Contents

Approaches for setting ABC in the Bogoslof Region under US Fishery Management practices

James Ianelli
AFSC NMFS/NOAA
Seattle WA 98115

Stock status summary

The National Marine Fisheries Service has conducted echo-integration-trawl (EIT) surveys for Aleutian Basin pollock spawning in the Bogoslof Island area annually since 1988, with three exceptions: a Bogoslof Island area EIT survey was not conducted in 1990, 2004 and in 1999 the survey was conducted by the Fisheries Agency of Japan. The annual Bogoslof Island area EIT survey results (Fig 1) show that population decline occurred between 1988 and 1994, was stable and variable then dropped again to the level it has maintained since 2000. The 2003 Bogoslof Island EIT survey results have been published as an AFSC Processed Report (McKelvey and Williamson 2003). The 1989 year class moved into the Bogoslof Island area and was partly responsible for the 1995 increase (Fig. 2), but the abundance of all ages increased between 1994 and 1995. The decrease between 1995 and 1996 was followed by a continued decline in 1997. This suggests that the 1995 estimate may have been over-estimated, or that conditions in that year affected the apparent abundance of pollock. The summary Bogoslof Island area EIT survey biomass estimates, 1988-2005, are shown in Table 1. The 1996 and 1999 year classes have thus far failed to materialized to any great extent in this region even though their abundance on the EBS shelf region is above average. The current population levels on the eastern Bering Sea shelf, and the absence of extremely large year classes, suggests that pollock distribution throughout the Bering Sea has shifted. The extent that this is due to environmental causes is unclear.

The information available for pollock in the Aleutian Basin and the Bogoslof Island area indicates that these fish belong to the same "stock". The pollock found in winter surveys are generally older than age 5 and are considered distinct from eastern Bering Sea pollock. Data on the age structure of Bogoslof-Basin pollock show that a majority of pollock in the Basin originated from year classes that were also strong on the shelf, 1972, 1978, 1982, 1984, 1989, 1992, and 1996 (Fig. 3). There has been some indication that there are strong year classes appearing on the shelf that have not been coincidentally as strong (in a relative sense) in the Bogoslof region (Ianelli et al., 2001). The conditions leading to strong year classes of pollock in the Basin appears to be density related and may be functionally related to abundance on the shelf. Additional information relating the total mortality of the 1992 cohort shows that the estimate is much higher than expected in the Bogoslof region compared to the EBS shelf (Fig. 4).

Differences in spawning time and fecundity have been documented between eastern Bering Sea pollock and Aleutian Basin pollock. Pollock harvested in the Bogoslof Island fishery (Area 518) have noticeably different age compositions than those taken on the eastern Bering Sea shelf. For example, the average number of age 15 and older pollock observed from the Bogoslof EIT survey since 1988 is 18% while for the same period in the EBS region, age 15 and older averages only 2% (by number for all fish older than age 7). Pollock in the northern shelf have a similar size at age as Aleutian Basin pollock although a very different age composition. However, Aleutian Basin pollock may not be an independent stock. Very few pollock younger than 5 years old have ever been found in the Aleutian Basin including the Russian portion. Recruits to the basin are coming from another area, most likely the surrounding shelves either in the US or Russian EEZ.

Computation of ABC and OFLs

Since 1999 the North Pacific Fishery Management Council (NPFMC) have generally been presented with a number of alternative methods for computing ABC values for the Bogoslof region. These have included:

1) Using a biomass-adjusted harvest rate rule (with 2,000,000 ton estimate as a target stock size) with an estimate of a F_{ABC} based on growth, natural mortality, and maturation rate.

2) Using a harvest rate as a simple fraction of natural mortality rate (e.g., F_{ABC} =0.75M) .

3) An approach using a simple age-structured model.

The NPFMC Science and Statistical Committee (SSC) considered the third approach using an age-structured model to be inappropriate since it covered only part of the stock. The approach 1) and 2) above are provided below for comparison (along with alternative assumptions about F_{ABC} level for 1). The section included in this document reviews the details of the current NPFMC's Tier system for setting ABCs and OFLs.

Using method 1) above and given the survey estimate of exploitable biomass of 0.253 million t and M = 0.2 and considering of a target stock size of 2 million tons, the F_{ABC} level is computed as:

$$F_{abc} \le F_{40\%} \bullet \left(\frac{B_{2005}}{B_{40\%}} - 0.05 \right) \Big/ (1 - 0.05) \ .$$

Assuming that $F_{40\%}$ = 0.27 (as in past assessments), this gives a fishing mortality rate of 0.0217 that translates to an exploitation rate of 0.0215. This value multiplied by 253,000 t, gives a **2006 ABC of 5,501 t for the Bogoslof region.** The value assumed for $F_{40\%}$ that is critical for this calculation was based on uncertain assumptions about selectivity, natural mortality, growth, and maturation. Some of these assumptions were reevaluated here using a simple knife-edged selectivity at age 4 and age 5. Female pollock were specified to be 50% mature by age 5 and immature for younger pollock and 100% mature for older pollock with a natural morality of 0.3. This results in an $F_{40\%}$ level of 0.22 for age-4 knife edge assumption and $F_{40\%}$ = 0.33 for the age-5 knife-edge assumption. These two scenarios provide ABCs for 2006 that would be 4,482 t or 6,723 t for the age-4 and age-5 knife edge assumptions, respectively. Clearly, these rules are sensitive to assumptions about expected selectivity, assumed growth, natural mortality, and maturation rates.

The approach for computing ABC levels under 2) above (a Tier 5 computation) simply uses the most recent survey biomass estimate applied to an adjusted natural mortality. Given a value of *M=0.3* then the ABC level would be (2005 survey biomass $\times M \times 0.75$) of **56,925 t** at a biomass of 253,000 t. With *M = 0.2,* the ABC would be 37,950 t.

Further work on developing a simple age-structured model tuned to the EIT winter survey data (Fig. 5) suggest that, by the same NPFMC rules used for setting groundfish ABCs, the current Bogoslof stock size is about 75% of the target level ($B_{40\%}$) and that the "unfished" level (given observed recruitment at age 6 to this region) is approximately 330,000 t (female spawning biomass). This is substantially lower than the 1 million t "target" currently in use. Forward simulations using this model result (and fishing using the maximum permissible ABC) shows that the 90 percentile range of female SSB is between about 50,000 t and 430,000 t while under a no-fishing scenario, this range increases to nearly 1 million t (Fig. 6). This reflects the main characteristic that seems to prevail for basin pollock: they are highly susceptible to year-class variability.

In summary, there is a range of ABC levels that have been calculated under the NPFMC guidelines. The second approach results in the highest ABC level since the levels are not adjusted by some perceived

target level. The first approach results in ABC levels that are nearly an order of magnitude lower due to the built-in adjustment to recover stock sizes to a target level. This approach was sensitive to assumptions about selectivity (and maturation rates). The age-structured model, while not accepted by the SSC due to stock structure concerns, could be argued to represent an alternative method to set ABCs and subsequent TACs. In practice, all of these approaches undergo scientific review each year in light of available data. The NPFMC has a record of being very conservative and setting a low ABC level and NMFS has responded by prohibiting any directed pollock fishery in this region.

Literature cited

Ianelli, J.N., T. Buckley, T. Honkalehto, N. Williamson and G. Walters. 2001. Bering Sea-Aleutian Islands Walleye Pollock Assessment for 2002. *In*: Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. North Pac. Fish. Mgmt. Council, Anchorage, AK, section 1:1-105.

Ianelli, J.N.,S. Barbeaux, G. Walters, T. Honkalehto, and N. Williamson. 2004. Bering Sea-Aleutian Islands Walleye Pollock Assessment for 2004. *In*: Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. North Pac. Fish. Mgmt. Council, Anchorage, AK, section 1:37-126. http://www.afsc.noaa.gov/refm/docs/2004/EBSpollock.pdf

Table 1. Biomass of pollock as surveyed in the Bogoslof region, 1988-2005. Note that in 1999 the Fishery Agency of Japan conducted the survey.

Biomass (millions of t)

Year:	1988	1989	1990	1991	1992	1993	1994	1995	1996
	2.4	2.1	-	1.3	0.9	0.6	0.49	1.1	0.68

Year:	1997	1998	1999	2000	2001	2002	2003	2004	2005
	0.39	0.49	0.48	0.30	0.23	0.23	0.20	-	0.253

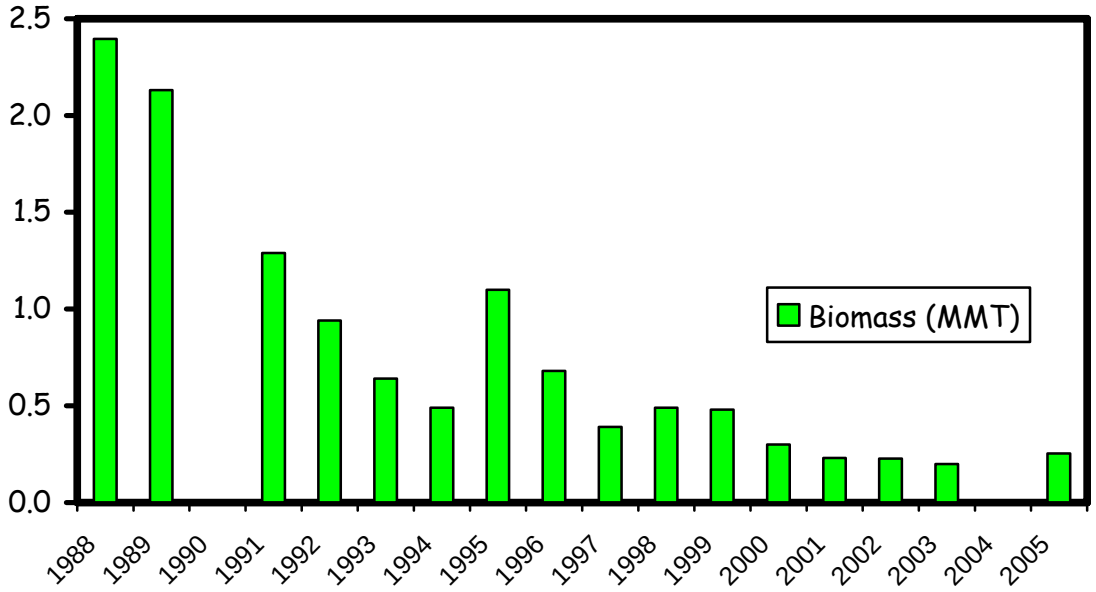

Figure 1. Pollock biomass estimates from the 1988-2005 Bogoslof Area EIT surveys in millions of tons. There were no surveys in 1990 and in 2004.

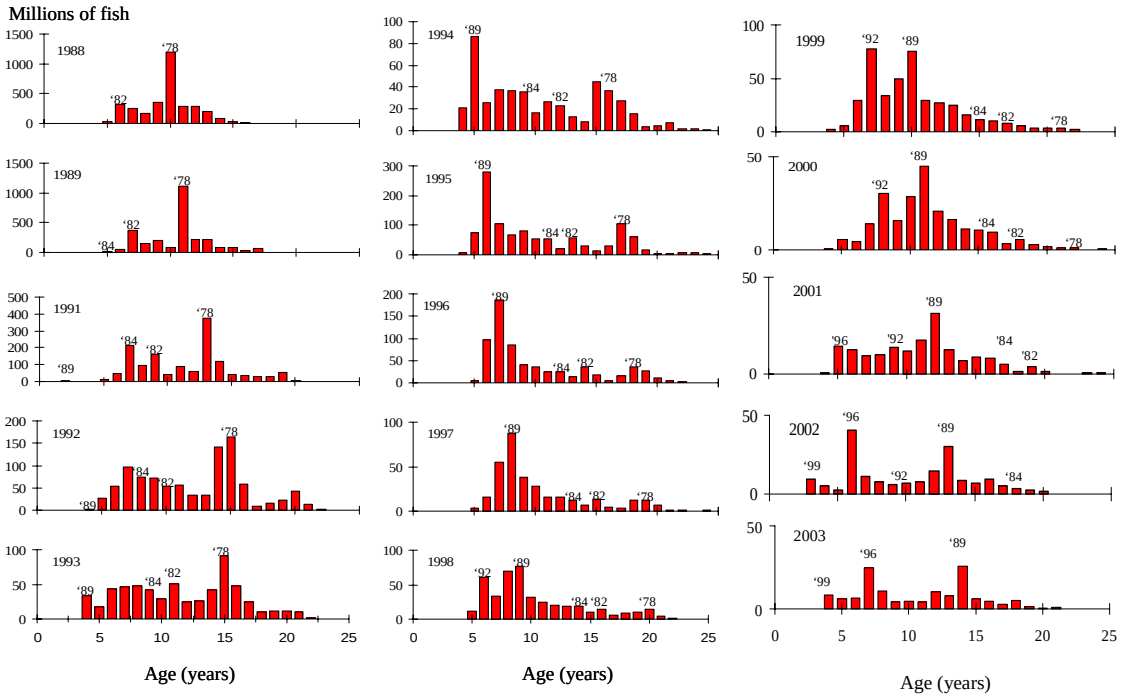

Figure 2. Numbers-at-age estimates (millions) obtained during echo integration-trawl surveys of walleye pollock near Bogoslof Island in winter 1988-2003. Major year classes are indicated. The United States conducted all but the 1999 survey (Japan). No survey was conducted in 1990. Note y-axis scales differ.

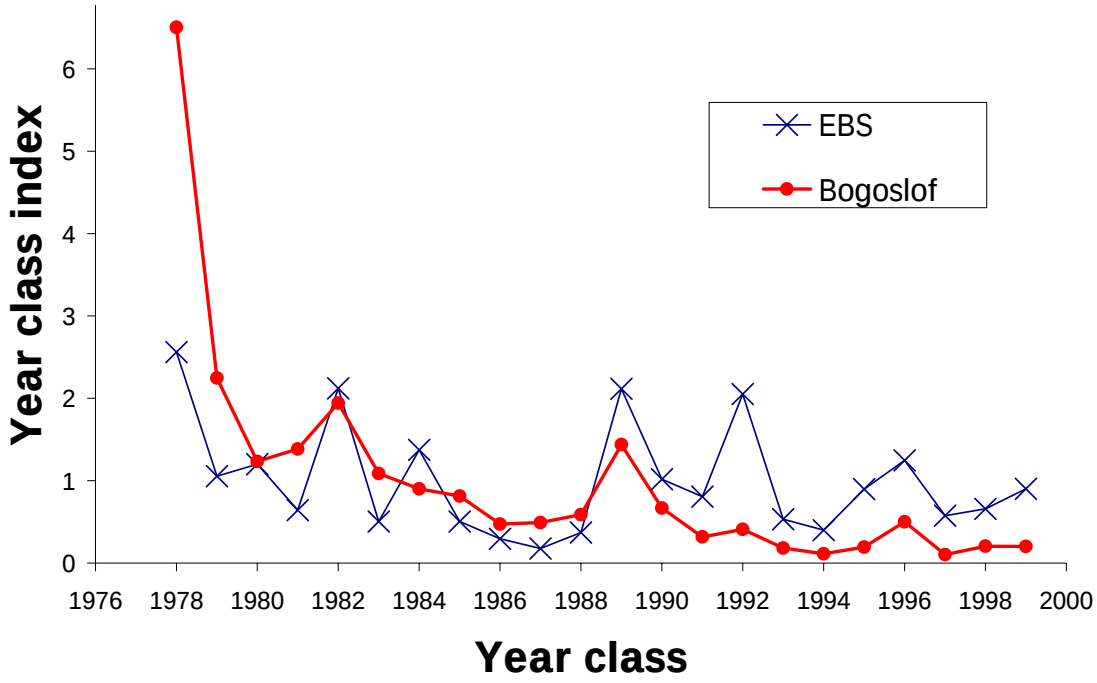

Figure 3. Relative year-class strengths (normalized to have a mean value of 1) for pollock as observed (averaged) from the Bogoslof EIT surveys and from a simple age-structured model for the Bogoslof Island stock compared with those observed from the main EBS pollock stock assessment model (Ianelli et al. 2004).

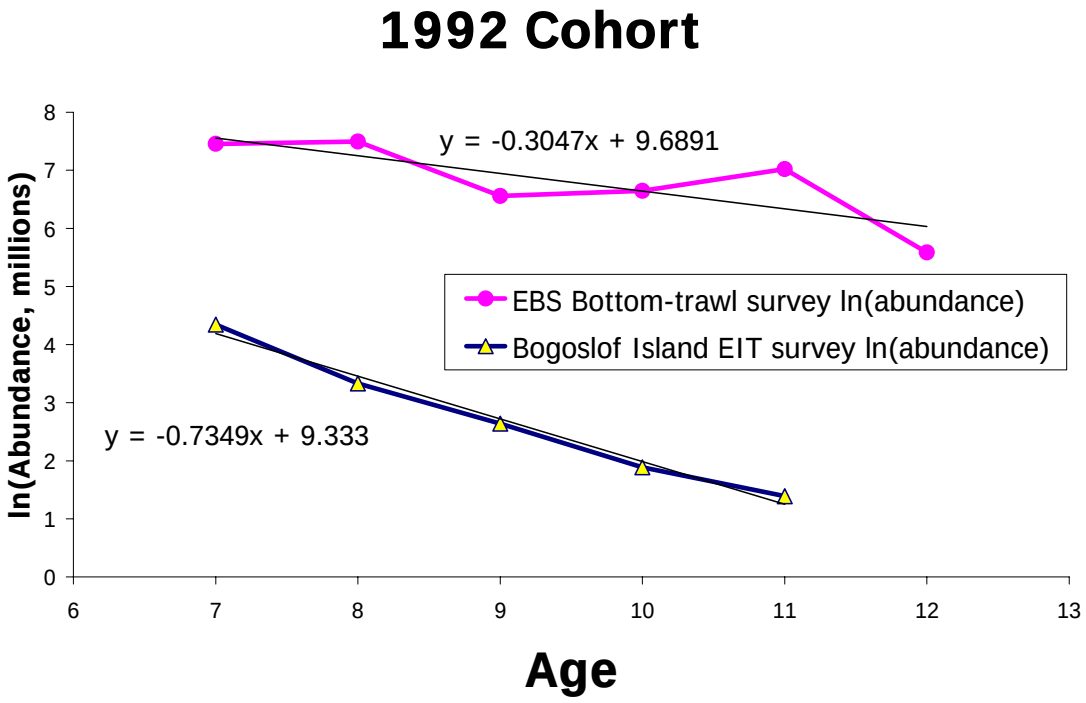

Figure 4. The 1992 pollock cohort abundances-at-age as observed from the EBS summer bottom trawl survey (top lines) and from the EIT survey in the Bogoslof region (lower lines).

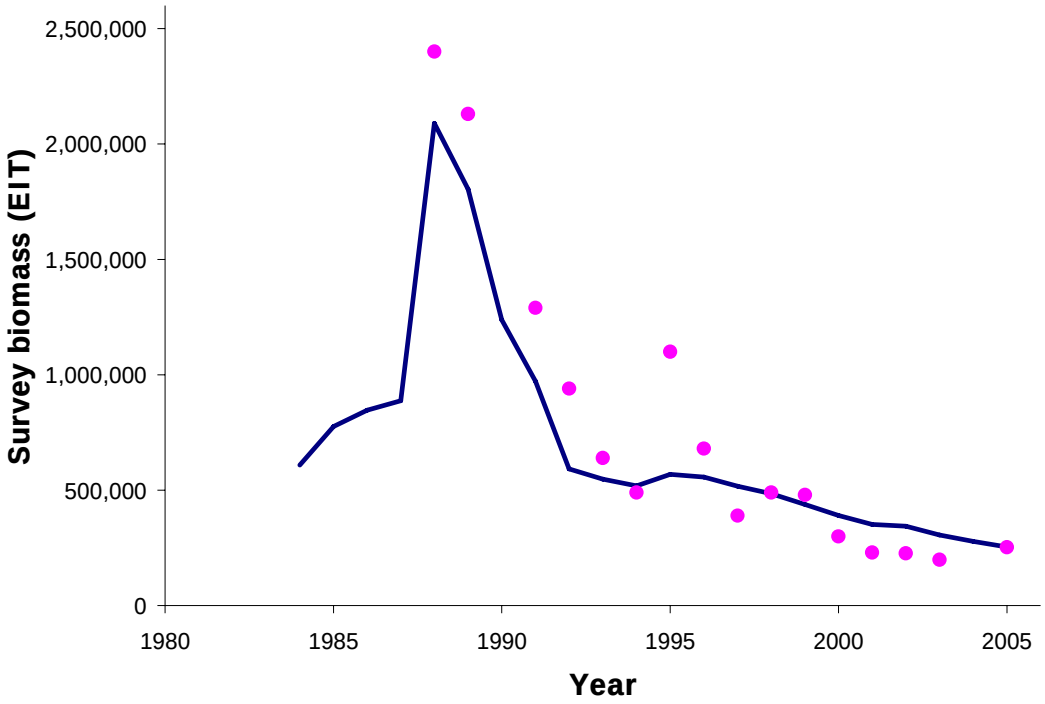

Figure 5. Simple age-structured model (line) tuned to the winter EIT Bogoslof pollock survey biomass estimates (points) 1984-2005.

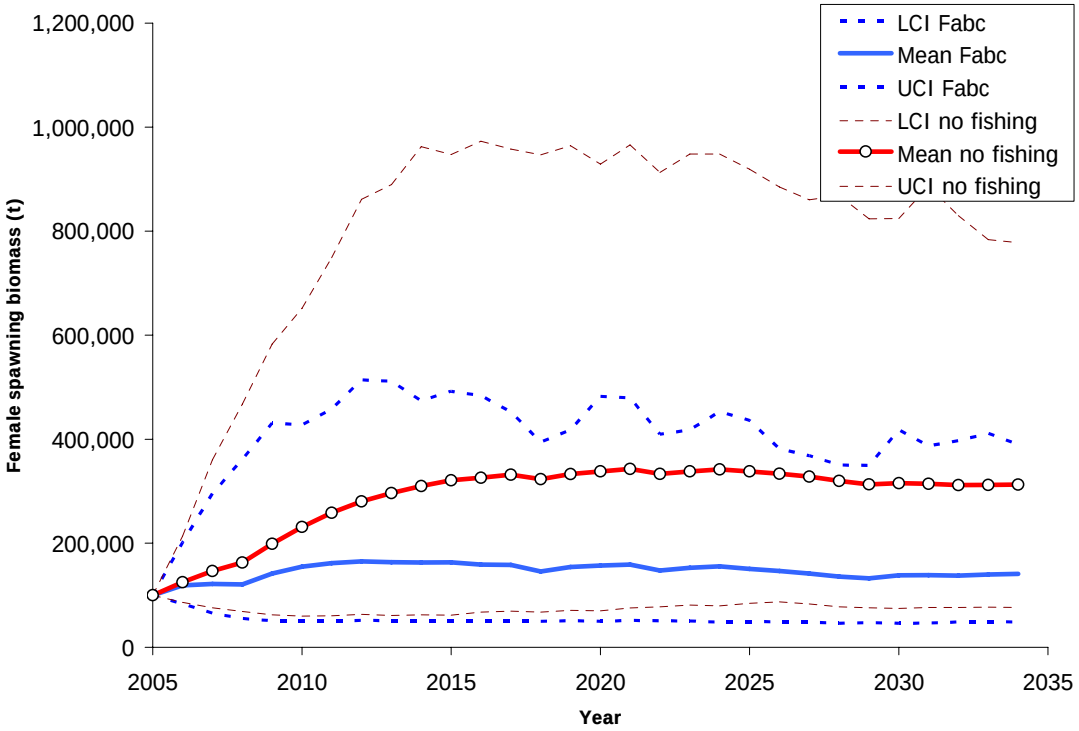

Figure 6. Projection simulations for Bogoslof region pollock based on the simple age structured model under no fishing and under fishing at the maximum permissible rate (as defined for the NPFMC for Tier 3 stocks).