Alaska skate – *Bathyraja parmifera*

Overall Vulnerability Rank = Low

Biological Sensitivity = Moderate

Climate Exposure = Low

Sensitivity Data Quality = 75% of scores ≥ 2

Exposure Data Quality = 33% of scores ≥ 2

	Bathyraja parmifera	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Habitat Specificity	1.6	2.7	
	Prey Specificity	1.2	2.3	
	Adult Mobility	1.3	2.7	
	Dispersal of Early Life Stages	2.9	1.3	
	Early Life History Survival and Settlement Requirements	1.5	2.3	
	Complexity in Reproductive Strategy	2.9	2.3	
	Spawning Cycle	1.7	1.3	
	Sensitivity to Temperature	1.7	2.7	
	Sensitivity to Ocean Acidification	1.5	2.3	
	Population Growth Rate	3.9	3.0	
	Stock Size/Status	1.2	2.7	
	Other Stressors	1.3	1.3	
	Sensitivity Score	Moderate		
Exposure factors	Sea Surface Temperature	NA	NA	
	Sea Surface Temperature (variance)	NA	NA	
	Bottom Temperature	2.0	3.0	
	Bottom Temperature (variance)	2.0	3.0	
	Salinity	NA	NA	
	Salinity (variance)	NA	NA	
	Ocean Acidification	4.0	3.0	
	Ocean Acidification (variance)	1.3	3.0	
	Phytoplankton Biomass	1.4	1.2	
	Phytoplankton Biomass (variance)	1.5	1.2	
	Plankton Bloom Timing	1.6	1.0	
	Plankton Bloom Timing (variance)	2.1	1.0	
	Large Zooplankton Biomass	1.3	1.0	
	Large Zooplanton Biomass (variance)	1.5	1.0	
	Mixed Layer Depth	1.5	1.0	
	Mixed Layer Depth (variance)	2.0	1.0	
	Currents	NA	NA	
	Currents (variance)	NA	NA	
	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		

Low
Moderate
High
Very High

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Alaska skate (*Bathyraja parmifera*)

Overall Climate Vulnerability Rank: **Low**. (95% 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: **Moderate**. Population growth rate (3.9) was ranked as "very high" sensitivity, and complexity in reproductive strategy (2.9) and dispersal of early life stages (2.9) were ranked as "moderate" sensitivity.

Potential for distribution change: **High** (99% certainty from bootstrap analysis). Adult mobility indicated a very high potential for distribution change, whereas habitat specificity indicated a high potential for distribution change.

Directional Effect in the Eastern Bering Sea: Projected climate change in the eastern Bering Sea is expected to have a neutral effect on Alaska skate, with 59% certainty in expert scores.

Data Quality: 75% of the sensitivity attributes, and 33% 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: Potential climate effects on Alaska skate abundance are unknown. However, a large increase in abundance on the eastern Bering Sea (EBS) shelf during the 1980s may have been associated with the late 1970s climate regime shift that resulted in a period of warmer ocean temperatures (Ormseth 2016). Alaska skates are known to make horizontal movements of up to 100s of kilometers, including ontogenetic migrations across the breadth of the EBS shelf (Ormseth 2016). The horizontal and vertical distribution of big skate *Beringraja binoculata* and longnose skate *Raja rhina* was altered during a period of anomalously warm temperatures in Alaskan waters, particularly the Gulf of Alaska (Ormseth 2017).

Life History Synopsis: Alaska skate occurs throughout the Bering Sea and Aleutian Islands, most commonly at depths of 50 to 200 m (Stevenson 2004). It is particularly dominant on the EBS shelf where it has accounted for between 91% and 97% of aggregate skate biomass estimates since species identification became reliable in 1999 (Ormseth 2016). It is an omnivorous demersal species with a diet that includes fish, crabs, and shrimp.

Alaska skate is relatively long-lived (maximum observed age of 20 years) and slow to mature (length at 50% maturity is 9-10 years), suggesting a vulnerable life history strategy. Females produce two eggs at a time, which are enclosed in a leathery eggcase before being released by the female. Alaska skate eggcases are deposited in small, highly discrete areas along the upper continental slop known as skate nurseries. Densities of eggcases in these areas can be over 100,000 km^{-2} (Hoff 2007). Cohort analysis based on embryo lengths measured at an Alaska skate nursery site in the EBS suggested that Alaska skate embryos have an egg-case development time of over 3 years, possibly due to the cold ocean temperatures in the EBS (Hoff 2007). Captive studies at the Alaska Sealife Center (Seward, AK) have provided preliminary data that validate this conclusion and suggest that embryo development is highly influenced by ambient

temperature (J. Guthridge, ASLC, pers. comm.). Skate species in more southerly waters where temperatures are warmer have dramatically shorter embryonic stages (Hoff 2007). Increased temperatures in the EBS may therefore result in reduced embryo development time and altered population dynamics. The location of skate nurseries may also be dependent on the availability of dissolved oxygen (DO), so changes in DO in the EBS may also impact embryos.

Alaska skate is managed as part of the Bering Sea and Aleutian Islands skate complex. The results of an age-structured model are used to make harvest recommendations that are then combined with the harvest recommendations for the other skate species to make a single set of harvest recommendations for the complex. The biomass of the skate complex increased dramatically during the 1980s but since then has been fairly stable. As of 2016 the stock is not overfished or subjected to overfishing (Ormseth 2016).

Literature Cited:

Hoff, G.R. 2007. Reproduction of the Alaska skate (*Bathyraja parmifera*) with regard to nursery sites, embryo development and predation. PhD dissertation, University of Washington, Seattle.

Ormseth, O.A. 2016. Assessment of the skate stock complex in the eastern Bering Sea and Aleutian Islands. In: Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions, pp. 1769-1868. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501.

Ormseth, O.A. 2017. Assessment of the skate stock complex in the Gulf of Alaska. In: Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska region, pp. 1497-1546. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501.

Stevenson, D. 2004. Identification of skates, sculpins, and smelts by observers in north Pacific groundfish fisheries (2002-2003), U.S. Department of Commerce Technical Memorandum NMFS-AFSC142. 67 p.