gross Bycatch Vl	$1,224,400	$1,153,942	$1,220,614	$1,229,488	$1,220,524	$1,137,857	$1,214,771	$1,228,818
Net Groundfish Revenue - Net Bycatch Value	$463,283	$437,367	$461,850	$465,204	$461,318	$431,131	$459,220	$464,244

Table 3.3 Benefit-cost tradeoffs between foregone groundfish and decreased bycatch for the Bering Sea/Aleutian Islands.

1990

Fishery		Groundfish catch Total	Retained	% ret.	Groundfish value per mt of groundfish catch gross	net	Bycatch value per mt of groundfish catch gross	net	Benefit-cost ratios gross	net
FXD	C	52,629	49,808	94.6	1,249	475	33.8	17.6	.03	.04
FXD	S	3,897	3,705	95.1	3,154	1,198	75.7	40.1	.02	.03
FXD	T	423	409	96.7	1,409	535	19.2	10.2	.01	.02
TWL	A	32,091	23,534	73.3	880	335	20.7	11.0	.02	.03
TWL	B	180,116	155,116	86.1	841	320	23.6	12.0	.03	.04
TWL	C	135,193	92,412	68.4	988	375	92.7	47.6	.09	.13
TWL	F	773	354	45.8	1,328	505	48.7	23.0	.04	.05
TWL	K	31,742	21,597	68.0	751	285	29.7	15.6	.04	.05
TWL	P	1,200,826	1,126,228	93.8	771	293	1.1	.6	.00	.00
TWL	R	32,106	13,119	40.9	987	375	113.4	53.6	.11	.14
TWL	S	690	238	34.6	866	329	170.4	90.0	.20	.27
TWL	T	13,022	8,451	64.9	941	358	233.6	123.5	.25	.35
TWL	W	1,639	966	59.0	449	171	42.2	21.1	.09	.12
TWL	Y	18,124	9,987	55.1	410	156	24.8	11.5	.06	.07

1991

FXD	C	74,776	67,289	90.0	1,475	560	33.5	17.5	.02	.03
FXD	S	3,565	2,893	81.1	2,762	1,049	59.0	31.3	.02	.03
FXD	T	9	9	100.0	1,722	654	17.1	9.0	.01	.01
TWL	A	27,917	24,047	86.1	751	285	9.4	5.0	.01	.02
TWL	B	154,216	135,006	87.5	717	272	22.1	10.9	.03	.04
TWL	C	118,154	84,204	71.3	1,112	422	90.5	46.9	.08	.11
TWL	F	13,080	7,666	58.6	589	224	54.3	24.7	.09	.11
TWL	K	8,489	5,209	61.4	690	262	88.5	46.9	.13	.18
TWL	P	1,182,073	1,144,030	96.8	760	289	4.0	2.1	.01	.01
TWL	R	67,794	23,927	35.3	806	306	119.9	58.9	.15	.19
TWL	S	527	159	30.2	952	362	336.9	178.2	.35	.49
TWL	T	7,593	5,842	76.9	963	366	218.9	115.2	.23	.31
TWL	W	1,961	1,474	75.2	429	163	131.9	69.7	.31	.43
TWL	Y	118,124	72,067	61.0	455	173	44.0	21.3	.10	.12

First quarter 1992

FXD	C	29,690	26,853	90.4	1,244	473	17.0	8.9	.01	.02
FXD	S	486	392	80.6	2,970	1,128	92.6	49.1	.03	.04
TWL	A	28,029	24,580	87.7	778	296	9.5	5.0	.01	.02
TWL	B	84,527	69,533	82.3	942	358	37.4	18.9	.04	.05
TWL	C	30,951	20,813	67.2	1,057	402	95.6	49.6	.09	.12
TWL	F	593	185	31.2	759	288	139.1	68.7	.18	.24
TWL	K	4,161	3,418	82.1	738	281	46.0	24.5	.06	.09
TWL	P	391,513	378,032	96.6	827	314	9.9	5.1	.01	.02
TWL	R	35,679	11,475	32.2	1,008	383	120.2	58.7	.12	.15

Table 3.3 continued.

First quarters 1990, 1991, 1992

Fishery		Groundfish catch Total	Retained	% ret.	Groundfish value per mt of groundfish catch gross	net	Bycatch value per mt of groundfish catch gross	net	Benefit-cost ratios gross	net
FXD	C	51,414	47,880	93.1	1,346	512	15.9	8.4	.01	.02
FXD	S	1,986	1,769	89.1	3,004	1,141	108.3	57.4	.04	.05
TWL	A	57,045	49,567	86.9	770	293	14.7	7.8	.02	.03
TWL	B	169,765	146,355	86.2	898	341	41.5	21.1	.05	.06
TWL	C	158,186	115,734	73.2	1,308	497	117.1	60.4	.09	.12
TWL	F	784	285	36.3	881	335	153.1	76.4	.17	.23
TWL	K	6,191	4,603	74.4	696	265	55.0	29.3	.08	.11
TWL	P	1,164,427	1,113,148	95.6	953	362	4.7	2.5	.00	.01
TWL	R	116,725	37,863	32.4	937	356	125.7	61.2	.13	.17
TWL	S	466	272	58.3	1,496	568	377.1	199.3	.25	.35
TWL	T	5,468	3,521	64.4	972	369	689.5	365.4	.71	.99
TWL	W	23	23	100.0	965	367	116.0	57.5	.12	.16

Target Fishery Designations:

A = Atka Mackerel
B = Bottom Pollock
C = Pacific Cod
F = Flatfish
K = Rockfish
O = Other groundfish
P = Pelagic Pollock
R = Rock Sole
S = Sablefish
T = Turbot
W = Arrowtooth
Y = Yellowfin Sole

Gear Designations:

TWL = Pelagic or Bottom Trawl Gear

FXD = Fixed Gear: Pot or Longline

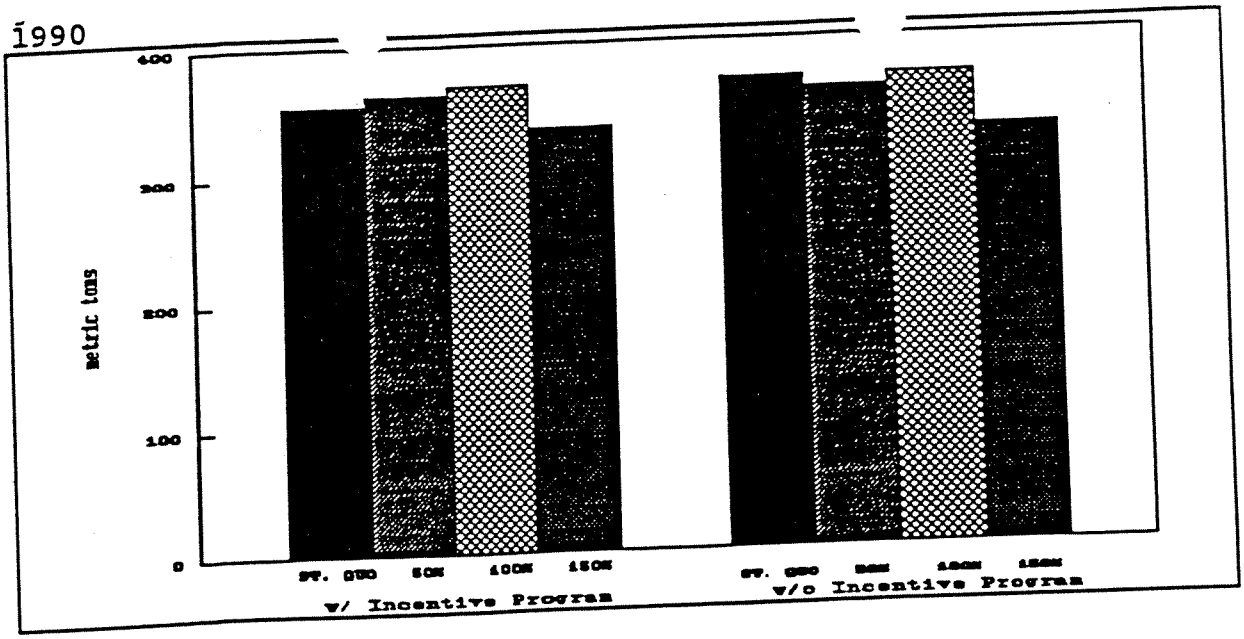
Note: 1991 prices are used for all years.

Table 3.4 Changes in household income and total community impacts due to increases in landings.

Fishery/Impact	Alaska	Alaska & PNW
Halibut-1mt		
Direct Income	$1,311	$4,716
Total Impacts	$1,893	$8,671
FLL Cod-104mt		
Direct Income	$11,530	$95,373
Total Impacts	$28,245	$216,921
F/T Cod-43mt		
Direct Income	$3,757	$33,555
Total Impacts	$6,108	$68,966

Note: These estimates were calculated using the Alaska Fishery Economic Assessment (FEAM), based on 1991 cost and revenue information. The FEAM model calculated direct income as the sum of net returns to owners, fishing crew wages, and processing crew wages. Total dollar impacts (direct, indirect, and induced) are estimated using input/output type multipliers. Income and dollar impacts in Table 3.4 are not adjusted for payment to foreign interests. The economic values are estimates of the effects of the incremental tonnages in the fisheries indicated. Differences in product form and value added between fisheries, gear groups, and location affect both income and total dollar results. Halibut is modeled as a catcher vessel delivery ($1.75/lb exvessel) to a BS/AI inshore processing plant with a finished product (H&G) price of $2.52/lb. Longline cod is harvested and processed by a BS/AI freezer-longliner assuming a 100% production of H&G product at $1.27/lb. Factory trawler cod is modeled as 5.9% whole ($1.25/lb). 15.9% H&G ($1.24/lb), 7.1% fillets ($2.39/lb), 1.1% mince ($1.13/lb), and 2.3 % meal ($.28/lb). Round weight tonnage in converted to product weight based on NMFS product recovery and discard rates.

1990



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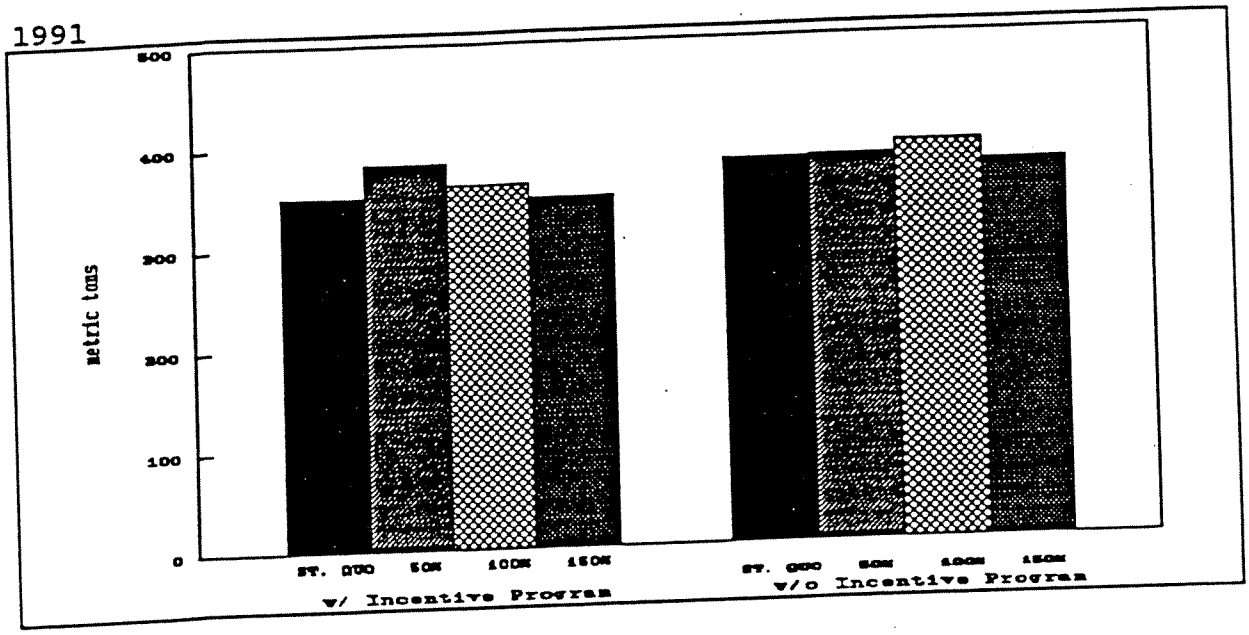

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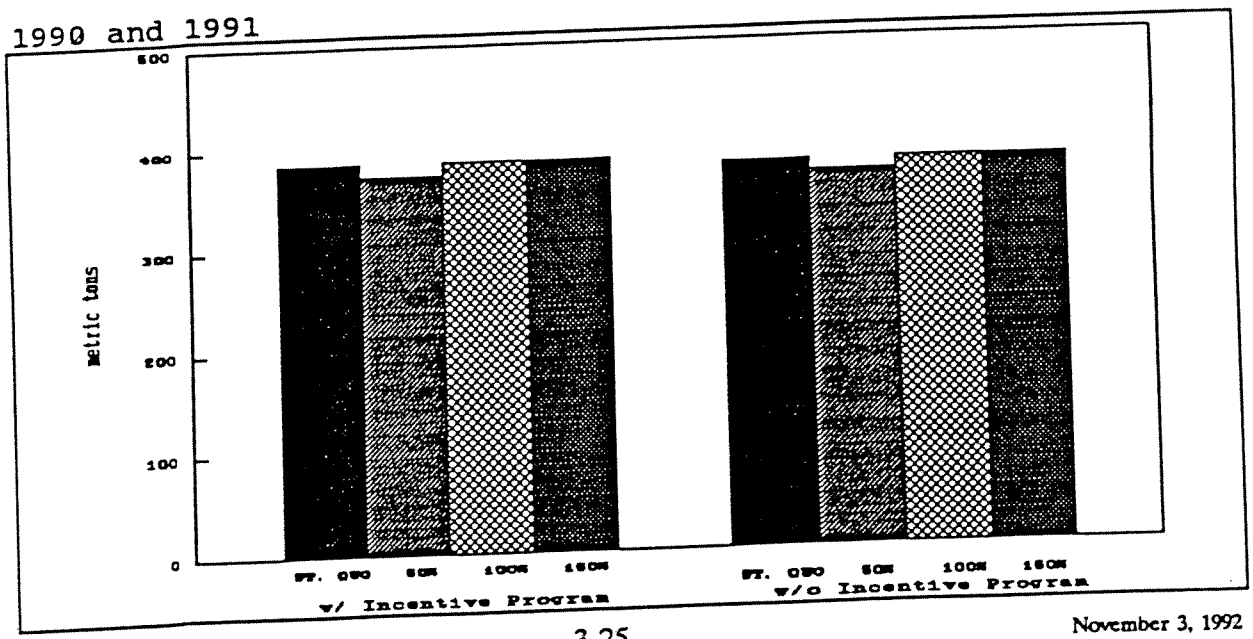

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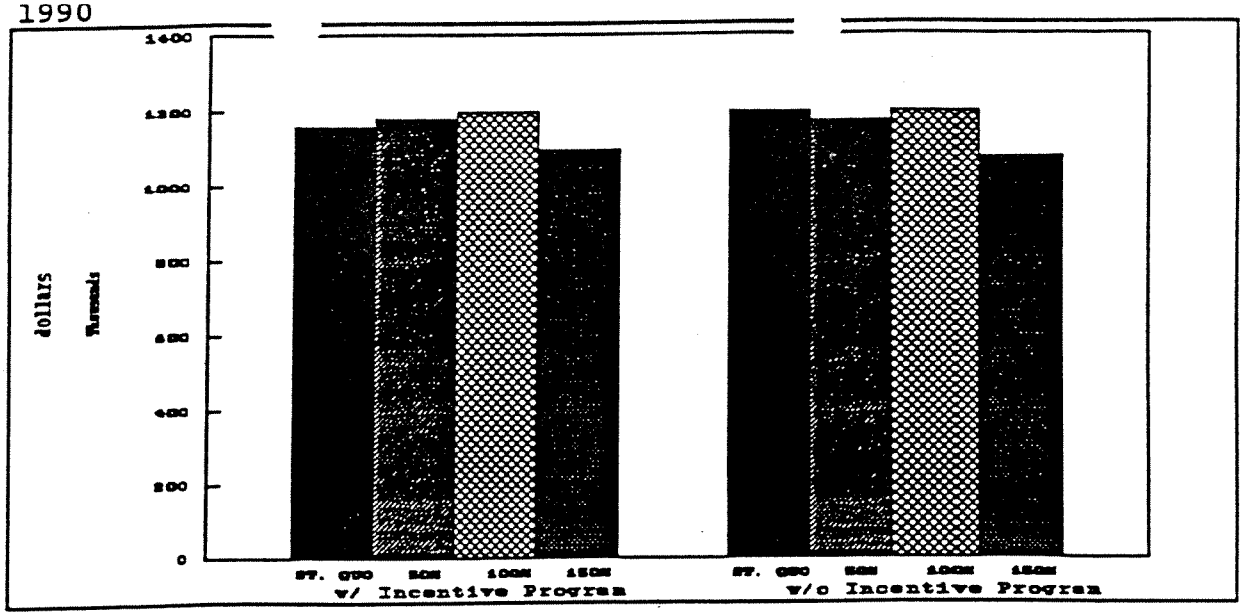

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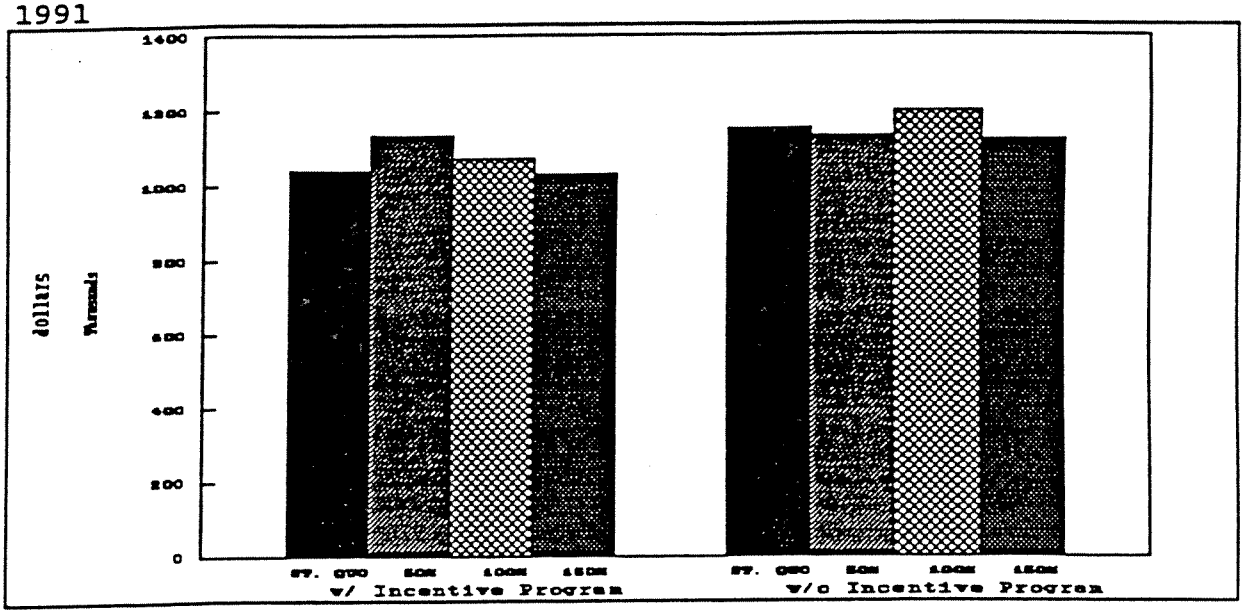

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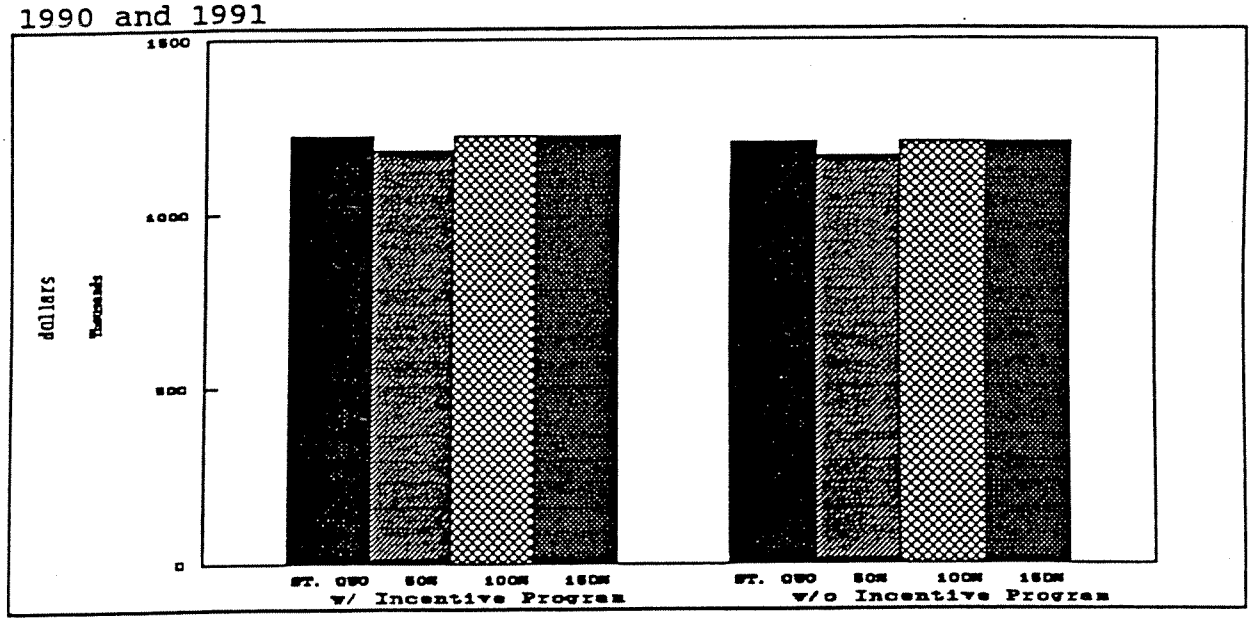

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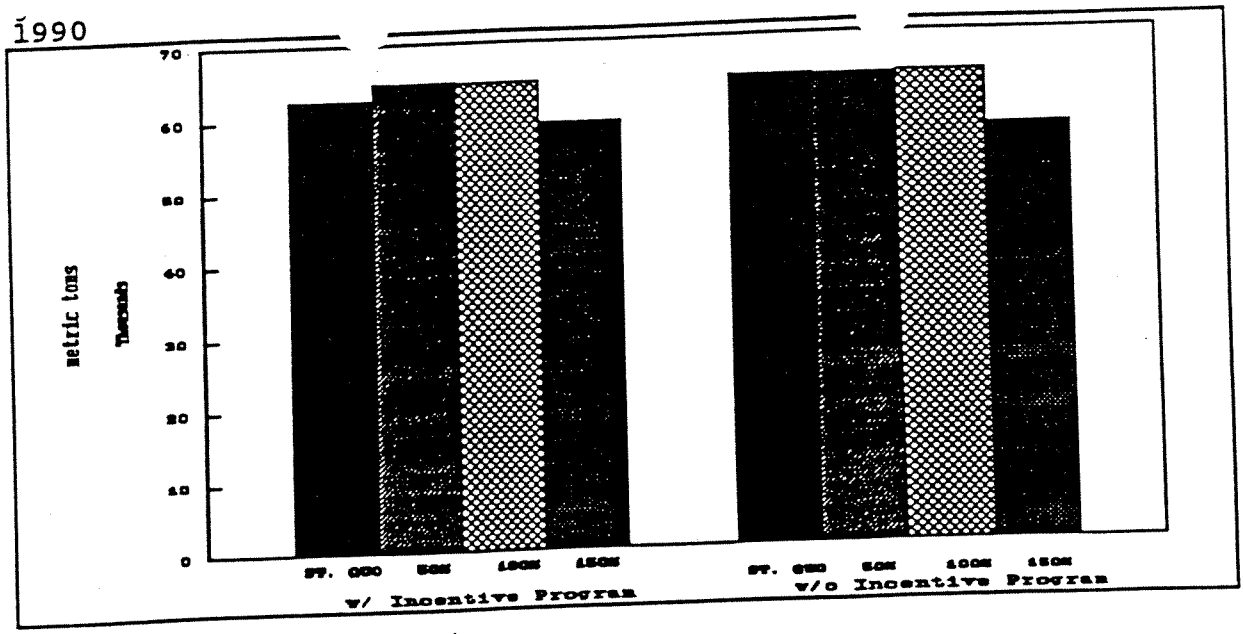

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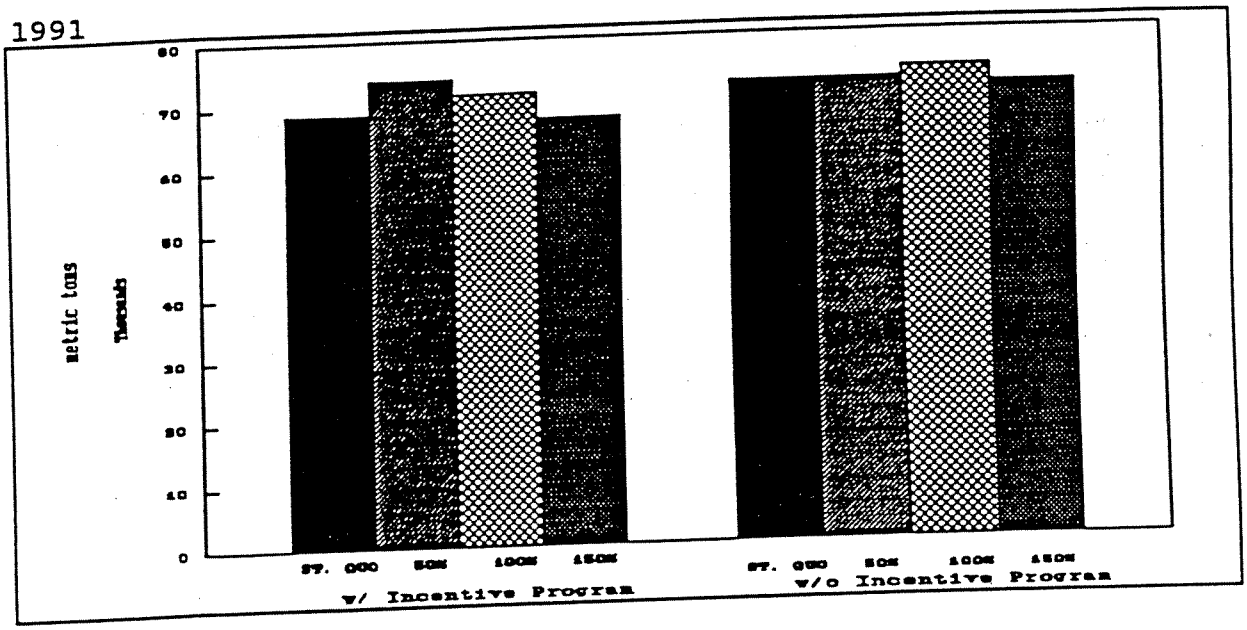

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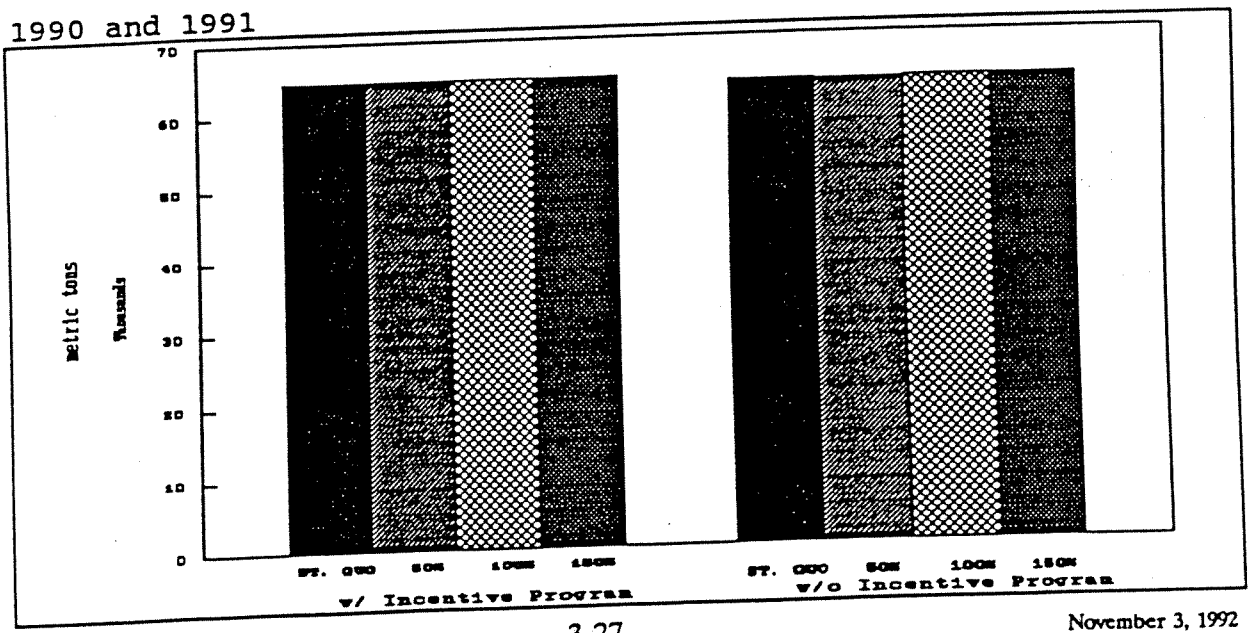
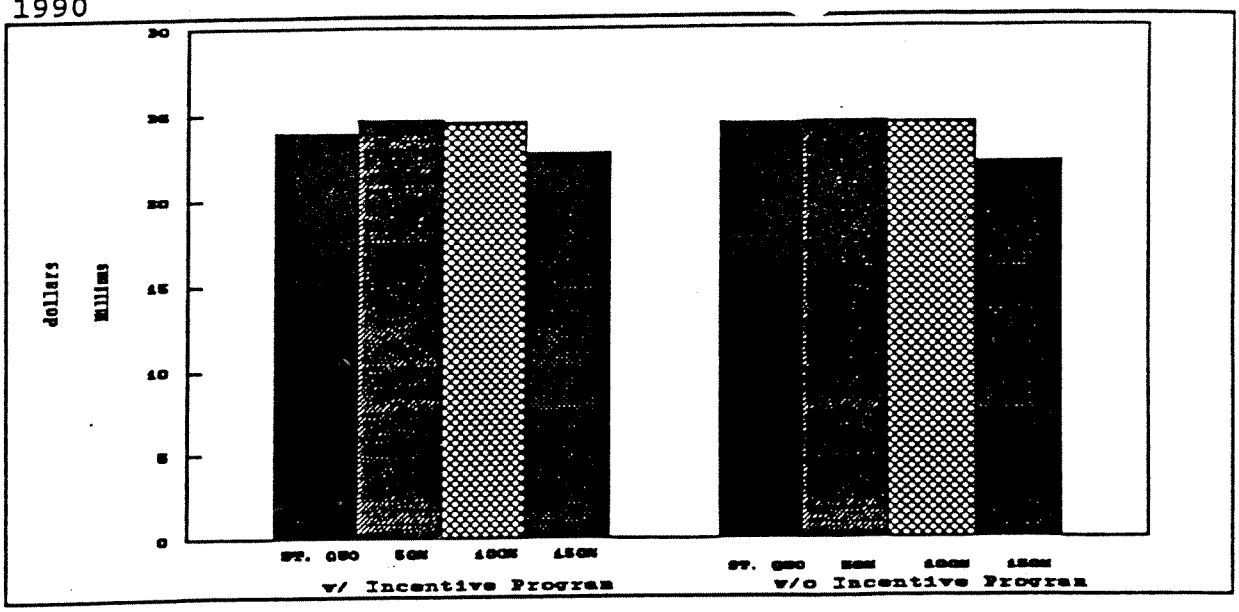


(Net revenue net value of bycatch)

1990



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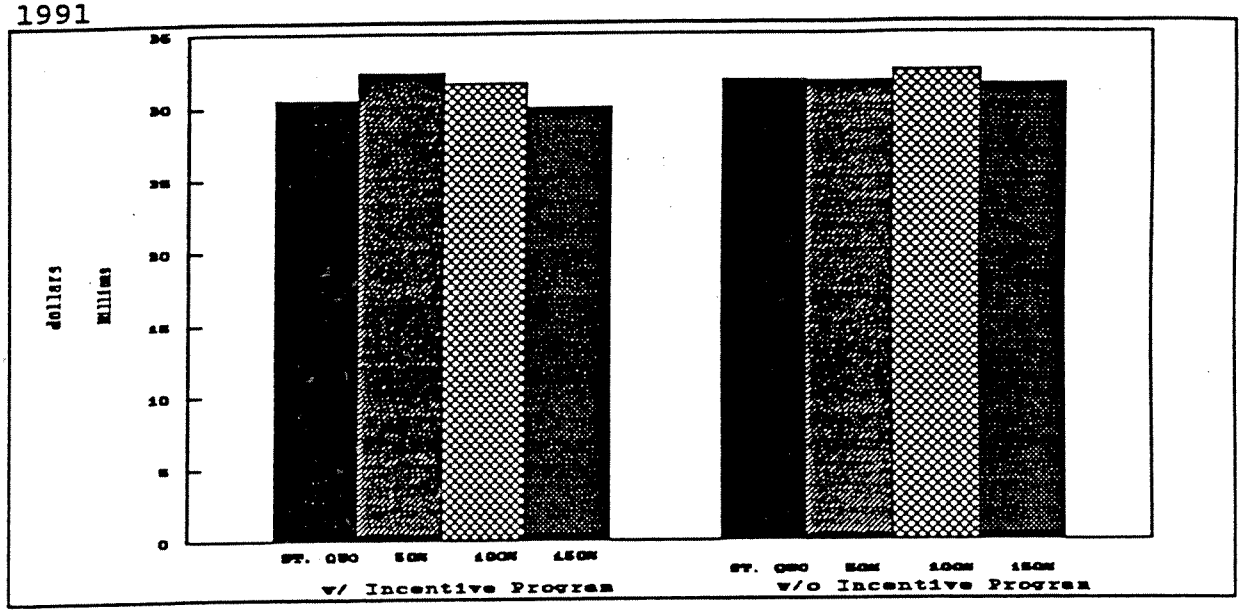

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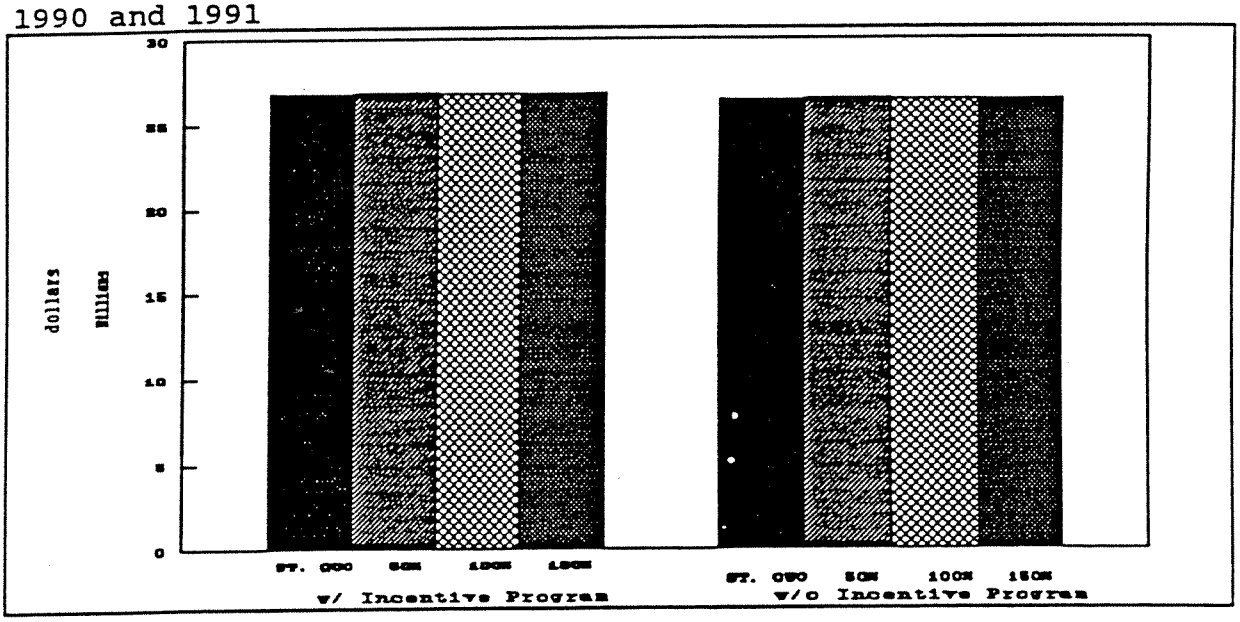
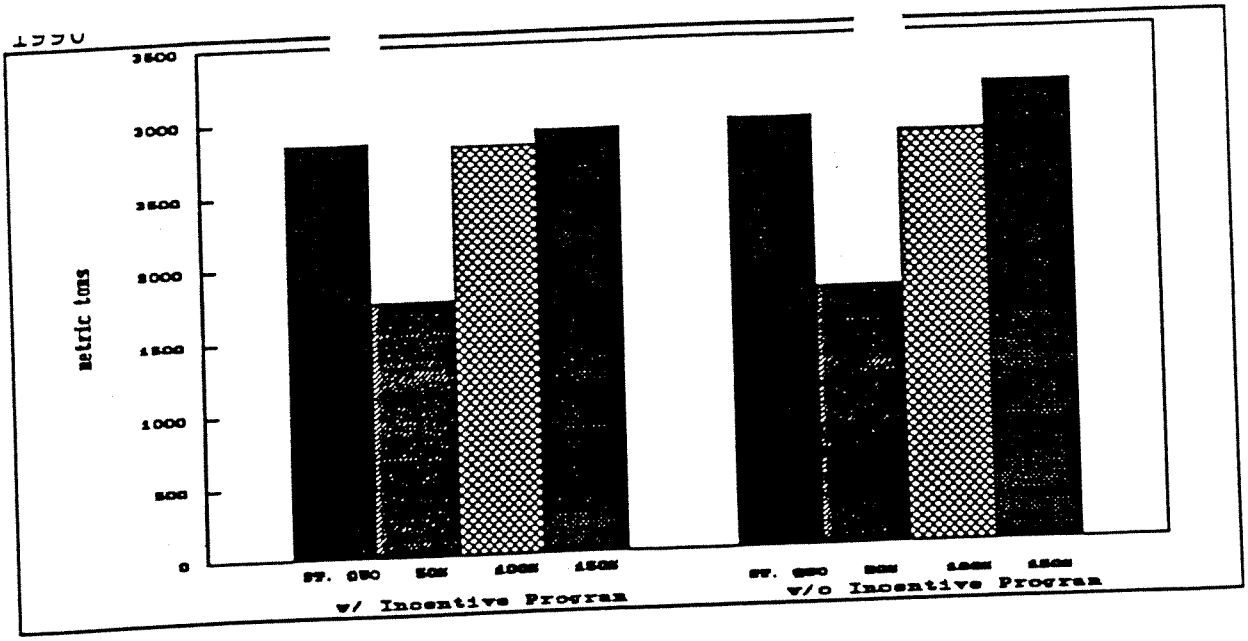
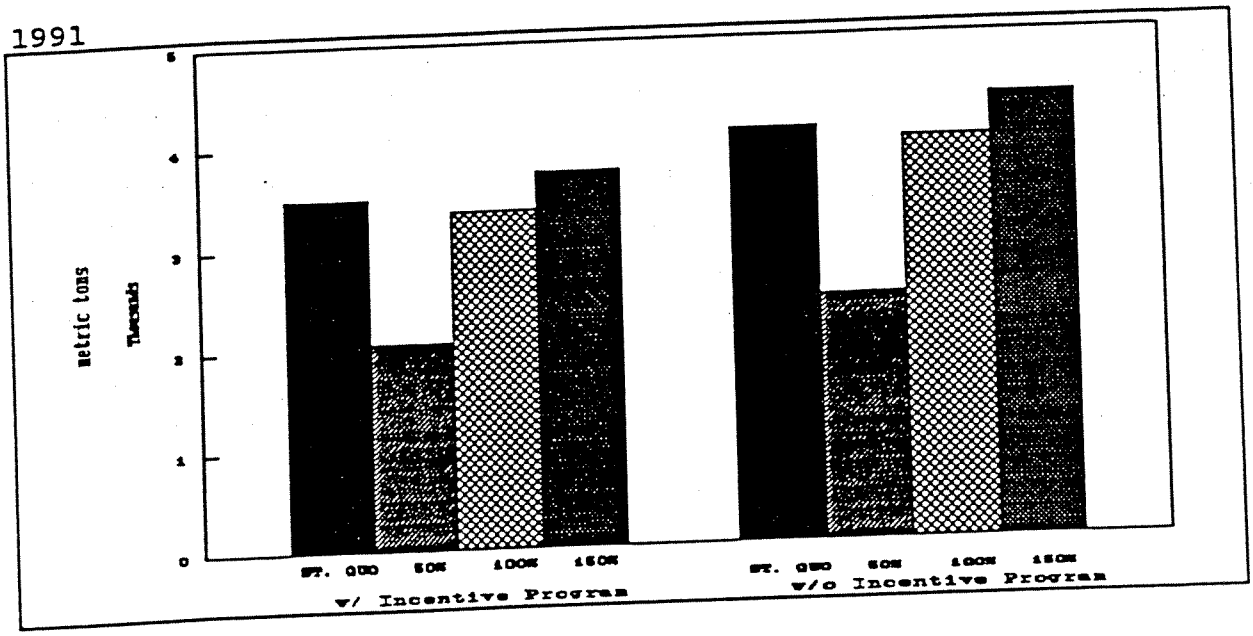



1990
3500
3000
2500
2000
1500
1000
500
0
Metric tons
w/ Incentive Program
w/o Incentive Program


1991
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2
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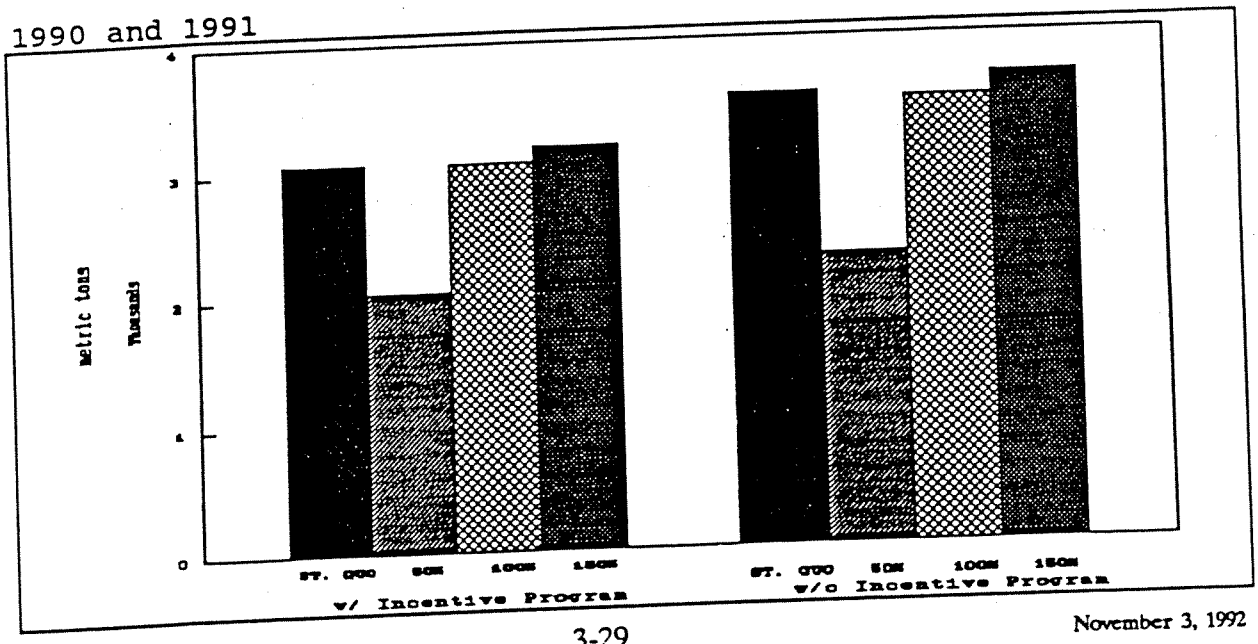
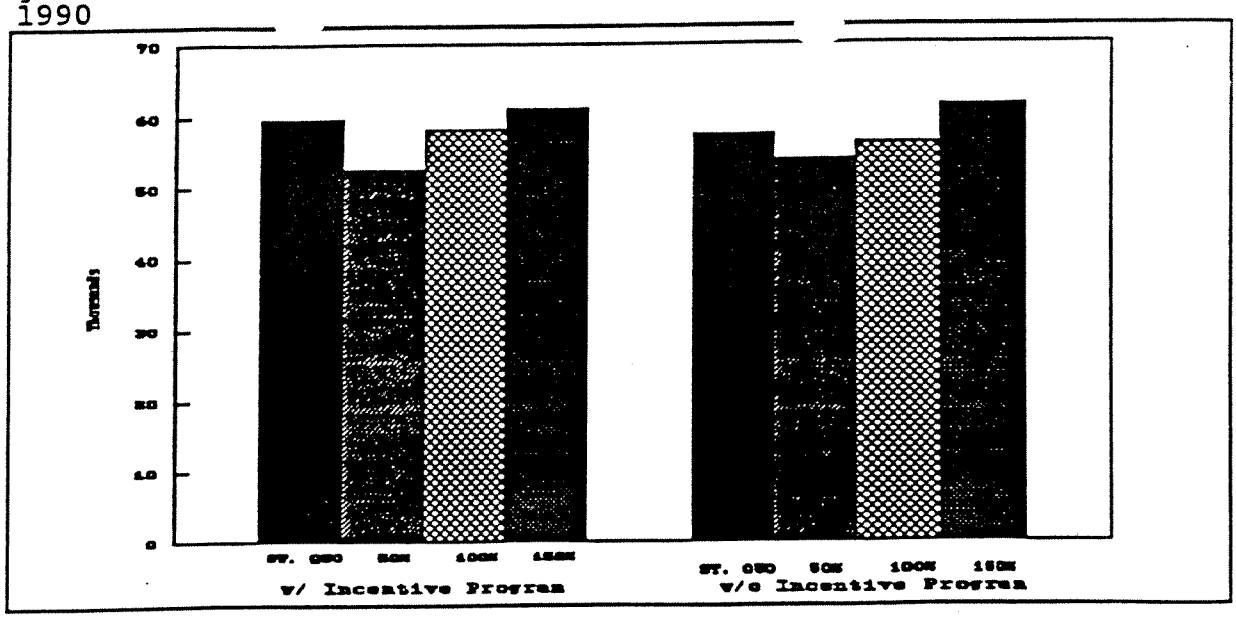
Metric tons
Thousands
w/ Incentive Program
w/o Incentive Program


1990 and 1991
4
3
2
1
0
Metric tons
Thousands
w/ Incentive Program
w/o Incentive Program

1990



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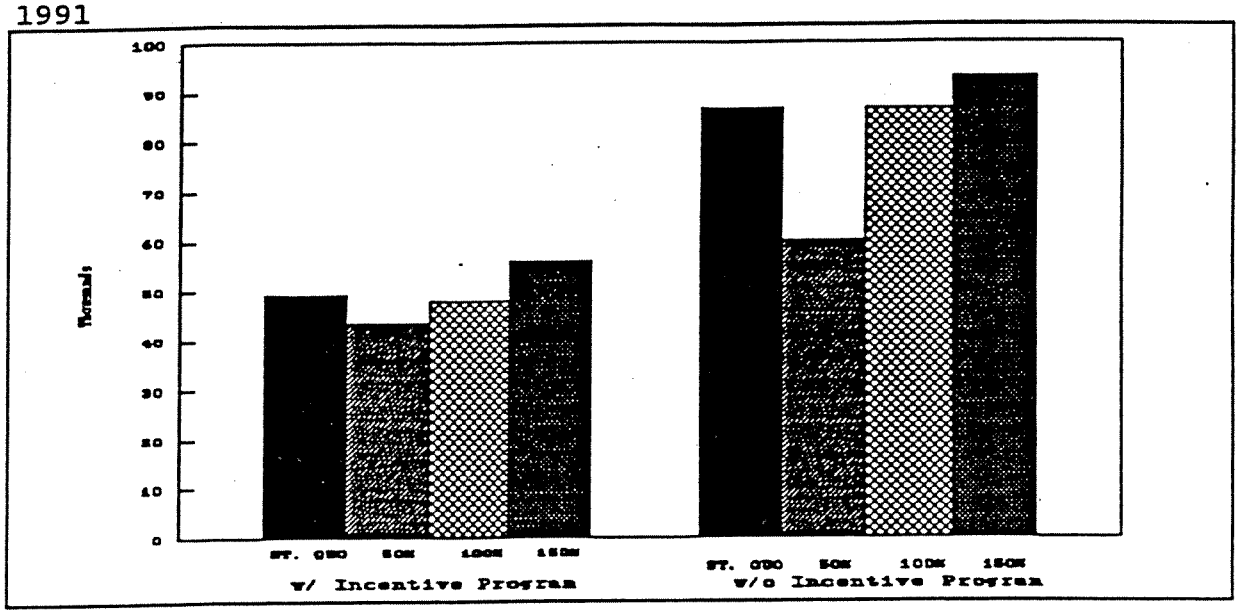

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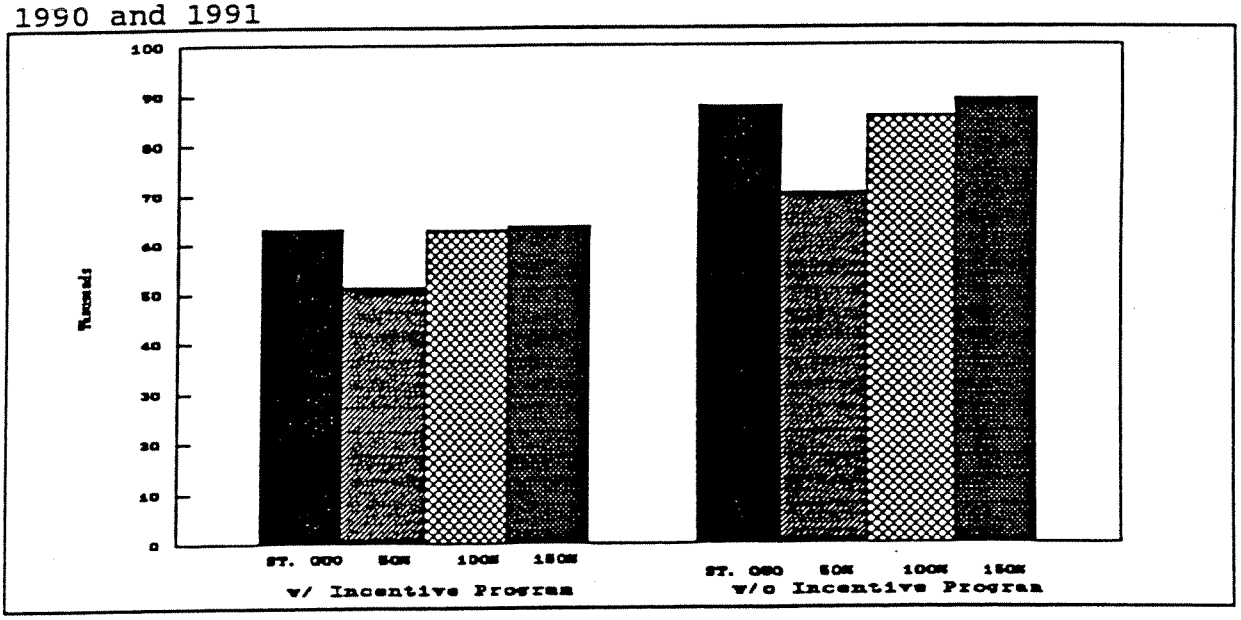

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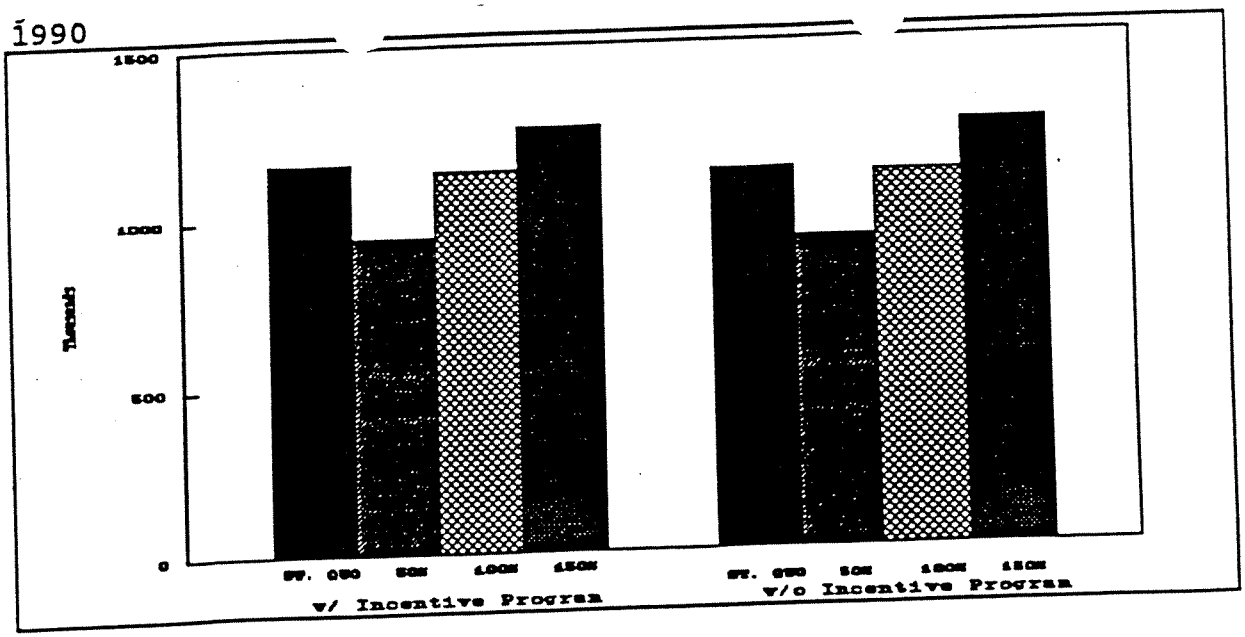

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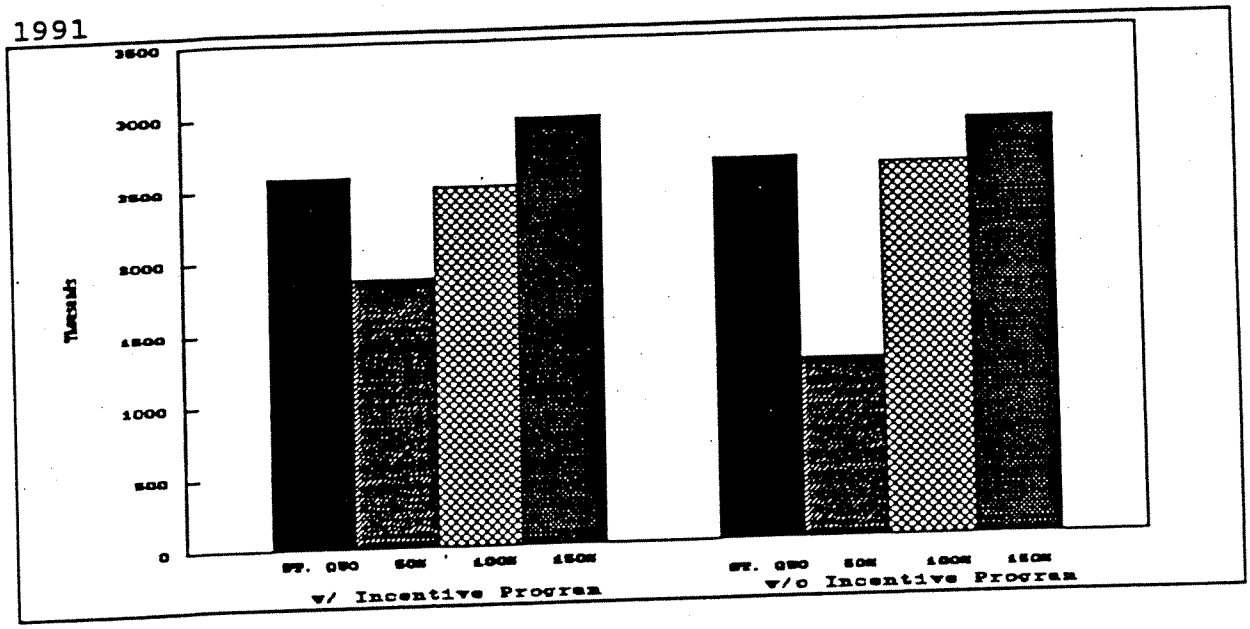

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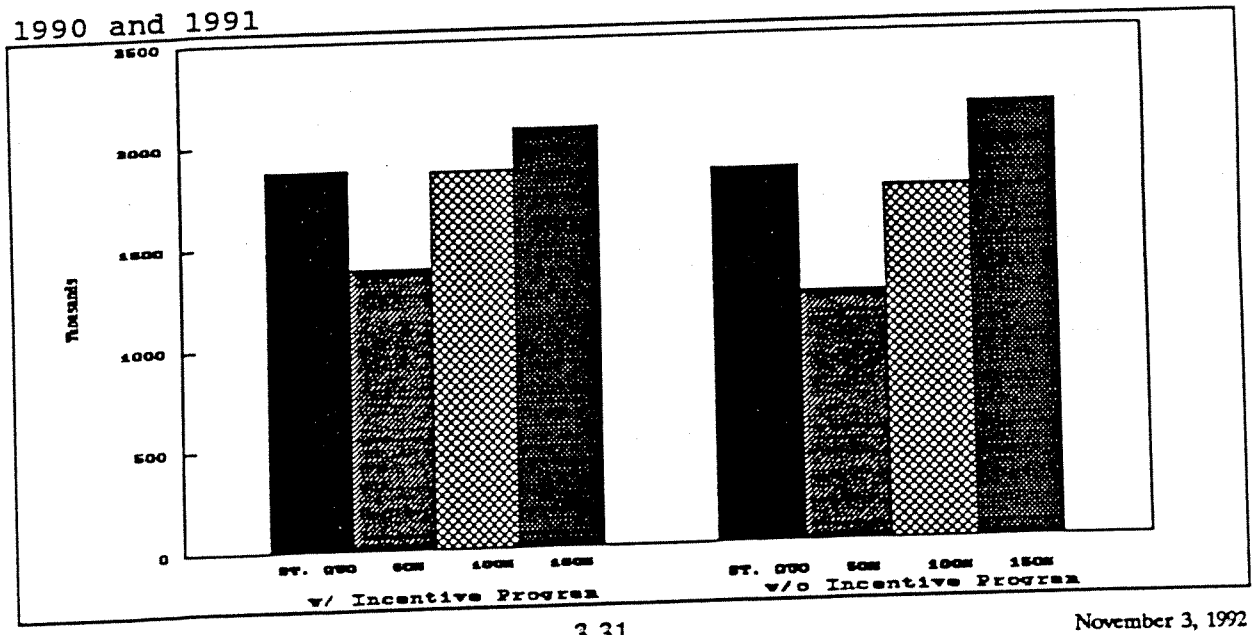

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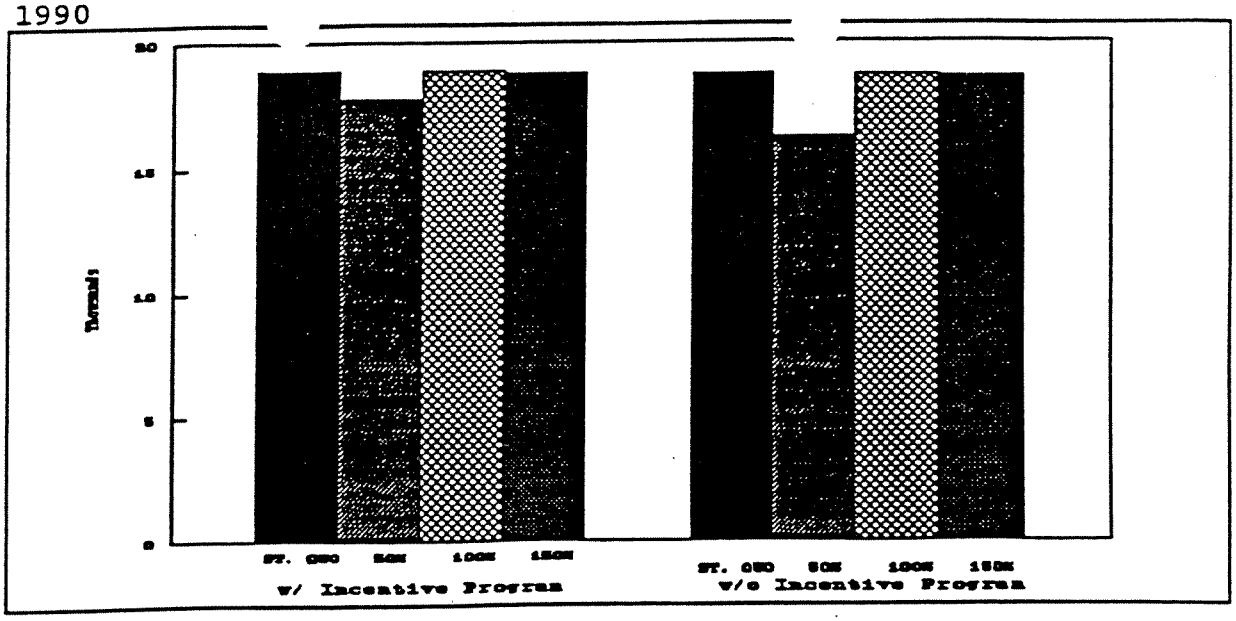

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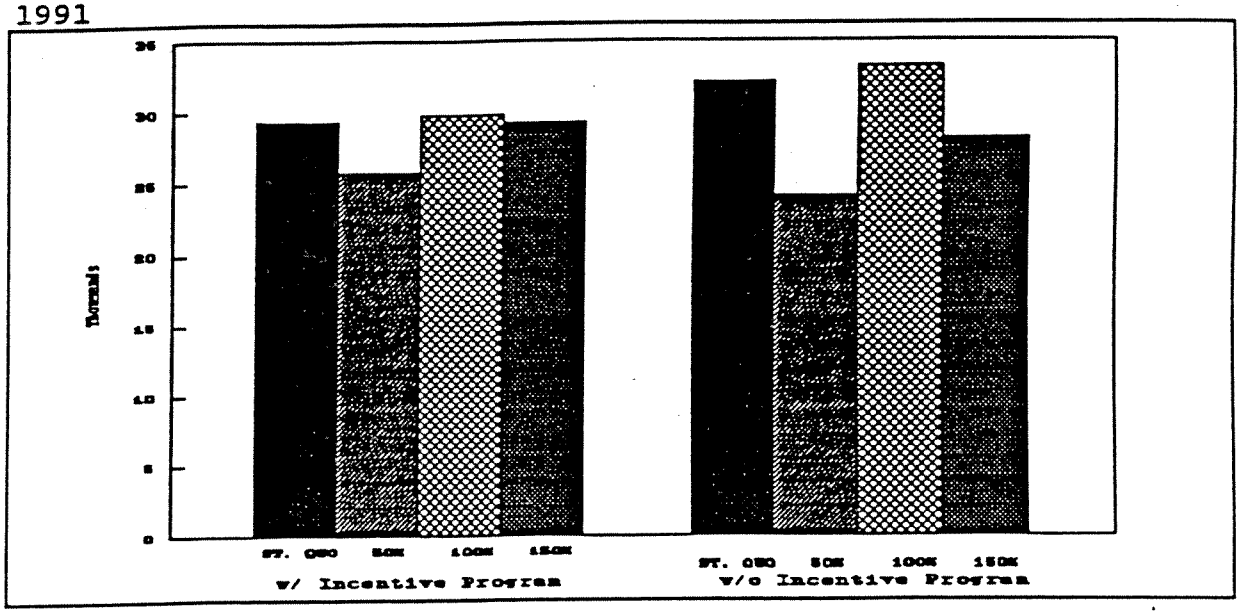

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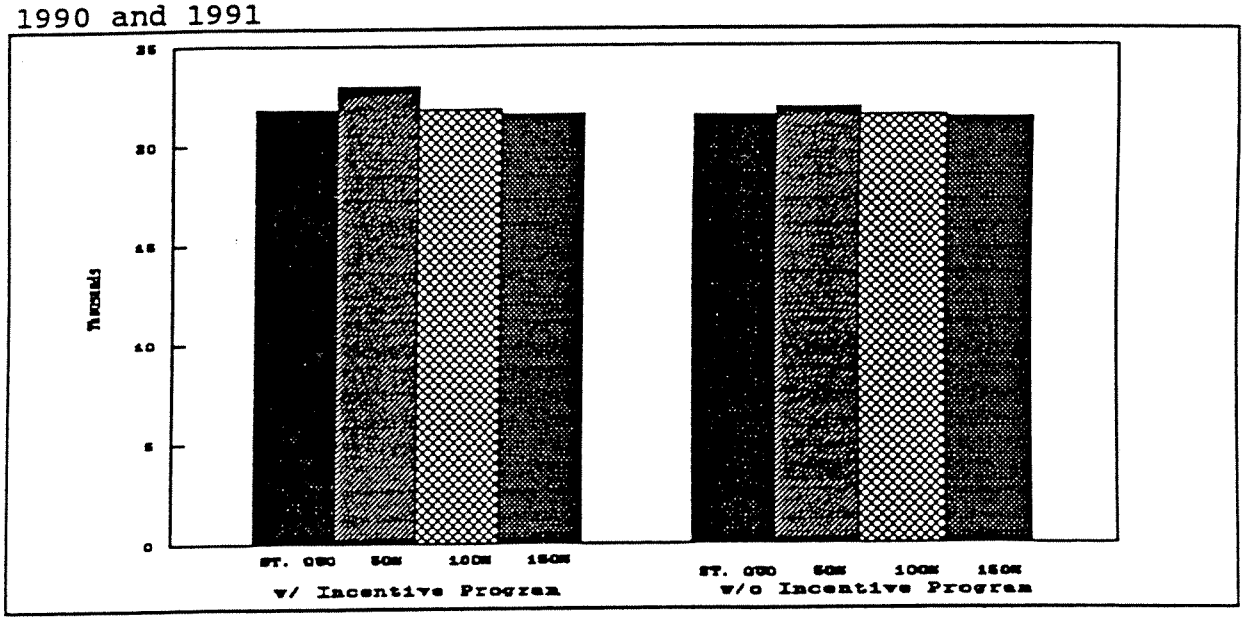

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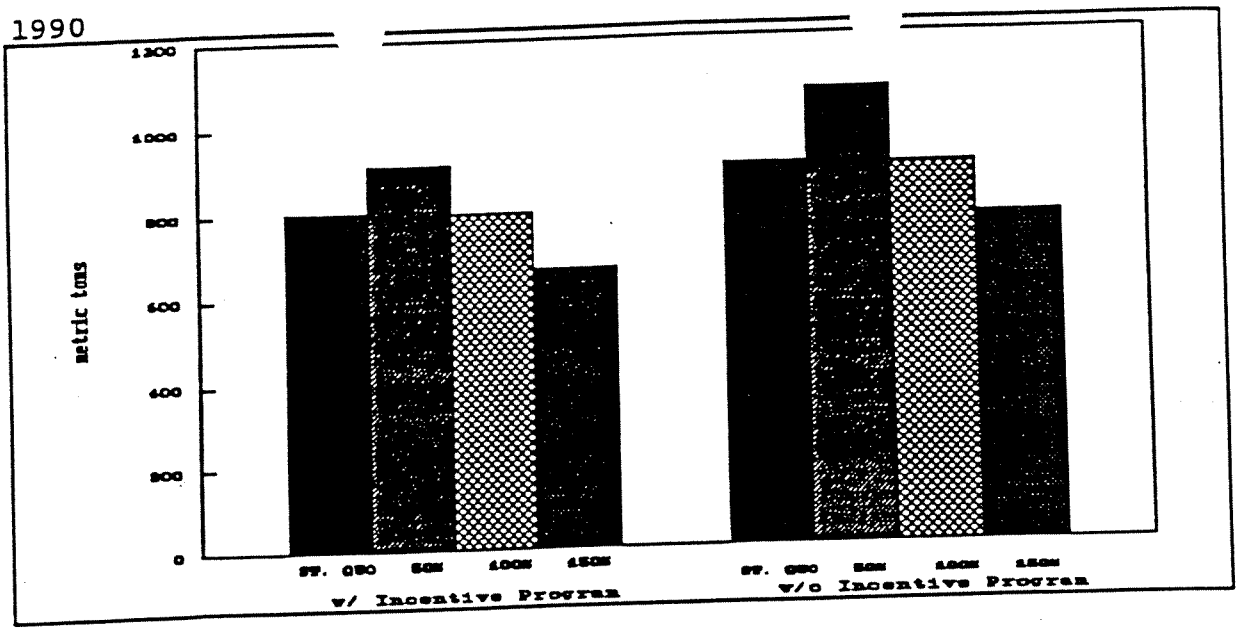

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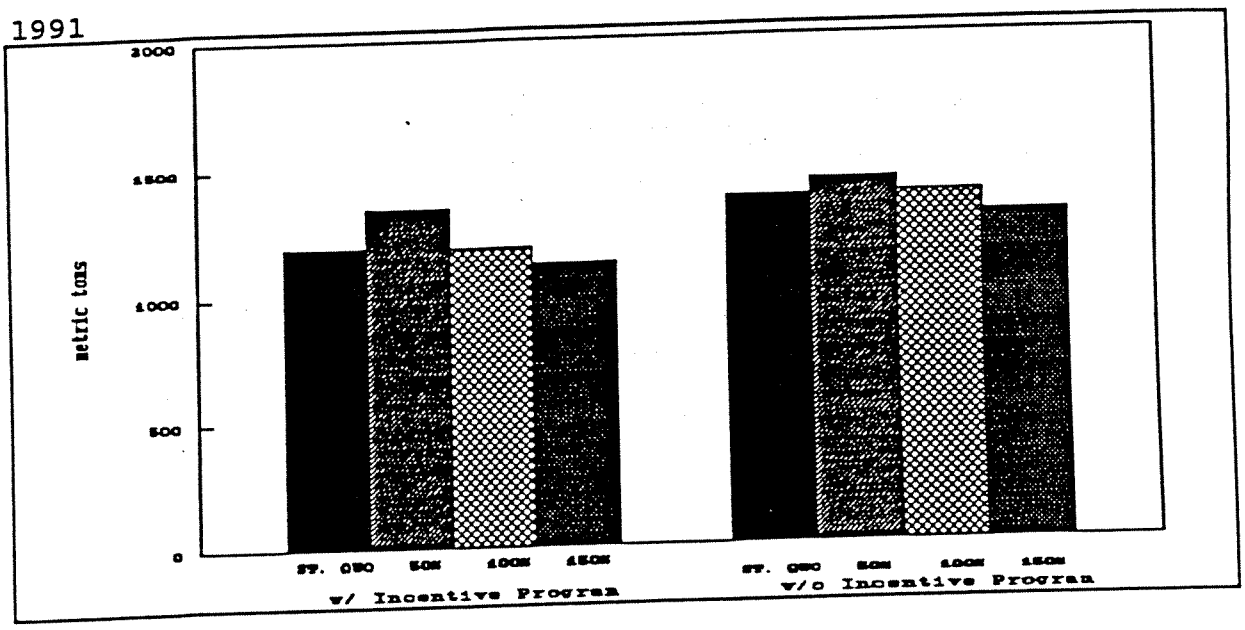

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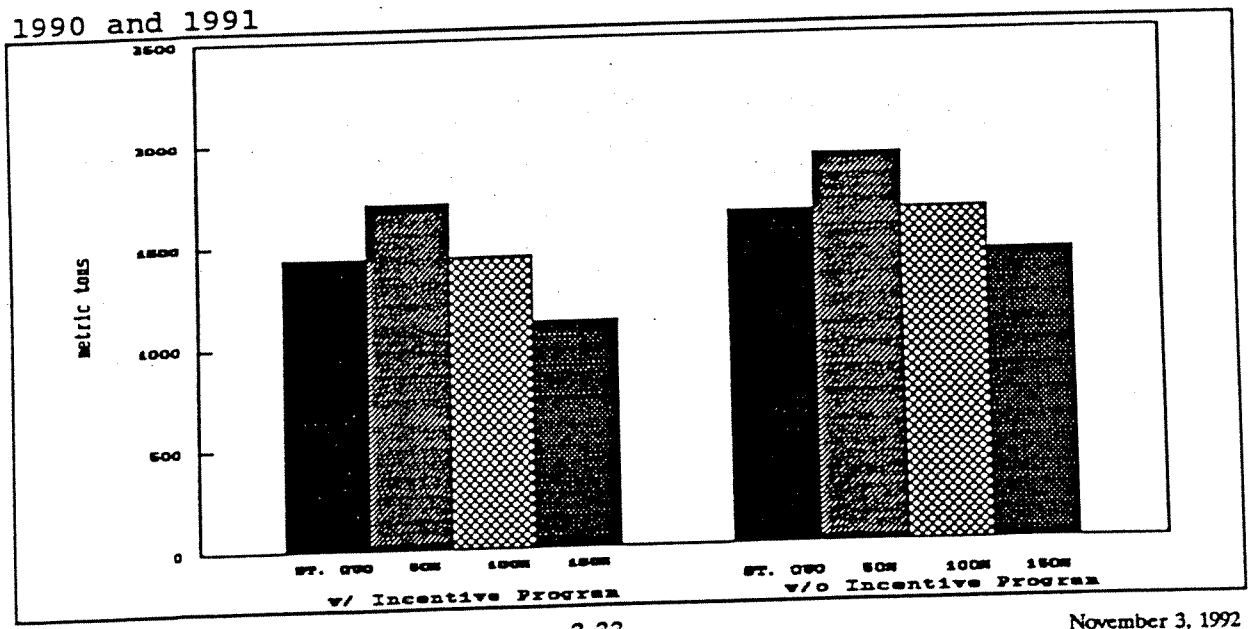

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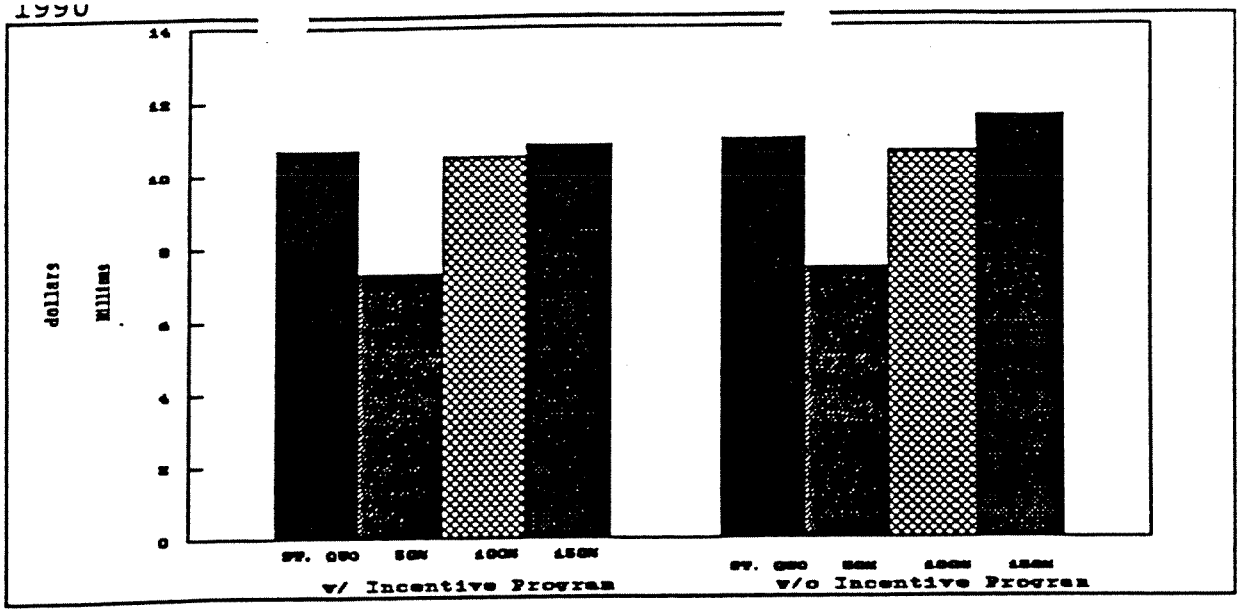

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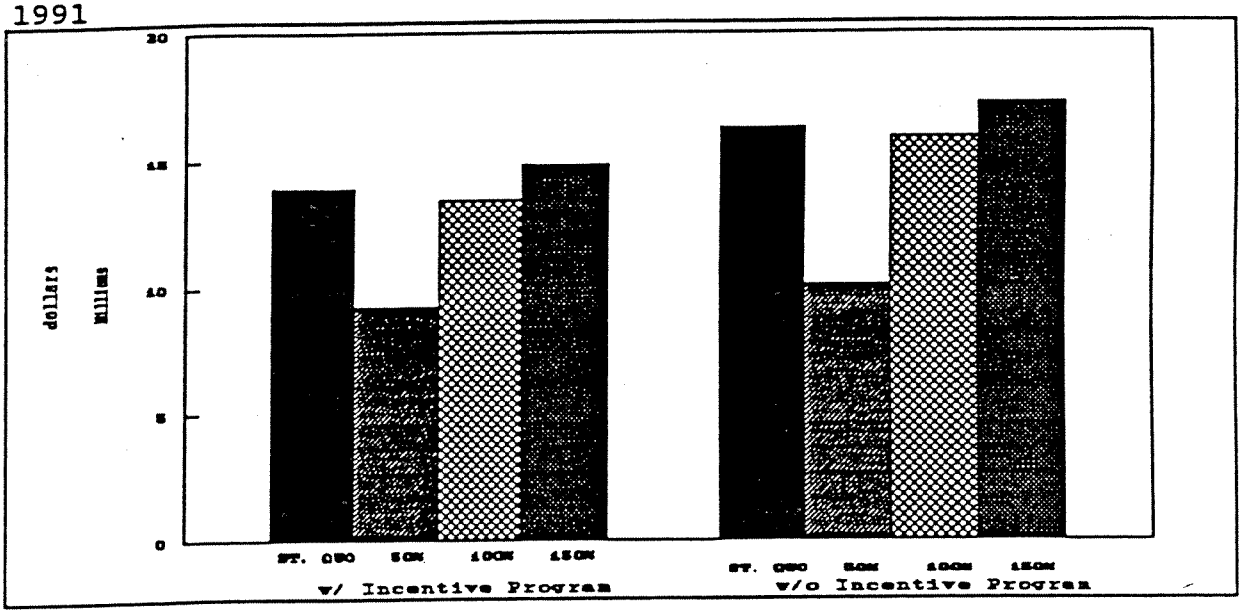

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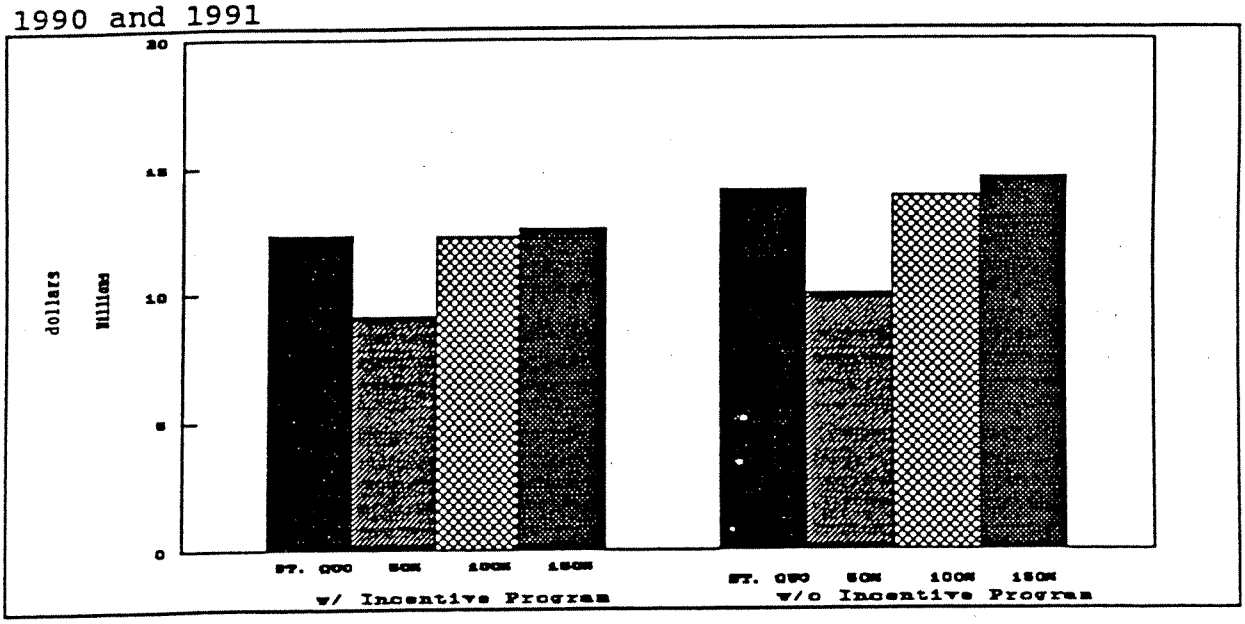

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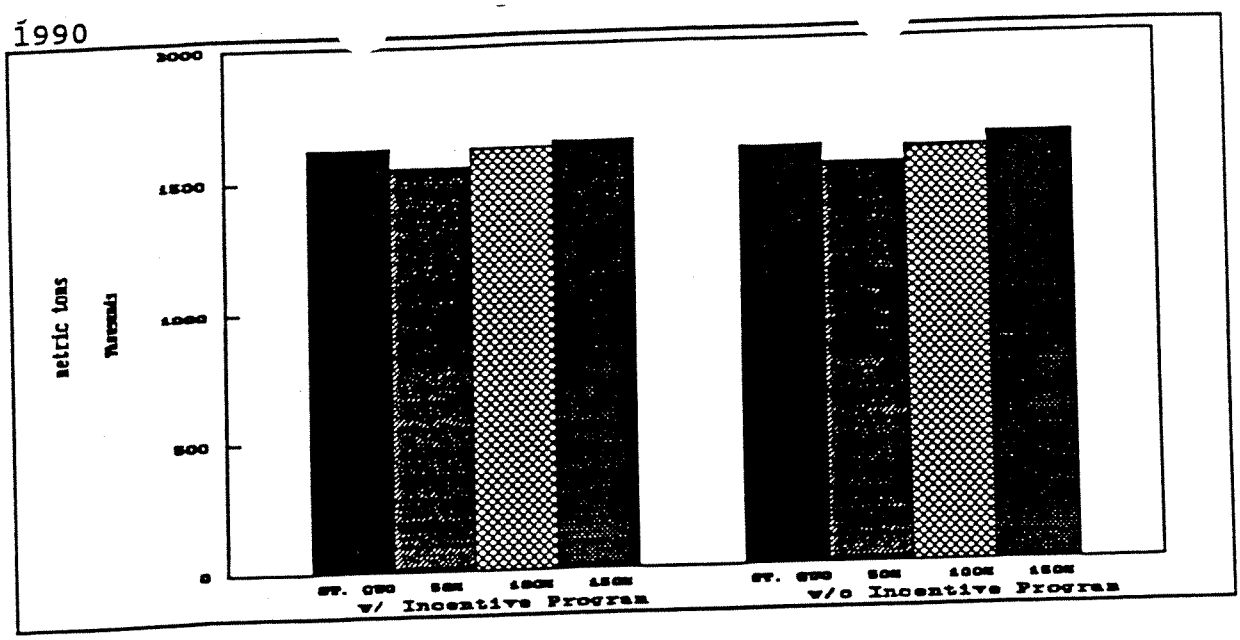

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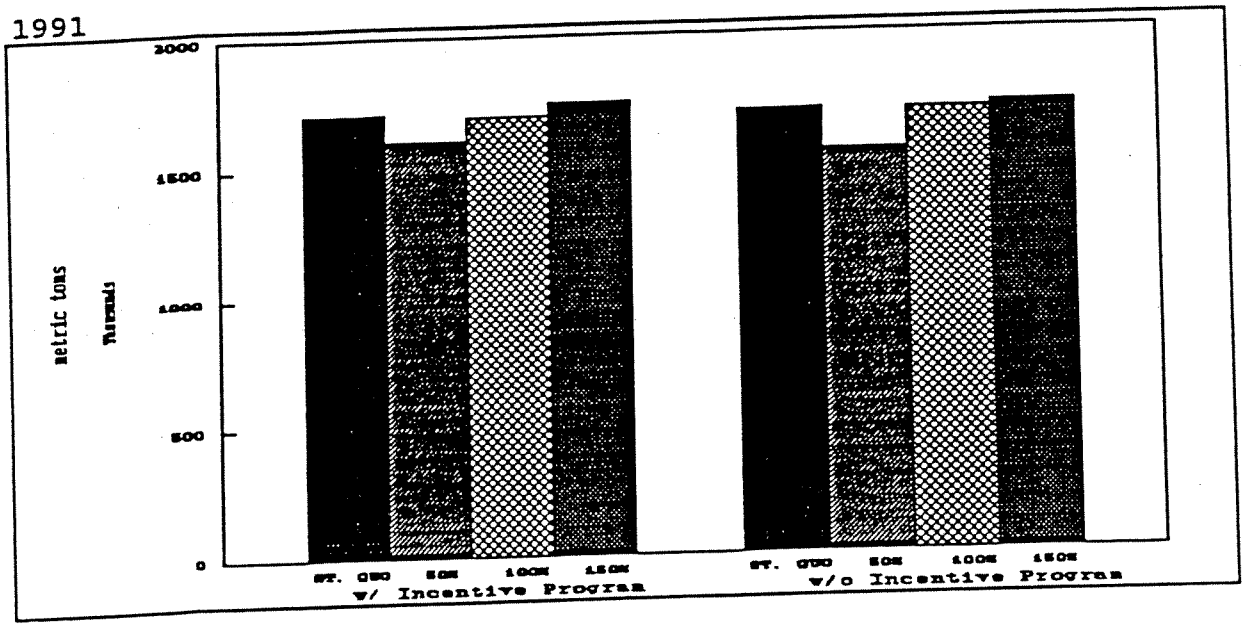

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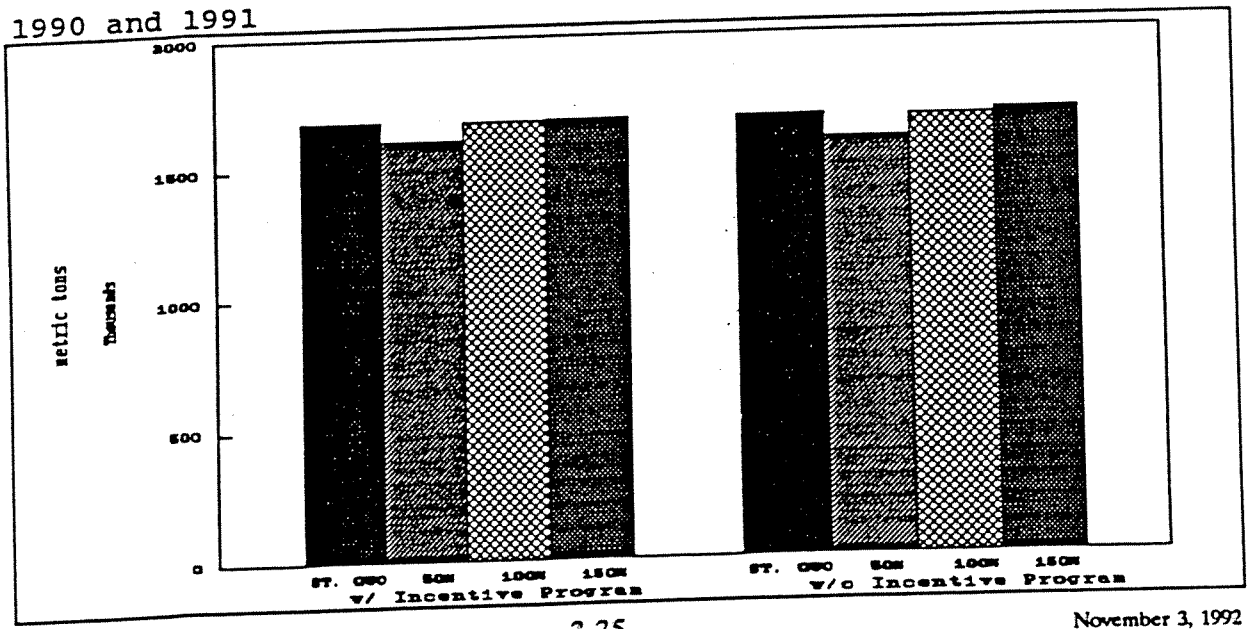

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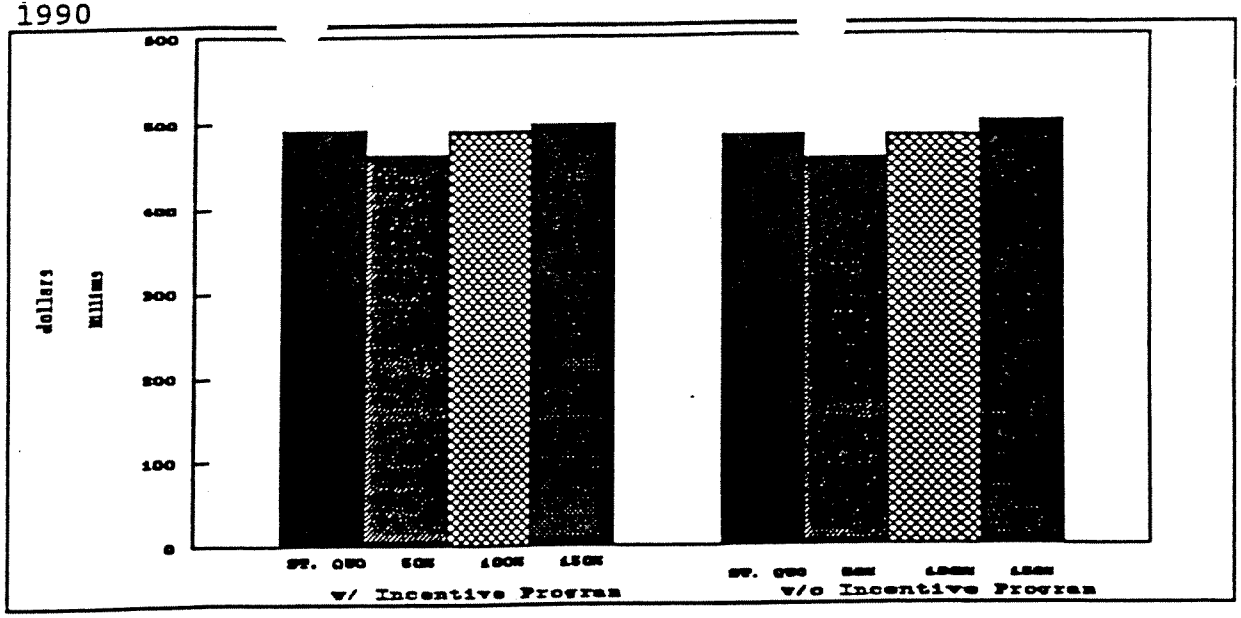

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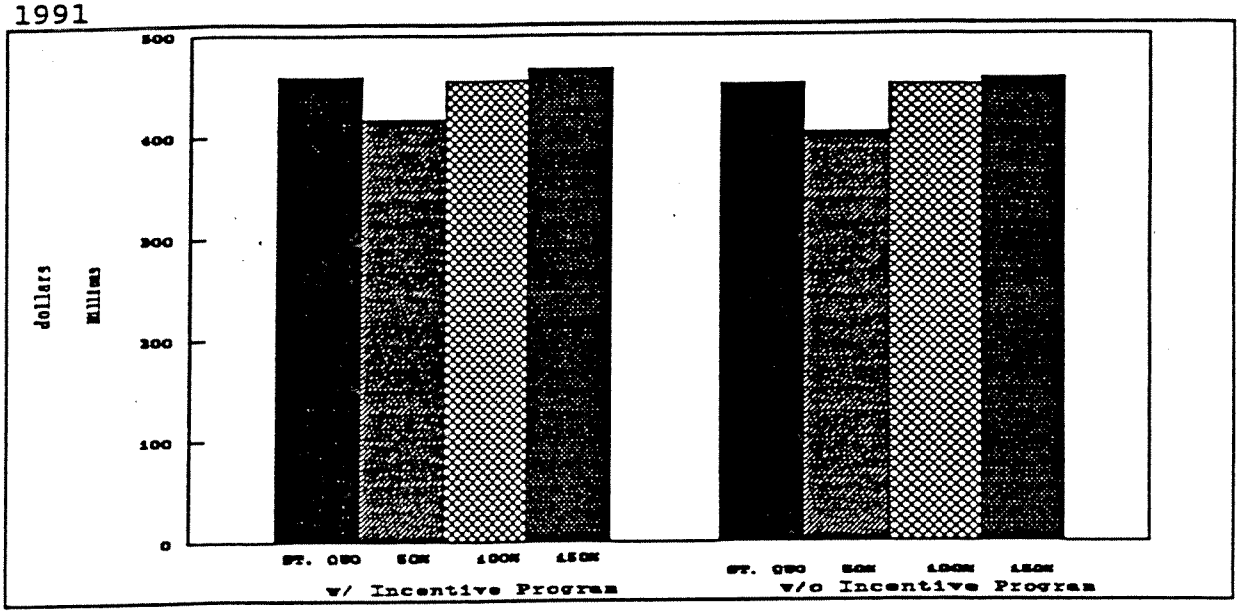

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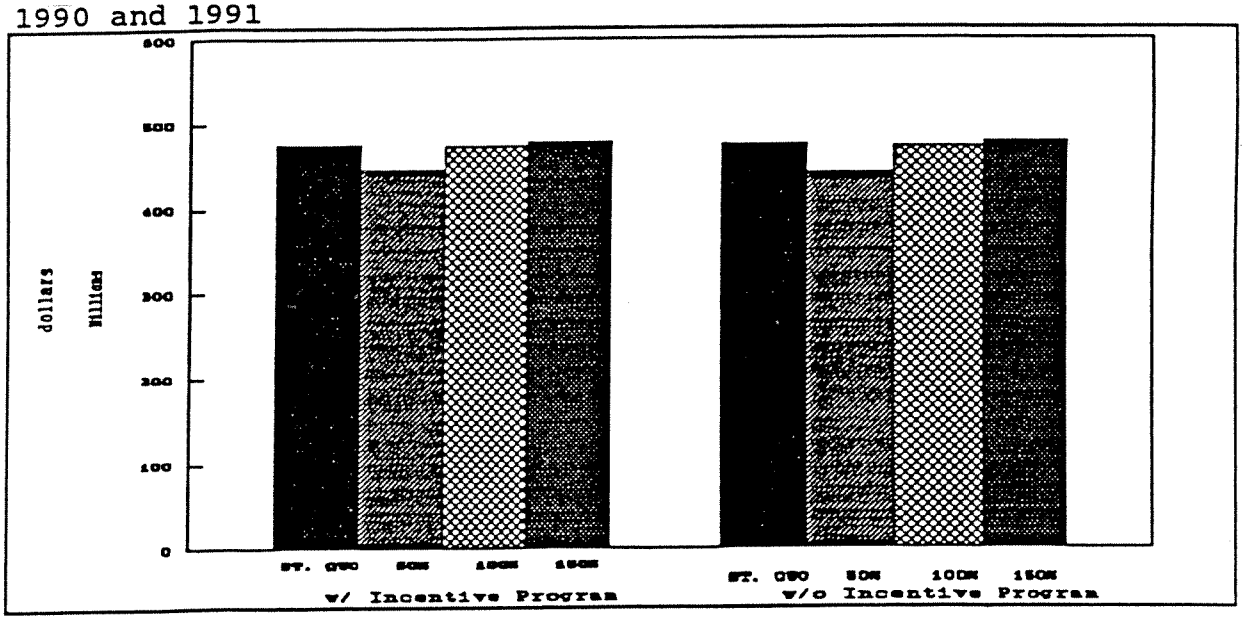
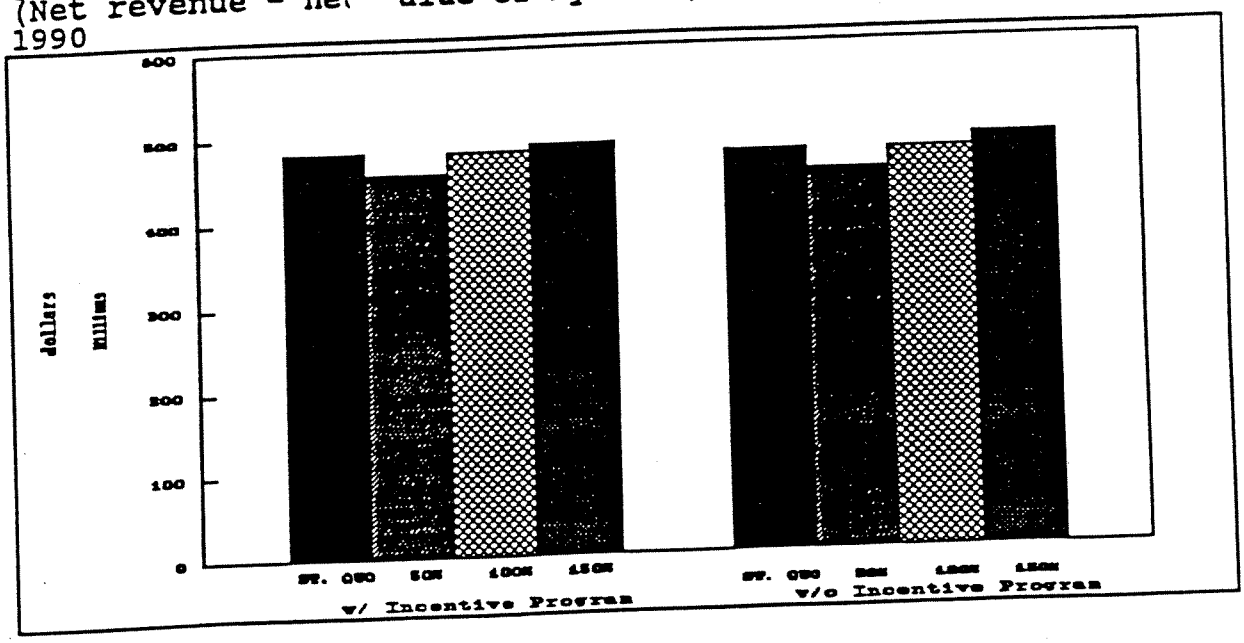


(Net revenue - net alue of bycatch)

1990



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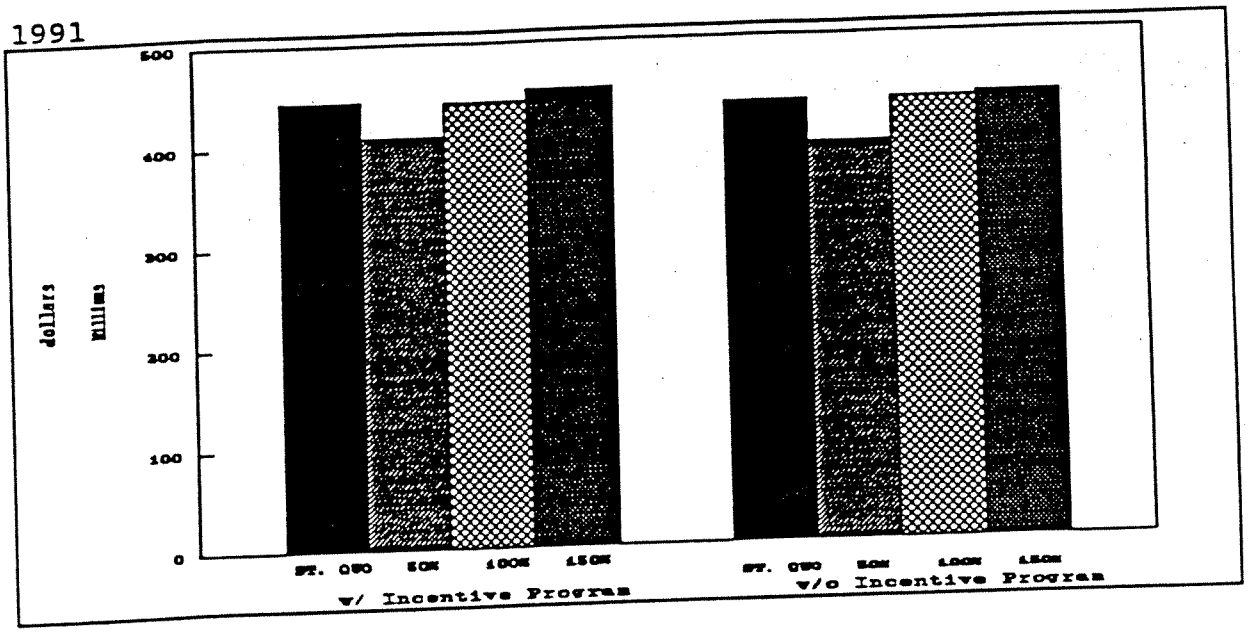
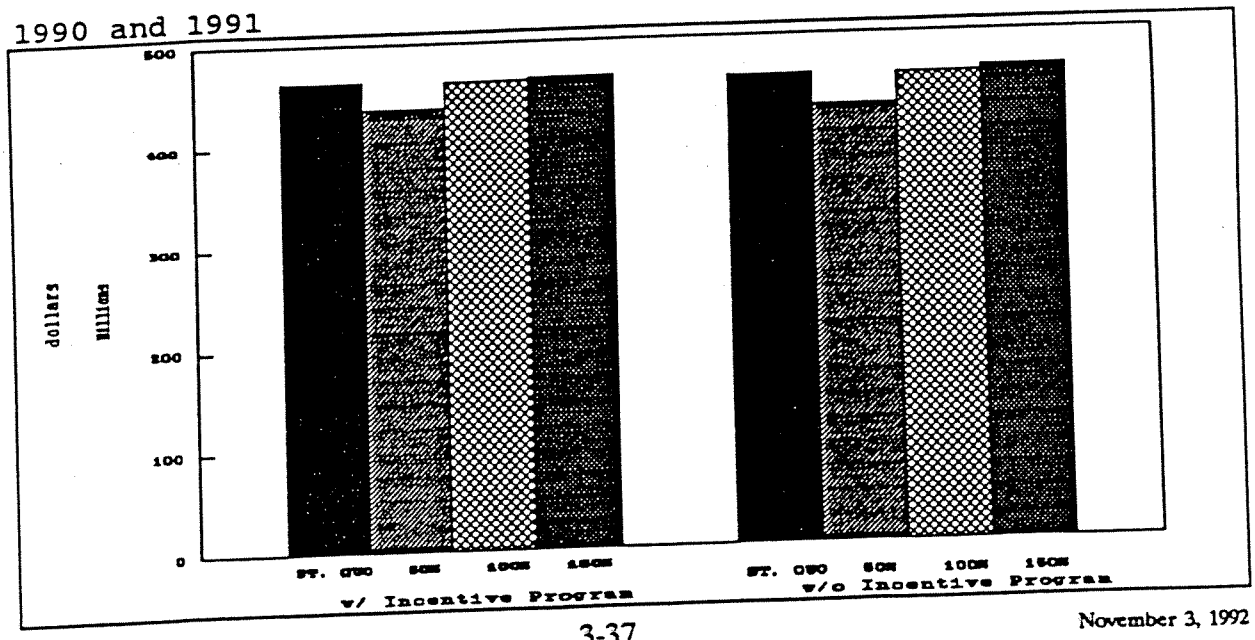
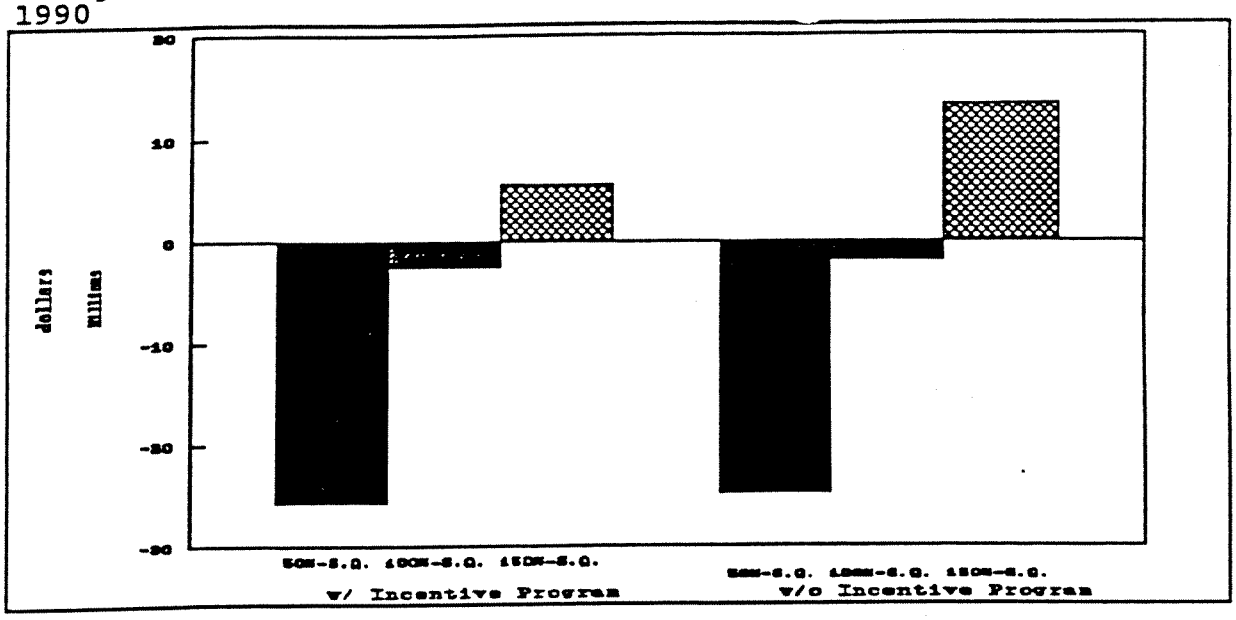


1990 and 1991



Change in (ne groundfish revenue - net [illegible]

1990



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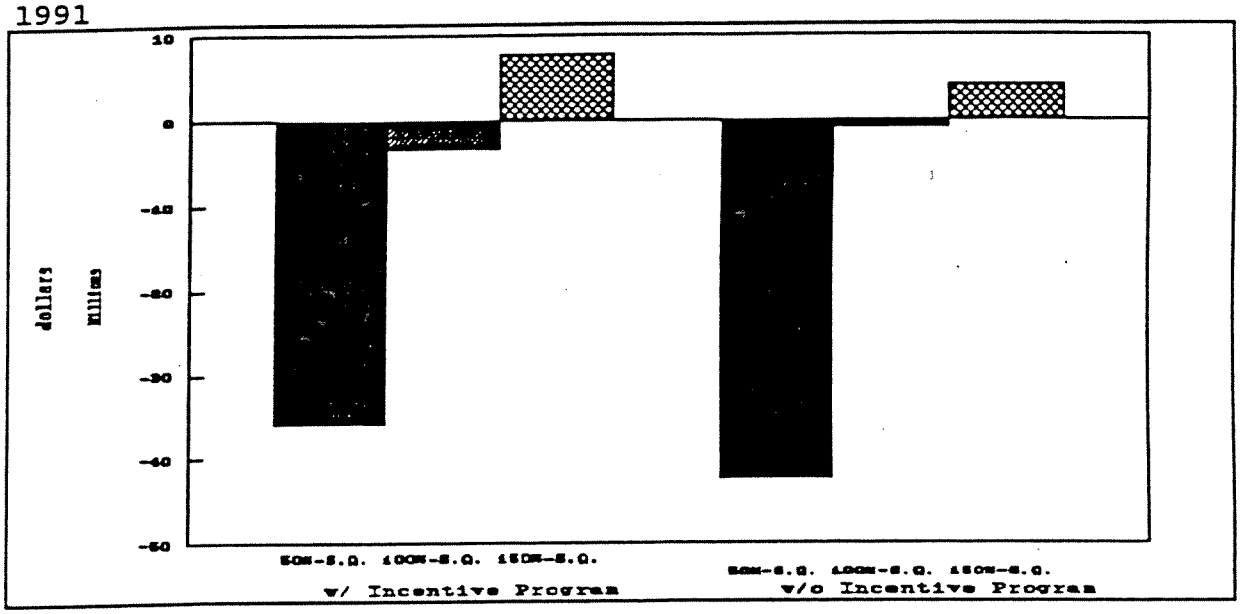

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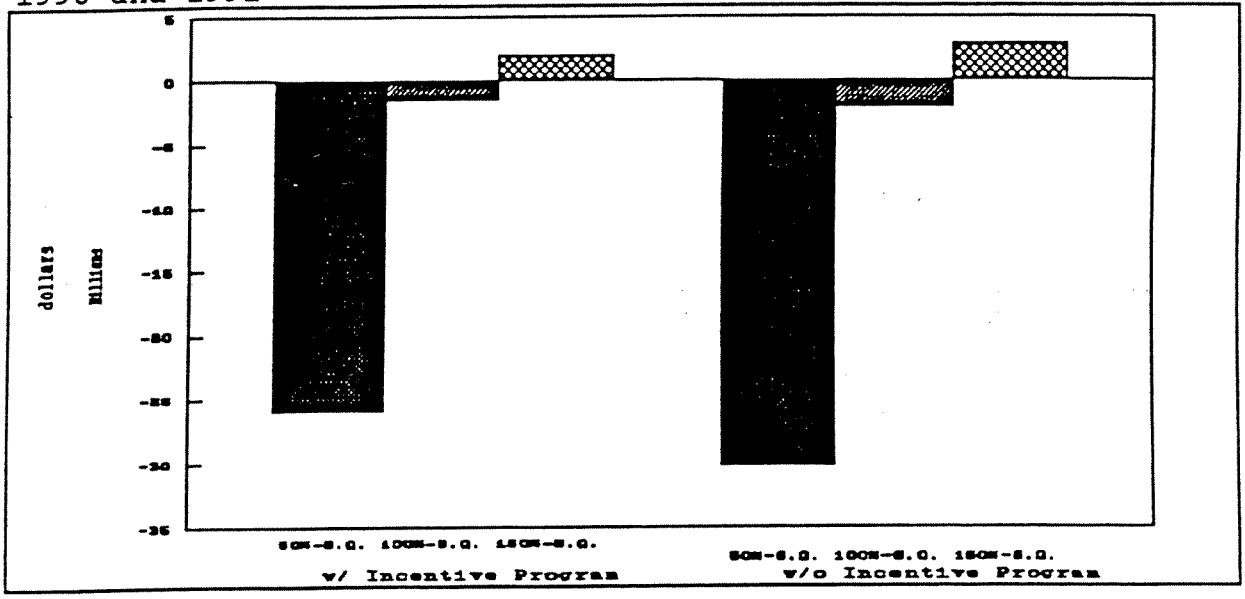

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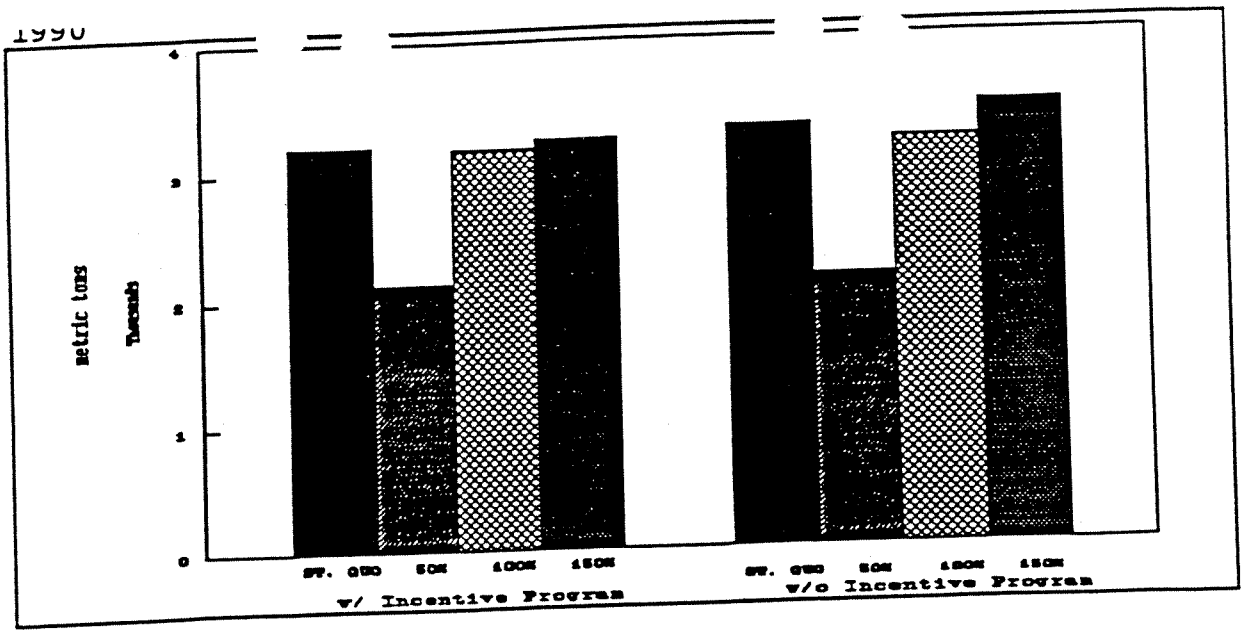

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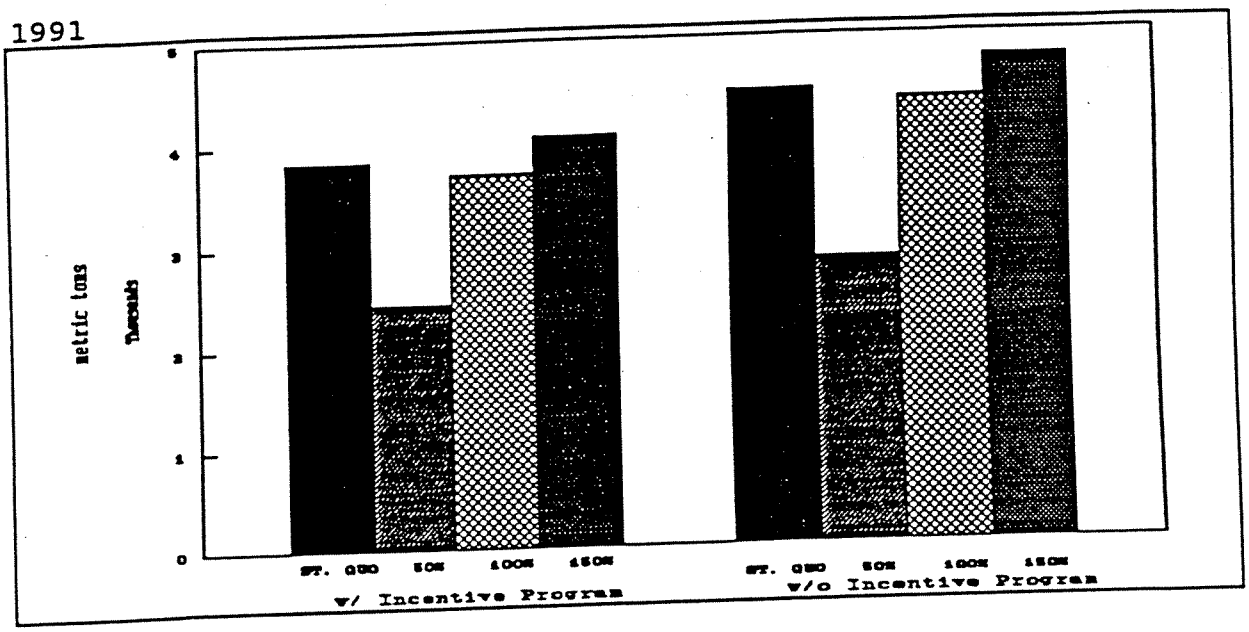

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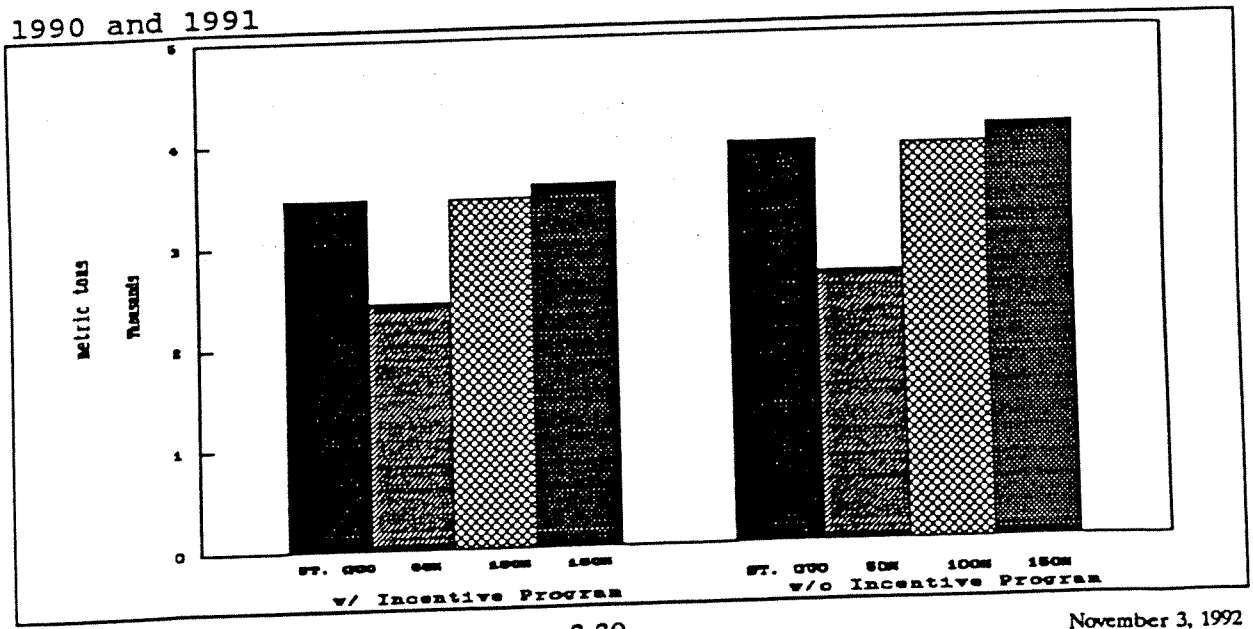

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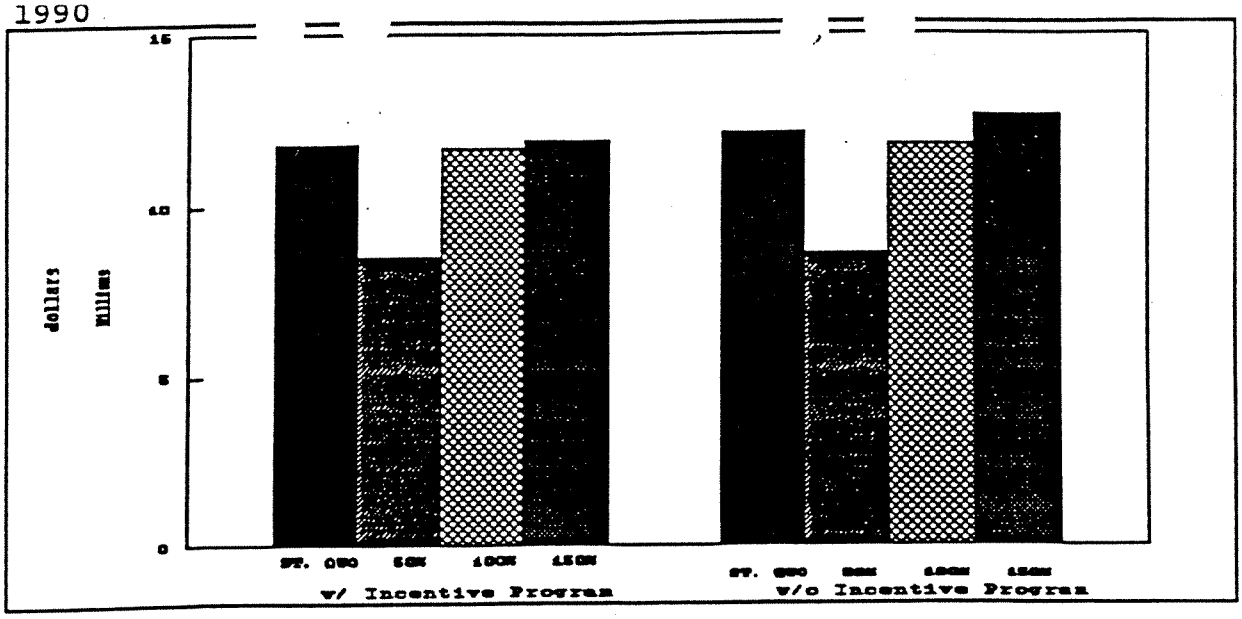

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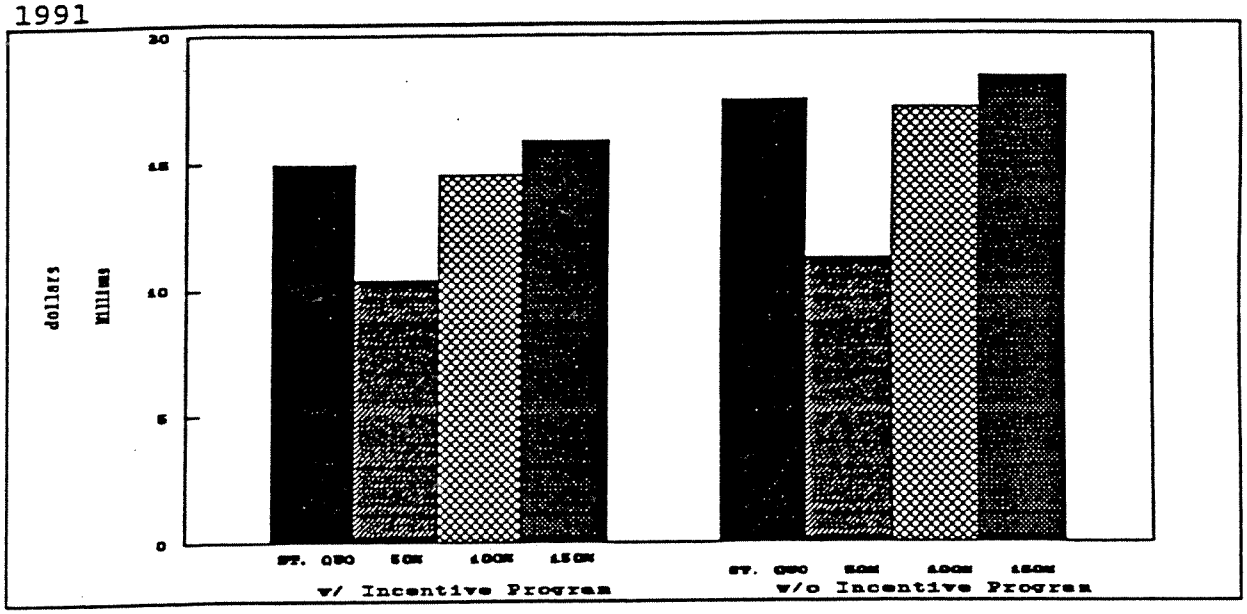

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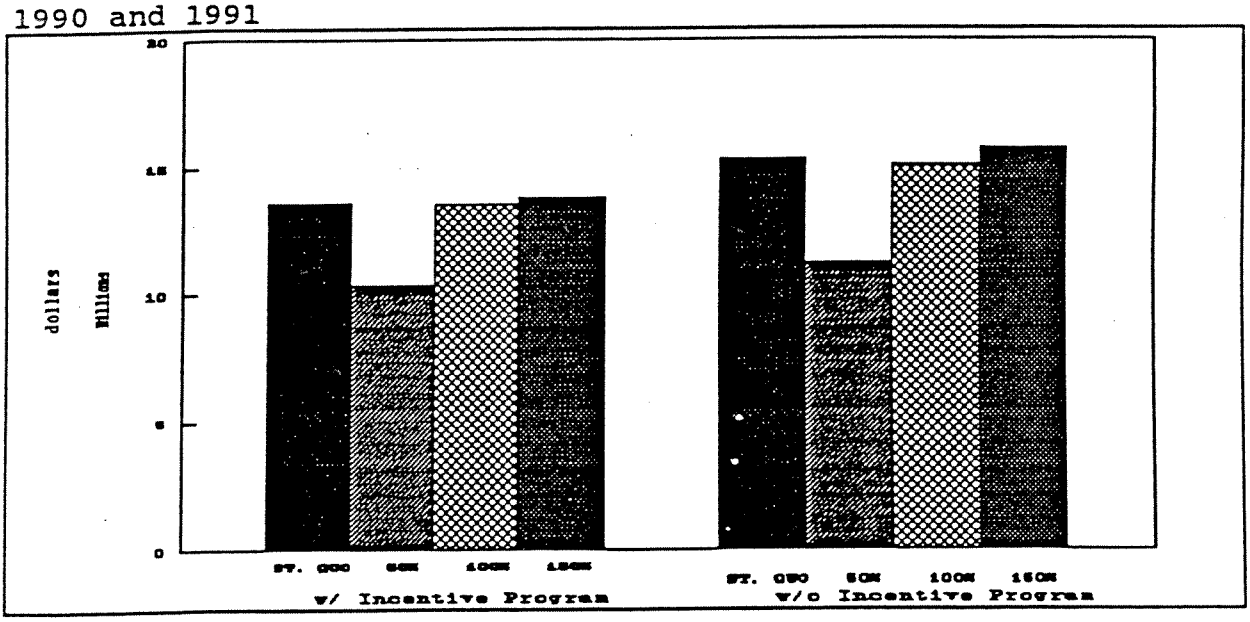

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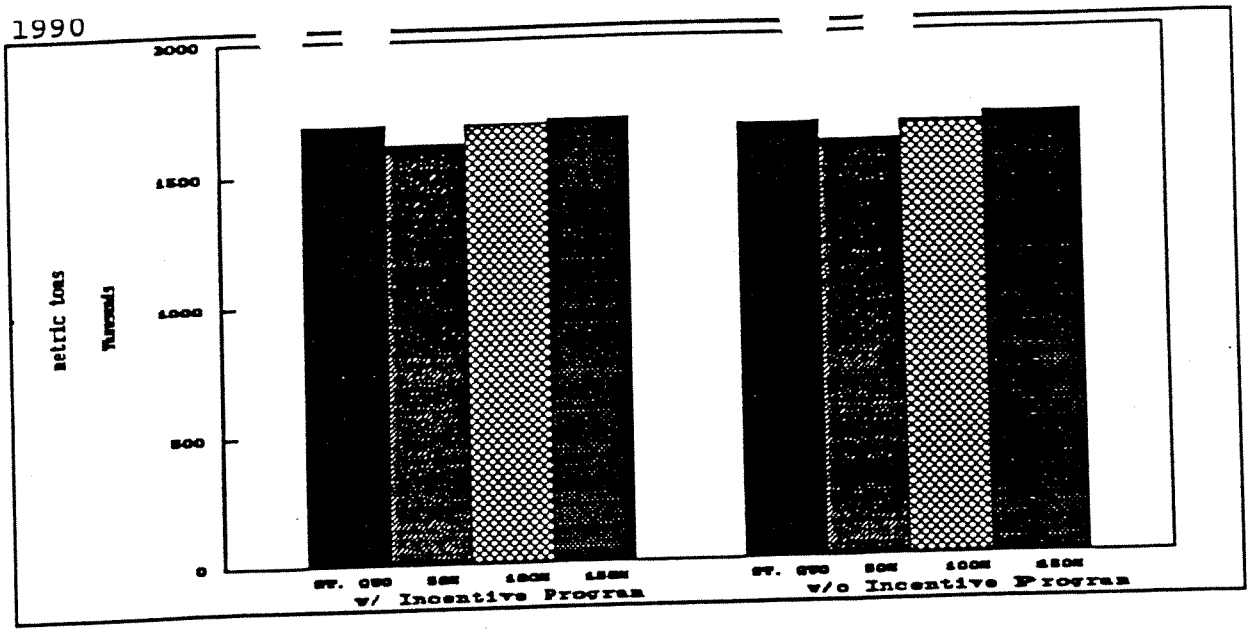

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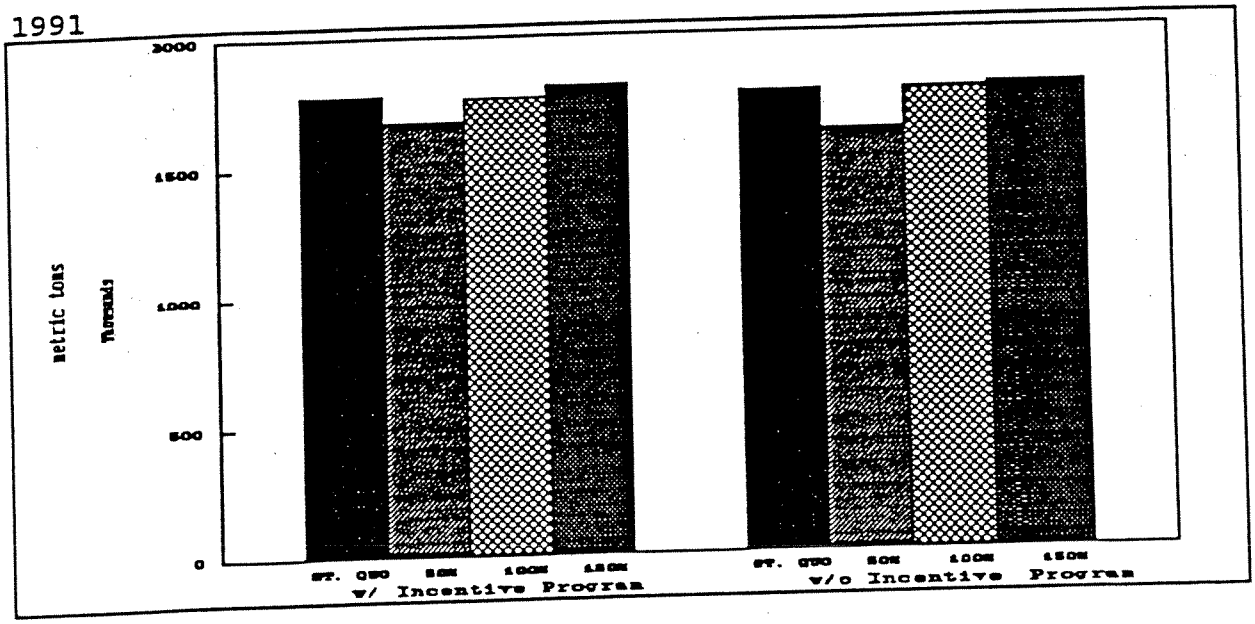

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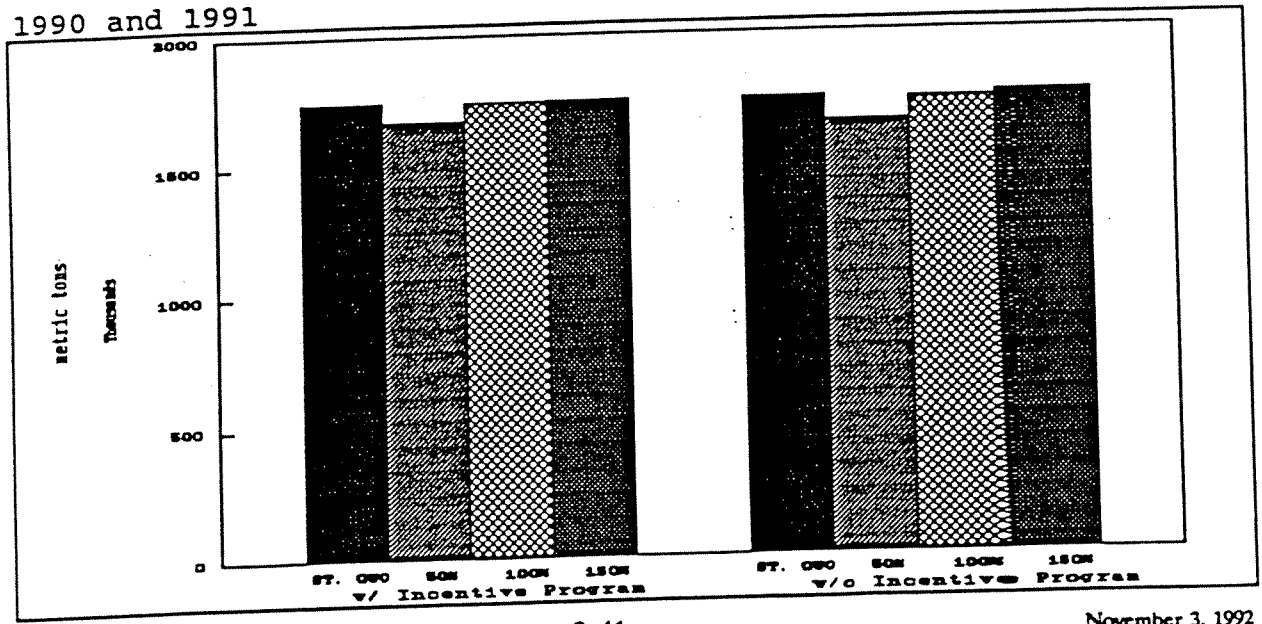

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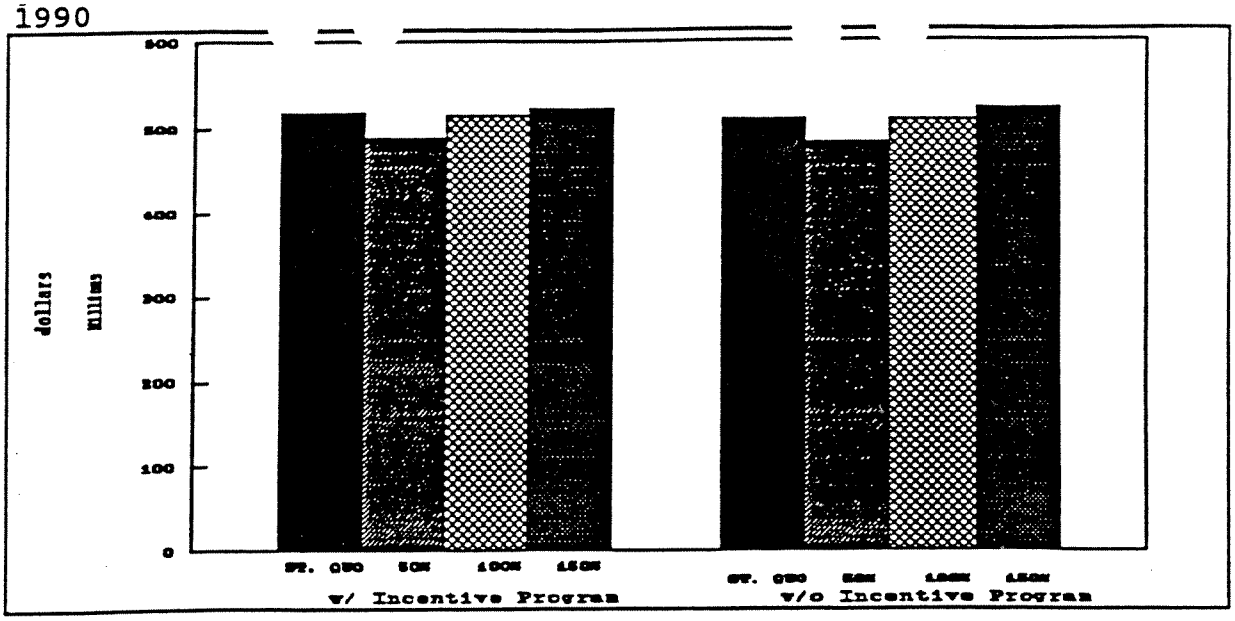

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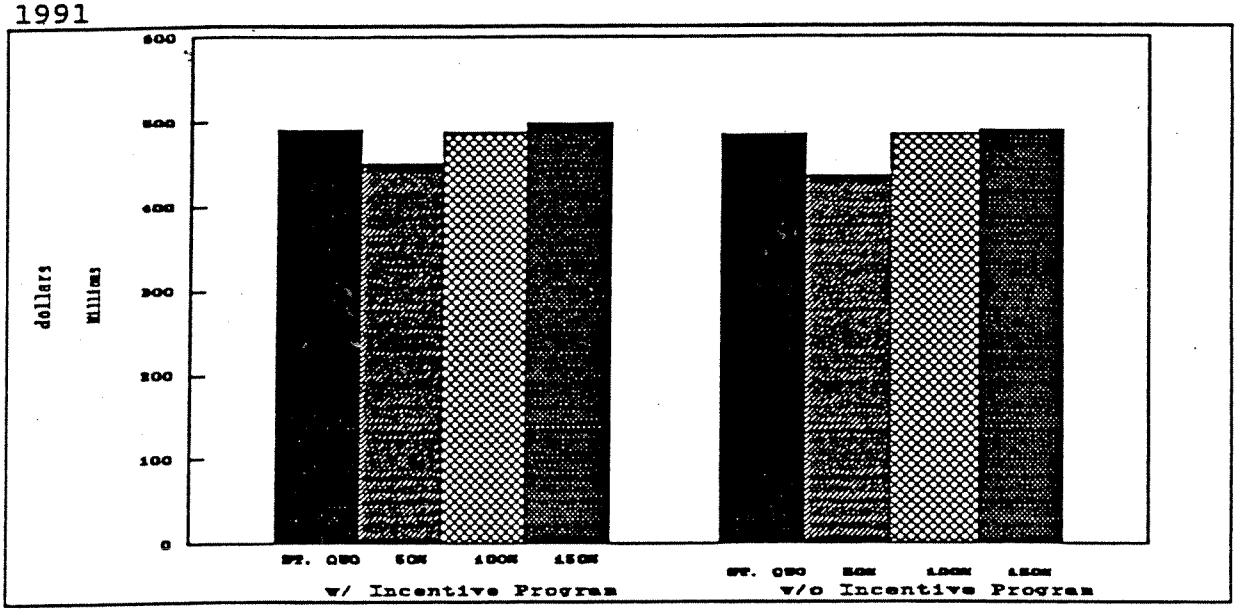
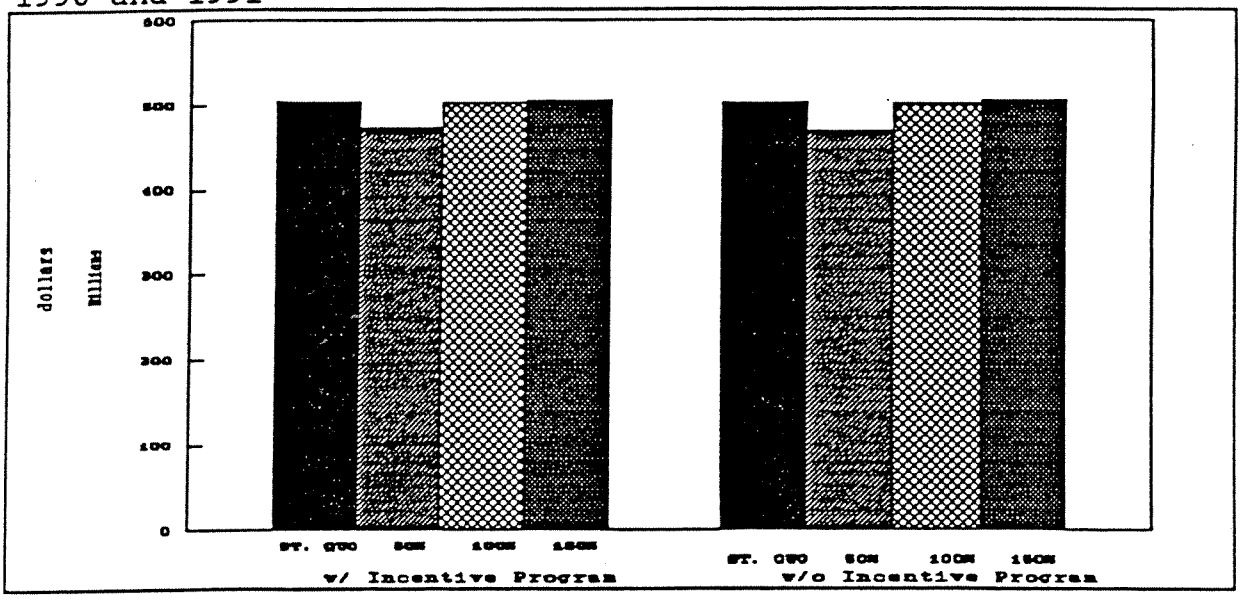
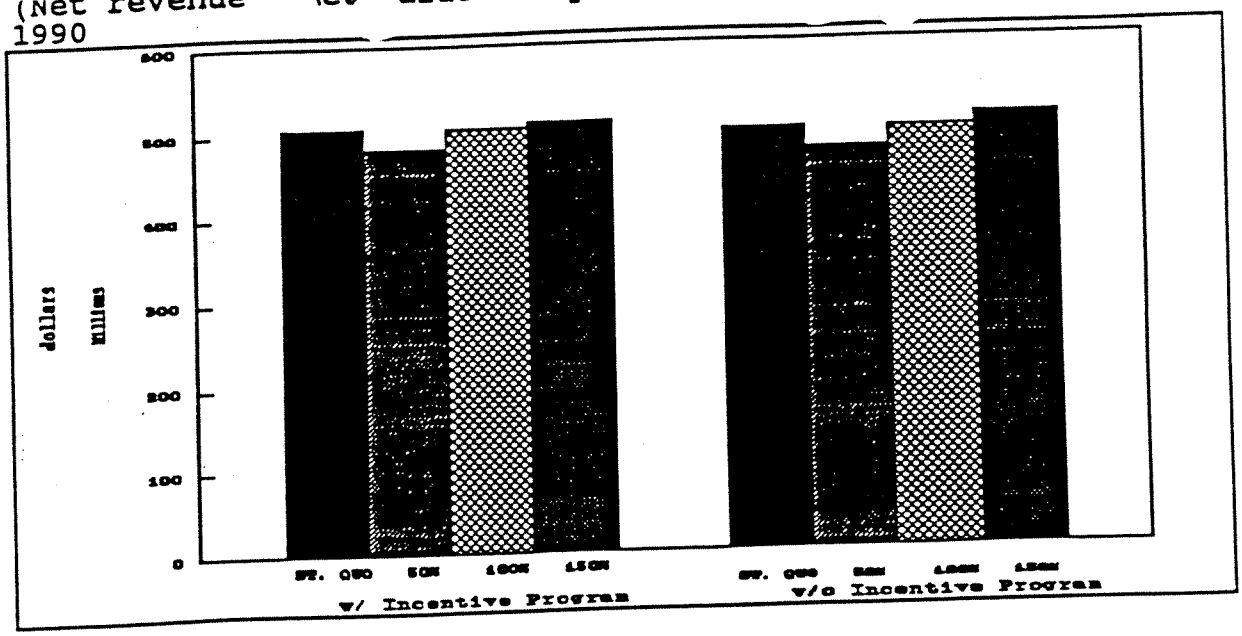


1990 and 1991

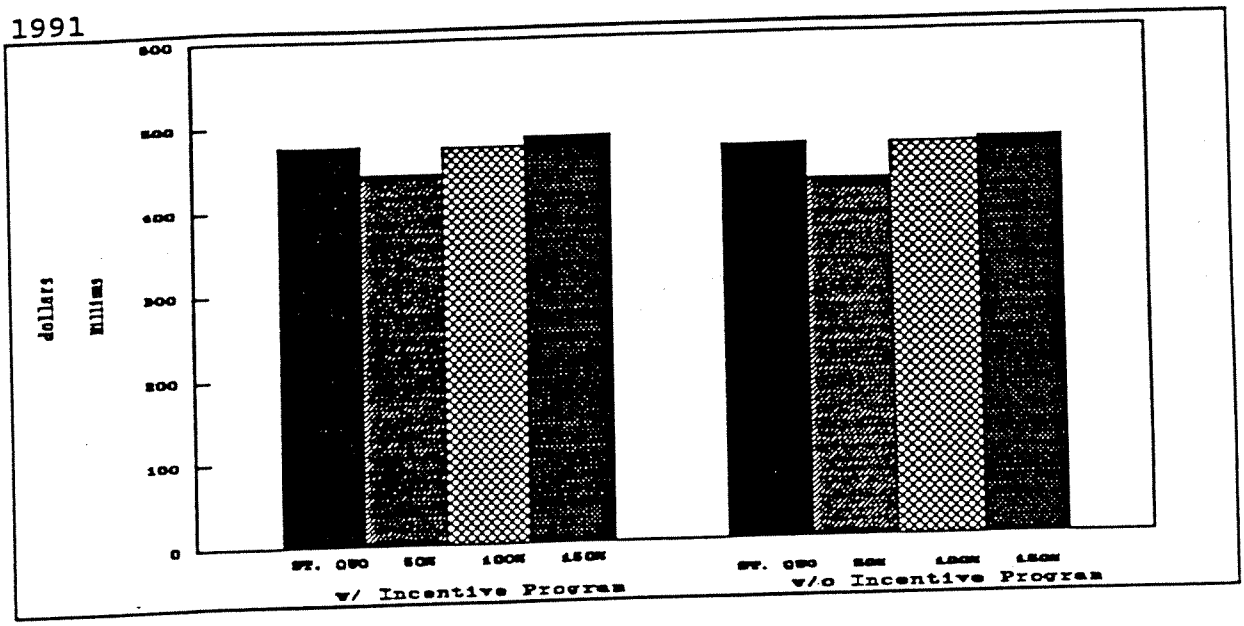


(Net revenue - net value of bycatch)

1990



1991



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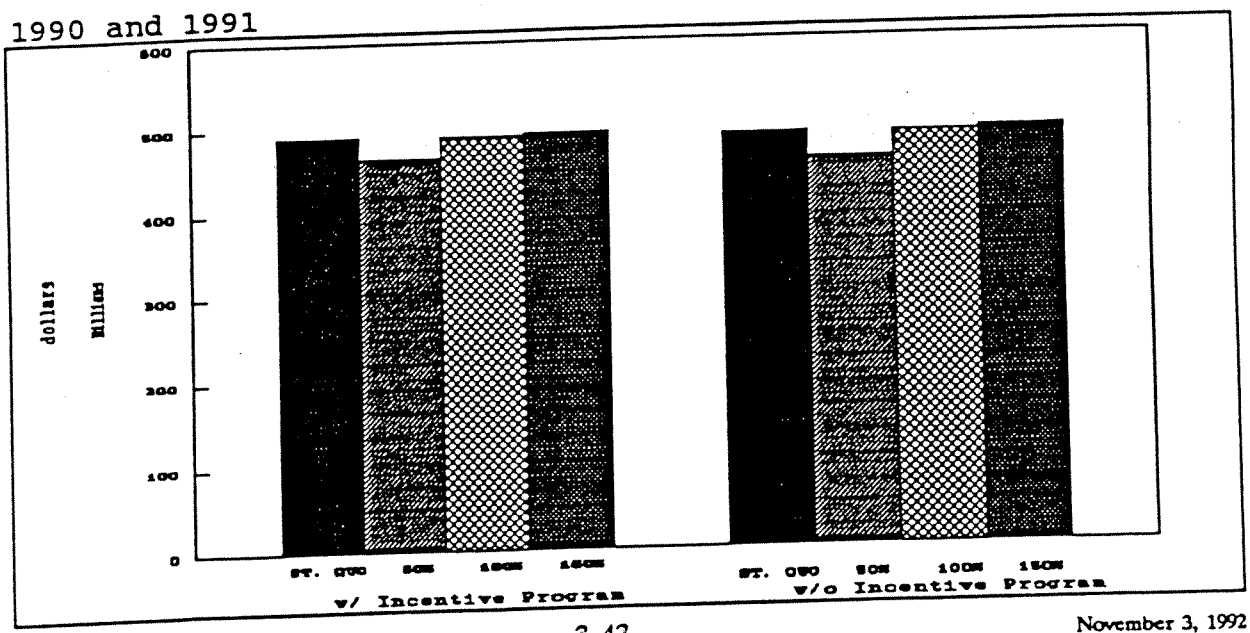

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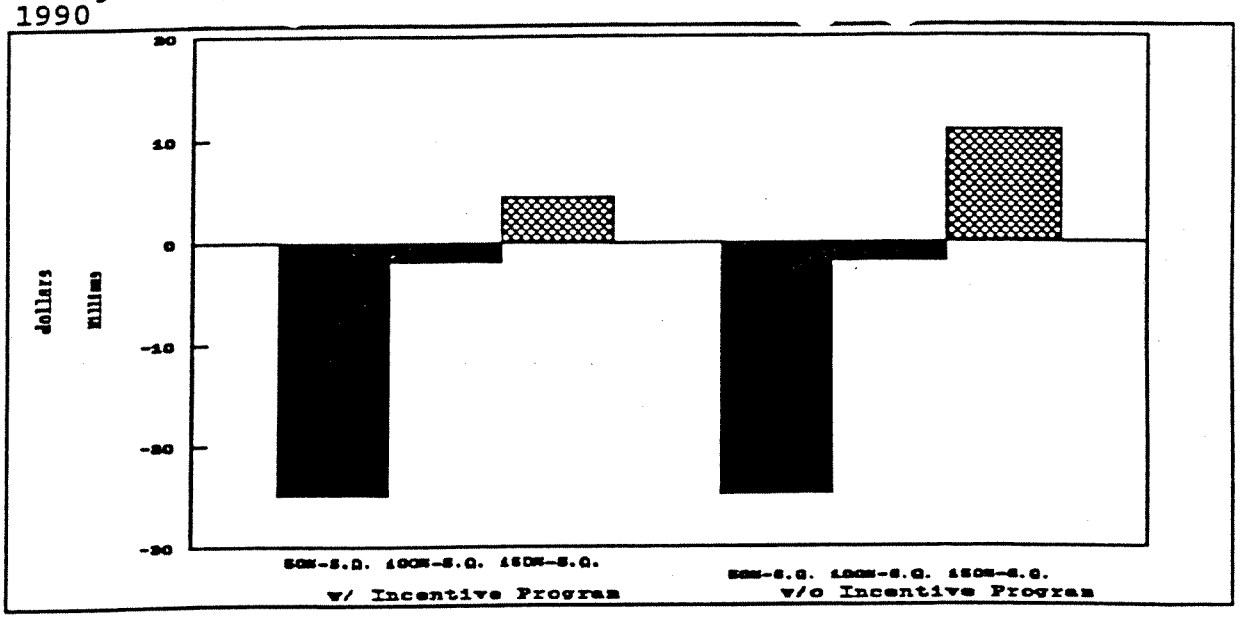

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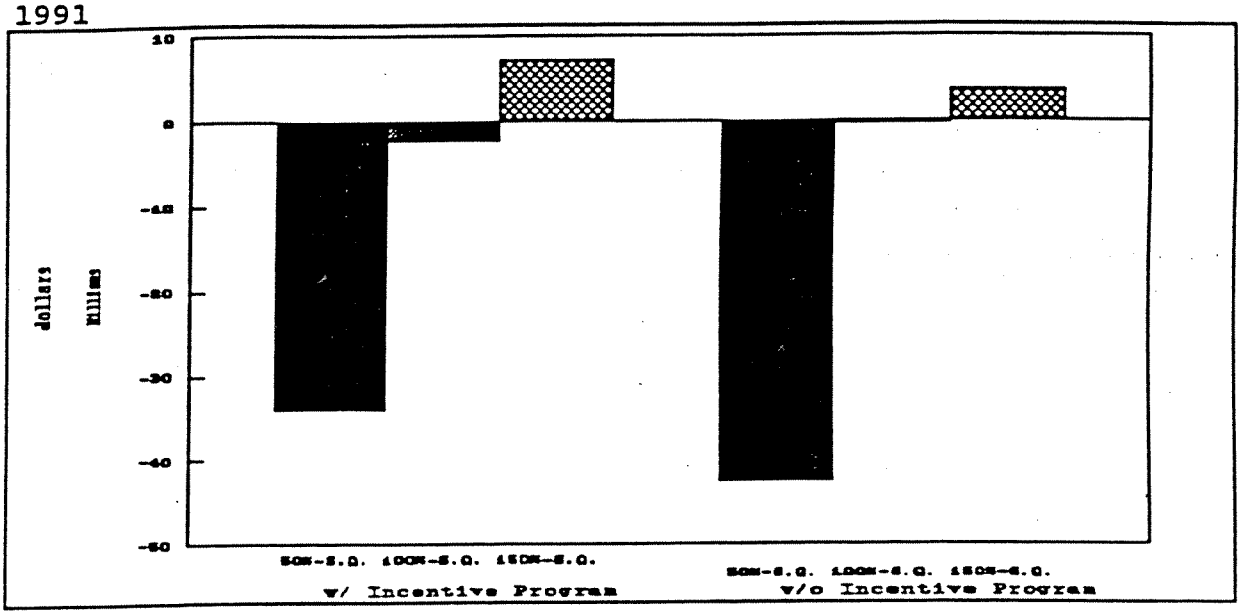

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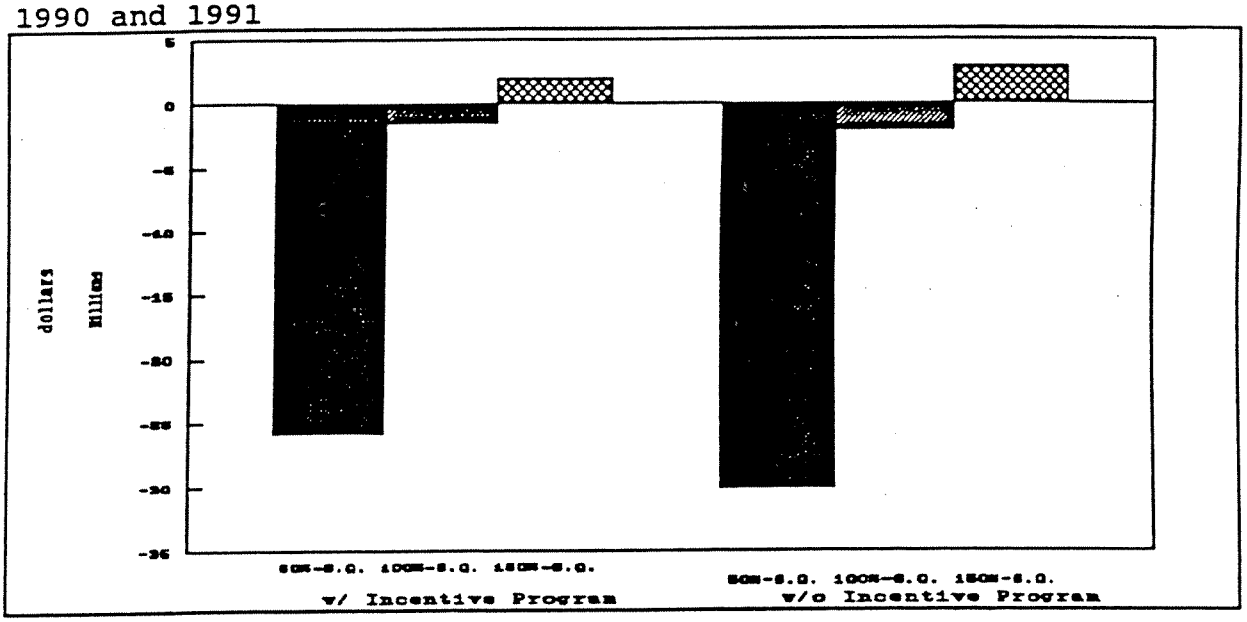


4.0 SUMMARY OF BIOLOGICAL AND ECONOMIC DIFFERENCES AMONG THE ALTERNATIVES

This Chapter summarizes the estimated biological and economic differences among the alternatives. The estimates were discussed in more detail in Chapters 2 and 3.

4.1 Biological Implications

The estimated biological differences among the alternatives are summarized below by species.

Groundfish

None of the alternatives reduces the protection provided for the groundfish stocks by the FMP. The differences among the alternatives in terms of total groundfish catch or the catch of individual groundfish species is not expected to have a measurable effect on any groundfish stocks.

Halibut

Section 2.0 of this document discusses halibut biology and the effects of halibut bycatch in the Alaska groundfish fisheries. In summary, if the IPHC's reproductive compensation is done correctly and if the bycatch is estimated correctly, the halibut spawning stock size will remain in the same condition whether bycatch occurs or not. The halibut fishery pays for maintenance of the resource through lower catches. Therefore, changes of $\pm$ 50 percent in the bycatch limits will be felt in the halibut fishery, but should not affect the condition of the resource. This would mean that the differences in expected halibut bycatch among the alternatives being considered are expected to affect halibut fishery quotas but not the condition of the halibut resource.

Crab

The adjustments to crab fishery quotas in response to crab bycatch in the groundfish fishery do not begin immediately as they do for halibut. The adjustments are made as the effects of bycatch affect the estimates of adult male and female crab. That is, crab catch limits are based on estimates of the condition of the mature crab stocks with particular emphasis being given to the population of male crab unless the female stocks are at a critically low level.

The PSC limits for crab would not be changed by any of the alternatives being considered and the estimated differences in crab bycatch among the alternatives are very small; therefore, none of the alternatives is expected to have a measurably different effect on crab populations or fisheries.

Herring

The PSC limit for herring would not be changed by any of the alternatives being considered and the estimated differences in herring bycatch among the alternatives are very small; therefore, none of the alternatives is expected to have a measurably different effect on herring populations or fisheries.

Salmon

The estimated differences in salmon bycatch among the alternatives are not large enough to be expected to have a measurable effect on chinook salmon stocks or fisheries.

Marine Mammals and Birds

None of the actions proposed under any of the alternatives considered are expected to have an adverse impact on Steller sea lions, other marine mammals, or sea birds. Substantial declines in abundance of North Pacific Ocean Steller sea lion (Eumetopias jubatus) and harbor seal (Phoca vitulina) populations have been observed over the past two decades. Presently, the cause or causes of these observed population reductions are unknown. NMFS permanently listed the Steller sea lion as a threatened species on November 26, 1990, and implemented regulations under the Endangered Species Act and Amendments 20 and 25 to the BSAI and GOA FMPs, respectively, to minimize potential adverse effects of groundfish fisheries on Steller sea lions. Given these protection measures and the fact that none of the management measures considered will significantly change fishing distribution or harvest levels, adoption of either alternative is not likely to have any effect on Steller sea lions, other marine mammals, or birds.

4.2 Reporting Costs

Existing reporting practices would not need to be augmented to implement any of the alternatives. Observers aboard most groundfish fishing vessels would be expected to provide estimates of catch regardless of which alternative is selected.

4.3 Administrative, Enforcement, and Information Costs

Non of the alternatives considered would require an increase in NMFS or other management agency staff beyond that which is already required for the inseason monitoring and enforcement of PSC limits. NMFS currently monitors non-trawl halibut bycatch amounts in the BSAI and the additional time required to initiate and enforce closure actions resulting from non-trawl halibut bycatch restrictions could be accomplished within existing staff levels.

4.4 Distribution of Costs and Benefits

The principal differences among the alternatives are expected to be in terms of total benefits and costs and their distribution among participants in the various fisheries, particularly the halibut and groundfish fisheries. The data in Tables 3.1 and 3.2 provide estimates of the distributions of benefits and cost that can be quantified more readily, respectively, for the alternative trawl and non-trawl PSC limits being considered. Other benefits and costs that have not been quantified are discussed in Section 3.

4.5 Effects on Consumers

None of the alternatives is expected to have a large enough effect on groundfish, halibut, herring, crab, or salmon catch to measurably change the well being of domestic consumers in terms either of the amount of product available to domestic consumers or the prices they pay for fishery products as a whole. Because the alternatives tend to result in tradeoffs, principally between groundfish catch and halibut catch, the net effects on domestic consumers are expected to be small and would be dispersed very broadly because groundfish and halibut are minor items in the food budgets for most households.

5.0 EFFECTS ON ENDANGERED AND THREATENED SPECIES AND ON THE ALASKA COASTAL ZONE

None of the alternatives are expected to have any adverse effect on endangered or threatened species or their habitat. Thus, formal consultation under Section 7 of the Endangered Species Act is not required.

Also, for each of the reasons discussed above, each of the alternatives would be conducted in a manner consistent, to the maximum extent practicable, with the Alaska Coastal Management Program within the meaning of Section 307(c)(1) of the Coastal Zone Management Act of 1972 and its implementing regulations.

6.0 OTHER EXECUTIVE ORDER 12291 REQUIREMENTS

Executive Order 12291 requires that the following three issues be considered:

(a) Will the amendment have an annual effect on the economy of $100 million or more?

(b) Will the amendment lead to an increase in the costs or prices for consumers, individual industries, Federal, State, or local government agencies or geographic regions?

(c) Will the amendment have significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of U.S. based enterprises to compete with foreign enterprises in domestic or export markets?

Regulations impose costs and cause redistribution of costs and benefits. If the proposed regulations are implemented to the extent anticipated, these costs are not expected to be significant relative to total operational costs

The amendment would not have significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of U.S. based enterprises to compete with foreign enterprises in domestic or export markets.

The amendment should not lead to a substantial increase in the price paid by consumers, local governments, or geographic regions since no significant quantity changes are expected in the groundfish markets. Where more enforcement and management effort are required, costs to state and federal fishery management agencies will increase.

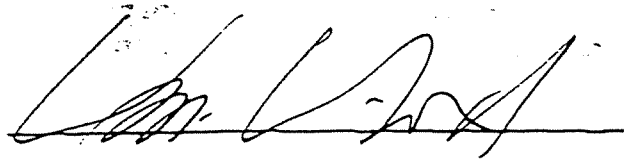
These amendments should not have an annual effect of $100 million, since although the total value of the domestic catch of all groundfish species is over $100 million, these amendments are not expected to substantially alter the amount of distribution of this catch.

7.0 IMPACT OF THE AMENDMENTS RELATIVE TO THE REGULATORY FLEXIBILITY ACT

The Regulatory Flexibility Act (RFA) requires that impacts of regulatory measures imposed on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions with limited resources) be examined to determine whether a substantial number of such small entities will be significantly impacted by the measures. Fishing vessels are considered to be small businesses. Over 2,000 vessels may fish for groundfish off Alaska in 1993, based on Federal groundfish permits issued by NMFS. While these numbers of vessels are considered substantial, regulatory measures will only affect a smaller proportion of the fleet.

8.0 FINDINGS OF NO SIGNIFICANT IMPACT

For the reasons discussed above, neither implementation of the status quo nor any of the alternatives would significantly affect the quality of the human environment, and the preparation of an environmental impact statement on the final action is not required under Section 102(2)(c) of the National Environmental Policy Act or its implementing regulations.



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APPENDIX

BERING SEA/ALEUTIAN ISLANDS AREA FISHERY SIMULATION MODEL

A fishery simulation model was developed by Terry Smith (1989) to analyze Amendment 12a, it was modified by Fritz Funk (1990) to analyze Amendments 16 and 16a, it was modified by Smith (1991) to analyze Amendment 19, and most recently it was modified and used by Dave Ackley of the Alaska Department of Fish and Game to make quantitative estimates of the likely consequences of alternatives in this document. Ben Muse of the Alaska Commercial Fisheries Entry Commission (CFEC) developed relative cost and return parameters for the groundfish, halibut, crab, herring, and salmon fisheries and produced estimates of value for the alternatives considered here.

Caveats

As was discussed in Chapter 1, there are several limitations in the ability of the model to predict the effects of alternative bycatch management measures. The model is based on catch and bycatch data collected in 1990 and 1991, and contains any management, regulatory or participatory actions which may have occurred in those years. For variables which are relatively homogenous across years, the 1990 and 1991 data will provide a reasonable simulation of what might be expected to occur in future years. For data such as annual bycatch levels for which there is a high degree of variability across years, however, the model may not accurately predict future conditions. Movement of effort into areas which were not heavily fished in 1990 or 1991 for a given target species will not be accurately predicted by the model.

Using the data provided for chinook salmon bycatch as an example, there was a high degree of spatial and temporal variability in bycatch numbers and rates between 1990 and 1991. The model averages across these two years as an attempt to smooth this variability. The means, however, will be less than the upper extremes, so that bycatch numbers and rates may be less than individual high numbers encountered in either of the two years. Given the rates used by the model, the number of chinook salmon predicted is less than the number encountered in 1991, the year with higher chinook salmon bycatch. The model is therefore not able to simulate future chinook salmon bycatch which exceeds the combination of 1990 and 1991 levels. Nor is the model able to predict the effect of caps which exceed these levels. Model runs that were made using only 1990 or only 1991 data eliminate part of this problem.

The model also uses economic information which can have a high degree of variability, so that accurate prediction of prices and recovery rates may be limited as well. The same is true for the ability of the model to predict the impact costs per unit of bycatch. Among the costs which are not included in the model analysis are the unknown costs of any threats to conservation of a resource which may occur as a result of bycatch. The economic estimates provided by the model may underestimate the cost of bycatch to the directed fisheries in the face of resource endangerment.

Vessel Incentive Program Assumptions

Two sets of alternatives were run under different vessel incentive program (VIP) assumptions. Under the first assumption, the VIP was considered to be effective in reducing bycatch rates for halibut and red king crab. Under the second alternative the VIP was assumed to have no effects.

In alternatives which assume an effective vessel incentive program, the model currently includes the Council recommended incentive program rate standards as indicated at the December, 1991 Council

meeting (see Appendix 1, Table 1). These rate standards are applied to halibut and red king crab bycatch. Although the vessel incentive program (VIP) is not currently in place for all of the fisheries as recommended by the Council, it is assumed in the runs including the VIP, that the guidelines would be in place during the 1993 fishing year.

The effect of the VIP is approximated in the model by dropping any monthly vessel observations with a bycatch rate which is greater than double the standard rate in a given fishery and month. Since this occurs before mean estimates are made within the model, this has the same effect as assuming that individuals exceeding the VIP by twice the standard rate would recognize the bycatch rate as excessive and would consequently behave as those who did not exceed the standard. This assumes that the VIP is effective in altering fishing behavior and thus bycatch rates.

Season Delay

It is assumed in all alternative runs of the model that the groundfish season would, as in 1992, be delayed for all trawl fisheries by three weeks. Fishing for all targets was delayed through the week ending January 21. Similarly, the flatfish fishery was delayed until May 1 in all model runs.

Inshore/Offshore

The inshore/offshore apportionment of groundfish was not included in model runs. There were two reasons for not including the inshore/offshore component. First, the inshore/offshore allocations are not defined for 1993. Second, it was unclear how prohibited species were to be apportioned to the inshore and offshore components.

Model Sequence

Summary:

In summary, data for the years 1990 and 1991 were retrieved from weekly processor reports, weekly observer reports, the processor annual reports, and various economic information. The aggregated data served as the base for a SAS model which simulated weekly fishing activity in the Bering Sea. Output from simulations provided measures by which to compare the effects of various alternative management actions. Model output includes total groundfish catch, gross and net wholesale value, total retained catch, and total bycatch and wholesale value of prohibited species for each target fishery.

Simulation Data set:

Weekly processor data is available by three digit statistical area. Recent management measures, however, require that closures occur within only a subsection, or sub-area of the three digit area. An example of a subarea is the winter herring savings area which comprises a portion of area 521. In order to apportion catch and bycatch within smaller sub-areas, observer data from 1990 and 1991 were summarized by the NMFS Alaska Fisheries Science Center (AFSC) for each 1/2 degree latitude by 1 degree longitude block in each year. For each month and fishery, the bycatch rate for each species (weight or number divided by the total groundfish catch in metric tons) and the total groundfish catch from each subarea and area were calculated. The ratio of bycatch rates and total groundfish catch from a subarea to the catch and bycatch from the larger three digit statistical area was determined. These values were used to assign catch and bycatch from the weekly processor reports to subareas.

The main data set was also supplied by NMFS AFSC and contained catch information from weekly processor reports for both 1990 and 1991 and preliminary value information from the annual processor survey for 1991. For each target species in each area, the data set had total groundfish catch, total retained catch, retained and discarded catch by species, weight (kilograms) of Pacific herring and Pacific halibut, numbers of red king and C. bairdi Tanner crab, and numbers of chinook and other salmon. Data identifiers are year, month, day, vessel id, processor type, area, gear, and target fishery. Wholesale price information was based on the NMFS and CFEC 1991 groundfish processor annual survey. The target fisheries were as defined for mid-water pollock, bottom trawl pollock, Atka mackerel, arrowtooth flounder, bottom trawl Pacific cod, fixed gear for sablefish, fixed gear for Pacific cod, yellowfin sole, rock sole, flatfish, rock fish, trawl for sablefish, and Greenland turbot.

The data were summarized into a template consisting of the proportion of the total groundfish catch each fishery, month, subarea (calculated with auxiliary data as discussed above) and type (inshore or offshore - not currently used in the model) contributed as an average of 1990 and 1991 data. These proportions were then multiplied by the total TAC for 1992 which created the simulation data set for 1993.

The specific steps used in creating the simulation data set from 1990 and 1991 weekly observer data were as generally follows: 1) input data from 1990 and 1991 separately, discarding observations with 0 total catch; 2) delete all trawl observations prior to January 22 in each year; 3) determine vessels in a month and fishery which had exceeded the VIP and drop these observations; 4) using an iterative process, assign all catch in area 515 to area 518 or area 519 based on 1990 and 1991 values for fisheries, quarters, and months; 5) calculate the mean catch by species over years, and calculate bycatch rates and species catch as proportions of the total groundfish catch in a month, fishery and subarea; 6) using an iterative process with the 1991 data, calculate herring bycatch for 1990 data which was previously missing and calculate the means as for the other species; 7) calculate the amount of catch and bycatch in each subarea using auxiliary information; 8) calculate the total groundfish catch over all months, fisheries and subareas, and determine the proportion represented by each month, fishery and subarea; 9) multiply each of these proportions by the total allowable catch for the entire BSAI area to calculate the proportion of the TAC given each month, fishery and subarea; 10) within each fishery, month and subarea, calculate the total retained and discarded catch by species based on proportions calculated previously.

This simulation data set changed for different versions of the VIP discussed above. In order to simulate the effect of the VIP, individual observations of a year, month, fishery and vessel (summed over weeks) were dropped if the vessel had exceeded the VIP standard rates by 100%. The dropped observations varied with the alternative of the VIP under consideration as discussed above.

Simulation Model:

After construction of the simulation data set, the simulation model was run using the catch numbers and bycatch rates provided by the simulation data set. The simulation model approximated fishing activity and management actions on a weekly basis in each fishery by dividing the monthly catch values into four equal parts. In each month, four model iterations prosecuted one quarter of the monthly catch each, roughly simulating 4 fishing weeks per month. In each iteration, catch and bycatch in each subarea was calculated and added to the totals from previous weeks. Catch and bycatch were allowed to accumulate in each subarea until either a prohibited species cap, or a TAC was attained. If a subarea was closed within a week, the catch which was foregone due to the closure was apportioned to all of the subareas which remained open to that particular fishery. If no subareas

remained open to a fishery, the catch was not redistributed to other fisheries.

The rules of closures were as stipulated in the 1992 regulations. TACs and prohibited species catch are as currently in place or as expected to be implemented in the 1993 fishery (see Appendix 1, Tables 2 and 3).

Economic Model:

After output from the fishery simulation model, the data was input into an economic model. The economic effect of bycatch on the trawl and fixed gear fisheries, and on the fisheries that harvest the bycatch species as target species, was estimated in terms of foregone wholesale value and foregone wholesale value net of variable costs. The impacts on five bycatch species, halibut, herring, red king crab, C. bairdi Tanner crab, and chinook salmon, were evaluated.

The economic model used the assumptions about recovery factors, wholesale prices, and trawl variable cost proportions, that were used in the late 1991 analysis of Amendments 19 and 24. The estimates of the foregone catch factors and variable cost proportions in the impact model, and the estimate of the variable cost proportion for fixed gear, were updated and some changes were made. The calculations for these are detailed below.

New Fixed Gear Costs

In January, 1992, the Alaska Fisheries Science Center collected survey data about the operating costs of four freezer longliners. Three of these observations came from longlining firms and one came from a lending institution. Three of these observations were used to estimate variable cost percentages for the fixed gear fleet. Variable costs were estimated to be 72% of gross revenues for the fixed gear fleet (Baldwin, 1992).

Foregone catch factors

For each fishery the factors that convert the reduced bycatches of fish into increased directed harvests in targeted fisheries are based on assumptions about the length of time until fish that escape the bycatch enter the directed fishery, the natural mortality rate, the growth of individual fish, the social rate of discount, and for salmon only the extent of migration out of U.S. waters. The social rate of discount is assumed to be 5% in this analysis.

The foregone catch for halibut was estimated assuming that a one pound reduction in bycatch mortality in one year would reduce halibut harvests over the next nine years by about 1.6 pounds. This is based on International Pacific Halibut Commission estimates of the changes in the yield associated with a given decline in the bycatch mortality. After discounting these changes using the 5% rate, the result was that a one ton change in halibut bycatch would produce a 1.32 metric ton change in targeted fishery metric tonnage "value" (Sullivan, 1990).

The bycatch of halibut in the trawl fishery is composed of fish that average about four years old. The halibut fishery is targeted on eight to thirteen year old fish. The long run impact on the halibut fishery harvest is composed of two parts: an "adult reproductive compensation" effect and an "adult equivalent loss in catch" effect.

The adult reproductive compensation effect is a "factor which, when multiplied by the bycatch in biomass, will indicate the amount that the allowable catch in biomass must be reduced to maintain

the reproductive potential of the stock at the level that would have been attained had no bycatch occurred" (Sullivan, 1990, p.36). The IPHC maintains the reproductive potential by reducing the halibut fishery harvest in year two to compensate for bycatch in year one. A one pound bycatch of younger fish is compensated for in the next year by a one pound reduction in the halibut fishery harvest of older fish.

The reduction in this harvest of older fish in year two allows those eight to thirteen years old to remain in the water. The survival of the older fish through year two allows the commission to let fishermen take about 0.6 pounds of additional harvest in years three through seven. This is an average of 0.15 pounds per year. The reduction of harvest in year two, and the partially offsetting increase in harvests in years three through seven, is the "adult reproductive compensation" effect.

The four years old taken in the bycatch would have been taken in the halibut fishery as eight to thirteen years old four to nine years later. Each pound of bycatch in year one, therefore, deprives the halibut fishery of about 1.2 pounds of harvest during years four to nine. This is about 0.2 pounds per year during that period. This is the "adult equivalent loss in catch" effect.

The foregone catch for herring was estimated assuming that the herring were harvested as bycatch about six months before they would have been taken in the sac roe fisheries. A one ton change in bycatch was converted to a 0.88 ton change in sac roe harvests to account for natural mortality, individual fish growth, and the social rate of discount during the six months. This factor was calculated using Togiak mortality and growth rate assumptions obtained from the ADF&G 1992 herring forecast and from a 1990 paper on Togiak herring (Funk, 1992).

The red king crab impact factor was calculated in the following way.

> In 1989 the average weight of red king crab taken as by-catch in the Bering Sea was 3.2 pounds; a crab of that weight is about seven years old. On this basis an assumption of convenience was made that all red king crab bycatch was taken at age seven.
>
> Information on weight at age and on instantaneous natural mortality rates was used to calculate the number of pounds of lost target catch of red king crab per 1,000 crabs of bycatch. This was done twice; first on the assumption that the red king crabs were harvested by the target fishery at age eight and second on the assumption that they were harvested at age ten.
>
> If red king crabs were taken in the targeted fishery at age eight, one year of aging would remain, and 1,000 crabs of bycatch would translate into 3,602 pounds of targeted catch. If red king crabs were taken in the targeted fishery at age ten, three years of aging would remain, and 1,000 crabs of bycatch would translate into 4,183 pounds of targeted catch. The weight of the lost catch was discounted by 5%. The discounted value of the 1,000 crab bycatch, if the target age was eight years old, is $3,602 \div (1.05)^1$ or 3,430 pounds. The discounted value of the 1,000 crab bycatch if the target age was ten years is $3,602 \div (1.05)^3$ or 3,613 pounds.
>
> A simple average of the two discounted values is about 3,500. Divided by 1,000 crabs, this gives a targeted fishery increase of 3.5 pounds of crab for every one crab bycatch reduction.

A similar process was used to calculate the impact factor for C. bairdi Tanner crab.

The foregone salmon factor will be calculated in the following way: (1) assume a bycatch of 1,000 fish; (2) deduct migration out of U.S. waters; (3) calculate the length of time between bycatch and impact; (4) deduct natural mortality for this period; (5) multiply remaining number of fish by average weight of fish when they return; (6) discount by 5% per annum; and (7) divide by 1,000.

About 14% of the fish taken as bycatch are from Asia, so of 1,000 fish escaping the bycatch about 860 are from North America. On average the fish are expected to return to the salmon fishery a year after they escape the bycatch. If the natural mortality is 10% a year, the returns of chinook salmon drop from 860 to 774. The fish are assumed to weigh 18 pounds each when they enter the salmon fisheries. Thus the total weight returning is 13,932 pounds. Discounting one year using a five percent discount rate gives 13,269 pounds. Dividing by 1,000 fish gives a foregone catch factor of 13.269 pounds for each salmon taken as bycatch.

Variable Cost Ratios

The variable cost percentages were developed using the FEAM model designed by Jensen and Radtke. Jensen and Radtke gathered their original information from industry sources under contract to the Council in 1988-89 and delivered the model in mid-1989. The groundfish portions of the models were updated at the Council in 1989-90 using information from the OMB groundfish survey (Cornelius, 1992).

Variable cost proportions for each species were developed for a specific type of vessel delivering to a specific type of processor. FEAM model parameters were used in the following way to calculate the variable cost proportions.

Sum up the processor's labor, direct materials, and manufacturing overhead costs in cents per pound.

Use the ex-vessel price from the processor's parameters and the percentage crew share to calculate the harvester's labor costs in cents per pound.

Sum up the harvester's costs in cents per pound.

Divide the harvester's costs in cents per pound by the yield for the processor to get the actual harvester's costs per pound of final product

Add up the processor's and harvester's costs and divide by the wholesale price. The result is the variable cost ratio.

The C. bairdi Tanner crab and red king crab ratios were calculated using a FEAM SS1 type processor at Dutch Harbor, and a king crab vessel delivering to Dutch Harbor. Halibut ratios were calculated for a longliner (FEAM vessel type "3") delivering to a FEAM SS1 processor at Dutch Harbor.

The herring ratio was calculated using data for a freezer-processor. The FEAM model does not contain any model for a Western Alaska harvester taking sac roe herring. The variable costs for a Western Alaska fishing operation taking sac roe herring have been estimated from data on operating costs and crew shares contained the McDowell Group "Alaska Seafood Industry Study" (McDowell, 1989). This report provides information on variable expenses in the Norton Sound, Nunivak, Security Cove, Togiak, Kuskokwim, and Yukon sac roe herring gill net fisheries, and on the Togiak sac roe

herring seine fishery in 1986. These data were updated into 1989 dollars where appropriate using the GNP price deflator and combined with 1989 gross earnings and average harvest information to produce estimates of average 1989 variable costs.

The FEAM variable processing costs, ex-vessel and wholesale prices, and yields for fresh frozen chinook salmon did not vary by the size of the fresh frozen plant, or by region of the state (for Kodiak and west). This information was used to calculate the price per pound for the manufacture of fresh-frozen chinook salmon. The information for these calculations came from the NPCAK version of the FEAM model. The FEAM model does not provide models of gillnet operations for the AYK region. It does provide a model of a Bristol Bay drift gillnet operation and a model of a generic set net operation. The fishing costs per pound for each of these types of operations were calculated from the parameters of the FEAM model and averaged.

Appendix 1 Table 1. Council Recommendations for the 1992 Vessel Incentive Program

Fishery and quarter	Halibut (as a % of Groundfish)	Red King Crab (number of animals per mt groundfish)	Chinook Salmon (number of animals per mt groundfish)
1 G. Turbot, A. Flounder & Sablefish			
First Quarter	**Bycatch Only	n/a	0.02/mt
Second Quarter	All Quarters**		0.02/mt
2 Yellowfin Sole			
First Quarter	none	2.5/mt	0.02/mt
Second Quarter	0.5%	2.0/mt	0.02/mt
3 Rock Sole & O. Flatfish			
First Quarter	2.0%	2.5/mt	0.02/mt
Second Quarter	1.6%	2.5/mt	0.02/mt
4 Pacific Cod			
First Quarter	3.0%	n/a	0.02/mt
Second Quarter	2.5%		0.02/mt
5 Rockfish			
First Quarter	2.0%	n/a	0.02/mt
Second Quarter	2.0%		0.02/mt
6 Other*			
First Quarter	0.5%	n/a	0.02/mt
Second Quarter	0.5%		0.02/mt
7 Pollock, Midwater			
First Quarter	0.1%	n/a	0.02/mt
Second Quarter	0.1%		0.02/mt

Appendix 1 Table 2. 1992 Council Recommended Groundfish Specifications (mt)

Species	Area	Seasons\1	ABC	TAC	ITAC\2	Seasonal Allowances	DAP
Pollock	EBS		1,490,000	1,300,000	1,105,000		1,105,000
		Roe (1/20-4/15)			442,000	40%	442,000
		Non-Roe (6/1-12/31)			663,000	60%	663,000
	AI		51,600	51,600	43,860		43,860
	518		25,000	1,000	850		850
Pacific cod			182,000	182,000	154,700		154,700
Yellowfin sole			372,000	235,000	199,750		199,750
Greenland turbot			7,000	7,000	5,950		5,950
Arrowtooth flounder			82,300	10,000	8,500		8,500
Rock sole			260,800	40,000	34,000		34,000
Other flatfish			199,600	79,000	67,150		67,150
Sablefish	EBS		1,400	1,400	1,190		1,190
	AI		3,000	3,000	2,550		2,550
POP complex							
True POP	EBS		3,540	3,540	3,009		3,009
Other POP complex	EBS		1,400	1,400	1,190		1,190
True POP	AI		11,700	11,700	9,945		9,945
Sharp/Northern	AI		5,670	5,670	4,820		4,820
Short/Rougheye	AI		1,220	1,220	1,037		1,037
Other rockfish	EBS		400	400	340		340
	AI		925	925	786		786
Atka mackerel			43,000	43,000	36,550		36,550
Squid			3,600	2,000	1,700		1,700
Other species			27,200	20,000	17,000		17,000
BS/AI TOTAL			2,773,355	1,999,855	1,699,877		1,699,877

\1 Only the EBS pollock fishery is seasonally apportioned

\2 Recommended TAC less 15% reserve

Appendix 1 Table 3. Council Recommendations for Apportionments to PSC Categories
1992 BSAI Trawl Fisheries

Fishery Group	Halibut, Primar (mt)		Halibut, 2nd (mt)		Herring (mt)	Red King Crab Zone1		C. baird Zone1		C. bairdi Zone2	
1 G. Turbot, A. Flounder & Sablefish	0		0		0	0		0		0	
2 Yellowfin Sole	743		849		134	75,000		100,000		1,225,000	
May-July		50%		50%							
August - December		50%		50%							
3 Rock Sole & O. Flatfish	660		755		0	85,000		700,000		300,000	
First Quarter		75.0%		75.0%							
Second Quarter		12.5%		12.5%							
Third Quarter		12.5%		12.5%							
Fourth Quarter		0%		0%							
4 Pacific Cod	2,063		2,359		29	10,000		100,000		712,500	
First Quarter		60%		60%							
Second Quarter		30%		30%							
Third Quarter		10%		10%							
Fourth Quarter		0%		0%							
5 Rockfish	330		377		10	0		0		50,000	
First Quarter		10%		10%							
Second Quarter		30%		30%							
Third Quarter		60%		60%							
Fourth Quarter		0%		0%							
6 Other*	605		692		210	30,000		100,000		712,500	
Pollock 'A' Season		32%		32%			32%		32%		32%
Pollock 'B' Season		68%		68%			68%		68%		68%
7 MW Pollock (Herring)		n/a	n/a		574	n/a		n/a		n/a	
TOTAL	4,400		5,033		956	200,000		1,000,000		3,000,000	

* "Other" group includes b.t. pollock, m-w pollock, Atka mackerel, and other.

Appendix 1 Table 4. Estimated Bycatch Impact Cost

	Halibut	Herring	Red King Crab	Bairdi Crab	Chinook Salmon
Foregone catch	1.32	0.88	3.50	0.76	13.27
Recovery factor	0.75	1.00	0.66	0.66	0.80
Wholesale price	$2.52	$0.75	$9.37	$3.50	$4.44
Foregone gross wholesale value	$5,500.09	$1,455.05	$21.64	$1.76	$35.35
Variable cost proportion	0.47	0.49	$0.54	0.61	0.42
Foregone net wholesale value	$2,915.05	$742.08	$9.96	$0.68	$20.50

Notes: Foregone catch is in metric tons per metric ton of bycatch for halibut and herring, and in pounds per animal of bycatch for crab and salmon. Wholesale prices are dollars per pound. Variable cost proportions show the proportion of the wholesale value spent on variable costs.

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