AGENDA D-1(c, d)
DECEMBER 1996

MEMORANDUM

TO: Council, SSC and AP Members

FROM: Clarence G. Pautzke
Executive Director

DATE: December 3, 1996

SUBJECT: Final Gulf of Alaska Groundfish Specifications for 1997

ESTIMATED TIME
11 HOURS
(all D-1 items)

ACTION REQUIRED

(c) Approval of Final 1997 Stock Assessment and Fishery Evaluation (SAFE) report for GOA groundfish fisheries for 1997.

(d) Approval of final GOA groundfish specifications for 1997:
1. Acceptable Biological Catch (ABC) and Annual Total Allowable Catch (TAC)
2. PSC Limits for halibut by gear
3. Halibut discard mortality rates and stock assessment report.

BACKGROUND

At this meeting, the Council is scheduled to approve the 1997 Final SAFE report and specify final groundfish quotas and bycatch allowances for the Gulf of Alaska for the 1997 fishing year. Within the specification process for 1997, the Council may choose to set separate ABCs and TACs for the nearshore and offshore components of pelagic shelf rockfish, as described under Agenda D-1(b). The Council will also approve halibut discard mortality rates for 1997.

(c) Approve GOA SAFE Document for Public Review

The Gulf of Alaska (GOA) Groundfish Plan Team met November 18-21, 1996 in Seattle to prepare the final 1996 SAFE report distributed on November 27, 1996. The final SAFE report contains the Plan Team's recommendations for ABCs for all groundfish species covered under the FMP and halibut bycatch for establishing PSC apportionments. Tables 1, 2, and 3 from the SAFE summary chapter (Items D-1(c)(1), D-1(c)(2), and D-1(c)(3)) list the 1996 ABCs, TACs, and catches through November 9, 1996, and the Plan Team's recommended 1997 ABCs and corresponding overfishing levels for each of the species or species complexes. None of the Plan Team's recommended ABCs exceeds its corresponding overfishing level. Minutes from the Joint GOA/BSAI Team Meeting are included under Item D-1(c)(4). Minutes from the GOA Plan Team meeting will be provided as a supplemental item during the meeting.

(d) Initial ABCs, TACs, and Apportionments for the 1997 GOA Fisheries

Tables 1 - 3 compare the 1996 and recommended 1997 ABCs, overfishing levels, and stock status of 16 GOA groundfish management groups. The Plan Team's recommended ABCs for 1997 total 495,410 mt. The sum of 1996 ABCs is 475,170 mt and TACs were set at 260,207 mt. Groundfish catch through November 9, 1996 totaled 199,992 mt, or 77% of allowable landings. The SSC and AP recommendations will be provided to the Council during the week of the Council meeting.

The results of the 1996 NMFS trawl survey were incorporated into all stock assessments except for sablefish and demersal shelf rockfish (DSR), which are assessed from longline surveys. The 1996 assessments indicated significant increases in ABCs since last year for pollock (from 54,810 to 79,980 mt), Pacific cod (from 65,000 to 81,500 mt), and Pacific ocean perch (POP) (from 8,060 to 12,990 mt). Thornyheads also increased from 1,560 to 1,700 mt. The 1996 assessment indicated slight to moderate declines for all species of flatfish and rockfish, except for POP. DSR were unassessed in 1996 and Atka mackerel biomass estimates were determined to be unreliable, so 1996 ABCs were rolled over for both species.

For sablefish, the Plan Team recommended a rollover of the combined 1996 GOA and BSAI ABC (19,600 mt), using the 1996 longline survey biomass apportionments for each area. The Team decided that the $F_{40\%}$ adjusted ABC was too high given the declining trend in abundance and lack of recent recruitment. This decision resulted in a slight decrease in the 1997 GOA ABC (from 17,080 to 16,560 mt). The Team recommendation differed from that of the stock assessment authors. While the authors also decided that the $F_{40\%}$ adjusted ABCs were too optimistic, they calculated a range of ABCs between 16,800 to 17,600 mt, based on equilibrium adjusted values in 3-year increments. The authors recommended a combined area ABC of 17,200 mt based on the mid-point of the range and a 1997 ABC of 14,525 mt for the Gulf.

Initial PSC Limits for Halibut

The PSC limits for halibut in the Gulf of Alaska are set by gear type and may be apportioned seasonally over the fishing year. In recommending seasonal allocations, the Council will consider its objective to promote harvest of as much of the groundfish optimum yield as possible with a given amount of halibut PSC.

During 1996, halibut PSC mortality applied only to the bottom trawl fisheries and to the hook-and-line fisheries. The sablefish hook-and-line fishery, the pot fishery (primarily Pacific cod), and the midwater trawl fishery (primarily pollock) have all been exempted from bycatch-related closures. The following halibut PSC apportionments were approved by the Council for 1996:

Trawl gear			**Hook and Line**		
1st quarter	600 mt	(30%)	1st trimester	250 mt	(86%)
2nd quarter	400 mt	(20%)	2nd trimester	15 mt	(5%)
3rd quarter	600 mt	(30%)	3rd trimester	25 mt	(9%)
4th quarter	400 mt	(20%)	DSR	10 mt	
	2,000 mt			300 mt	

Beginning in 1994, PSC limits for trawl gear were further apportioned by specific fishery. The Council may apportion PSC limits by fishery during the annual specification process. Apportionments of the overall cap may be made to a 'shallow water complex' and a 'deep water complex.' Species in the shallow water complex are: pollock, Pacific cod, shallow water flatfish, Atka mackerel, and other species. Deep water complex species include: deep water flatfish, rockfish, flathead sole, sablefish, and arrowtooth flounder. The following apportionments were made for 1996:

Quarter	Shallow water Complex	Deep water Complex	Total
1	500 mt	100 mt	600 mt
2	100 mt	300 mt	400 mt
3	200 mt	400 mt	600 mt
4	No apportionment		400 mt

Halibut Discard Mortality Rates

Pacific halibut bycatch discard mortality rates in the Alaskan groundfish fisheries are routinely estimated from viability data collected by NMFS observers. These data are analyzed by staff of the International Pacific Halibut Commission (IPHC) and the National Marine Fisheries Service (NMFS), which results in recommendations to the Council for managing halibut bycatch in the upcoming season.

The Teams requested that IPHC provide additional information on the number of vessels observed, hauls sampled, and sampled fish and reexamine the recommended rates for the 1995 GOA hook-and-line rockfish fishery and 1992 BSAI sablefish pot fishery. Table 5 of Attachment 2 lists the revised IPHC recommendations for setting discard mortality rates for the 1997 fishery.

Table 1. Gulf of Alaska groundfish 1996 and 1997 ABCs, 1996 TACs, and 1996 catches reported through November 9, 1996. MSY is unknown for all species.

SPECIES		ABC (mt) 1996	ABC (mt) 1997	TAC 1996	CATCH 1996
Pollock	W (61)	25,480	18,600	25,480	24,190
	C (62)	12,840	31,250	12,840	12,247
	C (63)	13,680	24,550	13,680	13,165
	E	2,810	5,580	2,810	604
	TOTAL	54,810	79,980	54,810	50,206
Pacific Cod	W	18,850	28,500	18,850	19,798
	C	42,900	51,400	42,900	47,238
	E	3,250	1,600	3,250	930
	TOTAL	65,000	81,500	65,000	67,966
Deep water flatfish[1]	W	670	340	460	19
	C	8,150	3,690	7,500	1,954
	E	5,770	3,140	3,120	167
	TOTAL	14,590	7,170	11,080	2,140
Rex sole	W	1,350	1,190	800	503
	C	7,050	5,490	7,050	5,123
	E	2,810	2,470	1,840	115
	TOTAL	11,210	9,150	9,690	5,741
Shallow water flatfish[2]	W	26,280	22,570	4,500	430
	C	23,140	19,260	12,950	8,547
	E	2,850	1,320	1,180	28
	TOTAL	52,270	43,150	18,630	9,005
Flathead sole	W	8,880	8,440	2,000	827
	C	17,170	15,630	5,000	2,064
	E	2,740	2,040	2,740	61
	TOTAL	28,790	26,110	9,740	2,952
Arrowtooth flounder	W	28,400	31,340	5,000	2,011
	C	141,290	142,100	25,000	19,490
	E	28,440	24,400	5,000	682
	TOTAL	198,130	197,840	35,000	22,183
Sablefish	W	2,200	2,120	2,200	1,641
	C	6,900	7,310	6,900	6,747
	WY	3,040	2,750	3,040	2,843
	EY/SEO	4,940	4,380	4,940	4,595
	TOTAL	17,080	16,560	17,080	15,826
Other Slope rockfish	W	180	20	100	19
	C	1,170	650	1,170	619
	E	5,760	4,590	750	241
	TOTAL	7,110	5,260	2,020	879

(Table 1 continued)

SPECIES		ABC (mt) 1996	ABC (mt) 1997	TAC 1996	CATCH 1996
Northern rockfish	W	640	840	640	170
	C	4,610	4,150	4,610	3,192
	E	20	10	20	24
	TOTAL	5,270	5,000	5,270	3,386
Pacific ocean perch	W	1,460	1,840	1,260	987
	C	3,860	6,690	3,333	5,136
	E	2,740	4,460	2,366	2,241
	TOTAL	8,060	12,990	6,959	8,364
Shortraker/rougheye	W	170	160	170	126
	C	1,210	970	1,210	956
	E	530	460	530	577
	TOTAL	1,910	1,590	1,910	1,659
Pelagic shelf rockfish[3]	W	910	570	910	178
	C	3,200	3,320	3,200	1,868
	E	1,080	990	1,080	256
	TOTAL	5,190	4,880	5,190	2,302
Demersal Shelf Rockfish[4]		950	950	950	401
Atka Mackerel	W			2,310	1,572
	C			925	8
	E			5	0
	TOTAL	3,240	1,580	3,240	1,580
Thornyhead rockfish	GW	1,560	1,700	1,248	1,100
Other Species	GW	NA	NA	12,390	4,302
TOTAL		475,170	495,410	260,207	199,992

1/ Deep water flatfish includes dover sole, Greenland turbot and deepsea sole.
2/ "Shallow water flatfish" includes rock sole, yellowfin sole, butter sole, starry flounder, English sole, Alaska plaice, and sand sole.
3/ Plan Team has recommended removal of black and blue rockfishes from the FMP.
4/ Redbabnded rockfish was removed from DSR and combined with other slope rockfish beginning in 1995.
NOTE:
ABCs and TACs are rounded to nearest 10, except for Pacific ocean perch.
GW means Gulfwide.
Catch data source: NMFS Blend Reports.

Table 2. Gulf of Alaska exploitable biomasses, 1997 ABCs, and estimated trends and abundance for Western, Central, Eastern, Gulfwide, West Yakutat, and Southeast Outside regulatory areas.

SPECIES		ABC	1997 Overfishing Level	Abundance[1] Trend
Pollock	W (61)	18,600		Below
	C (62)	31,250	103,500	declining
	C (63)	24,550		
	E	5,580	7,770	
	TOTAL	79,980	111,270	
Pacific Cod	W	28,500		Above
	C	51,400		declining
	E	1,600		
	TOTAL	81,500	180,000	
Deep water flatfish	W	340		Unknown,
	C	3,690		Unknown
	E	3,140		
	TOTAL	7,170	9,440	
Rex sole	W	1,190		Unknown,2
	C	5,490		Stable
	E	2,470		
	TOTAL	9,150	11,920	
Shallow water flatfish	W	22,570		Unknown,[2]
	C	19,260		increasing
	E	1,320		
	TOTAL	43,150	59,540	
Flathead sole	W	8,440		Unknown,[2]
	C	15,630		stable
	E	2,040		
	TOTAL	26,110	34,010	
Arrowtooth flounder	W	31,340		Above,
	C	142,100		stable
	E	24,400		
	TOTAL	197,840	280,800	
Sablefish	W	2,120		Low,
	C	7,310		declining
	WYK	2,750		
	EY/SEO	4,380		
	TOTAL	16,560	35,950	
Other Slope rockfish	W	20		Unknown,
	C	650		unknown
	E	4,590		
	TOTAL	5,260	7,560	

(Table 2 continued)

SPECIES		ABC	1997 Overfishing Level	Abundance Trend
Northern rockfish	W	840		Unknown, unknown
	C	4,150		
	E	10		
	TOTAL	5,000	9,420	
Pacific ocean perch	W	1,840	2,790	Below, increasing
	C	6,690	10,180	
	E	4,460	6,790	
	TOTAL	12,990	19,760	
Shortraker/ rougheye	W	160		Unknown, Unknown
	C	970		
	E	460		
	TOTAL	1,590	2,740	
Pelagic shelf rockfish[3]	W	570		Unknown, Unknown
	C	3,320		
	E	990		
	TOTAL	4,880	8,190	
Demersal shelf rockfish	SEO	950	1,450	Unkown, unknown
Atka mackerel	GW	1,580	6,200	Unkown, unknown
Thornyhead rockfish	GW	1,700	2,400	Unknown, stable
Other species				TAC = 5% of the sum of TACs.

1/ Abundance relative to target stock size as specified in SAFE documents.
2/ Historically lightly exploited therefore expected to be above the specified reference point.
3/ Plan Team has recommended removal of black and blue rockfishes for the FMP.
NOTE:
ABCs are rounded to nearest 10.
Overfishing is defined Gulf-wide, except for pollock and POP.
Northern rockfish were separated from slope rockfish in 1993.
Rex sole was part of deepwater flatfish until 1994.
Redbanded rockfish removed from DSR beginning in 1995 and combined with other slope rockfish.

Table 3. Summary of fishing mortality rates for the Gulf of Alaska, 1997.

Species	ABC Rate[1]	FABC[2]	OFL Rate[3]	F_{OFL}
Pollock	0.275	$F_{40\% \text{ adjusted}}$	0.41	$F_{30\% \text{ adjusted}}$
Pacific cod	0.18	F_{ABC}	0.45	$F_{30\%}$
Deepwater flatfish	NA	F_{ABC}[4]	NA	F_{ofl}[5]
Rex sole	0.15	F=.75M	0.20	F=M
Flathead sole	0.15	F=.75M	0.20	F=M
Shallow water flatfish	0.15-0.17	F=.75M, $F_{40\%}$[6]	0.2-0.25	F=M, $F_{30\%}$[7]
Arrowtooth	0.185	$F_{0.40}$	0.271	$F_{30\%}$
Sablefish	0.76	F_{abc}	0.175	$F_{30\%}$[8]
Pacific ocean perch	0.056	$F_{40\% \text{ adjusted}}$	0.08	$F_{30\% \text{ adjusted}}$
Shortraker/rougheye	0.22/0.025	F=.75M, F=M[9]	0.03/0.046	$F_{30\%}$F=M[10]
Rockfish (other slope)	0.03-0.75	F=.75M, F=M[12]	0.04-0.10	F_{30}[11]
Northern rockfish	0.060	F=M	0.113	$F_{30\%}$
Pelagic Shelf Rockfish	0.09	F=M	0.151	$F_{30\%}$
Demersal Shelf Rockfish	0.020	F=M	0.034	$F_{30\%}$
Thornyhead rockfish	.062	$F_{40\%}$	0.89	$F_{30\%}$
Atka mackerel	0.30	F=M	0.45	$F_{30\%}$

1/ Maximum 1993 catch level allowable under overfishing definition.
2/ Fishing mortality rate corresponding to acceptable biological catch.
3/ Maximum fishing mortality rate allowable under overfishing definition.
4/ F_{ABC}=.75M for Dover sole, ABC=.75 x average catch (1978-1995) for other deepwater flatfish.
5/ F=M for Dover sole, average catch (1978-1995) for other deepwater flatfish.
6/ $F_{40\%}$ for rocksole, F=.75M for remaining shallowater flatfish.
7/ $F_{30\%}$ for rocksole, F=M for remaining shallow water flatfish.
8/ Adjusted by ratio of current biomass to $B_{40\%}$.
9/ F=.75M for shortraker, F=M for rougheye
10/ $F_{30\%}$ for rougheye, F=M for shortraker.
11/ $F_{30\%}$ for sharpchin, F=M for other species.
12/ F=M for Sharpchin rockfish, F=.75M for other species

AGENDA D-1(c)(4)
DECEMBER 1996

Draft Minutes of the Joint GOA and BSAI Groundfish Plan Team Meeting November 18-21, 1996

Members Present:

Bering Sea/Aleutian Islands Team
Loh-lee Low (NMFS-AFSC, Chair)
Dave Colpo (NMFS-AFSC)
Rich Ferrero (NMML)
Vivian Mendenhall (USFWS)
Mike Sigler (NMFS-ABL)
Andrew Smoker (NMFS-AKRO)
Grant Thompson (NMFS-AFSC)
Ivan Vining (ADF&G)
Farron Wallace (WDF)
Dave Witherell (NPFMC)
Brenda Norcross (UAF)
Dave Ackley (ADF&G)

Gulf of Alaska Team
Sandra Lowe (NMFS-AFSC, Chair)
Bill Bechtol (ADF&G)
Kaja Brix (NMFS-AKRO)
Jane DiCosimo (NPFMC)
Jeff Fujioka (NMFS-AB)
Lew Haldorsen (UAF)
Jim Hastie (NMFS-AFSC)
Jon Heifetz (NMFS-AB)
Jim Ianelli (NMFS-AFSC)
Vivian Mendenhall (USFWS)
Tory O'Connell (ADF&G)
John Sease (NMML)
Farron Wallace (WDF)
Dave Jackson (ADF&G)

The Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) Groundfish Plan Teams met November 18-21, 1996 at the Alaska Fisheries Science Center. The meeting was open to the public, and several industry representatives attended. A packet of materials was distributed to team members prior to the meeting, and several additional documents were distributed at the meeting. The agenda included a review of the revised combined GOA/BSAI sablefish stock assessment, halibut discard mortality rates and stock assessment, 1996 ecosystem considerations chapter, the revised forage fish amendment, groundfish summary proposals, research priorities, and SAFE issues referred by the SSC.

The meeting convened briefly on Monday afternoon with introductions, a review of the agenda and a discussion of SSC concerns. The teams welcomed new GOA Plan Team member Dave Jackson of ADF&G. The teams met again jointly on Thursday for the remaining topics.

At the September 1996 Council meeting, the SSC requested that the Plan Teams consider seven specific concerns identified in the September 1996 SSC minutes. A working group of AFSC scientists convened to address those concerns. The Team reviewed the working groups' response and affirmed their findings. Their summary is appended to these minutes as Attachment 1.

Gregg Williams presented the IPHC staff recommendations for 1997 halibut discard mortality rates. The teams requested that IPHC staff provide: (1) additional information on the number of vessels observed, the number of hauls sampled, and size frequency; (2) revised estimates for the 1995 Gulf of Alaska hook-and-line rockfish fishery; and (3) revised estimates for the 1992 BSAI sablefish pot fishery. Original estimates for 1995 GOA H&L rockfish indicated a discard mortality rate of 60%, and a preseason assumed discard mortality rate of 34%. The Teams believed these values to be unusually high and asked that staff further examine the observer data. Mr. Williams later determined that an IFQ halibut trip had been inadvertently included in the data for this fishery. Removing these data results in a 1995 discard mortality rate of 4%, and a final recommendation for 1997 of 6%. original estimates indicated a discard mortality rate of 65% for the 1992 BSAI sablefish fishery, and a preseason assumed discard mortality rate of 65%. The Teams thought these values seemed unusually high. Upon reexamination, IPHC determined that sampling was limited to relatively few hauls and were not representative of the overall fishery. IPHC staff revised the recommendation for 1997 from 65% to 10%, which is the value used for the cod fishery. The revised IPHC reports are appended to the minutes as Attachment 2. The Team supported the recommendation of the IPHC rates to the Council. They further recognized that industry would request that the Council apply seasonal rates as supplied by IPHC staff and would support seasonal rates.

Mr. Williams also briefed the teams on the pending results of the revised halibut stock assessment. The IPHC was conducting their interim meeting in Seattle during the same week as the Team meeting. He distributed a press release that reported that halibut quotas were expected to increase for all regulatory areas in 1997. Team members reported that they would like to review the assessment methodology at their next meeting. Findings of a regime shift for halibut parallels results of similar findings for other groundfish stocks. A review would benefit all scientific staffs. This will be scheduled for August 1997.

The teams reviewed the draft ecosystem chapter and made several recommendations. Dave Witherell provided a brief overview of the chapter's contents, noting that several new sections were added this year. New sections included a general literature review of ecosystem-based management, a discussion of seabird status and interactions with fisheries, and recent research on localized depletion of Atka mackerel. Consequently, the teams added additional ecosystem concerns for this years chapter: (1) localized depletion of Atka mackerel; (2) seabird declines; and (3) effects of fishing gear on habitat and ecosystems. Concerns expressed last year of crab predation by fish, along with disproportionate harvest rates of groundfish, was combined into one concern "fishery effects on species composition." The teams recommended that next year's chapter include a review of literature on gear impacts to habitat [to be completed by Ivan Vining], status of sea otters and ecosystem relationships [Rich Ferrero], and approaches being taken to address ecosystem management and getting this information into the quota setting process [Richard Merrick, Anne Hollowed, and Vivian Mendenhall].

The teams also had a general discussion of ecosystem-based management and collection of local knowledge. The teams agreed that ecosystem research is important and endorse those studies already underway (e.g., PICES, FOCI). However, team members felt that agencies need to focus more on ecosystem modeling of key stocks. Specifically, the teams recommend that NMFS create a new ecosystem group (including a multi-species modeler and anthropologist) to focus on how to incorporate ecosystem information into stock assessments. The teams also felt that local and traditional knowledge may provide early indications of regime shifts and other changes that could be valuable to managers. As such, the team formed a committee to examine ways to collect local knowledge, a summary of which would be included in future ecosystem considerations chapters. The committee consists of Ivan Vining (chair), Vivian Mendenhall, and Richard Merrick. Chris Blackburn also volunteered to assist. It was suggested that the group could work with ADF&G Subsistence Division and the USFWS community liaisons, as well as getting the word out through the Council's Advisory Panel.

The teams received the forage fish amendment during the meeting and were directed to provide comments directly to the author, Kaja Brix at the Alaska Region. The Teams approved a draft of plan amendment summaries provided by Jane DiCosimo. The Teams also separately provided revisions to the Council's research priorities. They are incorporated into the revised Council recommendations to NMFS that will be approved during the December 1996 meeting.

Others in attendance at the joint meeting were:

Laure Jansen	Tamra Faris	Denise Fredette
Chris Blackburn	Fran Bennis	Mike Szymanski
Pat Livingston	Denby Lloyd	Anne Hallowed
Lowell Fritz	Ken Stump	Dave Fluharty
Thorn Smith	Hazel Nelson	Kevin O'Leary
Kim Dietrich	Michiyo Shima	Brent Paine
Eric Brown	Michael Guttormsen	Chris Wilson

ATTACHMENT 1

SAFE Working Group Meeting Summary

The SAFE Working Group consisting of Lowell Fritz, Anne Hollowed, Jim Ianelli, Sandra Lowe, and Grant Thompson met October 7, 1996 to discuss the seven SAFE concerns raised by the SSC at the September Council meeting. These concerns which are in the September SSC minutes, are listed below with the following italicized responses from the group.

General SAFE Issues

The SAFE documents, implications of Amendment 44 on ABCs and OFLs, and ecosystem considerations led the SSC to raise the following issues with the groundfish teams for their examination and comments. The SSC recognizes that these issues may not be resolved between now and December.

1. Adjustment of $F_{40\%}$ to the middle of the spawning period (e.g., Atka mackerel): The issue is whether $F_{40\%}$ should be calculated based on spawning biomass at the middle of the spawning period. The Atka mackerel assessment showed how different the recommended F and corresponding ABC can be when the middle of the spawning period is used rather than the typical January 1 spawning biomass. It is unclear which approach has been used in other groundfish stock assessments. The advantages and disadvantages of the two approaches need to be laid out, and a consistent approach adopted for all assessments.

The working group agreed that the calculation of spawning biomass is most appropriately calculated at the middle of the spawning period. For species that spawn during the winter, using a January 1 date as a proxy may not have much of an impact on the $F_{40\%}$ calculations, in contrast to what was seen for Atka mackerel which is a summer spawner and has very fast growth rates. The stock assessment authors will be asked to specify whether they are assuming a January 1 date or the peak spawning date in their calculations of spawning biomass. They will be advised that assuming a peak spawning date is most appropriate.

2. Biomass-based adjustment of $F_{40\%}$ by the factor $(1\text{-}B/B_{40\%})$: The issue is whether total biomass, exploitable biomass, spawning biomass, or some other biomass measure should be used in the adjustment. Currently, where this is done, it appears that spawning biomass is used. This choice needs to be justified. Because the adjustment is related to full-recruitment fishing mortality, the adjustment should probably be related to fully-recruited ages, which often are similar to mature ages. An evaluation of harvest policies with different measures of biomass should be undertaken, with clear specification of objective criteria.

Grant agreed to provide a paragraph stating that spawning biomass appears to be the most reasonable biomass measure to track, and that an evaluation of harvest policies could be done at a later date. Please see attached paragraph submitted by Grant Thompson (11/18/96).

3. Use of harvest policies based on use of historical average recruitment: Most groundfish harvest policies are based on multiplication of projected biomass by a harvest rate. Some assessments (e.g., POP in the Bering Sea and Aleutians, the Gulf Team's recommendation for P. cod ABC) are using an alternative procedure, which involves determining the expected or equilibrium yield based on historical recruitment patterns. The SSC would appreciate Plan Team comment on which approach is appropriate. As in 2, evaluation of these harvest policies is needed.

The determination of whether and when to employ a constant catch or a constant exploitation strategy should be made on a case by case basis. Depending on the species' life history and fishery characteristics, cases can be made for either of the constant policies. Both policies have economic implications which would need to be considered. A bioeconomic analysis would be appropriate to evaluate these types of harvest policies at a later date.

4. Determination of $B_{40\%}$. One of the main features of Amendment 44 is to use $B_{40\%}$ as a target biomass level and to adjust fishing mortality downward when biomass is less than this target biomass. $B_{40\%}$ is determined by multiplying biomass per recruit by an estimate of average recruitment. The issue is the best measure of central tendency: average, median, mode, and which set of time periods to use. The current default appears to be using the average over all years. However if recruitment is highly variable and skewed, then the average recruitment could exceed recruitment in most years, requiring downward adjustment of fishing mortality in those years. If recruitment is assumed to be lognormal, then a better choice would be to use the geometric mean or median. A rationale needs to be laid out.

It was noted that utilizing the geometric mean would result in a less conservative harvest strategy ($B_{40\%}$ would be at a lower level). The use of the arithmetic mean is recommended. The more critical aspect of this issue, is what years to use in the calculation of average recruitment. The stock assessment authors will be asked to state explicitly what years they deem appropriate to include in their average recruitment calculation , and the rationale. They will be asked not to include recruitment values that they believe to be poorly estimated.

5. Additional information needed in the SAFE's: Amendment 44 has resulted in greater complexity of the ABC and OFL specifications. At least until basic procedures are specified and followed, there is need to present clearly how these specifications were obtained, that is, which tier, which ranges of years were used for average recruitment, which measure of biomass was used for downward adjustment.

The stock assessment authors will be asked to state explicitly which tier their species falls into, the range of years used for average recruitment, and which measure of biomass is used to calculate $B_{40\%}$ (spawning biomass will be suggested as the most appropriate).

6. Overparameterization: Many stock assessment models have tens if not hundreds of parameters. An emerging issue is whether these models are overparameterized. (An overparameterized model may fit the data but has biased parameter estimates that could lead to errors in ABC and OFL.) Because data are frequently variable and data sets are sometimes contradictory, uncertainty in stock assessments needs to be made more explicit. At least three potential directions could be followed: (1) use the Akaike or Bayesian Information Criterion to select parsimonious models; (2) conduct sensitivity and/or Monte Carlo studies to examine parameter effects on biomass and ABC estimates; or, (3) place prior probability distributions on uncertain parameters and use Bayesian methods with stock assessment models to develop posterior distributions for these parameters.

Please see accompanying discussion paper submitted by Grant Thompson (11/18/96).

7. Differential exploitation: The Teams note in the Ecosystem Considerations section of the SAFE that flatfishes are exploited at lower exploitation rates than many other groundfish species. The lower exploitation relates to constraints imposed by bycatch limits and the overall OY cap. It is unclear what changes in species compositions might result by persistent differential exploitation. It might be possible to learn more about these effects by GIS studies of survey and observer data to see if areas can be delineated where flatfish exploitation has been above or below average and whether differences in species compositions are apparent. Second, it might be possible to define adaptive management policies or experiments that attempt to learn more about this issue. For example, one might protect flatfish on a number of small areas and see if species composition differs compared to similar unprotected areas.

This is an area of research which might allow us to gain valuable knowledge. However, it is a long-term and large-scale project. This suggested research has been relayed to the scientists working on flatfish.

Plan Team Response to Point #2 in the SSC's 9/96 list of "General SAFE Issues"

The SSC's concern was minuted as follows:

> "Biomass-based adjustment of $F_{40\%}$ by the factor $(1\text{-}B/B_{40\%})$: The issue is whether total biomass, exploitable biomass, spawning biomass, or some other biomass measure should be used in the adjustment. Currently, where this is done, it appears that spawning biomass is used. This choice needs to be justified. Because the adjustment is related to full-recruitment fishing mortality, the adjustment should probably be related to fully-recruited ages, which often are similar to mature ages. An evaluation of harvest policies with different biomass measures should be undertaken, with clear specification of objective criteria."

Due to time constraints, the Plan Teams have so far been unable to undertake a formal evaluation of alterative harvest policies along the lines requested by the SSC. Pending completion of such an evaluation, however, the Plan Teams feel that it would be reasonable to adopt spawning biomass as the appropriate measure to use in the adjustment formula. The Plan Teams' justification for this choice is that spawning biomass is the measure most consistent with the use of spawning-per-recruit (SPR) as the basis for defining biological reference points. The motivation for using SPR-based reference points is that they are designed to preserve the spawning potential of the stock. In computing these reference points, spawning biomass is typically used as a proxy for the actual amount of spawning. If spawning biomass is used as a proxy for the actual amount of spawning in the computation of SPR values, it seems logical to use spawning biomass as the measure by which SPR reference points are scaled. If conservation of the stock's spawning potential is the motivation for adopting a biomass-based adjustment factor, it would be difficult to justify a decision to limit this adjustment to the biomass of fully recruited ages, except in those cases where exploitable biomass is used as a proxy for spawning biomass. A decision to restrict the adjustment to fully recruited ages would be especially problematic in cases where the selectivity curve is strongly domed, meaning that only a single age or size group would be included in the adjustment.

Some Thoughts on the Problem of Overparametrization

--A Paper for Discussion Purposes Only--

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Introduction

At its September, 1996 meeting, the North Pacific Fishery Management Council's Scientific and Statistical Committee (SSC) asked the Groundfish Plan Teams to comment on a number of general issues. Among these was the issue of assessment model "overparametrization." Specifically, the SSC minutes (page 13) state the following:

> "Many stock assessment models have tens if not hundreds of parameters. An emerging issue is whether these models are overparameterized. (An overparameterized model may fit the data but has biased parameter estimates that could lead to errors in ABC and OFL.) Because data are frequently variable and data sets are sometimes contradictory, uncertainty in stock assessment needs to be made more explicit. At least three potential directions could be followed: (1) use the Akaike or Bayesian Information Criterion to select parsimonious models; (2) conduct sensitivity and/or Monte Carlo studies to examine parameter effects on biomass and ABC estimates; or, (3) place prior probability distributions on uncertain parameters and use Bayesian methods with stock assessment models to develop posterior distributions for these parameters."

At least two premises are implicit in the concept of "overparametrization:" First, that the level of parametrization is quantifiable, and second, that there is some objective against which the level of parametrization can be evaluated (i.e., there is some "optimal" number of parameters, with fewer parameters implying underparametrization and more parameters implying overparametrization). Both of these premises are problematic. First, counting the number of parameters in a model is not always a straightforward exercise, as the line between "parameter" and "assumption" can be indistinct. Second, a number of possible objectives can be imagined, and it is not immediately obvious which is the "right" one. The SSC minute suggests that minimization of bias in parameter estimates might be a suitable objective, but so might minimization of variance in parameter estimates or minimization of correlation between parameter estimates. In the context of stock assessment, it is not clear that any of these is the appropriate objective; perhaps "maximization of prudence in the selection of a recommended catch level" would be more appropriate.

What is a Parameter?

Before the number of parameters can be counted, it is necessary to know what one is. One possible definition might be the following: A "parameter" is an unknown arbitrary constant appearing in a model, where a "model" is an equation or set of equations fit to data. A parameter's value is estimated during the modeling process. Except in cases of formally superfluous or confounded parameters, a parameter's estimated value has the potential to impact the model's fit to the data. To illustrate this definition, some examples of 2-parameter models are given below (in all cases, x and y are variables for which data are available and a and b are unknown arbitrary constants).

Example 1: $y = ax + b$. Straightforward.

Example 2: $y = ae^{-bx}$. Note that *e* is not a parameter (it is a constant, but is not unknown).

Example 3: $y = ax + 0b$. This is an example of a superfluous parameter. Regardless of the value of *b*, the model's fit to the data will be the same (the variance of the estimate of *b* is infinite).

Example 4: $y = abx$. This is an example of confounded parameters. There will always be an infinite number of possible estimates of *a* and *b* that maximize the model's fit to the data (the absolute value of the correlation between the estimates of *a* and *b* is identically 1.0).

In the area of stock assessment, examples of quantities which would *not* qualify as parameters under the above definition include projected biomass (it does not appear *in* the model, although it is estimated *by* the model) and a particular value for *M* taken from the literature or estimated from auxiliary data (once a particular value for a constant has been assumed, it is no longer unknown).

A Fairly Unambiguous Example from Ordinary Least Squares Regression

Of the hypothetical examples given in the preceding section, it is relatively easy to conclude that those with formally superfluous or confounded parameters (Examples 3 and 4) are overparameterized. Another case in which a determination regarding the appropriate level of parametrization can be made without ambiguity is the situation in which the "true" model is known. For example, suppose the following quadratic expression represents the "true" model:

$$y_i = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 + \epsilon_i ,$$

where x_i represents the *i*th observation of independent variable *x*, y_i represents the *i*th observation of dependent variable *y*, β represents a vector of parameters, and ϵ_i represents the *i*th realization of a random variable ϵ distributed normally with mean 0 and standard deviation σ_ϵ. As an illustration, let β_0=2, β_1=2, β_2=-0.2, σ_ϵ=1, and let the vector *x* be set equal to

i:	1	2	3	4	5	6	7	8	9	10	11
x_i:	0	1	2	3	4	5	6	7	8	9	10

Then, one possible realization of the vector *y* might be

i:	1	2	3	4	5	6	7	8	9	10	11
y_i:	3.273	3.190	5.487	5.925	8.115	7.111	3.788	6.706	6.382	3.107	2.495

Suppose that *y* were going to be modeled as a polynomial function of *x*. The "true" model, where *y* is a quadratic function of *x* (plus an error term), is given above. However, a second-degree polynomial is not the only possible choice of model form. To illustrate some of the potential effects of under- and overparameterization, a range of models will be developed based on polynomials of degree zero through three. The polynomials of degree 0 and 1 will represent underparameterized models, the polynomial of degree 2 will represent a correctly parameterized model, and the polynomial of degree 3 will represent an overparameterized model. Using ordinary least squares regression, the estimated value of each parameter in each model is shown below (where the estimate of parameter β_j is designated b_j):

	Model of degree 0	Model of degree 1	Model of degree 2	Model of degree 3
b_0:	5.053	5.248	2.773	2.772
b_1:		-0.039	1.611	1.612
b_2:			-0.165	-0.165
b_3:				1.060×10^{-5}

Note that the parameter estimates obtained in the models of degree 0 and degree 1 are quite different from the true parameter values, while the parameter estimates obtained in the models of degree 2 and degree 3 are much closer to the true parameter values. Note also that the parameter estimates obtained in the models of degree 2 and degree 3 are virtually identical. These results are consistent with some well-known characteristics of ordinary least squares regression, namely that underparameterized models have biased parameter estimates, while correctly parameterized and overparameterized models have unbiased parameter estimates.

In addition to the accuracy (i.e., unbiasedness) of parameter estimates, another important property is the precision (i.e., variance) of parameter estimates. The estimated standard deviation of each parameter estimate in each model is shown below:

	Model of degree 0	Model of degree 1	Model of degree 2	Model of degree 3
St. dev. of b_0:	0.585	1.151	1.011	1.261
St. dev. of b_1:		0.195	0.471	1.149
St. dev. of b_2:			0.045	0.275
St. dev. of b_3:				0.018

Note that the smallest estimated standard deviation of b_0 is obtained in the model of degree 0, the smallest estimated standard deviation of b_1 is obtained in the model of degree 1, and the smallest estimated standard deviation of b_2 is obtained in the model of degree 2. Note also that even though the parameter estimates obtained under the models of degree 2 and degree 3 are virtually identical, the estimated standard deviations of those estimates are uniformly larger under the model of degree 3. This is illustrative of another well-known property of ordinary least squares regression, namely that parameter estimates obtained under an overparameterized model have higher variances than those obtained under a correctly parameterized model. Thus, even though the parameter estimates obtained under the model of degree 3 turned out to be virtually identical to those obtained under the model of degree 2 in the present example, those estimates *could* have been very different (though still unbiased).

The estimated variance of a parameter estimate obtained from an under- or overparameterized model can give a misleading indication of the uncertainty associated with that parameter estimate. To see this, note that for a given model and parameter estimate, a two-tailed t-test can be used to test the null hypothesis that the parameter is equal to its true value. The p-value resulting from each such test is shown below (e.g., the hypothesis that β_0=2 would be rejected under the model of degree 1 for any significance level greater than 2%):

	Model of degree 0	Model of degree 1	Model of degree 2	Model of degree 3
H_0: β_0=2	3.904×10^{-4}	0.020	0.467	0.560
H_0: β_1=2		2.415×10^{-6}	0.433	0.745
H_0: β_2=-0.2			0.463	0.903
H_0: β_3=0				1.000

Thus, the underparameterized models (the models of degree 0 and degree 1) not only exhibit biased parameter estimates, but the estimated variances about those values are misleadingly small. The correctly parameterized and overparameterized models (the models of degree 2 and degree 3, respectively) exhibit parameter estimates whose confidence intervals (under any reasonable level of significance) easily overlap the true parameter values.

It should be stressed that the results in this section pertain to a hypothetical situation in which the "true" model is known. In a complicated natural system such as a fishery, of course, it is not clear that such a thing as a "true" model exists, and even if it did, no one would know what it was.

How Many Parameters are We Talking About, Anyway?

To give some idea of the number of parameters being estimated in current stock assessment models, a sampling of age- and length-structured assessments from the final 1996 SAFE reports were examined and the number of parameters counted (an attempt was made to standardize the time frames of the various models by omitting estimated recruitments for years prior to 1978). The results were as shown below:

Assessment	Parameters
EBS pollock (Bayesian model in Appendix B)	423
EBS pollock (cohort analysis in main text)	246
EBS Pacific cod	236
GOA Pacific cod	216
GOA pollock	77
BS/AI Atka mackerel	64
GOA arrowtooth flounder	52
BS/AI/GOA sablefish	49

The above parameter counts should be viewed as tentative, in that some constants for which values appear to have been *assumed* in an assessment's final model may actually have been *estimated* in earlier versions of the same model. In conformity with the definition given earlier, fishing mortality rates are counted as parameters even though the models typically assume that catch is measured without error.

Conclusions

The SSC's concern regarding the appropriate level of parametrization in stock assessment models is well taken. Either under- or overparametrization of a model can lead to serious errors in parameter estimates and management recommendations generated by the model. It is not clear, however, that overparametrization is a worse problem than underparametrization. If minimization of bias in parameter estimates is the main concern, there is reason to suspect that underparametrization is the worse of the two. In general, the problems of under- and overparametrization appear difficult to solve, although the potential remedies suggested by the SSC provide a useful set of places to start. It seems unlikely these problems will be solved in the near future.

GULF OF ALASKA PLAN TEAM MEETING
NOVEMBER 18-21, 1996

PLAN TEAM MEMBERS

Sandra Lowe (NMFS), chairman
Tom Pearson (NMFS)
Jeff Fujioka (NMFS)
Jim Hastie (NMFS)
Jim Ianelli (NMFS)
Farron Wallace (WDF)
Gregg Williams IPHC)
Jane DiCosimo (NPFMC), plan coordinator
John Sease (NMFS)
Lew Haldorsen (UAS)
Jon Heifetz (NMFS)
Tory O'Connell (ADFG)
Bill Bechtol (ADFG)
Vivian Mendenhall (USFWS)
Dave Jackson (ADFG)

The GOA Plan Team met beginning on Monday afternoon, November 18, 1996, to review the GOA stock assessments for 1997. New member Dave Jackson from ADFG /Kodiak was welcomed to the Team. Tom Pearson, NMFS/Kodiak, substituted for Kaja Brix.

Eric Brown, AFSC trawl survey coordinator gave a brief summary of the 1996 GOA trawl survey. The fifth survey for the Gulf successfully sampled at 807 of 868 attempted sites; 263,000 fish were measured and 13,000 otoliths collected for aging.

Pollock The team reviewed the 1996 echo integration survey results for Shelikof Strait. The biomass of pollock for Shelikof Strait was estimated at 745,400 mt, up from 725,200 mt in 1995. These values were adjusted in the stock assessment to be comparable to estimates from the old system to provide a time series of a relative abundance index. The Gulfwide biomass estimate was 707,434 mt. High abundance of eulachon in Shelikof Strait was also reported.

Length frequency data from the 1990 to 1996 hydroacoustic surveys showed the progression of the strong 1988 year class through the population. In the 1995 and 1996 surveys, evidence of a strong 1994 year class was also apparent. The age compositions from the 1993 bottom trawl survey and the 1995 fishery revealed strong 1988 and 1989 year classes. The 1989 year class in the Bering Sea has also been shown to be strong. The presence of the strong 1989 year class found in the Shumagin, Chirikof and Kodiak areas suggests that mixing of pollock stocks may occur between the Bering Sea and the Gulf of Alaska. Alternatively, 1989 oceanic conditions may have favored recruitment in the Western Gulf of Alaska more than the Central area. The 1995 year class appears to be average based on FOCI predictions.

The Team evaluated and concurred with the stock synthesis model configuration chosen by the assessment scientists. The Team recommended the W/C Gulf ABC of 74,400 mt be apportioned according to the biomass distribution of the exploitable population in the 1996 bottom trawl survey: 25% in the Shumagin area (18,600 mt), 42% in the Chirikof area (31,250 mt), and 33% in the Kodiak area (24,550 mt). Relative to the 1993 distribution, the current biomass distribution has increased in the Kodiak area and decreased in the Shumagin area, and is similar to the 1990 survey distribution.

The Team still had no information on which to set an ABC for the Eastern Gulf. However, analysis of Eastern Gulf length frequency data show that recruitment patterns appear similar to that observed in the W/C Gulf. Thus, the Team agreed that it would be appropriate to apply the ratio of W/C ABC to 1996 W/C survey exploitable biomass to the Eastern Gulf 1996 exploitable biomass estimate. The recommended Eastern Gulf ABC is 5,580 mt. Similarly calculated, the overfishing level for the Eastern Gulf is 7,770 mt.

The Team again expressed interest in further exploration and incorporation of the predation model, in light of initial indications of higher natural mortality, particularly on younger fish. An additional year of stomach data is available for this analysis. For 1997, the team also requested that the authors examine other means of assessing central tendency for $B_{40\%}$, such as the geometric mean or median.

Atka Mackerel The assessment authors reported that the 1996 trawl survey did not provide a reasonable estimate for Atka mackerel. The survey estimate had a 100% coefficient of variance based on one haul and did not sample the known fishery locations. The authors recommended a bycatch only fishery, with an ABC of 1,000 mt. The team examined the results of a tier 6 ABC definition equal to 75% of the average catch of 6,200 mt and determined that an ABC of 4,650 mt was inappropriate because it was an increase from the 1995 ABC when the stock is believed to be declining. The team is recommending an ABC of 1,580 mt, equal to the 1996 catch. Approximately 1,400 mt was harvested during a 12-hour fishery near Umnak Island. The team reviewed a fishery CPUE analysis for Atka mackerel and encourages the authors to continue development of alternative assessment methodology. The team noted that genetic analysis indicate no difference between Gulf and Aleutian stocks and also would support a combined stock assessment in the future. It was noted that Atka mackerel area a prey species for Steller sea lions. The team has noted these fishery and ecosystem concerns in the past and recommended conservative TACs.

Flatfish The flatfish group are subdivided into deep water flatfishes, rex sole, shallow water flatfishes, and flathead sole. Rock sole are separated into two species for the first time. The 1997 exploitable biomass for each category is based on abundance estimated from the 1996 triennial trawl survey. For 1997, ABC for the deepwater group was determined by applying tier 5 calculations (ABC = 0.75M) to Dover sole and tier 6 (ABC = 0.75 x average catch 1978-1995) to the remaining species. ABCs for rex sole and flathead sole were calculated based on tier 5, as were all species in the shallow water group, except rock sole, for which tier 4 calculations were made. This is a departure from the exploitation strategy used in the 1995 assessment which utilized fishing mortality rates equal to $F_{35\%}$. It was determined in the 1996 assessment, that the generic maturity schedule previously applied to all flatfish species was not appropriate. Currently, there is only Bering Sea maturity data for rock sole which is applied to the Gulf rock sole to calculate $F_{40\%}$ and $B_{40\%}$.
The team expressed some concern about using the maturity schedules for Bering Sea rock sole for both species in the Gulf. The team expressed a strong interest in having maturity schedules developed for all flatfish species in the assessments. The Team concurs with the authors' recommendations for ABCs for each group, with area apportionments based on biomass distributions in the 1996 trawl survey.

Arrowtooth A separate analysis utilizing stock synthesis for arrowtooth flounder was presented to the Plan Team. The 1997 spawning biomass is estimated to be greater than $B_{40\%}$; therefore, arrowtooth flounder is in tier 3a of the overfishing definitions. The team concurred with the authors' recommendations of an ABC of 197,840 mt for arrowtooth flounder based on $F_{40\%}$ (Tier 3a), and recommended that area apportionments be based on biomass distributions in the 1996 trawl survey.

Slope Rockfish The team determined that the objectives of the rebuilding plan for Pacific ocean perch appear to have been met from results of the 1996 stock synthesis analysis. Current estimated female spawning biomass of 160,500 mt exceeds the rebuilding target of 150,000 mt. An updated Age at 50% sexual maturity was found to be age 10 for Southeast Alaska, previously reported to be age 7, and was applied gulfwide. The authors reported that incorporating the maturity schedule into the model would still find that the POP stock was rebuilt. Although the objectives of the rebuilding plan appear to have been met, the team recommended that determination of ABC proceed with caution because: 1) the current population is only slightly above the rebuilding target; 2) verification of rebuilding may not be available until next survey in 1999; and 3) age composition data from the 1996 survey have not been incorporated into the current analysis. The team concurred with the authors that reliable estimates of B_{msy} and F_{msy} cannot be determined, thus POP are in Tier 3b and ABC based on the adjusted $F_{40\%}$ is 12,990 mt. The previously used apportionment scheme for POP was again applied (and also applied to all other slope rockfish). A 4:6:9 weighting is applied to the 1990, 1993, and 1996 trawl surveys, respectively.

Current estimates of exploitable biomass from 1996 survey results are 16,673 mt for shortraker rockfish and 48,709 mt for rougheye rockfish. Applying the new definitions for ABC and OFL places shortraker rockfish in tier 5 and tier 4 for rougheye rockfish. The team recommends that the previously used weighting scheme be applied to shortraker and rougheye rockfish. The team concurs with the authors for recommending an ABC for the subgroup of 1,590 mt, with apportionments of 160 mt for the Western area, 970 mt for the Central area and 460 mt for the Eastern area. The team felt that a SRA analysis presented by Dan Ito required revision and did not recommend including it in the SAFE report.

The team concurred with the authors' recommendation of an ABC of 5,000 mt for northern rockfish. Area distributions results in ABCs of 840 in the Western area, 4,150 mt in the Central area, and 10 mt in the Eastern area. The team also concurred with the authors on the other slope rockfish ABC of 5,260 mt and area apportionments of 20 mt in the Western area, 650 mt in the Central area, and 4,590 mt in the Eastern area. The team suggested that the small Eastern area ABC be combined with the other slope rockfish ABC in the Eastern area.

Demersal Shelf Rockfish The ABC projection for 1997 is unchanged from 1996 as no survey was conducted in 1996. Catches were below TAC for 1996, with the November fishery just commencing at meeting time. The team reiterated their concerns about the high level of unreported DSR mortality associated with the halibut fishery and the uncertainty in accounting for this mortality. Anecdotal information from commercial fishermen suggest that the 10% bycatch provision for DSR taken during directed halibut fishing operations is inadequate and that for some trips the bycatch level may be much higher than 10%. Many fishermen do not land or report overages because they would be in violation of directed fishing standards. Although this information is anecdotal, the team recommends that the Council consider either raising the bycatch rate or allowing landing of overages to be surrendered without penalty to promote reporting of true mortality.

Thornyheads The 1996 NMFS survey indicated an increase in the biomass of thornyheads. The team deliberated at length about the discrepancy between increases in biomass as estimated from the last three surveys while the model estimates of the stock suggested a stable or slightly declining trend in abundance. The author explained that given the relatively low levels of natural mortality, the magnitude of removals, and the lack of strong recruitment signals, the increase was inconsistent. The low 1990 survey estimate for many of the rockfish species may indicate an unusual problem with that year's survey. The team accepted the author's recommendation of 1,700 mt for ABC based on $F_{40\%}$ (Tier 3a). The Team noted the author's concern that the Gulf-wide management practice may be inappropriate and create localized depletion. Ideally, the catch apportionment by areas should reflect the biomass distribution assuming relative recruitment contributions are equal in each area. However, the team recognized the practical difficulties in creating additional management areas and requested that an examination of area-specific harvests be pursued by the stock assessment authors.

Sablefish The combined sablefish stock assessment review occurred during a session of the joint team meeting, but is reported in the Gulf Team's minutes. The revised survey incorporates the results of the 1996 longline survey, an analysis of underreporting of catch, and recalculated survey indices. This assessment generated considerable debate among all team members which including the authors). Both teams concurred with the authors that an ABC based on an adjusted F40% strategy (Tier 3b) would be inappropriately high for stocks recognized to be in decline and with no sign of recent recruitment. The authors recommended a combined area ABC of 17,200 mt and a 1997 ABC of 14,525 mt for the Gulf. The team differed with the authors and recommended a rollover of the combined 1996 GOA and BSAI ABC (19,600 mt), using the 1996 longline survey biomass apportionments for each area. This decision resulted in a slight decrease in the 1997 GOA ABC to 16,560 mt from 17,080 in 1996. The team based their decision on a depiction of spawning biomass reaching the lowest observed level regardless of the level of underreporting or harvest strategy (Figure 5.11a). The team recommended that those 'foregone' fish be allowed to be taken by the commercial fishery.

Pacific cod The team reviewed a risk averse methodology for calculating an ABC for Pacific cod that would incorporate an increased biomass from the 1996 survey, increased biomass projections from the assessment model, a strong signal of 1995 year class strength, and declining short-term biomass projections. The author provided a comprehensive analysis on the affect of uncertainty in the natural mortality rate and survey catchability that allowed the author to derive a risk-averse level of ABC levels which the team noted as appropriate for this stock. This analysis provided a theoretical approach to modifying the model's projection preferable to ad-hoc methods employed by the team in the past. The team agreed with the author's recommendation to set ABC equal to 81,500 mt, based on the risk averse model.

The Team discussed the proposed Pacific cod state water fisheries and reviewed biological and fisheries data for Gulf P. cod to determine the effects of state water fisheries on the stock. The team felt that internal water harvests of P. cod should not affect federal TACs (they were counted against the Eastern Gulf TAC in 1995 and 1996). The Team does recommend that separately managed P. cod harvests from the state coastal waters fisheries be counted against federal TACs since P. cod is recognized as a single stock and is assessed in the NMFS GOA trawl survey. The Team recognized that a biological basis for recommending an allocation between the state and federal fisheries would be ideal, but that given the migratory nature of this species and the limited available information, such recommendations would be tenuous. The Team recommends that ADF&G examine their annual groundfish (and crab) surveys to determine P. cod distribution and that ADF&G and NMFS staff collaborate so that future federal and state P. cod surveys be comparable.

Pelagic Shelf Rockfish The team recommends separating the Pelagic Shelf Rockfish (PSR) assemblage into an inshore component, consisting of black and blue rockfish, and an offshore component, consisting of dusky, widow, and yellowtail rockfish. The exploitable biomass and recommended ABC for the offshore component is based on the triennial trawl surveys. Setting the offshore exploitation rate equal to the natural mortality rate of 0.09 for dusky rockfish resulted in an ABC of 4,880 mt for the offshore complex. This gives ABCs of 570 mt for the Western area, 3,320 mt for the Central area, and 990 mt for the Eastern area.

The Team supports Alternative 4 in the EA/RIR for Amendment 46 because: (1) black and blue rockfish are not adequately sampled by trawls, (2) both the resource and the fishery for the black and blue rockfish primarily occur in state waters, and (3) removing these species from the FMP will allow the State of Alaska to provide appropriate localized, inseason management for this fishery. Under this alternative, black and blue rockfishes would be withdrawn from the FMP and management would be assumed by ADF&G. If the Council prefers to keep them under the FMP, the team calculated an appropriate ABC for the nearshore species of 600 mt, with area apportionments of 170 mt for the Western area, 260 mt for the Central area, and 170 mt for the Eastern area.

Adjourn The meeting was adjourned on Thursday, November 21, at 4 p.m.

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ANCILLARY SABLEFISH INFORMATION

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Ancillary sablefish information including trawl and longline survey length frequency distributions, and fishery length frequency and catch per unit effort (CPUE) data are provided. This information is of a qualitative nature and was not utilized directly (expect for longline survey length frequency information) in the 1996 sablefish stock assessment. Work is currently underway to incorporate these types of ancillary information in the analysis of incoming recruitment, and juvenile and exploitable biomass trends. In particular, commercial fishery logbook information is being analyzed for future use in the stock assessment process.

Length Frequency Information

A comparison of the length frequency distributions from the 1993 and 1996 trawl surveys with the longline survey and fishery data shows that the distribution of trawl caught fish includes smaller fish and less of the larger sablefish than the longline data (Figures 1-4). The trawl data are also more variable and cover a larger range of sizes than the relatively homgeneous distributions from the longline fishery and survey. Sablefish catches in the Western Gulf of Alaska (WGOA) from the 1993 and 1996 trawl surveys showed modes at 55 and 60 cm, respectively (Figures 1-2). There was a very small mode of juvenile fish (~30 cm, 1-year-olds) in the 1996 WGOA area. The Central Gulf of Alaska (CGOA) trawl survey data showed a bimodal distribution of fish at 50 and 65 cm. The mode of 50 cm fish is presumed to be 2-3 year old sablefish. The bulk of smaller-sized sablefish were captured in the Eastern Gulf of Alaska (EGOA), with a mode of 45 cm fish in 1993 (Figure 1), and modes at 35, 45, 65 (males), and 75 (females) cm in 1996 (Figure 2). Overall, male (GOA) trawl-survey caught sablefish ranged from ~35-75 cm in 1993, and ~35-80 cm in 1996. Female sablefish attain larger lengths than males which is reflected in the overall ranges of female trawl survey lengths of ~35-85 cm in 1993, and ~35-95 cm in 1996.

The length frequency distributions from the longline survey and fishery are quite similar for all years and areas (Figures 3-4). (Complete commercial fishery data from 1996 are not available at this time, but would be expected to become available in early 1997). Longline data from the WGOA show the bulk of sablefish between 50 to 80 cm, with a mode at 65 cm from the longline survey (Figure 3), and modes at 55, 60, and 65 cm from the fishery (Figure 4). The length distributions from the CGOA and EGOA longline survey were very similar with modes at ~65 and 75 cm from the longline survey, and a single mode at ~65 cm from the fishery (Figures 3-4). Overall, most of the longline caught sablefish ranged from ~50 to 90 cm.

The longline survey and fishery are clearly selective for the larger adult sablefish, and do not select for, or fish in areas of juvenile abundance. While the trawl surveys capture smaller juvenile sablefish, the 1993 and 1996 data do not show any strong indications of significant recruitment in the population.

Another source of recruitment and/or juvenile abundance is habitat surveyed by the longline survey which lies outside the main fishery area. Data from these areas are not incorporated in the stock assessment model of the adult exploitable population. The main fishery area includes the upper continental slope and deep gullies such as Spencer Gully. Surveyed areas usually not fished include shallow gullies such as Shelikof Trough.[1] Both the exploitable and unexploitable populations show a mode in the length frequencies in 1993 most likely due to a relatively strong 1990 year class (Figure 5). Individual gullies also are plotted along with the adjacent slope area to compare sizes between gully and slope. Generally fish in shallow gullies are smaller on average than fish on the adjacent slope (eg. Yakutat Valley) whereas fish in deep gullies are similar in size to fish on the adjacent slope (eg. Spencer Gully) (Figures 6-9).

Catch Per Unit Effort Information

The spatial and temporal distributions of observed sablefish longline catch per unit effort (CPUE) data in units of kilograms of sablefish per hook (kg/hook) in 1993, 1994, and 1995, show concentrated effort along the 200m depth contour line (Figures 10-13). The data shown represent observed and sampled sablefish sets in which sablefish comprised the largest percentage (by weight) of the groundfish species composition. The data plotted represent the following percentages of the total (retained and discarded) sablefish catches:

Percent of total sablefish hook and line catch represented by observed hook and line sablefish target catches in the Bering Sea and Aleutian Islands. (Data plotted in Figures 10 and 11)

Management Area	1993	1994	1995
Bering Sea	2	1	7
Aleutian Islands	22	17	20

---

[1]Shallow gullies are defined as gullies with all habitat at depths < 400 m and deep gullies are defined as gullies with at least some habitat at depths ≥ 400 m. The shallow gullies are Shumagin Gully, Shelikof Trough, Amatuli Gully, W-grounds, Yakutat Valley, Alsek Strath and Iphigenia Trench. The deep gullies are Spencer Gully, Ommaney Trench and Dixon Entrance.

Percent of total sablefish hook and line catch represented by observed hook and line sablefish target catches in the Gulf of Alaska. (Data plotted in Figures 12 and 13).

Management Area	1993	1994	1995
Western Gulf	37	23	36
Central	16	12	24
West Yakutat	19	5	15
East Yakutat/SEO	1	<1	7

Aleutian Island and Gulf of Alaska data only are presented. The Bering Sea data is minimal; coverage was less than 10 percent, and not considered informative. The data shown in the charts represent less than 25% of the total sablefish hook and line catches by year and area, except for the 1993 and 1995 Western Gulf of Alaska data. Thus, caution must be used in interpreting the data. If this data is to be considered representative of the directed hook and line sablefish fishery, one must assume that the small percentage of sets observed are generally representative of the time and areas fished by the unobserved fishery, and that observed vessels fish in the same manner as unobserved vessels. Because of the low level of observer coverage for the sablefish fishery, this data is of limited use for distinguishing changes in fishing patterns and inferring sablefish abundance trends, because it is not possible to distinguish areas where fishing did not occur as opposed to being unobserved.

The 1993, 1994, and 1995 Aleutian Islands data show fishing occurring year-round and throughout the Aleutian chain (Figures 10 and 11). There are no 1995 first quarter data, as the IFQ hook and line fishery did not open unit March 15. The greatest concentration of observed hauls overall and hauls with CPUE greater than 0.3 kg/hook occurred in quarters 2 and 3 in 1993 (Figure 10c,e) and in quarters 2 and 4 in 1994 (Figure 10d,h). Catch per unit effort was notably lower in 1995, the first year of the IFQ fishery, with no observations of CPUE greater than 0.3 kg/hook (Figure 11). Notable areas where observed sets caught more than 0.3 kg/hook occurred north and south of the chain from Atka Island to the Delarof Islands along the 200m contour (Figure 10c,d,e,h). Additionally, there were notable catches southwest and southeast of Kiska Island during the second quarter of 1993 (Figure 10c).

Gulf of Alaska data are only available for the second quarter of 1993 and 1994 as the hook and line sablefish fishery opened May 15 and 18 in 1993 and 1994, respectively, and TACs were generally reached by the end of June. There is limited first quarter data for 1995 when the IFQ fishery opened March 15. It is notable that with the implementation of the IFQ fishery, the season extended through the year. There was considerably more observed effort in 1993 relative to 1994 (Figure 12), despite the larger TAC in 1994 (25,500 mt compared to 20,900 mt in 1993). Second quarter CPUE data picked up again in 1995, with CPUE values greater than 1 kg/hook in the Central Gulf (Figure 13). There was less observed effort in the third and fourth quarters of 1995, and CPUE values greater than 1 kg/hook occurred in the West Yakutat and Southeast Outside areas (areas 640 and 650).

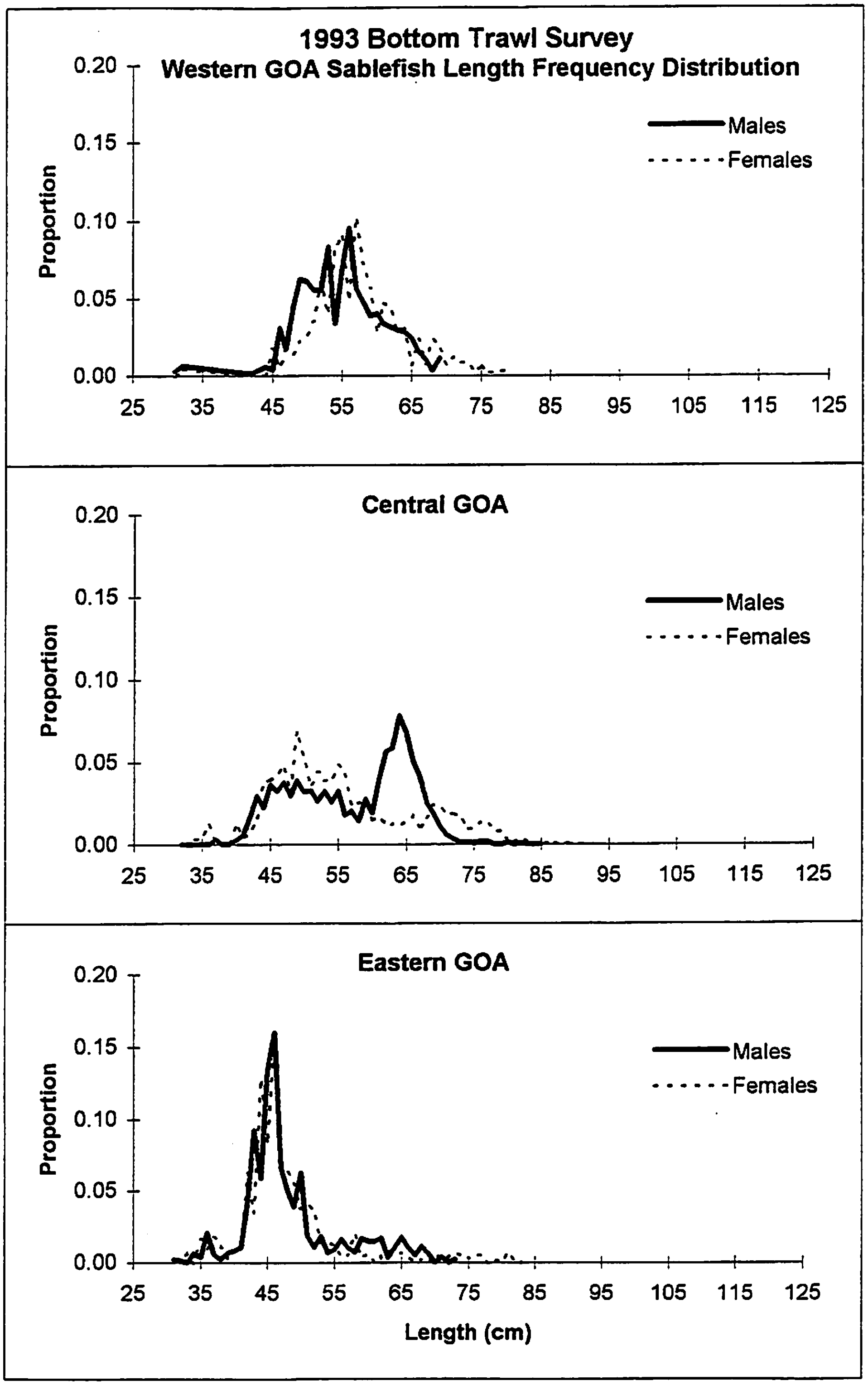


Figure 1. Sablefish length frequency distributions from the 1993 Gulf of Alaska (GOA) bottom trawl survey.

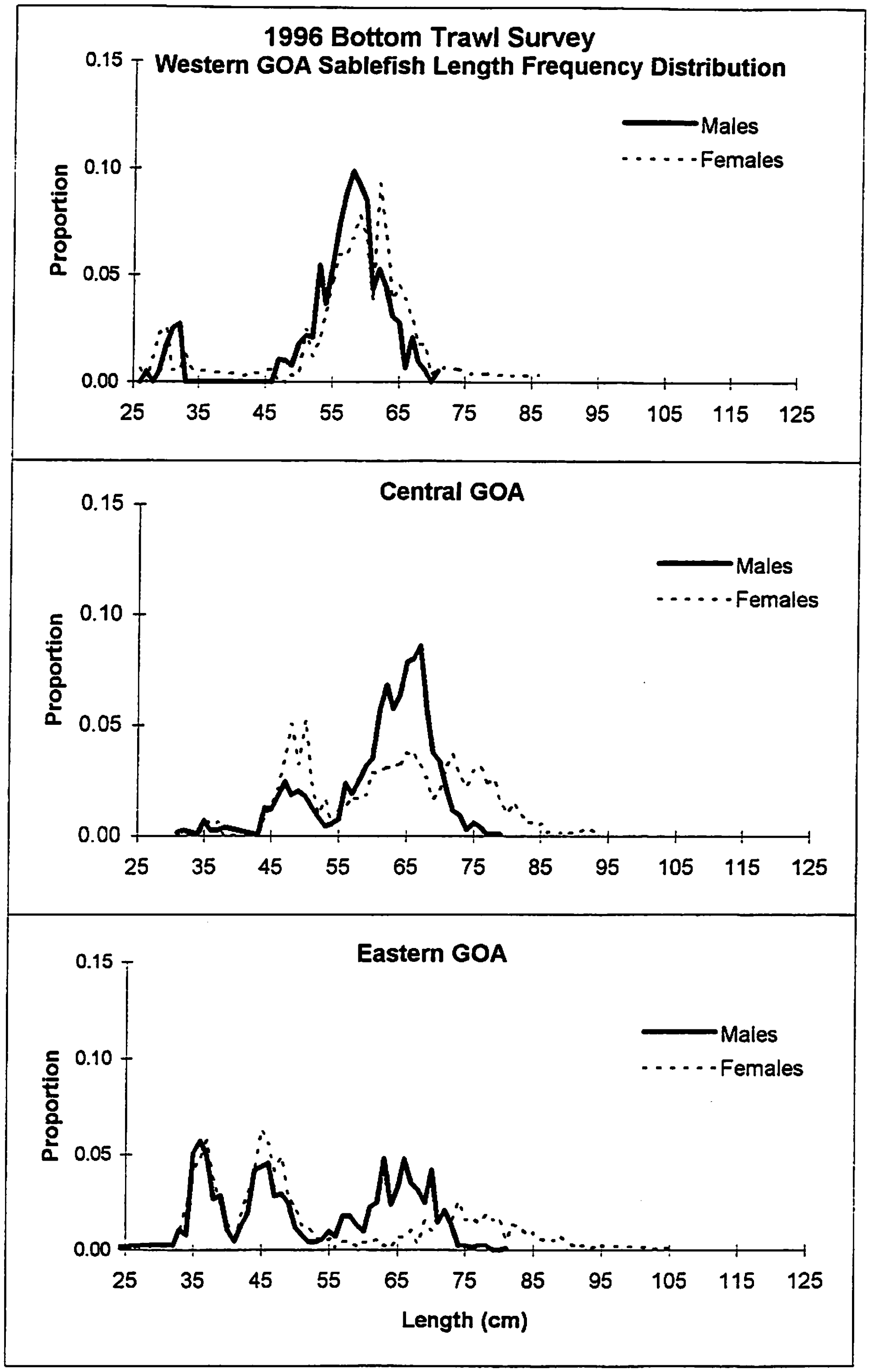


Figure 2. Sablefish length frequency distributions from the 1996 Gulf of Alaska (GOA) bottom trawl survey.

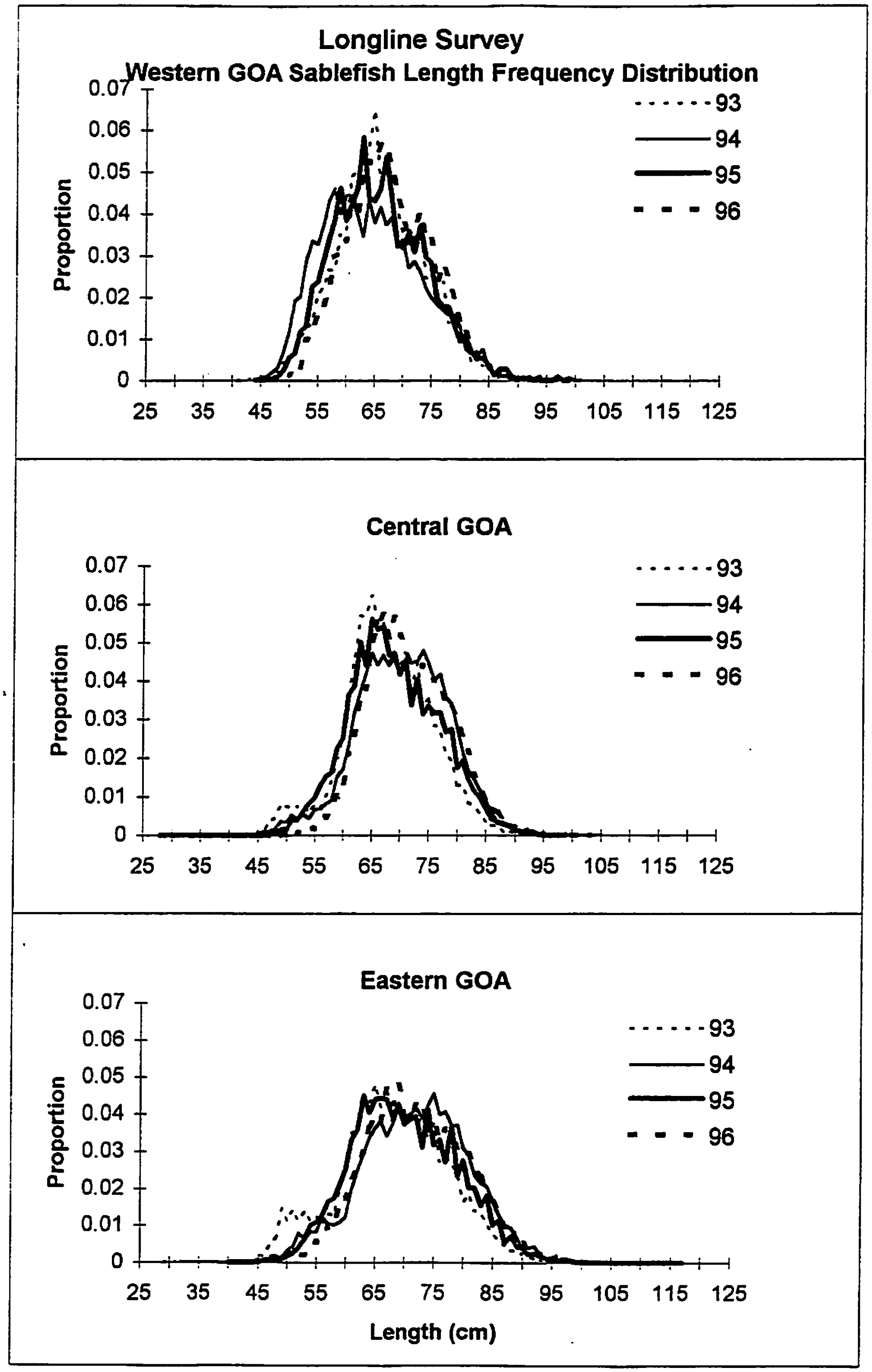


Figure 3. Sablefish length frequency distributions from the 1993-1996 Gulf of Alaska (GOA) longline surveys.

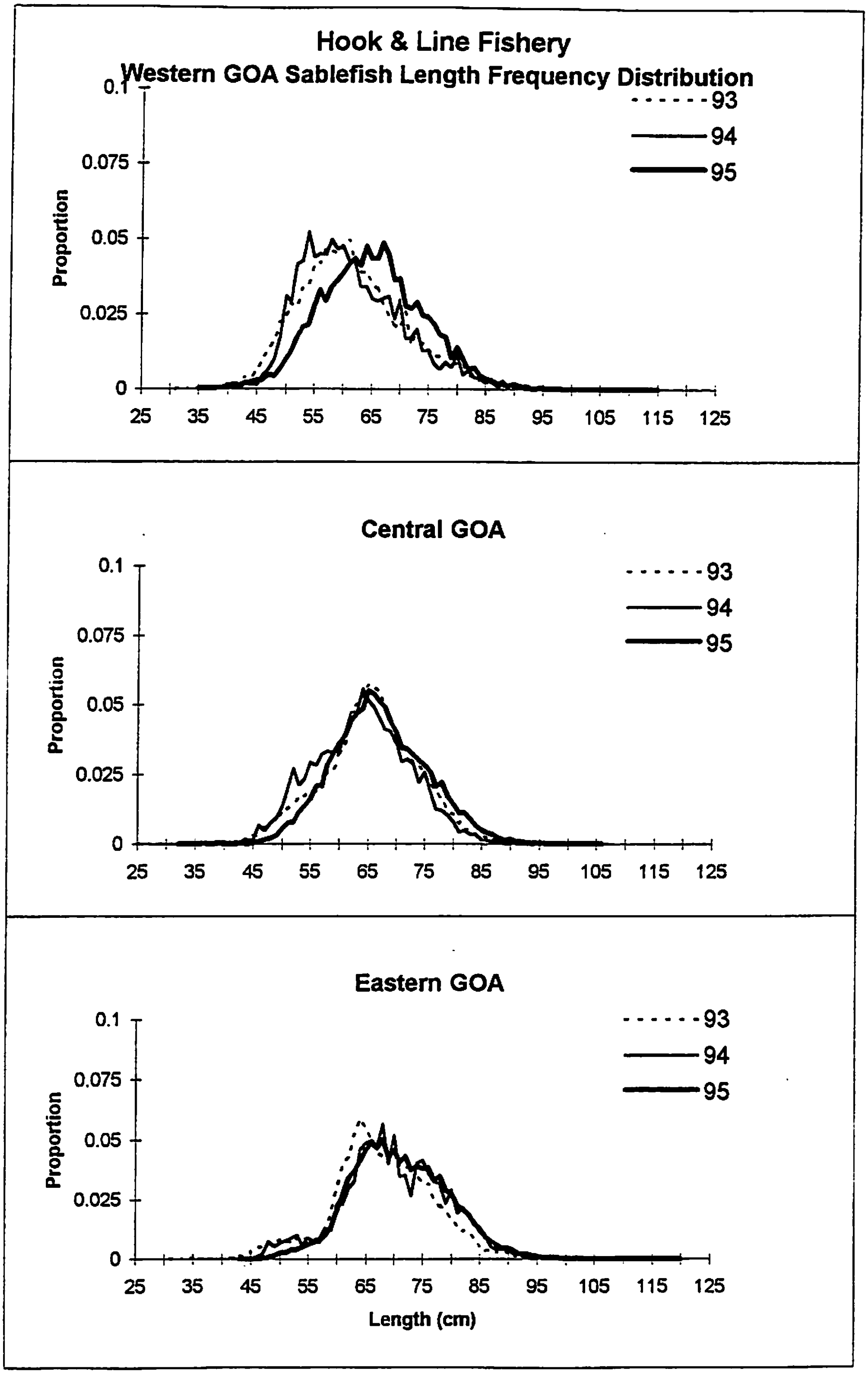


Figure 4. Sablefish length frequency distributions from the 1993-1995 Gulf of Alaska (GOA) hook and line fisheries.

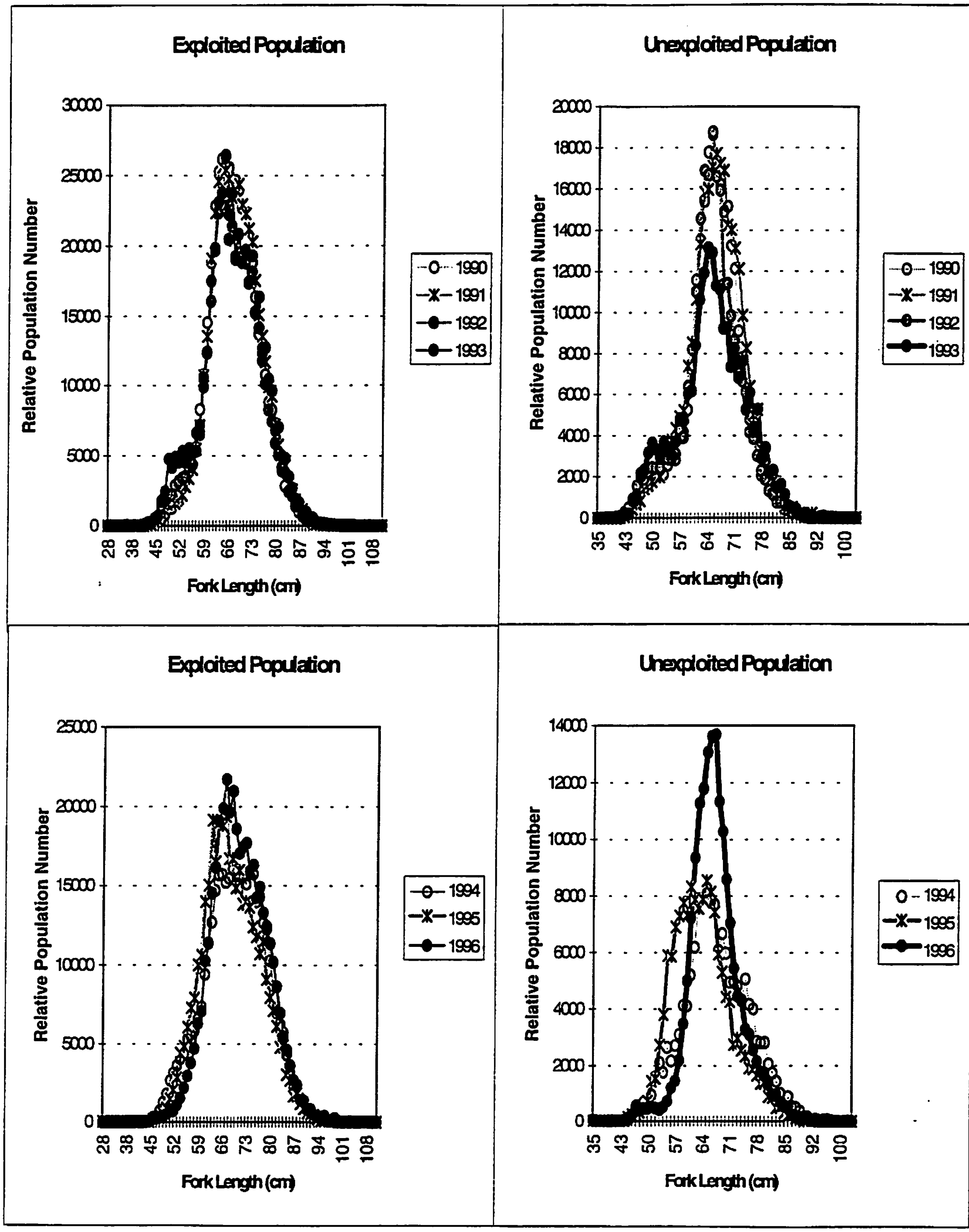


Figure 5.--RPN weighted length frequencies of exploited and non-exploited populations.

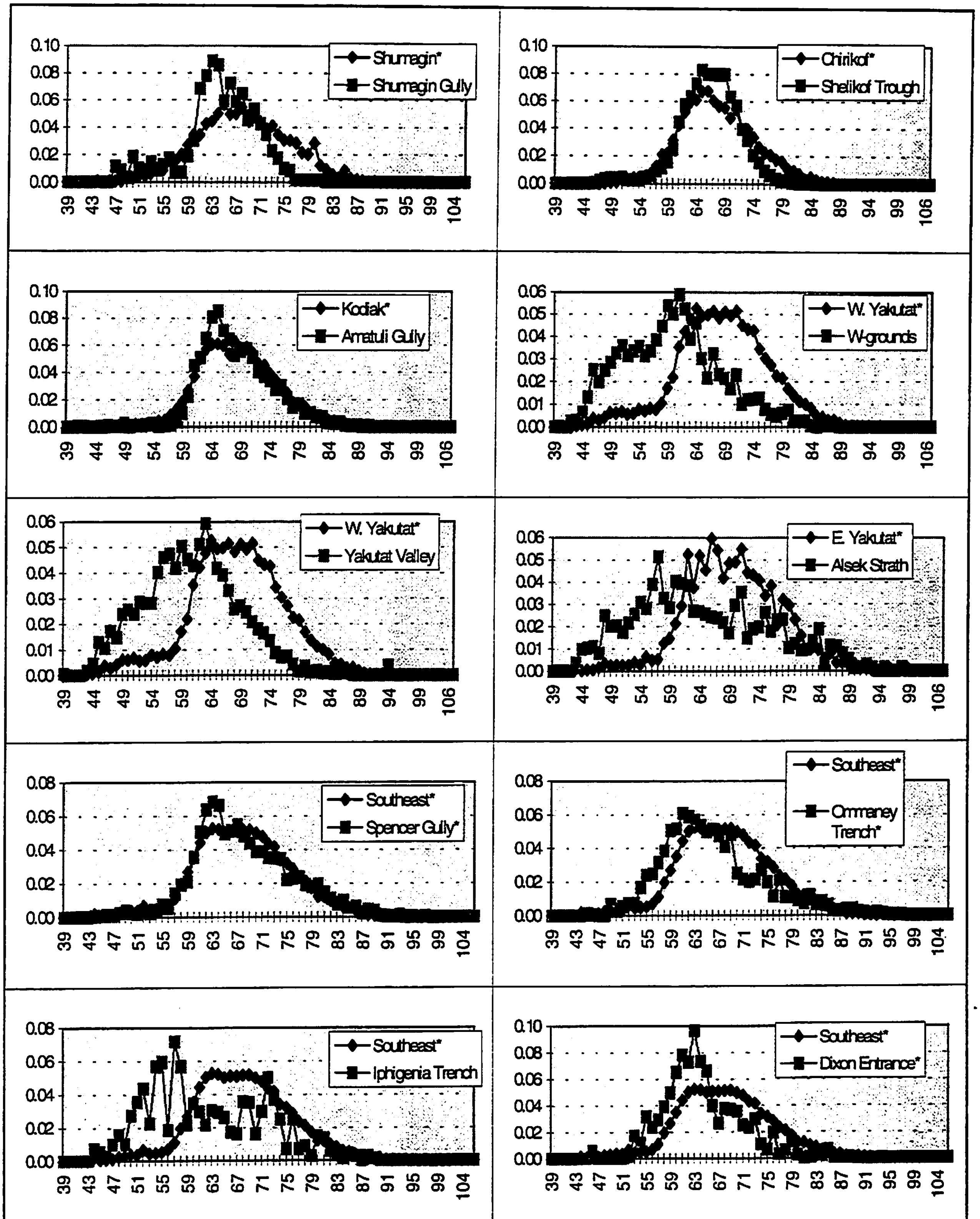


Figure 6. --Percent length frequencies versus fork length (cm) by area, 1990.

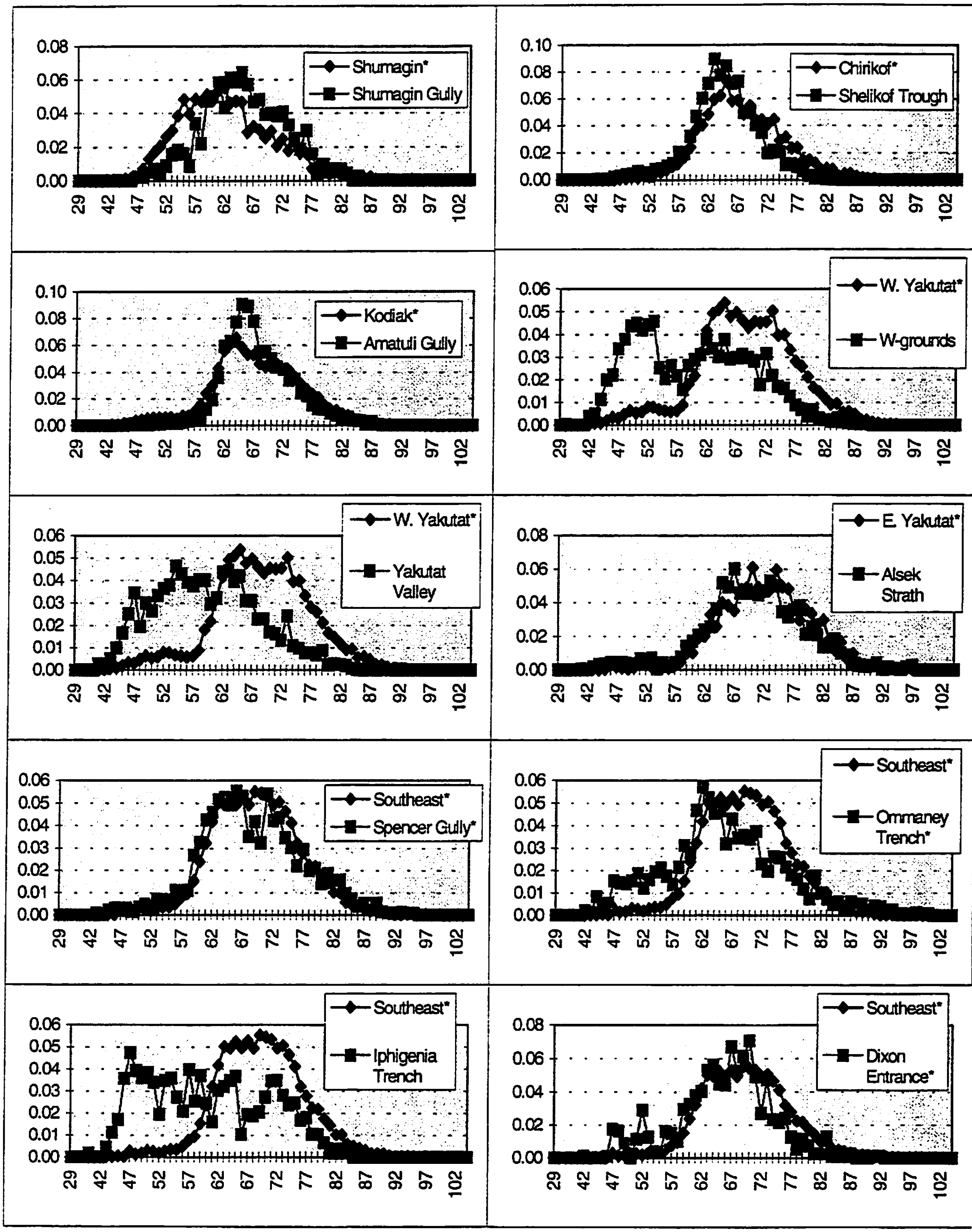


Figure. 7. --Percent length frequencies versus fork length (cm) by area, 1992.

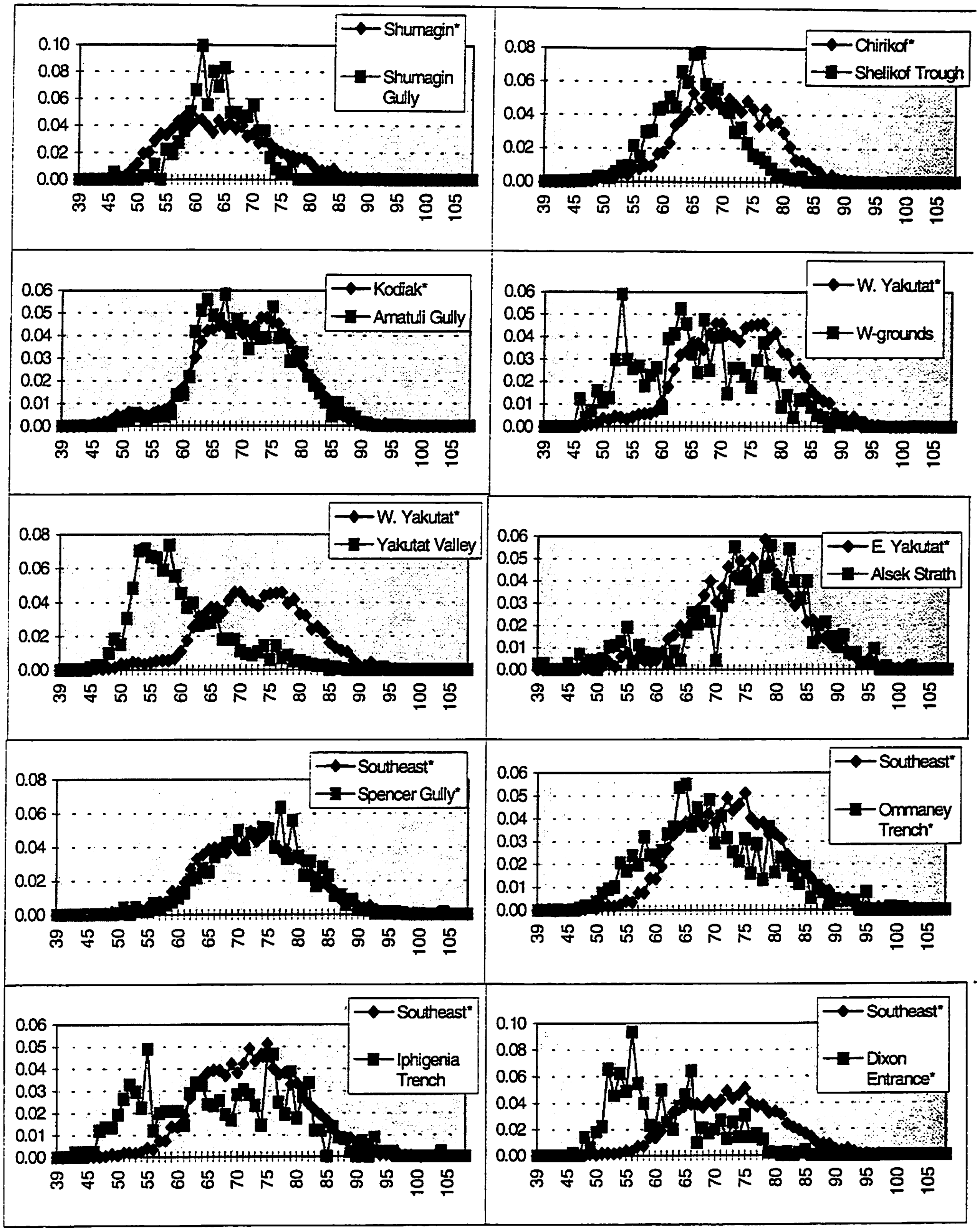


Figure. 8. --Percent length frequencies versus fork length (cm) by area, 1994.

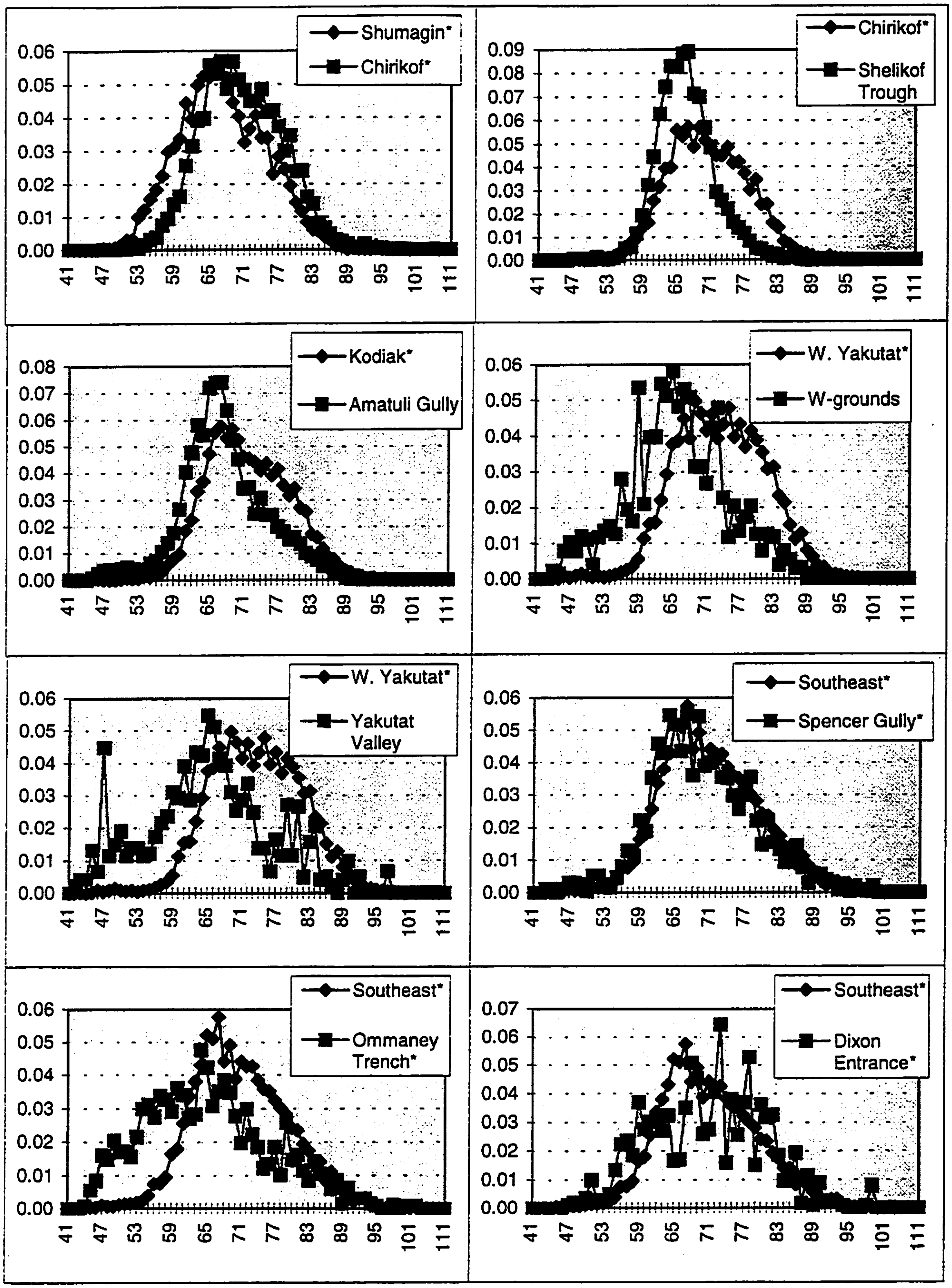


Figure 9. --Percent length frequencies versus fork length (cm) by area, 1996.

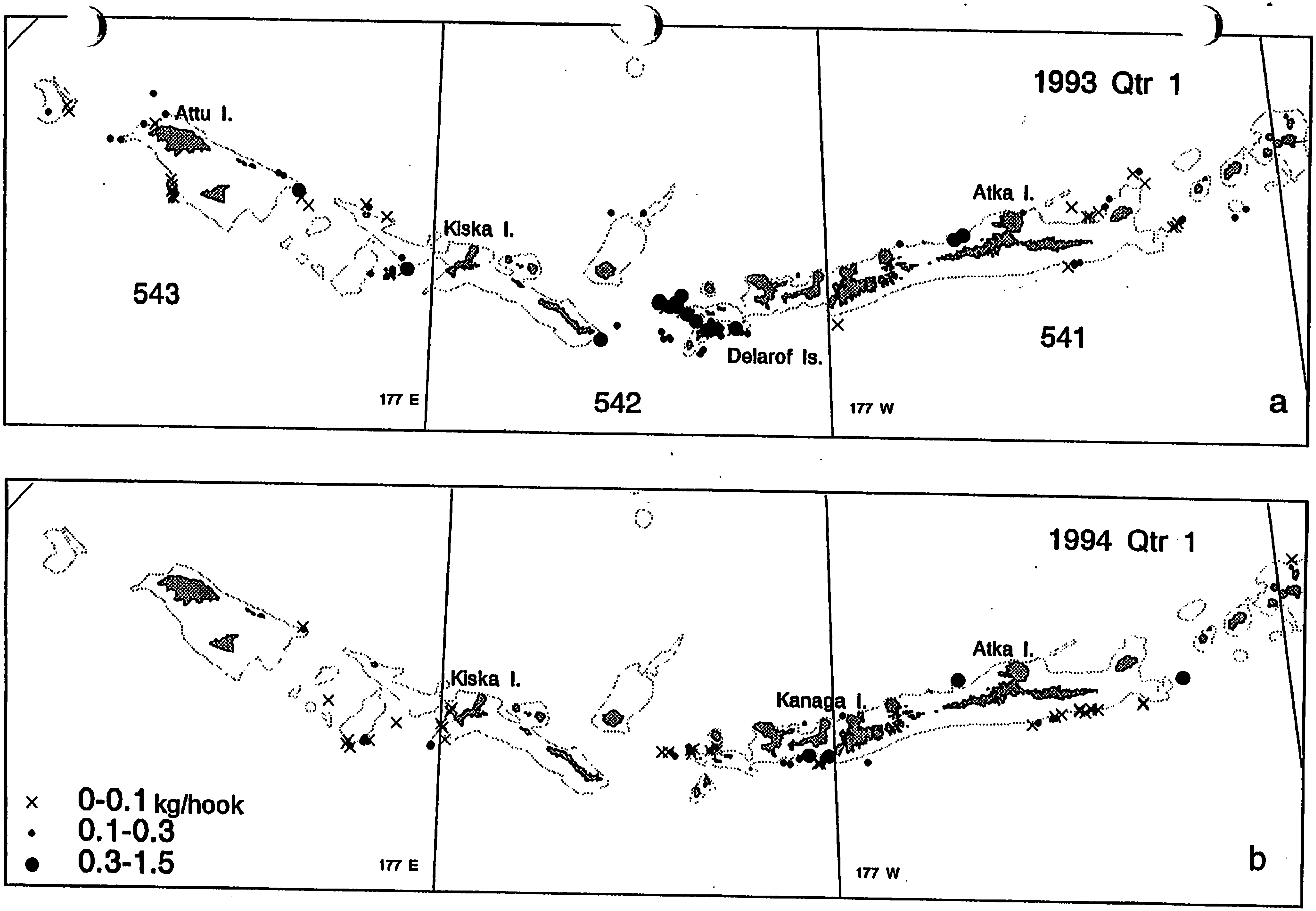


Figure 10. Locations of observed and sampled sablefish sets in the Aleutian Islands in the first quarters of 1993 and 1994.

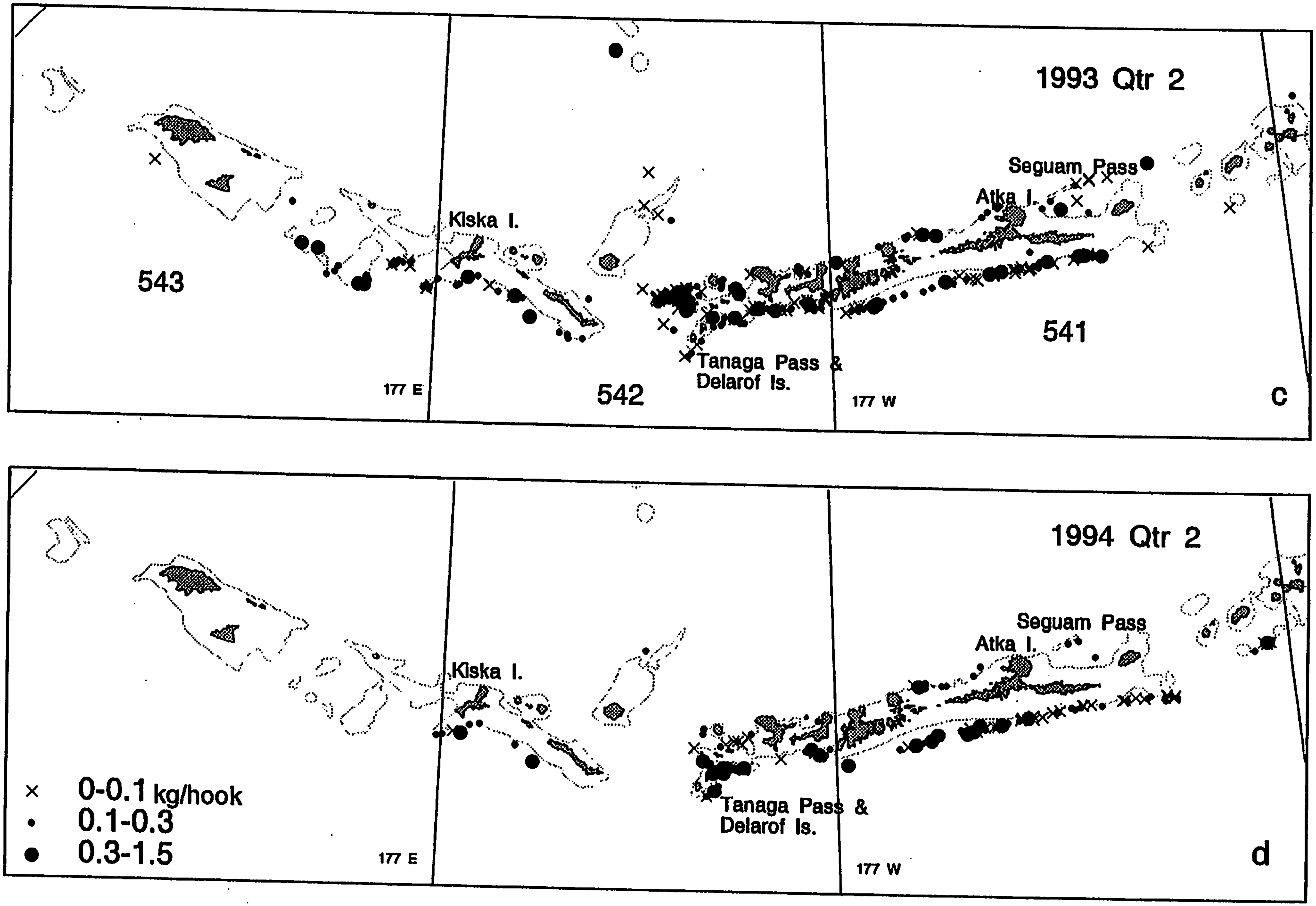


Figure 10. cont. Locations of observed and sampled sablefish sets in the Aleutian Islands in the second quarters of 1993 and 1994.

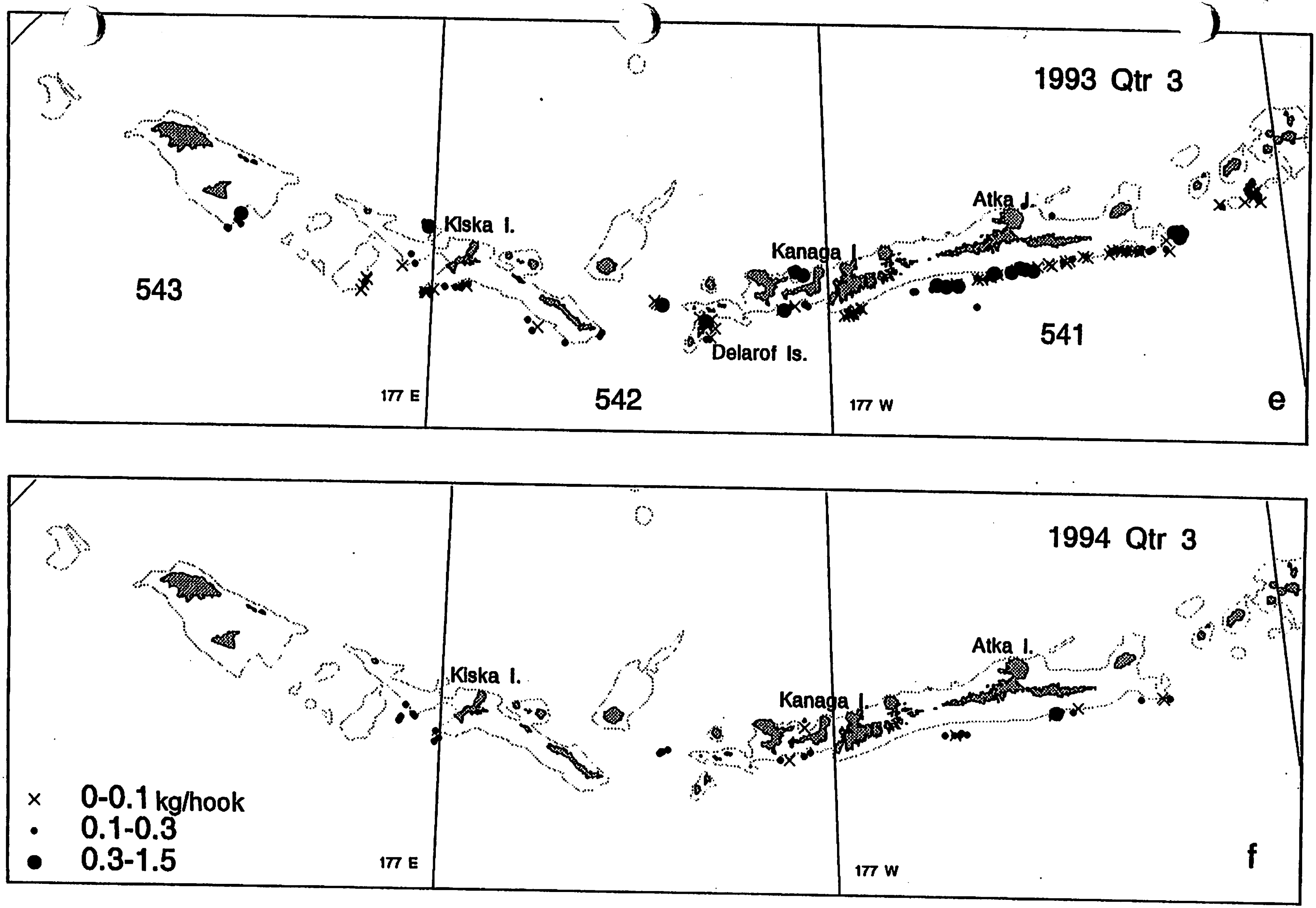
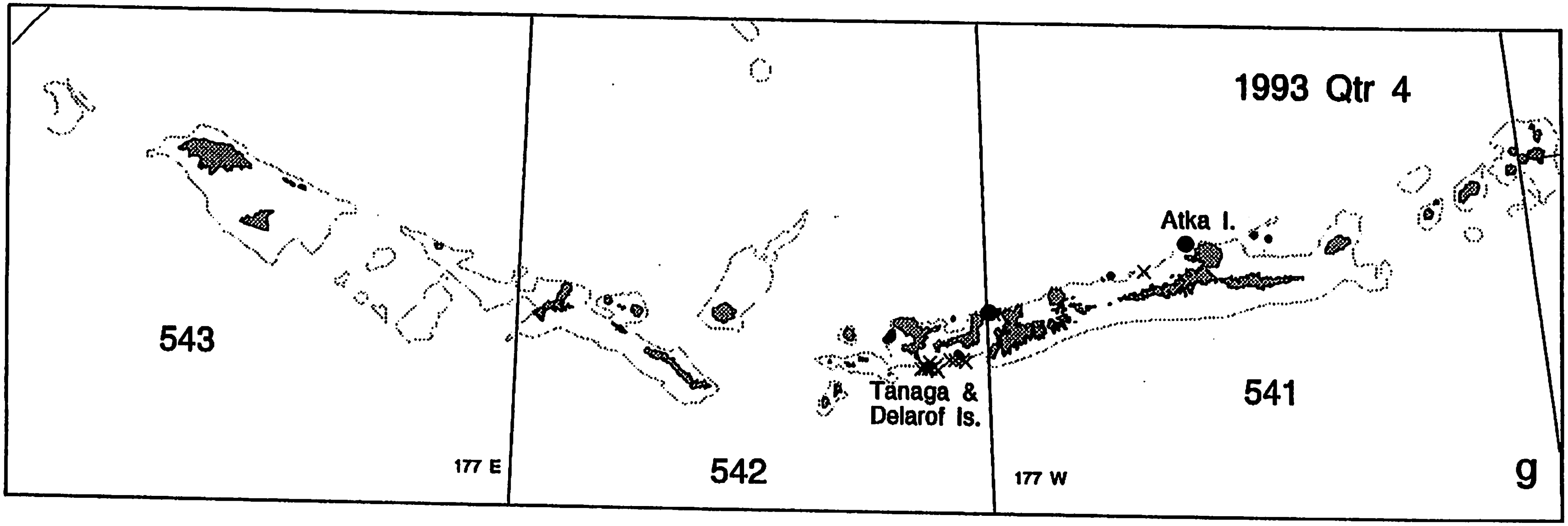


Figure 10. cont. Locations of observed and sampled sablefish sets in the Aleutian Islands in the third quarters of 1993 and 1994.



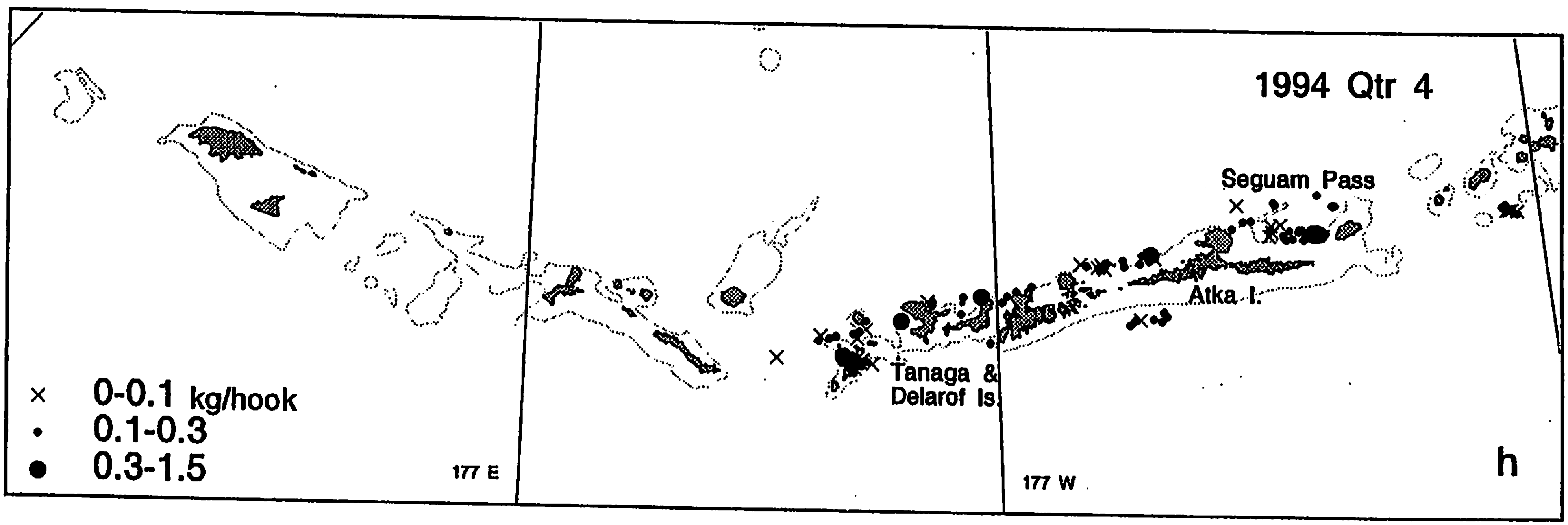


Figure 10. cont. Locations of observed and sampled sablefish sets in the Aleutian Islands in the fourth quarters of 1993 and 1994.

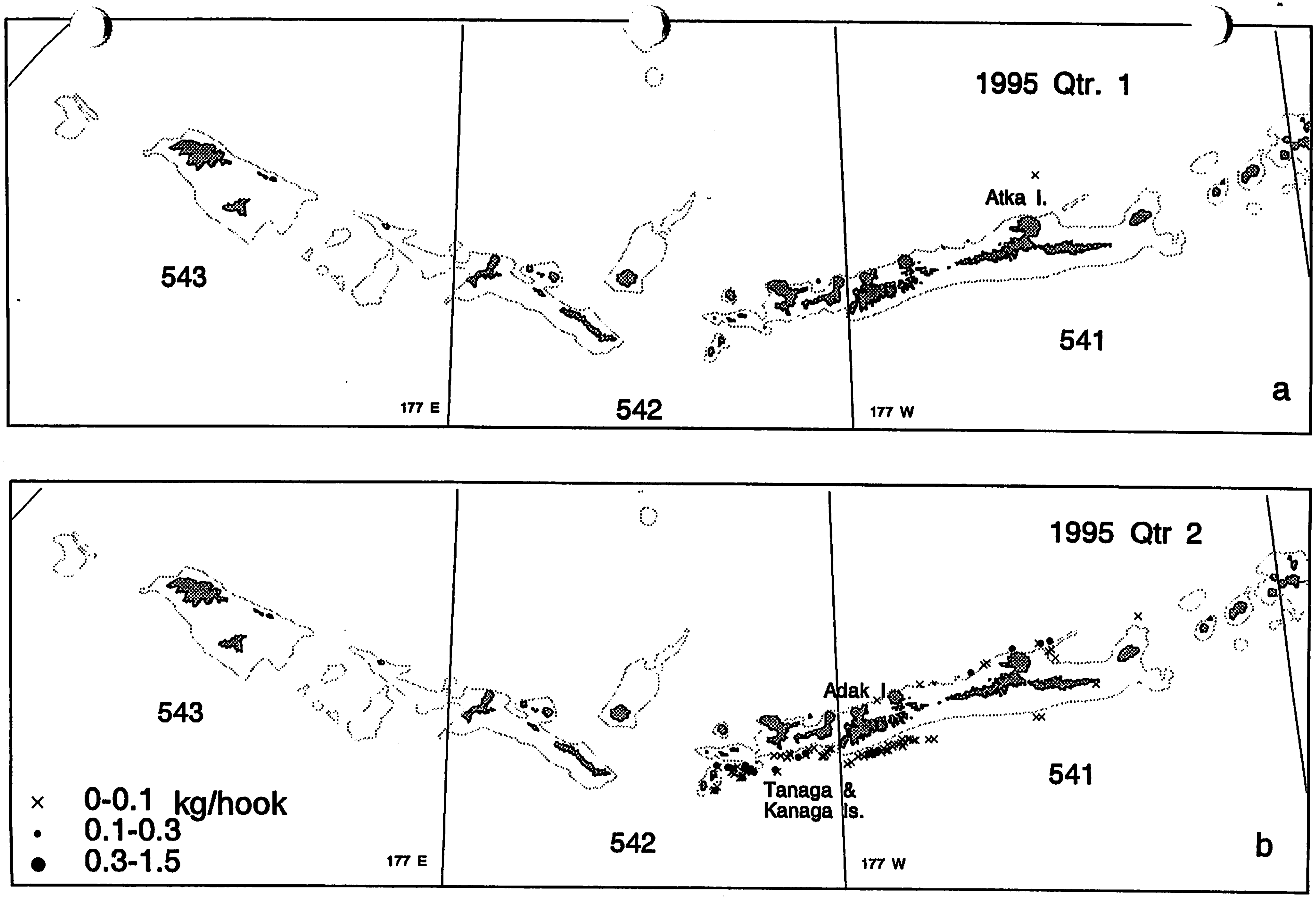


Figure 11. Locations of observed and sampled sablefish sets in the Aleutian Islands in the first and second quarters of 1995. There was only one observations in the first quarter.

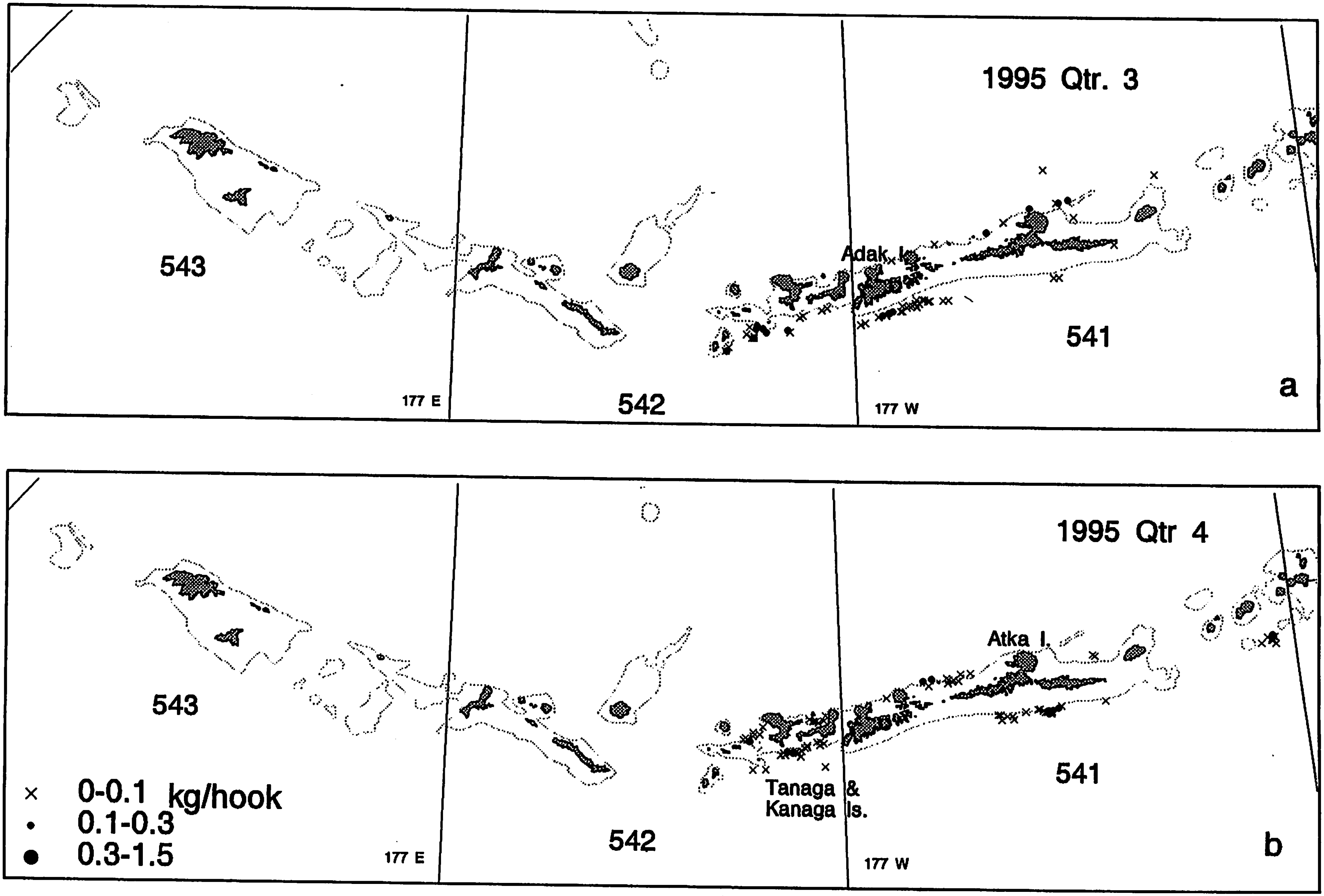
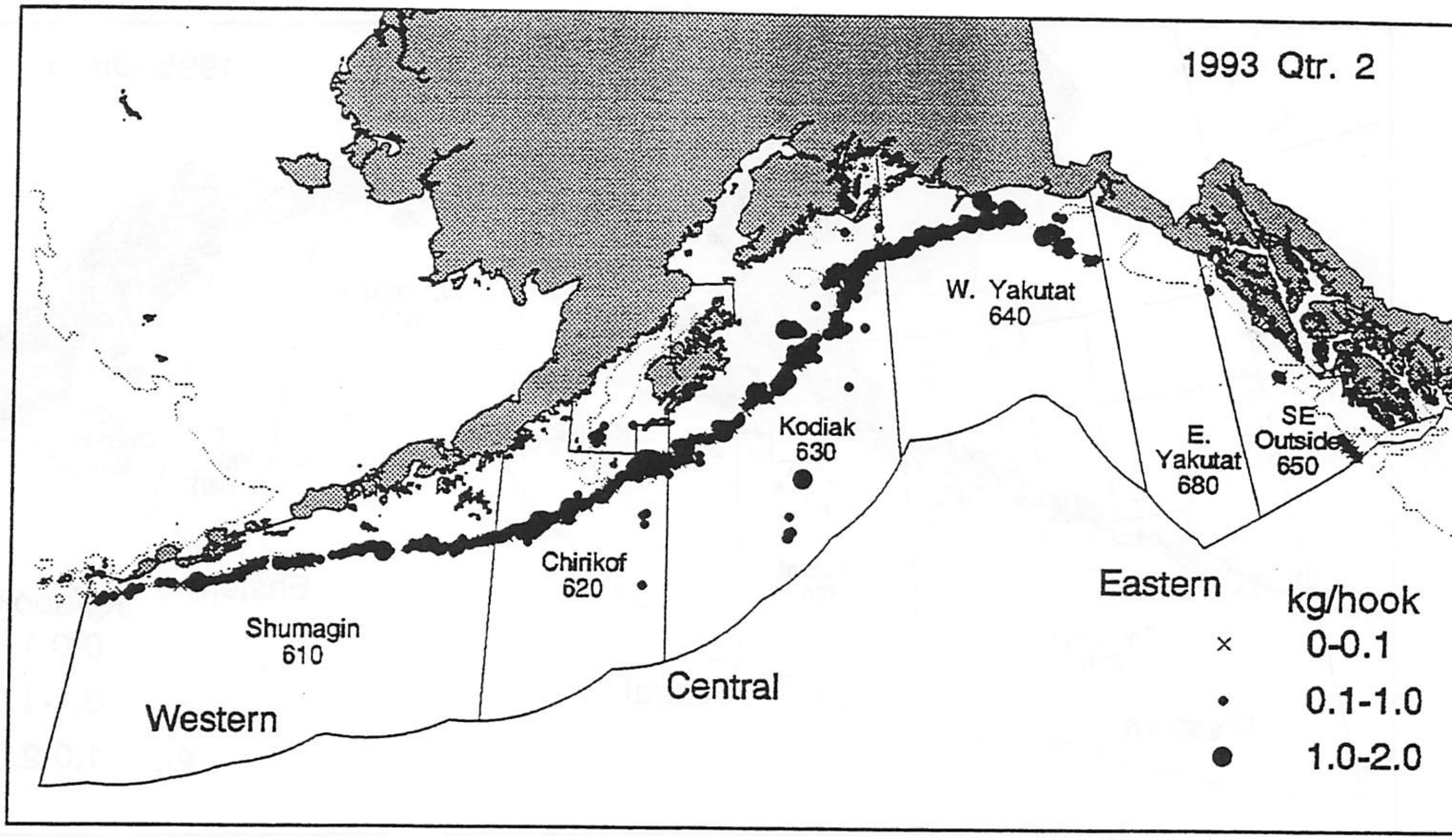


Figure 11. Locations of observed and sampled sablefish sets in the Aleutian Islands in the third and fourth quarters of 1995.



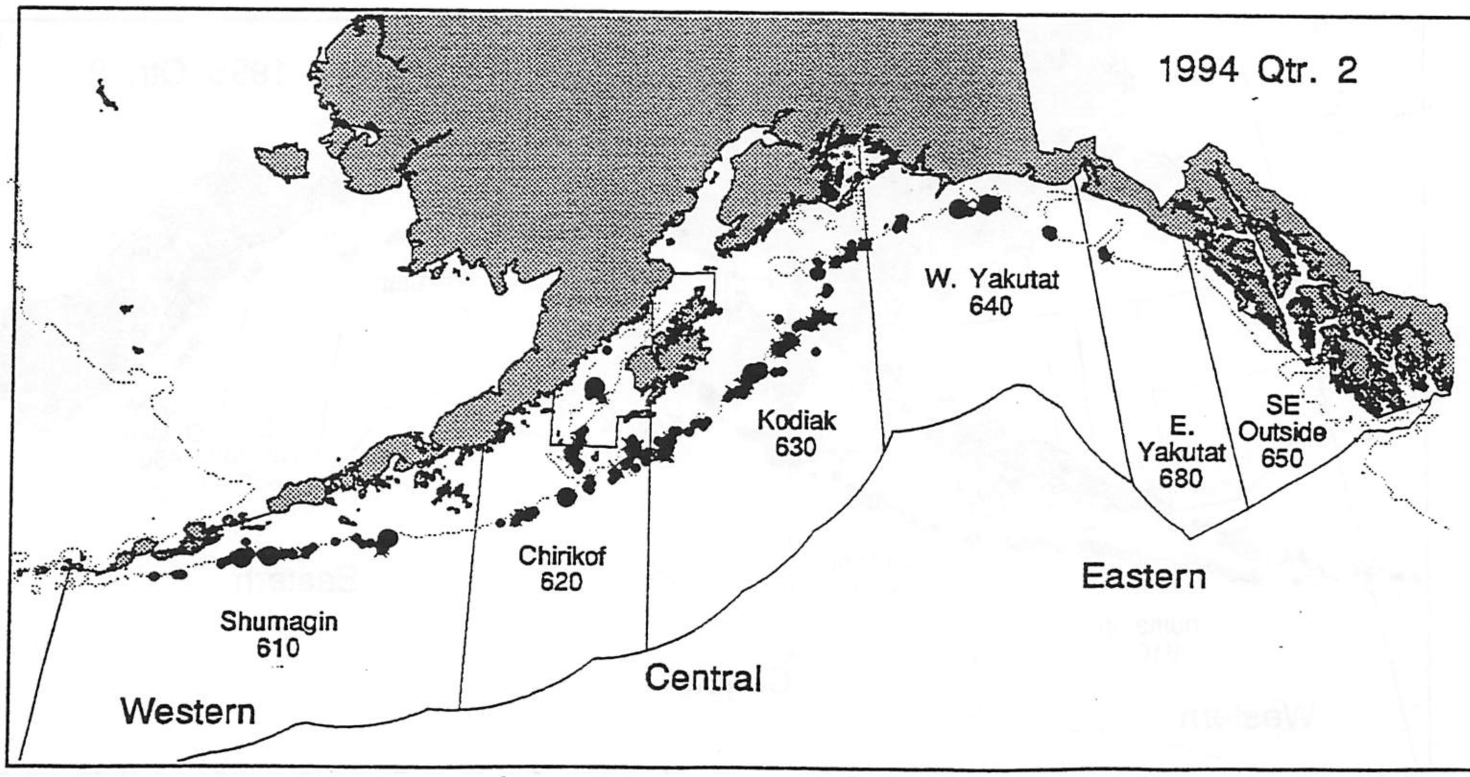
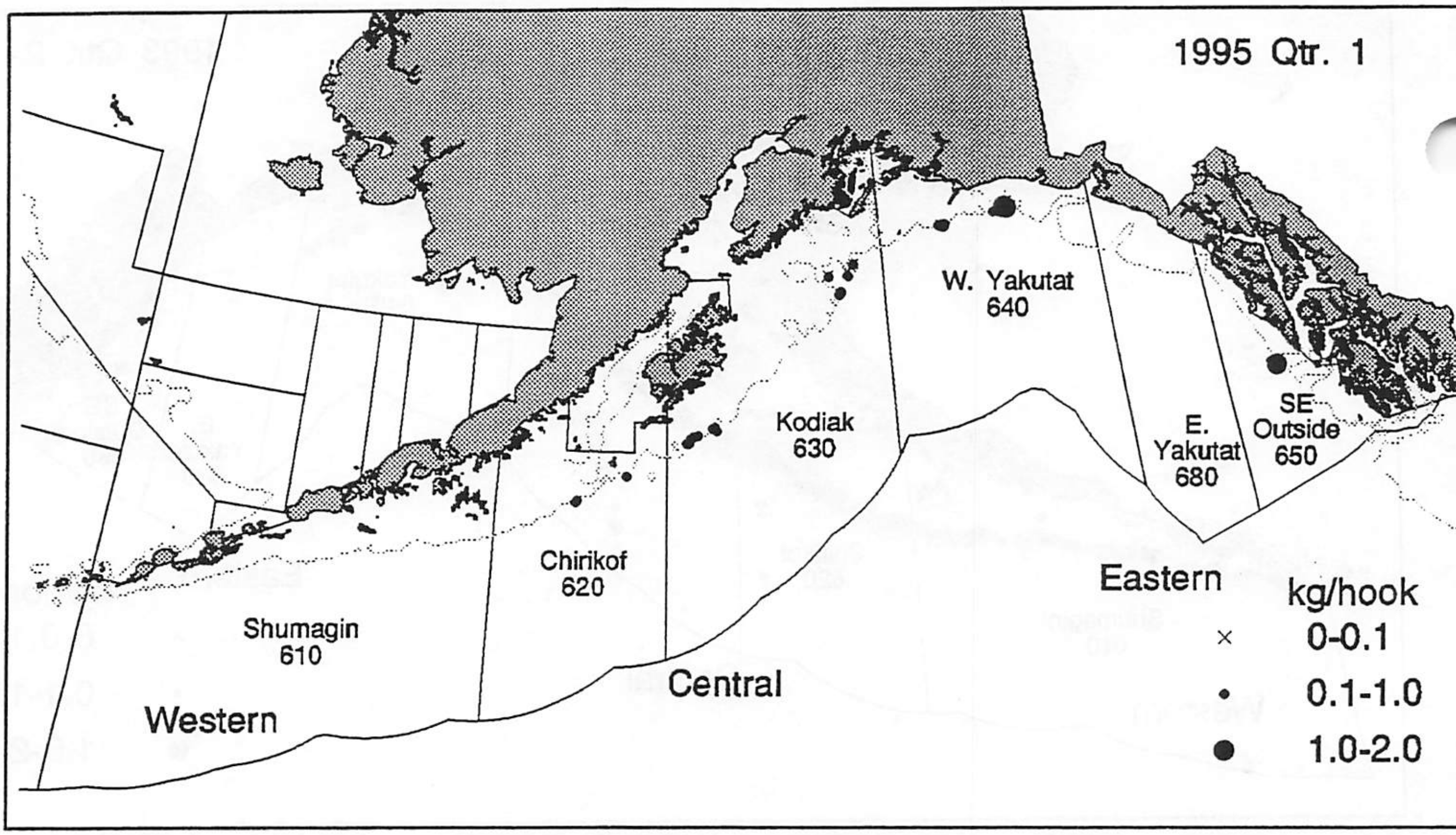


Figure 12. Locations of observed and sampled sablefish sets in the Gulf of Alaska in the second quarters of 1993 and 1994.



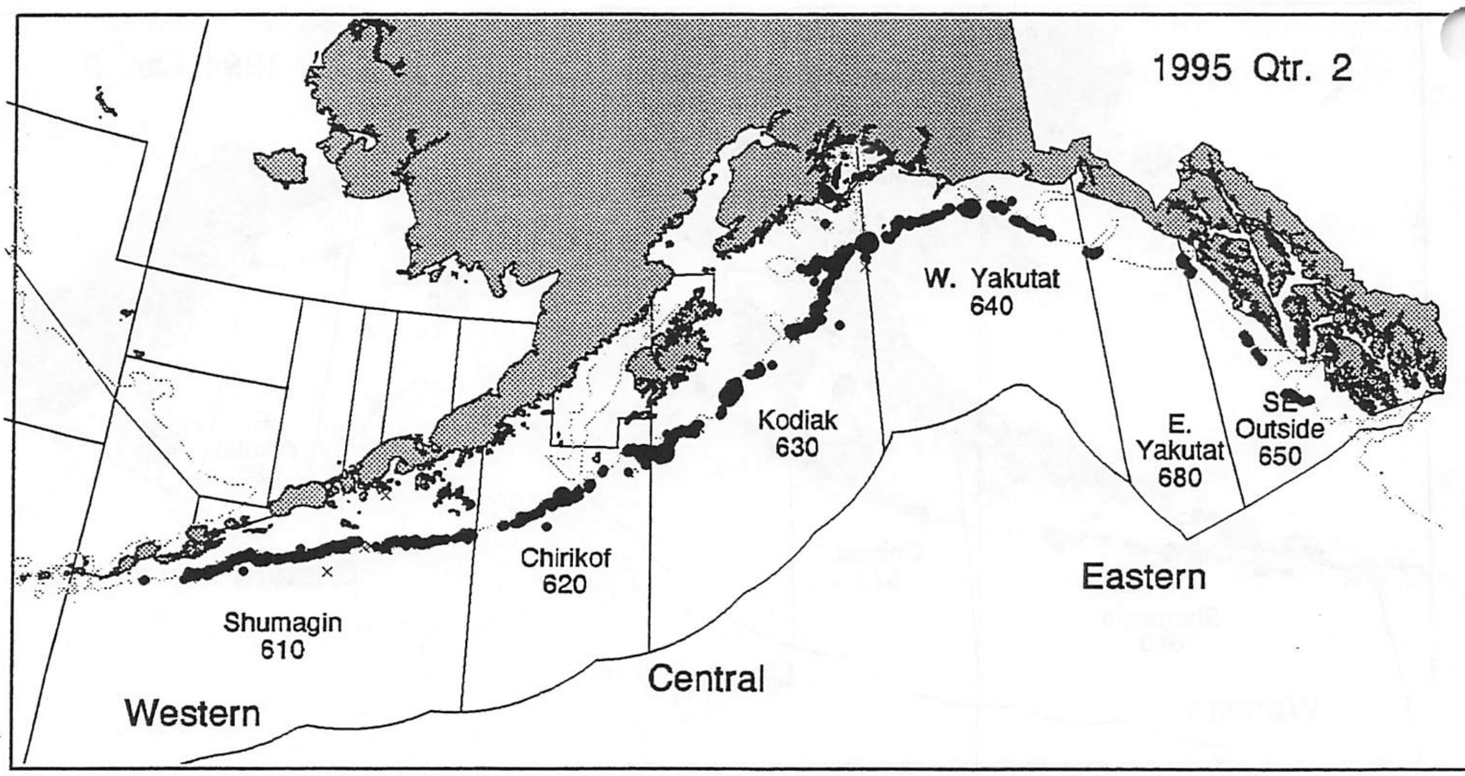
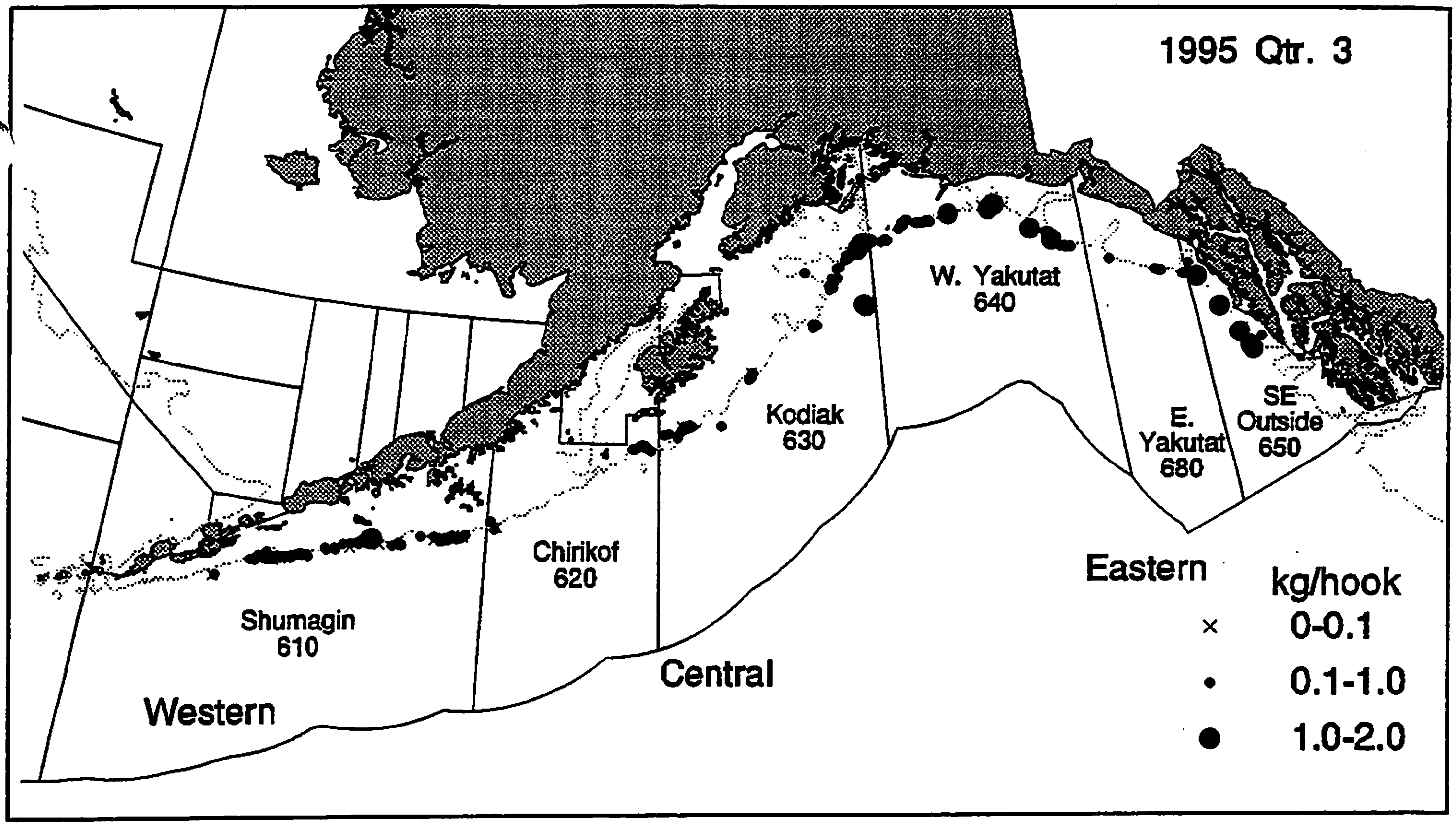


Figure 13. Locations of observed and sampled sablefish sets in the Gulf of Alaska in the first and second quarters of 1995.



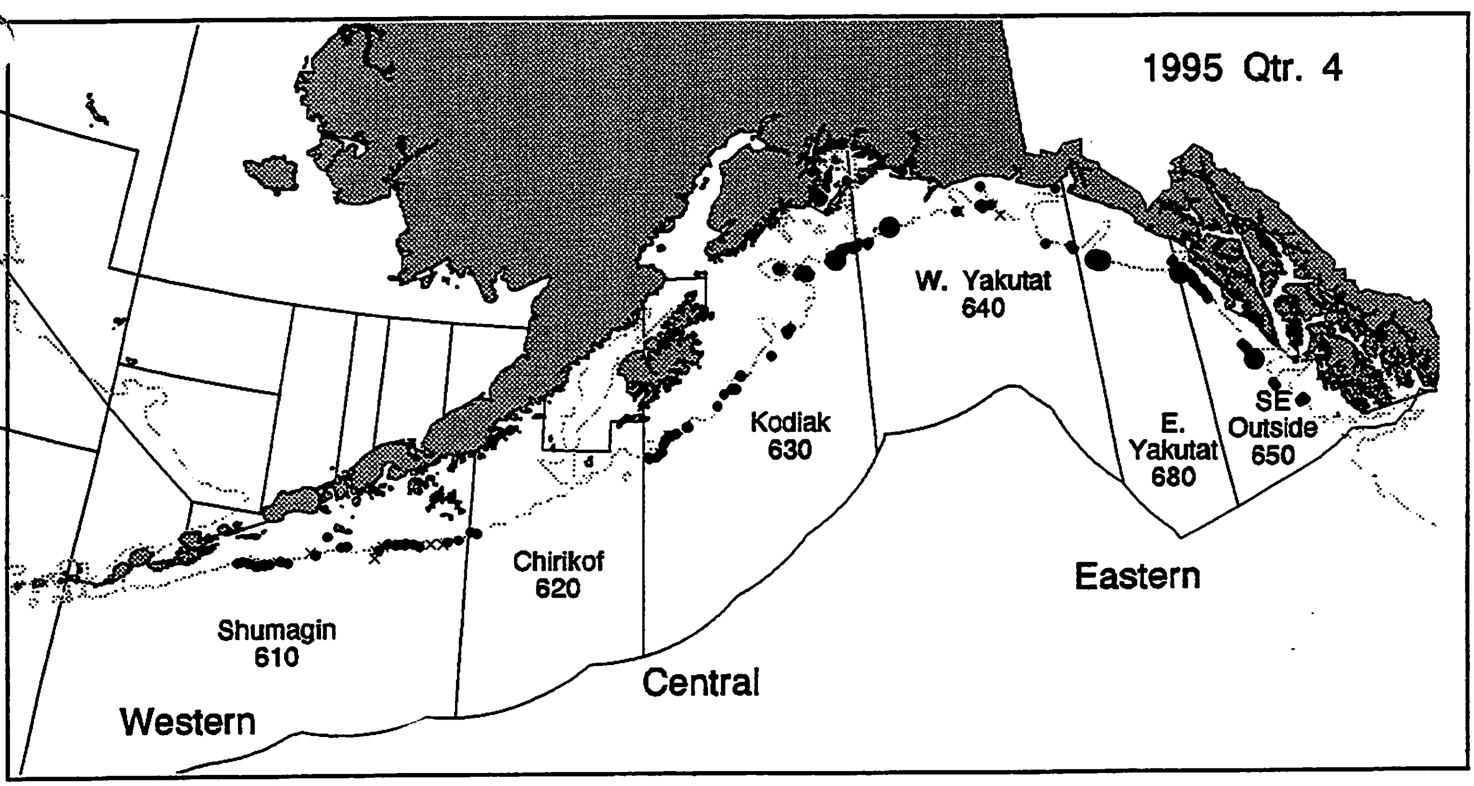


Figure 13. cont. Locations of observed and sampled sablefish sets in the Gulf of Alaska in the first and second quarters of 1995.

Attachment 2

INTERNATIONAL PACIFIC HALIBUT COMMISSION

ESTABLISHED BY A CONVENTION BETWEEN CANADA

AND THE UNITED STATES OF AMERICA

DIRECTOR
DONALD A. MCCAUGHRAN

P.O. BOX 95009
SEATTLE, WA 98145-2009

TELEPHONE
(206) 634-1838

FAX:
(206) 632-2983

November 27, 1996

Dr. Clarence Pautzke, Director
North Pacific Fishery Management Council
605 West 4th Avenue, Suite 306
Anchorage, Alaska 99501-2252

RE: December Council Meeting, Agenda Item D-1(g) Halibut Discard Mortality Rates

Dear Clarence:

At the recent Plan Team meetings, I presented a report containing an analysis of halibut bycatch viability data and recommendations for Preseason Assumed Discard Mortality Rates for monitoring halibut bycatch 1997. The teams requested that we provide additional information on several items in the analysis prior to the upcoming Council meeting. This letter is intended to provide the requested information to the Council.

(1) Additional information on the number of vessels observed, the number of hauls sampled, and size frequency. This can be found in the accompanying table.

(2) 1995 Gulf of Alaska hook-and-line rockfish fishery. Table 5 in my report indicated a discard mortality rate of 60% for this fishery in 1995, and a preseason assumed discard mortality rate of 34%. The Teams believed these values to be unusually high and asked that we further examine the observer data. We determined that an IFQ halibut trip had been inadvertently included in the data for this fishery. ***Removing these data results in a 1995 discard mortality rate of 4%, and a recommendation for 1997 of 6%.***

(3) 1992 BSAI sablefish pot fishery. Table 5 in my report indicated a discard mortality rate of 65% for this fishery, and a preseason assumed discard mortality rate of 65%. As with the rockfish fishery, these values seemed unusually high. Upon examining the data, I found that sampling was limited to relatively few hauls, which are not representative of the greater fishery. Based on this fact, ***I revise my recommendation for 1997 from 65% to 10%, which is the value used for the cod fishery.***

I have included a revised table which includes the new discard mortality rates mentioned above. I will be attending the December meeting and can address these issues with Council.

Sincerely,

Gregg Williams

Gregg H. Williams
Biologist

encl.

Table 1. Summary of halibut viability data set collected by NMFS observers during 1995.

Region, Gear and Target	No. of Vessels	No. of hauls sampled	No. of fish meas.	Extrapolated # of fish meas.	Percent < 65 cm	Percent < 82 cm
BSAI Trawls						
A	11	63	114	3,678	31	77
B	72	756	5,555	126,821	86	95
C	93	2,038	18,426	480,943	90	98
F	18	91	246	5,794	40	74
K	6	59	125	2,705	24	65
L	11	191	1,509	30,248	53	87
P	90	942	3,099	12,670	59	85
R	42	1,224	7,459	259,715	79	94
S	0	0	0	0	-	-
T	38	177	1,119	33,294	6	58
Y	47	428	1,910	32,010	37	66
BSAI Pots						
C	45	895	3,294	5,397	37	89
P	1	4	8	16	100	100
BSAI Longlines						
C	37	3,101	37,350	637,284	41	90
S	11	62	338	3,450	7	42
T	25	168	1,375	17,045	14	49
GOA Trawls						
A	0	0	0	0	-	-
B	36	202	2,569	22,140	57	84
C	82	902	12,268	95,075	75	95
D	13	82	693	4,621	23	59
H	25	191	1,815	28,604	75	94
K	26	319	1,944	24,259	13	48
L	10	36	367	3,269	42	88
P	44	103	232	450	65	85
S	7	56	262	3,236	11	58
X	14	158	1,118	25,680	51	92
GOA Pots						
B	1	2	7	20	100	100
C	37	388	2,070	3,108	23	84
GOA Longlines						
C	17	195	3,054	33,223	43	85
K	2	2	4	95	0	98
S	49	242	1,860	22,404	2	38

Table 5. Summary of halibut discard mortality rates (DMRs) during 1990-1995 and recommendations for Preseason Assumed DMRs to use in monitoring halibut bycatch mortality in 1997.

Region/Target	1990	1991	1992	1993	1994	1995	1994-95 Average	Used in 1996	Recommendations for 1997
BSAI Trawl									
A	66	77	71	69	73	73	73	63	73
B	68	74	78	78	80	73	76	78	76
C	68	64	69	67	64	71	68	63	68
F	80	75	76	69	61	68	65	73	65
K	65	67	69	69	75	68	72	75	72
L	-	-	-	-	67	62	65	73	65
O	-	-	-	-	-	-	-	82	68
P	85	82	85	85	80	79	80	88	79
R	64	79	78	76	76	73	75	73	73
S	46	66	-	26	20	-	23	49	23
T	69	55	-	-	58	75	66	49	66
Y	83	88	83	80	81	77	79	73	79
Z	20	-	-	-	-	-	-	-	20
BSAI Pot									
C	12	4	12	4	10	10	10	7	10
O	-	-	-	-	-	-	-	7	10
P	-	-	-	-	-	19	19	7	19
S	-	-	65	-	-	-	-	-	10
BSAI Longline									
C	19	23	21	17	15	14	15	11.5	14
K	17	55	-	6	23	-	15	24	15
O	-	-	-	-	-	-	-	11.5	14
S	14	32	14	13	38	19	29	17	29
T	15	30	11	10	14	9	11	22	11
GOA Trawl									
A	67	89	81	67	53	-	60	48	53
B	51	62	66	57	48	66	57	54	57
C	60	62	66	59	53	64	59	56	59
D	61	58	70	59	60	56	58	60/52	58
H	66	71	69	65	62	70	66	67	66
K	65	75	79	75	58	71	65	57	65
L	-	-	-	-	54	64	59	67	59
O	-	-	-	-	-	-	-	47	66
P	71	82	72	63	61	51	56	72	51
S	70	60	68	59	67	58	62	57	62
X	-	-	-	-	56	76	66	60/52	66
GOA Pot									
B	-	-	-	-	-	100	100	17	100
C	12	7	16	24	17	21	19	17	19
O	-	-	-	-	-	-	-	17	19
GOA Longline									
C	15	18	13	7	11	13	12	12	12
K	6	-	-	7	-	4	6	18	6
O	-	-	-	-	-	-	-	12	12
S	17	27	28	30	22	31	27	23	27

AGENDA D-1(c,d)
DECEMBER 1996
Supplemental

Alaska Groundfish Data Bank P.O. Box 2298 • Kodiak, A

TO: RICK LAUBER
NORTH PACIFIC FISHERY MANAGEMENT COUNCIL

RE: GULF SPECIFICATIONS

DATE: DECEMBER 4, 1996

SENT BY FAX:

COMMENTS REGARDING THE 1997 GULF SPECIFICATIONS (Agenda Item D-1(d))

FLATFISH TAC'S: To prevent encouraging additional or new investment in processing or catching Gulf flatfish the Central/Western TAC's have historically been set below ABC to reflect what might actually be taken under the halibut cap rather than the total tonnage available.

CENTRAL GULF				PLAN TM	AGDB
FLATFSH	96 ABC	96 TAC	96 CAT	97 ABC	97 TAC
ARRWT	141290	25000	19537	142100	25000
DEEP FLT	8150	7500	1956	3690	3690
SHW FLT	17170	12950	8616	19260	12950
FLTHD	23140	5000	2091	15360	5000
REX SO	7050	7050	5137	5490	5490

WESTERN GULF				PLN TM	AGDB
FLATFSH	96 ABC	96 TAC	96 CAT	97 ABC	97 TAC
ARRWT	28400	5000	2980	31340	5000
DEEP FLT	670	460	19	540	460
SHW FLT	8880	4500	443	22570	4500
FLTHD	26280	2000	840	8440	2000
REX SO	1350	800	504	1190	800

PACIFIC OCEAN PERCH - CENTRAL GULF:
AGDB supports the Plan Team recommended ABC for Gulf Pacific Ocean Perch. Despite the fact that POP in the Gulf has reached the rebuilding plan goal, we see no reason to change the conservative strategy being used for POP. We want to point out the two following points:

1. The exploitation rate for 1997 calculates out to around 5%.
2. The biomass estimate generated by the model is below the lowest end of the survey confidence range.
3. The Gulfwide Overfishing Level is 19,765 MT, well above the 12,990 ABC recommended by the Plan Team.

It appears that extreme conservatism has been used in every calculation leading to an ABC and there is no justification for making further reductions in the ABC or TAC in the Central Gulf.

Pacific Ocean Perch was harvested and processed in 1996 by shorebased operations in Kodiak. All participants were pleased with the market reception of the products produced. (Letters from each processing plant in Kodiak detailing the use of POP were submitted to the Council in September).

Chris Blackburn • Director • (907) 486-3033 • FAX (907) 486-3461 • e-mail 7353974@mcimail.com

1997 PACIFIC OCEAN PERCH FISHERY - PREVENTING A REOCURRENCE OF THE 1996 PROBLEMS

Pacific Ocean Perch was harvested and processed in 1996 by shorebased operations in Kodiak. All participants were pleased with the market reception of the products produced. (Letters from each processing plant in Kodiak detailing the use of POP were submitted to the Council in September).

This was a new fishery for shorebased Kodiak and the following problems which occurred in 1996 are not expected to occur in 1997.

1. Vessels backed up waiting for unloading: Processors had underestimated the time it took to unload rockfish. Rotations were changed when the problem occurred. This problem is not expected to occur in 1997.
2. Overages on sablefish bycatch: Pacific Ocean Perch weigh about 70% per volume in the hold as pollock or Pacific cod. This resulted in a number of unintended overages of sablefish bycatch. Based on the 1996 experience the fleet is now able to estimate more accurately the weight of the fish onboard.
3. Exceeding the Sablefish quota: This year the retention rate for sablefish in the trawl deep species fisheries, which includes rockfish, is 7%, less than half of last year's 15%. This change should slow down the catch of sablefish in all trawl fisheries, reduce efforts to "top off" since the rate appears to be closer to the natural bycatch rate and allow NMFS time to properly manage the fishery.
4. Overfishing of Pacific Ocean Perch. Deliveries in 1997 should be more predictable than 1996 which allows better tracking of catch.

TO ASSURE THAT NEITHER THE TRAWL SABLEFISH OR PACIFIC OCEAN PERCH QUOTAS ARE EXCEEDED, both the shorebased and at sea Pacific Ocean Perch operations are willing to provide daily production reports to NMFS directly or to NMFS through an industry funded representative such as AGDB, Sea State or other -- whichever way NMFS prefers -- during the rockfish target fishery.

QUARTERLY APPORTIONMENT OF GULF TRAWL HALIBUT CAP:
AGDB members recommend the same quarterly apportionment used in 1996 be used in 1997. All user groups feel the current apportionment is working well.

1996 HALIBUT CAP APPORTIONMENT FOR TRAWL GEAR
AGDB RECOMMENDS THE SAME APPORTIONMENTS BE USED IN 1997

QUARTER	SHALLOW CMPLX	DEEP CMPLX	TOTAL
QTR 1	500 MT	100 MT	600 MT
QTR 2	100 MT	300 MT	400 MT
QTR 3	200 MT	400 MT	600 MT
QTR 4	NO APPORTION	NO APPORTION	400 MT
TOTAL	800 MT	800 MT	2000 MT

Sincerely,

Chris Blackburn, Director
Alaska Groundfish Data Bank

AGDB COMMENTS RE GULF SPECS - DEC. 4, 1996 - PAGE 2 OF 3

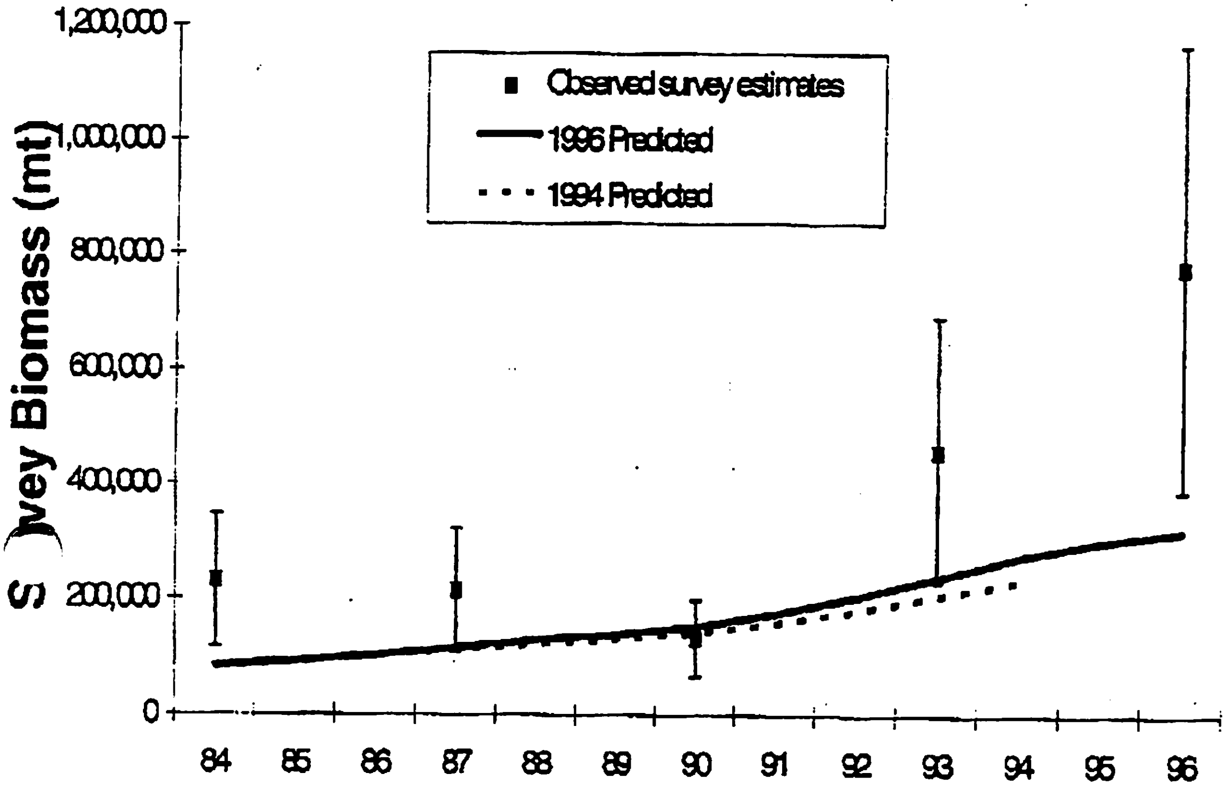


Figure 6-7.-- Observed and predicted survey biomass estimates for Pacific ocean perch in the Gulf of Alaska. Ninety-five percent confidence limit is shown for each observed biomass estimate. "1994 predicted" indicates model used in previous assessments; "1996 predicted" indicates model used in the current assessment.

D-1c(d.)

North
Pacific
Longline
Association

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DEC - 4 1996

Agenda D-1

December 4, 1996

Mr. Richard B. Lauber, Chariman
North Pacific Fishery Management Council
605 West 4th Avenue
Anchorage, AK

RE: Season Changes to Reduce Halibut Bycatch

Dear Rick:

Janet Smoker of Fisheries Information Services has calculated that longline fishermen would achieve reductions in halibut bycatch if **the BSAI cod "B" season for hook-and-line cod were changed from September 1 to September 15, and the directed fishery for turbot were started April 1 rather than May 1.**

We would like to request that these changes be made. In a discussion with NMFS staff it was suggested that the former change could be accomplished by releasing the "B" season halibut PSC on Sepetmber 15. We are hopeful that the same method could be used to accelerate the opening of the turbot fishery. We are also hopeful that these changes do not require a regulatory amendment.

Thank you.

Sincerely,

Thorn

Thorn Smith

4209 21st Avenue West, Suite 300, Seattle, Washington 98199
[illegible]

North
Pacific
Longline
Association

- FAX TRANSMISSION -

RECEIVED
DEC - 3 1996

DATE: December 3, 1996

TO: NPFMC - Clarence Pautzke

FROM: NPLA - Thorn Smith

SUBJECT: Letters for Council Notebooks

Assumed Halibut Mortality Rate - BSAI Fixed Gear Cod (D-1)

Using 1995 observer data, the IPHC has recaclulated halibut mortality in the BSAI cod fishery at 14%. This is 2.5% above our current 11.5% rate, and would cost us about 25% of our fishery. The difficulty with 1995 was that NMFS implemented a short "B" season for fixed gear cod, and hung out an even shorter "C" season in November. Our FIS industry monitoring program cannot perform optimally in short seasons, and fishermen throw caution to the winds in a race for fish (points we made to NMFS repeatedly). Our amendment requests would prevent a repetition of this experience.

Janet Smoker of FIS has calculated our current halibut mortality rate using 1996 observer data and the old calculation model. She finds an average rate of about 12%. There is reason to think that this number may be reduced by the new model. Next week Janet will present a paper to the SSC and to the Council on this topic. We wish to request that the Council leave our assumed mortality rate at 11.5% for the first part of 1997, await IPHC calculation of our actual 1996 performance, and recalculate our 1997 halibut mortality using the more current number - just as the Council did in 1995.

In implementing the halibut careful release program Janet and I do a "good cop/bad cop" act. I am the bad cop. I lean on people. If the Council focuses on rewarding positive behavior (we cut our halibut bycatch rate by 36% the first time out, have now cut our turbot rate by 50%) it makes my job a lot easier. If on the other hand rates get raised, the fishermen's response to me is, "Why the hell should I go to all this trouble if it's not doing me any good?" Remember, one "hey asshole" wipes out a thousand "attaboys."

Thank You,

Thorn

North Pacific Fisheries Management Council
Scientific and Statistical Committee
and Advisory Panel

RECEIVED DEC - 4 1996

December 4, 1996

Richard Lauber, Chairman

re: GOA Specs. - Consideration and recommendation of a bycatch mortality rate for Chionoecetes bairdi, tanner crab, in the GOA Pacific cod pot fishery.

Beginning in 1997, five Pacific cod management plans for Alaska's 3 mile limit state waters will take effect in the GOA. These plans restrict fishing gear to pots and jigs on a preestablished portion of the federal/state combined stock ABC. The fisheries will begin 7 to 14 days after closure of the concurrent federal/state season, about mid March, and extend through the summer and fall ending with catch of the state waters' TAC or end of the calendar year.

A concern has been raised that exclusive use of pots and jigs will increase the mortality of tanner crab. Using Pacific Associates "Discards in the Groundfish Fisheries....during 1994" as the most recent analyzed data, it is clear - although harvest was limited(93 mt) - the crab bycatch for jigs was reported as zero and therefore cannot be identified as a problem at this time.

The concern is appropriate at first glance for the pot fishery. GOA pot Pacific cod fishery bycatch mortality rate for bairdi calculates as:

15,340 crab bycatch with landing of 9177 mt = 1.67 crab/mt of P. cod.

However, this is based on an assumed bycatch mortality of 100%. If this is going to be used as a critical measure for the management plans, this simple default assumption must be assessed to see if is sustainable as the best available evidence.

A number of studies give insight to the question. Several aspects have been identified as contributing factors to discard mortality and they can be examined individually.

1] Effect of air temperature and surface handling time.

2] Effect of handling damage.

3] Effect of raising tanner crab through the water column and crab passing back down to the bottom once or multiple times.

4] Effect of predation primarily by P. cod while crab are in a free fall return to the bottom.

1] Temperature and handling time in a pot fishery are specifically addressed by Carls and O'Clair *Responses of Tanner Crabs, Chionoecetes bairdi, Exposed to Cold Air* in Fishery Bulletin 93(1) 1995. They found that adult Tanner crab mortality was directly related to a combined temperature and exposure time factor. As can be seen in table 1 and figure 2, even temperatures of -20.3C exhibited no significantly increased mortality even up to 35 days after exposure if returned to the water within 4 minutes. Zhou and Shirley (1996) collected data during the commercial Bering Sea Red King crab fishery and determined maximum return time was less than 4 minutes. Although their data relates to a different fishery, that sorting process is more complex and my vessel's experience is that any crab are returned in much less time in our P. cod pot fishery.

It should also be noted that the proposed State fishery will start when the weather is warming in March and progress through the summer, fall and the generally warmer part of winter if it has not closed before December.

2] Handling damage is specifically addressed by Macintosh et al, *Effects of Handling and Discarding on Mortality of Tanner Crabs* at the 1996 Symposium on High Latitude Crabs. Investigation of common handling injuries artificially induced showed no significant increase in mortality after 60 days. This included multiple belly flops into water, bending and pinching of leg, and cracking of carapace.

3] Repeatedly raising and lowering tanner crab through the water column was also investigated by Macintosh et al. " The Elevator experiment was designed to simulate repeated capture of crabs in a pot as closely as possible." .... "Repeated retrieval of crabs through the water column followed by air exposure on deck as a significant source of mortality is not supported by this study."

A Cook Inlet study conducted during the P. cod fishery in 1992 by Al Kimker, ADF&G 2A92-21, *Tanner Crab Survival in Closed Pots*, shows very low mortality. Even though this was a starvation study, it is evident that over the period of 2 weeks with 3 picks - mortality was only 1.5 percent, and after a month with four picks - the mortality was only 2.3 percent.

4] Effect of Pacific cod predation on discarded crab free falling through the water column was summarized in the Macintosh discussion. Livingston (1989, 1993) has shown that although tanner crab are common prey for P. cod, almost none over 60 mm (2.4 inches) are taken, and Jewett(1978) found that the largest in the GOA was 70 mm or 2.8 inch.

I observe the mesh size used on cod pots would let 3 inch juveniles pass through and not be trapped and upon starting a lift they would easily pass through the bottom web. Thus the size of Tanner crab bycatch in the pot cod fishery is generally well above the size range for P. cod predation.

As Macintosh concluded "...there is no evidence that injured or uninjured, Tanner crab would be vulnerable to Pacific cod predation."

These studies provide a scientific basis for establishing a pot bycatch mortality rate for the Pacific cod pot fishery in the Gulf of Alaska, or at least eliminating Tanner crab bycatch mortality as a significant concern in the pot gear allocation. I suggest that the best data would be the Kimker Cook Inlet study. Since that was conducted under starvation conditions, it should be very conservative for non-starved crab. If the SSC/Council wishes to look long term, the 30 day mortality rate would be 2.3%

Bycatch under optimized State management would yield the following projected increase of tanner crab bycatch mortality (All amounts caught in the jig fishery would reduce the bycatch to zero for each ton so caught. There is currently no way to predict the apportionment of actual P. cod catch between pot and jig, although each will have an assigned opportunity for 50% of the cod quota for 6 months)(Currently pots account for 20% of the GOA harvest and the following calculations do not consider offset reduction for crab not caught in the trawl and longline foregone harvest):

1997 12385 mt cod with 80 % shifted from other gears = 9,908 mt
x 1.67lb/mt =16,546 crab x .023 mortality rate = 380 dead crab
1998 16380 mt cod with 80 % shifted from other gears =13,104
x 1.67lb/mt = 21,884 crab x .023 mortality rate = 503 dead crab
1999 20375 mt cod with 80 % shifted from other gears =16300
x 1.67lb/mt = 27,221 crab x .023 mortality rate = 626 dead crab

Total increase crab killed under the fully implemented 3 year State Pacific cod management = 1,509 crab

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High Latitude Crabs: Biology, Management, and Economics
Alaska Sea Grant College Program • AK-SG-96-02, 1996

3 of 14 pages

Effects of Handling and Discarding on Mortality of Tanner Crabs (*Chionoecetes bairdi*)

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Abstract

The substantial bycatch of female and sublegal male Tanner crab (*Chionoecetes bairdi*) in Alaskan commercial pot fisheries has been a subject of some concern. The process of crab capture, deck handling, and discard can result in damage that causes mortality. This study evaluated the separate effects of dropping crabs into water, inducing leg or carapace injuries, and repeatedly capturing crabs on the mortality of sublegal and legal size male Tanner crabs. After a 60-day holding period there was no significant difference in the percent of Tanner crabs dying in treatment groups (0-6%) and control groups (1-12%). Tanner crabs readily autotomize limbs that have been injured. Eighty-five percent of crabs with a merus/carpus joint injured had autotomized that leg within 24 hours, and 94% had done so by the 14th day.

Introduction

The Tanner crab (*Chionoecetes bairdi*) is one of the most important commercial crab species in Alaska. Over the 10-year period 1984-1993, the eastern Bering Sea alone accounted for 66,000 mt with an ex-vessel value of $228 million (ADF&G 1994). The Tanner crab fisheries use pots to target mature males greater than or equal to 140 mm (5.5 inches) carapace width (minimum legal size statewide except Prince William Sound, where the size limit is 5.3 inches) (ADF&G 1993). There is no minimum pot mesh size restriction, although in some areas two escape rings 121 mm in minimum inside diameter must be sewn into the mesh. In both Tanner and king crab fisheries, large numbers of sublegal-size male and female Tanner crabs are caught and must be returned to the sea. In the 1994 eastern Bering Sea Tanner crab fishery which captured

In the Elevator experiment, there was no significant difference ($G^2 = 2.74$, P-value = 0.10) in autotomy rates between controls (7 of 75) and elevated crabs (13 of 69; Table 3).

Discussion

There are many factors that by themselves, or in some combination, could potentially affect the survival of Tanner crab discarded from commercial pot fisheries. In our crab Drop and Injury experiments, we chose to narrow the focus of the treatment so that any observed mortality could be better linked to one treatment factor. The Elevator experiment linked a number of handling factors together and more closely resembled a commercial handling regimen.

Dropping crabs either one or four times into still water on their ventral surface did not increase mortality in our experiment. While we didn't simulate the drop from a moving vessel (crabs are usually discarded overboard from a vessel as it travels between pots), the height that we dropped from (2.5 m) was somewhat higher than the 1.7 m average rail height in a sample of twelve eastern Bering Sea crab vessels (Leslie Watson, Alaska Dept. Fish. and Game, Kodiak, Alaska, Dec. 1993, pers. comm.). Two recent experiments with red king crab also found no mortality associated with water impacts. Zhou and Shirley (1995) simulated deck handling and discard with a process that included an aerial drop into water and found no increase in mortality with up to three handlings. When Watson and Pengilly (1994) dropped tagged legal size red king crab from a height of 1.7 m from a vessel moving through the water at 7.5 knots, the rate of tag return from the commercial fishery was the same as for crabs that they dropped only 37 cm into still water. These experiments taken together would suggest that hard-shelled crabs are not damaged by water impacts alone.

Our Injury experiment was designed to isolate three common injury types from other handling factors. While no treatment group suffered significantly higher mortality than control crabs, it is possible that injured crabs or even uninjured crabs released into the natural environment would not have fared as well as tank-held crab. Gooding (1985) observed a high rate of fish predation on uninjured spiny lobsters (*Panulirus marginatus*) released from pots that resulted primarily from their vulnerability while falling through the water column and disorientation upon landing on the bottom. Fish predation in the eastern Bering Sea, however, may not be a problem. Food habits studies of Pacific cod (*Gadus macrocephalus*) (Livingston 1989) and of nine common groundfish predators (Livingston et al. 1993) have shown that while small Tanner crab are common fish prey, almost no crab over 60 mm carapace width are taken. In the Gulf of Alaska, Jewett (1978) found that while Tanner crab was the most frequently occurring species in Pacific cod stomachs, the largest crab taken was 70 mm, and 78% of crabs were between 7 and

28 mm. Since almost all male Tanner crab discarded from the eastern Bering Sea pot fisheries are larger than 70 mm (Tracy 1995a, 1995b), there is no evidence that, injured or uninjured, Tanner crab would be highly vulnerable to Pacific cod predation.

Autotomy is a common response to limb injury in Tanner crabs, and this was certainly the case with the bent group in the Injury experiment. Ninety-six percent of the crab in this group autotomized the injured leg. The 85% autotomy rate within 24 hours of treatment and the extremely low (1.4%) experimental mortality rate of these crabs suggests that leg injuries that lead to autotomies will seldom result in mortality.

The Elevator experiment was designed to simulate repeated capture of crabs in a pot as closely as possible. One substantial deviation, of course, was that the crabs rode the pot both up and down through the water column. By avoiding rough handling each time the pot was brought on deck, emptied, and refilled, we avoided some physical damage that might itself have caused mortality. No crab sustained body damage as a result of the elevator treatment and most leg damage was remedied by autotomy, as only three crabs had minor leg damage. Repeated retrieval of crabs through the water column followed by air exposure on deck as a significant source of mortality is not supported by this study.

There are several additional issues that need to be considered when evaluating these experiments and their relevance to actual fishery conditions. Only males were used in the experiments although females made up 38% of the 9.6 million Tanner crab discarded in the 1994 eastern Bering Sea Tanner crab fishery (Tracy 1995a). When Hayes and Reid (1974) held trawl-caught Tanner crabs on deck in air or buried in bins of fish, they found that, overall, egg-bearing females had a lower mortality rate than males. Because of their more compact shape, pot-caught females might also be less subject to limb injury and autotomy than males. Among trawl-caught "adult" Tanner crabs, Edwards (1972) found that 43% of males and 23% of females had autotomies. The discard mortality rate of large females is probably no greater than for large males.

The size of males that we used was dictated largely by what we could catch. The percentage of legal size males used in the Drop, Injury, and Elevator experiments was 52, 18, and 60%, respectively. Both sublegal and legal-size males are discarded in Alaskan commercial crab fisheries. The State of Alaska has, however, attempted to minimize crab bycatch by allowing the take of legal size Tanner crab during the most recent (1993) Bristol Bay red king crab fishery (Tracy 1995a).

No softshell and very few very oldshell crab were used in these experiments. Do commercial pots catch substantial numbers of these crabs, and if they do, might their mortality rates be higher? Observer data from the eastern Bering Sea Tanner crab fishery from 1991 through 1994 show that no softshell crabs of either sex are caught (Tracy 1995a). This is probably because few crabs are soft-shelled when the late fall

Responses of Tanner crabs, *Chionoecetes bairdi*, exposed to cold air

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Abstract.—Female and sublegal-size male Tanner crabs, *Chionoecetes bairdi*, are often caught incidentally in the males-only fishery for this species. Effects of low air temperature during the winter fishery on juvenile and female adult crabs and on the developing eggs brooded by the females were simulated in the laboratory by exposing crabs to cold air (−20 to +5°C) up to 32 minutes; controls were not exposed. Exposure was expressed as degree-hours (°h), the product of temperature (°C) and time (hours). Severe exposure caused death: median lethal exposure stabilized at −3.3 ± 0.8°h for juveniles and −4.3 ± 0.5°h for adults after 16 days. Exposure also reduced vigor (measured by righting ability), caused pereiopod autotomy, and depressed adult feeding rates and juvenile growth. Exposures causing one-half the crabs to cease righting were −1.2 ± 0.3°h for juveniles and −2.1 ± 0.3°h for adults (measured immediately after exposure). Mean pereiopod autotomy ranged up to 44% for juveniles exposed to −2°h, and up to 10% for adults exposed to −10.6°h. Ecdysis of juveniles was not affected, but exposed juveniles frequently shed additional pereiopods with the molt. Prompt return of incidentally caught Tanner crabs to the sea when temperatures are below freezing should reduce adverse effects of cold aerial exposure.

Manuscript accepted 23 May 1994.
Fishery Bulletin 93:44–56 (1995).

Tanner crabs, *Chionoecetes bairdi* Rathbun, 1893, are the target of a large commercial pot fishery and are an important commercial species in Alaskan waters (Otto, 1989). Landings of *C. bairdi* rose to a peak of 57,923 metric tons (t) in 1978, then declined to 5,390 t in 1987; landings increased to 23,507 t in 1990.[1]

Current Alaska fishing regulations require release of small (<139-mm carapace width) male and all female *C. bairdi*. Commercial fishery openings in recent years have generally ranged from November through April,[2] when minimum daily air temperatures can drop to −21°C.[3] The amount of time incidentally captured crabs remain on deck varies, ranging from a few minutes during pot fishing to hours in some trawling operations (Stevens, 1990). Exposure to cold air during fishing operations may be detrimental to individual crabs (Carls and O'Clair, 1990), exposed egg clutches, and possibly—with sufficient fishing pressure—to the population. Regulations also require that Tanner crabs caught incidentally by multispecies trawling operations in the eastern Bering Sea be returned to the sea, but these regulations may be ineffective because of poor survival (22 ± 3.6% for *C. bairdi*) of the culled crabs (Stevens, 1990).

Here we report the responses of juvenile and adult female Tanner crabs and their offspring exposed to cold air. Our objectives were to determine the effects (immediate

[1] Kruse, G. Alaska Dep. Fish and Game, Div. Commer. Fish., Juneau, AK 99802. Pers. commun., July 1992.

[2] ADF&G (Alaska Department of Fish and Game).
1989a. Report to the Alaska Board of Fisheries. Southeast Alaska and Yakutat (Region 1) 1988/89 shellfish fisheries. Regional Information Rep. No. 1J89-01. ADF&G, Div. Commercial Fisheries, Juneau, AK.
1989b. Westward region shellfish report to the Alaska Board of Fisheries. ADF&G Regional Information Rep. No. 4K89-3. ADF&G, Div. Commercial Fisheries, Westward Regional Office, 211 Mission Rd., Kodiak, AK 99615, 325 p.
1989c. Prince William Sound management area shellfish report to the Alaska Board of Fisheries. ADF&G Regional Information Rep. No. 2C89 03. ADF&G, Div. Commercial Fisheries, Central Region, 333 Raspberry Rd., Anchorage, AK 99581, 56 p.
1989d. Cook Inlet area shellfish management report to the Alaska Board of Fisheries. 1988–89. Regional Information Rep. No. 2H89-03. ADF&G, Div. Commercial Fisheries, 333 Raspberry Rd., Anchorage, AK 99581, 75 p.
1989e. Synopsis of the Montague Strait experimental harvest area 1985–1988. ADF&G Regional Information Rep. No. 2C89-04. ADF&G, Div. Commercial Fisheries, Central Region, 333 Raspberry Rd., Anchorage, AK 99581, 21 p.
1989f. Report to the Board of Fisheries Norton Sound red king crab fishery (summer fishery only). ADF&G Regional Information Rep. No. 3N89-05. ADF&G, Div. Commercial Fisheries, Central Region, Juneau, AK. 14 p.

[3] NOAA. 1987. Local climatological data, monthly and annual summaries with comparative data. U.S. Dep. Commer., National Climatic Data Center, Asheville, NC 28801.

cal treatment ranges (0–32 minutes, –20 to +5°C; see Results section) and could be described by the same types of simple linear or nonlinear models, we used the same technique here.

Regression techniques and logit analysis were used to relate response variables to exposure (Berkson, 1957; BMDP, 1983). We compared median lethal responses with log-likelihood ratio tests (Fujioka, 1986). Multiple regression was used to test for differences in the slopes of regression lines and to adjust for covariates (Kleinbaum and Kupper, 1983). The relation of selected response variables to one another was tested with parametric correlation. After one-way analysis of variance, comparisons of treatment means were made with Tukey's or Dunnett's a posteriori multiple comparison tests and judged significantly different if $P \leq 0.05$. Proportional data were arcsine transformed. Reported error ranges are ±95% confidence limits.

Results

Mortality

Below –1 to –3 degree hours, exposure to cold air killed crabs. Almost all mortality occurred 1–2 days after exposure; in groups where more than half the crabs died, mortality always reached 50% within 2 days. Mortality was inversely related to exposure and increased rapidly below –1°h for juveniles and below –3°h for adults (logistic regressions [large *P*-values indicate good fits], $P_{juvenile}$=0.959, P_{adult}=0.882; Fig. 2). Nearly all deaths occurred within 8 days after exposure; no crabs died after day 16. For juveniles, calculated median lethal exposures rose from –7.7 ± 3.4°h 1 day after exposure to –3.3 ± 0.8°h 16 days after exposure, and for adults from –7.2 ± 1.6°h to –4.3 ± 0.5°h over the same time period (Table 2).

Righting response

The speed with which crabs righted themselves when placed on their backs was inversely related to exposure (Fig. 3A). The response was most clearly described by the percentage of crabs not righting within two minutes (logistic regressions, P=0.799 [n=6] for juveniles; P=0.978 [n=22] for adults; Fig. 3B). Percentages of crabs not righting increased sharply below –1.0°h for juveniles and below –2.2°h for adults, and crabs ceased righting entirely after exposure to ≤–4.0°h for juveniles and ≤–6.9°h for adults (Fig. 3B). Median exposures causing one-half the crabs to cease righting (EC50) were –1.2 ± 0.3°h for juveniles and –2.1 ± 0.3°h for adults, measured immediately after exposure; values declined to –1.6 ± 0.3°h for juveniles and –3.8 ± 0.5°h for adults measured 32 days after exposure (Table 3). The percentage of crabs unable to right themselves immediately after exposure was significantly correlated with cumulative mortality ($P_{juvenile}$=0.003, $r^2_{juvenile}$=0.91, n=6; P_{adult}<0.001, r^2_{adult}=0.67, n=22) and, therefore, could serve as a predictor of death.

Righting times tended to improve (decrease) during the first eight days after exposure, but this recovery was generally not statistically significant.

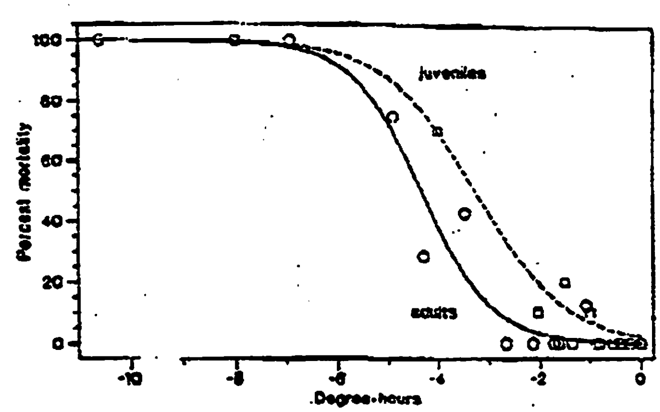

Figure 2

Cumulative percent mortality (P) of juvenile and adult female *Chionoecetes bairdi*, observed 32 days after emersion, as a function of exposure (°h): $P_{juveniles}=100/(1+e^{(3.74+1.14\times°h)})$, $P_{adult}=100/(1+e^{(6.42+1.48\times°h)})$.

Table 1

Temperature and duration of exposure of *Chionoecetes bairdi* to cold air. The number of crabs exposed (*n*) is also indicated. Controls were not exposed to air. SE = standard error.

Air temperature (Celcius) mean	SE	Exposure time (minutes)	Degree-hours	*n*
Juveniles				
—	—	0	0.00	10
–5.0	0.02	12	–0.99	10
–7.5	0.06	12	–1.50	10
–10.2	0.24	12	–2.05	10
–15.0	0.03	16	–4.00	10
–20.0	0.07	24	–8.02	10
Adults				
5.1	0.12	8	0.683	7
5.0	0.01	32	2.872	7
—	—	0	0.000	31
–3.2	0.21	4	–0.211	8
–3.1	0.04	8	–0.411	8
–3.1	0.08	16	–0.813	8
–3.0	0.03	32	–1.621	8
–8.2	0.19	4	–0.544	8
–8.1	0.11	8	–1.075	8
–8.1	0.06	16	–2.149	8
–8.1	0.03	32	–4.299	7
–13.1	0.18	4	–0.875	8
–12.9	0.08	8	–1.720	8
–13.0	0.03	16	–3.472	7
–13.0	0.02	32	–6.933	8
–20.3	0.34	4	–1.353	8
–20.1	0.15	8	–2.676	8
–18.4	0.08	16	–4.899	8
–19.9	0.04	32	–10.597	8

weights ($F_{5,54}$=0.02, P>0.99) of the crabs did not differ significantly between treatments. Change in juvenile crab body weight was estimated from initial and final measurements (32 d).

Female crabs were randomly placed in 20 groups (including controls) in a complete 4 (temperature) by 5 (length of exposure) design, with 7 to 8 crabs per group. Treatment temperatures ranged from –3.1 to –20.3°C and exposure duration ranged from 0 (controls) to 32 minutes (Table 1). Two additional groups were tested at 5°C for 8 and 32 minutes (Table 1). The crabs did not differ significantly in length ($F_{21,149}$=1.13, P=0.324) or weight ($F_{21,149}$=1.36, P=0.149) between treatments. Exposure took place 16 and 17 February (about six days after capture). Observation continued through 22 June.

Mortality and limb autotomy were monitored daily. Crabs were judged dead when scaphognathite movement stopped. Generally, dead crabs were rechecked the following day before they were removed from test tanks. The number of legs missing on each crab was counted and autotomized legs were removed from the tanks.

Righting response (the time it took a crab to right itself when placed on its back underwater), which we considered to be a measure of vigor, was timed to the nearest 0.01 second immediately after aerial exposure and 1, 2, 4, 8, 16, 24, and 32 days thereafter. Crabs that could not right themselves after 2 minutes were recorded as "not righting" and were placed upright in the tank.

A subset of 40 female crabs randomly selected from the entire exposure range was used for reproductive observations. The crabs were isolated 32 days after exposure in covered 70-L tanks that overflowed into 19-L buckets containing conical 363-μ mesh nets designed to trap zoeae. Flow rates were approximately 1.5 L/minute; 95% turnover time was 2.3 hours and water temperatures ranged from 5.2 to 5.9°C during this period (23 March–11 May).

Feeding rates were measured before and after the zoeal hatch while the 40 ovigerous females were individually isolated. Mussels, *Mytilus trossulus*, were fed ad libitum to crabs during each feeding period. Live mussels were cut in half and drained tissue-side down on paper towels for five minutes, weighed, then placed in the tanks. Twenty-four hours later the remaining food was removed, drained, and weighed as before. At each feeding, four food portions were placed as controls in tanks without crabs. Consumption was corrected for the mean weight changes in the control portions. Feeding observations were repeated every 1 to 3 days, from 41 to 60 and from 86 to 98 days after exposure.

Zoeae were collected daily, rinsed from the nets, concentrated in a known volume, and subsampled with a 5- or 10-mL Hensen-Stemple pipette (Carls and O'Clair, 1990). Subsamples, which contained a minimum of 200 zoeae, were preserved in 5% formalin and counted later; the occasional large subsample was divided with a Folsom plankton splitter before being counted. After zoeal hatching, all debris from each tank bottom was preserved to determine the number of dead eggs and zoeae.

Responses of the crabs were related to aerial exposure, expressed as the product of air temperature (°C) and length of time in air (hours), i.e. degree-hours (°h). In a similar experiment, Carls and O'Clair (1990) demonstrated the usefulness of this technique for interpreting responses to aerial exposure in adult king crabs, *Paralithodes camtschaticus*. Because the responses of the Tanner crabs to exposure (in °h) were similar in form to those of the king crabs over identi-

TANNER CRAB SURVIVAL IN CLOSED POTS

by
Al Kimker
Regional Shellfish Biologist

Regional Information Report[1] No. 2A92-21

Alaska Department of Fish and Game
Division of Commercial Fisheries Central Region
333 Raspberry Road
Anchorage, AK 99518-1599

October 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.

Kimker 1992

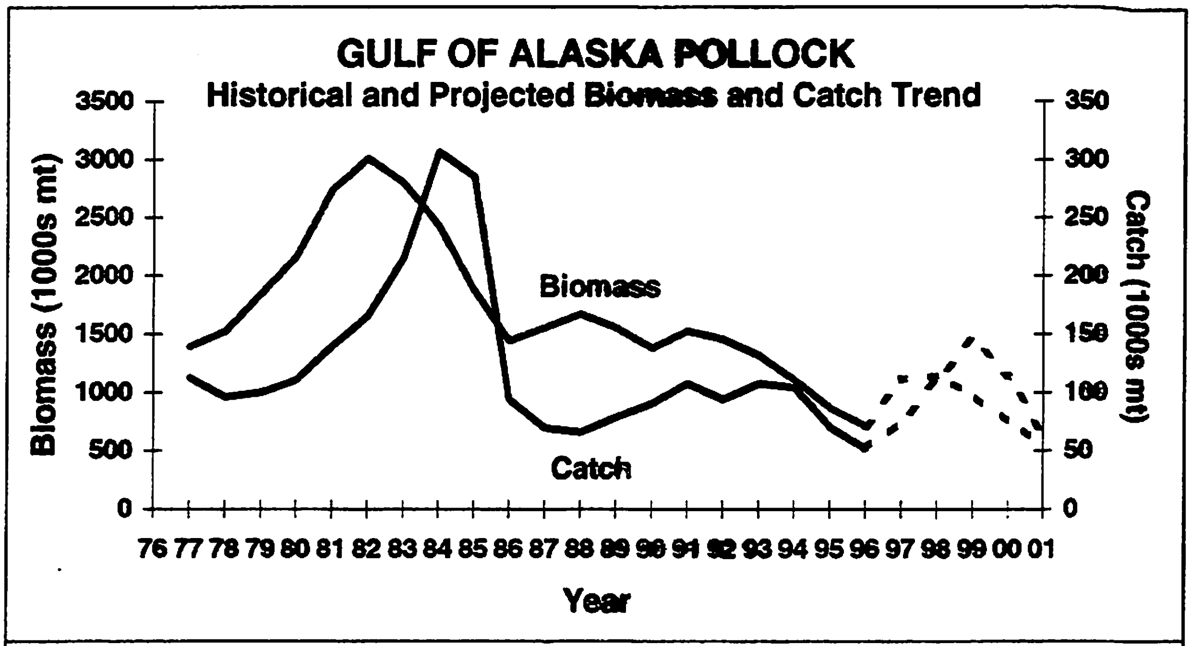
Table 1. Number of adult male Tanner crabs surviving capture, without feeding, by retrieval date, 1992 male Tanner crab survival experiment.

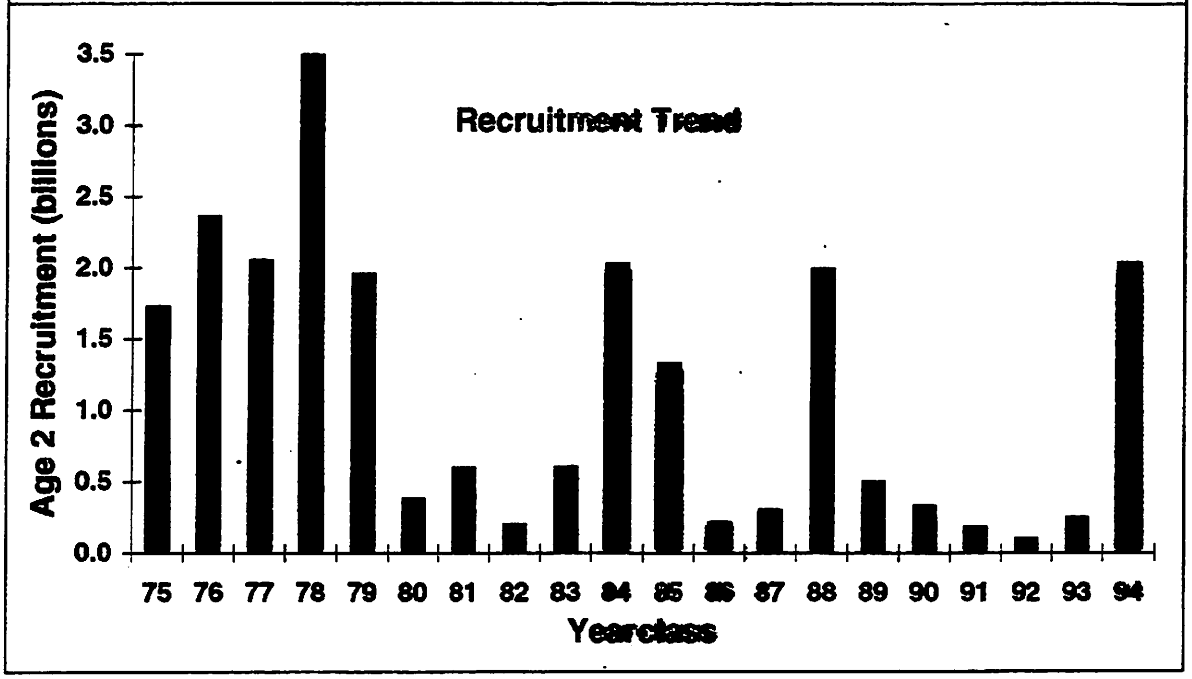
	Pot Number					
Date	128	CC	171	55	Total	
12/31/91[a]	33	33	33	33	132	
01/07/92	33	33	33	33	132	
01/14/92	33	32	33	32	130	1.5% mortality
01/28/92	33	32	32	32	129	2.3% mortality
02/25/92	25	27	30	27	109	
03/10/92	24	26	28	27	105	
03/17/92	24	25	28	27	104	
04/10/92	20	21	23	23	87	
04/28/92[b]	19	16	22	23	80	

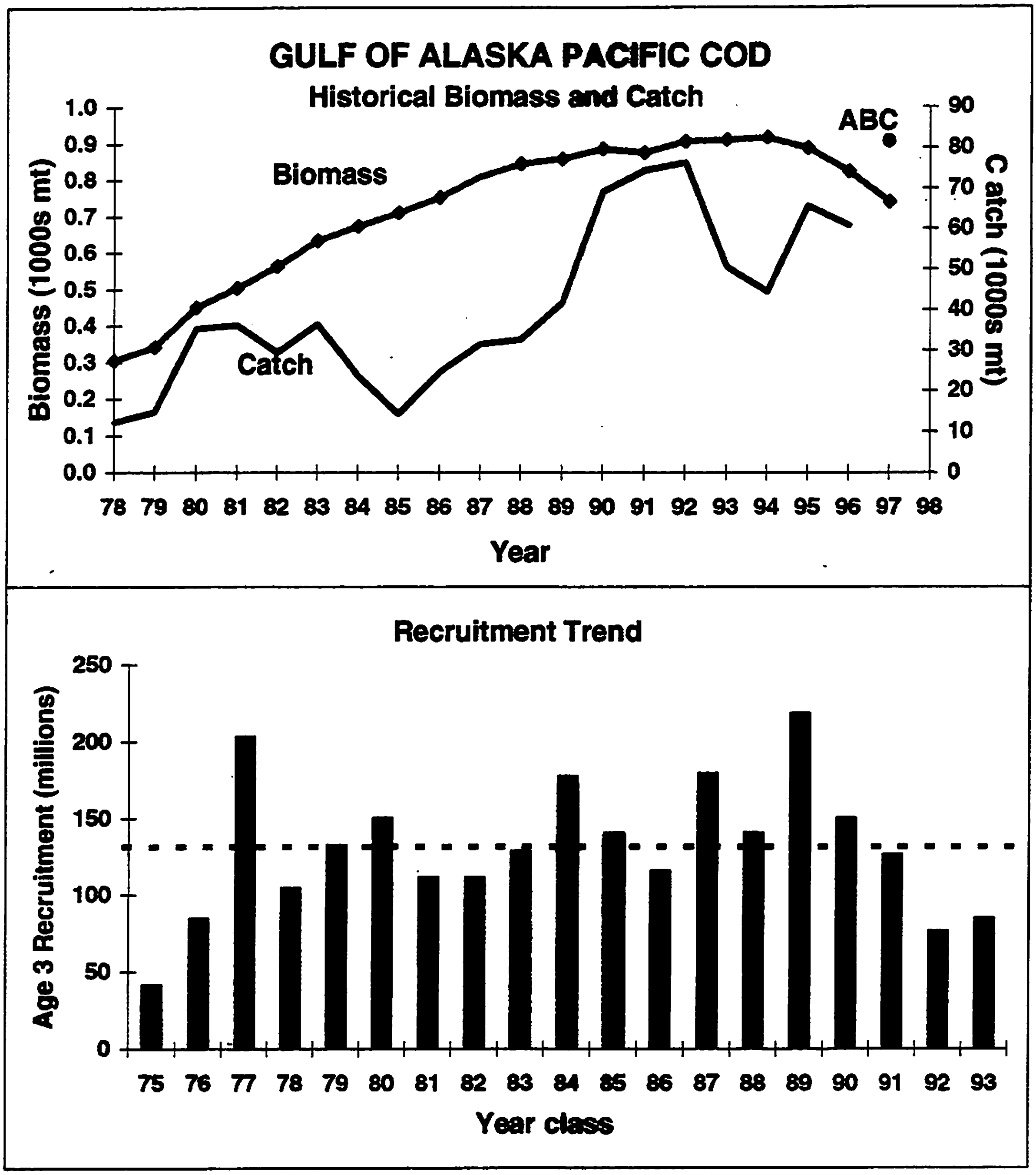
[a] Date of initial capture and beginning of experiment.

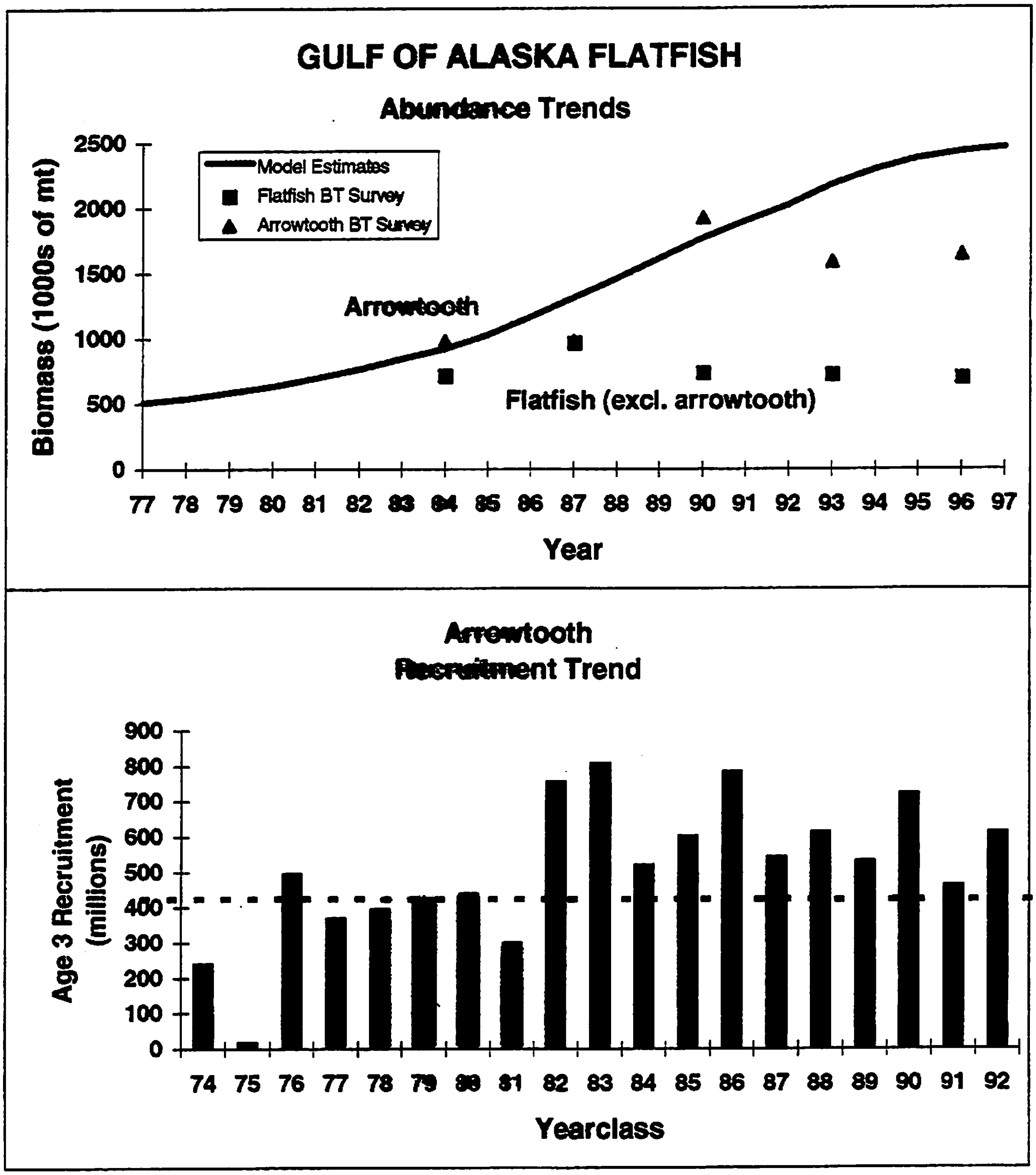
[b] Experiment terminated.

D-1c,d


GULF OF ALASKA POLLOCK
Historical and Projected Biomass and Catch Trend
Biomass (1000s mt)
Catch (1000s mt)
Biomass
Catch
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01
Year
3500
3000
2500
2000
1500
1000
500
0
350
300
250
200
150
100
50
0


Recruitment Trend
Age 2 Recruitment (billions)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Yearclass


GULF OF ALASKA PACIFIC COD
Historical Biomass and Catch
ABC
Biomass
Catch
Biomass (1000s mt)
Catch (1000s mt)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
90
80
70
60
50
40
30
20
10
0
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year
Recruitment Trend
Age 3 Recruitment (millions)
250
200
150
100
50
0
75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93
Year class



GULF OF ALASKA FLATFISH
Abundance Trends
Model Estimates
Flatfish BT Survey
Arrowtooth BT Survey
Arrowtooth
Flatfish (excl. arrowtooth)
Biomass (1000s of mt)
2500
2000
1500
1000
500
0
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97
Year
Arrowtooth
Recruitment Trend
Age 3 Recruitment (millions)
900
800
700
600
500
400
300
200
100
0
74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92
Yearclass

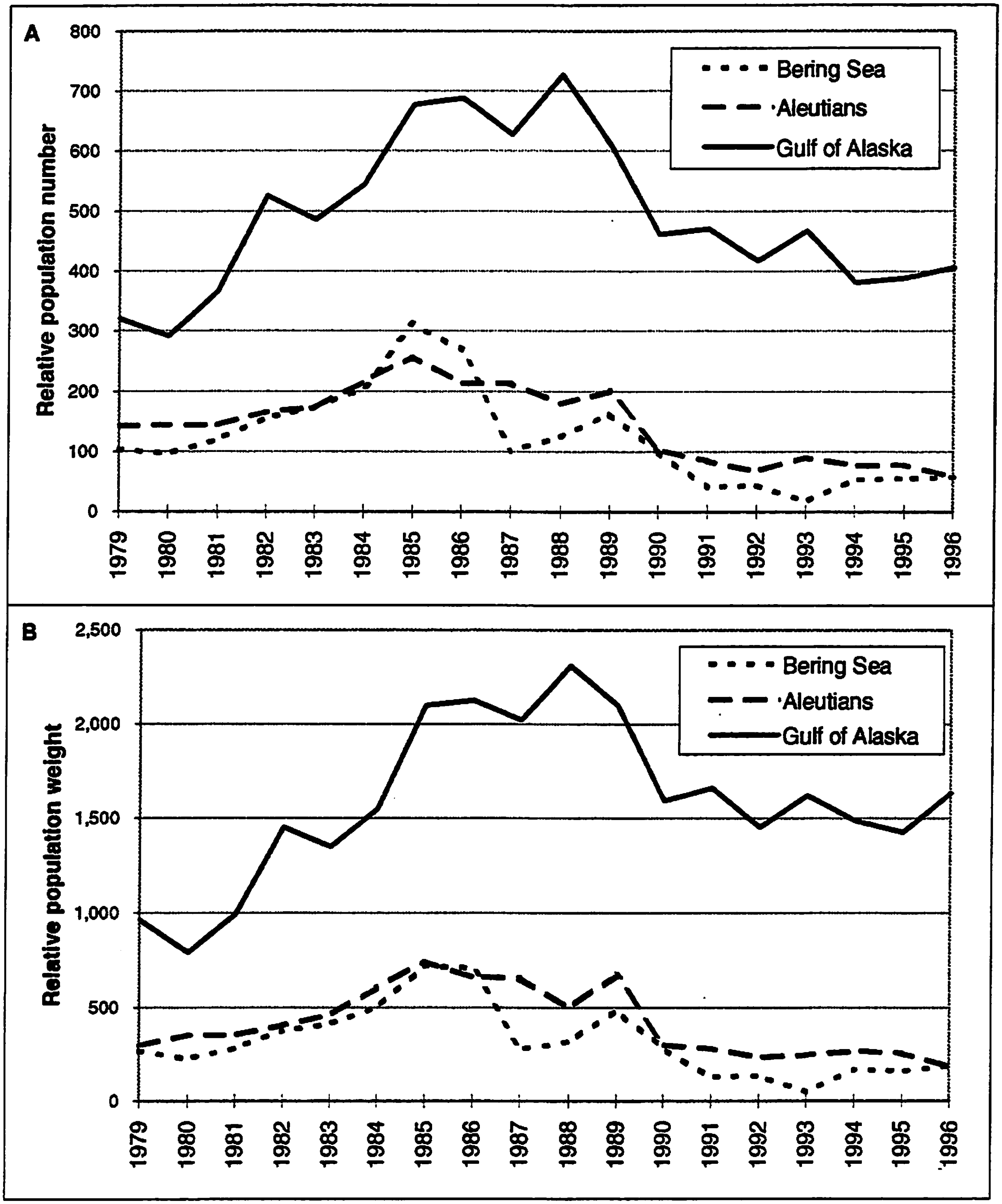


Figure 5.2.--Relative population number (A) and weight (B) from sablefish longline surveys by region. The Bering Sea (1979-81, 1995-96) and Aleutian Islands (1979, 1995) were not sampled and instead these values were extrapolated from values for adjacent regions and years.

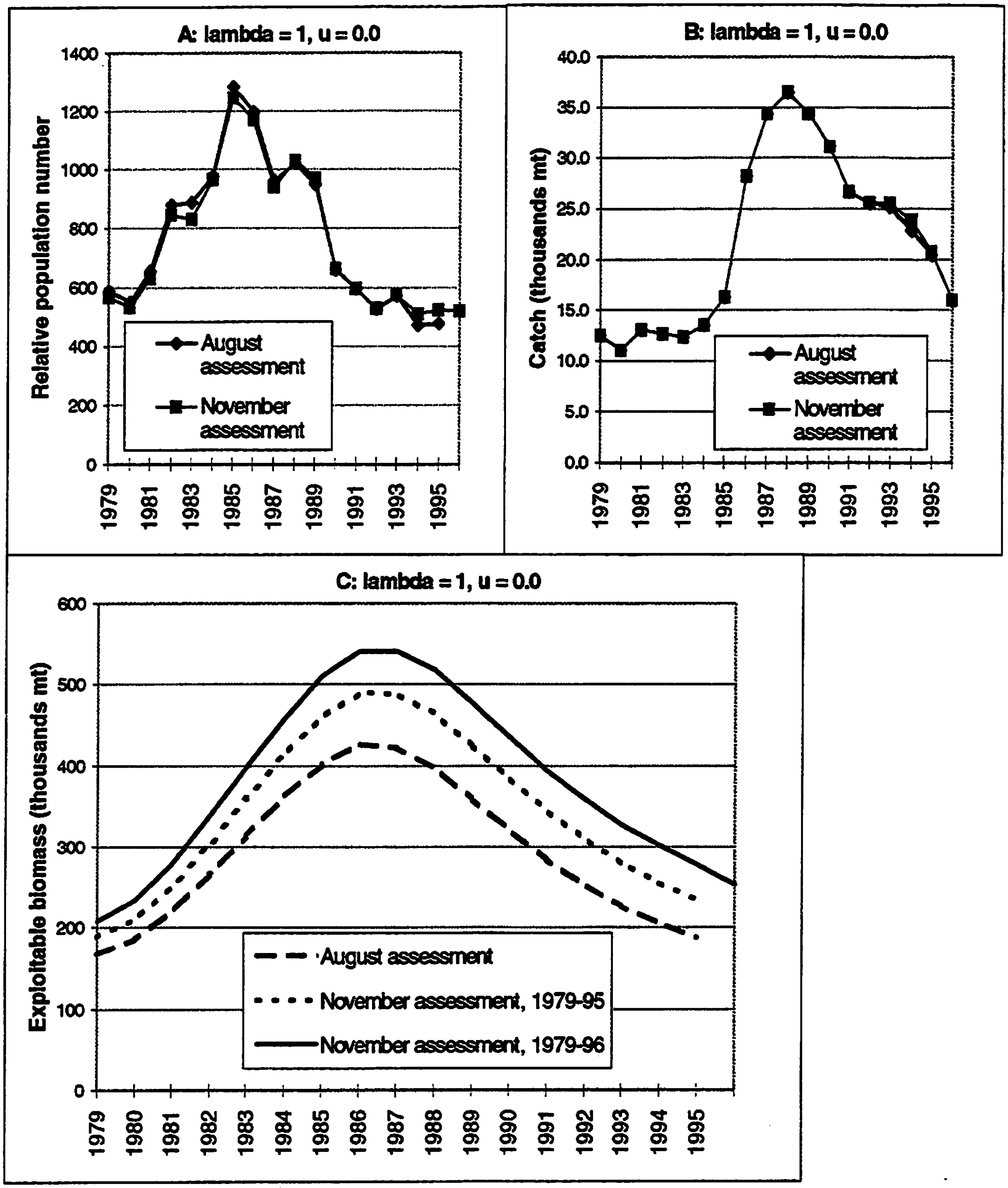


Figure 5.4 .–Relative population number (A) and catch (thousands mt, B) from the August and November assessments. C: Estimated exploitable biomass (thousands mt) from the August (1979-95) and November assessments (1979-95 and 1979-96). $\lambda = 1$ and unreporting rate = 0.0.

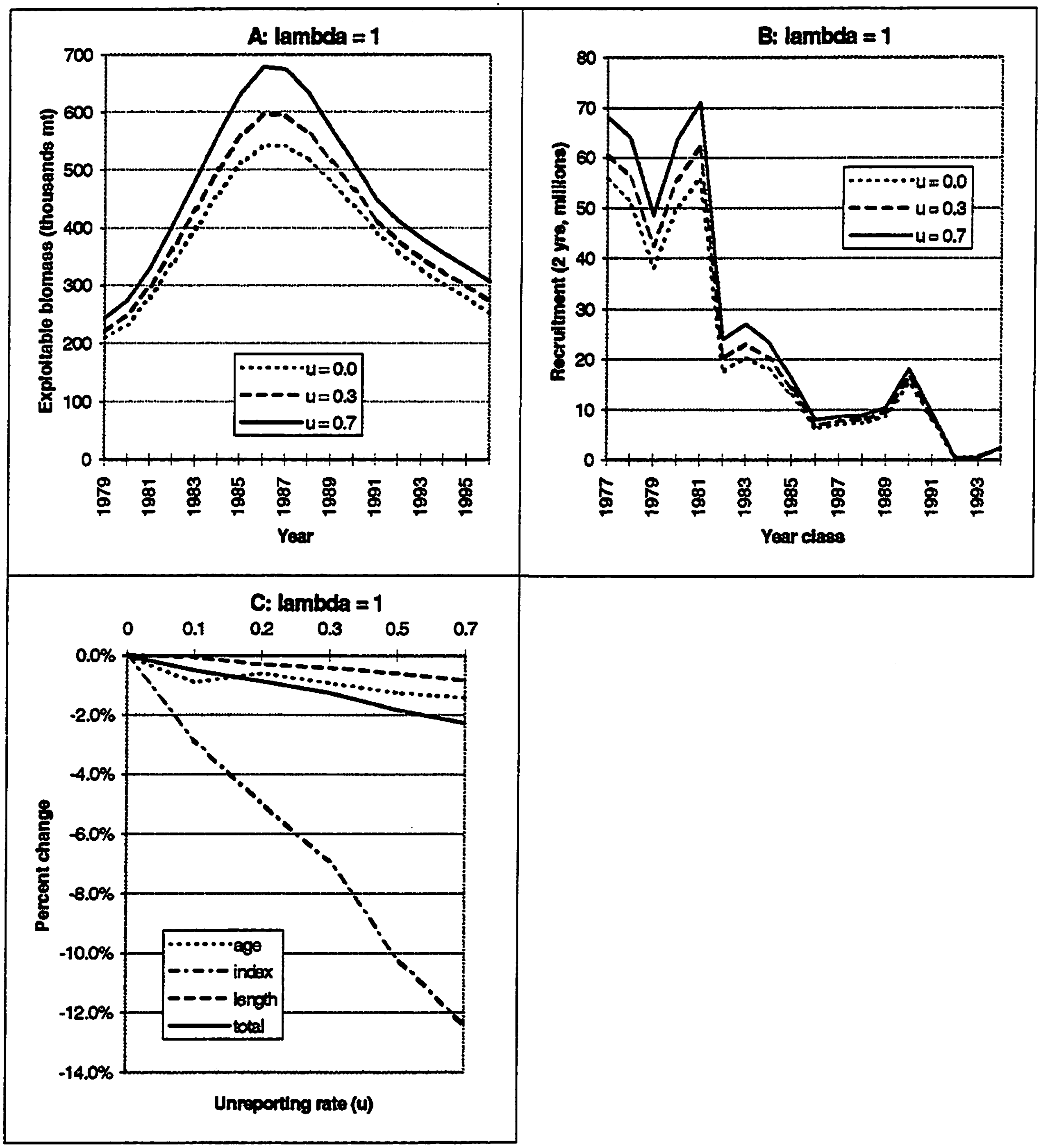


Figure 5.5.--Exploitable biomass (thousands mt, A) and recruitment (2 years old, millions, B) for unreporting rate (u) = 0.0 and $\lambda = 7$. C: Exploitable biomass for $u = 0.3$ and $\lambda = 7$.

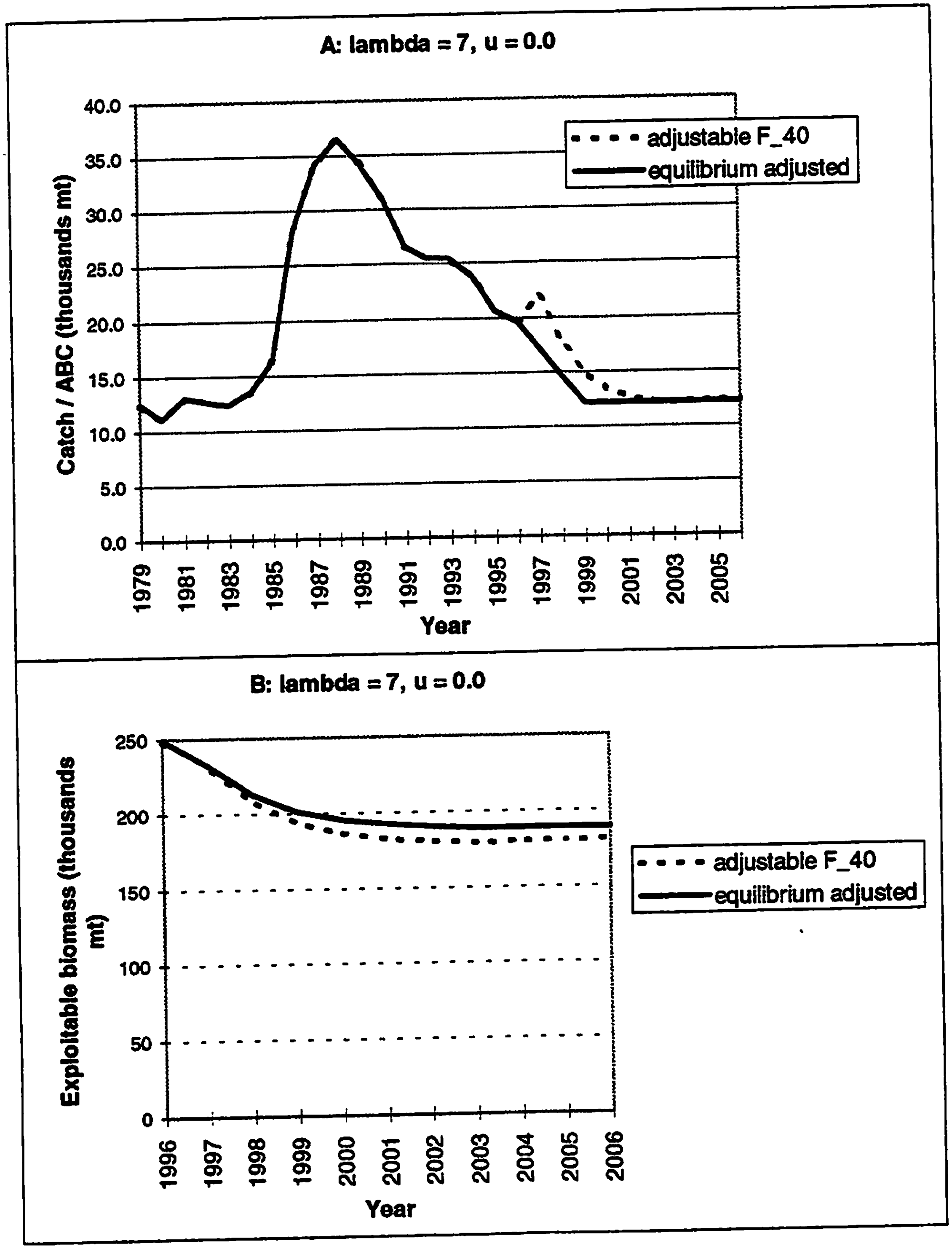
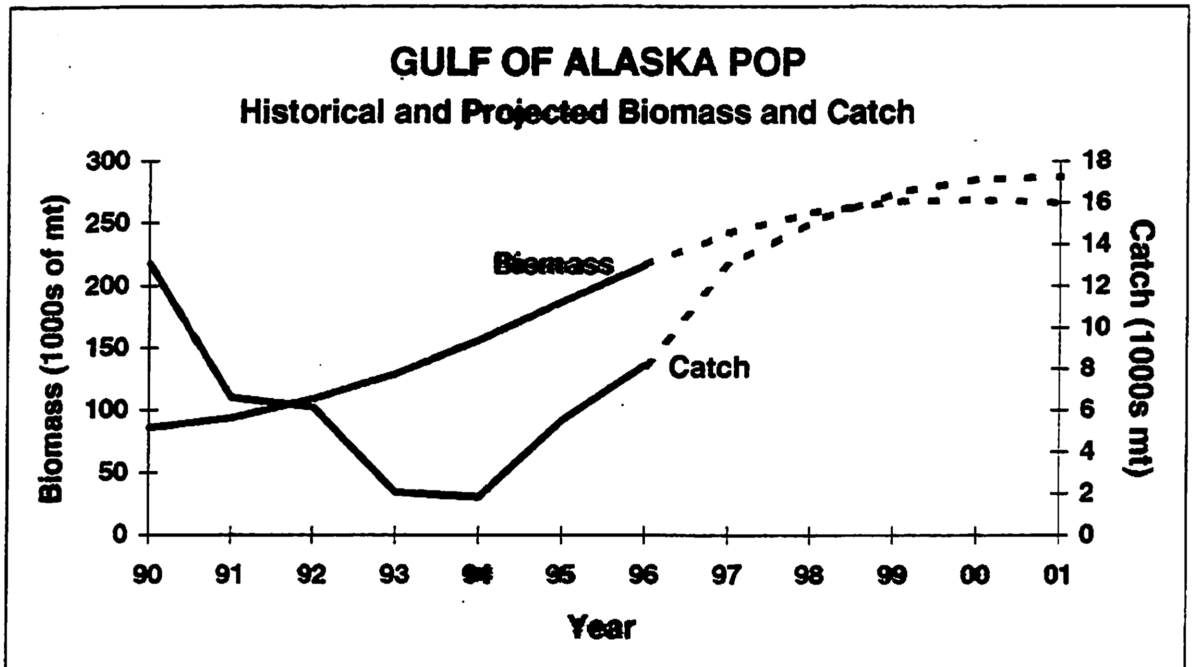
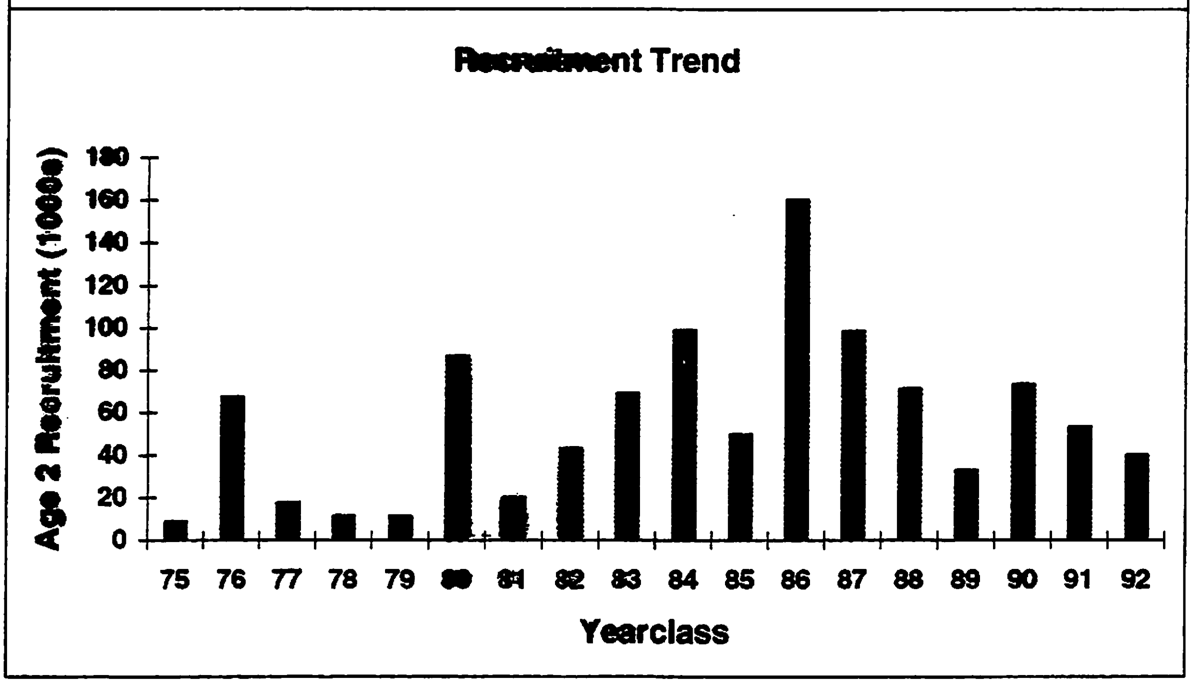
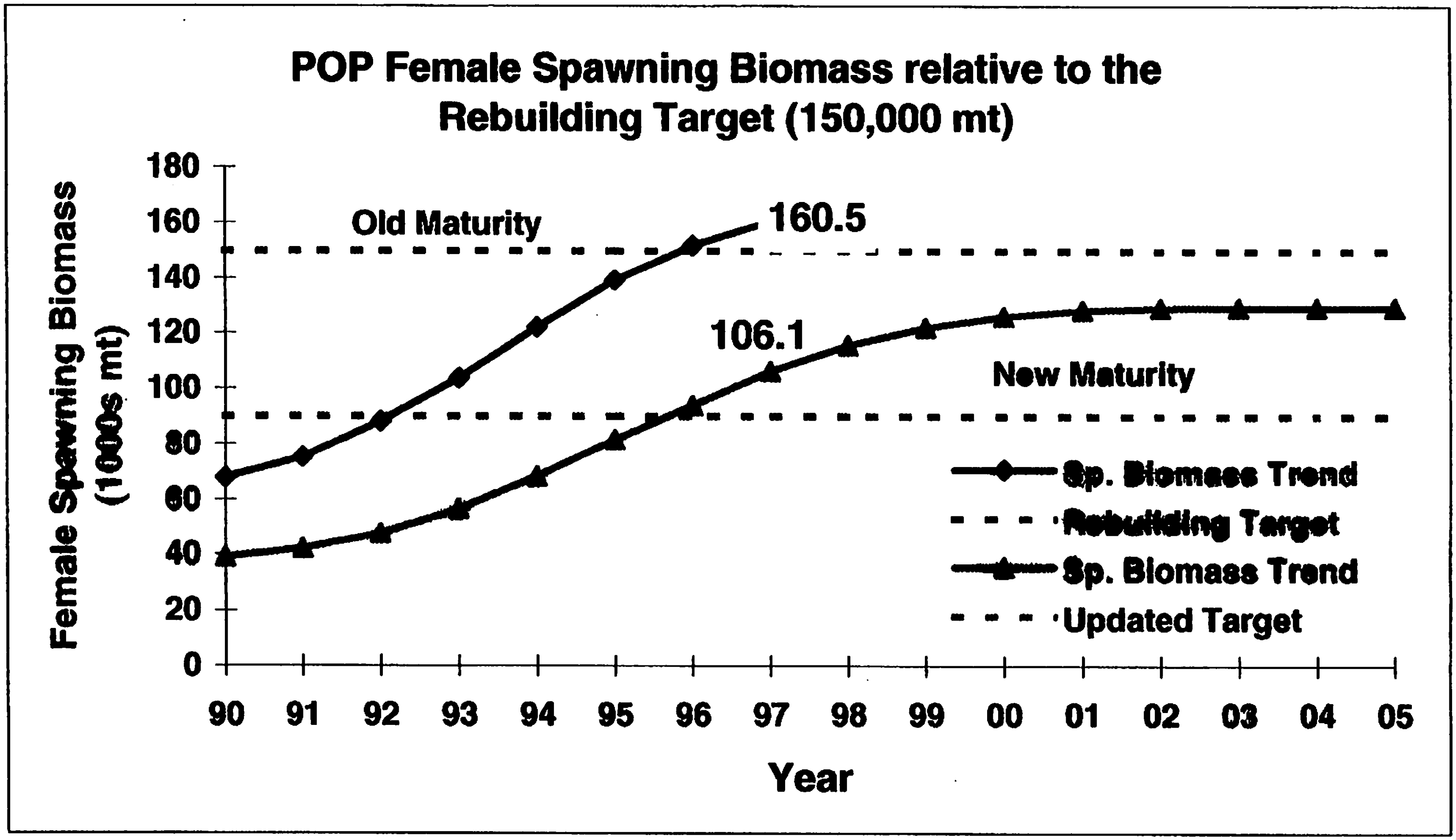
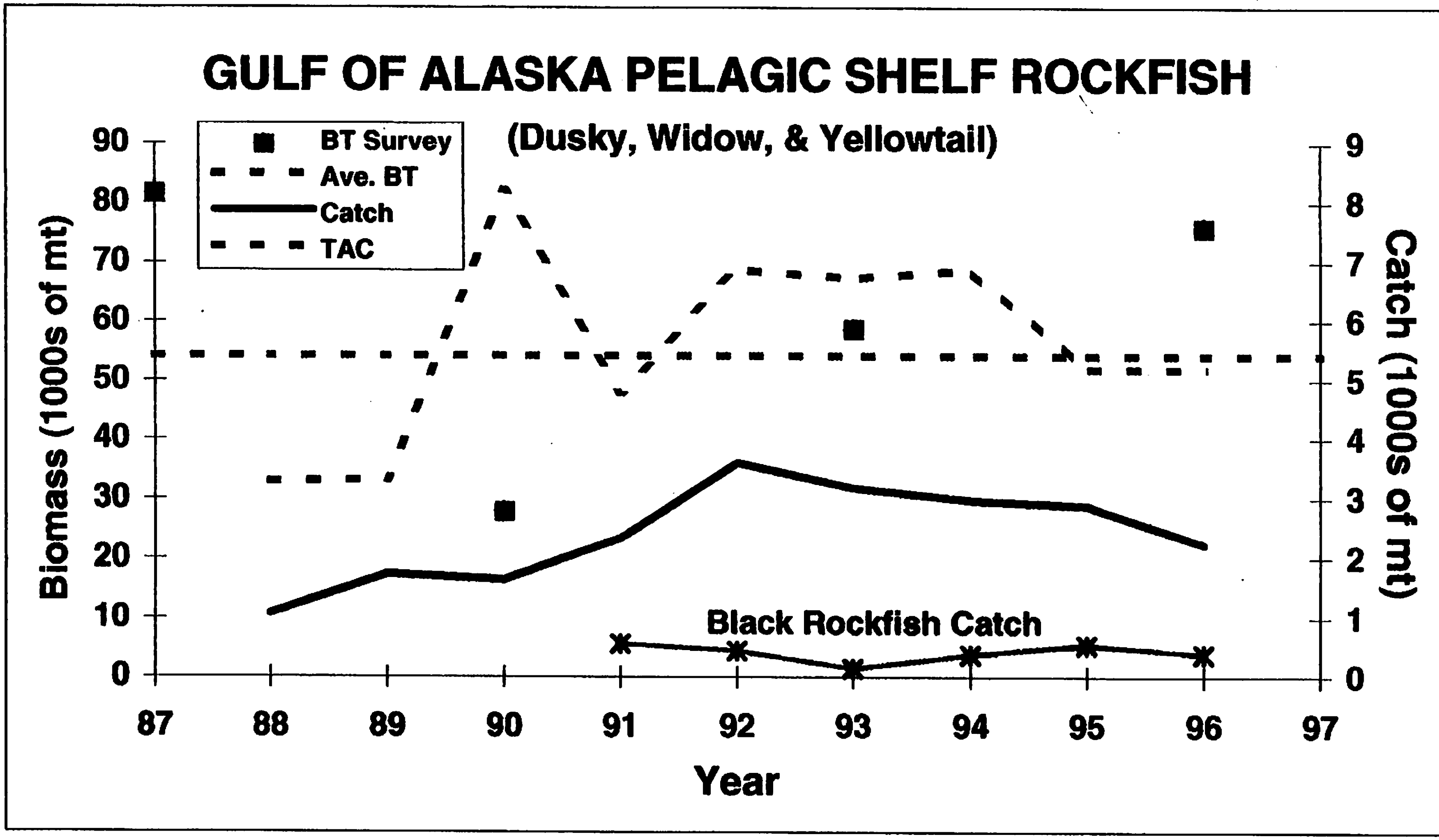


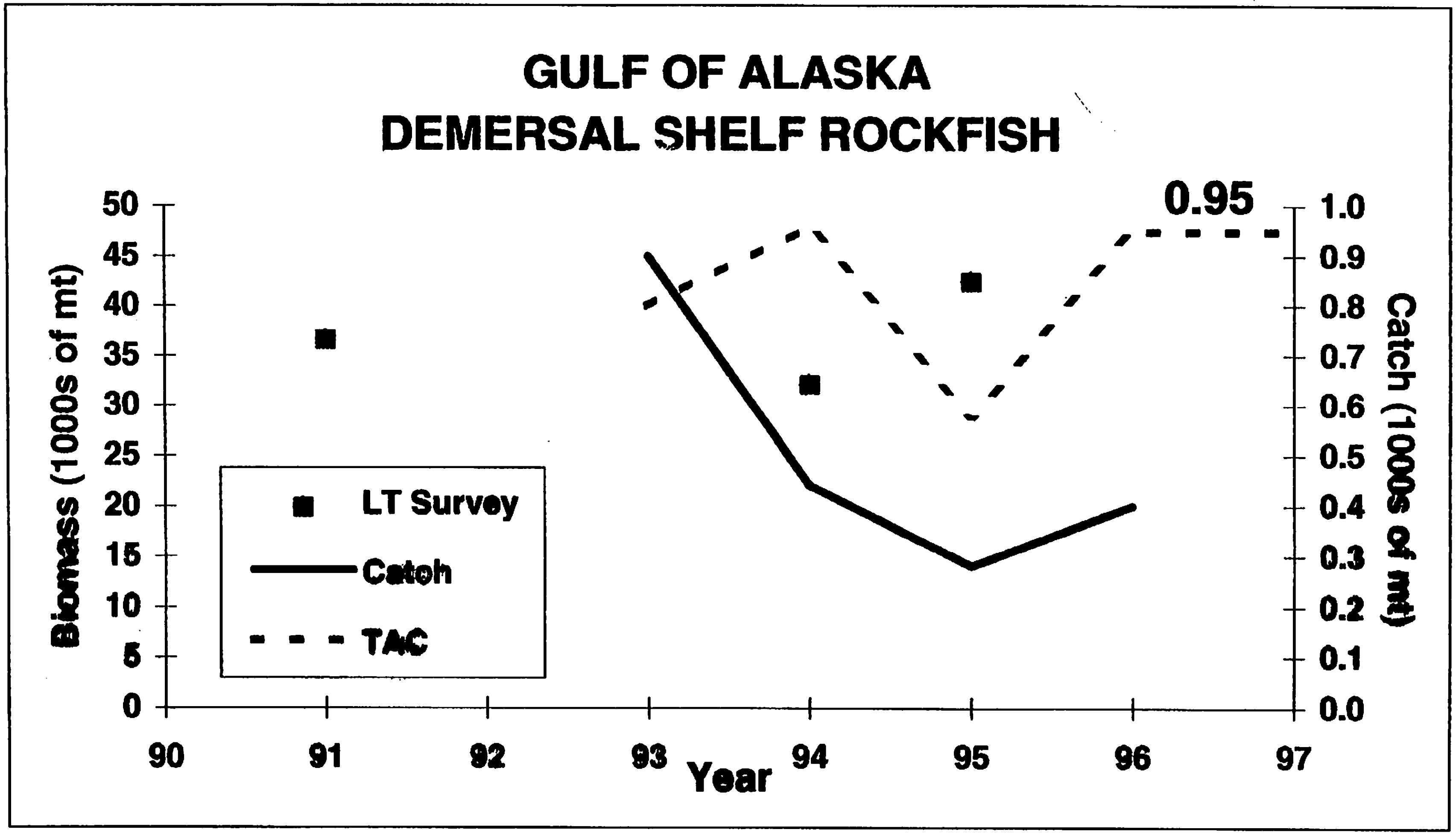
Figure 5.11.--A: Catch (thousands mt, 1979-96) and projected yield (thousands mt, 1997-2006) by harvest strategy. B: Estimated (1996) and projected (1997-2006) exploitable biomass (thousands mt) by harvest strategy. Harvest strategies are described in the "Population projection" section. $\lambda = 7$ and unreporting rate = 0.0.


GULF OF ALASKA POP
Historical and Projected Biomass and Catch
Biomass (1000s of mt)
300
250
200
150
100
50
0
Biomass
Catch
Catch (1000s mt)
18
16
14
12
10
8
6
4
2
0
90
91
92
93
94
95
96
97
98
99
00
01
Year


Recruitment Trend
Age 2 Recruitment (1000s)
180
160
140
120
100
80
60
40
20
0
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
Yearclass

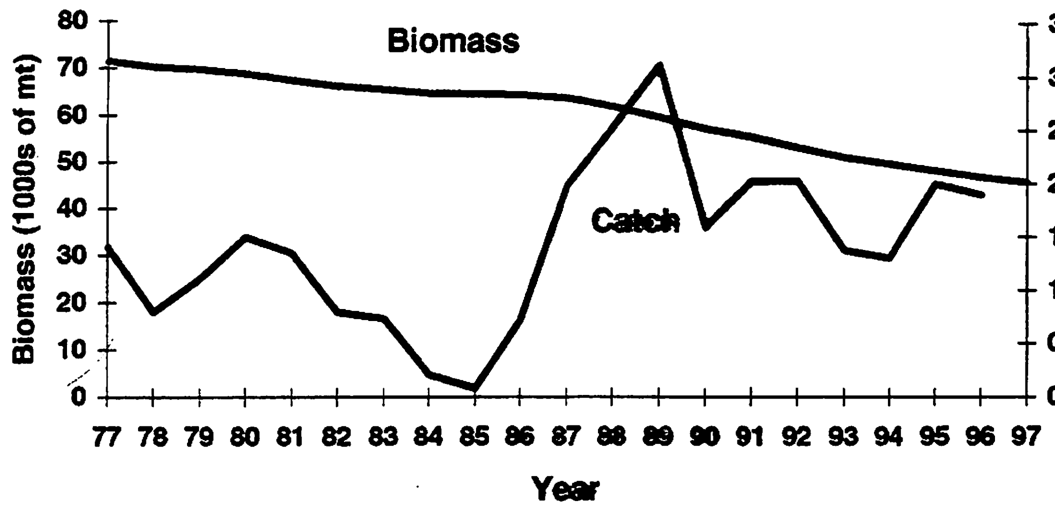

POP Female Spawning Biomass relative to the Rebuilding Target (150,000 mt)
Female Spawning Biomass (1000s mt)
180
160
140
120
100
80
60
40
20
0
Old Maturity
160.5
106.1
New Maturity
Sp. Biomass Trend
Rebuilding Target
Sp. Biomass Trend
Updated Target
90
91
92
93
94
95
96
97
98
99
00
01
02
03
04
05
Year

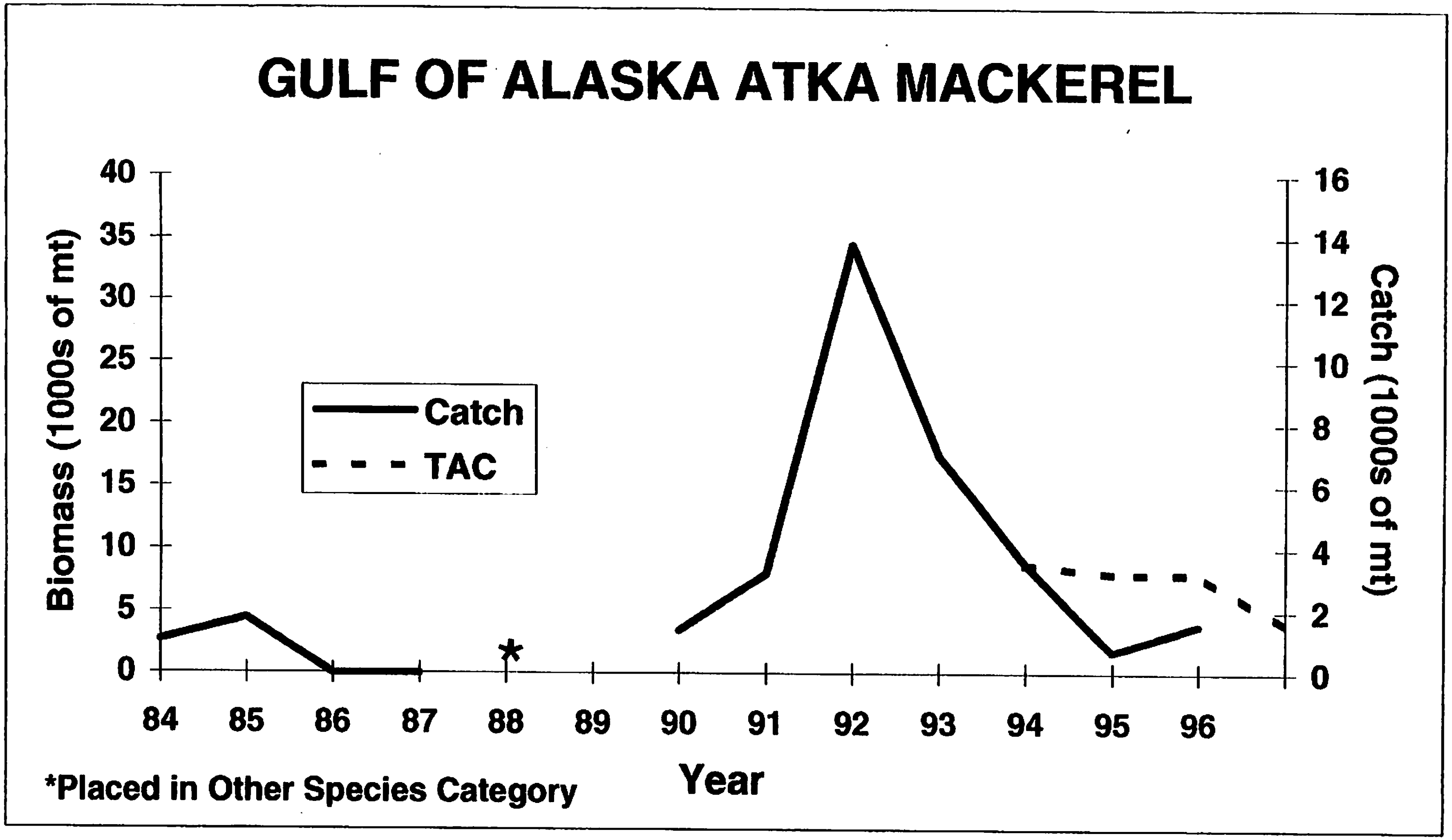

GULF OF ALASKA PELAGIC SHELF ROCKFISH
(Dusky, Widow, & Yellowtail)
BT Survey
Ave. BT
Catch
TAC
Black Rockfish Catch
Biomass (1000s of mt)
Catch (1000s of mt)
Year
90
80
70
60
50
40
30
20
10
0
9
8
7
6
5
4
3
2
1
0
87
88
89
90
91
92
93
94
95
96
97



GULF OF ALASKA
DEMERSAL SHELF ROCKFISH
0.95
Biomass (1000s of mt)
Catch (1000s of mt)
50
45
40
35
30
25
20
15
10
5
0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
90
91
92
93
94
95
96
97
Year
LT Survey
Catch
TAC

GULF OF ALASKA THORNYHEADS




GULF OF ALASKA ATKA MACKEREL
Biomass (1000s of mt)
40
35
30
25
20
15
10
5
0
Catch (1000s of mt)
16
14
12
10
8
6
4
2
0
Catch
TAC
*
84
85
86
87
88
89
90
91
92
93
94
95
96
Year
*Placed in Other Species Category