Alaska plaice − *Pleuronectes quadrituberculatus*

Overall Vulnerability Rank = Low

Biological Sensitivity = High

Climate Exposure = Low

Sensitivity Data Quality = 92% of scores ≥ 2

Exposure Data Quality = 56% of scores ≥ 2

	Pleuronectes quadrituberculatus	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Habitat Specificity	1.4	3.0	
	Prey Specificity	1.4	3.0	
	Adult Mobility	1.4	3.0	
	Dispersal of Early Life Stages	1.2	2.5	
	Early Life History Survival and Settlement Requirements	2.6	1.5	
	Complexity in Reproductive Strategy	1.6	2.2	
	Spawning Cycle	3.8	2.5	
	Sensitivity to Temperature	1.8	2.5	
	Sensitivity to Ocean Acidification	1.1	2.8	
	Population Growth Rate	3.5	3.0	
	Stock Size/Status	1.0	3.0	
	Other Stressors	1.3	2.8	
	Sensitivity Score	High		
Exposure factors	Sea Surface Temperature	2.1	2.2	
	Sea Surface Temperature (variance)	1.3	2.2	
	Bottom Temperature	2.2	3.0	
	Bottom Temperature (variance)	1.8	3.0	
	Salinity	1.4	2.0	
	Salinity (variance)	2.2	2.0	
	Ocean Acidification	4.0	3.0	
	Ocean Acidification (variance)	1.3	3.0	
	Phytoplankton Biomass	2.2	1.2	
	Phytoplankton Biomass (variance)	1.9	1.2	
	Plankton Bloom Timing	1.6	1.0	
	Plankton Bloom Timing (variance)	1.9	1.0	
	Large Zooplankton Biomass	1.8	1.2	
	Large Zooplanton Biomass (variance)	1.3	1.2	
	Mixed Layer Depth	1.3	1.0	
	Mixed Layer Depth (variance)	1.8	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		

Low
Moderate
High
Very High

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Alaska plaice (*Pleuronectes quadrituberculatus*)

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: **High**. Spawning cycle (3.8) and population growth rate (3.6) were ranked as "very high" sensitivity.

Potential for distribution change: **Very High** (60% certainty from bootstrap analysis). Three attributes (adult mobility, dispersal of early life stages, and habitat specificity) indicated 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 plaice, with 85% certainty in expert scores.

Data Quality: 92% 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: It is not known what effect the climate has on the distribution and abundance of Bering Sea Alaska plaice. Estimates of recruitment variability are low and have not been linked to any particular environmental variable although it is suspected that a year effect on somatic growth exists where temperature is positively correlated with annual bottom temperature as for yellowfin sole and northern rock sole. Analysis of spatial abundance from survey catches did not indicate large differences in population distributions between warm and cold years (Spencer 2008). Temperature effects on spawning are unknown. Alaska plaice have a blood glycolprotien that inhibits ice crystal formation enabling increased tolerance to colder temperatures (Knight et al. 1991). Tolerance and/or behavior response to warming is unknown.

Life History Synopsis:

Adults exhibit a benthic lifestyle and live year round on the shelf and move seasonally within its limits. From over-winter grounds near the shelf margins, adults begin a migration onto the central and northern shelf of the eastern Bering Sea, primarily at depths of less than 100 m. Spawning aggregations probably form on the middle shelf and some near-shore areas of Bristol Bay (Wilderbuer et al. 2014). The extent of the migrations are unknown. Spawning usually occurs in March and April on hard sandy ground. This habitat is abundant and partially disturbed. Existing on both sand and mud and sand/mud habitats, they may be considered habitat generalists. They are also abundant in the northern Bering Sea (Wilderbuer et al. 2014, Lauth 2011, Lauth and Conner 2014. Zhang 1987). Alaska plaice have been aged as old as 36 years and their age at 50% maturity is estimated at 9.6 years (TenBrink and Wilderbuer 2015).

Eggs are pelagic and, after hatching, larvae have been found in ichthyoplankton sampling over a widespread area of the middle Bering Sea shelf, typically in late spring through summer (Duffy-Anderson et al. 2010, Norcross and Holladay 2005, NPFMC 2010). Advection may be crucial for Alaska plaice as the spawning and nursery grounds are spatially separate. This species may rely on tides, currents and winds to deliver larvae to inshore areas where metamorphosis occurs (Wilderbuer et al. 2002, 2013; Duffy-Anderson et al. 2010). The survival of larvae is thought to be more strongly dependent upon arrival of the larvae to the preferred nursery areas and the availability of suitable prey than on predation pressure. Food availability is unknown but larvae can be advected to undesirable locations where a mismatch can occur. The extent of larval starvation is unknown.

The age at metamorphosis is unknown but is assumed to be around 100 days. Upon settlement in nearshore areas from 1-40 m deep, juveniles preferentially select sediment suitable for feeding on meiofaunal prey and burrowing for protection. Small juvenile fish feed on meiofaunal prey such as gammarid amphipods, larger juveniles feed on polychaetes, bivalves, amphipods and echiurids. Juveniles are separate from the adult population, remaining in shallow areas (<50m) until they reach approximately 15-20 cm. Adults consume polycheates, bivalves, amphipods and echinoderms. The diet depends on substrate type and they tend to be generalists (Yang and Yeung 2013, Yeung and Yang 2014, Yeung et al. 2013, Livingston and Dereynier 1996). Recent study (Yeung et al. 2013) indicates that the polycheate proportion of diet (by weight) may be as high as 50%.

Literature Cited:

Duffy-Anderson, J., M. Doyle, K. Mier, P. Stabeno, and T. Wilderbuer. 2010. Early life ecology of Alaska plaice (*Pleuronectes quadrituberculatus*) in the eastern Bering Sea: seasonality, distribution and dispersal. J. Sea Res. Vol. 64, issues 1-2, pages 3-14.

Knight,C., C. Cheng, and A DeVries. 1991. Absorbtion of alpha-helix antifreeze peptides on specific ice crystal surface planes. Biophysical J. 59(1991)409-418.

Lauth, R. 2011. Results of the 2010 eastern and northern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate fauna. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-227, 256 p. (.pdf, 13 MB).

Lauth, R., and J. Conner. 2014. Results of the 2011 Eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate fauna. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-266, 176 p. (.pdf, 8 MB).

Livingston, P.A. and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.Norcross, B. and B. Holladay. 2005. Feasibility to design and implement a nearshore juvenile flatfish survey-eastern Bering Sea. Final Tech. Rep., Coop. Inst. Arctic Research. Award No. NA17RJ1224.

NPFMC (North Pacific Fishery Management Council). 2010. Essential Fish Habitat (EFH): 5-year review for 2010, Summary Report. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501.

Spencer, P.D. 2008. Density-independent and density-dependent factors affecting temporal changes in spatial distributions of eastern Bering Sea flatfish. Fish. Oceanogr. 17:396-410.

TenBrink, T. T. and T. K. Wilderbuer. 2015. Updated maturity estimates for flatfishes (Pleuronectidae) in the eastern Bering Sea, with notes on histology and implications to fisheries management. Coastal and Marine Fisheries 7(1):474-482.

Wilderbuer, T., A., Hollowed, A., Ingraham, J., Spencer, P., Conner, L., Bond, N., Walters, G. 2002. Flatfish recruitment response to decadal climatic variability and ocean conditions in the eastern Bering Sea. Progress in Oceanography, 55, 235-247.

Wilderbuer, T., W. Stockhausen, N. Bond. 2013. Updated analysis of flatfish recruitment response to climate variability and ocean conditions in the Eastern Bering Sea. Deep Sea Research II 94(2013) 157-164.

Wilderbuer, T.K. and D. Nichol and P. Spencer. 2014. Assessment of the Alaska plaice stock in the Eastern Bering Sea and the Aleutian Islands. In Stock Assessment and Fishery Evaluation Report for the groundfish resources of the Eastern Bering Sea and Aleutian Islands. Compiled by the Plan Team for the fishery resources of the Bering Sea and Aleutian Islands. North Pacific Fisheries Management Council, Anchorage, AK.

Yang, M. and C. Yeung. 2013. Habitat-associated Diet of some flatfish in the southeastern Bering Sea. NOAA Tech. Mem. NMFS-AFSC-246.

Yeung, C, and M. Yang. 2014. Habitat and infauna prey availability for flatfishes in the northern Bering Sea. Polar. Biol (2014) 37:1669-1784.

Yeung, C, M. Yang, S. Jewett, A. Naidu. 2013. Polychaete assemblage as surrogate for prey availability in assessing southeastern Bering Sea flatfish habitat. J. Sea Res. 76(2013)211-221.

Zhang, C.I. 1987. Biology and Population Dynamics of Alaska plaice, *Pleuronectes quadriterculatus*, in the eastern Bering Sea. PhD. Dissertation, University of Washington. P 1-225.