AGENDA C-3(b)
DECEMBER 2009

MEMORANDUM

ESTIMATED TIME
4 HOURS
(All C-3 items)

TO: Council, AP and SSC

FROM: Chris Oliver
Executive Director

DATE: December 2, 2009

SUBJECT: BSAI Groundfish SAFE Report and 2010/2011 harvest specifications

ACTION REQUIRED

(b) Final action to approve the BSAI Stock Assessment and Fishery Evaluation (SAFE) report and final BSAI groundfish harvest specifications for 2010 and 2011:

1. Acceptable Biological Catch (ABC) and annual Total Allowable Catch (TAC)
2. Prohibited Species Catch Limits (PSCs) and seasonal apportionments of Pacific halibut, red king crab, Tanner crab, opilio crab, and herring to target fishery categories
3. Pacific halibut discard mortality rates for the 2010-2012 CDQ and non-CDQ fisheries

BACKGROUND

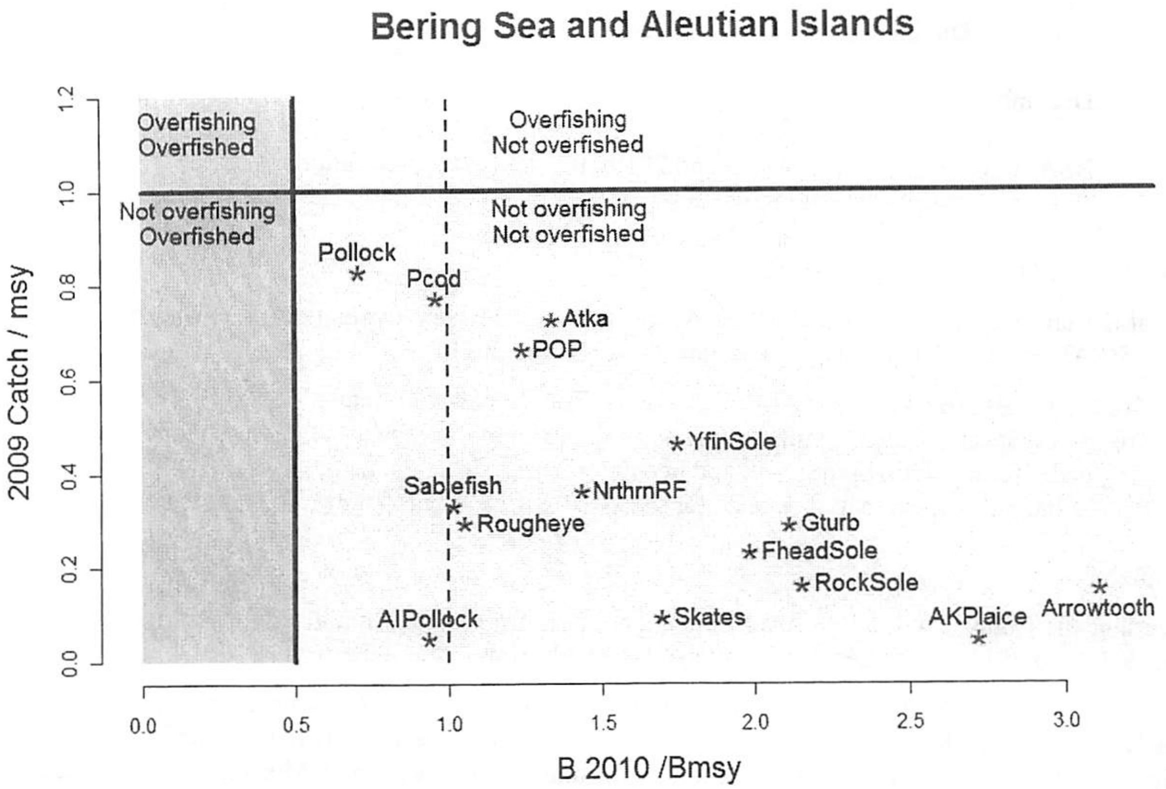
At this meeting, the Council will adopt final recommendations on groundfish and PSC specifications to manage the 2010 and 2011 Bering Sea/Aleutian Islands (BSAI) groundfish fisheries.

BSAI SAFE Report The BSAI Groundfish Plan Team met in Seattle on November 16-20, 2009, to prepare the BSAI Groundfish SAFE report. The SAFE report forms the basis for BSAI groundfish harvest specifications for the 2010 and 2011 fishing years. The introduction to the BSAI SAFE report was mailed to the Council and Advisory Panel on November 24, 2009. The full report was mailed to the SSC and is available through the Council website.

The Plan Team's recommendations for final specifications for 2010 and 2011 are attached as Item C-3(b)(1). In October, the Council adopted proposed specifications of OFL and ABC for 2010 and 2011 that were based on last year's stock assessments (Item C-3(b)(2)). In this SAFE report, the Plan Team has revised those projections due to the development of new models; collection of new catch, survey, age composition, or size composition data; or use of new methodology for recommending ABCs. November 2009 Plan Team minutes are attached as Item C-3(b)(3). The SSC and AP recommendations will be provided to the Council during the meeting.

ABCs, TACs, and Apportionments The Plan Team recommended ABCs for 2010 and 2011 are 2,120,000 t and 2,457,000 t, respectively. These are 89,000 t below and 248,000 t above the sum of the 2009 ABCs (2,209,000 t), indicating an anticipated rebound in stock status in 2011, after a slight drop in 2010. While the total groundfish ABC still exceeds the 2 million t optimal yield cap set by the Council as a conservation measure in setting TACs (and now required by statute), the sum of 2009 TACs totaled 1,680,000 t.

The current status of individual groundfish stocks managed under the FMP is summarized in this section. Plan Team recommendations for 2010 and 2011 ABCs and OFLs are summarized in Tables 1, 5, and 6. Overall, the status of the stocks continues to appear relatively favorable. Most stocks are above B_{MSY} (or the B_{MSY} proxy of $B_{35\%}$), although many stocks are declining due to poor recruitment in recent years. The abundances of AI pollock, sablefish, all rockfishes managed under Tier 3, all flatfishes managed under Tiers 1 or 3, and Atka mackerel are projected to be above B_{MSY} or the B_{MSY} proxy of $B_{35\%}$ in 2010. The abundance of EBS pollock is projected to be below B_{MSY} in 2010 and the abundance of Pacific cod is projected to be slightly below $B_{35\%}$ in 2010. No groundfish stocks are overfished or experiencing overfishing, as shown in lower right quadrant of the figure.



Summary status of age-structured BSAI species relative to 2009 catch levels (vertical axis) and projected 2010 spawning biomass relative to B_{msy} levels.

Total groundfish biomass for 2010 (15.9 million t) is the same as last year's estimate. Groundfish ABCs recently have trended down for gadoids, but generally up for flatfishes. The 2009 bottom trawl survey biomass estimate for pollock was 2.28 million t, down 25% from the 2008 estimate, and the lowest point in the 1982-2009 time series. The estimate from the EIT survey was 0.924 million t, down 7% from last year's survey, and the lowest point in the 1979-2009 time series. The 2006 year class is above-average, though not as strong as estimated previously. The 2010 pollock ABC recommendation of 813,000 t is about equal to the 2009 ABC (815,000 t); the 2011 ABC recommendation is 1,100,000 t, anticipating recruitment of the 2006 year class.

Following the highest observation in 1994, the Pacific cod bottom trawl survey biomass estimate declined steadily through 1998. While the estimates remained around 600,000 t from 2002 through 2005, the estimates dropped consistently from 2005 through 2008. The 2009 survey biomass estimate was 421,000 t, up 4% from 403,000 t in 2008. The numeric abundance estimate from the 2009 EBS shelf bottom trawl survey of 717 million fish was up about 50% from the 2008 estimate. The 2008 year class, which has been observed only once, appears to be extremely large, although this estimate is accompanied by a large confidence interval. The 2006 year class, which appeared exceptionally strong in the 2007 survey, still appears to be above average. However, the 2006 year class follows a string of five consecutive sub-par year classes spawned from 2001-2005. The Pacific cod ABC recommendation is down 4 percent in 2010 compared to 2009 and up 18 percent in 2011 compared to 2009.

Adopt prohibited species catch limits for Pacific halibut, crab, and herring

Beginning in 2008, the head and gut trawl catcher/processor sector, which targets flatfish, Pacific cod, Pacific ocean perch, and Atka mackerel, was allocated groundfish TACs and PSCs and allow members of the "Amendment 80" sector that joined a cooperative. Regulations require that crab and halibut trawl PSC be apportioned between the BSAI trawl limited access and Amendment 80 sectors after subtraction of prohibited species quota (PSQ) reserves, as presented in Table 7a for proposed 2010 and 2011 PSCs under Item C-3(b)(4). Crab and halibut trawl PSC assigned to the Amendment 80 sector is then sub-allocated to Amendment 80 cooperatives as PSC cooperative quota (CQ) and to the Amendment 80 limited access fishery as presented in Tables 7d and 7e, respectively. PSC CQ assigned to Amendment 80 cooperative is not allocated to specific fishery categories. Regulations require the apportionment of each trawl PSC limit not assigned to the Amendment 80 cooperative be assigned into PSC bycatch allowances for seven specified fishery categories. The Council may revise the proposed 2010 and 2011 fishery category allocations for the BSAI trawl limited access and the Amendment 80 limited access sectors as shown in Tables 7b, 7c, and 7e. Specifications for PSCs as shown in Tables 7a and 7d are fixed.

Categories used for prohibited species catch

Trawl fisheries

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

Non-trawl fisheries

1. Pacific cod
2. other non-trawl (longline sablefish and rockfish, and jig gear)
3. groundfish pot (exempt in recent years)

Halibut Trawl Fisheries: The halibut PSC limit can be apportioned to the trawl fishery categories as shown in the box at right. While an overall PSC limit of 3,675 t has been established for trawl gear, Amendment 80 effectively will reduce the PSC limit by 150 mt between 2008 (2,525 t) and 2012 (3,250 t). The PSC apportionments for 2010 and 2011 are shown below. Additional reductions of 5 percent would occur if PSC amounts are transferred from the trawl limited access sector to the Amendment 80 trawl sector.

Schedule for Halibut Trawl PSC Limits for 2010-2011

2010	**3,626**	**Total Trawl Halibut Apportionment**
	2,425	Amendment 80
	875	Trawl Limited Access
	326	50 t added to CDQ Allocation
2011	**3,576**	**Total Trawl Halibut Apportionment**
	2,375	Amendment 80
	875	Trawl Limited Access
	326	CDQ Allocation

Halibut Fixed Gear Fisheries: A 900 t non-trawl gear halibut mortality limit can be apportioned to the fishery categories listed in the adjacent box. Beginning in 2008, Amendment 85 divided the halibut PSC limit for the hook-and-line Pacific cod fishery between the hook-and-line CP and CV sectors (CVs ≥60 ft (18.3 m) LOA and CVs <60 ft (18.3 m) LOA combined). The Council can provide varying amounts of halibut PSC by season to each sector, tailoring PSC limits to suit the needs and timing of each sector (see Table 7c).

Crab: Prescribed bottom trawl fisheries in specific areas are closed when PSC limits of Tanner crab *C. bairdi*, snow crab *C. opilio*, and red king crab are reached. A stair step procedure for determining PSC limits for red king crab taken in Zone 1 trawl fisheries is based on the abundance of mature Bristol Bay red king crab. Based on the 2009 estimate of effective spawning biomass of 70.4 million pounds, the PSC limit for 2010 is 197,000 red king crabs. Up to 25% of the red king crab PSC limit can be used in the 56° - 56°10'N strip of the Red King Crab Savings Area. The red king crab cap has generally been allocated among the pollock/mackerel/other species, Pacific cod, rock sole, and yellowfin sole fisheries.

PSC limits for *C. bairdi* in Zones 1 and 2 are based on a percentage of the total abundance minus an additional reduction implemented in 1999 of *C. bairdi* crab as indicated by the NMFS trawl survey. Based on the 2009 abundance (346 million crab), the PSC limit in 2010 for *C. bairdi* will be 830,000 *C. bairdi* crab in Zone 1 and 2,520,000 crab in Zone 2. *The C. bairdi limits are reduced in 2010 for the first time since 2001* because the stock is approaching an overfished condition (see Agenda C-6(c)).

PSC limits for red king crab and *C. bairdi* Tanner crab

Species	Zone	Crab Abundance	PSC Limit
Red King Crab	Zone 1	≤ 8.4 million mature crab threshold or 14.5 million lb effective spawning biomass (ESB)	32,000
		> threshold, but < 55 million lb ESB	97,000
		≥ 55 million lb ESB	197,000
Tanner Crab	Zone 1	0-150 million crab	0.5% total abundance - 20,000
		150-270 million crab	730,000
		270-400 million crab	830,000
		> 400 million crab	980,000
Tanner Crab	Zone 2	0-175 million crab	1.2% total abundance - 30,000
		175-290 million crab	2,070,000
		290-400 million crab	2,520,000
		> 400 million crab	2,970,000

Snow crab (*C. opilio*) PSC limits are based on total abundance of *opilio* crab as indicated by the NMFS standard trawl survey. The cap is set at 0.1133% of the total snow crab survey abundance index, with a minimum cap of 4.5 million snow crab and a maximum cap of 13 million snow crab; the cap is further reduced by 150,000 crab. The 2009 survey estimate of 3,059,200,000 crabs result in a 2009 *opilio* crab PSC limit of 3,466,074 crabs, if left unadjusted. However, the crab FMP mandates a minimum of 4,350,000 snow crab. Snow crab taken within the "*C. opilio* Bycatch Limitation Zone" accrues toward the PSC limits established for the trawl sectors.

Herring: In 1991, an overall herring PSC bycatch cap of 1 percent of the EBS biomass of herring was implemented. This cap is apportioned to the seven PSC fishery categories. Annual herring assessments indicate there will be very little change in the Bering Sea herring PSC limit for 2009. The herring biomass estimate for spring 2008 for the eastern Bering Sea was estimated to be 169,675 t. The corresponding herring PSC limit for 2009 at 1% of this amount is 1,697 t. The 2009 herring biomass estimate will be provided at the meeting; staff will report the resultant herring PSC limit for 2010.

Seasonal apportionment of bycatch limits The Council may also seasonally apportion the bycatch allowances. Regulations require that seasonal apportionments of bycatch allowances be based on information listed in the adjacent box.

Halibut discard mortality rates International Pacific Halibut Commission (IPHC) staff recommendations for halibut bycatch mortality rates for the 2010-2012 CDQ and non-CDQ fisheries are provided for Council action. The BSAI and GOA Plan Teams accepted the IPHC recommendations. Rates for CDQ fisheries also would be set on a 3-year cycle now that sufficient data is available to use the same methodology as that for non-CDQ fisheries.

Factors to be considered for seasonal apportionments of bycatch allowances.

1. Seasonal distribution of prohibited species;
2. Seasonal distribution of target groundfish species relative to prohibited species distribution;
3. Expected prohibited species bycatch needs on a seasonal basis relevant to change in prohibited species biomass and expected catches of target groundfish species;
4. Expected variations in bycatch rates throughout the fishing year;
5. Expected changes in directed groundfish fishing seasons;
6. Expected start of fishing efforts; and
7. Economic effects of establishing seasonal prohibited species apportionments on segments of the target groundfish industry.

Recommended Pacific halibut discard mortality rates for 2010-12 CDQ and non-CDQ groundfish fisheries.

1. Non-CDQ

	Bering Sea/Aleutians	
Gear/Target	**Used in 2007-2009**	**2010-2012 Recommendation**
Trawl		
Atka mack	76	76
Bottom poll	74	73
Pacific cod	70	71
Other Flats	74	72
Rockfish	76	81
Flathead sole	70	74
Midwtr poll	88	89
Rock sole	80	82
Sablefish	75	75
Turbot	70	67
Arr. fldr	75	76
YF sole	80	81
Pot		
Pacific cod	7	8
Longline		
Pacific cod	11	10
Rockfish	17	9
Turbot	13	11

II. Bering Sea/Aleutian Isl. CDQ

Gear/Target	Used in 2009	2010-2012 Recommendation
Trawl		
Atka mackerel	85	85
Bottom pollock	85	85
Pacific cod	--	90
Rockfish	82	84
Flathead sole	84	84
Midwtr pollock	90	90
Rock sole	88	87
Turbot	--	88
Yellowfin sole	84	85
Pot		
Sablefish	34	32
Longline		
Pacific cod	10	10
Turbot	4	4

Table 1. Bering Sea Aleutian Islands Groundfish Plan Team OFL and ABC Recommendations for the 2010-2011 Fisheries

DRAFT

Species	Area	2009				2010			2011		
		OFL	ABC	TAC	Catch	OFL	ABC	TAC	OFL	ABC	TAC
Pollock	EBS	977,000	815,000	815,000	810,052	918,000	813,000		1,220,000	1,100,000	
	AI	34,000	28,200	19,000	1,282	40,000	33,100		39,100	32,200	
	Bogoslof	58,400	7,970	10	9	22,000	156		22,000	156	
Pacific cod	BSAI	212,000	182,000	176,540	163,587	205,000	174,000		251,000	214,000	
Sablefish	BS	3,210	2,720	2,720	876	3,310	2,790		2,970	2,500	
	AI	2,600	2,200	2,200	1,055	2,450	2,070		2,200	1,860	
Atka mackerel	Total	99,400	83,800	76,400	72,274	88,200	74,000		76,200	65,000	
	EAI/BS		27,000	27,000	26,433		23,800			20,900	
	CAI		33,500	32,500	29,541		29,600			26,000	
	WAI		23,300	16,900	16,300		20,600			18,100	
Yellowfin sole	BSAI	224,000	210,000	210,000	103,808	234,000	219,000		227,000	213,000	
Northern rock sole	BSAI	301,000	296,000	90,000	48,593	243,000	240,000		245,000	242,000	
Greenland turbot	Total	14,900	7,380	7,380	4,284	7,460	6,120		6,860	5,370	
	BS		5,090	5,090	2,074		4,220			3,700	
	AI		2,290	2,290	2,210		1,900			1,670	
Arrowtooth flounder	BSAI	190,000	156,000	75,000	28,931	191,000	156,000		191,000	157,000	
Flathead sole	BSAI	83,800	71,400	60,000	19,424	83,100	69,200		81,800	68,100	
Other flatfish	BSAI	23,100	17,400	17,400	2,155	23,000	17,300		23,000	17,300	
Alaska plaice	BSAI	298,000	232,000	50,000	13,698	278,000	224,000		314,000	248,000	
Pacific Ocean perch	BSAI	22,300	18,800	18,800	14,780	22,400	18,860		22,200	18,680	
	BS		3,820	3,820	623		3,830			3,790	
	EAI		4,200	4,200	3,867		4,220			4,180	
	CAI		4,260	4,260	3,879		4,270			4,230	
	WAI		6,520	6,520	6,411		6,540			6,480	
Northern rockfish	BSAI	8,540	7,160	7,160	3,087	8,640	7,240		8,700	7,290	
Shortraker	BSAI	516	387	387	198	516	387		516	387	
Blackspotted/ Rougheye	BSAI	660	539	539	194	669	547		650	531	
Other rockfish	BSAI	1,380	1,040	1,040	586	1,380	1,040		1,380	1,040	
	BS		485	485	193		485			485	
	AI		555	555	393		555			555	
Squid	BSAI	2,620	1,970	1,970	353	2,620	1,970		2,620	1,970	
Other species	BSAI	80,800	66,700	50,000	26,653	88,200	61,100		88,100	60,900	
Total	BSAI	2,638,226	2,208,666	1,681,546	1,315,879	2,462,945	2,121,880		2,826,296	2,457,284	

2009 catches through November 7 from AKR Catch Accounting including CDQ.

AGENDA C-3)(b)(2)
DECEMBER 2009

TABLE 1– PROPOSED 2010 AND 2011 OVERFISHING LEVEL (OFL), ACCEPTABLE BIOLOGICAL CATCH (ABC), TOTAL ALLOWABLE CATCH (TAC), INITIAL TAC (ITAC), AND CDQ RESERVE ALLOCATION OF GROUNDFISH IN THE BSAI[1]

[Amounts are in metric tons]

Species	Area	Proposed 2010 and 2011				
		OFL	ABC	TAC	ITAC[2]	CDQ[3,4,5]
Pollock	BS	977,000	815,000	815,000	733,500	81,500
	AI	36,800	30,400	19,000	17,100	1,900
	Bogoslof	58,400	7,970	10	10	-
Pacific cod[4]	BSAI	235,000	199,000	193,030	172,376	20,654
Sablefish[5]	BS	2,980	2,520	2,520	1,109	98
	AI	2,410	2,040	2,040	474	41
Atka mackerel	BSAI	84,400	71,100	71,100	63,492	7,608
	EAI/BS		22,900	22,900	20,450	2,450
	CAI		28,500	28,500	25,451	3,050
	WAI		19,700	19,700	17,592	2,108
Yellowfin sole	BSAI	210,000	198,000	180,000	160,740	19,260
Rock sole	BSAI	314,000	310,000	75,000	66,975	8,025
Greenland turbot	BSAI	14,400	7,130	7,130	6,061	n/a
	BS		4,920	4,920	4,182	526
	AI		2,210	2,210	1,879	-
Arrowtooth flounder	BSAI	196,000	161,000	60,000	51,000	6,420
Flathead sole	BSAI	81,800	69,800	50,000	44,650	5,350
Other flatfish[6]	BSAI	23,100	17,400	17,400	14,790	-
Alaska plaice	BSAI	354,000	275,000	30,000	25,500	-
Pacific ocean perch	BSAI	22,100	18,600	18,600	16,447	n/a
	BS		3,780	3,780	3,213	-
	EAI		4,160	4,160	3,715	445
	CAI		4,210	4,210	3,760	450
	WAI		6,450	6,450	5,760	690
Northern rockfish	BSAI	8,580	7,190	6,000	5,100	-
Shortraker rockfish	BSAI	516	387	387	329	-
Rougheye rockfish	BSAI	640	552	552	469	-
Other rockfish[7]	BSAI	1,380	1,040	1,040	884	-
	BS		485	485	412	-
	AI		555	555	472	-
Squid	BSAI	2,620	1,970	1,970	1,675	-
Other species[8]	BSAI	80,700	63,680	34,221	29,088	-
TOTAL		2,706,826	2,259,779	1,585,000	1,411,768	152,968

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[1] These amounts apply to the entire BSAI management area unless otherwise specified. With the exception of pollock, and for the purpose of these harvest specifications, the Bering Sea (BS) subarea includes the Bogoslof District.

[2] Except for pollock, the portion of the sablefish TAC allocated to hook-and-line and pot gear, and Amendment 80 species, 15 percent of each TAC is put into a reserve. The ITAC for these species is the remainder of the TAC after the subtraction of these reserves.

[3] Under § 679.20(a)(5)(i)(A)(1), the annual Bering Sea subarea pollock TAC, after subtracting first for the CDQ directed fishing allowance (10 percent) and second for the incidental catch allowance (4 percent), is further allocated by sector for a directed pollock fishery as follows: inshore - 50 percent; catcher/processor - 40 percent; and motherships - 10 percent. Under § 679.20(a)(5)(iii)(B)(2)(i) and (ii), the annual Aleutian Islands subarea pollock TAC, after subtracting first for the CDQ directed fishing allowance (10 percent) and second for the incidental catch allowance (1,600 mt), is allocated to the Aleut Corporation for a directed pollock fishery.

[4] The Pacific cod TAC is reduced by three percent from the ABC to account for the State of Alaska's (State) guideline harvest level in State waters of the Aleutian Islands subarea.

[5] For the Amendment 80 species (Atka mackerel, Aleutian Islands Pacific ocean perch, yellowfin sole, rock sole, flathead sole, and Pacific cod), 10.7 percent of the TAC is reserved for use by CDQ participants (see §§ 679.20(b)(1)(ii)(C) and 679.31). Twenty percent of the sablefish TAC allocated to hook-and-line gear or pot gear, 7.5 percent of the sablefish TAC allocated to trawl gear, and 10.7 percent of the TACs for Bering Sea Greenland turbot and arrowtooth flounder are reserved for use by CDQ participants (see § 679.20(b)(1)(ii)(B) and (D)). Aleutian Islands Greenland turbot, "other flatfish," Alaska plaice, Bering Sea Pacific ocean perch, northern rockfish, shortraker rockfish, rougheye rockfish, "other rockfish," squid, and "other species" are not allocated to the CDQ program.

[6] "Other flatfish" includes all flatfish species, except for halibut (a prohibited species), flathead sole, Greenland turbot, rock sole, yellowfin sole, arrowtooth flounder, and Alaska plaice.

[7] "Other rockfish" includes all Sebastes and Sebastolobus species except for Pacific ocean perch, northern, shortraker, and rougheye rockfish.

[8] "Other species" includes sculpins, sharks, skates, and octopus. Forage fish, as defined at § 679.2, are not included in the "other species" category. Pending approval of amendment 95 from the Secretary, skates will be broken out from the "other species" category in the 2011 fishing year. The OFL, ABC, and TAC for "other species" will be 42,507, 31,680, and 31,680 mt, respectively. The OFL, ABC, and TAC for skates will be 38,200, 32,000, and 30,000 mt, respectively.

AGENDA C-3(b)(3)
DECEMBER 2009

BSAI Groundfish Plan Team Minutes
AFSC- Seattle, WA
November 16-19, 2009

Loh-Lee Low (AFSC), Chair	Brenda Norcross (UAF)
Grant Thompson (AFSC), Special Envoy to the SSC	Leslie Slater (USFWS)
Mike Sigler (AFSC), Vice-chair	Kerim Aydin (AFSC)
Jane DiCosimo (NPFMC), Coordinator	Brenda Norcross (IPHC)
Dave Carlile (ADF&G)	Lowell Fritz (NMML)
Mary Furuness (AKRO)	David Barnard (ADF&G)
Dana Hanselman (AFSC)	Yuk W. (Henry) Cheng (WDFW)
Alan Haynie (AFSC)	

The BSAI Groundfish Plan Team convened on Monday, November 16, 2009, at 3:30 pm. All members were in attendance.

EBS walleye pollock Jim Ianelli summarized this year' assessment. New data included:

1) This year's bottom trawl survey biomass estimate was down 25% from last year, but slightly above expectations based on last year's assessment.
2) This year's EIT survey biomass estimate was about the same as last year, but below expectations based on last year's assessment.
3) As in previous assessments, an age-length key (ALK) from this year's bottom trawl survey was constructed and used to compute the age composition from this year's bottom trawl survey.
4) In previous assessments, the ALK from the current year's bottom trawl survey was also used to compute the age composition from the current year's EIT survey. For this year's assessment, however, 100 otoliths from this year's EIT survey were incorporated into the bottom trawl survey ALK (only when applied to the EIT length composition) to give a more accurate estimate of this year's EIT age composition.
5) The relative abundance of three-year-olds in this year's EIT (2006 year class) was lower than expected from last year's assessment.
6) This was the fourth consecutive year of cold temperatures in the bottom trawl survey.
7) Fishery otoliths from the first part of 2009 were read, but the resulting age composition was not used in the final model (see "Sensitivity testing of the model and projections" below).

Jim reviewed the assessment model and projection methodology. The assessment model is identical to last year's model. As with other age-structured assessments, the EBS pollock model is based on numbers at age, but harvest specifications are based on catch measured in weight. Accurate harvest specifications therefore require an accurate projection of fishery weight at age in the next 1-2 years. For EBS pollock, the current method is to use a three-year running average. In this year's assessment, several alternatives were evaluated, including different durations for the running average and a variety of regressions using data that are typically available at the time of the assessment (e.g., average date of catch, average location of catch, etc.). Results of this evaluation indicated that, of the alternatives considered, the best predictor was a ten-year running average, which the authors recommend for use in this year's harvest specifications.

Two methods were provided for computing the probability that spawning biomass will fall below 20% of B_0 (because EBS pollock is managed under Tier 1, the relevant reference point for Steller sea lion mitigation measures is 20% of B_0 rather than $B_{20\%}$). The first, which is used in assessments of several other stocks, is to define the ratio of future spawning biomass to 20% of B_0 as a variable for which the population modeling software AD Model Builder (ADMB) provides a mean and standard deviation (or MCMC distribution). The second is a new method, which is something like a "management strategy evaluation," in that it evaluates the probability that a future assessment will result in a point estimate of spawning biomass lower than 20% of the point estimate of B_0 from the same assessment. For the time being, the second method is limited to a two-years-ahead projection.

Estimates of most quantities related to harvest specifications are lower than projected in last year's assessment, due largely to a decrease in the estimated size of the 2006 year class (down 37% from last year's estimate).

B_{MSY} = 1.863 million t, down about 3% from last year's estimate.
Spawning biomass for 2010 = 1.316 million t, down about 28% from last year's projection for 2010, but down only about 9% from last year's estimate of SB2009.
Probability of falling below 20% of B_0 in 2011 < 5% (using the second method described above).
Maximum permissible ABC for 2010 = 813,000 t, down about 34% from last year's projection for 2010, but almost identical to ABC2009.
Maximum permissible ABC for 2011 = 1.110 million t.
OFL for 2010 = 918,000 t, down about 36% from last year's projection for 2010, but down only about 6% from OFL2009.
OFL for 2011 = 1.220 million t.

Jim reviewed the following sensitivity testing of the model and projections.

1) Initial explorations of an alternative functional form for age-specific natural mortality were conducted (the traditional schedule of age-specific natural mortality rates was retained for this assessment, however).
2) Alternative model specifications explored in previous assessments were tabulated, showing that a wide range of alternatives have been considered at various times in the past.
3) The "CABE" series of analyses was conducted (as in last year's assessment), showing the effects of the most recent year's data from the catch, fishery age, bottom trawl survey, and EIT survey time series; in various combinations.
4) Preliminary fishery age data from the first part of 2009 were included in sensitivity runs of the model. These indicated a smaller probability of the stock falling below $B_{20\%}$, slightly larger recent recruitment, and a slightly larger 2010 maximum permissible ABC.
5) Two types of retrospective analysis were conducted. The first type examined the difference between estimates from previous assessments versus the current assessment. The second type re-runs the current model several times, each time omitting one year's data (starting with the most recent year and working backward through time). The results indicate that the EBS pollock assessment does not have a strong retrospective bias.
6) An alternative projection was also conducted with the 2006 year class strength set equal to the long-term average, rather than as estimated in the assessment model. The maximum permissible ABC for 2010 under this alternative run was 738,000 t.

Following Jim's presentation, the Plan Team discussed the assessment. Primary discussion topics included the assessment model, estimates and variances of year class strengths (particularly the 2006 year class), tier designation, and ABC recommendations.

Assessment model The Team noted that the assessment model is unchanged from last year, and agreed that it is appropriate for use in recommending harvest specifications. The Team also agreed with the authors' recommended change in the method for projecting fishery weight at age.

Year class strengths The following were among the points raised during discussion of the year class strengths, both in general and with respect to the 2006 year class in particular (note that this list is intended simply to reflect the nature of the discussion, and does not necessarily represent Team consensus):

1) In addition to the point estimate of the 2006 year class strength shifting downward since last year's assessment, the confidence interval now overlaps the mean (in last year's assessment, the lower end of the confidence interval was slightly above the mean).

2) The 2008 year class is estimated to be above average, but, because this estimate is based only on the 2009 survey, the confidence interval is extremely large.
3) In last year's assessment, every year class from 2001-2005 was estimated to be below average, but in this year's assessment, the 2001 year class is estimated to be almost exactly equal to the average.
4) The average of the negative recruitment deviations from 2002-2005 are much bigger than the average of the positive deviations from 2006 and 2008, which may indicate that the stock-recruitment relationship is less certain than before.
5) A recent paper by Franz Mueter shows a dome-shaped relationship between recruitment and temperature.
6) The assessment model does not estimate cohort-specific growth of the 2006 year class.
7) Because the 2006 year class is still only 3 years old, no information on possible cohort-specific maturity of this year class is available.
8) Figure 1.6 in the assessment indicates that the fishery operated in a manner that increased the selectivity of ages 3 and 4, which is not typical.
9) A member of the public stated that large numbers of young fish, perhaps from the 2006 year class, seemed to show up shortly after the survey took place.
10) Another member of the public offered the possibility that year class strength (in general) may be related to the extent of ice cover and the presence of vessels in areas of spawning concentrations during the spawning season.

Tier designation The Team discussed whether EBS pollock should be managed under Tier 1 or Tier 3 and, as listed under point #4 above, whether the stock-recruitment relationship is as reliably estimated as previously believed. During this discussion, it was noted that the EBS pollock assessment is scheduled for a CIE review in 2010. Following discussion, the Team agreed that this stock continues to qualify for management under Tier 1 (Tier 1b, specifically).

ABC recommendation The Team reviewed last year's minutes regarding ABC for this stock. The Team discussion on a recommended ABC focused on two alternatives: the maximum permissible value based on the assumption that the strengths of all year classes through 2008 are equal to the estimates from the present assessment (giving a 2010 ABC of 813,000 t), and the maximum permissible value based on the assumption that the strength of the 2006 year class is equal to the long-term average (giving a 2010 ABC of 738,000 t).

Arguments in favor of a 2010 ABC of 738,000 t (2006 year class = average) included the following:

1) The estimated strength of the 2006 year class has dropped considerably from last year's assessment, and may drop again.
2) Last year's assessment projected that the stock would recover to B_{MSY} by 2010, but this year's assessment indicates that this will not occur until 2012.
3) Recent survey biomass estimates have been low and the model projects that next year's bottom trawl survey biomass estimate will be the lowest in the time series.
4) The estimate of the 2006 year class is still fairly uncertain.
5) Even if the 2006 year class is above average, all of the other year classes currently in the fishery since the 2001 year class have all been below average (the 2008 year class has not yet recruited to the fishery).
6) There have been relatively few previous instances in which this stock has been so dependent on one year class. In other years when the stock was extremely dependent on a single year class, the dominant year class was an extremely strong one, whereas in the present case, the dominant year class is much closer to average in strength.
7) The stock-recruitment relationship is uncertain.

Arguments in favor of a 2010 ABC of 813,000 t (2006 year class = model estimate) included the following:

1) The Team agreed that the model is appropriate for making harvest specifications, and there is no reason to believe that the model's estimate of the 2006 year class is biased.
2) Reducing the ABC from 813,000 t to 738,000 t will have no discernible effect on the time the stock will take to recover to B_{MSY}.
3) The 2008 year class appears to be above average (in last year's minutes, the Team indicated that this year's recommendation for the 2010 ABC would be based in part on evidence of an additional strong year class).
4) Setting the 2006 year class equal to the long-term average value lacks statistical justification; a similar assumption could be applied to weak year classes as well.
5) While the stock is highly dependent on the 2006 year class, the extent of this dependence is not unprecedented.
6) A 2010 catch of 813,000 t would maintain the spawning exploitation rate below 20%, which has been used as a reference point in past Team recommendations.

Following discussion, the Plan Team recommended (by a one-vote margin) a 2010 ABC of 813,000 t. Given this decision, the Team recommended a 2011 ABC of 1.10 million t (equal to the maximum permissible value).

Plan Team Recommendations for Future Assessments

As a general recommendation (i.e., not specific to the EBS pollock assessment), the Plan Team recommends that a workshop be held, or a working group be formed, to develop guidance regarding how to decide when a stock qualifies for management under Tier 1. In so doing, the Plan Team recognizes that the SSC has final responsibility for making tier determinations.

Noting that a CIE review is scheduled for next summer, the Plan Team makes no new recommendations for the EBS pollock assessment. There are no outstanding recommendations for this assessment from previous years.

Bogoslof pollock Jim Ianelli reported that the standard assessment approach was applied again this year. A biennial cycle of the survey by the R/V *Oscar Dyson* was completed in March 2009. This survey resulted in the lowest estimate of biomass recorded since 1988. The next survey is scheduled for 2011. The decreased biomass estimate results in a recommendation for a decreased ABC. The Team accepted the author's recommendation for OFL and ABC under Tier 5 and noted that the ABC value follows the SSC's approach, which is less than the maximum permissible.

Aleutian Islands Pollock Steve Barbeaux presented the updated assessment, which includes recent catch data. He presented two model configurations which differ only in that model 1 excludes catches east of 174 west longitude (which may be part of the eastern Bering Sea stock). Model 2, which includes all catches for the Aleutian Islands, was adopted by the team to recommend ABC and OFL values. The model estimates that there is less than 1% chance that the population would be below $B_{20\%}$ of unfished spawning biomass.

The Plan Team recommended that an Aleutian Islands survey be conducted in 2010. The survey normally is conducted every other year. However no survey was conducted in 2008 because of lack of funds. The last survey was completed in 2006.

Directed catch has mostly been taken from small areas located outside Steller sea lion critical habitat. SSL critical habitat in the Aleutian Islands is closed to pollock fishing. Very little targeting of pollock in the AI occurred in the past decade, with targeted catch in 2009 of less than 600 t. Current catches are mostly bycatch in target fisheries for other species. Pollock catches were low and typically mixed with Pacific ocean perch. In the future the fishery may grow in size, but the TAC is limited by statute to no more than 19,000 t. If this occurs, the Team recommends that a winter survey be conducted because the pollock distribution is different during winter. Steve Barbeaux noted that a winter survey likely is dependent on availability of industry-cooperative survey funds.

Pacific cod Grant Thompson reviewed the alternative models during the joint team meeting. The joint teams discussed the advisability of using the age composition data and the reliability of the bias correction procedure. At the opening of the BS/AI discussion, Dana Hanselman put forth that the bias correction, although not based on any external data, was effective, as shown by its success in bringing the survey modes and mean lengths at age into line. Mike Sigler agreed. Grant Thompson pointed out that in fact the model predictions matched the survey modes without the bias correction; the real benefit was a better fit to the age composition data. Dave Barnard supported model B1. Bill Clark commented that even Model B2 used the questionable bias correction to fit mean length at age along with length composition data, so it was also suspect. A majority of the team favored Model B1, while others supported Model A2, mostly due to concerns about the age data.

Kerim Aydin pointed out that the key issue that resulted in the very large number of model runs is the applicability of the age data. Tom Helser, AFSC, plans to complete a bomb radiocarbon study with IPHC within the next year to aid in resolution of the issue of whether to use the age data in the model.

The team adopted the ABC and OFL values produced by Model B1 without dissent. Two industry representatives suggested that the team adopt a rollover of the 2009 ABC in view of the projected sharp increase in biomass in 2011. Mike Sigler replied that model projections change each year as the assessment model is updated with new data. Grant Thompson clarified that the team could not adopt an ABC that is above the maximum permissible ABC produced by the accepted model.

Request to the assessment author The Team requested that the lead author analyze three alternative models for the September 2009 meeting: 1) current Model B1, 2) Model B1 with data-based estimates of aging bias from the radiocarbon study if available, and 3) Model B2 without mean length at age data and with maturity a function of length rather than age.

Request to the AFSC The team considered new operational policies to avoid the large number of models that have characterized the assessment for the last several years, which overloads the lead author and team each year. The team requests the AFSC adopt an earlier deadline than exists for public requests for specific model runs so that assessment author(s) have time to evaluate these model runs for consideration by the team at the September meeting. The team further requests the AFSC filter those proposals, along with SSC and Plan Team requests, for alternative cod models so as to schedule selection of final model runs at the September Plan Team meeting (and October SSC meeting). This would facilitate examination of likely preferred alternative model runs by the team each November (and by the SSC each December). This would better notify the public of likely outcomes for determination of ABC each cycle.

Sablefish See Joint Plan Team minutes.

Yellowfin sole Tom Wilderbuer summarized the results of the assessment. He addressed an observation that Henry Cheng made last year that the ratio of the estimated values of M (estimated outside the assessment model) and K for yellowfin sole were outside the range of usual ratios. The usual range of ratios are in the vicinity of M = 1.5K based on Jensen (1996). Tom investigated this and found that while outside this usual range of ratios, the values of M were appropriate for yellowfin sole.

The author reviewed the changes to the input data. The estimated catch for 2009 used in the assessment model now appears to be a slight overestimate, due to lower-than-expected actual catch taken late in the year. The survey biomass was down in 2009, as it was for all flatfish with the exception of Alaska plaice.

The split sex model was again applied this year. The author reviewed changes in the weights at age, noted the continued light exploitation of the stock, and the geographic distribution of catch over time. The decline in the shelf survey estimate of biomass may be related to the colder bottom temperatures. Among various models examined, the author chose Model B, which uses 1978-2003 data for to estimate the spawner-recruit relationship, parameters for which are estimated within the model. This is the same model used in last year's assessment. The model provides estimates of OFL and ABC which are fairly close together.

Bill Clark suggested that using the complete time series of age data might improve the within-model estimate of M. Tom clarified that the whole time series of age data is used in the model. The 2003 year class is stronger than average.

Industry representatives asked whether the trawl survey might be overestimating abundance of yellowfin sole (e.g., due to herding by the survey trawl). This question arose because the fleet catch rates and size of fish have gone down in some instances in spite of the high survey estimates of abundance. Bill Clark pointed out that there was substantial research supporting the catchability (q = 1.1) of the survey trawl, along with a long time series of survey data suggesting good biomass estimates.

Request to the assessment author Although the team thinks that the abundance estimates are robust, it requested that the author determine if data (e.g., fishery CPUE) indicate decreasing fishery catch rates, how fishery catch rates compare to survey catch rates, and possible time and area influences on the rates.

Greenland turbot Jim Ianelli highlighted recent trends in Greenland turbot abundance indices, catch and quota. Quotas and catches generally remain at low levels, although trawl catch increased in 2008, apparently due largely to retention in the arrowtooth flounder fishery. The EBS shelf survey biomass was lower in 2009 than in 2008.

The 2008 and 2009 catch data were updated and added to the model, as were biomass and length composition estimates from the 2009 Eastern Bering Sea shelf survey.

The current assessment uses a new version of Stock Synthesis, and some differences between last year's assessment and this year's assessment are likely attributable to changes in the software. Considerable time was devoted to trying to "tame unruly selectivity parameters."

Difficulties in estimating selectivity parameters were attributed largely to differing sex ratios among gear types and fisheries incorporated into the sex specific model for Greenland turbot. The difficulties in estimating selectivity parameters were exacerbated by recent changes in the proportion of catch among gear types and in sex ratios among some fisheries. These difficulties were due partly to changes in the way certain fisheries were conducted as a result of implementing Amendment 80 in 2008 (e.g., percent of females in the trawl fisheries during 2006-2009 varied from 16 to 60%; see Table 5.3). For the first time in recent years more than 1,000 tons of Greenland turbot were taken in the trawl fisheries in the EBS and the Aleutian Islands in 2008 and 2009, respectively (see Table 5.3). Another example of the influence of Amendment 80 on fishing patterns, and retention of Greenland turbot is seen in the target trawl fishery for arrowtooth flounder, which has exhibited a marked increase in the catch and retention of Greenland turbot since Amendment 80 was implemented (e.g., estimated catch of Greenland turbot increased from 3 to 1,176 t between 2007 and 2008; Table 5.4). As another example of the changing nature of the fisheries the decreasing percentage of females in the longline fishery was highlighted (see Table 5.5).

The team noted that the proportion of trawl survey tows with Greenland turbot has been fairly consistent over time; however, the shelf trawl survey index of biomass has declined by 49% over the last four years. In recent years there have been some signs of younger fish entering the population, specifically the 2007-2008 year classes, with the 2008 year class (observed only once, in the 2009 EBS shelf trawl survey) currently estimated to be the largest since 1978. Catch increased slightly between 2008 and 2009.

New age data were incorporated into the model in the form of mean lengths at age. The addition of these new data, in combination with the implementation of the latest version of Stock Synthesis, resulted in increasingly lower weights at age for females, particular notable beyond age 14, compared to those used in the 2008 assessment.

The team noted year-to-year sex and size variability within an area. The sex-specific differences and sampling error made it difficult to estimate selectivity patterns and underscored the need for additional data to try to enhance the ability to estimate these parameters.

The author called attention to the large difference in model-estimated time series of age 1+ biomass between 2008 and 2009. There was substantial discussion about factors that might have contributed to this difference including the shift to SS3 (compared to SS2, used for the 2006-2008 assessments), and the addition of new data. Jim noted that the large historical removals (i.e., 1970s – 1980s) suggest large historical abundance. To reconcile this large historical catch, the model estimates high abundance. The author focused attention on the changing patterns of fishing mortality rates (sexes and gears combined) over time and unexpected sex-specific patterns of selectivity among various abundance indices.

In response to a question posed about the reason for using SS, Jim reported that SS2 and now SS3 have been used because historically the assessment has been a length-based assessment and SS lends itself well to assessments based primarily on length.

With reference to Fig. 5.8, the team members discussed with the author changes between the 2008 and current assessments in the fit of model results to the data for the shelf and slope trawl surveys and the longline survey. Comparing the fit from the 2009 model to 2008 model, the current assessment does not fit the slope trawl survey data as well, but fits the longline and shelf trawl survey indices better.

The team discussed the ABC recommendation at length. The team recounted that the 2009 ABC was set at 60% of the maximum permissible amount based on it being an off-year for a survey, stock structure issues, and data and modeling uncertainties. It was the first in a stair-step increase to the maximum permissible recommended by the Plan Team and supported by the author. Indications of better recruitment were mentioned during this discussion. The team discussed the differences in selectivity related to depth and the probable interplay between factors such as depth, sex ratio, and selectivity patterns (e.g., the 400-600 m depth range with an increased percentage of males). The team also discussed the possible, but unknown, influences of using SS3, although no contemporary comparison of model results based on the SS2 and SS3 programs was available. The model run with the updated data was conducted only with SS3, because it is the most current, and presumably best, version of the software. Because of the various uncertainties and the inability to differentiate influences of factors such as the changing sex-specific selectivities and the SS3 model itself, the team discussed the merits of using the ABC results of the model vs. using results from last year's model and rolling over the ABC from 2009 or the 2010 ABC projection from last year's model. Using a Tier 5 designation was also suggested for discussion. If the new model is accepted, the team observed that it would be inappropriate to use the 2009 ABC, since it is above the maximum permissible value for the 2010 ABC from the new model. The difficulties of identifying the sources of the differences between the 2008 and 2009 model results (new data and/or the use of the SS3 software), prompted a discussion about the merits and potential difficulties of introducing a revised modeling approach between the September and November Plan Team meetings. The team decided to accept the current model, noting the concerns identified above, and recommended the resultant maximum permissible ABC; it abandoned the stair-step approach that was adopted last year.

The team also discussed future ways to evaluate the performance and results from SS3, including comparing the results from SS2 using the same data in both models. The team could then evaluate possible reasons for changes in the results in the next assessment if the author used both versions of SS.

Jim Ianelli mentioned a master's student who was working on some early life history aspects of Greenland turbot, which could also improve model results when incorporated.

Arrowtooth flounder Tom Wilderbuer presented the assessment. With fixed female M=0.2, the run with male M=0.35 provides a reasonable fit to all the data components and is consistent with observations of differences in sex ratios observed from trawl surveys. The maximum shelf survey selectivity for males occurs at 0.93 for age-8 fish. The base model includes Aleutian Islands data again this year.

The estimated age 1+ biomass for 2009 from the 2008 assessment was 1,137,000 t, compared with an estimated age 1+ biomass of 1,120,000 t for 2010 from this year's assessment. The recommended ABCs for 2009 and 2010 (156,000 t) are the same in both assessments. There was no public comment. The Plan Team agreed with the authors' recommended ABC.

Northern rock sole

The rock sole stock is expected to remain relatively stable through 2011. The survey biomass is 75% of the 2008 value; however, good recruitment in 2001 through 2004 should increase the stock biomass at the beginning of the next decade. Because of new model maturity-at-length calculations, the ABC is going down.

The authors examined length-at-age for 8 yr old fish because there are three growth stanzas: 1982-91 (fastest growth), 1992-2003 (slowest growth), and 2004-08 (fast growth). Only northern rock sole and Pacific halibut have these distinct time-varying growth stanzas. Bill Clark noted that for Pacific halibut a year-by-year analysis was conducted on an immense data base to account the growth stanzas. For northern rock sole, male and female sizes diverge at maturity, ~age 6; then females grow more and attain larger sizes. Therefore, instead of keeping constant weight-at-age, the authors incorporated a 3-yr running average of length-at-age to capture time-varying differences in growth.

The model also was changed to include a new length-based relationship for maturity (Stark model) as it was shown to be more accurate than the relationship used in the past. The anatomical scans used in the past underestimate maturity at age. This change in the maturity ogive has an effect on productivity estimates. Since the maturity curve moved to the right, F_{msy} was lower, meaning that northern rock sole cannot be fished as hard.

Northern rock sole is a nicely behaved fishery. Currently, under amendment 80 the fish are mostly retained. It is mainly a high-value roe fishery occurring January through March. Though in some years there is a targeted rock sole fishery after the roe fishery (as per John Gauvin's comments), after that time it is usually bycatch from the yellowfin sole fishery.

The authors examined Model F and again showed that there is no relationship between water temperature and catchability (Q). This is done every year and has never been shown to have an effect. The bottom trawl survey represents where the fish really are, and therefore it is a good estimate of fish abundance. The authors and the Plan Team chose model A, which models abundance and life history relationship of each sex separately. There were good year classes in the 1990s. Female spawning biomass is going down now, but is expected to go up again in coming years.

This stock is classified as Tier 1. The Tier 1 status results in very close ABC and OFL values. This fishery would be hard to manage if it were fishing at capacity.

Flathead sole Buck Stockhausen presented the results of the 2009 stock assessment. The current model was updated with the 2008 fishery catch data and the most current 2009 fishery catch data. Recent trends indicate a decrease in catch this year with a retention rate of 90%. Catches of prohibited species are also decreasing. Recent fishery patterns were similar to 2008. There was increased presence of Bering flounder due to better recognition of the species by onboard observers in 2009 relative to previous years. Overlap of Bering flounder catch with flathead sole catch occurred west of the Pribilof Islands and south of St. Matthew Island. The size distributions of the catches of male and female flathead sole in 2009 have remained unchanged for the last several years. Model predictions indicate a strong 2001 year class.

The survey estimated biomass indicates a 21% decrease from the 2008 survey. This follows the same temporal trend for most of the Bering Sea flatfish. Survey size frequencies were very similar to the fishery size frequencies. Mike Sigler noted that the colors used in the size frequency charts made it hard to compare male and female fish. Buck noted that there is an indication of a strong 2001 year class and a decreased 2002 year class followed by a stronger 2003 year class.

The assessment model is the same as last year. This is a Tier 3 stock. Environmental effects on recruitment will be addressed in future models. This year's assessment looked at 3 models involving differing temperature dependent catchability (TDQ): 1) a base model including the same year TDQ, 2) a model with no TDQ, and 3) a model including TDQ lagged by 1 year. Based on AIC the lagged TDQ model had the best fit. There is no biological mechanism to explain this result. This result is discussed in Appendix B in the assessment chapter. Buck's speculated that last year's temperatures may affect where the fish end up in the fall. The three versions of the model showed near identical results for total and spawning biomasses. Based on fits to the survey data the non-lagged TDQ model was selected for the assessment.

Results from the model indicate a decline in total biomass over the last few years and possible good recruitment from the 2001 and 2003 year classes. The control rule plot does not indicate problems. The results from this year's model assessments are nearly identical to results from the last few years. Buck briefly talked about correlation between recruitment and the ocean current direction and an indication of good recruitments for 2001-2003 and 2006, so-so recruitment in 2004, and poor recruitment in 2005. Based on model projections this stock is not overfished and is well above B_{msy} as far out as 2022. The ABC and OFL for 2010 are 69,200t and 81,800t, and for 2011 are 68,100t and 72,500t, respectively.

The Team agreed to keep the base model and to accept the ABC and OFL values from that model. John Gauvin reiterated comments that the survey and assessment were overestimating the numbers of flatfish including flathead sole, based on the observations of vessels in the fisheries and their difficulty finding large flatfish and declining CPUEs. The Team recommended that the author compare survey and fishery catch rates. Allen Haynie suggested focusing on spatial and temporal shifts in fishery catch rates.

Alaska plaice This is only assessment that did not have split-sex model in past years. The SSC and the Plan Team requested development of a split-sex model. September was the first time a split-sex model was presented. The authors recommended, and the Plan Team concurred, with using this approach. The analysis was included in this year's assessment. The total biomass numbers are very different now because of the split-sex model and because good year classes are coming in. However, the ABCs are about the same because of the differences in survey selectivity between the combined sex used last year and the split-sex model used this year.

There was a slight increase in survey biomass in 2009. The model does not estimate M, but it may be feasible. Good data exist, including survey age composition.

Other flatfish complex Tom Wilderbuer presented the updated other flatfish assessment. The biomass of other flatfish is primarily starry flounder, longhead dab, rex sole. Lacking Aleutian Islands trawl surveys, the other flatfish biomass was extrapolated by regression for this region.

From 1982 to 2009, there has been a reverse in trends of species caught. Originally it was composed mostly of longhead dab, but now it is mostly starry flounder. A few butter sole are captured in the rock sole fishery, but the EBS is the northern extent of their range, which basically is only as far north as the GOA. In the past the SSC had been concerned about catches of butter sole, but the Plan Team determined that it is not a concern at this time. The discussion of butter sole prompted a discussion about which specific species to retain in the Other Flatfish category. For example, there is little to no information and few Dover sole in BSAI. However, the basic work for the FMP and EFH has been done; therefore the Plan Team recommended that all species be retained in the assemblage. Species that are now at the northern extent of their ranges may be an issue in the future if their distribution changes.

Recommendation:

The Plan Team recommended that the time interval of survey biomass estimates used for calculating the Tier 5 recommendation be examined. Currently the most recent 3 surveys are used.

Blackspotted/Rougheye Rockfishes Paul Spencer presented this off-year update assessment. Catch was much less than ABC. The projection model was updated with a complete catch for 2008 and estimates for 2009 and 2010. The Team accepted the authors' recommendation for ABC and OFL for 2010 and 2011. The Plan Team encouraged the authors to apply the new stock structure template to the blackspotted/rougheye rokfish complex.

Shortraker rockfish Paul Spencer presented the off-year update assessments for all rockfishes. Shortraker rockfish is in Tier 5 and uses a surplus production model. This model was not updated for 2010 because there was no new survey information. Catch was much less than ABC. The Team accepted the authors' recommendation for ABC and OFL.

Pacific Ocean perch Catch was about 80% of ABC. The projection model was updated with complete catch for 2008 and estimates for 2009 and 2010. The Team accepted the authors' recommendation for ABC and OFL for 2010 and 2011. The Team continues to recommend examining modeling fishery-selectivity as constant within blocks of time that might correspond to significant changes (i.e., switch from foreign fishery to domestic fishery, changes in depth distribution, etc.).

Northern rockfish Catch was much less than ABC. The projection model was updated with complete catch for 2008 and estimates for 2009 and 2010. The Team accepted the authors' recommendation for ABC and OFL for 2010 and 2011. The Plan Team encouraged the authors to apply the new stock structure template to the northern complex.

Other rockfish The other rockfish complex is in Tier 5. Because there was no new survey information, the estimates were the same as last year, except that dark rockfish have been removed from the complex and is now managed by the State of Alaska. Catch was much less than ABC. The estimates for 2010 were slightly smaller because of the removal of dark rockfish. The Team accepted the authors' recommendation for ABC and OFL.

Atka mackerel Sandra Lowe presented an update of the Atka mackerel stock assessment. There were no changes in the assessment methodology. The most recent bottom trawl survey of the Aleutian Islands was conducted in 2006. Consequently, all new data added since 2006 has been catch and fishery age data.

Atka mackerel abundance is decreasing from a peak supported by a series of strong year classes (1999-2002), but remains above $B_{40\%}$. In this year's assessment, addition of the 2008 fishery data changed our perception of the magnitude of two recent year-classes. The 2004 year-class decreased relative to last year's assessment, while the 2006 year-class more than doubled. This is not surprising considering that the last survey was in 2006. Atka mackerel mature faster than they are selected by the fishery, and in this year's assessment, the fishery selectivity curve indicated a further move to older more mature fish (evidence of the strength of the early 2000s year-classes). This resulted in an increase (6%) in the recommended fishing mortality rate. However, this year's assessment indicates that Atka mackerel are somewhat less abundant than estimated last year, though still above target levels ($B_{2010} = B_{47\%}$). This resulted in an ABC recommendation that is down 12% from last year. The probability that the stock will be below $B_{20\%}$ is near zero. Atka mackerel is not overfished nor has it been subject to overfishing.

The 2009 Steller sea lion pup survey indicated that pup production in the western and most of the central Aleutian Islands (all of 543 and most of 542 west of 178°W) continues to decline. In the eastern area between 170-178°W (all of 541 and a small part of 542), pup production in 2009 was slightly higher than that in 2005. The Atka mackerel fishery is prohibited from fishing inside sea lion critical habitat east of 178°W, while up to 60% of the 542 and 543 TACs can be taken within critical habitat west of 178°W.

The Team recommends that a bottom trawl survey of the Aleutian Islands region be conducted in 2010.

Sharks Jon Heifetz reported the assessment update. This presentation was prepared by Cindy Tribuzio who participated in the meeting by phone. There was a new biomass estimate from the trawl survey but the survey estimate is not used to estimate abundance. Catch data was revised to correct an error in the

Catch Accounting System, but the effect of revised estimates in the BS/AI region was minor. The authors had calculated Tier 6 ABC and OFL for two reference time periods, 1997-2007 and 1997-2008. The team adopted the reference points for 1997-2007, as recommended by the SSC.

Jon showed the results of two methods of estimating shark bycatch in the halibut fishery using IPHC setline survey data. One method uses all the data to estimate shark catch per hook. The other attempts to select a subset that better resembles commercial sets by using only sets that produced a halibut CPUE that ranks in the top third of all sets. This second method conforms to IPHC methods for estimating commercial discards of sublegal halibut. The two approaches result in large differences in estimates.

Skates Olav Ormseth presented the skate assessment using the same assessment methodology used in 2008. The Team accepted the model and the authors' recommendation for Tier 3 management for Alaska skates and Tier 5 management for "other skates." The Alaska skate model output for 2009 is very similar to 2008. The total skate biomass estimate from the trawl surveys has been declining since the mid-2000's. Pacific cod longline and flatfish trawl fisheries have the largest incidental catches. Skate catch has increased in the pollock fishery, as the fleet targets older populations of pollock which are found closer to the bottom. Area 521 (outer shelf) continues to have the highest skate catches. The author also discussed possible explanations for the model underestimating length at age for older skates. For 2010 the author plans to revise the Alaska skate model using Stock Synthesis 3 as it has more flexibility in modeling growth.

Octopus Liz Conners summarized the octopus chapter. She reported that species identification by observers continues to improve. The 2009 shelf survey octopus biomass was 81% comprised of *E. dofleini*. The 2009 catch is low as a result of the low effort in the pot catcher-vessel Pacific cod B season fishery. The Team concurred with last year's approach for setting OFL and ABC using a Tier 6 average. The Team also recommended that the author use 1997-2008, the same years used for the shark assessment for the catch history time interval to set OFL and ABC. The author presents a Tier 5 alternative, but does not recommend its use until a more realistic estimate of biomass and natural mortality are available. In 2008, the joint Plan Teams endorsed the use of gear-specific discard mortality rates in catch accounting for octopus. The Team continues to encourage studies and/or data collection to document octopus mortality rates. These could be included in the proposed analysis for moving octopus either into its own specification category or into the forage fish category.

Surveys The Team strongly supported the completion of the AI trawl survey in 2010, and noted that a number of assessments rely on the survey for biomass estimates for stocks that concentrate in that area (e.g., Atka mackerel, rockfishes).

Essential Fish Habitat Stock assessment authors reviewed current FMP text relating to EFH for each species or species complex and reported new habitat information available since the 2005 EFH EIS. The Plan Teams were requested to assist the Council in two ways. First, the Plan Team was asked to indicate whether the author's review is complete, and consider author recommendations on including new information since the 2005 EFH analysis. Second, the Teams were asked to assist the Council with its evaluation of whether the new information warrants Council action to initiate an FMP amendment(s).

The Teams reviewed brief summaries of author recommendations on potential HAPC or EFH conservation recommendations and summaries of proposed revisions to FMP text. The Team concurred with author recommendations for nearly all species/complexes. The team did not concur with the author's recommendation to remove the EFH description for dover sole from the other flatfish assemblage (as noted above). The team discussed Paul Spencer's recommendation to delete the EFH text in the BSAI Groundfish FMP on yelloweye rockfish in more detail. He reported that this species is at the end of its range in the BSAI and are seldom encountered in the fisheries or surveys; further, there was little EFH information included in the EFH text to delete. Jane DiCosimo responded that if the EFH text was removed because the species does not occur in the BSAI, then the species should be removed from the species list in the other rockfish assemblage for the same reason. Bill Clark suggested that a decision should be made first whether the species should be included in the assemblage, and then the EFH text issue should follow that rationale. After the meeting, Paul provided additional information supporting his recommendation to delete the EFH text, but the team did not readdress this issue.

The Team confirmed that the EFH text review was completed and would require FMP amendments and recommended that Council action for nearly all species/complexes as a low priority, except for EFH text amendments for sablefish, Atka mackerel, and skates (additional detail is provided in the attached table). The Team did not provide additional recommendations to the Council on potential candidate sites for HAPC, recommendations for EFH conservation or enhancement.

		Plan Team review			
			Recommendations for Council action		
Species/ complex as identified in BSAI SAFE report	**Species/ complex for which EFH is defined in BSAI FMP**	**Is review complete?**	**FMP amendment?**	**Priority?**	**Other recommendations**
pollock	pollock	Y	Y	L	
pacific cod	pacific cod	Y	Y	L	
sablefish	sablefish	Y	Y	M*	Information added to the EFH description for early juveniles; general information sections; minor updates to the timing of the spawning season; recent fishery information; updated literature sections; ongoing studies identified; research priorities for sablefish identified; HAPC recommendation: small, unobtrusive research closures in areas of extensive and intensive bottom trawling to see whether EFH is being adversely affected; EFH conservation recommendation: more research on the recovery rates of sensitive habitat features and their role in the survival and growth of the early juvenile life stage of sablefish and other species that inhabit those areas.
yellowfin sole	yellowfin sole	Y	Y	L	
greenland turbot	greenland turbot	Y	Y	L	
arrowtooth flounder	arrowtooth flounder	Y	Y	L	
Northern rock sole	rock sole[1]	Y	Y	L	
flathead sole	flathead sole	Y	Y	L	
Alaska plaice	alaska plaice	Y	Y	L	
other flatfish	Rex sole	Y	Y	L	
	dover sole	Y	Y	L	
Pacific ocean perch	Pacific ocean perch	Y	Y	L	
northern rockfish	northern rockfish	Y	Y	L	

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[1] EFH is defined generally for rock sole, not specifically for northern rock sole, and the life history section of the FMP text is written for southern rock sole.

Species/ complex as identified in BSAI SAFE report	Species/ complex for which EFH is defined in BSAI FMP	Plan Team review			
		Is review complete?	Recommendations for Council action		Other recommendations
			FMP amendment?	Priority?	
shortraker rockfish	shortraker/ rougheye rockfish	Y	Y	L	
blackspotted/ rougheye rockfish		Y	Y	L	
other rockfish	yelloweye rockfish	Y	Y	L	
	dusky rockfish	Y	Y	L	
	thornyhead rockfish	Y	Y	L	
atka mackerel	atka mackerel	Y	Y	M*	New information available on: distribution of eggs (nesting sites); habitat, biological, and prey associations for various life history stages; prey information; fishery information; literature references added (substantial); minor change to evaluation of fishing effects text to indicate that stock no longer at peak spawning biomass, although biomass is still relatively high; several research priorities; No indication of substantial changes in fishing activity since the EFH EIS that would affect Atka mackerel EFH
squid	squid	Y	Y	L	
other species	octopus	Y	Y	L	
	sharks	Y	Y	L	
	sculpins	Y	Y	L	
	skates	Y	Y	M*	added info on skate nursery areas and suggested upgrading EFH info level for "eggs" from 0 to 1; updated fishery information; updated contact information; text regarding potential impact of bottom gear on skate nursery habitat; updated relevant literature; research priorities for BSAI skates identified potential for HAPC designation for skate nursery areas, which may affect fishery management
forage fish	forage fish complex	Y	Y	L	

* medium ranking – more information that low ranking EFH amendments, but would **not** warrant a separate, higher ranking amendment package

Compilation of recommendations to authors

- **AFSC stock assessment authors** should conduct a workshop to develop guidance regarding how to decide when a stock qualifies for management under Tier 1.

- The **Pacific cod** assessment should analyze three alternative models for the September 2010 meeting: 1) current Model B1, 2) Model B1 with data-based estimates of aging bias from the radiocarbon study if available, and 3) Model B2 without mean length at age data and with maturity a function of length rather than age.
- The **yellowfin sole** assessment should determine if data (e.g., fishery CPUE) indicate decreasing fishery catch rates, how fishery catch rates compare to survey catch rates, and possible time and area influences on the rates.
- The **flathead sole** assessment should compare survey and fishery catch rates; another suggestion was to focus on spatial and temporal shifts in fishery catch rates.
- The **other flatfish** chapter should examine the time interval of survey biomass estimates used for calculating the Tier 5 recommendations.
- The authors of the **blackspotted/rougheye rockfish** complex should apply the new stock structure template.
- The authors of the **Pacific ocean perch** assessment should model fishery-selectivity as constant within blocks of time that might correspond to significant changes (i.e., switch from foreign fishery to domestic fishery, changes in depth distribution, etc.).
- The authors of the **northern rockfish** complex should apply the new stock structure template.

Next meeting The Team identified several issues, along with others yet to be identified, for the BSAI Plan Team agenda in September 2010:

1) review of spatial management approaches for some rockfish species;

2) issues related to proposed ACL FMP amendments to manage sharks, sculpins, octopuses, grenadiers, and GOA squids;

3) report of workshop on Tier 1 management (could be scheduled during joint team meeting)

4) report of economic subgroup (could be scheduled during joint team meeting)

5) revise summary assignments for November 2010.

Items to be scheduled for a joint discussion with the GOA Plan Team are listed in the November 2009 Joint Team minutes.

Attendance

Agency: Steve Whitney, Obren Davis, Jim Ianelli, Steve Barbeaux, Karla Bush, Craig Faunce, Dana Seagars, Lisa Rotterman, Scott Miller, Steve Davis, Bill Wilson, Neal Williamson, Kalei Shotwell, Stephanie Zador, Patrick Russler, Dan Nichols, Peter Munro, Bob Lauth, Taina Honkalehto, Phil Rigby, Chris Lunsford, Anne Hollowed, Pat Livingston, Ken Goldman, Jennifer Stahl, Karla Bush, Diana Evans, Jack Turnock, Lou Rugolo, Tom Wilderbuer, Teresa A'Mar, Kaja Brix, Beth Matta, Buck Stockhausen, many others. Via Webex :Doug Demaster, Melanie Brown, Cindy Tribuzio, Cara Rogveller, Dave Clausen, Chris Oliver.

Public: Frank Kelty, Jim Hamilton, Dick Curran, Tory O'Connell, Leonard Herzog, Kenny Down, Julie Bonney, Gerry Merrigan, Jan Jacobs, Donna Parker, Dave Wood, Tom Gemmell, Brad Warren, Paul Peyton, Lori Swanson, John Gruver, John Gauvin, Ed Richardson, Paul MacGregor, Anne Vanderhoeven, Jon Warrenchuk, Karl Haflinger, Tim Tuttle, Gary Stauffer, Jim McManus, Ed Melvin, Brent Paine, Glenn Reed, Brad Warren, Tim Thomas, Dave Fraser, Neil Rodriguez, Larson Hunter, Mike Szymanski, Dave Benson, many others

The Team adjourned by 4 pm on Thursday, November 19, 2009.

AGENDA C-3(b)(4)
DECEMBER 2009

TABLE 7a–PROPOSED 2010 AND 2011 APPORTIONMENT OF PROHIBITED SPECIES CATCH (PSC) ALLOWANCES TO NON-TRAWL GEAR, THE CDQ PROGRAM, AMENDMENT 80, AND THE BSAI TRAWL LIMITED ACCESS SECTORS

PSC species and area	Total non-trawl PSC	Non-trawl PSC remaining after CDQ PSQ[1]	Total trawl PSC	Trawl PSC remaining after CDQ PSQ[1]	CDQ PSQ reserve[1]	Amendment 80 sector		BSAI trawl limited access fishery
						2010	2011	
Halibut mortality (mt) BSAI	900	832	3,675	3,349	393	2,425	2,375	875
Herring (mt) BSAI	n/a	n/a	1,697	n/a	n/a	n/a	n/a	n/a
Red king crab (animals) Zone 1[1]	n/a	n/a	197,000	175,921	21,079	98,920	93,432	53,797
C. opilio (animals) COBLZ[2]	n/a	n/a	4,350,000	3,884,550	465,450	2,148,156	2,028,512	1,248,494
C. bairdi crab (animals) Zone 1[2]	n/a	n/a	980,000	875,140	104,860	414,641	391,538	411,228
C. bairdi crab (animals) Zone 2	n/a	n/a	2,970,000	2,652,210	317,790	706,284	667,031	1,241,500

[1] Section 679.21(e)(3)(i)(A)(2) allocates 326 mt of the trawl halibut mortality limit and § 679.21(e)(4)(i)(A) allocates 7.5 percent, or 67 mt, of the non-trawl halibut mortality limit as the PSQ reserve for use by the groundfish CDQ program. The PSQ reserve for crab species is 10.7 percent of each crab PSC limit.

[2] Refer to § 679.2 for definitions of zones.

TABLE 7b-PROPOSED 2010 AND 2011 HERRING AND RED KING CRAB SAVINGS SUBAREA PROHIBITED SPECIES CATCH (PSC) ALLOWANCES FOR ALL TRAWL SECTORS

Fishery Categories	Herring (mt) BSAI	Red king crab (animals) Zone 1
Yellowfin sole	146	n/a
Rock sole/flathead sole/other flatfish[1]	25	n/a
Greenland turbot/arrowtooth flounder/sablefish	12	n/a
Rockfish	9	n/a
Pacific cod	25	n/a
Midwater trawl pollock	1,296	n/a
Pollock/Atka mackerel/other species[2]	184	n/a
Red king crab savings subarea non-pelagic trawl gear[3]	n/a	49,250
Total trawl PSC	1,697	197,000

[1] "Other flatfish" for PSC monitoring includes all flatfish species, except for halibut (a prohibited species), flathead sole, Greenland turbot, rock sole, yellowfin sole, and arrowtooth flounder.

[2] Pollock other than pelagic trawl pollock, Atka mackerel, and "other species" fishery category.

[3] In October 2009 the Council recommended that the red king crab bycatch limit for non-pelagic trawl fisheries within the RKCSS be limited to 25 percent of the red king crab PSC allowance (see § 679.21(e)(3)(ii)(B)(2)).

TABLE 7c–PROPOSED 2010 AND 2011 PROHIBITED SPECIES BYCATCH ALLOWANCES FOR THE BSAI TRAWL LIMITED ACCESS SECTOR AND NON-TRAWL FISHERIES

BSAI trawl limited access fisheries	Prohibited species and area[1]				
	Halibut mortality (mt) BSAI	Red king crab (animals) Zone 1	C. opilio (animals) COBLZ	C. bairdi (animals)	
				Zone 1	Zone 2
Yellowfin sole	162	47,397	1,176,494	346,228	1,185,500
Rock sole/flathead sole/other flatfish[2]	0	0	0	0	0
Turbot/arrowtooth/sablefish[3]	0	0	0	0	0
Rockfish, April 15	3	0	2,000	0	1,000
Pacific cod	585	6,000	50,000	60,000	50,000
Pollock/Atka mackerel/other species	125	400	20,000	5,000	5,000
Total BSAI trawl limited access PSC	875	53,797	1,248,494	411,228	1,241,500

Non-trawl fisheries	Catcher processor	Catcher vessel
Pacific cod-Total	760	15
January 1-June 10	314	10
June 10-August 15	0	3
August 15-December 31	446	2
Other non-trawl-Total	58	
May 1-December 31	58	
Groundfish pot and jig	Exempt	
Sablefish hook-and-line	Exempt	
Total non-trawl PSC	833	

[1] Refer to § 679.2 for definitions of areas.

[2] "Other flatfish" for PSC monitoring includes all flatfish species, except for halibut (a prohibited species), flathead sole, Greenland turbot, rock sole, yellowfin sole, and arrowtooth flounder.

[3] Greenland turbot, arrowtooth flounder, and sablefish fishery category.

TABLE 7d–PROPOSED 2010 PROHIBITED SPECIES BYCATCH ALLOWANCE FOR THE BSAI AMENDMENT 80 COOPERATIVES

Year	Prohibited species and zones[1]				
	Halibut mortality (mt) BSAI	Red king crab (animals) Zone 1	C. opilio (animals) COBLZ	C. bairdi (animals)	
				Zone 1	Zone 2
2010	1754	70,237	1,461,309	304,290	518,898

[1] Refer to § 679.2 for definitions of zones.

TABLE 7e–PROPOSED 2010 PROHIBITED SPECIES BYCATCH ALLOWANCES FOR THE BSAI AMENDMENT 80 LIMITED ACCESS FISHERIES

	Prohibited species and zone[1]				
	Halibut mortality (mt) BSAI	Red king crab (animals) Zone 1	C. opilio (animals) COBLZ	C. bairdi (animals)	
Amendment 80 trawl limited access fisheries				Zone 1	Zone 2
Yellowfin sole	353	5,594	601,032	58,002	142,335
Jan 20-Jul 1	208	5,410	591,926	53,727	114,843
Jul 1-Dec 31	146	184	9,106	4,274	27,492
Rock sole/other flat/flathead sole [2]	218	22,921	85,051	52,053	44,231
Jan 20-Apr 1	174	22,585	82,173	45,921	38,635
Apr 1-Jul 1	20	168	1,511	3,214	2,798
Jul 1-Dec 31	24	168	1,366	2,918	2,798
Turbot/arrowtooth/sablefish [3]	n/a	n/a	n/a	n/a	n/a
Rockfish	49	n/a	n/a	n/a	n/a
Pacific cod	1	168	765	297	819
Pollock/Atka mackerel/other species[4]	49	0	0	0	0
Total Amendment 80 trawl limited access PSC	671	28,683	686,848	110,351	187,385

[1] Refer to § 679.2 for definitions of zones.

[2] "Other flatfish" for PSC monitoring includes all flatfish species, except for halibut (a prohibited species), flathead sole, Greenland turbot, rock sole, yellowfin sole, and arrowtooth flounder.

[3] Greenland turbot, arrowtooth flounder, and sablefish fishery category.

[4] Pollock other than pelagic trawl pollock, Atka mackerel, and "other species" fishery category.

AGENDA C-3
Supplemental
DECEMBER 2009

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November 24, 2009

Chairman Eric A. Olson
Executive Director, Chris Oliver
North Pacific Fisheries Management Council
605 West 4th, Suite 306
Anchorage, AK 99501-2252

Subject: **December 2009 NPFMC Meeting.**

Comments for Scientific and Statistical Committee

Agenda Item C-3
Groundfish Final Catch Specifications
BSAI Pacific Cod

Dear Chair Livingston and SSC Committee Members,

Attached you will find a copy of Dr. Mark Maunders report on the November Plan Team meeting concentrating on the BSAI Pacific cod assessment as presented by Grant Thompson and deliberated by the September and November Plan Team.

Our simple request this year is that we take the time necessary at the SSC committee during the December meeting to consider several issues Dr. Maunder illuminates in his report. While I do not expect any of these issues to be overly time consuming, it is of paramount importance to our members that the process of improving the assessment continues and hopefully soon lands on a base model that can be agreed upon and moved forward year to year.

Both Dr. Maunder and I will be available in Anchorage and will be in attendance at the SSC meetings. We plan to make public comments on the current year's assessment with Dr. Maunder focusing on the scientific modeling approach and some of the ongoing issues with the assessment. On behalf of the FLC members I will offer some helpful observations from the fishery and some historical notes on the process since the 2006 Pacific cod modeling workshop.

It remains our full intention to help in this process, especially in beginning to narrow the field of alternative models and ongoing requests that have intensified the process and unfortunately resulted in an over laborious yearly procedure for both industry and scientific staff.

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COALITION

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Bering Sea Pacific Cod November Plan Team Report

The assessment author presented several alternative models to the Plan Team. These models were generally related to requests by the Plan Team, SSC, and public. However, the stock assessment author also made additional decisions about the data and assumptions used in the models. The models were grouped into three categories 1) models similar to the model used in the 2008 assessment; 2) Models containing the main suggestions from the Plan Team and SSC; and 3) models from category 2 without the age composition data. The main suggestions from the Plan Team and SSC that were included in categories 2 and 3 were a) a correction for the potential bias in age readings, b) survey selectivity is held constant at base values for the two most recent years, c) growth rates are cohort-specific, and d) catchability over the appropriate sizes fixed at the estimates from the tagging data. Mean size-at-age data were also included in these models to aid in the estimation of cohort specific growth. The variations of models included modifications related to survey catchability, 2008 fishery age composition data, selectivity of the old individuals, and temporal variability in survey selectivity.

The Plan Team was divided between using or not using the age data. This division was further complicated by the fact that the models in category 3, which did not include the age composition data, still included the mean size-at-age data. There was no model that did not use the age data in any way and also included the desirable characteristics suggested by the Plan Team and the SSC (e.g. cohort specific growth). Model F2, which we had requested in this and previous assessments, relied least on the age data, but it did not include the Plan Team and SSC suggestions. Due to the disagreement among the Plan Team members, a vote was taken to determine which model should be used. The vote was limited to three models, A2 (last years model with no age composition data), B1 (the assessment authors preferred model), and B2 (B1 without the age composition data, but this model still included the mean size-at-age data). There were eight votes for model B1, five for A2 and none for B2. Therefore, B1 was chosen as the assessment model.

Using the age data

We have argued for several years that the evidence suggests that the aging data is biased and should not be used in the assessment until the issue has been resolved. A presentation at the September Plan Team provided additional evidence that the age data may be biased. There are several augments against using the age data in the assessment model.

1) The explicit inclusion of a correction factor for aging bias in the assessment model and the request by the Plan Team to include the bias correction factor provides recognition that there is an issue with the aging data.

2) The fit to the mean size-at-age data is better when no age composition data is included (B2) compared to when the age composition data is included (B1). This indicates an inconsistency between the age composition data and the mean size-at-age data.
3) The effective sample size estimated for the age composition data is lower than assumed in the model indicating that the age composition data should be further down weighted.
4) The 2008 fishery age data has larger size at age than the survey age data even though it is collected five months earlier.
5) The assumption about the variation of length at age is much less influential if both the age composition and mean size-at-age data are removed from the analysis (results obtained by rerunning the models).

Mean size-at-age data

The assessment author added the mean size-at-age data into the assessment model to provide information on cohort specific growth. This was done because length composition data was removed from the analysis for years in which there is age composition data, and without the length composition data, there is no information on growth for those years.

The influence of the mean size-at-age data is dependent on the sample sizes assumed for the data. No effective sample size estimates were presented so it is not clear if the assumed sample sizes are reasonable. However, since the likelihood is based on a normal distribution with the standard deviation inversely proportional to the sample size (see the SS technical manual) it is likely that some of the sample sizes, which are in the hundreds, have too much influence on the results. Confounding this is the fact that very little in SS can change the mean length at age because length at age is assumed to be normally distributed around the mean length at age. Two factors are the growth parameters and size specific selectivity for the gear that the samples come from. The survey selectivity is age-based and should not influence the fit to the mean size-at-age data. The longline fishery selectivity is length based and there is one year of mean size-at-age data for this fishery. Unfortunately, there is no model run without the mean size-at-age data for the longline fishery. Rerunning the model without the 2008 mean size-at-age data for the longline fishery showed that it had little influence on the abundance estimates, but may be more pessimistic for ABC calculations.

Aging error (bias and/or variance) can cause the predicted mean size-at-age to be influenced by other model parameters. Because the predicted mean size-at-age that is compared to the observed mean size-at-age is a combination of multiple age classes due to the aging error, any model parameter that changes the proportions at age can influence the predicted mean size-at-age. Therefore, the mean size-at-age data from the survey can essentially influence the estimate of any model parameter. Rerunning the model without any age composition data and mean size-at-age data (i.e. modifying B2 to ignore the mean size-at-age data) produces results that appear more optimistic.

Since the model only allows cohort specific growth, the amount of temporal variability in mean size-at-age is restricted. Therefore, the model will try to explain changes in mean size-at-age by changing other model parameters, which may bias the results. It might be more appropriate to allow for annual variation in size-at-age. Complete freedom in mean size-at-age could cause shrinkage in size as fish age, which is not realistic. SS is formulated so that shrinkage can not occur and only allows temporal variation in mean size-at-age through temporal variation in model parameters (although there is an option for mean weight-at-age to be directly input). More research is needed to determine if the temporal variation in growth is better represented by cohort specific growth, temporal variation in the growth model parameters, or some other representation of growth variability.

When mean size-at-age data is included in the model, the fit to the data (measured by the likelihood) is very sensitive to the assumptions about the variation of length at age. Changing from the standard deviation as a function of mean size-at-age (B1) to the CV being a function of mean size-at-age caused a reduction of over 500 negative loglikelihood units (results obtained by rerunning the models). This is a massive improvement in the fit to the data and indicates that the mean size-at-age data is over weighted. The over weighting of the mean size-at-age data is corroborated by the fact that the Pearson residuals are generally higher for the mean size at age data than for the other data. There is also a substantial pattern in the residuals across age that is consistent over time. The observed mean size-at-age is always higher for the large fish than the model estimates.

There may be more appropriate ways to include information about growth in the stock assessment model. For example, the data could be included as age conditioned on length and length composition data rather than age composition and mean size-at-age. Including both age and length composition data at the same time may be duplication of data, but the bias may be minimal if the number of fish aged is substantially smaller than the number of fish measured for length. If I remember correctly, previous efforts to include the conditional age at length data were problematic. However, the model has changed somewhat and the issues may have been resolved.

Aging bias correction

The assessment author estimated a bias correction to the aging data. This was achieved by running the model multiple times under different assumed aging error biases for each age. The assessment author found that a constant aging error of 0.4 for all ages 2 and older was best. The model already has a variance component to the aging error. It is not clear if the variance should be adjusted to account for the aging bias. For example, if all fish were aged 0.4 years older than they actually were, adjusting the aging bias may be appropriate. However, if only 40% of the fish were aged one year older than they really were, this may mean that the variance of the aging error should also be increased and the aging error would not be normally distributed as assumed in stock synthesis.

There are two types of age based data included in the assessment model, the age composition and the mean size-at-age. The correction for the aging bias may adjust better for one type of age based data than the other. For example, the aging bias correction may line the mean size-at-age data up with the modes of the length composition data, but may not appropriate distribute the data among the ages to fit to the age composition data.

Previous assessment models have been able to fit both the modes in the length composition data and the age composition data. These fits were achieved when the fishery selectivities were changed to length based and the survey was included in numbers rather than biomass. Therefore, adding the aging bias did not improve the fit to the age composition data as much as would have been expected. If there is really a problem with the aging data other parameters in the model may have been compensating for the bias in previous assessments.

Age information is used in other components of the model. For example, the age data is used to determine the age at maturity and the fixed value of natural mortality is based on estimates using the age at maturity. It may be better to use maturity at length and natural mortality based on length at maturity. The variation of length at age is calculated outside the model based on the age data and perhaps it should be estimated inside the model or outside the model based on the length composition data.

Biomass projections

The ABC calculations are based on the tier 3b harvest rule that reduces the fishing mortality rate because the spawning biomass is below $B_{40\%}$ (40% of the unexploited spawning biomass). However, due to the estimated recent strong recruitments, the spawning biomass will be above $B_{40\%}$ in 2013 even if the OFL fishing mortality (F_{OFL}) is applied (Figure 1; see table 2.31 of the assessment report). The spawning biomass is projected to be very close to B35% by 2011 under F_{OFL}. The catch from applying F_{OFL} is 205,000 t in 2010 (much higher that the 174,000 ABC from model B1) and even higher in later years (Figure 1). The projections do not take parameter uncertainty into consideration, but do take future recruitment variability into consideration. Therefore, the uncertainty will be under estimated. Keeping this in mind, the lower bound for spawning biomass in 2013 is also above $B_{40\%}$.

CPUE

There is a consistent pattern in the fishery CPUE data for many of the fisheries. Six of the CPUE series have CPUE in 2009 higher than it has been for several years and one is higher than several recent years except for 2008 (Figure 2). The halibut survey has also been trending up in recent years. The exceptions are the Jun-Aug longline CPUE, which has very little effort, and the Sep-Dec longline CPUE. The CPUE is related to the vulnerable biomass for the respective fisheries. The assessment document does not provide the vulnerable biomass for each fishery. It only provides the zero plus and the spawning biomass. Both of these have been declining over the past few years and only the age zero plus biomass is projected to increase in 2010. There is a striking inconsistency with most of the CPUE data and the model estimates of abundance. It should be noted that the Jan-May longline CPUE data has been consistently increasing since 2003 and that the 2008 age data for this fishery indicates a high abundance of age 6 individuals (2002 year class), which is not in the survey age data. This large cohort is also consistent with modes in the length frequency data from earlier years (Figure 3). The increasing CPUE may be due to this age class.

The survey index goes up in 2009. However, this is due to age one fish that are generally not vulnerable to the fisheries.

It also should be noted that the the root mean square error of the fit to the CPUE and halibut survey indices for B1 is worse (higher) for most gears than all the other "1" models.

This vulnerable biomass relates to the ABC through the application of the fishing mortality rate to the vulnerable population. If the CPUE is increasing for the majority of fisheries, the ABC would be expected to also increase given the same levels of fishing mortality.

Natural mortality

It might be appropriate to estimate the natural mortality inside the stock assessment model now that there is a bias correction factor for the aging error. The estimate of natural mortality using model B1 is 0.36. This is higher than the value used in the current assessment (0.34). If both catchability and natural mortality are estimated, natural mortality is estimated much higher (0.44) and catchability is estimated lower.

The value currently used for natural mortality is based on the age at maturity and since the aging data is biased this value should be reevaluated.

Age specific natural mortality should be reconsidered given the changes in the model.

Requested models

The assessment process allows for public input into the development of the stock assessment model. In particular, the public are allowed to request that the stock assessment models be run with certain specifications. The requested models will be run if possible given the limited time available. We requested that the assessment author modify the authors preferred model using these scenarios:

1) Conduct a model run with catchability fixed at the best value estimated from the tagging data.
2) Conduct a model run using the -999 special setting for the selectivities at the oldest ages/sizes.
3) Using cohort specific growth
4) Using cohort specific growth and turning off the temporal deviates in selectivity for the survey

We also requested that all model runs (the ones suggested above and the ones conducted by the assessment author) be repeated with the age data removed (and the appropriate length data added)

Finally, we requested that Model F2 presented at the 2008 November Plan Team Meeting be repeated with updated data.

The stock assessment author ran all the models that we requested.

The process of deciding on which models should be requested is complicated by the fact that the public does not know what the stock assessment author will propose as his preferred model until after the deadline for requests. The stock assessment author may, as was the case this year, decide to make an assumption or include a data set that was not done in previous assessments. This year the stock assessment author included mean size-at-age data in the model to provide information on cohort specific growth. We requested model runs without the age composition data because we believe the aging to be biased and if we had know that the mean size-at-age data was to be used in the model we would have requested that the model runs also eliminate the mean size-at-age data.

The stock assessment model changes substantially from year to year and even from the September Plan Team meeting to the November Plan Team meeting. These changes cause substantial work for the stock assessment author and make it difficult for the public to develop the appropriate requests for model runs. It is not possible to request model runs with alternative assumptions during the Plan Team or SSC meetings even if such a request would greatly improve the model or the understanding of the model. It would be preferable if the model structure was decided upon before the September Plan Team meeting or at least the number of candidate models reduced. Developing the most appropriate model requires several iterations between running model suggestions and viewing results and needs input from several experts to cover all aspects of the model. It would be beneficial to have some form of workshop or review before the September Plan Team to develop and run multiple model configurations to achieve the above.

Other points

The 2006 year class is estimated by the 2009 survey to be about 30% smaller compared to the previous survey.

Fixing the selectivity for the max age/length at a common value fit the data better than the -999 option. Both of these models had some problematic looking selectivity patterns at old ages. In contrast, the full double normal appeared to behave well.

The length data is generally underweighted, some fisheries more than others.

Estimation of the catchability of the pre 1982 survey did not influence the results. Estimation of the catchability of the post 1981 survey did influence the results and it was estimated higher than in the current assessment.

The model is not sensitive to fitting to equilibrium catch.

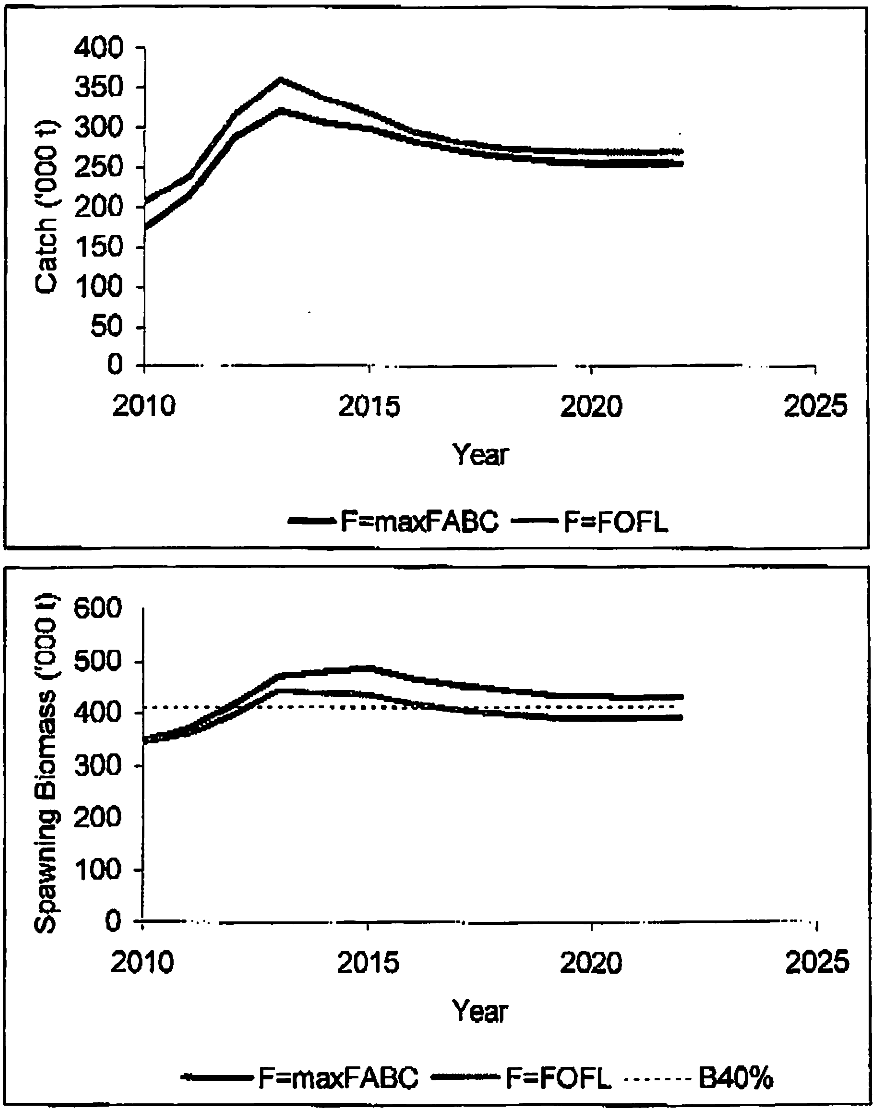

Figure 1. Mean catch (top) and spawning biomass (bottom) projected under a F_{OFL} level.

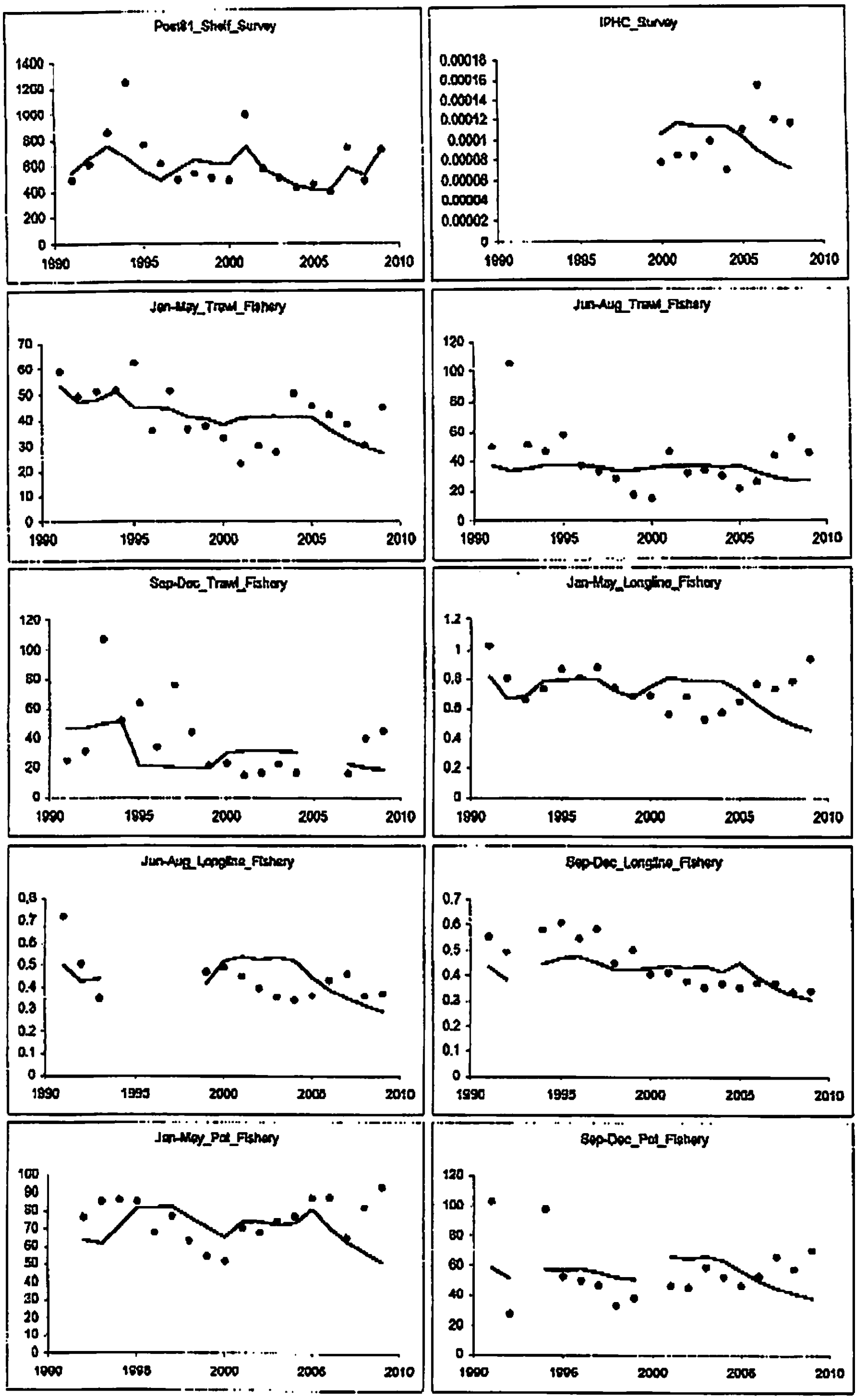

Figure 2. Model B1 fit to the survey and CPUE indices of abundance (points are observations and lines are model estimates).

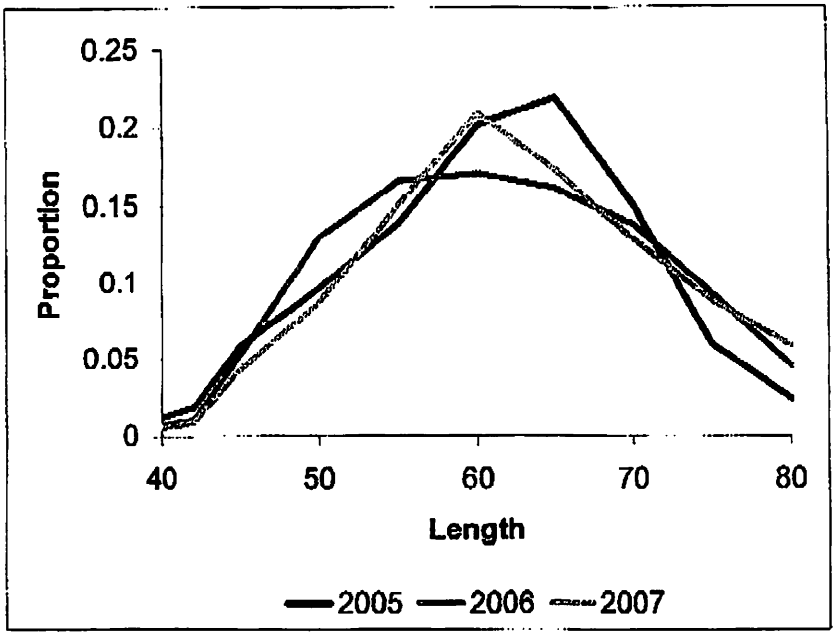

Figure 3. Jan-May longline fishery length composition showing the increase in the young individuals as the 2002 year class enters the fisher at age 4 (about 55cm) in 2006 and grows to 60 cm in 2007.

PUBLIC TESTIMONY SIGN-UP SHEET

Agenda Item: C-3(b) BSAI Specs

	NAME (*PLEASE PRINT*)	TESTIFYING ON BEHALF OF:
1	> Jon Warrenchuk	Oceana handout
2	Ed Richardson, Brent Paine, Lori	Swanson - Industry
3	George Pletnikoff	Greenpeace
4	dave fraser	ACDC
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NOTE to persons providing oral or written testimony to the Council: Section 307(1)(I) of the Magnuson-Stevens Fishery Conservation and Management Act prohibits any person " to knowingly and willfully submit to a Council, the Secretary, or the Governor of a State false information (including, but not limited to, false information regarding the capacity and extent to which a United State fish processor, on an annual basis, will process a portion of the optimum yield of a fishery that will be harvested by fishing vessels of the United States) regarding any matter that the Council, Secretary, or Governor is considering in the course of carrying out this Act.

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December 7, 2009

Mr. Eric Olson, Chair
North Pacific Fishery Management Council
605 W. Fourth Avenue, Suite 306
Anchorage, AK 99501-2252

Mr. Doug Mecum, Regional Administrator
National Marine Fisheries Service
709 W. Ninth Street
Juneau, AK 99802-1668

RE: Agenda Item C-3 Groundfish Final Catch Specifications

Dear Chairman Olson and Mr. Mecum:

We remain concerned that the National Marine Fisheries Service and North Pacific Fishery Management Council are failing to ensure enough pollock remain in the Bering Sea to spawn, rebuild the pollock stock, provide prey for endangered Steller sea lions and Northern fur seals, and provide for an ecologically sustainable pollock fishery.

With the pollock spawning biomass at very low levels, the uncertainty that the biomass is at or below B20 must be fully evaluated. Fishing must stop if biomass is predicted to fall below 20% of the unfished spawning biomass of important Steller sea lion prey.[1] To comply with this provision, enough prey must be available during critical periods for sea lions, including during the winter. A spawning biomass of B20 is the proxy for the absolute minimum prey biomass, at any time, which can support Steller sea lions without causing jeopardy. However, it is uncertain whether NMFS is meeting these requirements. To date, NMFS has only reported a single point estimate of spawning biomass for sea lion prey stocks. This estimate is only applicable for the single calendar day for which it is estimated. The spawning biomass at all times of the year, including during the critical winter period, are not estimated, measured, or projected. There is considerable risk that pollock biomass is dropping below a level that causes jeopardy. To fully evaluate the risk of jeopardy, NMFS must include and account for estimates of spawning biomass throughout a calendar year, taking into account fishery removals, and should depict these estimates graphically.

Further, there is no generally accepted method for estimating unfished biomass, which provides the reference point for the B20 rule. Rather, the methods for estimating the unfished biomass vary among stock assessments. Different methods appear to be used depending on availability of data and convenience of fit to data. To date, NMFS has estimated unfished Eastern Bering Sea pollock biomass based on a stock recruitment relationship. This has resulted in a steadily lower shifting unfished biomass baseline, and lower associated B20 threshold. A more conservative approach may be to estimate the unfished biomass from average recruitment. In addition, estimates derived from average recruitment may be a more robust reference point in some cases.[2] To resolve this issue, B20 should be calculated using requirements similar to Amendment 56,

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[1] *See* 50 C.F.R. § 679.20(d) (4).

[2] Haltuch, M.A., A.E. Punt, and M.W. Dorn. 2009. Evaluating the estimation of fishery management reference points in a variable environment. Fisheries Research (100): 42-56.

which evaluates scenarios based on several harvest scenarios and uses the management thresholds predicted from average recruitment.

Last year's stock assessment was markedly inaccurate in its predictions. This year's trawl survey, echo integration survey, fishery catch and resultant updated stock assessment now estimate the 2009 spawning biomass to have been 20% lower than was predicted (Table 1). While this estimate did fall within the lower bounds of the confidence intervals, the overestimation of spawning biomass over that last three years of declining abundance is cause for concern (Table 1).

Table 1: Decreases in spawning biomass estimates

		Hindsight change in current year's estimate of spawning biomass due to updated information
change in spawning biomass estimate from previous year's stock assessment	2009	-19.5%
	2008	-9.4%
	2007	-10.3%

We understand that predictive models are difficult to develop and that predictions may be marked with uncertainty. The stock assessment authors do caution that the Tier 1b harvest control rule results in extreme sensitivity to model uncertainty. Nonetheless, a review of assumptions within the model that may be causing an overestimation bias should be undertaken.

In addition, the fishing mortality on the prime ages of spawning pollock in the Eastern Bering Sea is well above the long-term average, which means that the remaining prime spawners of the stock are under extraordinary fishing pressure. For pollock aged six to nine, estimated fishing mortality is at the highest level observed in 31 years (Table 2).

Table 2: Percent of pollock age class removed by fishery

age class	**2009**	**mean 1978-2009**
1	0.0%	0.0%
2	0.3%	0.6%
3	3.7%	3.8%
4	**16.8%**	9.7%
5	**29.4%**	16.1%
6	**38.9%**	21.4%
7	**38.1%**	23.3%
8	**37.1%**	23.1%
9	**36.3%**	22.9%
10+	**18.0%**	13.1%

Table 2 is calculated from *October 2009 Plan Team Draft Assessment of the walleye pollock stock in the Eastern Bering Sea,* Table 1.20 *Estimates of numbers at age for the EBS pollock stock as estimated in 2009* and Table 1.21 *Assessment model-estimated catch-at-age of EBS* *pollock.* Shaded cells indicate age classes in 2009 whose fishing mortality was the highest observed in 31 years.

These larger, older pollock are the most fecund, productive age classes of pollock, which may be key to successful recruitment, and a diminishing proportion is able to survive the fishing season to spawn. A recent meta-analysis of 25 marine fish species, including pollock, showed strong maternal effects of larger and older fish on recruitment.[3] The winter pollock fishery harvests a sizable proportion of the remaining pollock spawners and will significantly diminish the contribution of quality spawners to recruitment.

The North Pacific Fishery Management Council needs better information to make an informed decision about the risks of current and proposed fishing activities on Steller sea lions and the Eastern Bering Sea pollock spawning biomass. Unless and until such information is brought forward, the NPFMC should authorize only the most conservative harvests of prey important to Steller sea lions in 2010.

We look forward to reviewing the forthcoming stock assessments, ecosystem considerations and biological opinion and working with you to maintain the health, productivity, and biodiversity of the North Pacific marine ecosystem while maintaining fishing opportunities and vibrant coastal communities.

Sincerely,

Jim Ayers

Jim Ayers,
Vice President, Oceana

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[3] Venturelli, P.A., B.J. Shuter, and C.A. Murphy. 2008. Evidence for harvest-induced maternal influences on the reproductive rates of fish populations. Proc. R. Soc. B (276): 919-924.

An independent review of the Assessment of the walleye pollock stock in the Eastern Bering Sea

Steven Martell

December 4, 2009

Summary of findings

This is an independent review of the assessment of walleye pollock in the Eastern Bering Sea. The following bullet points summarize the findings of this review.

- This review focuses on the methods that were used to obtain the reference points that are used to define the harvest control rule, and is not a critic of the harvest control rule or management objectives for this fishery.
- The tier 1b harvest control rule requires estimates of F_{MSY}, B_{MSY} (reference points), and projections of spawning stock biomass and vulnerable biomass, as well as associated measures of uncertainty. There are ample data available to estimate these reference points; however, a large number of assumptions are required to make use of these data.
- This years assessment model has changed considerably over last years assessment in that 100s of additional parameters have been added to the model, the prior distribution for steepness has changed, and the sample sizes for the age-composition data have been down weighted. All of these changes are likely to increase statistical uncertainty and increase estimates of the optimal fishing mortality rate (F_{MSY}).
- Despite the increase in model complexity (as measured by the number of estimated parameters), estimates of statistical uncertainty are slightly less than expected from statistical theory. This increase in certainty may be attributed to the recent contrast available in the data that is associated with below average recruitment in the last few years.
- Estimates of reference points are sensitive and confounded with other model parameters that are estimated independently (i.e., natural mortality and maturity-at-age). Maturity-at-age data is relatively easy to obtain and can be measured reliably. Estimate of natural mortality, however, are much more difficult to obtain. Furthermore, uncertainty in natural mortality is not incorporated into the stock assessment and as such estimates of uncertainty in reference points are too precise. This implies that the harmonic mean of F_{MSY} is likely biased upwards and ABC calculations are also biased upwards.
- There are a very large number of selectivity parameters estimated in this model, and these parameters are only estimable if a very informative prior (or penalty weights) on the variability in selectivity is specified. These priors appear to be *ad hoc*. Sensitivity to changes in these penalty weights should be examined to determine the potential policy influence of these ad hoc priors.
- There is a strong confounding between estimates of recruitment in recent years and how selectivity of younger fish changes in time. It takes several years (2-4) to reliably determine how large and how vulnerable a cohort is. A less informative prior for steepness and or reduced sample sizes for age-composition data in the terminal year may increase the projected uncertainty biomass forecasts to a more reasonable level.

1 Executive Summary

This is a review of the methodology and assumptions used in reconstructing the abundance and status of walleye pollock in the Eastern Bering sea in 2009 as reported by Ianelli et al. (2009). In this review I focus on the variables that define the harvest control rule that is used for determining the Acceptable Biological Catch (ABC) each year. In short, the harvest control rule requires estimates of $\mathrm{F_{MSY}}$, $\mathrm{B_{MSY}}$ (also referred to as MSY based reference points) and a projected estimate spawning stock biomass (B_t) in 2010 in order to determine the fishing mortality rate to apply to the projected biomass that is vulnerable to fishing. The harvest control rule also takes into consideration the uncertainty in $\mathrm{F_{MSY}}$ and to a lessor extent B_t. The MSY based reference points ($\mathrm{F_{MSY}}$ and $\mathrm{B_{MSY}}$) are estimated by first fitting a dynamical statistical catch-age model to time series data on relative abundance (e.g., commercial CPUE and fisheries independent surveys) and to composition information (age and size) from commercial samples and fisheries independent (or scientific) survey data. The estimated parameters of this model, along with other structural assumptions (e.g., a Ricker type stock recruitment model) are then used to derive reference points (e.g., $\mathrm{F_{MSY}}$) based on equilibrium considerations.

A total of 772 model parameters were estimated in the 2009 assessment of EBS pollock. This is a very large number of estimated parameters in comparison to the majority of stock assessments conducted in the western US. The statistical criterion or objective function that is used to estimate model parameters contains at least 13 major components (of which only 6 were carefully reviewed in this document) to deal with the vast amount of available information for EBS pollock. Given the level of structural complexity built into this model and the various types of data available, a large number of assumptions regarding the variability in observation and process errors were made in order to proceed with parameter estimation (i.e., these variance components are not estimable in a mixed error model such as this). Furthermore, a number of model parameters that are key in defining the productivity of the stock (e.g., natural mortality and maturity at age) were estimated independently and uncertainty in these parameters are not integrated into the model. Therefore, uncertainty in MSY based reference points and the stock status is likely to be biased. Of the six components of the objective function that I had time to examine, I did not find any major discrepancies between the functions described in the text and what is actually computed in the computer code that would cause any serious bias in the model results.

Estimates of $\mathrm{F_{MSY}}$ and $\mathrm{B_{MSY}}$ are sensitive to the independent estimates of natural mortality (M) and maturity (or fecundity). Increases in natural mortality lead to increase in $\mathrm{F_{MSY}}$, and vice versa. The authors of the assessment model have used lower values of M in comparison to other findings from multispecies models; this appears to be conservative. However, natural mortality is normally confounded (usually positively correlated) with estimates of unfished biomass (or unfished recruitment). Unfished biomass and the steepness parameter of the stock recruitment relationship are usually negatively correlated. Therefore, if the assumed values of M are too low, then estimates of unfished biomass may be biased downward and/or estimates of steepness may be biased upwards. In the case of fecundity-at-age schedules, estimates of $\mathrm{F_{MSY}}$ increase if fish mature earlier, assuming that the selectivity of the fishery remains the same. If the fishery selectivities change such that all sexually mature fish are vulnerable to the fishing gear, then estimates of $\mathrm{F_{MSY}}$ decrease. Critical to the establishment of reasonable estimates of MSY reference points is the ability to reliably estimate selectivity-at-age.

Other changes to the assessment model that would affect estimates of reference points include changes to the prior distribution for steepness. In the previous two assessment years (2007 and 2008) the assumed prior for steepness had a mean and CV of 0.45 and 0.15, respectively. In this year's assessment, this has increased and become more precise (mean 0.6 and CV of 0.12). This change would imply an increase in the estimate of F_{MSY}. Also, in the most recent assessment selectivity in all gears was assumed to change on an annual basis rather than every 2 years. This increases the number of estimated fishing mortality parameters from 276 in 2008, to 507 in 2009. This increase in the number of estimated parameters would not necessarily change the maximum likelihood estimate of F_{MSY}, but it would increase the uncertainty of reference points if the assumed standard deviations in selectivity parameters remained the same between the two assessment models. Although an increase in certainty in the estimates of B_{MSY} appears to have occurred between the 2008 and 2009 assessments (CV of 24% and 20% in 2008 and 2009, respectively, see Tables 1.18 in the assessment documents). Finally, a new diagnostic tool for evaluating the effective samples sizes in the age-composition data appears to be new in this years assessment. The net results appears to be a slight decrease in the effective sample size for all gears, with exception of the 2007 samples in the fishery data where it increased from 364 in the 2008 assessment, to 408 in 2009 assessment. Sample sizes for the BTS survey remain unchanged and a slight decrease to 51 from 55 in the EIT survey. The net result of reducing the effective sample size would place more weight on other sources of data (i.e., trends in CPUE and survey abundance) and would also increase the uncertainty in estimates of selectivity parameters.

Overall, the complexity of the model has increased (in terms of the number of estimated parameters) in comparison to last year's assessment, but the overall uncertainty appears to remain the same or has even decreased slightly. This contradicts much of the statistical theory. The prior for steepness has become more informative in comparison to previous assessments; this increase in prior information could influence the overall estimates of uncertainty. Retrospective analysis is a common tool for evaluating potential performance of an assessment model and data weighting schemes; there does not appear to be any significant retrospective bias in the assessment model (see Figure 1.23 in Ianelli et al., 2009). However, in recent years there has been a slight upward retrospective bias with past assessment models (see Figure 1.34 in Ianelli et al., 2009); with the most recent assessment resulting in lower estimates of age 3+ abundance. Estimates of selectivity parameters in the most recent year are critical for determining reference points, yet these parameters are highly uncertain until each cohort has been in the fishery for several years. Retrospective estimates of selectivity parameters should also be presented to look for potential confounding between changes in fishing practice (or areas fished) and the relative strength of new cohorts that are just recruiting to the fishery.

2 Introduction

Catch advice for the Eastern Bering Sea (EBS) walleye pollock fishery is based on a tier 1 harvest control rule (Figure 1a). Calculating the Acceptable Biological Catch (ABC) proceeds by estimating the reference points $\mathrm{B_{MSY}}$ and $\mathrm{F_{MSY}}$ (which are defined as the spawning stock biomass level that produces the maximum sustainable yield, respectively) by fitting an integrated statistical catch-at-age assessment model to time series information from the EBS walleye pollock fishery (hereafter, EBS pollock). In addition to reference points, short-term predictions (1-2 years) about biomass are required to calculate ABC in the upcoming fishing season. Given an estimate of the projected spawning stock biomass relative to the level associated with $\mathrm{B_{MSY}}$, the harvest control rule then assigns a fishing mortality based on the projected status of the spawning stock biomass. If the spawning stock biomass is greater than $\mathrm{B_{MSY}}$, the fishing mortality rate is set at the $\mathrm{F_{ABC}}$ level (defined as the harmonic mean from the marginal posterior distribution for $\mathrm{F_{MSY}}$). If the spawning stock biomass is less than $\mathrm{B_{MSY}}$, the prescriptive fishing mortality rate declines linearly to 0 when the spawning stock biomass is at 5% of the $\mathrm{B_{MSY}}$ level (Figure 1a). The catch advice for any given year is given by the corresponding fishing mortality rate multiplied by the predicted vulnerable biomass; if the spawning stock biomass is greater than $\mathrm{B_{MSY}}$ then catch is roughly proportional to the vulnerable biomass. If the spawning stock biomass is less than $\mathrm{B_{MSY}}$, then catch declines at a much faster rate (Figure 1b). Based on uncertainty in the estimates of $\mathrm{F_{MSY}}$, the target harvest level should be less than MSY.

The key to successfully implementing this harvest policy for pollock is the ability to estimate the reference points $\mathrm{B_{MSY}}$ and $\mathrm{F_{MSY}}$ as well as predict spawning stock biomass and vulnerable biomass 1-2 years into the future. The harvest control rule is defined as:

$$\begin{aligned}
\mathrm{ABC} &= \acute{B}\hat{\mu}\zeta \\
\acute{B} &= \exp(\ln(\hat{B}) - 0.5\sigma^2_{\hat{B}}) \\
\hat{\mu} &= \exp(\ln(\mathrm{F_{MSY}}) - 0.5\sigma^2_{\mathrm{F_{MSY}}}) \\
\zeta &= \begin{cases} \dfrac{B_t/\mathrm{B_{MSY}} - 0.05}{1 - 0.05} & B_t < \mathrm{B_{MSY}} \\ 1 & B_t \geq \mathrm{B_{MSY}} \end{cases}
\end{aligned} \tag{1}$$

where $\acute{B}$ is the point estimate of the predicted fishable biomass (and its associated variance $\sigma^2_{\hat{B}}$), B_t and $\mathrm{B_{MSY}}$ are the point estimates of the spawning stock biomass in year t and at equilibrium $\mathrm{F_{MSY}}$ (and its associated uncertainty $\sigma^2_{\mathrm{F_{MSY}}}$).

The focus of this review is to evaluate the assumptions in estimating the variables that define the harvest control rule and estimates of current stock size. Specifically, if assumptions are violated (e.g., mis-specification of the instantaneous natural mortality rate) how would this alter the catch advice in any given year? This review is **not** intended to evaluate how robust the harvest control rule is to management objectives (see A'mar et al., 2008, for discussion on this topic). In this review I first consider the assumptions in deriving reference points that define the harvest control rule. Second, I consider parameter estimation and the implications for estimating current stock size and forecasting future abundance.

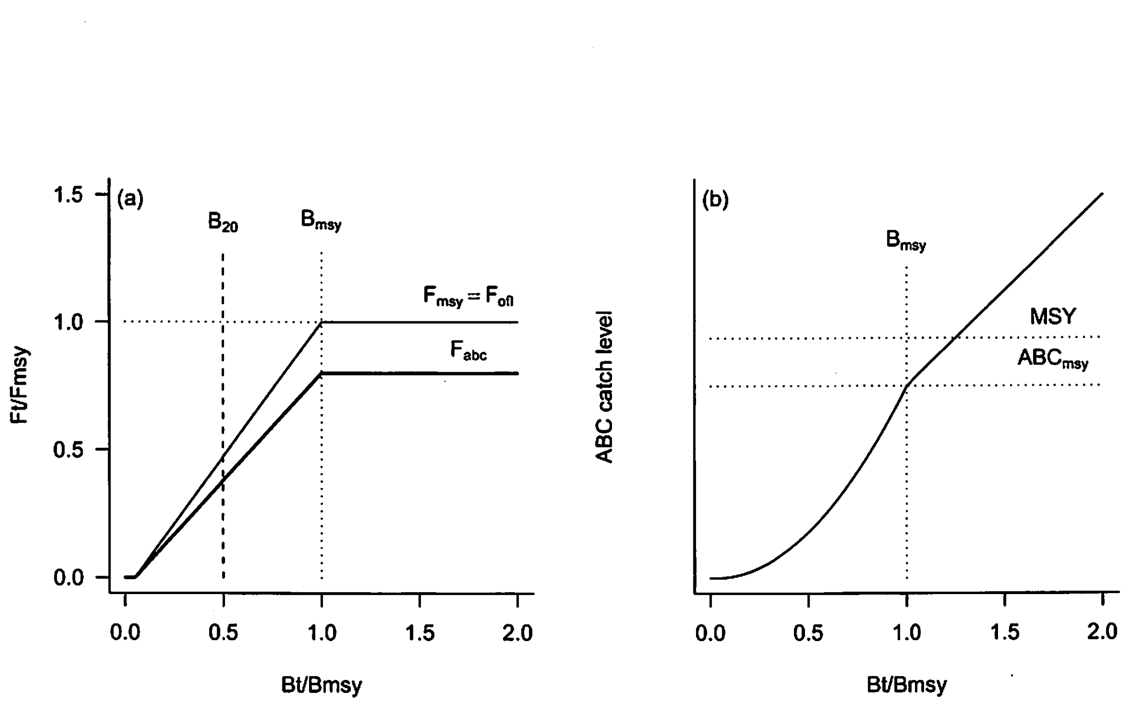

Figure 1: Harvest control rule (a) used for estimating annual catch advice in the EBS walleye pollock fishery and the corresponding ABC catch level (b). The over-fishing-limit $\mathrm{F}_{\mathrm{OFL}}$ and $\mathrm{F}_{\mathrm{ABC}}$ are defined as the geometric mean and the harmonic mean of the marginal posterior distribution for $\mathrm{F}_{\mathrm{MSY}}$, respectively.

3 Analytical methods for obtaining reference points

The variables used in the Tier 1b harvest control rue include: the spawning stock biomass ($\mathrm{B}_{\mathrm{MSY}}$) at which yield is maximized, the fishing mortality rate ($\mathrm{F}_{\mathrm{MSY}}$) require to achieve the maximum yield, a current estimate of the spawning stock biomass (B_t), and the variances associated with spawning stock biomass and fishing mortality rates ($\sigma^2_{\hat{B}}$ and $\sigma^2_{\mathrm{F}_{\mathrm{MSY}}}$). Estimated parameters that are required to derive these reference points include: natural mortality, unfished age-1 recruits (R_o), the steepness of the stock recruitment relationship, fecundity, weight and selectivity age-schedules. In the following sub-sections, I will examine how the potential catch advice would vary if, for example, we assumed the wrong natural mortality rates or over-estimated the steepness of the stock recruitment relationship. An equilibrium age-structured model is used to demonstrate the sensitivities of reference points to alternative assumptions; a series of four figures (e.g., Figure 2). The age-structure model uses the same age-specific natural mortality, maturity-at-age, and approximate weights-at-age and selectivities (for future years, Figure 1.26 in Ianelli et al. (2009)) provided in the most recent stock assessment document.

3.1 Relationship between $\mathrm{F_{MSY}}$, $\mathrm{B_{MSY}}$ and model parameters

The mathematical procedure used for obtaining estimates of $\mathrm{F_{MSY}}$ and $\mathrm{B_{MSY}}$ from the integrated model is documented in Ianelli et al. (2001). In summary this method consists of calculating the equilibrium yield (Equation 2) for a given exploitation rate and then numerically searching for the exploitation rate (i.e., $\mathrm{F_{MSY}}$) that maximizes equilibrium yield. Note that an analytical solution for $\mathrm{F_{MSY}}$ does not exist for integrated models that use either the Beverton-Holt or Ricker stock recruitment models. Obtaining estimates of equilibrium yield for a given fishing mortality rate is given by:

$$Y_e = F_e B_e = F_e R_e \phi_q, \tag{2}$$

where Y_e is the equilibrium yield (t), F_e is the equilibrium fishing mortality rate, B_e is the equilibrium biomass which can also be expressed as the product of equilibrium recruitment R_e times the vulnerable biomass per recruit ϕ_q. Equilibrium recruitment is a function of the natural mortality rate (M), and age-specific fecundity, as well as the parameters unfished recruits (R_o) and steepness h that are estimated within the integrated assessment model (see Martell et al., 2008, for more details on the equilibrium models). Within the EBS model it is assumed that natural mortality and weight-at-age are known with certainty. Weights-at-age are obtained directly from catch samples in both commercial fisheries and fisheries independent surveys each year and it's not very likely that errors in the estimates of weights are large enough to result in substantial changes in the reference point estimates. MSY based reference points are insensitive to the absolute fecundity, as the units associated with the total number of eggs produced cancel out in the derivation of the parameters for the stock recruitment models. Therefore, it does not matter if an average age-4 female pollock produces 1,000 eggs or 1,000,000 eggs. Relative fecundity between different age classes is important in the derivation of reference points; therefore, changes in mean weight-at-age over time could affect relative egg production. This is currently preserved in the pollock assessment model where fecundity is measured as the spawning stock biomass (i.e. the product of numbers-at-age times mean weight-at-age).

3.1.1 Sensitivity to natural mortality (M_a)

Estimates of age-specific natural mortality rates, however, are difficult to measure and are currently fixed in the EBS pollock assessment ($M_a = \{0.9, 0.45, 0.3, \ldots\}$ for ages $a = \{1, 2, 3+, \ldots\}$). Estimates of reference points ($\mathrm{F_{MSY}}$ and $\mathrm{B_{MSY}}$) are very sensitive to mis-specification of natural mortality rates (Thompson, 1994; Clark, 1999). In the example model shown in Figure 2, the default values for M_a result in an estimate of $\mathrm{F_{MSY}}$=0.25. This is obtained by calculating the equilibrium yield (Eq. 2) over a range of F_e values and then finding the corresponding F_e value that maximizes this yield (e.g., solid black line in Figure 2a). To explore the sensitivities of M, I multiply the M_a vector by 1.1 and 0.9 to scale up or down the assumed age-specific values of M; this corresponds to the M=0.33 and M=0.27 cases (dashed red line and dotted green line) in Figure 2, respectively. The results of this sensitivity analysis show that if M is over-estimated, then estimates of $\mathrm{F_{MSY}}$ will be biased upwards and vice versa. Estimates of MSY decrease as M increases (Fig. 2a) and estimates $\mathrm{B_{MSY}}$ increase as M increases (defined by the horizontal lines in Fig. 2b). Estimates of age-1 recruits and spawners per recruit (SPR) at $\mathrm{F_{MSY}}$ are insensitive to alternative values of M (Fig. 2cd).

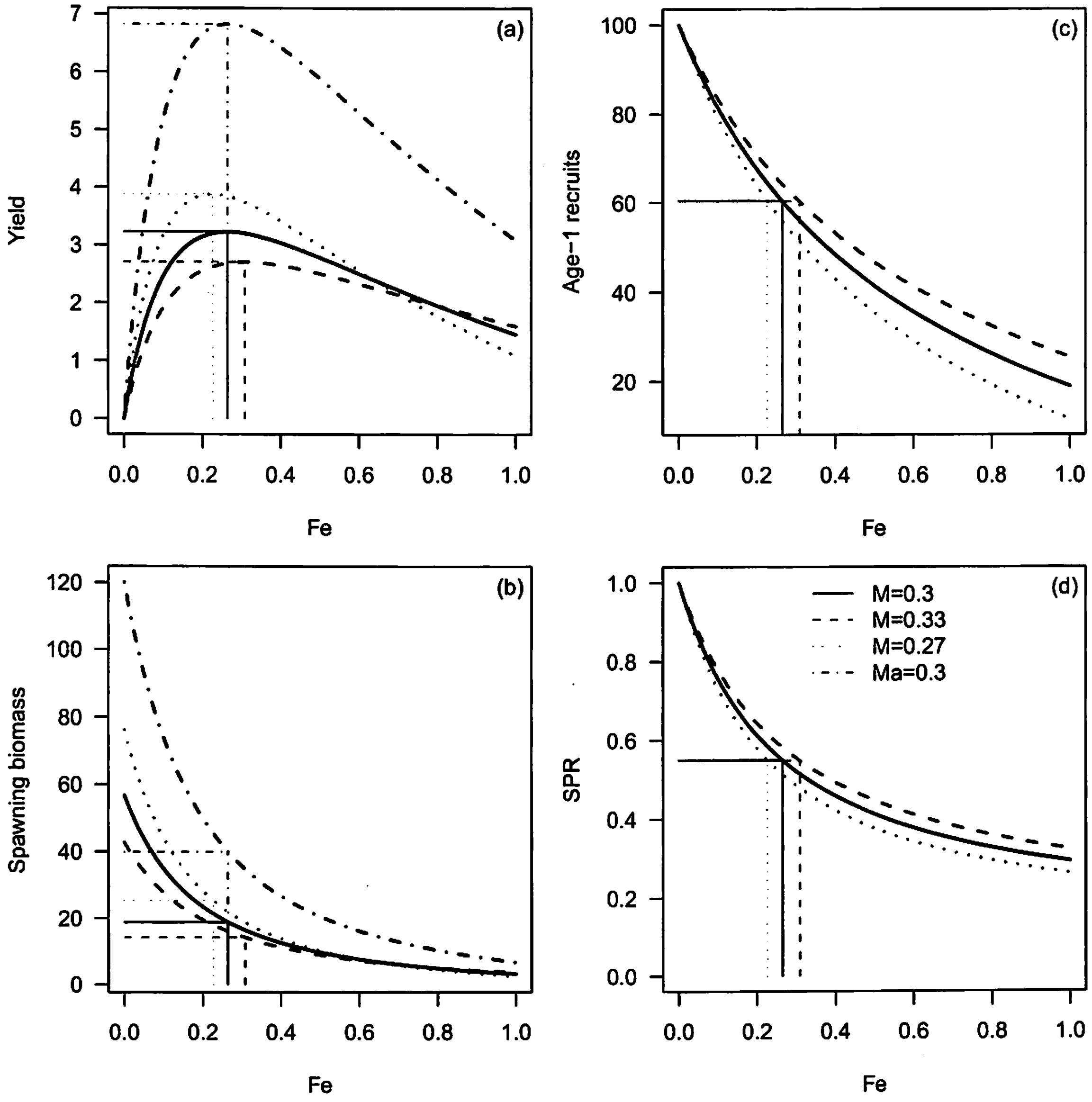

Figure 2: Estimates of equilibrium yield (a) versus equilibrium fishing mortality rates for alternative values of the natural mortality rate. Corresponding equilibrium values of spawning stock biomass (b), age-1 recruitment (c), and spawners per recruit (d) versus equilibrium fishing mortality rate are also shown which indicate $\mathrm{F_{MSY}}$ reference point estimates. Vertical lines demarcate $\mathrm{F_{MSY}}$ reference points for alternative hypotheses about M, and horizontal lines correspond to MSY (a), $\mathrm{B_{MSY}}$ (b), age-1 recruits (c) and SPR reference points values (d) at $\mathrm{F_{MSY}}$.

In addition to the scaling up or down of the age-specific natural mortality rates, I also explored the effects of assuming age-independent natural mortality (M_a=0.3 case in Fig. 2, blue dot-dash line). Assuming natural mortality is independent of age does not change the overall estimate of $\mathrm{F_{MSY}}$ (Fig. 2a) because only a tiny fraction of fish less than age-3 are sexually mature and contribute to total egg production. If the age-at-maturity schedules were younger, or selectivities for younger animals increases, then estimates of $\mathrm{F_{MSY}}$ are likely to be lower. Furthermore, assuming age-independent M increases the estimate of MSY and $\mathrm{B_{MSY}}$ (Fig. 2ab) substantially because there is a much larger fraction of age-2 fish surviving to age-3 with the lower natural mortality rates. Therefore, if we over-estimate M_a for younger age-classes then estimates of $\mathrm{B_{MSY}}$ will be biased downwards. Again, estimates of Age-1 recruits and SPR value at $\mathrm{F_{MSY}}$ are insensitive to age-specific values of M, the latter is due to the very low assumed fraction of age-2 fish that are sexually mature.

The work of Clark (1999) have clearly shown that assuming values of M that are higher that the true value is very likely to lead to underestimating annual fishing mortalities F_t in each year. This leads to over-estimating the total numbers in the population. To hedge on the conservative side, low values of natural mortality should be assumed; this will lower estimates of $\mathrm{F_{MSY}}$, but increase estimates of $\mathrm{B_{MSY}}$ assuming all other parameter values are the same. Two other studies have estimated much higher natural mortality rates for EBS pollock (Livingston and Jurado-Molina, 2000; Jurado-Molina et al., 2005) using Multi-Speices Virtual Population Analysis (MSVPA) and statistical catch-at-age models that directly incorporate predation interactions. Based on this other research, I would conclude that the assumed vector of M_a values would lead to more conservative estimates of MSY based reference points.

3.1.2 Sensitivity to stock recruitment parameters (R_o, h)

In general, there is usually a large amount of confounding between the two underlying parameters that define the stock recruitment relationship (R_o– unfished age-1 recruits, and h– the steepness parameter or fraction of R_o that is obtained when spawning abundance is 20% of its unfished state). There is no figure or table of correlations quantifying the amount of correlation between R_o and h in Ianelli et al. (2009). An informative prior for h was used in this assessment, and according to the text when a uniform prior was assumed the estimates of $\mathrm{F_{MSY}}$ corresponded to SPR values of 18%. This would translate into a very large value of h (i.e,. the informative prior reduces estimates of productivity), implying that the EBS pollock stock is very productive and capable of sustaining high fishing mortality rates.

Four combinations of R_o and h were explored using the equilibrium age-structured model (based on a Ricker stock-recruitment relationship) and estimates of reference points are shown in Figure 3. Estimates of $\mathrm{F_{MSY}}$ increase with increasing values of h and are insensitive to R_o (Fig. 3a). Estimates of MSY are usually more certain than estimates of h and R_o themselves due to the negative correlations that are usually found between these two parameters. For example, Figure 3a) shows that estimates of MSY change very little between the $R_o = 120$, $h = 0.536$ and $R_o = 80, h = 0.8$ scenario in comparison to $R_o = 100$, $h = 0.67$ and $R_o = 150, h = 0.67$. Ultimately, R_o is a global scaling parameter in the determination of MSY reference points; if estimates of R_o are biased upwards so are estimates of $\mathrm{B_{MSY}}$ and age-1 recruits (Fig 3c). Spawner per recruit based reference points are insensitive to variation in R_o, but are sensitive to variation in steepness (Fig. 3d).

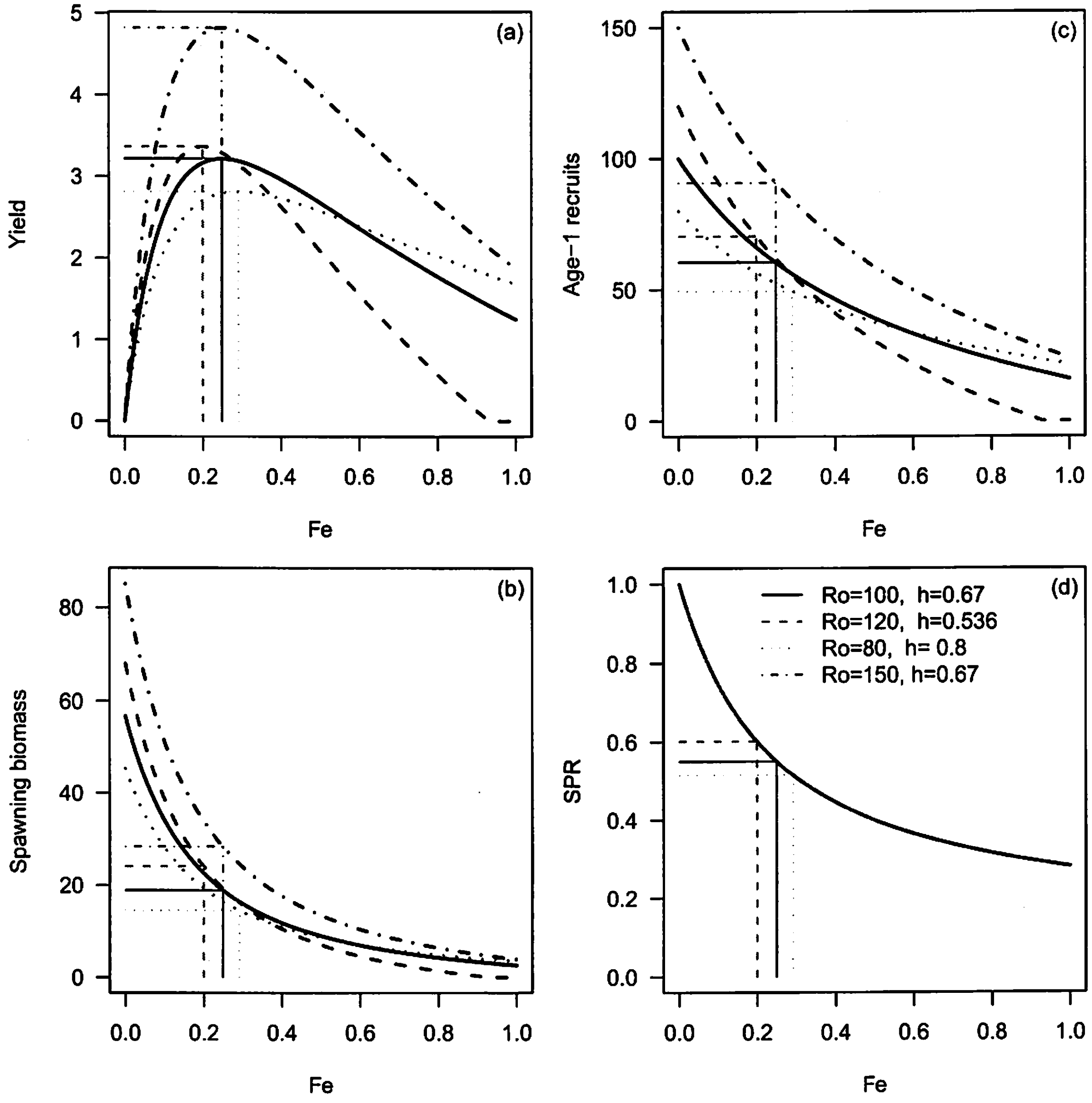

Figure 3: Estimates of equilibrium yield (a) versus equilibrium fishing mortality rates for alternative values of unfished age-1 recruits (R_o) and steepness (h). Corresponding equilibrium values of spawning stock biomass (b), age-1 recruitment (c), and spawners per recruit (d) versus equilibrium fishing mortality rate are also shown which indicate $\mathrm{F_{MSY}}$ reference point estimates. Vertical lines demarcate $\mathrm{F_{MSY}}$ reference points for alternative R_o and h values, and horizontal lines correspond to MSY (a), $\mathrm{B_{MSY}}$ (b), age-1 recruits (c) and SPR reference points values (d) at $\mathrm{F_{MSY}}$.

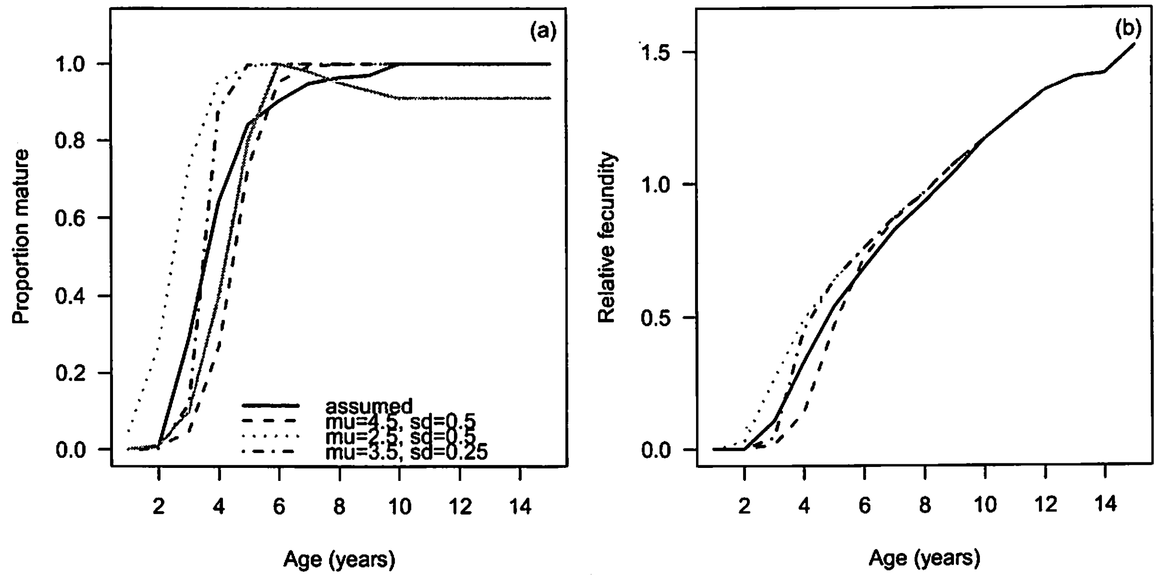

Figure 4: Proportion mature by age (a) and approximate estimates of relative fecundity-at-age ($f_a = w_a m_a$, panel (b)). Also shown in (a) is the assumed selectivity-at-age used in stock projections. Assumed values used in the stock assessment for EBS pollock are shown with the solid black line, and three alternative maturity schedules with age-at-50% maturity denoted by mu and corresponding standard deviation (sd).

3.1.3 Sensitivity to fecundity at age

In the stock recruitment function in Ianelli et al. (2009), it is assumed that total egg production is proportional to the weight of mature spawning females. The proportion assumed mature are reported on page 11 in Ianelli et al. (2009) and the product of weight-at-age and maturity-at-age represents age-specific fecundity (Figure 4). Estimated reference points are sensitive to the relative differences in fecundity-at-age, as well as, the age at which fish first recruit to the fishing gear. To explore this sensitivity, I also assumed three alternative maturity schedules based on a logistic function with the age at 50% maturity given by $\mu = \{2.5, 4.5, 3.5\}$ and standard deviations of $\sigma = \{0.5, 0.5, 0.25\}$, respectively (Fig. 4a). These alternative maturity schedules translate into minor differences in age-specific fecundity for age classes that are only partially mature, age classes that are fully mature are assumed to have the same fecundity-at-age and fecundity is proportional to body weight.

For a given selectivity curve, estimates of $\mathrm{F_{MSY}}$ increase if fish mature earlier in life and decrease if they mature later in life (Fig. 5a). Equilibrium yields and MSY values also increase slightly if fish mature earlier in life relative to the age-at-which they recruit to the fishery. $\mathrm{B_{MSY}}$ reference points also increase if fish mature earlier because a higher fraction of the total biomass is sexually mature (Fig. 5b). Estimates of age-1 recruits and SPR reference points at $\mathrm{F_{MSY}}$ are insensitive to alternative maturity-at-age schedules (Fig. 5cd). However, if SPR reference points are used as a proxy for $\mathrm{F_{MSY}}$ (e.g., the fishing mortality that reduces the spawners per recruit to 35% of its unfished state, $F_{35\%}$), then estimates of $F_{35\%}$ are *extremely sensitive* to minor differences in fecundity-at-age relative to selectivity schedules (Fig. 5d).

3.1.4 Sensitivity to estimated selectivity schedules

Estimated reference points are also sensitive to selectivity schedules in much the same way as they are sensitive to maturity-at-age schedules. A key element in determining $\mathrm{F}_{\mathrm{MSY}}$ reference points is the ratio of selectivity to maturity at age; if fish are allowed to spawn before they recruit to the fishing gear then the population can tolerate much higher levels of fishing mortality. The assumed age-specific selectivities (as read off Figure 1.26 in the 2009 stock assessment report) is shown in Figure 6 along with three alternative selectivity curves.

If fish recruit to the fishing gear well after the age-at-maturity then estimates of $\mathrm{F}_{\mathrm{MSY}}$ increase dramatically. However, if fish are harvested at ages much younger than the age of maturity then estimates of $\mathrm{F}_{\mathrm{MSY}}$ are greatly reduced and this also increases the possible risk of growth overfishing (as seen by the reduced MSY level in Fig. 7a). Spawning stock biomass reference levels ($\mathrm{B}_{\mathrm{MSY}}$) are insensitive to alternative selectivity schedules (unless a large fraction of immature fish are harvested), as are age-1 recruits and SPR levels at $\mathrm{F}_{\mathrm{MSY}}$. If SPR reference points are used as proxies for $\mathrm{F}_{\mathrm{MSY}}$ (e.g., $F_{35\%}$), then $F_{35\%}$ estimates are extremely sensitive to assumed future selectivities. If selectivity is more a function of where fishing occurs relative to the distribution of certain age-classes, then activities such as fishing on the spawning grounds during the spawning season would call for lower estimates of $\mathrm{F}_{\mathrm{MSY}}$ in comparison to more dispersed fisheries that catch higher proportions of immature fish (e.g., age-4 asymptotic selectivity, Fig. 6 and Fig. 7a).

3.2 Missing information

- Estimates of weight-at-age for ages 1-2. I approximated these by fitting a von Bertalannfy growth model to the mean weight-at-age data in Table 1.16 (ages 3:15) and calculating mean weight at age for ages 1 and 2 using $w_a = w_\infty(1 - \exp(-k * a))^3$. Assuming normal errors, parameter estimates were $w_\infty = 1.519$ and $k = 0.264$.

- Estimates of the vulnerability-at-age in the terminal and future years are provided in graphical format, but corresponding values are not available in any of the tables. The equilibrium values presented in Figure 2 (and similar figures) require age-specific estimates of selectivity, natural mortality, mean weight-at-age, fecundity-at-age, steepness and the unfished recruitment level. Because vulnerabilities-at-age are not available, I could not verify the reference point estimates presented in Table 1.18 in Ianelli et al. (2009)

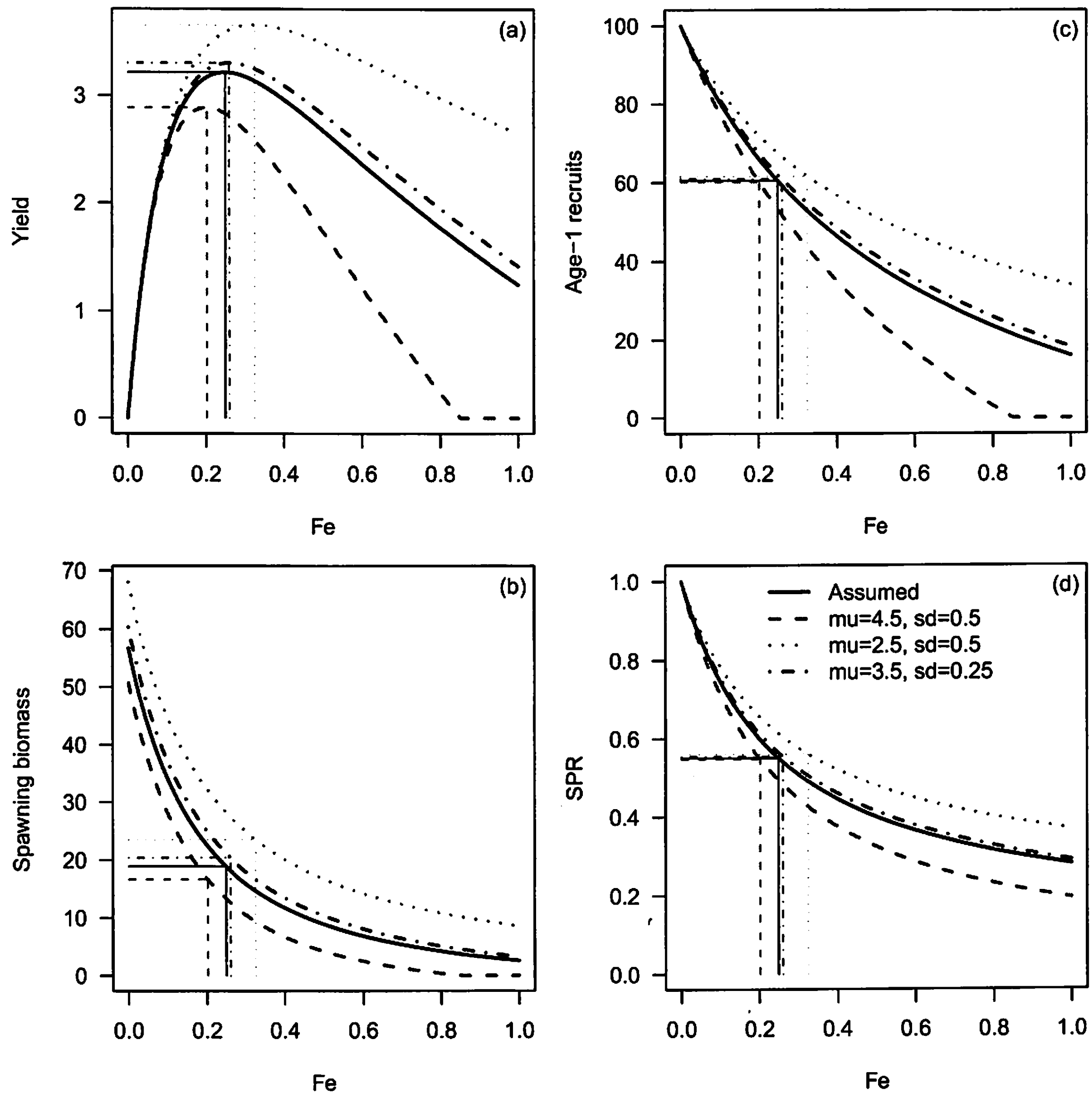

Figure 5: Estimates of equilibrium yield (a) versus equilibrium fishing mortality rates for alternative age-at-maturity schedules. Corresponding equilibrium values of spawning stock biomass (b), age-1 recruitment (c), and spawners per recruit (d) versus equilibrium fishing mortality rate are also shown which indicate F_{MSY} reference point estimates. Vertical lines demarcate F_{MSY} reference points for alternative maturity schedules where mu is the age-at-50% maturity. Horizontal lines correspond to MSY (a), B_{MSY} (b), age-1 recruits (c) and SPR reference points values (d) at F_{MSY}.

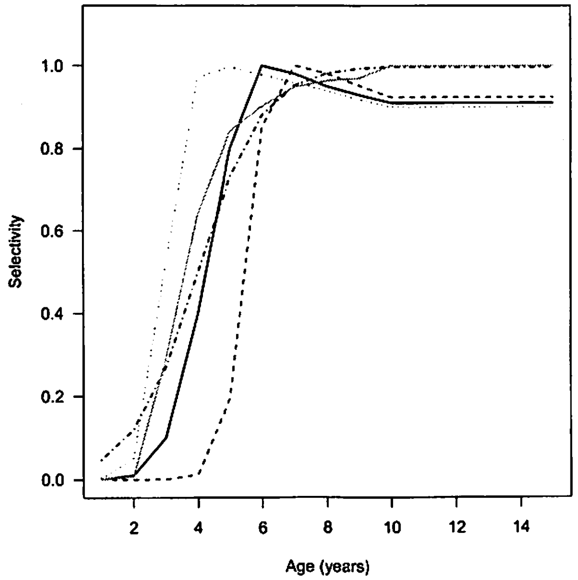

Figure 6: Assumed (black line) and three alternative selectivity schedules used in calculating the reference points shown in Figure 7. Also shown (solid grey line) is the assumed maturity-at-age values for reference.

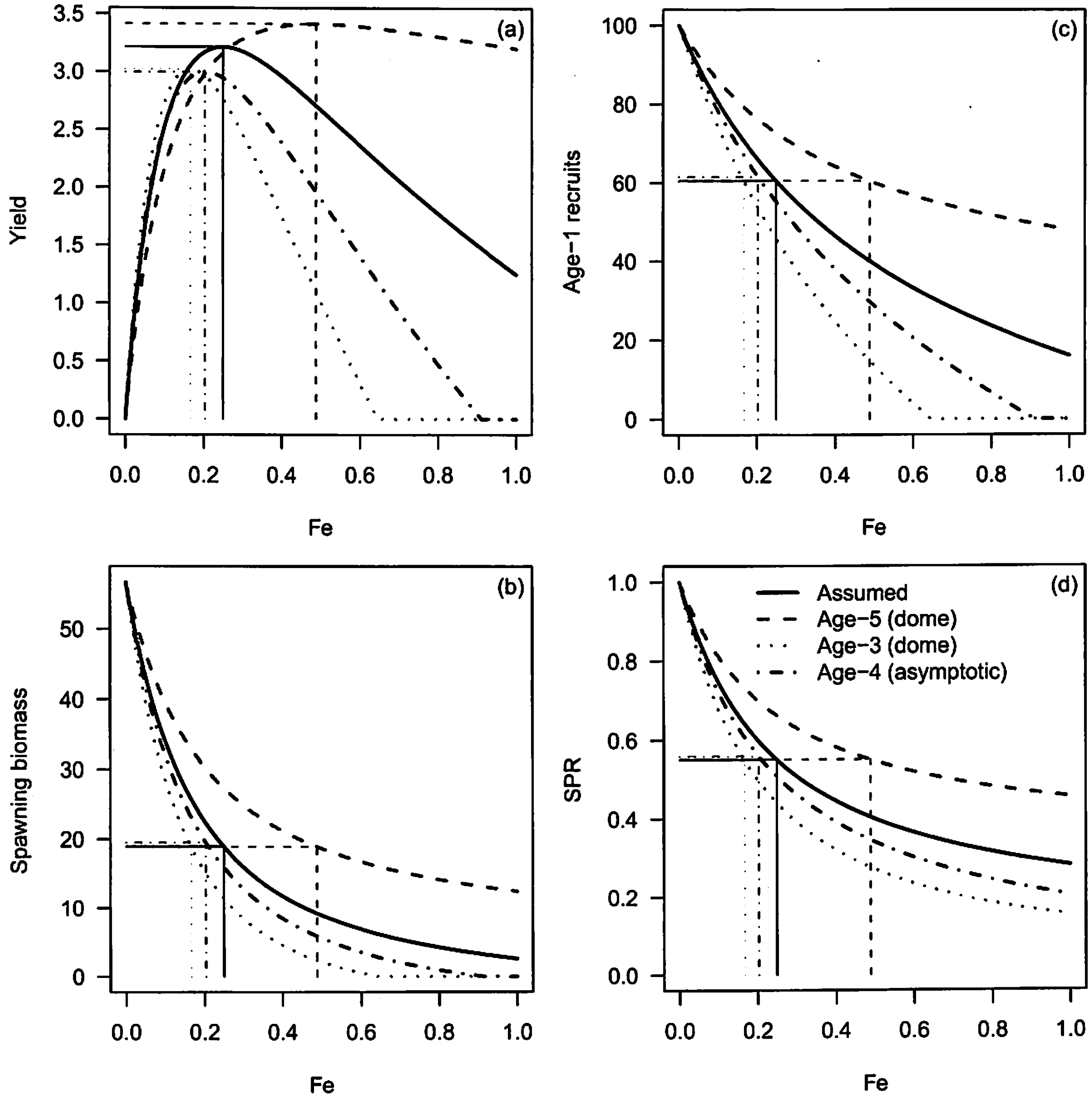

Figure 7: Estimates of equilibrium yield (a) versus equilibrium fishing mortality rates for alternative selectivity schedules. Corresponding equilibrium values of spawning stock biomass (b), age-1 recruitment (c), and spawners per recruit (d) versus equilibrium fishing mortality rate are also shown which indicate F_{MSY} reference point estimates. Vertical lines demarcate F_{MSY} reference points for alternative maturity schedules where mu is the age-at-50% maturity. Horizontal lines correspond to MSY (a), B_{MSY} (b), age-1 recruits (c) and SPR reference points values (d) at F_{MSY}.

4 Reconstructing the objective function

Parameter estimation in the EBS pollock assessment consists of estimating all 772 parameters by minimizing an objective function. In this assessment, parameter estimation proceeds over 5 separate phases, and the objective function itself changes with each successive phase. Here I attempt to recover the objective function used in the last phase of parameter estimation.

$$f(\Theta) = \ell_C + \ell_A + \sum_g \ell_{C^g_{t,a}} + \ell_R + \ell_S + \ell_{CPUE} \tag{3}$$

The negative loglikelihood for the total catch data is given by:

$$\ell_C = \lambda_C \sum_{t=1}^{T} \left[\ln(O_t + 0.0001) - \ln(C_t + 0.0001)\right]^2, \tag{4}$$

where O_t and C_t are the observed and predicted total catch (in kilo tonnes) in year t. The negative loglikelihood for the EIT survey is given by:

$$\ell_A = \lambda_A \sum_g \sum_{t \in A^g_t} \frac{\left(\ln(A_t + 0.01) - \ln(\hat{N}_t + 0.01)\right)^2}{2\sigma^2_{A^g_t}} \quad \text{where} \tag{5}$$

$$\hat{N}_t = \sum_a N_{t,a} q^g s^g_{t,a} e^{-0.5 Z_{t,a}},$$

where g is an index for gear (BTS and EIT surveys), A_t and $\hat{N}_t$ are the observed and predicted survey abundances and $\sigma^2_{A^g_t}$ is the variance in the survey observation in year t.

The negative loglikelihood for the catch-at-age data is given by the following robust likelihood function:

$$\begin{aligned} \ell_{C^g_{t,a}} = & -\frac{1}{2}\sum_{a=1}^{A}\sum_{t=1}^{T} \ln\left[2\pi\left(\eta_{t,a} + \frac{0.1}{T}\right)\right] - \sum_{a=1}^{A} T\ln(\tau) \\ & + \sum_{a=1}^{A}\sum_{t=1}^{T} \ln\left[\exp\left(-\frac{(p_{t,a} - \hat{p}_{t,a})^2}{2\left(\eta_{t,a} + \frac{0.1}{T}\right)\tau^2}\right) + 0.01\right] \\ & \text{where} \quad \eta_{t,a} = \hat{p}_{t,a}(1 - \hat{p}_{t,a}) \quad \text{and} \quad \tau^2 = \frac{1}{n_t} \end{aligned} \tag{6}$$

where A and T are the number of ages and years in the catch-age matrix, $p_{t,a}$ and $\hat{p}_{t,a}$ is the observed and predicted proportions-at-age, and n_t is the effective sample size in year t. The text states that the variance term $2\left(\eta_{t,a} + \frac{0.1}{T}\right)\tau^2$ uses the predicted proportions-at-age to calculate $\eta_{t,a}$. The actual code appears to use the **observed** proportions-at-age and the denominator is computed as $\left(\frac{0.1}{A} + 2(\eta_{t,a})\right)\tau^2$ (i.e., the small term that is added to the variance to ensure it does not approach zero, is $0.1/A$ not $0.1/T$).

The following is a portion of the TPL code used for calculating the robust likelihood function for age-composition data.

```
//dvar_matrix v = a  + 2. * elem_prod(pred ,1.  - pred );
  dvar_matrix v = a  + 2. * elem_prod(obs ,1.  - obs );
  dvar_matrix l  =  elem_div(square(pred - obs), v);
  dvariable log_likelihood = 0.;
  for (i=obs.indexmin();i<= obs.indexmax() ;i++)
  {
    log_likelihood -=  sum(log(mfexp(-1.* double(b(i)) * l(i)) + .01));
  }
  log_likelihood  += 0.5 * sum(log(v));
  return(log_likelihood);
```

The recruitment likelihood (ℓ_R) is given by six separate components in the ADMB code, but only the following four are active in the last phase of parameter estimation:

$$\ell_R = n\ln(\sigma_R) + \sum_{t=1978}^{t=2009} \frac{(\varepsilon_t - 0.5\sigma_R^2)^2}{2\sigma_R^2} + \lambda_\omega \sum_{t=1}^{T} \omega_t^2 + \lambda_\nu \sum_{a=2}^{A} \nu_a^2 + \frac{1}{0.001 + \frac{2}{T}\sum_t \omega_t^2} \sum_{t=2010}^{t=2014} \Omega_t^2 \quad (7)$$

where

$$\varepsilon_t = \ln(\bar{R}e^{\omega_t}) - \ln\left(S_t \frac{R_o}{B_o} \exp\left[\alpha\left(1 - \frac{S_t}{B_o}\right)\right]\right)$$

where S_t is the spawning stock biomass in year t, B_o and R_o are the unfished spawning stock biomass and age-1 recruits, ω_t are the annual recruitment deviations, ν_t are the deviations for the initial numbers at age in 1964, and Ω_t are the future recruitment deviations from 2010 to 2014 (which are estimated in phase 6 and are presumably used in stock projections only). Note that in the calculation of the recruitment residuals (ε_t), the estimated parameters include $\bar{R}, \omega_t, R_o$, and h, where α is given by $\alpha = \ln\left(\frac{-4h}{h-1}\right)$. Also the variable transformation of steepness (h) to the Ricker α parameter also implies a change in definition for h when moving from the Beverton-Holt model to the Ricker model. Therefore, the prior distribution (see Figure 1.48 in the assessment document) has an 8% chance of producing 70% of the unfished recruits when spawning abundance is reduced to 20% of its unfished state under the Beverton-Holt model. Whereas, for the Ricker model there is about an 8% chance of 119% of the unfished recruits being produced when the spawning stock is reduced to 20% of its unfished state. The unfished spawning biomass B_o is derived from survivorship and maturity-at-age information and the value of σ_R is fixed at an assumed value of 0.9 (this is thought to be an over-estimate of σ_R and is used such that uncertainty in $\mathrm{F_{MSY}}$ will be inflated).

On page 92 in Ianelli et al. (2009), the text states that an additional modification to include an environmental component that accounts for differential survival attributed to larval drift. This option appears to be turned off in the latest assessment (i.e., control flag # 27 is set to -3).

The likelihood function for selectivity parameters (ℓ_S) also consists of several components. First, there are three separate selectivity matrixes: one for the fishery, one for the Bottom Trawl

Survey (BTS) and one for the acoustic survey (EIT).

$$\ell_S = S^{(1)} + S^{(2)} + S^{(3)} + S^{(4)} + S^{(5)} + S^{(6)} \tag{8}$$

where

$$S^{(1)} = \begin{cases} \lambda_F \sum_t \sum_a (s_{t,a} - s_{t,a+1})^2, & \text{if} \quad s_{t,a} > s_{t,a+1} \\ 0, & \text{if} \quad s_{t,a} \le s_{t,a+1} \end{cases}$$

$$S^{(2)} = \begin{cases} \lambda_E \sum_t \sum_{a=2}^{A} (s_{t,a} - s_{t,a+1})^2, & \text{if} \quad s_{t,a} > s_{t,a+1} \\ 0, & \text{if} \quad s_{t,a} \le s_{t,a+1} \end{cases}$$

$$S^{(3)} = \lambda_{\gamma^F} \sum_t (\gamma_t^F)^2 + \lambda_{\gamma^E} \sum_t (\gamma_t^E)^2$$

$$S^{(4)} = \lambda_{s^F} \sum_t \sum_{a=2}^{A} (s_{t,a} - 2s_{t,a-1} + s_{t,a-2})^2$$

$$S^{(5)} = \lambda_{s^E} \sum_t \sum_{a=3}^{A} (s_{t,a} - 2s_{t,a-1} + s_{t,a-2})^2$$

$$S^{(6)} = \lambda_\alpha \sum_{t=2}^{T} (\delta_t^\alpha - \delta_{t-1}^\alpha)^2 + \lambda_\beta \sum_{t=2}^{T} (\delta_t^\beta - \delta_{t-1}^\beta)^2 + \lambda_\mu \sum_{t=2}^{T} (\delta_t^\mu - \delta_{t-1}^\mu)^2$$

where $s_{t,a}$ is the natural log of the selectivity parameter for a given year t and age a. The square of the second differences between the log selectivity parameters for different age classes will reduce the amount of curvature (or make the log selectivities increase linearly) if there is a high penalty weight associated with this component in the objective function. The ADMB code for this component of the objective function includes the second differences for all age-classes, but only ages 1-10 are estimated (ages 11-12 are set equal to the selectivity at age 10) so it's not clear if the second differencing should be applied to all 15 age classes or only the 10 that are estimated. It should not affect the objective function because the second differences are equal to zero.

Due to time constraints, I was not able to reconstruct the remainder of the objective function from the code and text. There are at least 7 other components of the objective function that I have not explored.

The model is also fit to historical CPUE data assuming the CPUE is proportional to the vulnerable biomass seen by the fishery along with normal observation errors as shown in the following code:

```
//CPUE predicted values..
    for (i=1;i<=n_cpue;i++)
    {
      iyr          = yrs_cpue(i);
      pred_cpue(i) = natage(iyr)*sel_fsh(iyr) * q_cpue;
    }
```

```
cpue_like.initialize();
  dvar_vector cpue_dev = obs_cpue-pred_cpue;
  for (i=1;i<=n_cpue;i++)
    cpue_like += square(cpue_dev(i))/(2.*obs_cpue_var(i));
```

Observation errors in commercial CPUE data are usually assumed to be log-normally distributed. On the bottom of page 16 and top of page 17 in Ianelli et al. (2009) is a qualitative description of statistical fit to these historical data:

"The fit to the early Japanese fishery CPUE data (Low and Ikeda, 1980) is consistent with the population trends for this period and is essentially unchanged since introduced to the assessment several years ago."

There is no figure or table to back up this statement. To what degree do these data influence stock size estimates and reference points?

Table 1: Assumed weightings for likelihood components in the objective function. Note that the standard deviation (σ) is related to λ via: $\lambda = 1/(2\sigma^2)$.

Likelihood component	λ value	standard deviation σ
Total catch (λ_C)	200	0.05
Survey (λ_A)	1	0.707
Fishery age comps ($\lambda_{C^g_{t,a}}$)	1	0.707
BTS age comps ($\lambda_{C^g_{t,a}}$)	1	0.707
EIT age comps ($\lambda_{C^g_{t,a}}$)	1	0.707
Recruitment deviations (λ_ω)	0.1	7.071
Initial number deviations (λ_ν)	0.1	7.071
Recruitment deviations (σ_R)	0.617	0.9
Selectivity components		
Fishery dome-shapedness (λ_F)	12.5	0.2
Acoustic survey dome-shapedness (λ_E)	1	0.707
Fishery selectivity trend(λ_{γ^F})	3.125	0.40
EIT selectivity trend(λ_{γ^E})	1	0.707
Fishery selectivity curvature($\lambda_{s(F)}$)	5.555	0.3
EIT selectivity curvature($\lambda_{s(E)}$)	0.1	2.236
BTS survey age 50% (λ_α)	12.5	0.2
BTS survey slope (λ_β)	12.5	0.2
BTS survey age-1 (λ_μ)	8	0.25
Historical foreign CPUE (λ_{CPUE})	1	0.707

4.1 Retrospective estimates of selectivity

Estimation of selectivity parameters in statistical catch-at-age models can be troublesome at times. Detecting an above average recruitment event may take a few years if the fish are not fully recruited to the fishing gear, or fishing operations are intentionally avoiding small fish. Conversely,

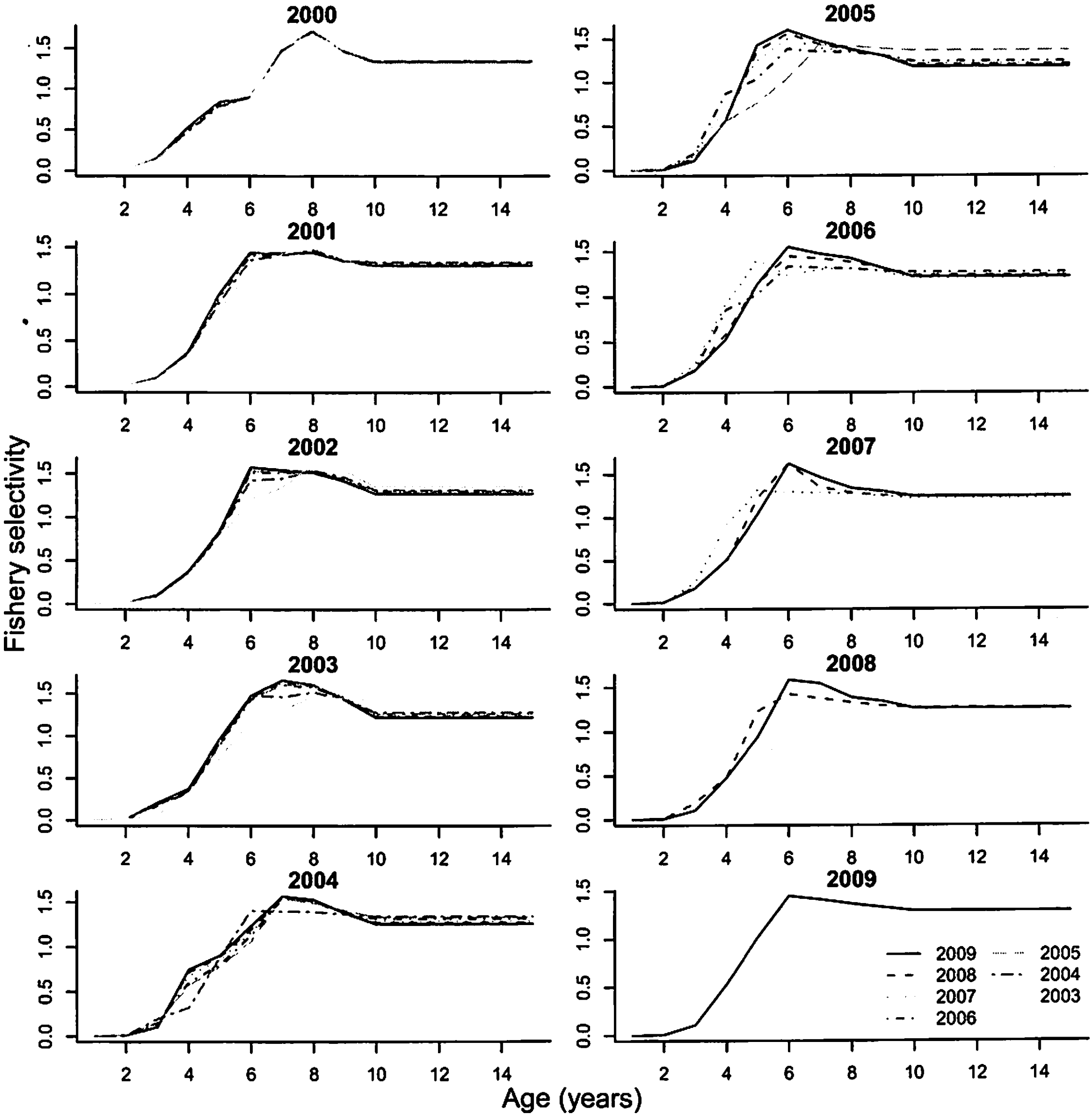

Figure 8: Retrospective estimates of fisheries selectivity where each panel represents the estimated selectivity curve for a given year (e.g., year 2000 in top left panel) and various terminal data years are defined in the legend in the lower right panel.

fishing operations may change such that small/younger fish become more vulnerable and give the appearance of a large cohort that is entering the population. In general, it will take several years (usually the number of years for the fish to become fully recruited) to be able to differentiate between a new large cohort or changes in selectivity over time.

Retrospective analysis is one tool that can be used to look at the estimability of selectivity parameters in the terminal year. For example, in Figure 8, estimates of the selectivity curves for 2008 fishing year using data up to 2008 and data up to 2009 are shown in the second column second from the bottom. In other words comparing last years estimate of the 2008 selectivity with this years estimate of 2008 selectivity. The addition of 1-year of new data resulted in an increase in the age-6 selectivity and a reduction in the age-5 selectivity. As more data accumulate, estimates of selectivity in 2005 have become more and more dome-shaped in comparison to the terminal year estimate in 2005. In the last 9 years estimates of selectivity appear to be reasonably stable, and in cases where there have been significant changes (e.g., 2004 and 2005) selectivity estimates tend to stabilize in 2-4 years.

Note that the results obtained in Figure 8 are conditioned on the effective samples sizes assumed for the age-composition data as well as the assumed variances (likelihood weightings) for the curvature penalties and deviations parameters that are used in calculating the objective function value. Reducing the samples sizes or increasing the penalty weights will tend to reduce the amount of variability seen in selectivity parameters over time.

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