1.B. Assessment of walleye pollock in the Bogoslof Island Region

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Executive Summary

There was no new Bogoslof pollock (*Theragra chalcogramma*) echo integration-trawl (EIT) survey in 2010 and the 2009 Bogoslof pollock EIT survey resulted in the lowest estimate of biomass (110,000 t) in the region since the EIT survey began in 1988. The distribution observed in 2009 resembles that of the 2000-2003 surveys with the highest concentration of pollock in the Samalga area (86% of biomass). Most of the decrease in abundance from the prior survey estimate was in the less than 50 cm length categories. This may indicate poor recruitment for the 2003 through 2005 year classes similar to that observed for the US EEZ Bering Sea pollock stock.

The following summarizes the 2011 ABC and OFL levels by approaches that include the SSC's harvest rule and Tier 5 values using different levels of natural mortality (recommendations in bold; these values would also apply for 2012):

Approach	ABC	OFL
Adjusted harvest rule		
($F_{40\%}$ = 0.27)	**156 t**	
Tier 5 (M = 0.2)	16,500 t	**22,000 t**
Tier 5 (M=0.3)	24,750 t	33,000 t

Introduction

Alaska pollock (*Theragra chalcogramma*) are broadly distributed throughout the North Pacific with largest concentrations found in the Eastern Bering Sea. The Bogoslof region is noted for having distinct spawning aggregations that appear to be independent from pollock spawning in nearby regions. The Bogoslof management district (INPFC area 518) was established in 1992 in response to fisheries and surveys conducted during the late 1980s, which consistently found a discrete aggregation of spawning pollock in this area during the winter. The degree to which this aggregation represents a unique, self-recruiting stock is unknown but the persistence of this aggregation suggests some spawning site fidelity that called for independent management. The Bogoslof region pollock has also been connected with the historical abundance of pollock found in the central Bering Sea (Donut Hole) due to concentrations of pollock successively moving toward this region prior to spawning (Smith 1981, Shuntov et al. 1993).

Collectively, pollock found in the Donut Hole and in the Bogoslof region are considered a single stock, the Aleutian Basin stock. Currently, based on an agreement from a Central Bering Sea convention meeting, it is assumed that 60% of the Aleutian Basin pollock population spawns in the Bogoslof region. The actual distribution of Aleutian Basin pollock is unknown and likely varies depending on environmental conditions and the age-structure of the stock. The Bogoslof component of the Aleutian Basin stock is one of three management stocks of pollock recognized in the BSAI region. The other stocks include pollock found in the large area of the Eastern Bering Sea shelf region and those in the Aleutian Islands near-shore region (i.e., less than 1000m depth; Barbeaux et al. 2004). The Aleutian Islands, Eastern Bering Sea and Aleutian Basin stocks probably intermingle, but the exchange rate and magnitude are unknown. The degree to which the Bogoslof spawning component contributes to subsequent recruitment to the Aleutian Basin stock also is unknown. From an early life-history perspective, the opportunities for survival of eggs and larvae from the Bogoslof region seem smaller than for other areas (e.g., north of Unimak Island on the shelf). There is a high degree of synchronicity among strong year-classes from these three areas, which suggests either that the spawning source contributing to recruitment is shared or that conditions favorable for survival are shared. From a biological perspective, the degree to which these management units are reasonable definitions depends on the active exchange among these stocks. If they are biologically distinct and have different levels of productivity, then management should be adjusted accordingly. Bailey et al. (1999) present a thorough review of population structure of pollock throughout the north Pacific region. They note that adjacent stocks were not genetically distinct but that differentiation between samples collected on either side of the N. Pacific was evident.

There are some characteristics that distinguish Bogoslof region pollock from other areas. Growth rates appear different (based on mean-lengths at age) and pollock sampled in the Bogoslof Island survey tend to be much older. For example, the average percentage (by numbers of fish older than age 6) of age 15 and older pollock observed from the Bogoslof EIT survey since 1988 is 18%; in the EBS region (from model estimates), the average from this period is only 2%. The information available for pollock in the Aleutian Basin and the Bogoslof Island area indicates that these fish may belong to the same "stock". The pollock found in winter surveys are generally older than age 4 and are considered distinct from eastern Bering Sea pollock. Although data on the age structure of Bogoslof pollock show that a majority of pollock originated from year classes that were also strong on the shelf, 1972, 1978, 1982, 1984, 1989, 1992, 1996, and 2000, there has been some indication that there are strong year classes appearing on the shelf that have not been as strong (in a relative sense) in the Bogoslof region (Ianelli et al., 2004). Strong year classes of pollock in Bogoslof may be functionally related to abundance on the shelf.

Fishery

Prior to 1977, few pollock were caught in the Donut Hole or Bogoslof region (Low and Akada 1978). Japanese scientists first reported significant quantities of pollock in the Aleutian Basin in the mid-to-late 1970's, but large-scale fisheries in the Donut Hole only began in the mid-1980's. By 1987 significant components of these catches were attributed to the Bogoslof Island region (Table 1b.1); however, the actual locations were poorly documented. The Bogoslof fishery primarily targeted winter spawning-aggregations but in 1992, this area was closed to directed pollock fishing.

In 1991, the only year with extensive observer data, the fishery timing coincided with the open seasons for the EBS and Aleutian Islands pollock fisheries (the Bogoslof management district was established in 1992 by FMP amendment 17). However, after March 23, 1991 the EBS region was closed to fishing and some effort was re-directed to the Aleutian Islands region near the Bogoslof district. In subsequent years, seasons for the Aleutian Islands pollock fishery were managed separately. Bycatch and discard levels were relatively low from these areas when there was a directed fishery (e.g., 1991). Updated estimates of pollock bycatch levels from other fisheries were small in recent years (Table 1b.2). The increase in pollock bycatch in the last two years (9.29 t in 2008 to 120.56 t in 2010) can be attributed to the non-pelagic trawl arrowtooth flounder target fishery.

Echo-integration trawl (EIT) surveys and stock conditions

The National Marine Fisheries Service has conducted echo-integration-trawl (EIT) surveys for Aleutian Basin pollock spawning in the Bogoslof Island area annually from 1988-2007 (except for 1990 and 2004) and biennial starting in 2009. In 1999 the survey was conducted by the Fisheries Agency of Japan. Survey reports have appeared in various publications (see list in Ianelli et al., 2005). Survey abundance declined between 1988 and 1994, and then sharply increased in 1995. The 1989 year class recruited to the Bogoslof Island area and was partly responsible for the 1995 increase, but the abundance of all ages increased between 1994 and 1995. A decrease between 1995 and 1996 was followed by a continued decline in 1997, suggesting that the 1995 estimate may be high, or that conditions in that year affected the apparent abundance of pollock. Thereafter, biomass was stable and variable, then dropped again to a somewhat stable level between 2000 and 2007.

The 2009 biomass estimate is the lowest since the survey has been conducted (Table 1b.3). The distribution observed in 2009 resembled that of the 2003 survey with the majority of pollock biomass in the Samalga area (86%). This may indicate poor recruitment for the 2003 through 2005 year classes similar to that observed for the US EEZ Bering Sea pollock stock. The 1996 year class appeared first in the 2001 survey, peaked in 2002 ,and continues to be present. As of the 2007 survey, the 2001, 2000, and 1999 year classes appeared to be strongest.

The following excerpts are from McKelvey (2009):

> "Most of the decreased abundance was observed for fish less than 50 cm FL. Although age-at length results for the 2009 EIT survey were not yet available, age data from previous years suggest that fish 41-49 cm FL were about 4-6 years old (Honkalehto et al. 2008). This decrease was likely due to weak recruitment from the 2003-2005 year classes, which were also relatively weak year classes on the Bering Sea shelf (Ianelli et al. 2008). Without the recruiting year classes, the population in Umnak and Samalga were primarily composed of older fish from the 1999-2002 year classes…"

> "Honkalehto et al. (2008) noted that walleye pollock biomass inside the CBS Convention Specific Area has been increasingly focused into two main regions since the late 1990s: off the northeast end of Umnak Island and in the Samalga Pass area. In the 2000-2003 surveys, the Umnak component accounted for a relatively small portion of the overall biomass ($\leq$ 26%), while in the 2005-2007 surveys, the Umnak component accounted for an increased portion of the overall biomass (34% in 2005, 58% in 2006, and 35% in 2007). In the 2009 survey, the Umnak portion was once again a relatively small portion of the overall biomass at 14%."

Analytical approach

For the purposes of this year's assessment, a strictly survey-based management approach was selected. Previous assessments (e.g., Ianelli et al. 2004) developed a full-age structure model. In those Ianelli et al. (2005) refinements to an age-structured model for Bogoslof pollock were made which included exploring the effect of Donut Hole catches in the 1980s on the stock assessment results. They assumed that 75% of the Donut Hole catches came from the Bogoslof stock, which is in accord with past practices of international pollock workshops (which used a range from 60 to 80%). However, concerns about this assumption were raised due to the uncertain degree of interchange between Bogoslof fish and central BS fish. In the SSC's December 2006 minutes they noted that additional research is needed to better understand the extent of these linkages. In July of 2009 the AFSC conducted a workshop on modeling the spatial dynamics of pollock in the Bering Sea. The report from this workshop is still in draft form but as time permits, the approaches discussed at the workshop may assist in refining a spatially explicit model for Bering Sea pollock that can help resolve issues related to the central Bering Sea and the Bogoslof region.

ABC Recommendation

Maximum permissible ABC and OFL estimates for 2010 and 2011 under Tier 5 were used in place of an age-structured stock assessment model. This method relies exclusively on the NMFS biennial echo integrated-trawl survey biomass estimate that has varied between 292,000 t and 110,000 t (with an inter-annual coefficient of variation of 26%) between 2000 and 2009. The most recent EIT survey of the Bogoslof spawning stock was conducted in February of 2009 (McKelvey 2009; Table 1b.3) and resulted in a biomass estimate of 110,000 t. Using Tier 5 as a basis for management, the maximum permissible ABC value would be 16,500 t (assuming M = 0.2 and F_{ABC} =0.75M=0.15)):

$$ABC = B_{2009} \times M \times 0.75 = 110{,}000 \times 0.2 \times 0.75 = 16{,}500t\,.$$

Historically, the SSC has selected an ABC for Bogoslof using a biomass-adjusted harvest rate rule with a 2,000,000 t target stock size and an F_{ABC} estimate based on growth, natural mortality, and maturation rate. The F_{ABC} has been set at $F_{40\%}$ and equals 0.27 (as in past assessments) which after adjustment, translates to an exploitation rate of 0.0014:

$$F_{ABC} = F_{40\%} \times \left(\frac{B_{2009}}{B_{target}} - 0.05 \right) \Big/ 1 - 0.05 = 0.27 \times \left(\frac{110{,}000t}{2{,}000{,}000t} - 0.05 \right) \Big/ 0.95 = 0.001421$$

Under this procedure, the 2011 ABC would be: $110{,}000t \times 0.001421 = 156t$.

The OFL under the Tier 5 calculation would be 22,000 t:

$$OFL = B_{2009} \times M = 110{,}000t \times 0.2 = 22{,}000t\,.$$

Ecosystem considerations

In general, a number of key issues for ecosystem conservation and management can be highlighted.

These include:

- Preventing overfishing;
- Avoiding habitat degradation;
- Minimizing incidental bycatch (via multi-species analyses of technical interactions);
- Controlling the level of discards; and
- Considering multi-species trophic interactions relative to harvest policies.

For the case of pollock, the NPFMC and NMFS continue to manage the fishery on the basis of these issues in addition to the single-species harvest approach. The prevention of overfishing is clearly set out as a main guideline for management. Habitat degradation has been minimized in the pollock fishery by converting the industry to pelagic-gear only. Bycatch in the pollock fleet is closely monitored by the NMFS observer program, and individual species caught incidentally are managed on that basis. Discarding rates have been greatly reduced in this fishery and multi-species interactions is an ongoing research project within NMFS with extensive food-habit studies and simulation analyses to evaluate a number of “what if” scenarios with multi-species interactions.

As reported in Loughlin and Miller (1989) pups of Northern fur seals, *Callorhinus ursinus*, were first observed on Bogoslof Island in 1980. By 1988 the population had grown at a rate of 57% per year to over 400 individuals, including 80+ pups, 159 adult females, 22 territorial males, and 188 sub-adult males. They noted that the rookery is in the same location where solitary male fur seals were seen in 1976 and 1979 and is adjacent to a large northern sea lion rookery. On July 22, 2005 NMFS surveys resulted in counts of 1,123 adult males, a substantial increase over this time period (L. Fritz, AFSC, pers. comm.). The estimated number of Northern fur seal pups born on Bogoslof Island increased from 5,096 (SE = 33) to 12,631 (SE = 335) (Angliss and Allen, 2007). This suggests that conditions in the ecosystem have changed and appear to favor Northern fur seals. The extent that this is due to environmental conditions is unknown. However, pollock abundance may play only a small role since during peak abundance levels, the Northern fur seal abundance was at very low levels. Also, pollock are most concentrated in this region during winter months when Northern fur seals have migrated to more southern areas.

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Table 1b.1 Catch in tons from the Donut Hole, the Bogoslof Island area, and the Bogoslof region assuming 60% of the Donut Hole catch was part of the stock corresponding to the Bogoslof region, 1977-2010.

Year	**Donut Hole (t)**	**Bogoslof Island (t)**	**Total (t)**	**Bogoslof Island + 60% of Donut Hole catch**
1977		11,500	11,500	11,500
1978		9,600	9,600	9,600
1979		16,100	16,100	16,100
1980		13,100	13,100	13,100
1981		22,600	22,600	22,600
1982		14,700	14,700	14,700
1983		21,500	21,500	21,500
1984	181,200	22,900	204,100	131,620
1985	363,400	13,700	377,100	231,740
1986	1,039,800	34,600	1,074,400	658,480
1987	1,326,300	377,436	1,703,736	1,173,216
1988	1,395,900	87,813	1,483,713	925,353
1989	1,447,600	36,073	1,483,673	904,633
1990	917,400	151,672	1,069,072	702,112
1991	293,400	316,038	609,438	492,078
1992	10,000	241	10,241	6,241
1993	1,957	886	2,843	2,060
1994		556	556	556
1995		334	334	334
1996		499	499	499
1997		163	163	163
1998		136	136	136
1999		29	29	29
2000		29	29	29
2001		258	258	258
2002		1,042	1,042	1,042
2003		24	24	24
2004		0.01	0.01	0.01
2005		0.02	0.02	0.02
2006		0.01	0.01	0.01
2007		0.03	0.03	0.03
2008		9.29	9.29	9.29
2009		73.14	73.14	73.14
2010		130.56	130.56	130.56

Table 1b.2. Estimated retained, discarded, and total pollock catch (t) from the Bogoslof region. Source: NMFS Regional office Blend database and catch accounting system.

Year	Discard	Retained	Total
1991	20,327	295,711	316,038
1992	240	1	241
1993	308	578	886
1994	11	545	556
1995	267	66	334
1996	7	492	499
1997	13	150	163
1998	3	133	136
1999	11	18	29
2000	20	10	29
2001	28	231	258
2002	12	1,031	1,042
2003	19	5	24
2004	0.01		0.01
2005	0.016	0.002	0.02
2006	0.006	0.006	0.01
2007		0.03	0.03
2008	0.003	9.29	9.29
2009	6.06	67.08	73.14
2010	9.81	120.75	130.56

Table 1b.3. Biomass (tons) of pollock as surveyed in the Bogoslof region, 1988-2009. For additional details see McKelvey (2009).

Year	Survey biomass estimates (t)	Survey area (nmi^2)	Relative error
1988	2,395,737	NA	*22%*
1989	2,125,851	NA	*22%*
1990		No survey	
1991	1,289,006	8,411	12%
1992	940,198	8,794	20%
1993	635,405	7,743	9%
1994	490,077	6,412	12%
1995	1,104,124	7,781	11%
1996	682,277	7,898	20%
1997	392,402	8,321	14%
1998	492,396	8,796	19%
1999	475,311	NA	*22%*
2000	301,402	7,863	14%
2001	232,170	5,573	10%
2002	225,712	2,903	12%
2003	197,851	2,993	22%
2004		No survey	
2005	253,459	3,112	17%
2006	240,059	1,803	12%
2007	291,580	1,870	12%
2008		No survey	
2009	110,191	1,803	19%
2010		No survey	