Eastern Bering Sea pollock – *Gadus chalcogrammus*

Overall Vulnerability Rank = Low

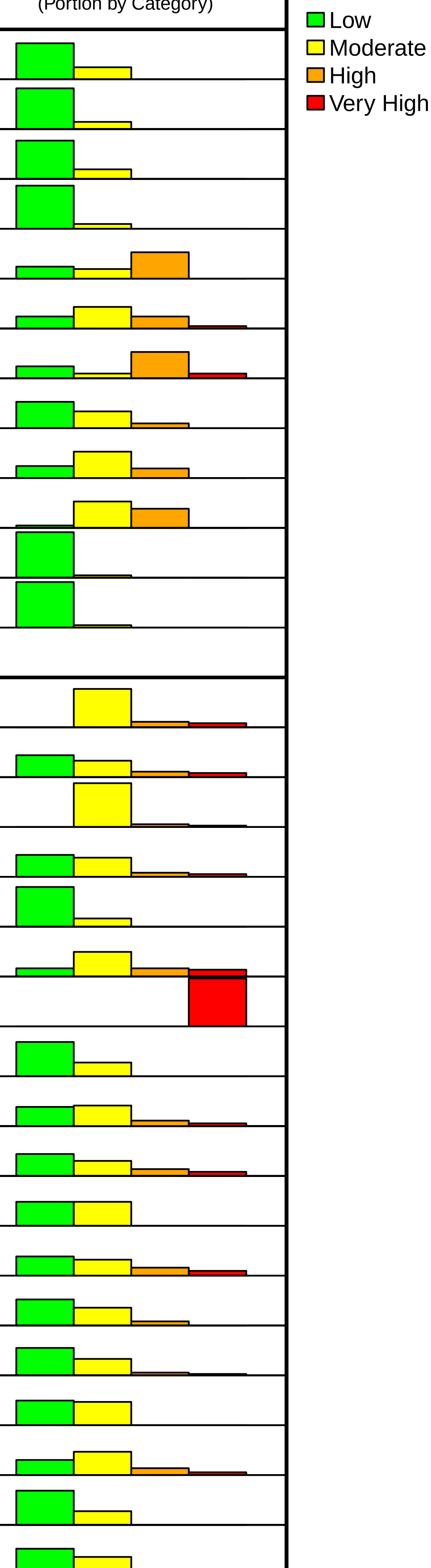
Biological Sensitivity = Low

Climate Exposure = Low

Sensitivity Data Quality = 83% of scores ≥ 2

Exposure Data Quality = 56% of scores ≥ 2

	Gadus chalcogrammus	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Habitat Specificity	1.2	2.2	
	Prey Specificity	1.1	2.4	
	Adult Mobility	1.2	2.4	
	Dispersal of Early Life Stages	1.1	2.1	
	Early Life History Survival and Settlement Requirements	2.3	1.8	
	Complexity in Reproductive Strategy	2.1	2.0	
	Spawning Cycle	2.5	2.5	
	Sensitivity to Temperature	1.6	2.4	
	Sensitivity to Ocean Acidification	1.9	1.7	
	Population Growth Rate	2.4	3.0	
	Stock Size/Status	1.0	2.5	
	Other Stressors	1.0	2.4	
	Sensitivity Score	Low		
Exposure factors	Sea Surface Temperature	2.3	2.2	
	Sea Surface Temperature (variance)	1.8	2.2	
	Bottom Temperature	2.1	3.0	
	Bottom Temperature (variance)	1.7	3.0	
	Salinity	1.2	2.0	
	Salinity (variance)	2.3	2.0	
	Ocean Acidification	4.0	3.0	
	Ocean Acidification (variance)	1.3	3.0	
	Phytoplankton Biomass	1.8	1.2	
	Phytoplankton Biomass (variance)	1.9	1.2	
	Plankton Bloom Timing	1.5	1.0	
	Plankton Bloom Timing (variance)	2.0	1.0	
	Large Zooplankton Biomass	1.5	1.2	
	Large Zooplanton Biomass (variance)	1.5	1.2	
	Mixed Layer Depth	1.5	1.0	
	Mixed Layer Depth (variance)	1.9	1.0	
	Currents	1.3	2.0	
	Currents (variance)	1.5	2.0	
	Air Temperature	NA	NA	
	Air Temperature (variance)	NA	NA	
	Precipitation	NA	NA	
	Precipitation (variance)	NA	NA	
	Sea Surface Height	NA	NA	
	Sea Surface Height (variance)	NA	NA	
	Exposure Score	Low		
Overall Vulnerability Rank		Low		



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Walleye pollock (Gadus chalcogrammus)

Overall Climate Vulnerability Rank: **Low**. (98% certainty from bootstrap analysis).

Climate Exposure: **Low**. With the exception of ocean acidification (4.0), all exposure factors had scores less than 2.5.

Biological Sensitivity: **Low**. Spawning cycle (2.5) was ranked as "moderate" sensitivity, whereas all other sensitivity attributes were ranked as "low" sensitivity.

Potential for distribution change: **Very High** (99% certainty from bootstrap analysis). Three attributes (adult mobility, dispersal of early life stages, and habitat specificity) indicated very high potential for distribution change.

Directional Effect in the Eastern Bering Sea (EBS): Projected climate change in the eastern Bering Sea is expected to have a negative effect on walleye pollock, with 92% certainty in expert scores.

Data Quality: 83% of the sensitivity attributes, and 56% of the exposure factors, had average data quality scores of 2 or greater (indicating at least "moderate" data quality).

Climate Effects on Abundance and Distribution: Pollock are a generalist in their habitat and prey use, but climate can affect their distribution and abundance in several ways. The timing of peak abundance of pollock eggs occurs earlier in warm years compared to cold years (Smart et al, 2012, Duffy-Anderson et al. 2015). Spawning occurs in aggregations and appears to be triggered by temperatures during late winter (warmer conditions result in earlier spawning) (Hinckley 1987, Ianelli et al. 2014, Duffy-Anderson et al. 2015). The effect of gyres and ocean currents on larval survival is considered as one factor towards year-class strengths. Mixing is also considered important as is the timing of wind-driven events and period of the bloom, and these factors could change be affected by climate change (Duffy-Anderson et al. 2015, Smart et al. 2012, Hunt et al. 2011, Mueter et al. 2011). Recruitment of pollock is diminished in warm years (Mueter et al. 2011, Spencer et al. 2016, with the mechanism thought to be the lack of large zooplankton in the late summer during warm years (Heintz et al. 2013).

Life History Synopsis: In the EBS pollock spawn generally in the period March-May and in relatively localized regions during specific periods (Bailey 2000). Generally spawning begins nearshore north of Unimak Island in March and April and later near the Pribilof Islands (Jung et al. 2006, Bacheler et al. 2010). Females are "iterative" spawners with up to 10 batches of eggs per female per year. Eggs and larvae of EBS pollock are planktonic for a period of about 90 days and appear to be sensitive to environmental conditions. These conditions likely affect their dispersal into favorable areas (for subsequent separation from predators) and also affect general food requirements for over-wintering survival (Gann et al. 2015, Heintz et al., 2013, Hunt et al. 2011). Pollock as feeders in the ecosystem have been considered to impact their forage with relatively high consumption rates as young-of-the year (e.g., Ciannelli et al. 2004, Boldt et al. 2012, Duffy-Anderson et al. 2015).

Throughout their range juvenile pollock feed on a variety of planktonic crustaceans, including calanoid copepods and euphausiids. In the EBS shelf region, one-year-old pollock are found throughout the water column, but also commonly occur in the NMFS bottom trawl survey. Ages 2 and 3 year old pollock are rarely caught in summer bottom trawl survey gear and are more common in the midwater zone as detected by mid-water acoustic trawl surveys. Younger pollock are generally found in the more northern parts of the survey area and a pattern of movement to the southeast occurs as they age (Buckley et al. 2009). Euphausiids, principally *Thysanoessa inermis* and *T. raschii*, are among the most important prey items for pollock in the Bering Sea (Livingston, 1991; Lang et al., 2000; Brodeur et al., 2002; Cianelli et al., 2004; Lang et al., 2005). Their diets with age become more piscivorous and cannibalism has been commonly observed for this region. However, Buckley et al. (2015) showed spatial patterns of pollock foraging by size of predators. For example, the northern part of the shelf region between the 100 and 200 m isobaths (closest to the shelf break) tends to be more piscivorous than counterparts in other areas.

Information available from ecosystem survey work in the Northern Bering Sea (NBS) region (north of Nunivak Island to the Russian convention line and into Norton Sound) suggests considerably more pollock present in 2017 compared to 2010 (1.3 million t in 2017 compared to 0.01 million t in 2010). Although the 2017 bottom temperatures were colder than recent years, the warm conditions in 2016 may have caused a portion of the pollock stock to move into this region (Ianelli et al. 2017).

Walleye pollock biomass has fluctuated somewhat with a period of poor year-classes between 2000 and 2005 which precipitated a drop in the acceptable biological catch (down to 800,000 t in 2009 and 2010. However, strong year-classes from 2008 and 2012 have resulted in substantial increases with total biomass estimates exceeding 10 million t in this region (Ianelli et al. 2017). The recent stock status based on the estimated female spawning biomass is well over the level estimated to provide MSY so the stock is well above the level of being overfished and also the fishing mortality rates have been maintained well below F_{msy} levels (Ianelli et al. 2017).

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