

Commercial fish and shellfish condition, survival, population biomass and catch have been negatively impacted by extreme events such as the 2014-2016 and 2018-2019 Marine Heat Waves in the Gulf of Alaska and Bering Sea and record low ice cover in the Bering Sea. Alaska fishermen and coastal communities that depend on vulnerable commercial fish species such Pacific cod, salmon and crab have experienced significant and ongoing economic losses.<sup>i</sup> Negatively impacted species support high revenue fisheries and a large proportion of Alaska fishermen earnings – and U.S. fishery harvest value.<sup>ii</sup>

Pacific cod are highly vulnerable to ocean warming - the Gulf of Alaska population declined by over two-thirds in abundance during the heat wave.<sup>iii</sup> The fishery accounts for nearly a third of Gulf of Alaska groundfish fishery value and supports the largest groundfish fleet - mostly smaller fixed gear vessels owned by Alaska residents.<sup>iv</sup> The fishery was a declared disaster in 2018 and again in 2020.<sup>v</sup> Harvests declined by 80 percent from 2015-2019 and fishermen's earning dropped from \$50 million to \$15.5 million.<sup>vi</sup> The fleet shrunk in half, from 386 to 176 vessels.<sup>vii</sup>

The Bering Sea snow crab and Bristol Bay red king crab fisheries are among the most highly valuable fisheries in the U.S.<sup>viii</sup> Roughly 100 vessels, 500 crew members, 12 processing plants and 2,500 workers depend on red king crab and snow crab because their high value and volume, respectively.<sup>ix</sup> 2021 surveys identified record low abundances of snow crab and suggest a mass mortality event.<sup>x</sup> The total snow crab biomass declined 86% relative to 2018.<sup>xi</sup> The Bristol Bay mature red male king crab biomass has declined by over two-thirds, closing the fishery for the 2021-22 season.<sup>xii</sup> The economic losses are likely to exceed several hundred million dollars to fishermen and processors.<sup>xiii</sup>

Salmon is Alaska's most important commercial fish species, accounting for over a third of Alaska's fishery value.<sup>xiv</sup> Ten Alaska commercial salmon fisheries from Norton Sound to Southeast Alaska suffered disastrous returns in recent years, affecting fishermen and workers throughout the state.<sup>xv</sup> Western Alaska fishermen have lost access to commercial Chinook salmon fisheries, making chum salmon the most important commercial salmon species in the region.<sup>xvi</sup> Poor conditions in the marine environment have caused ongoing and unprecedented chum run failures throughout western Alaska.<sup>xvii</sup> The impacts are as dramatic as larger economic losses in other fisheries because of the importance the cash income to western Alaska rural communities.<sup>xviii</sup>

Southeast Alaska salmon suffered from warming rivers and the Gulf of Alaska marine heat wave.<sup>xix</sup> 2017 was the last "normal" year with a catch of 50.1 million salmon and ex-vessel value of \$133 million.<sup>xx</sup> Fishermen's earnings have since dropped each year to a low of \$50 million in 2020.<sup>xxi</sup> Because

of a disastrously low even-year pink salmon return, the 2018 and 2020 harvests of 21.9 and 14.3 million fish were the lowest this century.<sup>xxii</sup> Sockeye salmon entering western Gulf of Alaska streams also returned at historically low levels following the heatwave. Chignik fishermen typically harvested over a million sockeye worth nearly \$9 million a year, but there were no harvests in 2018 and 2020, and the 2021 harvest barely exceeded 100,000 fish.<sup>xxiii</sup> From 2011-2015 the Upper Cook Inlet sockeye fishery generated \$35.2 million in average annual ex-vessel value with harvests typically exceeding several million fish.<sup>xxiv</sup> Annual average fishery values dropped to \$14.2 million between 2016-2020, including two declared disaster years in 2018 and 2020.<sup>xxv</sup>

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<sup>i</sup> Hunt, G.L., L. Eisner & N.M. Call. 2021. How will diminishing sea ice impact commercial fishing in the Bering Sea? *Arctic, Antarctic and Alpine Research* 53:1, 269-270; Westley, P.A.H. 2020. Documentation of en route mortality of summer chum salmon in the Koyukuk River, Alaska and its potential linkage to the heatwave of 2019. *Ecology and Evolution* 2020; 10:10296-10304; Siddon, E. 2021. Ecosystem Status Report 2021: Eastern Bering Sea, Stock Assessment and Fishery Evaluation Report. North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, AK 99501. Suryan et al. 2021. Ecosystem response persists after a prolonged marine heatwave. *Scientific Reports* (2021) 11:6235. Barbeaux, S.J., K. Holsman & S. Zador. 2020. Marine heatwave stress test of ecosystem-based fisheries management in the Gulf of Alaska Pacific Cod fishery. *Frontiers in Marine Science* 7:703.

<sup>ii</sup> Suryan et al. 2021. Barbeaux, S.J., et al 2020.

<sup>iii</sup> *Id.*

<sup>iv</sup> Fissel, B. et al. 2020. Stock Assessment and Fishery Evaluation Report for the groundfish fisheries of the Gulf of Alaska and Bering Sea/Aleutian Islands Area: Economic status of the groundfish fisheries off Alaska, 2019. Alaska Fisheries Science Center, Seattle, WA. January 5, 2021. See p. 3 & Tables 8, 26, 29 (between 70-79% of ex-vessel values accrue to Alaska residents; fixed gear vessels harvested slightly more than 75% of cod caught between 2015-2019; the median length of fixed gear vessels is between 40' and 58').

<sup>v</sup> Alaska Department of Fish and Game. 2020. Final DRAFT Distribution Plan for funds appropriated to address the 2018 Gulf of Alaska Pacific cod disaster declaration. Juneau, AK. December 15, 2020.;

<https://www.fisheries.noaa.gov/national/funding-and-financial-services/fishery-disaster-determinations>

<sup>vi</sup> Fissel, B. et al. 2020 at 3, Table1, p. 27; see also Alaska Department of Fish and Game. 2020. Final DRAFT Distribution Plan for funds appropriated to address the 2018 Gulf of Alaska Pacific cod disaster declaration; (Identifying unprecedented warming caused by the 2014-2016 heatwave and its 2018-2019 successor likely caused significant declines and estimating Gulf of Alaska cod harvester losses of nearly \$71 million- 72 percent of harvest value and processor estimated losses of \$61.3 million).

<sup>vii</sup> Fissel, B. et al. 2020. Table 9; see also *id.* Table 36 (Fishing effort in terms of time at sea dropped by over 75 percent between 2015 and 2019). Source for Table below: Fissel, B. et al. 2020 Tables 1, 3, 9.

	Catch	Ex-vessel value	# of vessels
2015	79.5	50.1	386
2016	64.1	40.9	360
2017	48.7	35.3	246
2018	15.2	14.3	154
2019	15.7	15.5	176

<sup>viii</sup> Garber-Yonts, B. & J. Lee. 2020. Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Gulf of Alaska and Bering Sea/Aleutian Islands Area: Economic Status of the BSAI King and Tanner Crab Fisheries Off Alaska 2019. Alaska Fisheries Science Center, Seattle, WA. January 21, 2020 (noting that the 63.1 million pound Alaska crab catch (including the Gulf of Alaska) accounted for 5% of total ex-vessel value of U.S. commercial seafood landings but less than a percent (.66%) of harvested seafood volume, and in Alaska, crab fisheries comprise 16.7 percent of ex-vessel value with just 1.13% of harvested seafood volume). In 2018, crew earned \$22 million, processing workers earned \$4.9 million. Snow crab supports the most processing worker earnings in general, at \$2.85 million in 2018. Each vessel typically earns between \$2.4 million and \$3.7 million and provides some of the highest paying crew jobs in Alaska, with crew members earning between \$100,000 and \$200,000 annually.

<sup>ix</sup> *Id.* (Garber-Yonts, B. & J. Lee. 2020).

<sup>x</sup> Szuwalski, C. 2021. An assessment for eastern Bering Sea snow crab at 3. Report, North Pacific Fishery Management Council, 1007 W. 3<sup>rd</sup> Ave, Suite 400, Anchorage, AK 99501.

<sup>xi</sup> Siddon, E. 2021. Ecosystem Status Report 2021: Eastern Bering Sea, Stock Assessment and Fishery Evaluation Report at 145. North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, AK 99501

<sup>xii</sup> *Id.* (Siddon, E. 2021); Litzow, M. 2021. Powerpoint: Bering Sea crab bottom trawl survey results. North Pacific Fishery Management Council. October 6, 2021; <https://fishermensnews.com/bristol-bay-red-king-crab-fishery-closed-for-2021-22/>; see also Swiney, K.M., W.C. Long & R.J. Foy. Decreased pH and increased temperatures affect young-of-the-year red king crab. ICES Journal of Marine Science 74: 1191-1200 (projecting that ocean warming and acidification may reduce the population below harvestable levels over the course of the 21<sup>st</sup> century).

<sup>xiii</sup> Table below reflects published data through 2018. Source: Garber-Yonts, B. & J. Lee. 2020. Tables 3.4, 3.8

Year	Snow Crab (million pounds)	Ex-vessel Value (million dollars)	Wholesale Value (million dollars)	Bristol Bay Red King Crab (million pounds)	Ex-vessel Value (million dollars)	Wholesale Value (million dollars)
2015	69.9	\$130.6	\$182.2	9.8	\$82.4	\$99.8
2016	39.6	\$112.5	\$160.4	8.4	\$91.1	\$108.1
2017	21.3	\$89.3	\$102.2	6.6	\$61.5	\$73.6
2018	18.8	\$75.2	\$87.7	4.2	\$44.0	\$51.2

<sup>xiv</sup> McKinley Group. 2022. The economic value of Alaska’s seafood industry. Prepared for: Alaska Seafood Marketing Institute.

<sup>xv</sup> <https://www.fisheries.noaa.gov/national/funding-and-financial-services/fishery-disaster-determinations>; State of Alaska. 2021. Letter re: State of Alaska Federal Fishery Disaster Requests. Warming rivers are also a contributing factor. See, e.g. Westley, P.A.H. 2020. Documentation of en route mortality of summer chum salmon in the Koyukuk River, Alaska and its potential linkage to the heatwave of 2019. Ecology and Evolution 2020; 10:10296-10304; Von Biela, V.R. et al. 2020. Evidence of prevalent heat stress in Yukon River Chinook salmon. Can. J. Fish. Aquat.Sci. 77: 1878-1892 (2020).

<sup>xvi</sup> Estenzen, J.L. et al. 2018. Annual management report Yukon Area, 2017. Alaska Department of Fish and Game, Fishery Management Report NO. 18-28, Anchorage. Appx. A11 (Yukon River commercial fishermen historically harvested upwards of 100,000 chinook worth up to \$5 million in peak years but now focus on summer and fall chum and fall coho in Yukon River fisheries with average value from 2012-2016 as \$5.1 million); JTC (Joint Technical Committee of the Yukon River U.S./Canada Panel). 2021. Yukon River salmon 2020 season summary and 2021 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3.A21-01, Anchorage. See Figure 4 & Appx. B2 & B3 (showing no Chinook commercial harvest in 2012-2014, 2015-2016, 2018, 2020 and chum harvests averaging over 800,000 fish per year from 2015-2019); Alaska Department of Fish and Game. 2017. 2017 Preliminary Yukon River Summer Season Summary. Anchorage, AK. October 6, 2017(Appendix C (reporting an average annual ex-vessel value of \$1.7 million from Yukon River summer chum from 2013-2017).

<sup>xvii</sup> Siddon, E. 2021. Ecosystem Status Report 2021: Eastern Bering Sea, Stock Assessment and Fishery Evaluation Report at 25-27. North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, AK 99501.

<sup>xviii</sup> Oke, K.B. et al. 2020. Recent declines in salmon body size impact ecosystems and fisheries. *Nature Communications* (2020) 11:4155. See also Tiernan, A., & B.P. Gray. 2020. 2018 Kuskokwim area management report. Alaska Department of Fish and Game, Fishery Management Report No. 20-23, Anchorage (identifying 38 communities and 4,800 households situated in the area of the Kuskokwim River that fish within the mainstem and many tributaries that contain salmon, and along the Bering Sea coast).

<sup>xix</sup> Pink salmon in particular suffered from drought conditions and the heat waves and returned below projected levels in each of the heat wave years from 2014-2018. See Alaska Department of Fish and Game. 2019. 2020 NOAA Fisheries Alaska Department of Fish and Game Southeast Alaska Pink salmon harvest forecast. Ketchikan, AK. November 20, 2019. Conrad, S. & D. Gray. 2018. Overview of the 2017 Southeast Alaska and Yakutat commercial, personal use, and subsistence salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 18-01, Anchorage. Tables 1, 11.

<sup>xx</sup> Sources: Alaska Department of Fish and Game. 2019. 2020 NOAA Fisheries Alaska Department of Fish and Game Southeast Alaska Pink salmon harvest forecast. Ketchikan, AK. November 20, 2019; Conrad, S. & D. Gray. 2018; Alaska Department of Fish and Game 2018-2020 Salmon Season summaries.

Year	Millions of fish	Ex-vessel Value (millions)	Pink salmon harvest	Pink salmon ex-vessel value
2007-2016 average	53.1	\$129.9	38.9	
2018	21.9	\$108.0	7.8	\$11.3
2019	32.2	\$101.8	21.1	\$23.7
2020	14.3	\$50.1	8.0	\$6.2

<sup>xxi</sup> *Id.*

<sup>xxii</sup> *Id.*

<sup>xxiii</sup> Alaska Department of Fish and Game. 2021. 2021 Chignik commercial salmon season summary. Juneau, AK. November 19, 2021. Tables 3, 4. Available at:

<https://www.adfg.alaska.gov/index.cfm?adfg=fishingCommercial.main>

Year	Chignik sockeye	Ex-vessel Value (millions)
2011-2020 average	1,180,560	\$8.916
2016-2020 average	586,098	\$4.058
2018	128	\$.001
2019	638,784	\$5.062
2020	0	0
2021	118,785	.867

<sup>xxiv</sup> Marston, B. & A. Frothingham. 2019. Upper Cook Inlet commercial fisheries annual management report, 2018. Alaska Department of Fish and Game, Fishery Management Report No. 19-25, Anchorage, Appx. B-7 (sockeye typically comprise 93% of the fishery's economic value).

<sup>xxv</sup> *Id.*; Alaska Department of Fish and Game. 2021. 2021 Upper Cook Inlet commercial salmon season summary. Soldotna, AK. November 15, 2021. Table 1. Available at:

<https://www.adfg.alaska.gov/index.cfm?adfg=fishingCommercial.main>

Year	Numbers of fish	Ex-vessel value
1975-2020 average	3,219,919	
2011-2020 average	2,356,914	\$24.7
2018	817,879	\$10.1
2020	695,754	\$4.06