MEMORANDUM

TO: Council, AP, and SSC Members

FROM: Clarence G. Pautzke
Executive Director

DATE: December 3, 1992

SUBJECT: Bering Sea/Aleutian Islands Groundfish Specifications for 1993

ACTION REQUIRED

(e) Approve the following:

1. The EA for 1993 groundfish specifications for BSAI;
2. The Stock Assessment and Fishery Evaluation (SAFE) report;
3. Final BSAI groundfish and bycatch specifications for 1993 including:
   - Annual Total Allowable Catch (TAC) and initial TAC (ITAC), and domestic annual processing (DAP)
   - Division of the pollock ITAC into the January 1-April 15 ('A' Season) and June 1-December 31 ('B' Season) allowances
   - Amount of the pollock TAC that may be taken with bottom trawls
   - Bycatch allowances, and seasonal apportionments of red king crab, Tanner crab, Pacific halibut, and herring to trawl and non-trawl target fishery (PSC) categories

(f) Recommend Vessel Incentive Program (VIP) bycatch rate standards for the first two quarters of the 1993 GOA and BSAI trawl fisheries.

BACKGROUND

Environmental Assessment for 1993 Groundfish Specifications

The specifications process now includes Council review and approval of an Environmental Assessment/Regulatory Impact Review/Initial Regulatory Flexibility Analysis (EA/RIR/IRFA) assessing potential impacts to the marine environment of the Council's proposed groundfish specifications. NMFS has prepared this analysis and will distribute it at this meeting. The public will be able to comment on the analysis this week, and, after this meeting, final EAs will be prepared based on the Council's final specifications. When the final specifications are published in the *Federal Register*, probably in late January, the final EAs will be made available for further public review.

SAFE Document

The Bering Sea/Aleutian Islands Groundfish Plan Team met in Seattle on November 16-20 to prepare the final SAFE report for the 1993 fisheries. This report was sent to you on November 27, 1992. It incorporates 1992 catch to date and survey data and analyses, and therefore differs from September's preliminary SAFE. Item D-1(e)(1) has Tables 6 - 8 from the SAFE's Executive Summary summarizing the biomass, ABCs, and stock status compared to 1992. The Plan Team's sum of recommended ABCs for 1993 is 2.8 million mt (The Council recommended 2.77 million mt for 1992). The largest changes in ABC include an increase of 308,000 mt for Atka mackerel, an increase of 144,000 mt for Bogoslof pollock, a decrease of 75,800 mt for Rock sole, and a decrease of 55,000 mt in the Pacific cod ABC. Note these comparisons are relative to the Council's 1992 recommendations, not the Plan Team's 1992 recommendations. Overall, the status of the stocks continues to appear relatively favorable.

The 1993 SAFE includes a new section titled "ecosystem considerations" located in the summary chapter. This section, drafted by the Plan Teams, represents the Teams' intent to view fisheries management from a holistic perspective, rather than by individual species.

Adopt Proposed Initial ABCs, TACs and Apportionments for 1993

Item D-1(e)(2) is a table indicating 1992 ABCs, TACs, and catch statistics. The Council's preliminary specifications from September are attached as Item D-1(e)(3). Item D-1(e)(4) is a worksheet on which final 1993 specifications can be filled in. It includes the Plan Team's 1993 ABCs. This worksheet will be updated with recommendations of the SSC and AP during the Council meeting.

Adopt Proposed Seasonal Allowances for the Pollock Seasons

The FMP requires the Council to apportion pollock in the BSAI between the roe (January 1 - April 15) and non-roe (June 1 - December 31) seasons, as indicated in the worksheet, Item D-1(e)(4). For the past two years and also at the September 1992 meeting, the Council has recommended a 40/60 percent split between the roe and non-roe seasons.

In recommending seasonal allowances of the BSAI pollock TAC, the Council will need to consider the following factors:

1. Estimated monthly pollock catch and effort in prior years;

2. Expected changes in harvesting and processing capacity and associated pollock catch;

3. Current estimates of and expected changes in pollock biomass and stock conditions, conditions of marine mammal stocks, and biomass and stock conditions of species taken as bycatch in directed pollock fisheries;

4. Potential impacts of expected seasonal fishing for pollock on pollock stocks, marine mammal stocks, and stocks of species taken as bycatch in directed pollock fisheries;

5. The need to obtain fishery-related data during all or part of the year;

6. Effects on operating costs and gross revenues;

7. The need to spread fishing effort over the year, minimize gear conflicts, and allow participation by various elements of the groundfish fleet and other fisheries;

8. Potential allocative effects among users and indirect effects on coastal communities; and,

9. Other biological and socioeconomic information that affects the consistency of seasonal pollock harvests with the goals and objectives of the FMP.

Information on these factors is presented in Appendix D of the 1993 SAFE document. Also at this meeting, the Council will consider a proposal to change the start date of the 'B' season (see Agenda Item D-2a).

Adopt Amounts of Pollock That Could Be Taken With Bottom Trawls

To control the bycatch of crab and halibut, the Council implemented Amendment 16a, which provided for the apportionment of pollock to pelagic trawl gear (i.e., set a limit on the amount of pollock that can be taken in the bottom trawl pollock fishery). In approving this amendment for Secretarial Review in 1990, the Council adopted the 88%-12% split (midwater-bottom trawl) recommended by the Region. The actual percentages from the 1990 fishery were 89%-11%. For 1991, the Council noted that additional pollock harvests with non-pelagic trawl gear likely would be constrained by halibut bycatch, and did not recommend a specific apportionment between pelagic and non pelagic gear. For 1992, the Council again did not recommend a specific apportionment between pelagic and non pelagic gear, primarily because non-pelagic trawl gear took less than 6 percent of the total pollock TAC in 1991.

For the 1992 pollock fishery, this trend did not continue. During the first season of the 1992 pollock fishery, non-pelagic trawl gear accounted for over 13 percent of the total pollock catch. In addition, due to the unexpectedly high bycatch amounts of halibut experienced during January and February, 1992 in the pollock fishery, the Council held a teleconference on February 26, 1992 and recommended that NMFS implement an emergency rule prohibiting the use of non-pelagic trawl gear for the 1992 pollock 'B' season in an attempt to reduce halibut bycatch.

Regulations require that pollock allocations to non pelagic trawls be based on the following types of information:

1. Bycatch allowances of PSC species;

2. Projected bycatches of prohibited species that might occur with and without constraining amounts of pollock taken with non pelagic trawls; and

3. Costs of a limit in terms of amounts of pollock TAC that may be taken with bottom trawls on the non pelagic trawl fisheries.

Adopt Proposed Bycatch Allowances of Pacific Halibut, Red King Crab, Tanner Crab (C. bairdi), and Herring, and Seasonal Allowances

Halibut PSCs

The Council will propose for public review bycatch allowances of halibut based on discard mortality rates to both the trawl fishery categories and the non-trawl fishery categories. Adoption of Amendment 21 establishes a 3,775 mt limit on halibut mortality for trawl gear and a 900 mt halibut mortality limit for the non-trawl fisheries. The trawl gear halibut mortality limit can be apportioned to the following BSAI fishery categories:

1. Greenland turbot, arrowtooth flounder and sablefish;
2. rock sole and 'other flatfish';
3. yellowfin sole;
4. rockfish;
5. Pacific cod; and,
6. pollock, Atka mackerel and 'other species'.

The 900 mt non-trawl gear halibut mortality limit can be apportioned to the following BSAI fishery categories:

1. Pacific cod;
2. Other non-trawl (includes hook and line sablefish, rockfish and jig gear); and,
3. Groundfish pot (recommended exempt for 1993 at the September meeting)

At the September meeting the Council recommended the 1992 halibut PSC allowances and seasonal apportionments as preliminary 1993 allowances for trawl gear. The Council also recommended preliminary 1993 non-trawl allowances and seasonal apportionments. Item D-1(e)(5) is a table indicating these PSC allocations and seasonal apportionments. Item D-1(e)(6) is a worksheet on which final 1993 PSC apportionments can be filled in as the meeting proceeds.

Note that the September 1992 halibut PSC recommendations were based on 75 percent and 16 percent discard mortality rates for the trawl and hook and line fisheries, respectively. The Council may wish to consider the effects of fishery specific discard mortality rates, as recommended by the IPHC, when apportioning halibut PSC among the different PSC fishery categories.

Crab PSCs

Overall crab PSC limits adopted by the Council in Amendment 16 are:

C. bairdi:	1,000,000 crabs in Zone 1 for a Zone 1 closure 3,000,000 crabs in Zone 2 for a Zone 2 closure
Red king crab:	200,000 crabs in Zone 1 for a Zone 1 closure

Zone 1 is comprised of Areas 511, 512 and 516. Zone 2 is comprised of Areas 513, 517 and 521. The Council adopted preliminary crab PSC apportionments in September as indicated in Item D-1(e)(5), and will need to recommend final apportionments at this meeting.

Herring PSC

Amendment 16a established an overall herring PSC bycatch cap of 1 percent of the EBS biomass of herring. This cap is to be apportioned to the same six PSC fishery categories listed above, plus a seventh group, mid-water pollock (see Item D-1(e)(5)). The Alaska Department of Fish and Game will provide the Council with 1993 biomass estimates from their 1993 forecast at this meeting.

Regulations require that seasonal apportionments of bycatch allowances be based on the following types of information:

1. Seasonal distribution of prohibited species;
2. Seasonal distribution of target groundfish species relative to prohibited species distribution;
3. Expected prohibited species bycatch needs on a seasonal basis relevant to change in prohibited species biomass and expected catches of target groundfish species;
4. Expected variations in bycatch rates throughout the fishing year;

5. Expected changes in directed groundfish fishing seasons;

6. Expected start of fishing efforts; and

7. Economic effects of establishing seasonal prohibited species apportionments on segments of the target groundfish industry.

Information on these factors is presented in Appendices C and E in the BSAI SAFE.

Bycatch Rate Standards for the Vessel Incentive Program (VIP)

Under Amendment 19/24, the VIP has been expanded to include all trawl fisheries in both the BSAI and GOA. The new VIP fishery categories are as follows:

BSAI Fishery	PSC Species
Midwater Pollock	Halibut (as a % of groundfish catch)
Bottom Pollock	Halibut
Yellowfin Sole	Halibut Red king crab (# of crab/ton groundfish catch)
Other Trawl	Halibut Red king crab

GOA Fishery	PSC Species
Midwater Pollock	Halibut
Other Trawl	Halibut

Note that regulations specify that the vessel incentive program for the midwater pollock fishery becomes effective after the directed fishery for pollock by trawl vessels using non-pelagic trawl gear is closed.

At this meeting, NMFS will provide an analysis of bycatch rates observed during the past two years for these fishery categories which will be useful in establishing rate standards. The Council will need to recommend to the Regional Director the bycatch rate standards for these categories for the first two quarters of the 1993 fishery. Item D-1(f)(1) provides the 1992 VIP bycatch rate standards and observed bycatch rates.

Table 6-- Summary of stock abundance, overfishing constraints, and fishing mortality rates for the eastern Bering Sea (EBS), Aleutian Islands (AI), and Bogoslof district (518) in 1993. Biomass and catch are in metric tons.

Species	Area	Biomass[a]	C_{OF}[b]	F_{OF}[c]	F_{ABC}[d]
Walleye pollock	EBS	5,900,000[e]	1,340,000	0.37	0.37
	AI	196,000	62,600	0.45	0.42
	518	650,000	196,000	0.40	0.33
Pacific cod		655,000	142,000	0.14	0.12
Yellowfin sole		2,500,000	275,000	0.12	0.11
Greenland turbot		292,000[f]	10,500	0.04	0.03
Arrowtooth flounder		480,000	96,000	0.25	0.18
Rock sole		1,550,000	270,000	0.21	0.14
Other flatfishes		1,250,000	228,000	0.22g	0.18[g]
Sablefish	EBS	13,400	2,000	0.17	0.12
	AI	23,600	3,400	0.17	0.12
POP complex					
True POP	EBS	59,700	3,750	0.07	0.06
Others[h]	EBS	29,700	1,400	0.05[g]	0.05[g]
True POP	AI	260,000	16,800	0.07	0.06
Sharp/Northern[i]	AI	94,500	5,670	0.06	0.06
Short/Rougheye[j]	AI	45,000	1,220	0.03	0.03
Other rockfish	EBS	8,000	400	0.05	0.05
	AI	18,500	925	0.05	0.05
Atka mackerel		1,170,000	771,000	0.51	0.24
Squid		n/a[k]	3,400	n/a[k]	n/a[k]
Other species		780,000	156,000	0.20	0.04

a. Projected exploitable biomass for January, 1993.
b. Maximum 1993 catch level allowable under overfishing definition.
c. Maximum fishing mortality rate allowable under overfishing definition.
d. Fishing mortality rate corresponding to acceptable biological catch.
e. B_{MSY} for walleye pollock is 6,000,000 t.
f. B_{MSY} for Greenland turbot is 439,000 t.
g. Weighted average of species-specific rates.
h. Sharpchin, northern, shortraker, and rougheye rockfish.
i. Sharpchin and northern rockfish
j. Shortraker and rougheye rockfish.
k. Not available.

Table 7-- Estimates of maximum sustainable yield (MSY) and acceptable biological catch (ABC) for 1992 and 1993 for groundfish in the eastern Bering Sea (EBS), Aleutian Islands (AI), and Bogoslof district (518). Where current MSY estimates encompass a range of values, the midpoint has been listed. Figures are in metric tons. Column totals are reported to three significant digits.

Species	Area	MSY[a]	ABC(1992)	ABC(1993)
Walleye pollock	EBS	1,880,000	1,490,000	1,340,000
	AI	145,000	51,600	58,700
	518	n/a[b]	25,000	169,000
Pacific cod		n/a[b]	182,000	127,000
Yellowfin sole		268,000	372,000	238,000
Greenland turbot		23,400	7,000	7,000
Arrowtooth flounder		62,800	82,300	72,000
Rock sole		184,000	260,800	185,000
Other flatfish		151,000	199,600	191,000
Sablefish	EBS	4,800	1,400	1,500
	AI	6,100	3,000	2,600
POP complex				
True POP	EBS	n/a[b]	3,540	3,330
Others[c]	EBS	n/a[b]	1,400	1,400
True POP	AI	n/a[b]	11,700	13,900
Sharp/Northern[d]	AI	n/a[b]	5,670	5,670
Short/Rougheye[e]	AI	n/a[b]	1,220	1,220
Other rockfish	EBS	n/a[b]	400	400
	AI	n/a[b]	925	925
Atka mackerel[f]		n/a[b]	43,000	351,000
Squid		10,000	3,600	3,400
Other species		62,900	27,200	26,600
Groundfish complex		2,800,000	2,770,000	2,800,000

a. Maximum sustainable yield (note: numbers in this column correspond to MSY estimates given by chapter authors, and may or may not be endorsed by the Plan Team).
b. Not available.
c. Sharpchin, northern, shortraker, and rougheye rockfish.
d. Sharpchin and northern rockfish.
e. Shortraker and rougheye rockfish.
f. The Plan Team recommends dividing the Atka mackerel ABC among four quadrants, as described in the text.

Table 8-- Summary of stock biomass, harvest strategy, 1993 acceptable biological catch (ABC), and stock condition for groundfish in the eastern Bering Sea (EBS), Aleutian Islands (AI), and Bogoslof district (518). Biomass and ABC are in metric tons.

Species	Area	Biomass[a]	Rate[b]	ABC	Relative abundance, trend
Walleye pollock	EBS	5,900,000	F_{MSY}	1,340,000	Average, declining
	AI	196,000	$F_{35\%}$	58,700	Average (?), declining
	518	650,000	$F_{35\%}$	169,000	Low, stable
Pacific cod		655,000	$F_{35\%}$	127,000	Average, declining
Yellowfin sole		2,500,000	$F_{35\%}$	238,000	High, stable
Greenland turbot		292,000	$F_{???}^{c}$	7,000	Low, declining
Arrowtooth flounder		480,000	$F_{35\%}$	72,000	High, stable
Rock sole		1,550,000	$F_{35\%}$	185,000	High, stable
Other flatfish		1,250,000	$F_{35\%}^{d}$	191,000	High, stable
Sablefish	EBS	13,400	$F_{35\%}^{e}$	1,500	Low, declining
	AI	23,600	$F_{35\%}^{e}$	2,600	Average, declining
POP complex					
True POP	EBS	59,700	$F_{35\%}$	3,330	Average, stable
Others[f]	EBS	29,700	$F=M^{d}$	1,400	Not available
True POP	AI	260,000	$F_{35\%}$	13,900	Average, stable
Sharp/Northern[g]	AI	94,500	$F=M^{d}$	5,670	Not available
Short/Rougheye[h]	AI	45,000	$F=M^{d}$	1,220	Not available
Other rockfish	EBS	8,000	$F=M$	400	Average, stable
	AI	18,500	$F=M$	925	Average, stable
Atka mackerel		1,170,000	$F=M^{i}$	351,000	High, stable
Squid		n/a[j]	F_{his}^{k}	3,400	Not available
Other species		780,000	$F=M$	26,600	High, increasing
Groundfish complex		15,975,400		2,800,000	High, declining

a. Projected exploitable biomass for January, 1993.
b. Harvest strategy used to compute ABC.
c. Harvest strategy for Greenland turbot is ad hoc.
d. Weighted average of species-specific rates.
e. Sablefish $F_{35\%}$ scaled by ratio of projected biomass to $B_{35\%}$.
f. Sharpchin, northern, shortraker, and rougheye rockfish.
g. Sharpchin and northern rockfish.
h. Shortraker and rougheye rockfish.
i. Ratio of catch to start-of-year biomass equals M (0.3); corresponding F is actually somewhat lower (about 0.24).
j. Not available.
k. Fishing mortality rate corresponding to the historic average catch.

BERING SEA/ALEUTIAN ISLANDS GROUNDFISH

1992 Council Recommended Groundfish Specifications (mt)

Species	Area	Seasons\1	ABC	TAC	ITAC\2	Seasonal Allowances	DAP	Catch as of 11/22/92
Pollock	EBS		1,490,000	1,300,000	1,105,000		1,105,000	1,255,748
		Roe (1/20-4/15)			442,000	40%	442,000	538,797
		Non-Roe (6/1-12/31)			663,000	60%	663,000	716,951
	AI		51,600	51,600	43,860		43,860	49,859
	518		25,000	1,000	850		850	128
Pacific cod			182,000	182,000	154,700		154,700	172,041
Yellowfin sole			372,000	235,000	199,750		199,750	119,588
Greenland turbot			7,000	7,000	5,950		5,950	1,622
Arrowtooth flounder			82,300	10,000	8,500		8,500	8,606
Rock sole			260,800	40,000	34,000		34,000	40,366
Other flatfish			199,600	79,000	67,150		67,150	28,854
Sablefish	EBS		1,400	1,400	1,190		1,190	567
	AI		3,000	3,000	2,550		2,550	1,423
POP complex								
True POP	EBS		3,540	3,540	3,009		3,009	3,044
Other POP complex	EBS		1,400	1,400	1,190		1,190	323
True POP	AI		11,700	11,700	9,945		9,945	9,819
Sharp/Northern	AI		5,670	5,670	4,820		4,820	1,041
Short/Rougheye	AI		1,220	1,220	1,037		1,037	1,247
Other rockfish	EBS		400	400	340		340	378
	AI		925	925	786		786	689
Atka mackerel			43,000	43,000	36,550		36,550	46,173
Squid			3,600	2,000	1,700		1,700	544
Other species			27,200	20,000	17,000		17,000	22,781
BS/AI TOTAL			2,773,355	1,999,855	1,699,877		1,699,877	1,764,841

\1 Only the EBS pollock fishery is seasonally apportioned

\2 Recommended TAC less 15% reserve (does not include in-season release of reserve)

Preliminary 1993 Council Recommendations for BSAI Groundfish Specifications (mt) September 1992

		1992	1993 Preliminary Recommendation			
Species	Area / Seasons\1	ABC	ABC\2	TAC	Seasonal Allowance	ITAC\3
Pollock	EBS	1,490,000	1,690,000	1,300,000		1,105,000
	Roe (1/20-4/15)				40%	442,000
	Non-Roe (6/1-12/31)				60%	663,000
	AL	51,600	67,000	51,600		43,860
	518	25,000	33,000	1,000		850
Pacific Cod		182,000	178,000	178,000		151,300
Yellowfin sole		372,000	372,000	200,000		170,000
Greenland turbot		7,000	7,000	7,000		5,950
Arrowtooth flounder		82,300	68,000	10,000		8,500
Rock sole		260,800	311,000	40,000		34,000
Other flatfish		199,600	226,000	79,000		67,150
Sablefish	EBS	1,400	1,400	1,400		1,190
	AL	3,000	3,000	3,000		2,550
POP complex						
True POP	EBS	3,540	2,100 - 3,540	2,100		1,785
Other POP Complex	EBS	1,400	1,400	1,400		1,190
True POP	AL	11,700	11,700 - 14,800	11,700		9,945
Sharp/Northern	AL	5,670	5,670	5,670		4,820
Short/Rougheye	AL	1,220	1,220	1,220		1,037
Other rockfish	EBS	400	400	400		340
	AL	925	925	925		786
Atka mackerel	BS/AI	43,000	117,100	32,000		27,200
Squid		3,600	3,400	2,000		1,700
Other Species		27,200	26,600	20,000		17,000
BS/AI TOTAL		2,773,355	3,126,915 - 3,131,455	1,948,414		1,656,153

/1 Seasonal allowances of pollock TAC are made after deduction for reserves
/2 Preliminary specifications subject to change upon incorporation of 1992 groundfish survey data
/3 Recommended TAC less 15% reserve

AGENDA D-1(e)(4)
DECEMBER 1992

BERING SEA/ALEUTIAN ISLANDS GROUNDFISH WORKSHEET

1993 Plan Team, SSC and AP Recommendations and Apportionments (mt)

Species	Area	Seasons	Council ABC 1992	Plan Team ABC 1993	SSC ABC 1993	Advisory Panal Seasonal Allowance	Advisory Panal TAC	Advisory Panal ITAC
Pollock	EBS		1,490,000	1,340,000				
		Roe						
		Non-Roe						
	AI		51,600	58,700				
	518		25,000	169,000				
Pacific cod	BS/AI		182,000	127,000				
Yellowfin sole	BS/AI		372,000	238,000				
Greenland turbot	BS/AI		7,000	7,000				
Arrowtooth flounder	BS/AI		82,300	72,000				
Rock sole	BS/AI		260,800	185,000				
Other flatfish	BS/AI		199,600	191,000				
Sablefish	EBS		1,400	1,500				
	AI		3,000	2,600				
POP complex								
True POP	EBS		3,540	3,330				
Other POP complex	EBS		1,400	1,400				
True POP	AI		11,700	13,900				
Sharp/Northern	AI		5,670	5,670				
Short/Rougheye	AI		1,220	1,220				
Other rockfish	EBS		400	400				
	AI		925	925				
Atka mackerel	BS/AI		43,000	351,000				
Squid	BS/AI		3,600	3,400				
Other species	BS/AI		27,200	26,600				
BS/AI TOTAL			2,773,355	2,799,645				

AGENDA D-1(e)(5)
DECEMBER 1992

Council Recommended Preliminary 1993 BSAI Trawl Fisheries Prohibited Species Bycatch Allowances (September 1992)

Fishery Group	Halibut, Primary (mt Mortality)*	Halibut, Secondary (mt Mortality)*	Herring (mt)	Red King Crab Zone1	C. bairdi Zone1	C. bairdi Zone2
Yellowfin sole	557	637	391	75,000	100,000	1,225,000
May 1 - Aug. 2		239				
Aug. 3 - Dec. 31		239				
Rocksole/other flatfish	495	566	0	85,000	700,000	300,000
Jan. 1 - Mar. 29		425				
Mar. 30 - June 28		71				
June 29 - Sept. 27						
Sept. 28 - Dec. 31		remainder				
Turbot/arrowtooth/sablefish	0	0	0	0	0	0
Jan. 1 - Dec. 31		0				
Rockfish	131	150	10	0	0	50,000
Jan. 1 - Mar. 29		15				
Mar. 30 - June 28		45				
June 29 - Sept. 27		90				
Sept. 28 - Dec. 31		remainder				
Pacific cod	1,007	1,153	29	10,000	75,000	712,500
Jan. 1 - June 28		976				
June 29 - Sept 27		177				
Sept. 28 - Dec. 31		remainder				
Pollock/mackerel/"o. species"	1,109	1,269	210	30,000	125,000	712,500
Jan. 1 - April 15		916				
April 16 - May 31		0				
June 1 - Dec. 31		353				
7 MW Pollock (Herring)	n/a	n/a	1,668	n/a	n/a	n/a
TOTAL	3,300	3,775	2,308	200,000	1,000,000	3,000,000

* Based on IPHC halibut mortality estimate for Trawl Gear of 75%

Council Recommended Preliminary 1993 BSAI Non-Trawl PSC Bycatch Allowances (September 1992)

Fishery Group	Halibut** (mt)	Seasonal Apportion %	(mt)
Pacific Cod	825		
Jan 1 - May 14		65%	536
May 15 - August 31		10%	83
Sept. 1 - Dec. 31		25%	206
Other Non-Trawl*	75		
Groundfish Pot	Exempt		
TOTAL	900		

* Includes Hook & Line Sable Fish, Rock fish and Jig

** Assumes IPHC mortality estimate for Hook & Line Gear of 16%

1993 BSAI Non-Trawl PSC Bycatch Allowances Worksheet

Fishery Group	Halibut (mt)	Seasonal Apportion %	(mt)
Pacific Cod	825		
Other Non-Trawl*	75		
Groundfish Pot	Exempt		
TOTAL	900		

* Includes Hook & Line Sable Fish, Rock fish and Jig

1993 BSAI Trawl Fisheries PSC Apportionments & Seasonal Allowances Worksheet

Fishery Group	Halibut, Primary (mt)	Halibut, Secondary (mt)	Herring (mt)	Red King Crab Zone1	C. bairdi Zone1	C. bairdi Zone2
Yellowfin sole May 1 - Aug. 2 Aug. 3 - Dec. 31						
Rocksole/other flatfish Jan. 1 - Mar. 29 Mar. 30 - June 28 June 29 - Sept. 27 Sept. 28 - Dec. 31						
Turbot/arrowtooth/sablefish Jan. 1 - Dec. 31						
Rockfish Jan. 1 - Mar. 29 Mar. 30 - June 28 June 29 - Sept. 27 Sept. 28 - Dec. 31						
Pacific cod Jan. 1 - June 28 June 29 - Sept 27 Sept. 28 - Dec. 31						
Pollock/mackerel/"o. species" Jan. 1 - April 15 April 16 - May 31 June 1 - Dec. 31						
7 MW Pollock (Herring)						
TOTAL	3,300	3,775	?	200,000	1,000,000	3,000,000

Table 1. 1992 bycatch rate standards and observed bycatch rates, by quarter, of halibut and red king crab in the fishery categories included in the expanded vessel incentive program.

Halibut Bycatch as a Percentage of Allocated Groundfish

Fishery and quarter	1992 Bycatch Rate Standards	1992 Observed Bycatch Rates
BSAI Midwater Pollock		
QT 1	-	0.148
QT 2	.	0.069
QT 3	0.1	0.046
QT 4	0.1	*****
Year to date		0.096
BSAI Bottom Pollock		
QT 1	.	0.861
QT 2	.	0.488
QT 3	0.5	0.185
QT 4	0.5	*****
Year to date		0.633
BSAI Yellowfin sole		
QT 1	-	*****
QT 2	-	0.329
QT 3	0.5	0.395
QT 4	0.5	*****
Year to date		0.357
BSAI Other Trawl Fisheries		
QT 1	-	1.256
QT 2	-	1.480
QT 3	3.0	0.461
QT 4	3.0	*****
Year to date		1.238
GOA Midwater Pollock		
QT 1	-	0.009
QT 2	-	0.006
QT 3	0.1	0.004
QT 4	0.1	*****
Year to date		0.007
GOA Other Trawl fisheries		
QT 1	.	1.965
QT 2	.	2.162
QT 3	5.0	2.519
QT 4	5.0	*****
Year to date		2.115

Zone 1 Red King Crab Bycatch Rates
(number of crab/mt of allocated groundfish)

Fishery and quarter	1992 Bycatch Rate Standards	1992 Observed Bycatch Rates
BSAI yellowfin sole		
QT 1	2.5	*****
QT 2	2.5	1.13
QT 3	2.5	*****
QT 4	2.5	*****
Year to date		1.13
BSAI Other Trawl		
QT 1	-	0.99
QT 2	-	1.60
QT 3	-	0.00
QT 4	-	*****
Year to date		1.02

North
Pacific
Longline
Association

AGENDA D-1(e) Supplemental
DECEMBER 1992

Agenda

DEC - 1 1992

December 1, 1992

Mr. Richard B. Lauber, Chairman
North Pacific Fishery Mangagement Council
P.O. Box 103136
Anchorage, AK 99510

RE: 1993 BSAI Cod ABC/TAC, Halibut PSC Specifications

Dear Rick:

The North Pacific Longline Association represents freezer-longliners who fish for groundfish in the Bering Sea/Aleutian Islands Area and the Gulf of Alaska. We would like to comment on the 1993 BSAI cod ABC and hook-and-line halibut PSC specifications.

__1993 ABC/TAC, BSAI Cod__

We were greatly surprised and alarmed by the recent announcement that the cod stock assessment model had been replaced by a "stock synthesis" model - which yielded a recommendation that the 1993 BSAI cod ABC be dropped by about 1/3 from its 1992 level, to 127,000 mt. The reason for our surprise was that we had been recently and consistently advised that the AFSC was confident in the model it had developed over the years, and that one year's trawl survey data would not cause much of a change from the 1992 ABC level. The reason for our alarm is that such a drastic cut in ABC/TAC would have a __very__ serious negative economic impact on fishermen who rely on cod.

Cod stocks have been declining in the BSAI because certain large year-classes are dying out, and because of poor recruitment in 1986-87-88. Recruitment for 1989 and 1990 appear to be better, though, and the 1991 and 1992 year classes are reported to be strong. The 1992 trawl survey actually indicated a slight increase in biomass, and biomass is projected to increase after 1993. It would appear that the biomass has "bottomed out" and will be on the increase in coming years. We would hope that under these circumstances it will not be necessary to reduce the 1993 exploitation rate and cod ABC/TAC so drastically.

4209 21st Avenue West, Suite 300, Seattle, Washington 98199
TEL: 206-282-4639; FAX: 206-282-4684

Halibut PSC Specifications

Halibut bycatch has proved to be a constraining factor in the BSAI cod fisheries for both hook-and-line and trawl fishermen. For this reason, the amount of halibut PSC apportioned to each gear group determines how much cod it can catch in a given season - PSC effectively allocates cod TAC. We are almost entirely dependent on this fishery. **Our position is that each gear group should receive an equal amount of halibut PSC for its BSAI cod fishery.**

The attached table by Fisheries Information Services indicates that even during the 1992 season when longliners encountered unprecedented numbers of halibut, our fishery caught more than 2 1/2 times as much cod per unit of halibut bycatch mortality as did the trawl fishery. The table also indicates that we were nearly three times as efficient in terms of other discards. When the trawlers are given more halibut PSC than we are, it seems to us that we are being penalized for being efficient in our use of halibut and other discards - or conversely, that they are being rewarded for being relatively inefficient. Considerations of fairness and equity suggest equal apportionments of halibut PSC in the BSAI cod fishery.

Seasonal Apportionment of Hook-and-Line Halibut PSC

At the September Council meeting our association asked that the seasonal BSAI cod TAC apportionment analysis be finished so that the wasteful summer fishery could be reduced or eliminated - and cod harvested in the fall when they are more valuable. As a corrolary, we asked that our halibut PSC be apportioned over the year. Since cod TAC will not be apportioned during 1993, there is no reason to apportion halibut PSC. **We withdraw our request for seasonal hook-and-line halibut PSC apportionment in 1993.**

Thank you for your attention.

Sincerely,

Thorn Smith

Thorn Smith

FIS
30/92

BERING SEA/ALEUTIAN ISLANDS PACIFIC COD TARGET FISHERIES

	1990			1991			1992*		
	H & L	POTS	TRAWL	H & L	POTS	TRAWL	H & L	POTS	TRAWL
GROUNDFISH MT	51,007	1418	178,075	69,792	4,361	94,287	104,740	12,077	66,232
PACIFIC COD %	92.6%	N/A	53.9%	88.1%	N/A	76.0%	85.9%	96.3%	60.4%
PACIFIC COD MT	47,232	N/A	95,982	61,511	N/A	71,661	89,948	11,632	39,982
HALIBUT MT	1,723	22	3,135	2,559	38	1,838	6,346	88	1,612
HALIBUT MORT %	16%	10%	100%	16%	10%	100%	16%	10%	75%
HALIBUT MORT. MT	276	2	3,135	409	4	1,838	1,015	9	1,209
CHINOOK SALMON N	7	N/A	4,466	41	0	3,675	53	0	401
RED KING CRAB NO.	N/A	N/A	N/A	76	2,713	178	2,769	142	128
B. TANNER CRAB NO.	N/A	N/A	N/A	8,286	52,482	364,851	17,201	197,796	167,050

*Preliminary Final

NOTES: CATEGORIES USED ARE DEFINED AS FOLLOWS:

1990 "O" - Pollock and Pacific cod >= 50%, Pacific cod >= 5% of retained catch
1991 "C" - Pacific cod is >= 45% of groundfish catch.
1992 "C" - Pacific cod is dominant species in retained catch

BYCATCH NUMBERS ARE EXTRAPOLATED NUMBERS USED BY NMFS INSEASON

SOME NMFS REPORTS ARE INCOMPLETE OR UNAVAILABLE

#15

10/30/92 RATE CALCULATIONS
(HALIBUT MORT. MT / MT COD)

1990

H & L	TRAWL	TRL/H&L
0.0058	0.0327	5.60

1991

H & L	TRAWL	TRL/H&L
0.0067	0.0256	3.85

1992*

H & L	TRAWL	TRL/H&L
0.0113	0.0302	2.68

4

REPORTED GROUNDFISH DISCARDS

1990

	H & L	TRAWL	TRL/H&L
CATCH	51,007	178,075	
DISCARD	2,754	45,935	
RATE	5.4%	25.8%	4.78

1991

	H & L	TRAWL	TRL/H&L
CATCH	69,792	94,287	
DISCARD	6,749	17,463	
RATE	9.7%	18.5%	1.92

1992*

	H & L	TRAWL	TRL/H&L
CATCH	104,740	66,232	
DISCARD	12,838	23,996	
RATE	12.3%	36.2%	2.96

* provided by NMFS 10/28/92

COUNCIL RECOMMENDED 1993 ABCs, TACs and SEASONAL APPORTIONMENTS
BERING SEA/ALEUTIAN ISLANDS GROUNDFISH

Species	Area	Seasons	ABC 1993	Seasonal Allowance	COUNCIL TAC	ITAC	CDQ
Pollock	EBS		1,340,000		1,300,000	1,105,000	97,500
		Roe		45%		497,250	43,875
		Non-Roe		55%		607,750	53,625
	AI		58,700		51,600	43,860	3,870
	518		42,000		1,000	850	75
						0	
Pacific cod	BS/AI		164,500		164,500	139,825	
						0	
Yellowfin sole	BS/AI		238,000		220,000	187,000	
						0	
Greenland turbot	BS/AI		7,000		7,000	5,950	
						0	
Arrowtooth flounder	BS/AI		72,000		10,000	8,500	
						0	
Rock sole	BS/AI		185,000		75,000	63,750	
						0	
Other flatfish	BS/AI		191,000		79,000	67,150	
						0	
Sablefish	EBS		1,500		1,500	1,275	
	AI		2,600		2,600	2,210	
						0	
POP complex						0	
True POP	EBS		3,330		3,330	2,831	
Other POP complex	EBS		1,400		1,200	1,020	
True POP	AI		13,900		13,900	11,815	
Sharp/Northern	AI		5,670		5,100	4,335	
Short/Rougheye	AI		1,220		1,100	935	
						0	
Other rockfish	EBS		400		360	306	
	AI		925		830	706	
						0	
Atka mackerel	BS/AI		117,100		32,000	27,200	
						0	
Squid	BS/AI		3,400		2,000	1,700	
						0	
Other species	BS/AI		26,600		26,600	22,610	
						0	
BS/AI TOTAL			2,476,245		1,998,620	1,698,827	

Council Recommended 1993 BSAI Trawl Fisheries PSC Apportionments & Seasonal Allowances

Fishery Group	Assumed Mortality\1	Halibut,Secondary Mortality Cap (mt)	Halibut,Secondary Allowable Bycatch (mt)	Halibut, Primary\2 Mortality Cap	Halibut, Primary\2 Allowable Bycatch	Herring (mt)	Red King Crab Zone1	C. baird Zone1	C. bairdi Zone2
Yellowfin sole	70%	592	846	518	739	359	40,000	175,000	1,225,000
May 1 - Aug. 2		230	328	201	287				
Aug. 3 - Dec. 31		362	517	317	452				
Rocksole/other flatfish	70%	588	840	514	734		80,000	475,000	200,000
Jan. 1 - Mar. 29		427	610	373	533				
Mar. 30 - June 28		80	115	70	100				
June 29 - Dec. 31		80	115	70	100				
Turbot/arrowtooth/sablefish	40%	137	343	120	299				
Jan. 1 - June 28		0	0	0	0				
June 29 - Dec. 31		137	343	120	299				
Rockfish	60%	201	335	176	293	9			25,000
Jan. 1 - Mar. 29		0	0	0	0				
Mar. 30 - June 28		81	134	70	117				
June 29 - Dec. 31		120	201	105	175				
Pacific cod	60%	1,000	1,667	874	1,457	27	40,000	175,000	400,000
Jan. 1 - June 28		1,000	1,667	874	1,457				
Pollock/mackerel/"o. species"	60%	1,257	2,095	1,099	1,831	193	40,000	175,000	1,150,000
Jan. 1 - April 15		314	524	274	458				
April 16 - May 31		943	1571	824	1,374				
June 1 - Dec. 31									
7 MW Pollock (Herring)						1,534			
TOTAL		3,775	6,125	3,300	5,354	2,122	200,000	1,000,000	3,000,000

\1 Mortality rates based on IPHC assumed mortality rates for 1993.

\2 Primary halibut cap closes Zones 1 and 2H (Areas 511, 512, 516 and 517).

12/11/92

Council Recommendations for 1993 VIP Rate Standards

Fishery and quarter	Incentive Program Rate Standards: Halibut (kg halibut/mt groundfish)	Zone 1 Red King Crab (# of crab/mt groundfish)
BSAI Midwater Pollock		
First Quarter	1.0	n/a
Second Quarter	1.0	
BSAI Bottom Pollock		
First Quarter	7.5	
Second Quarter	5.0	
BSAI Yellowfin Sole		
First Quarter	5.0	2.5/mt
Second Quarter	5.0	2.5/mt
BSAI Other Trawl Fisheries		
First Quarter	30.0	2.5/mt
Second Quarter	30.0	2.5/mt
GOA Midwater Pollock		
First Quarter	1.0	n/a
Second Quarter	1.0	
GOA Other Trawl Fisheries		
First Quarter	50.0	n/a
Second Quarter	50.0	

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

DIVISION OF COMMERCIAL FISHERIES

WALTER J. HICKEL, GOVERNOR

P.O. BOX 3-2000
JUNEAU, ALASKA 99802-2000
PHONE: (907) 465-4210

December 7, 1992

Dr. Clarence Pautzke
Executive Director
North Pacific Fishery Management Council
P.O. Box 103136
Anchorage, AK 99510

Dear Dr. ~~Pautzke~~: Clarence

The Division of Commercial Fisheries has completed preliminary forecasts of the abundance of Bering Sea herring for 1993. The enclosed report describes an age-structured stock assessment model which was used to produce the abundance forecast for the Togiak stock, the largest herring stock in the Bering Sea. Based on our analysis, the biomass of Bering Sea herring stocks for 1993 will total 212,187 metric tons:

Stock	Forecast Biomass (metric tons)
Port Moller	16,000
Togiak	135,102
Security Cove	5,699
Goodnews Bay	3,266
Cape Avinof	2,139
Nelson Island	3,188
Nunivak Island	3,576
Cape Romanzof	2,149
Norton Sound	41,068
Total:	212,187

PSC Limit (at 1% of biomass): 2,122 metric tons.

Because we are still reviewing some stock assessment data collected in 1992, these forecasts are preliminary and may be revised slightly. However, we do not anticipate that forecast revisions would result in any significant changes to the Bering Sea PSC limit.

Sincerely,

R. C. Clasby

Robert C. Clasby
Acting Director

Enclosure

AGE-STRUCTURED ASSESSMENT OF THE TOGIAK HERRING STOCK, 1978-1992, AND PRELIMINARY FORECAST OF ABUNDANCE FOR 1993

By:

Fritz Funk

Linda K. Brannian,

and

Katherine A. Rowell

REGIONAL INFORMATION REPORT[1] NO. 5J92-11

Alaska Department of Fish and Game
Division of Commercial Fisheries
P.O. Box 25526
Juneau, Alaska 99802-25526

December 1992

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[1] The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.

INTRODUCTION

Stock assessment information of various kinds has been collected for the Togiak herring stock since 1977. These data include age compositions of the purse seine and gillnet catches, the age composition of the mature run, and aerial survey estimates of biomass. Harvest quotas for the fishery have been determined by applying a fixed exploitation rate (20%) to aerial survey estimates of biomass. However, in years when aerial survey conditions are poor, the aerial surveys likely underestimate biomass. Strong 1977-78 year classes caused a very large pulse of biomass in the Togiak stock during the mid 1980's according to cohort analysis reconstructions (Baker 1991, Wespestad 1991, Zheng *in press*). On the other hand, aerial survey biomass estimates during this time period included years of varying survey conditions and interpretations and do not reflect this trend in abundance.

The large numbers of fish collected in age-weight-length samples from the Togiak stock likely provide precise estimates of age composition. These age compositions reflect relative abundance trends in the stock such as the recruitment of the strong 1977-78 year classes. However, the information contained in the time series of age composition estimates has not been incorporated simultaneously with aerial survey data to estimate abundance. Age-structured analysis or "ASA" provides a tool that can incorporate age compositions and selected years of good aerial surveys to generate abundance estimates. The ASA approach we used essentially scales relative abundance trends from age compositions to the approximate magnitude of the biomass estimates from subsets of aerial surveys taken from years with "good" weather conditions and adequate sample sizes during aerial surveys.

Aerial survey abundance estimates largely rely on summing "peak" estimates from a time series of abundance observations. Because immigration to and emigration from the herring spawning grounds is likely a continuous process; aerial surveys tend to be conservative estimates of abundance. This ASA approach only partially corrects this tendency for aerial surveys to be conservative. Because years of poor weather or inadequate geographic and temporal coverage during aerial surveys are excluded from the analysis, much bias is removed by the ASA model. However, to the extent tha some herring are unobserved even during years of good surveys, the resultant model estimates will tend to underestimate true herring abundance to some unavoidable degree. The primary goal of the ASA is to produce a one-year forecast which attempts to make maximum use of the information contained in age composition data and aerial survey years when it is likely that the "peak" abundances were at least observed under good aerial survey conditions, and aerial surveys were conducted throughout the run.

METHODS

Our approach uses an ASA model that incorporates auxiliary information, similar to that used by Deriso et al. (1985). Nonlinear least squares techniques are used to minimize a sum of squares constructed from heterogeneous types of auxiliary information. Many different sources of data can be incorporated into the parameter estimation process using this approach. ASA models that incorporate heterogenous data are reviewed by Hilborn and Walters (1992) and Megrey (1989). Whereas the primary goal was to use the model to generate a one-year forecast of abundance for 1993, the model is used to update estimates of historical abundances for 1978-1992, natural mortality, maturity, and gear selectivities for purse seine, and gillnet fisheries, as well.

In our conceptual model of the annual cycle of events affecting the Togiak herring stock (Figure 1), we increment age indices at the end of winter, coinciding with the approximate time of annulus formation. The population model begins accounting for herring cohorts at age 4, the first year that a measurable proportion usually return to spawn. Prior to spring, the conceptual model splits the herring population into two components: an immature portion that will not return to spawn, and the "pre-fishery mature" or "run" biomass that will return to inshore areas to spawn. Removals by purse seine and gillnet sac roe fisheries are then deducted to give the "escapement biomass" that actually spawns. In this preliminary model configuration, removals by the Dutch Harbor food and bait fishery and groundfish trawl bycatches are not explicitly accounted for, but are reflected in the survival rate estimate. These removals could be made explicit when catch by age is available from these fisheries. However, because selectivity in these fisheries is likely to be highly variable and these harvests occur on mixed stocks, catches from these fisheries may not provide useful "tuning" information for Togiak ASA model.

Survival Model

The survival model we used accounts for the above processes with a difference equation to describe the number of fish in the (N) in a cohort aged a in year y:

$$N_{a+1,y+1} = S\,(N_{a,y} - C_{a,y}^{seine} - C_{a,y}^{gillnet}\,)\,, \tag{1}$$

where S and is the annual survival rate estimated by the ASA model, $C_{a,y}^{seine}$ is the catch from the spring purse seine sac roe fishery, and $C_{a,y}^{gillnet}$ is the catch in the spring gillnet sac roe fishery. The number of fish in a cohort (N) includes both mature and immature herring measured at a time after annulus formation but before the spawning migration or spring roe fisheries (the "total population" of Figure 1). The model starts accounting for herring at age 4. Because herring age 9 and older were pooled in the age composition data for 1978-79, these fish are pooled into a single "9+" category for 1978-1979 estimates of abundance and age composition. Herring were aged to a "15+" category beginning in 1980, and recently have been aged to 18. In the model, the "9+" category of 1979 becomes the "10+" category of 1980, the "11+" category of 1982...until the "15+" category of 1985. From 1985 forward, herring aged 15 and older are pooled into the "15+" category.

The starting value for the annual proportionate survival rate was 70%, equivalent to a 0.35

instantaneous natural mortality rate (M). Starting values for the abundance of the 1969-88 year classes were estimated by graphically fitting mature run age compositions from the years 1978-92 and the 1981, 1988, and 1992 aerial survey biomass.

Observed Catch at Age

The harvest of herring by age for purse seine sac roe and gillnet sac roe fisheries was tabulated from published sources for the 1978 to 1992 period (Tables 1 and 2). For 1978 and 1979, the age composition of the harvest was obtained from Fried et al. (1983). Age composition were converted to number of fish in the harvest for 1978 and 1979 using the total catch weight for each gear (Skrade and Brookover 1991) and the weight at age (Table 3). For the 1980-89 period, catches at age were obtained from Baker (1991). For 1990 and 1991, catch in numbers at age was obtained from the catch weight at age distribution in the annual forecast report (Funk 1991, Funk and Harris 1992) and the weights at age of Table 3. Only preliminary purse seine catch at age data were available for 1992 at the time that this analysis was conducted.

The number of fish at age in the harvest was used as $C_{a,y}^{seine}$ and $C_{a,y}^{gillnet}$ in equation (1). Observed numbers of fish in the catch for each gear were also converted to age composition (percent by age) for each gear to compare with age compositions estimated from catch models.

Estimation of the Age Composition of the Catch

Gear Selectivity

For each gear, an estimated age composition of the catch for each year ($\hat{p}_{a,y}$) was computed from a model which incorporated an age-specific gear selectivity function $s(a)$ and the estimated abundance $N_{a,y}$ from equation (1):

$$\hat{p}_{a,y} = \frac{s(a)N_{a,y}}{\sum_a [s(a) \cdot N_{a,y}]} , \tag{2}$$

This equation defines selectivity as the proportion of the total population susceptible to capture by the fishing gear; it includes both the effects of immature fish not being present on the fishing grounds (partial recruitment or maturity), and active selection or avoidance of certain fish sizes by the gear or fisher's behavior. Gear selectivity was estimated separately for the two gears. Functions chosen to describe the relationship between gear selectivity and age were limited to two parameters because it is desirable to minimize the number of parameters estimated by the model; two parameters are the fewest that can adequately describe the age-selectivity relationship. The choice of a particular functional form represents an assumption which limits the possible ranges of the selectivities. Purse seine gear was assumed to have asymptotic selectivity and was represented by a logistic function:

$$s(a) = \frac{1}{1 + e^{\beta(a-\alpha)}}, \tag{3}$$

where the two parameters to be estimated are α, the age of 50% selectivity and β, a steepness parameter. Purse seine selectivity was constrained to be at least 98% by age 10.

The gamma-type function of Deriso et al. (1985) was used for gillnet gear where selectivity might decrease at the older ages:

$$s(a) = \frac{a^{\gamma} e^{-(\delta \cdot a)}}{\max_j [\, j^{\gamma} e^{-(\delta \cdot j)} \,]}, \tag{4}$$

where γ and δ are the two parameters to be estimated, and the subscript j ranges over all age classes. The denominator of the expression merely scales the values of the function to one at the age of maximum selectivity. Initial values for selectivity parameters for purse seine and gillnet gears were chosen to give selectivities similar to those in Funk and Sandone (1990) for Prince William Sound.

Comparing Estimated and Observed Age Compositions of the Catch

One measure of goodness of fit from the model was obtained by comparing estimated and observed age compositions of the commercial catch. For each gear, the sum of squares measuring the goodness of fit of the age composition of the catch was computed as:

$$SSQ_{agecomp:catch} = \sum_y \sum_a \left(\frac{C_{a,y}}{\sum_a C_{a,y}} - \hat{p}_{a,y}\right)^2, \tag{5}$$

where $(\hat{p}_{a,y})$ was the estimated age composition of the catch from equation (2). The transformation, $\sin^{-1}$(square root), was applied to observed and estimated age composition proportions to stabilize the variance.

Maturity

Maturity was estimated for each age by the ASA model to estimate the proportion of the population which returned to spawn each year. The maturity function was applied when comparing the abundances determined from equation (1) with aerial survey biomass estimates and mature run age compositions. Because maturity is expected to be an asymptotic function, a logistic expression was used:

$$\rho(a) = \frac{1}{1+e^{\phi(a-\tau)}} \quad , \tag{6}$$

where the two parameters to be estimated are τ, the age of 50% maturity, and ϕ, a steepness parameter. The maturity-age relationship was assumed not to change over the range of years in the model. The validity of this assumption was investigated by examining residuals of spawning age compositions for time trends over the duration of the model, which might indicate consistent shifts in the maturity-age relationship. Starting values for maturity parameters gave 50% maturity for age 4 with full maturity at age 7. Maturity function parameters were constrained in the model such that maturity at age 8 was essentially complete (98%). Biological sexual maturity is achieved at approximately age 6 (Wespestad 1991). Maturity as detected in ADF&G run age composition sampling is likely older than biological maturity because sampling tends to be curtailed at the end of the spawning run when younger fish are present. Maturity was constrained in this manner to prevent confounding with estimation of natural mortality.

Aerial Survey Biomass Estimates

During herring aerial surveys, observers estimate the surface area of herring schools on the spawning grounds. Surface areas are converted to biomass estimates using calibration samples in which entire herring schools were captured by purse seines after observers had estimated their surface area. Calibrations are stratified by three depth zones. The largest observed or "peak" biomass from each distinct spawning event is summed to obtain each year's biomass estimate. Distinct spawning events are identified by separation in space and time, differences in age composition, and differences in sexual maturity. Occasionally non-peak biomass estimates are included in the total estimate when age composition or sexual maturity data indicate herring that could not have been accounted for in the nearest "peak" estimate. Aerial surveys were rated during 1980-1992 (Table 4), taking into account survey frequency, the duration of the aerial surveys and weather during the main spawning events. Aerial surveys from five of the six highest rated years (1981, 1983, 1985, 1988, 1992) were considered for use in the ASA model. Although the 1982 aerial survey estimate was ranked relatively high according to aerial survey ratings, 1982 was excluded because the relatively low biomass estimated that year, relative to estimates from adjacent years with high ratings, contradicted the well documented phenomenon of the recruitment of the very strong 1977-78 year classes. Because relative ratings among these five remaining years were not obvious, the sensitivity of the ASA model to different subsets of these five years was evaluated. The 1992 aerial survey biomass was a preliminary estimate which will be updated when the final 1992 mature run age composition data become available.

A goodness of fit measure for the ASA model was developed from the differences between ASA estimates of mature run biomass and the aerial survey estimates of mature run biomass:

$$SSQ_{aerialbiomass} = \sum_{y} \{ \log_e (B_y^{survey}) - \log_e [\sum_{a} \rho(a)\, w_{a,y}\, N_{a,y}] \}^2 , \tag{7}$$

where B_y^{survey} are the aerial survey biomass estimates in year y, $w_{a,y}$ is the weight at age a in year y (Table 1), and $\rho(a)$ is the proportion mature at age a to be estimated by the ASA model, and $N_{a,y}$ are the ASA estimates of abundance (equation 1). Because there were too few abundance estimates to evaluate the appropriateness of the log transformation in equation (7), the sensitivity of the model's results to this assumption was evaluated.

Age Compositions of the Pre-Fishery Mature "Run" Biomass

In addition to the time series of the catch by age, a relatively long time series of age compositions of the pre-fishery mature or "run" biomass are available. The age compositions of the "run" biomass was tabulated from published sources for the 1978 to 1991 period (Table 5). For 1978 and 1979, the age composition was calculated from numbers of fish published by Brannian and Rowell (1989). For the 1980-89 period, the numbers of fish at age were obtained from Baker (1991). For 1990 and 1991, the age composition was obtained from Funk (1991) and Funk and Harris (1992). A goodness of fit measure was developed from these age compositions as:

$$SSQ_{agecomp:run} = \sum_{y} \sum_{a} [p_{a,y}^{run} - \frac{\rho_a N_{a,y}}{\sum_{a} (\rho_a N_{a,y})}]^2 , \tag{8}$$

where $p_{a,y}^{run}$ are the observed "run" age compositions. The transformation, $\sin^{-1}$(square root), was applied to observed and estimated age composition proportions to stabilize the variance.

Year-Ahead Forecast Methodology

The forecast of the abundance of mature herring for 1993 ($B_{1993}^{Forecast}$) is based on projecting the total abundance with the survival model (equation 1), modified by the ASA estimates of the proportion mature at age:

$$B^{Forecast}_{1993}) = \sum_a \rho(a)\, w_{a,1993}\, N_{a,1993}\,, \tag{9}$$

where $\rho(a)$ are the proportions mature at age a estimated by the ASA model, $w_{a,1993}$ are weights at age a from the Gompertz growth model fit to all years available data (Table 3) and $N_{a,1993}$ are the ASA estimates of abundance for 1993 from equation (1), except for the number of age 4 herring. At present, methods of predicting year class strengths are uncertain, and the median observed year class strength of the ASA estimates for the 1973-1988 year classes was used to generate the 1993 forecast of age 4 herring, $N_{4,1993}$. The median better represents recruitment in typical years than the mean year class strength, as the distribution of year class strengths is very skewed. Assumptions about future year class strength tend to be moderated by the fact that age 4 herring are only partially recruited (approximately 50%).

Parameter Estimation

Total Sum of Squares

A total sum of squares was computed by adding each of the components:

$$\begin{aligned} SSQ_{Total} = {} & \theta_{aerialsurvey}\lambda_{aerialsurvey}\, SSQ_{aerialsurvey} + \\ & \theta_{agecomp:seine}\lambda_{agecomp:seine}\, SSQ_{agecomp:seine} + \\ & \theta_{agecomp:gillnet}\lambda_{agecomp:gillnet}\, SSQ_{agecomp:gillnet} + \\ & \theta_{agecomp:run}\lambda_{agecomp:run}\, SSQ_{agecomp:run}\,, \end{aligned} \tag{10}$$

where the θ's and λ's are weights assigned to each sum of squares component. Because the variance of the aerial survey abundance estimator was unknown, an inverse variance weighting scheme could not be used. The θ's were used to scale each of the SSQ components to be of a similar order of magnitude, such that each SSQ component would have an approximately similar effect on the total SSQ when λ's were equal. The λ's were used to assign ad hoc weights to each SSQ component reflecting the degree of confidence in each component. The sensitivity of the model's results to varying λ's was evaluated. For most of the sensitivity analysis scenarios the three age composition data sources were weighted relative to each other according to the sample size for each data source. Mature run age compositions accounted for approximately 50% of the herring examined, while purse seine age compositions accounted for 34% and gillnet age composition accounted for 16% of the herring examined. Aerial survey biomass estimates were assigned weights ranging from 1% to 50% of the weight assigned to the combined age composition weights.

Minimization Methods

The model estimates a total of 27 parameters: 20 initial cohort sizes, four gear selectivity function parameters (α, β, γ, and δ) two maturity function parameters (ϕ and τ), and one survival rate parameter (S). When four aerial survey years were used, the four SSQ equations refer to 439 data observations. Therefore there would be 412 degrees of freedom and the data/parameter ratio is approximately 16. However, not all of the data observations are independent, so that the amount of information contained in the data is considerably less than would be the case with completely independent observations.

The Microsoft Excel[1] spreadsheet solver was used to estimate values for the parameters which minimized the combined weighted sums of squares. Parameter values manipulated by the solver were all scaled to a similar order of magnitude, as recommended by the software manufacturer. As the solver approached a solution, parameter values and SSQ_{total} were again rescaled to similar orders of magnitude if necessary to ensure that scaling problems did not influence the results.

Sensitivity Analysis

The sensitivity of the model to three groups of assumptions was investigated. Because the choice of which aerial survey years to include in the analysis was somewhat subjective, various combinations of aerial survey years were chosen from the five highest rated years. The appropriateness of the assumption of a lognormal error structure for aerial survey biomass observations was also examined. The choice of ad hoc weights among the 4 auxiliary information components was also subjective and could influence model results. A total of 26 combinations of these three groups of assumptions were examined in the sensitivity analysis (Table 6).

RESULTS AND DISCUSSION

Regardless of assumptions about biomass error structure, weighting of SSQ components, or choice of aerial surveys, the ASA estimates of biomass are relatively low in the early 1980's, and increase to a maximum in 1983 with the recruitment of the strong 1977 and 1978 year classes (Figure 2). In all scenarios, biomass declines to a low in 1991 because of poor recruitment and rebounds again in 1992 and 1993 as the moderately strong 1987 and 1988 year classes enter the mature population. Three scenarios (runs 20, 21, and 22) estimated substantially higher abundance in 1982-87. These three were the only scenarios that did not include either the 1983 or the 1985 aerial survey abundance estimates. The median biomass trend closely tracks run 1, a combination of assumptions thought to be likely which included all five aerial survey years and moderate

[1] Company names are listed only for archival purposes and do not represent an endorsement of any kind by ADF&G.

weighting factors. Estimates of maturity and gear selectivity for run 1 are shown in Figure 3. The recruitment time series (Figure 4) indicates that the 1988 year class may be even stronger than the 1977 year class. However, the 1988 year class first appeared in age composition samples in 1992, and age composition information for 1992 is incomplete. Because only purse seine age composition information is available for 1992 and the selectivity to purse seine gear at age 4 is low, there is a large amount of uncertainty about the strength of this year class. The estimated size of the 1987 year class also varied among scenarios to a lesser extent. In general, ASA estimates of abundance are least certain for the most recent years. Survival estimates ranged from a low of 75% (M=0.29) to a high of 82% (M=0.20), depending on the combination of assumptions in the various scenarios.

The histogram of outcomes of the sensitivity analysis reflects the amount of uncertainty in the 1993 forecast of abundance (Figure 5). Most of the results were clustered around the median forecast of 135,102 tonnes. The two lowest forecasts resulted when the 1992 aerial survey estimate of abundance was excluded from the model. However, the 1992 survey conditions were generally regarded as excellent, such that the 1992 aerial surveys should probably be included. The highest forecast occurred when aerial surveys were given an unrealistically low weight of 1%, and the age compositions were given 99% of the weight (run 21). Excluding these observations, the remaining scenarios fall within +/- 10% of the median. Because the outcome of run 1 and other scenarios thought to be likely combinations of assumptions were also similar to the median, the median value of 135,102 tonnes was used for the preliminary 1993 forecast of abundance.

This abundance forecast will be updated when additional age composition data from the 1992 gillnet fishery and the 1992 mature run become available. Because purse seine age compositions from 1978-1991 corresponded reasonably well with mature run age compositions when ASA estimates of maturity and purse seine selectivity were taken into account, these new data are not expected to have a significant effect on the 1993 forecast.

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Table 1. Togiak commercial purse seine harvest by year (in millions of herring), 1978-1991.

Year	Age 4	5	6	7	8	9	10	11	12	13	14	15	Source
1978	29.306	9.482	2.755	0.250	0.286	0.107							Fried et al. (1983)
1979	3.402	12.572	7.397	1.808	0.027	0.085							McBride and Whitmore (1981)
1980	0.517	0.350	27.033	25.906	5.103	0.224	1.601						Baker (1991)
1981	19.439	3.162	0.615	9.200	4.893	1.889	0.068	0.167					Baker (1991)
1982	11.931	30.367	1.859	0.459	6.850	2.967	0.475	0.108	0.081				Baker (1991)
1983	1.141	18.771	40.685	1.310	1.273	4.985	1.602	0.000	0.000	0.000			Baker (1991)
1984	0.106	2.508	16.586	19.763	1.183	3.373	1.683	0.238	0.000	0.000	0.000		Baker (1991)
1985	1.032	1.016	4.840	18.805	23.835	4.201	2.409	0.922	0.314	0.002	0.000	0.000	Baker (1991)
1986	0.000	0.769	0.695	5.478	14.025	10.070	1.413	0.848	0.295	0.075	0.000	0.000	Baker (1991)
1987	0.073	0.032	3.147	3.325	7.956	13.229	2.553	0.385	0.267	0.035	0.000	0.000	Baker (1991)
1988	0.247	1.975	0.411	4.319	1.522	4.772	7.980	4.031	0.699	0.123	0.041	0.000	Baker (1991)
1989	0.034	1.716	1.993	0.820	3.507	1.354	3.689	5.241	3.822	0.249	0.222	0.000	Baker (1991)
1990	0.017	0.113	1.417	2.971	0.808	4.093	1.371	3.083	5.448	1.862	0.149	0.086	Funk (1991)
1991	0.539	0.052	0.223	2.719	3.865	1.205	5.001	1.829	4.117	5.011	1.594	0.109	Funk and Harris (1992)
1992	16.661	21.312	0.880	2.233	6.467	5.484	1.453	2.964	2.806	2.494	3.693	0.496	Preliminary 1992 data.

Shaded cells include all older ages. Oldest age was 9+ from 1978-79. Oldest age categories summed where needed for 1980+ data, from Baker (1991)

Table 2. Togiak commercial gillnet harvest by year (in millions of herring), 1978-1991.

	Age												
Year	4	5	6	7	8	9	10	11	12	13	14	15	Source
1978	0.597	1.458	0.808	0.035	0.009	0.018							Fried et al. (1983)
1979	1.735	10.957	4.558	1.181	0.124	0.054							McBride and Whitmore (1981)
1980	0.171	0.217	8.140	4.023	0.590	0.052	0.028						Baker (1991)
1981	5.934	1.060	0.209	1.744	0.557	0.102	0.007	0.019					Baker (1991)
1982	6.226	18.979	1.147	0.021	1.048	0.509	0.211	0.000	0.288				Baker (1991)
1983	0.027	6.641	8.398	0.380	0.260	1.464	0.302	0.070	0.000	0.017			Baker (1991)
1984	0.073	1.032	5.123	6.513	0.739	0.900	0.420	0.041	0.008	0.000	0.000		Baker (1991)
1985	0.006	0.086	1.239	4.996	4.641	0.681	0.303	0.147	0.006	0.000	0.000	0.000	Baker (1991)
1986	0.000	0.021	0.232	1.812	4.623	2.330	0.233	0.140	0.000	0.000	0.000	0.000	Baker (1991)
1987	0.000	0.003	0.506	0.655	2.051	2.525	0.702	0.149	0.077	0.000	0.000	0.000	Baker (1991)
1988	0.000	0.000	0.024	1.102	0.588	2.032	3.648	1.077	0.245	0.024	0.024	0.000	Baker (1991)
1989	0.000	0.037	0.618	0.387	1.693	0.557	1.066	1.496	0.872	0.045	0.076	0.034	Baker (1991)
1990	0.000	0.022	0.460	1.056	0.361	1.321	0.424	1.101	1.473	0.698	0.105	0.094	Funk (1991)
1991	0.029	0.000	0.042	0.977	1.793	0.461	1.017	0.611	1.036	1.115	0.259	0.039	Funk and Harris (1992)

Shaded cells include all older ages. Oldest age was 9+ from 1978-79. Oldest age categories summed where needed for 1980+ data, from Baker (1991)

Table 3. Average weight (g) at age for the Togiak total run, 1977-1992. Shaded cells contained missing or bad data and were estimated fı Gompertz growth model of Baker (1991).

	Age												
	4	5	6	7	8	9	10	11	12	13	14	15	Source
1977	158	208	257	302	342	376	404	428	446	461	473	483	Gompertz Growth Model from Baker (1991)
1978	158	208	257	302	342	376	404	428	446	461	473	483	Gompertz Growth Model from Baker (1991)
1979	158	208	257	302	342	376	404	428	446	461	473	483	Gompertz Growth Model from Baker (1991)
1980	158	208	257	302	342	376	404	428	446	461	473	483	Gompertz Growth Model from Baker (1991)
1981	184	215	265	300	330	340	350	397	392	391	543	483	Baker (1991) Appendix Table 14
1982	185	237	270	297	346	383	409	411	480	417	371	483	Baker (1991) Appendix Table 14
1983	178	232	280	301	323	366	394	330	456	359	469	483	Baker (1991) Appendix Table 14
1984	145	208	261	304	340	373	396	410	424	434	473	483	Baker (1991) Appendix Table 14
1985	150	196	249	309	354	393	417	444	450	402	473	483	Baker (1991) Appendix Table 14
1986	138	186	231	286	333	371	410	425	432	409	473	483	Baker (1991) Appendix Table 14
1987	134	184	244	295	343	392	435	452	498	463	473	483	Baker (1991) Appendix Table 14
1988	127	167	253	295	327	384	401	414	418	446	473	483	Baker (1991) Appendix Table 14
1989	115	188	235	297	340	379	393	417	450	403	473	477	Baker (1991) Appendix Table 14
1990	152	201	250	302	344	344	379	384	425	461	473	483	Baker (1991) Appendix Table 14
1991	158	208	257	302	342	376	404	428	446	461	473	483	Gompertz Growth Model from Baker (1991)
1992	158	208	257	302	342	376	404	428	446	461	473	483	Gompertz Growth Model from Baker (1991)

Table 4. Aerial survey biomass estimates and ratings for the Togiak herring stock, showing the six highest rated aerial su (1981, 1982, 1983, 1985, 1988, and 1992).

Survey Year	Days Surveyed (partial) C	Days Surveyed (Total) D	Ratio d/c+d E	Avg Survey Rating F	Peak Survey (5 pts) G	Survey Rating (Peak) H	Total # Surveys L	Total Surveys W/fish M	Sum E+F+G+H		Biomass (tonnes)
1980	15	5	0.25	3.1	2	4.5	21	20	9.9		62,311
1981	8	25	0.76	2.8	4	4.5	34	33	12.1	*	143,925
1982	3	13	0.81	3.4	5	4	18	16	13.2	*	88,815
1983	4	25	0.86	2.8	4	4.5	29	29	12.2	*	128,623
1984	3	15	0.83	3.5	3	3	33	18	10.3		104,218
1985	0	13	1.00	3.0	5	2.5	16	13	11.5	*	119,204
1986	6	15	0.71	2.4	4	3	28	21	10.1		85,910
1987	8	9	0.53	3.0	2	2	23	20	7.5		80,195
1988	5	9	0.64	3.9	4	4	21	13	12.6	*	122,213
1989	4	8	0.67	3.9	3	2.5	13	12	10.1		89,780
1990	16	4	0.20	2.7	2	3	28	20	7.9		79,928
1991	3	8	0.73	3.7	4	2.5	22	11	11.0		75,504
1992	9	3	0.25	4.1	3	4	28	12	11.3	*	132,483

Table 5. Age composition of the pre-fishery mature herring run at Togiak for 1978-1992.

Year	Age 4	5	6	7	8	9	10	11	12	13	14	15+	Source
1978	0.556	0.326	0.087	0.006	0.017	0.008							Brannian and Rowell (1989)
1979	0.060	0.550	0.271	0.105	0.004	0.010							Brannian and Rowell (1989)
1980	0.051	0.009	0.411	0.385	0.125	0.005	0.015						Baker (1991)
1981	0.619	0.071	0.012	0.167	0.094	0.034	0.001	0.003					Baker (1991)
1982	0.216	0.552	0.031	0.009	0.119	0.060	0.010	0.002	0.002				Baker (1991)
1983	0.070	0.388	0.441	0.016	0.017	0.050	0.016	0.003	0.001	0.000			Baker (1991)
1984	0.005	0.039	0.338	0.415	0.037	0.113	0.051	0.002	0.000	0.000	0.000		Baker (1991)
1985	0.031	0.024	0.098	0.359	0.385	0.058	0.032	0.012	0.002	0.000	0.000	0.000	Baker (1991)
1986	0.000	0.020	0.030	0.174	0.446	0.266	0.045	0.013	0.005	0.000	0.000	0.000	Baker (1991)
1987	0.002	0.004	0.104	0.114	0.290	0.402	0.067	0.011	0.005	0.001	0.000	0.000	Baker (1991)
1988	0.059	0.092	0.017	0.147	0.051	0.163	0.294	0.137	0.023	0.017	0.000	0.000	Baker (1991)
1989	0.001	0.096	0.169	0.041	0.148	0.049	0.160	0.195	0.120	0.011	0.007	0.003	Baker (1991)
1990	0.002	0.005	0.089	0.132	0.037	0.176	0.065	0.148	0.234	0.099	0.008	0.003	Funk (1991)
1991	0.161	0.015	0.016	0.184	0.182	0.050	0.102	0.047	0.090	0.098	0.048	0.007	Funk and Harris (1992)

Shaded cells include all older ages. Oldest age was 9+ from 1978-79. Oldest age categories summed where needed for 1980+ data, from Baker (1991)

Table 6. Combinations of aerial surveys and weights (lambdas) used to examine the sensitivity of ASA model results. each combination, the scaling coefficients (thetas) were adjusted so that each sum of squares componen had approximately equal influence on the combined sum of squares before weighting.

	Aerial Surveys							Weights (Lambda's)					Equal Influence Scaling (Theta's)			
								Between		Within Age Compositions						
Run #	Log Transform	81	83	85	88	92	Total Surveys	Aerial Surveys	All Age Compositions	Total Run	Purse Seine	Gill Net	Aerial Surveys	Total Run	Purse Seine	Gill Net
1	Y	1	1	1	1	1	5	0.25	0.75	0.25	0.25	0.25	1	1.0	1.0	1.0
2	Y	1	1		1	1	4	0.5	0.5	0.5	0.34	0.16	5	0.8	0.9	0.9
3	Y	1	1	1		1	4	0.5	0.5	0.5	0.34	0.16	5	0.8	0.9	0.9
4	Y	1	1	1	1		4	0.5	0.5	0.5	0.34	0.16	5	0.8	0.9	0.9
5	Y	1		1	1	1	4	0.25	0.75	0.5	0.34	0.16	6	0.8	0.9	0.9
6	Y	1	1		1	1	4	0.25	0.75	0.5	0.34	0.16	4	0.8	0.9	0.9
7	Y	1	1	1		1	4	0.25	0.75	0.5	0.34	0.16	3	0.7	0.9	0.9
8	Y	1	1	1	1		4	0.25	0.75	0.5	0.34	0.16	4	0.9	0.9	0.9
9	N	1		1	1	1	4	0.25	0.75	0.5	0.34	0.16	4.0E-10	0.9	0.9	0.9
10	N	1	1		1	1	4	0.25	0.75	0.5	0.34	0.16	3.0E-10	0.9	0.9	0.9
11	Y	1	1	1	1	1	5	0.25	0.50	0.25	0.17	0.08	1	1.0	1.0	1.0
12	Y	1	1	1	1	1	5	0.50	0.50	0.28	0.17	0.08	2.5	1.0	1.0	1.0
13	N	1	1	1	1	1	5	0.25	0.75	0.25	0.25	0.25	1E-10	1.0	1.0	1.0
14	Y	1			1	1	3	0.50	0.50	0.50	0.34	0.16	5	0.8	0.9	0.8
15	Y		1		1	1	3	0.50	0.50	0.50	0.34	0.16	5	0.8	0.9	0.8
16	Y	1	1			1	3	0.50	0.50	0.50	0.34	0.16	7	0.5	0.5	0.5
17	Y	1		1	1		3	0.50	0.50	0.50	0.34	0.16	7	0.5	0.5	0.5
18	Y		1	1	1		3	0.50	0.50	0.50	0.34	0.16	7	0.5	0.5	0.5
19	Y		1		1	1	3	0.50	0.50	0.50	0.34	0.16	10	0.5	0.5	0.5
20	N	1			1	1	3	0.25	0.75	0.5	0.34	0.16	7.34E-09	0.9	0.9	1.0
21	N	1			1	1	3	0.01	0.99	0.5	0.34	0.16	7.34E-09	0.9	0.9	1.0
22	N	1			1	1	3	0.05	0.96	0.125	0.75	0.125	7.34E-09	0.9	0.9	1.0

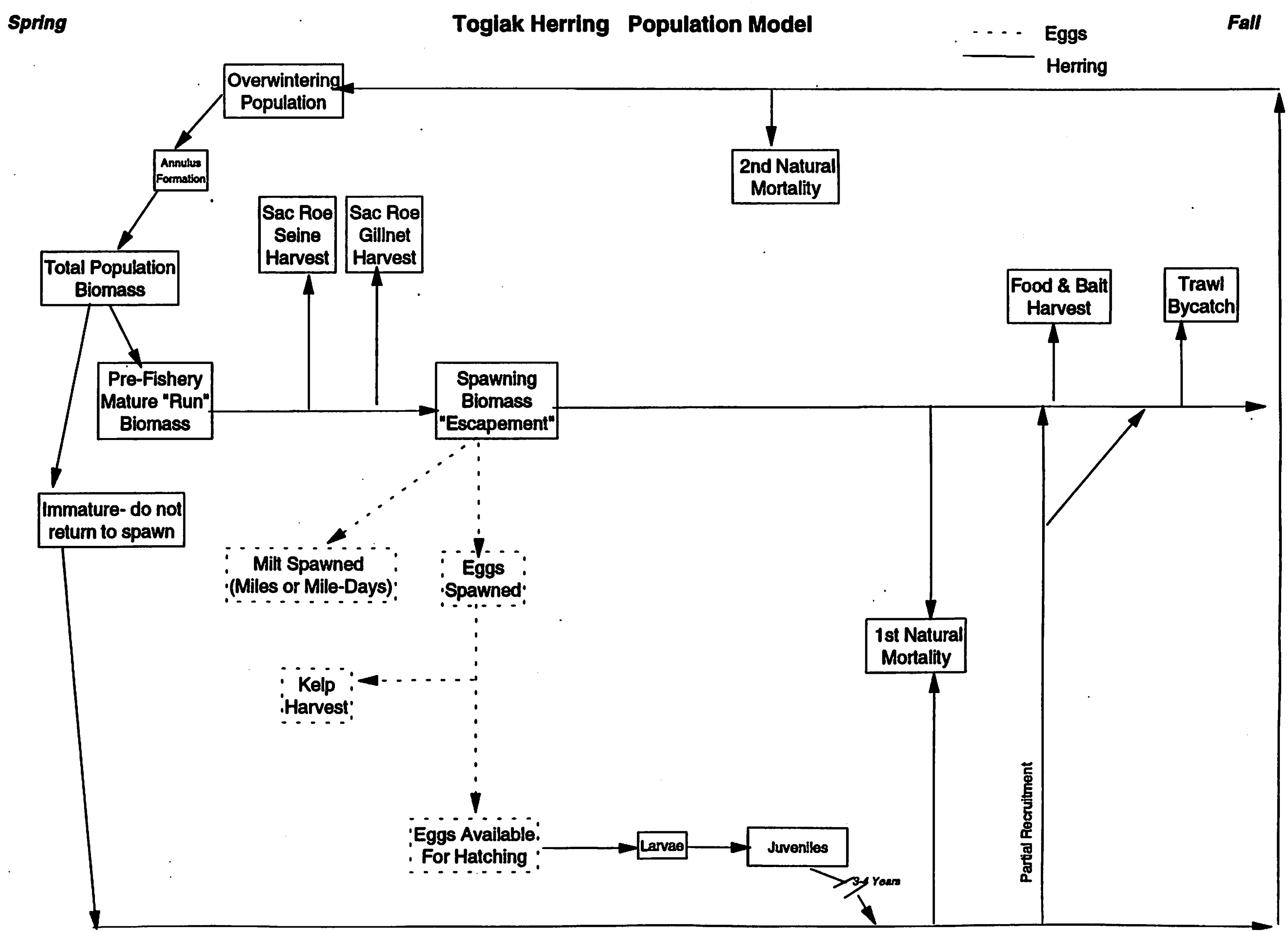

Figure 1. Conceptual model of the annual cycle of events affecting the Togiak herring stock.

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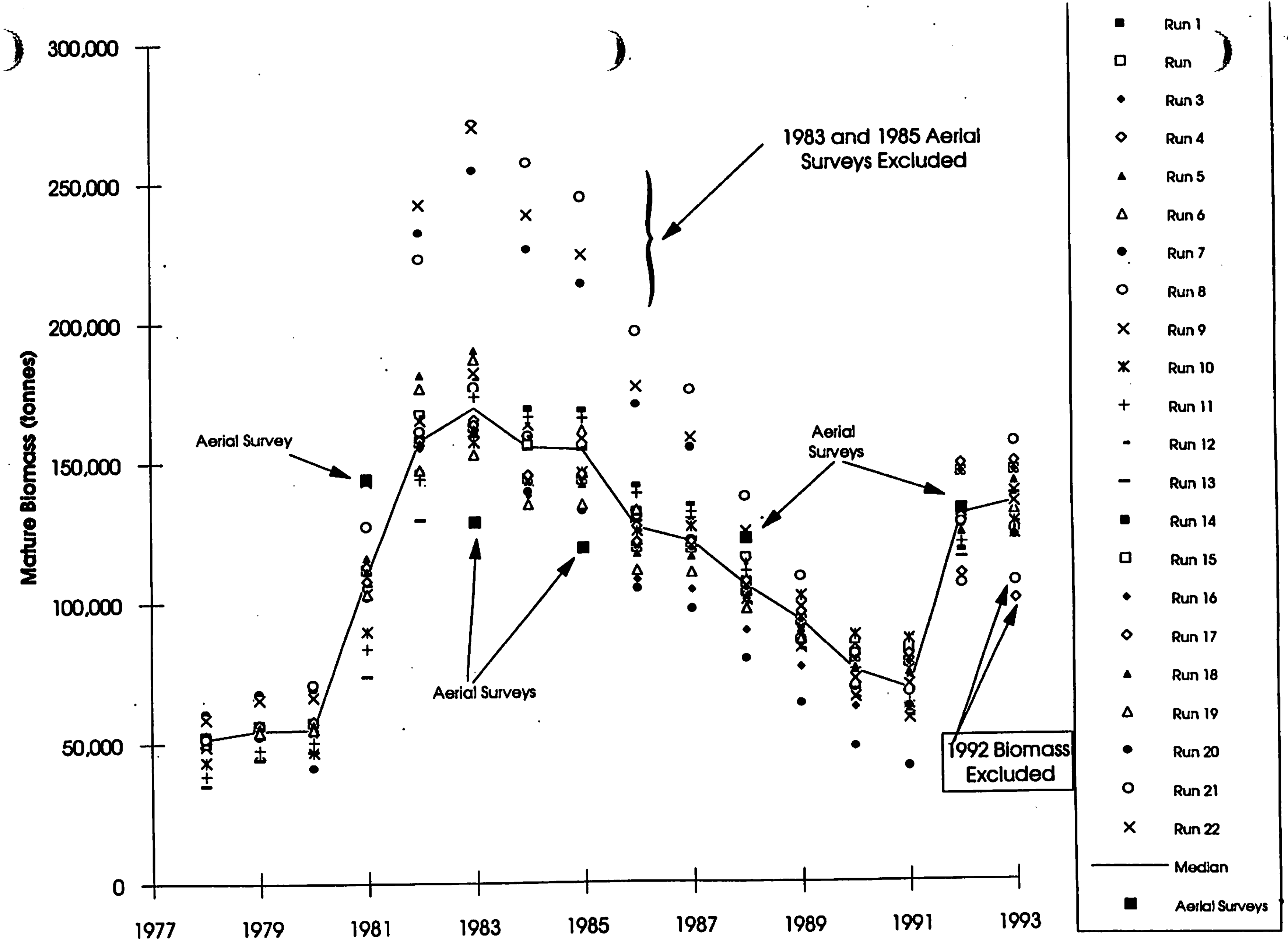


Figure 2. Mature biomass estimates resulting from the 22 sensitivity analysis scenarios for the Togiak ASA model, with the median of the 22 scenarios (solid line). Various combinations of 5 aerial survey biomass estimates (arrows) were used in the scenarios. The 1992 aerial survey biomass was not used in the 2 scenarios that generated unusually low 1993 forecast projections.

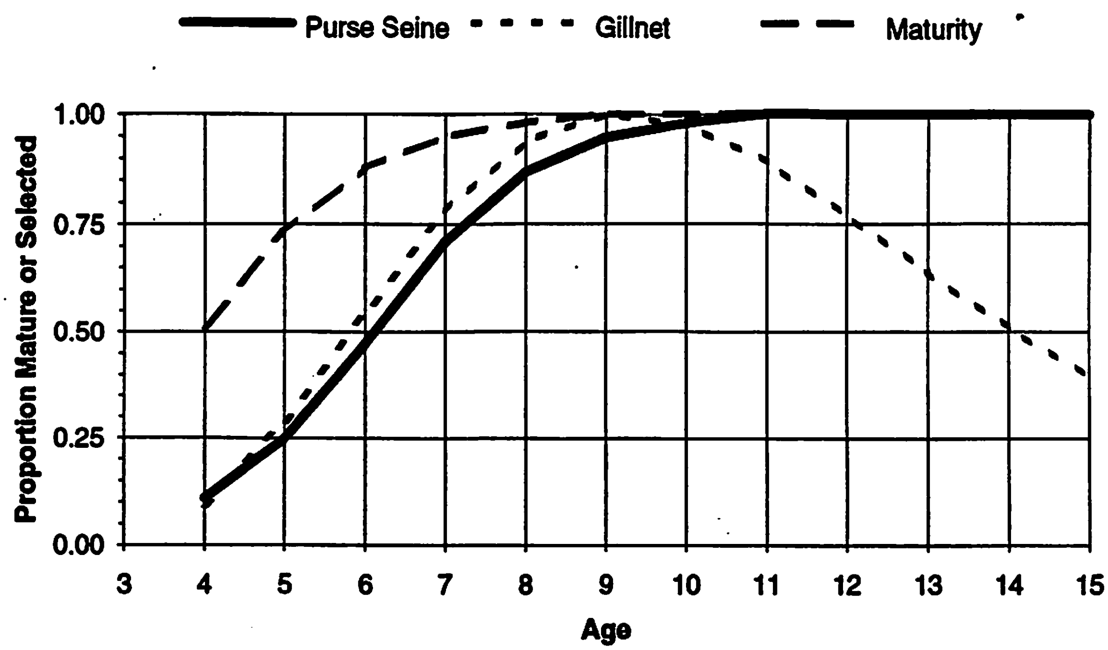


Figure 3. Maturity and selectivity proportions estimated by the Togiak ASA model under the assumptions of Run 1.

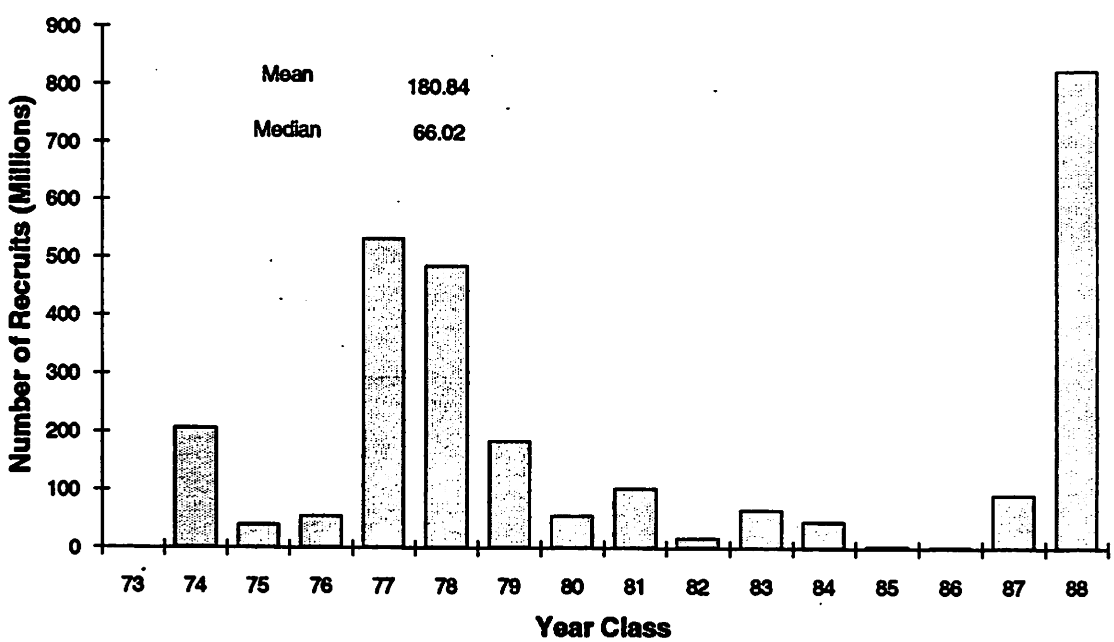


Figure 4. Recruit year class strength at age 4 estimated by the Togiak ASA model under the assumptions of Run 1.

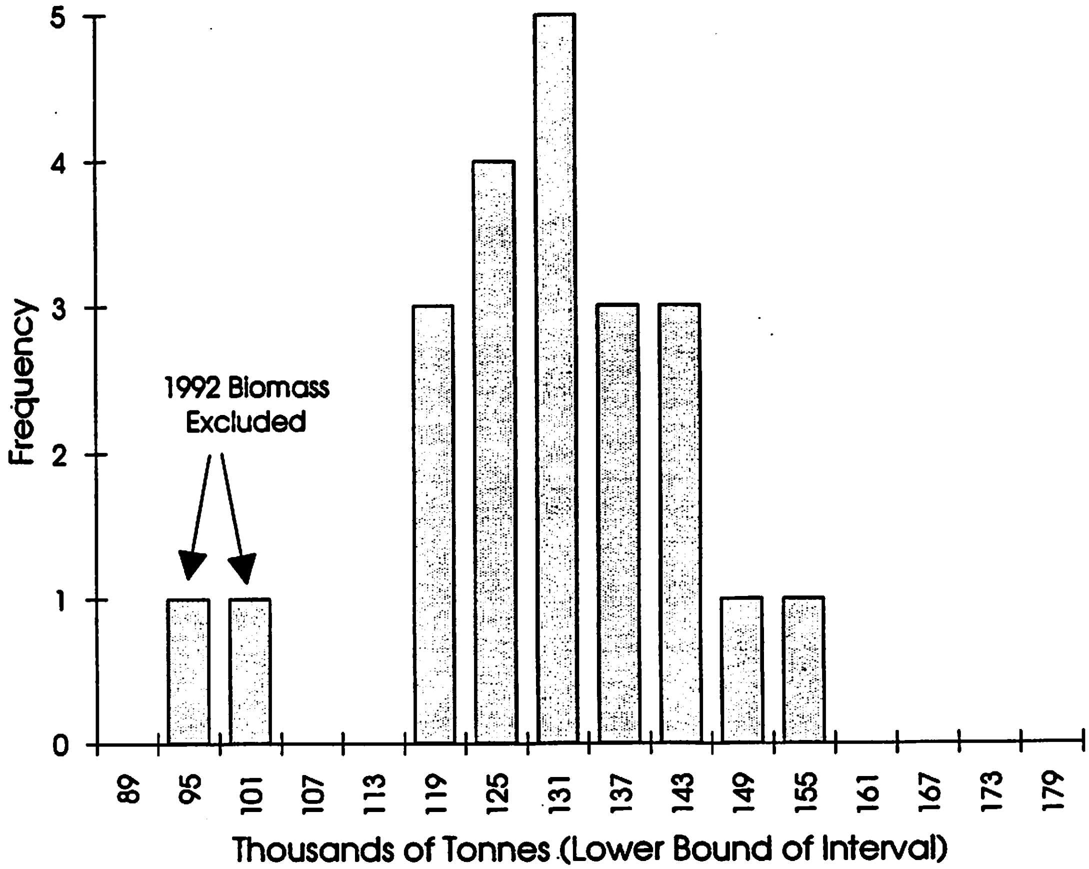


Figure 5. Histogram of 1993 forecast biomass from the 22 sensitivity analysis scenarios for the Togiak ASA model.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

December 4, 1992

Mr. Richard B. Lauber, Chairman
North Pacific Fishery Management Council
P.O. Box 103136
Anchorage, Alaska 99510

Dear Rick,

Standard bycatch rate standards for the vessel incentive program trawl fisheries during the first half of 1993 must be published in the Federal Register prior to the start of the 1993 trawl season on January 20. Attached for the Council's consideration is a table that summarizes quarterly observed bycatch rates for the incentive program fisheries during 1991 and 1992. The table also lists 1992 bycatch rate standards that were recommended by the Council during its June 1992 meeting. Also attached are a series of graphs that show the distribution of observed bycatch rates in the incentive program fisheries.

Sincerely,

Steven Pennoyer
Director, Alaska Region

1991 and 1992 observed bycatch rates, by quarter, of halibut and red king crab in the fishery categories included in the expanded vessel incentive program, and 1992 bycatch rate standards.

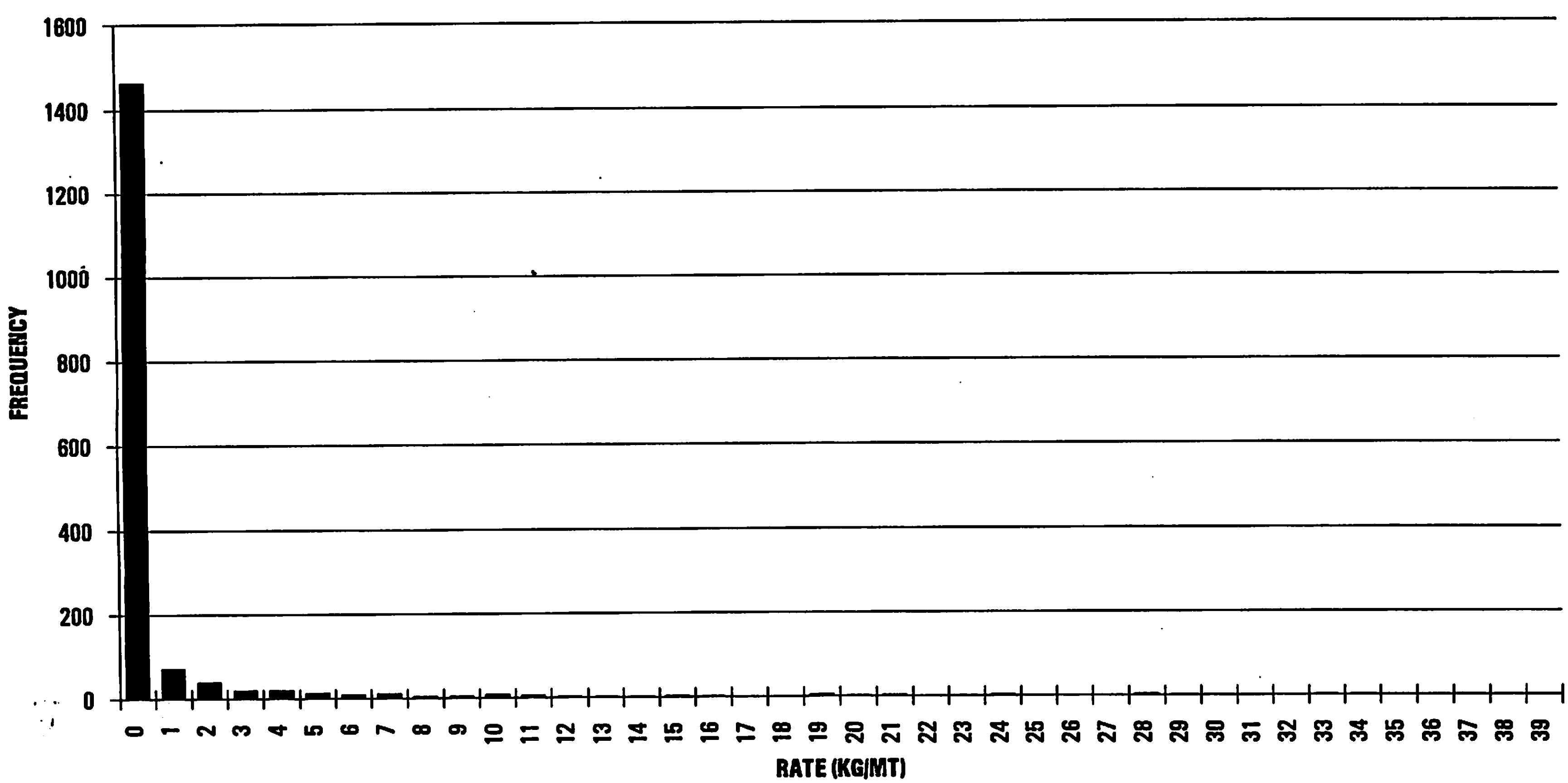
Halibut Bycatch (Kilograms Halibut/ MT Allocated Groundfish Catch

Fishery and quarter	1992 Bycatch Rate Standards	Observed Bycatch Rates 1991	Observed Bycatch Rates 1992
BSAI Midwater Pollock			
QT 1	-	0.05	1.40
QT 2	-	0.17	0.72
QT 3	1.0	0.55	0.51
QT 4	1.0	****	****
Year to date		0.23	0.92
BSAI Bottom Pollock			
QT 1	-	14.30	7.58
QT 2	-	8.27	4.30
QT 3	5.0	1.89	2.30
QT 4	5.0	0.00	****
Year to date		4.13	5.67
BSAI Yellowfin sole (in 1991, includes 'other flatfish')			
QT 1	-	5.38	****
QT 2	-	2.45	3.42
QT 3	5.0	7.17	3.35
QT 4	5.0	2.99	5.67
Year to date		5.06	3.84
BSAI Other Trawl Fisheries			
QT 1	-	13.82	12.09
QT 2	-	20.04	16.05
QT 3	30.0	10.90	4.89
QT 4	30.0	30.10	0.94
Year to date		16.24	12.66
GOA Midwater Pollock			
QT 1	-	0.05	0.12
QT 2	-	0.03	0.06
QT 3	1.0	0.18	0.03
QT 4	0.1	0.89	0.29
Year to date		0.41	0.10
GOA Other Trawl fisheries			
QT 1	-	23.96	19.76
QT 2	-	65.91	21.90
QT 3	5.0	23.59	24.52
QT 4	5.0	26.33	25.25
Year to date		31.07	21.70

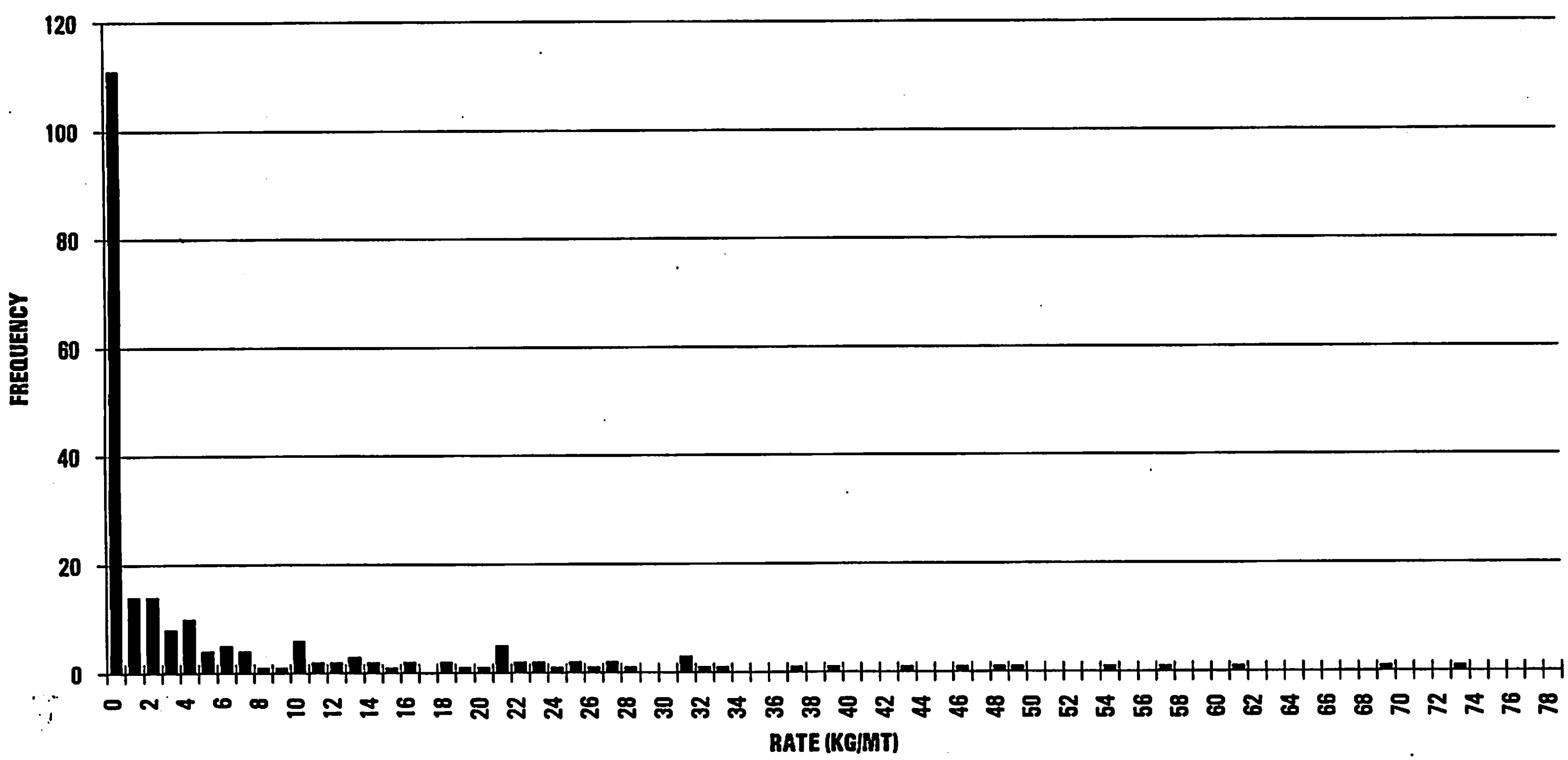
Zone 1 Red King Crab Bycatch Rates
(number of crab/mt of allocated groundfish

Fishery and quarter	1992 Bycatch Rate Standards	Observed Bycatch Rates 1991	Observed Bycatch Rates 1992
BSAI yellowfin sole (in 1991, includes 'other flatfish')			
QT 1	2.5	1.31	****
QT 2	2.5	1.44	1.36
QT 3	2.5	0.00	0.00
QT 4	2.5	****	****
Year to date		1.27	1.36
BSAI Other Trawl			
QT 1	-	0.93	1.19
QT 2	-	0.02	1.72
QT 3	-	0.00	0.00
QT 4	-	****	****
Year to date		0.78	1.21

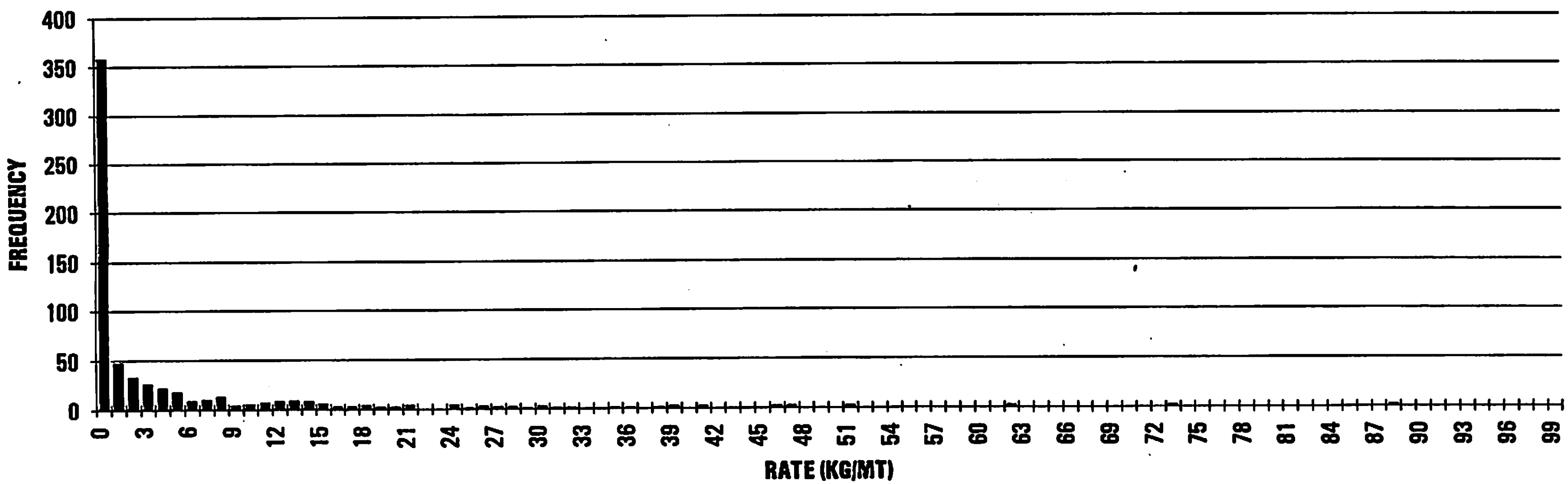
'92 BSA MIDWATER POLLOCK



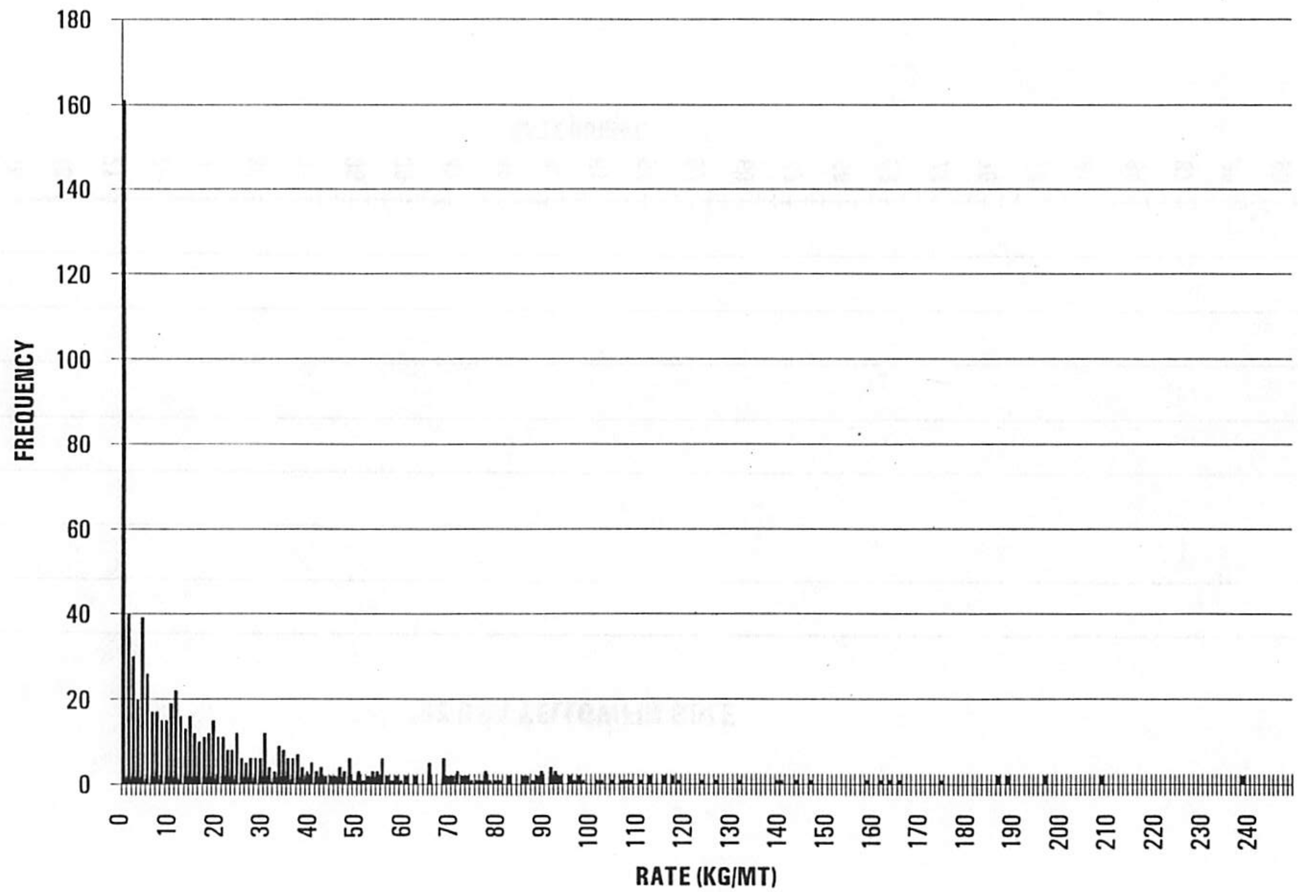
'92 BSA BOTTOM POLLOCK

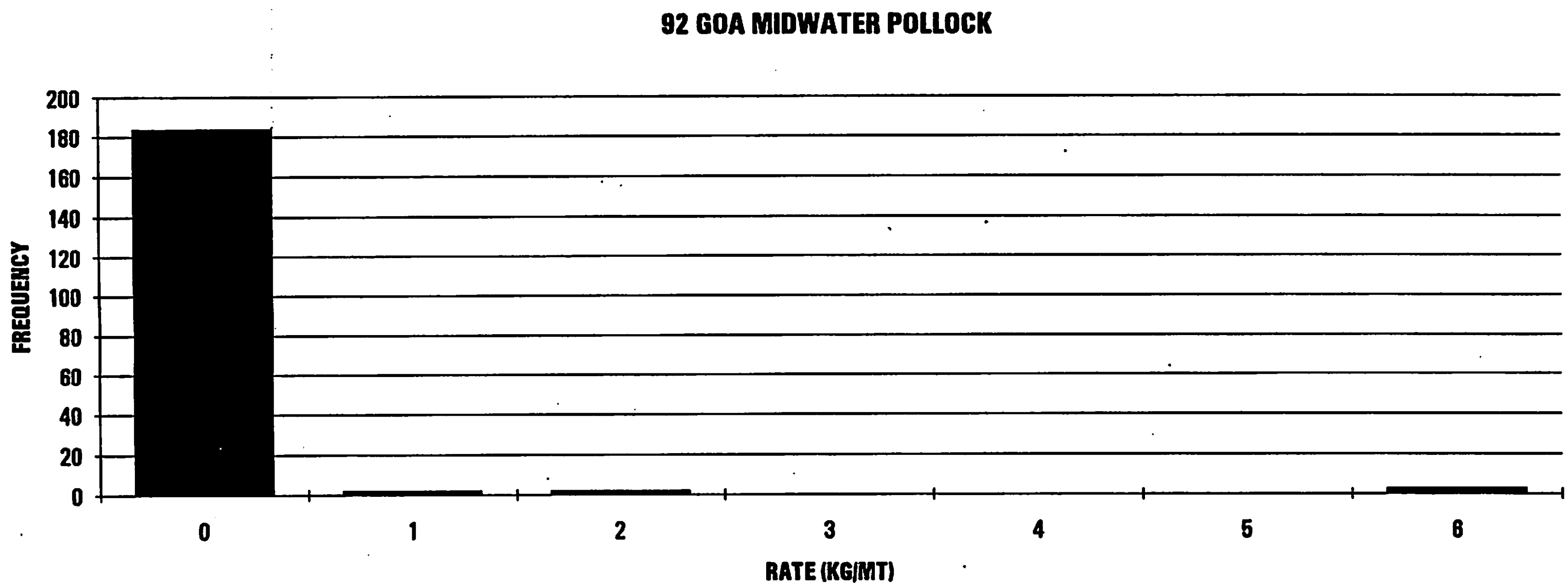


'92 BSA YELLOWFIN SOLE

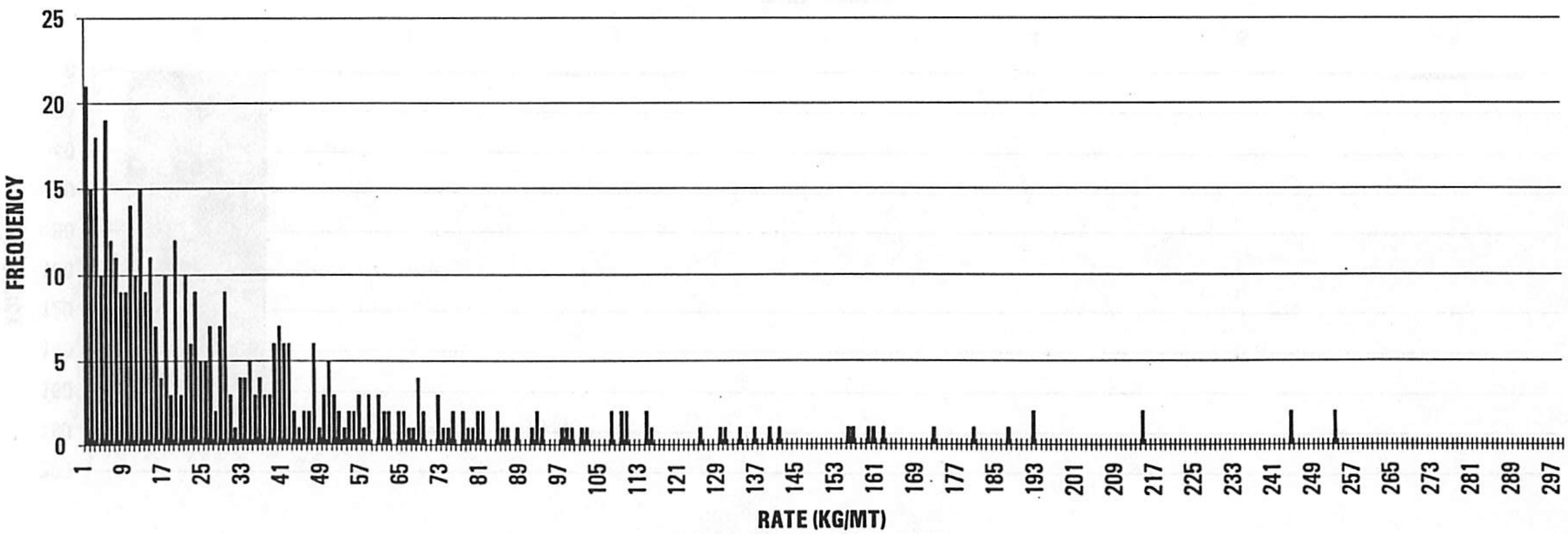


92 BSA ROCK SOLE, OTHER FLATS, PACIFIC COD, ROCKFISH, ATKA MACKEREL

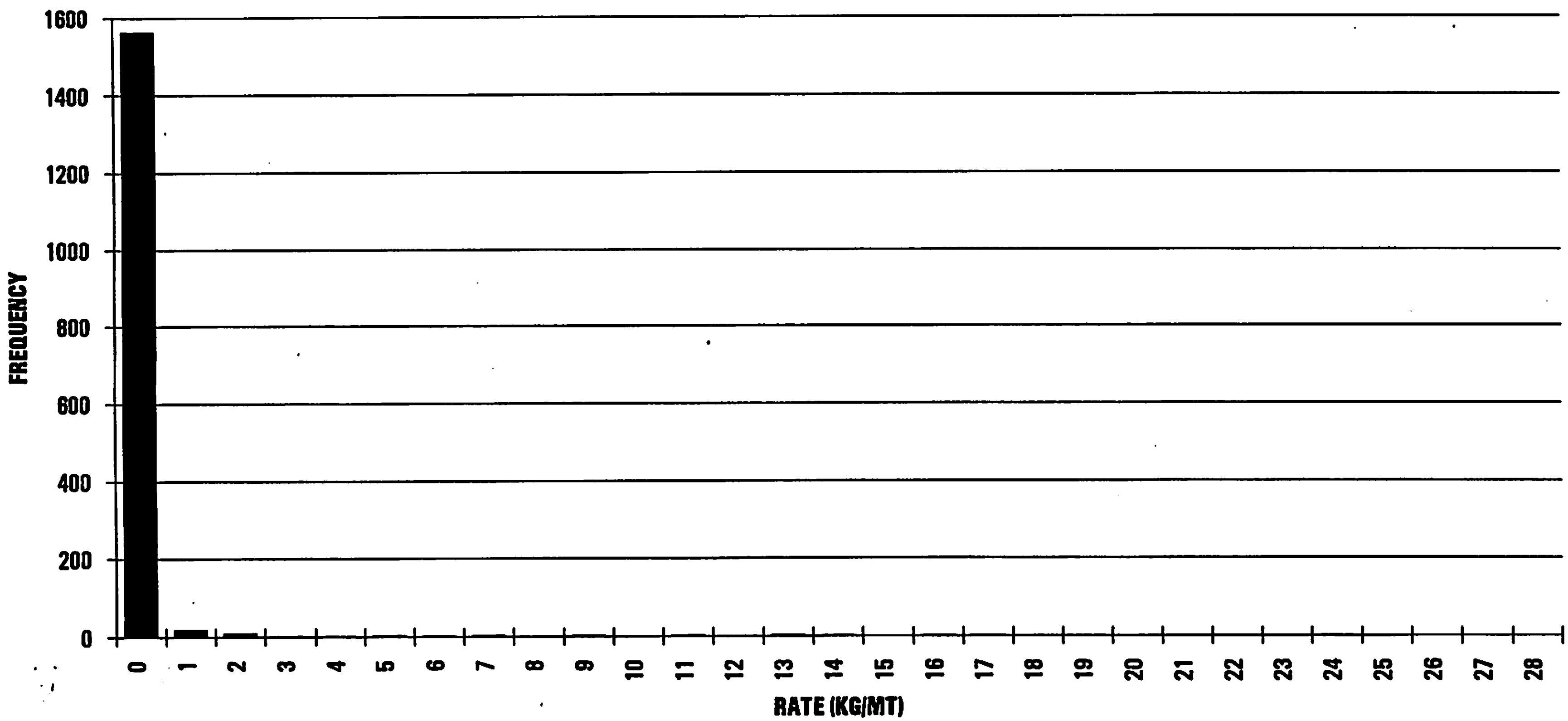


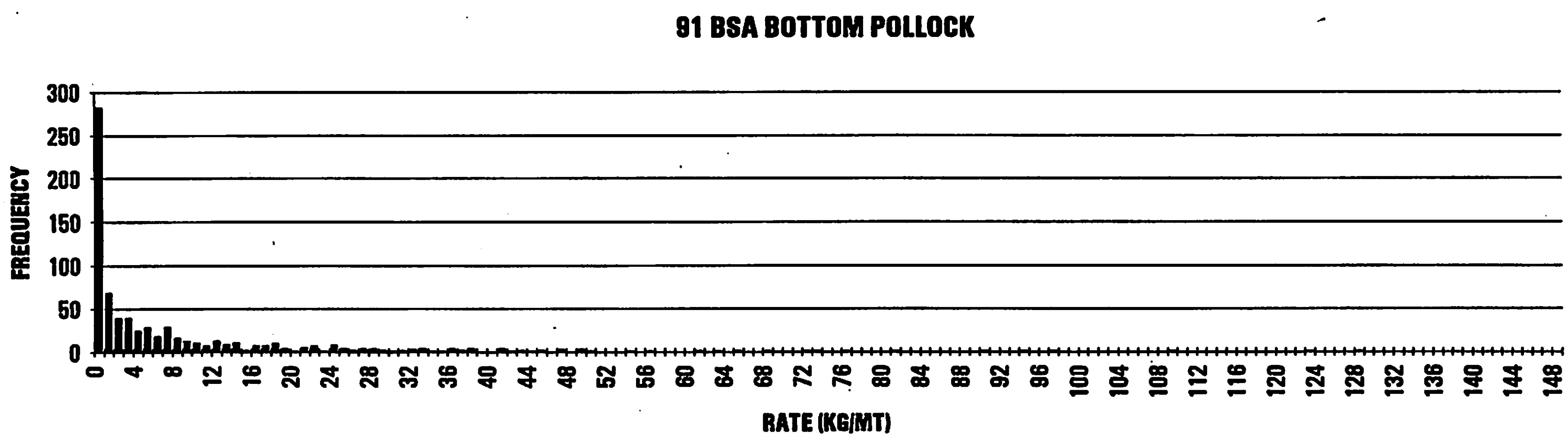

92 GOA MIDWATER POLLOCK
FREQUENCY
200
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
RATE (KG/MT)

92 GOA BOT.POLLOCK, COD,ROCKFISH,DEEP & SHALLOW FLATFISH

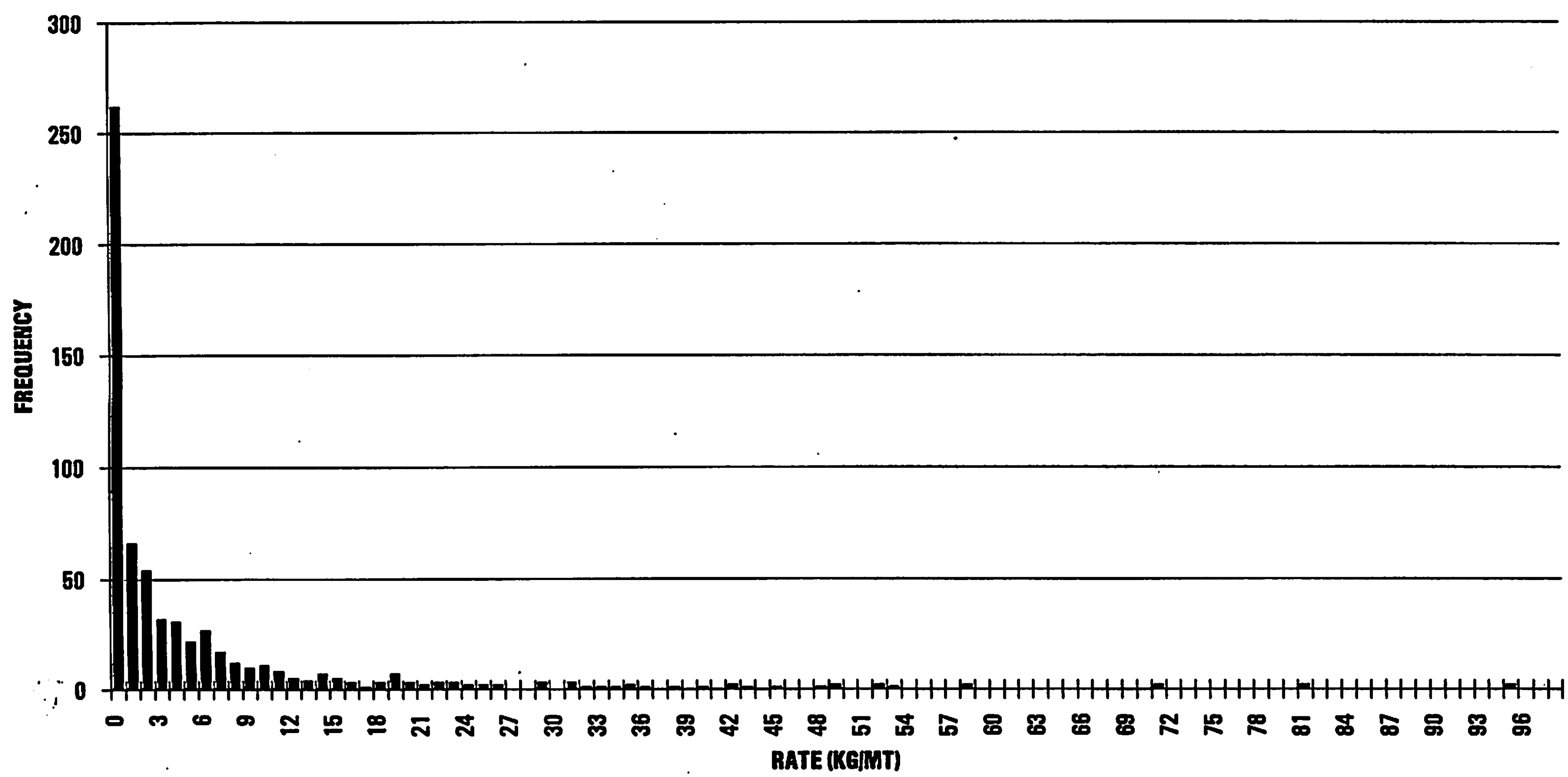


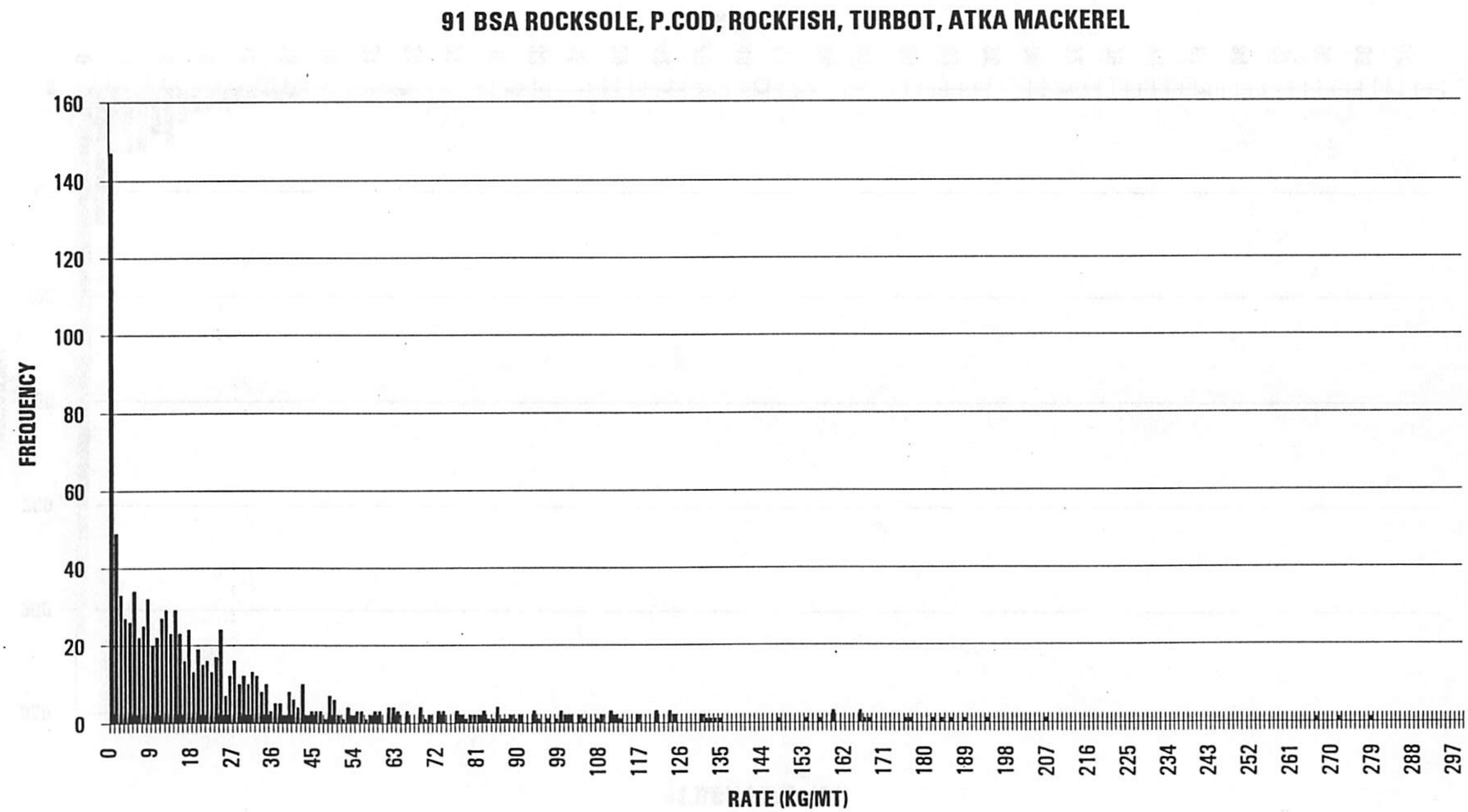
91 BSA MIDWATER POLLOCK

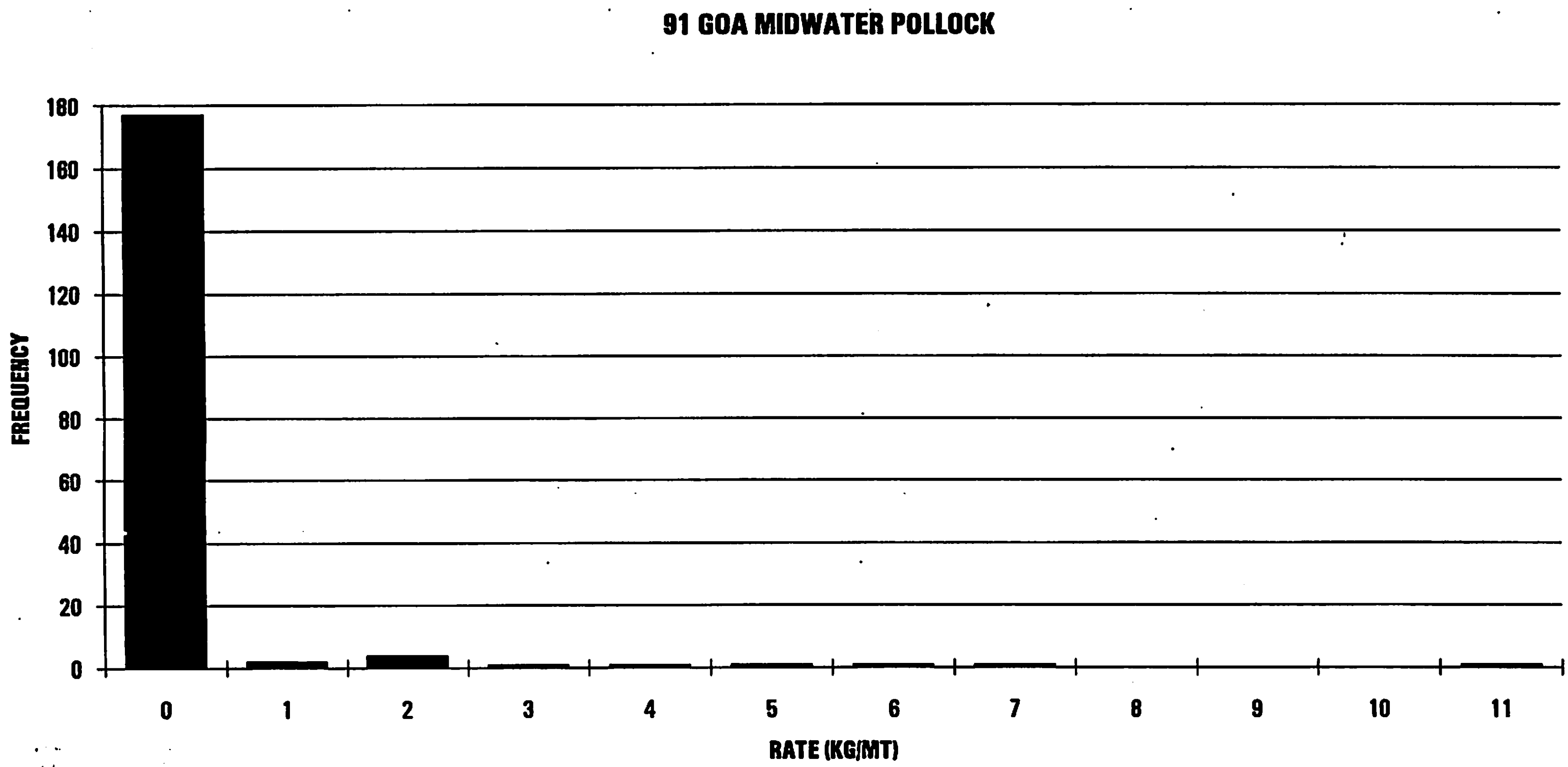



91 BSA BOTTOM POLLOCK
FREQUENCY
300
250
200
150
100
50
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96 100 104 108 112 116 120 124 128 132 136 140 144 148
RATE (KG/MT)

91 BSA FLATFISH




91 BSA ROCKSOLE, P.COD, ROCKFISH, TURBOT, ATKA MACKEREL
FREQUENCY
160
140
120
100
80
60
40
20
0
0 9 18 27 36 45 54 63 72 81 90 99 108 117 126 135 144 153 162 171 180 189 198 207 216 225 234 243 252 261 270 279 288 297
RATE (KG/MT)


91 GOA MIDWATER POLLOCK
FREQUENCY
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
RATE (KG/MT)

91 GOA BOTTOM POLLOCK, P. COD, ROCKFISH, DEEP AND SHALLOW WATER FLATFISH