Pribilof Islands Golden King Crab Stock Assessment 2026 DRAFT

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Executive Summary

1. **Stock**: Golden king crab, *Lithodes aequispinus*, Pribilof Islands (Pribilof District), Alaska.

2. **Catch**: Commercial fishing for golden king crab in the Pribilof District has been concentrated in the Pribilof Canyon. The domestic fishery developed in 1982/83, although some limited fishing occurred at least as early as 1981/82. Peak retained catch occurred in 1983/84 at 856,475 lb (388 t). The fishing season for this stock has been defined as a calendar year (as opposed to 1-July to 30-June crab fishing year) after 1983/84. Since then, participation in the fishery has been sporadic and annually retained catch has been variable: from there being none in the ten years that no vessels participated (1984, 1986, 1990–1992, 2006–2009, 2015, and 2016) to 341,908 lb (155 t) in 1995, when seven vessels made landings. The fishery is not rationalized and there is no state harvest strategy in regulation. A guideline harvest level (GHL) was first established for the fishery in 1999 at 200,000 lb (91 t). The GHL was reduced to 68 t (150,000 lb) for 2000–2014 and reduced to 59 t (130,000 lb) in 2015. No vessels participated in the directed fishery and no landings were made during 2006–2009 or 2015-2016. Catch data from 2003–2005, 2010–2014, and 2017-2019 cannot be reported here under the confidentiality requirements of State of Alaska (SOA) statute Sec. 16.05.815. The 2003 and 2004 fisheries were closed by emergency order to manage the retained catch towards the GHL; the 2005 and 2010–2014, 2017-2019 fisheries were not closed by emergency order. Four vessels participated in both 2020 and 2021, harvesting 48.8 t (107,679 lb) and 15.5 t (34,216 lb), respectively. Only 1 - 3 vessels have participated in the fishery annually since 2021, thus catch information is confidential.

   Discarded (non-retained) catch has occurred in the directed golden king crab fishery, the eastern Bering Sea snow crab fishery, the Bering Sea grooved Tanner crab fishery, and in Bering Sea groundfish fisheries.

   Estimates of annual discard mortality during due to crab fisheries range from 0 t (0 lb) to 17.2 t (37,902 lb), with an average of 2.7 t (5,856 lb) . Estimates of annual fishery mortality during 1991/92–2025 due to groundfish fisheries range from 0.05 t (110 lb) to 8.8 t (19,489 lb), with an average of 2.2 t (4,762 lb) (estimates of annually discarded catch during Bering Sea groundfish fisheries are reported for crab fishing years (July to June) from 1991 to 2008, and by calendar years from 2009 to 2021).

3. **Stock biomass**: Stock biomass (all sizes, both sexes) of golden king crab have been estimated for the Pribilof Canyon area using the area-swept technique applied to data obtained from the biennial eastern Bering Sea upper continental slope trawl survey performed by NMFS in 2002, 2004, 2008, 2010, 2012, and 2016 (Hoff and Britt 2003, 2005, 2009, 2011; Hoff 2013, 2016). See Appendix A1 for summaries of the slope survey as they pertain to data on and estimates of Pribilof Island golden king crab stock biomass. Complete data on size-sex composition of survey catch are available only from the 2008–2016 biennial surveys (J. Hoff, NMFS, Kodiak). Biomass estimates by sex and size class from the 2008, 2010, 2012, and 2016 surveys were presented in May 2017 (Pengilly and Daly 2017).

4. **Recruitment**: Estimated from size-sex composition data from the eastern Bering Sea upper continental slope trawl survey, mature male biomass in the entire survey area increased slightly from 1,790,154 lb (812 t) in 2012 to 1,916,329 lb (869 t) in 2016, and from 564,383 lb (256 t) in 2012 to 1,021,602 lb (463 t in 2016 in the Pribilof canyon.

5. **Management performance**: No overfished determination (i.e., MSST) has been made for this stock, although approaches to using data from the biennial NMFS eastern Bering Sea upper continental slope surveys have been presented to, and considered by, the Crab Plan Team (Gaeuman 2013a, 2013b; Pengilly 2015, Pengilly and Daly 2017; Jackson and Daly 2023). Four vessels participated in both 2020 and 2021, harvesting 48.8 t (107,679 lb) and 15.5 t (34,216 lb), respectively. Directed catch information has been confidential since 2021. Bycatch mortality in groundfish fisheries during 2024 - 2026 was 1.78 t (3,925 lb), 0.11 t (243 lb), and 0.05 t (110 lb), respectively. Overfishing did not occur in 2023, 2024, 2025. The GHL for the 2023-2026 seasons was 59 t. The 2027, 2028, and 2029 OFL and ABC in the table below are the author's recommendations, which follow previous determinations.

Metric t

Fishery Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2021	N/A	N/A	59	15.5	21.6	93.0	70.0
2022	N/A	N/A	59	CF	CF	93.0	70.0
2023	N/A	N/A	59	CF	CF	93.0	70.0
2024	N/A	517	59	CF	CF	113.7	85.3
2025	N/A	517	59	CF	CF	113.7	85.3
2026	N/A	517	59	CF	CF	113.7	85.3
2027	N/A	512				112.6	84.5
2028	N/A	512				112.6	84.5
2029	N/A	512				112.6	84.5

Million lb

Fishery Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2021	N/A	N/A	0.130	0.034	0.048	0.205	0.140
2022	N/A	N/A	0.130	CF	CF	0.205	0.140
2023	N/A	N/A	0.130	CF	CF	0.205	0.140
2024	N/A	N/A	0.130	CF	CF	0.189	0.142
2025	N/A	N/A	0.130	CF	CF	0.189	0.142
2026	N/A	N/A	0.130	CF	CF	0.189	0.142
2027	N/A	1.129				0.248	0.186
2028	N/A	1.129				0.248	0.186
2029	N/A	1.129				0.248	0.186

6. **Basis for the OFL and ABC**: The values for 2027-2029 are the author's recommendation. Tier 5 GF refers to the tier system used for BSAI and GOA groundfish fisheries.

7. **Basis for the ABC recommendation**: A 25% buffer on the OFL, the default; i.e., ABC = (1-0.25)·OFL. This is a data-poor stock.

8. **A summary of the results of any rebuilding analyses**: Not applicable; stock is not under a rebuilding plan.

A. Summary of Major Changes

Changes in management of the fishery

Fishery continues to be managed under authority of an ADF&G commissioner's permit; guideline harvest level (GHL) was reduced from 68 t (150,000 lb) to 59 t (130,000 lb) in 2015 to account for bycatch mortality

Fishery Year	Tier	Reference Years	Natural Mortality	Buffer
2021	5	1993-1998[a]		25%
2022	5	1993-1998[a]		25%
2023	5	1993-1998[a]		25%
2024	5 GF	2002-2016	0.22 yr^{-1}	25%
2025	5 GF	2002-2016	0.22 yr^{-1}	25%
2026	5 GF	2002-2016	0.22 yr^{-1}	25%
2027	5 GF	2002-2016	0.22 yr^{-1}	25%
2028	5 GF	2002-2016	0.22 yr^{-1}	25%
2029	5 GF	2002-2016	0.22 yr^{-1}	25%

[a] OFL was for total catch and was determined by the average of the annual retained catch these years multiplied by a factor of 1.052 to account for the estimated bycatch mortality occurring in the directed fishery plus an estimate of the average annual bycatch mortality due to non-directed crab fisheries and groundfish fisheries for the period.

in the directed fishery, non-directed crab fisheries, and groundfish fisheries, and to avoid exceeding the ABC. The GHL remained at 59 t (130,000 lb) from 2016 to 2026.

Changes to the input data

- Retained catch and discarded catch data in the directed fishery have been updated through the 2025 season.
- Bycatch estimates from non-directed crab fisheries have been updated through the 2025 season. Time series estimates have been updated using reproducible methods consistent with other Bering Seas crab stocks.
- Bycatch estimates from groundfish fisheries have been updated through the 2025 season.
- The assessment now uses NMFS Eastern Bering sea slope survey data from 2002 - 2016 as the basis for MMB. A correction of Jackson and Daly (2023) was made to the data analysis here. Previously the coordinate reference system of the polygon used to delineate the portion of the survey within the Pribilof District was not exactly the same as the coordinate reference system of the survey haul data. This resulted in a slightly different station selection, and small differences in total and mature male biomass (Table 3), as well as a $\sim$ 1 t difference in the OFL.

Changes to the assessment methodology

Following 2023 SSC recommendation this assessment uses the alternative Tier 4/5 approach detailed in Appendix B of the 2023 final assessment, which is based on Tier 5 of the BSAI and GOA groundfish tier system (Jackson and Daly 2023). This method applies an exploitation rate equal to natural mortality (M = 0.22 yr^{-1}) to average survey biomass from 2002 - 2016 (MMB = 512 t; Table 3).

Changes to the assessment results

The groundfish Tier 5 assessment resulted in an increased OFL (112.6 t; 248,329 lb) relative to the crab Tier 5 assessment with updated catch (94.7 t; 208,778 lb) (Jackson and Daly 2023). The data correction associated with the portion of the survey within the Pribilof District resulted in a marginal change in biomass and the resulting OFL compared to 2023 ($\sim$ 1 t; see Jackson and Daly 2023).

B. Responses to SSC and CPT Comments

SSC June 2023

Comment: "*The SSC notes an experimental survey expanding the shelf trawl sampling to depths up to 400 meters is forthcoming and looks forward to updates regarding the potential of this work to inform future assessments.* "

Response: This analysis does not use any slope survey data after 2016, but will consider those any data that come available for future assessments.

SSC June 2020

Comment: "*For the next full assessment, the SSC requests the authors provide three assessment alternatives:*

- *The current Tier 5 assessment methodology.*
- *A Tier 4 assessment. A key issue with the Tier 4 approach will be selecting an appropriate BMSY proxy and determining whether the estimates of biomass are sufficiently reliable to warrant a Tier 4 status for the stock. The SSC notes that estimates of MMB from the slope survey may only be sporadically available in the future, which complicates status determination under Tier 4 (i.e., stock status relative to MSST).*
- *A Tier 5 methodology that uses Tier 4 methods for calculating the OFL/ABC. This approach would use the historical EBS slope survey estimates (based on a reference period) and use F=M for OFL calculation (or perhaps a different F value). An example of this approach was used for spiny dogfish (see October 2010 SSC report)."*

Response: All three options were presented in the 2023 SAFE (Jackson and Daly 2023).

Comment: "*The SSC notes that assessing trends in catch is not currently possible because of confidential data. The SSC recommends that the authors consider rescaling catch across years (e.g., min/max or z-score) such that relative catch trends could potentially be displayed without violating confidentiality rules.*"

Response: We were advised by ADF&G staff not to do so as catch numbers could be reasonably approximated given the trend and known values of non-confidential seasons.

Comment: "*For the assessment alternatives using a survey reference period, the SSC recommends the authors and CPT provide a rationale for the preferred reference period, and clearly specify the objective associated with the chosen period (e.g., target the current productivity regime or the range of potential productivity).*"

Response: For tier 4 calculations in Appendix A, we chose to use all of the survey years available for two reasons: 1) survey data is limited to only 4-6 years over a 14 year time period, and 2) this is the best available fishery independent data to capture the range of potential productivity of the stock.

Comment: "*The SSC supports the CPT recommendation to evaluate EBS slope survey variance for the early survey years (2002 and 2004) and to continue investigating whether additional length and sex composition data are available for 2004.*"

Response: We were unable to recover additional biological data for 2002 and 2004, but variance in MMB proxies are now computed as suggested by the CPT.

Comment: "*The SSC supports continued efforts by ADF&G to coordinate with industry to conduct a pot survey, and reiterates its past recommendation to explore VAST model fits to the EBS slope survey data, recognizing that this method may not be successful given the spatial characteristics of the survey.*"

Response: We were unable to explore VAST model fits during this reporting period.

Comment: "*The SSC recommends the authors and CPT consider whether the Aleutians Islands estimate of M (0.21) is appropriate for the PIGKC stock (M=0.18).*"

Response: Authors acknowledge that a species specific estimate of natural mortality is likely appropriate and both values of M are considered in Tier 4 calculations (Appendix A of Jackson and Daly 2023).

CPT May 2020

Comment: "*Continue to explore the existence of 2004 survey size composition data.*"

Response: We were unable to recover new 2004 survey data.

Comment: "*Improve CV calculations for 2002 and 2004 MMB estimates.*"

Response: CVs were computed using variance of the division of two random variables.

Comment: "*Explore a simplified GMACS model.*"

Response: We were unable to explore a GMACS model during this reporting period, but are gathering data for future efforts.

C. Introduction

1. **Scientific name**: *Lithodes aequispinus* J. E. Benedict, 1895.
2. **Description of general distribution**: General distribution of golden king crab:

> Golden king crab, also called brown king crab, range from Japan to British Columbia. In the BSAI, golden king crab are found at depths from 200 m to 1,000 m, generally in high-relief habitat such as inter-island passes (NMFS 2004).
>
> Golden, or brown, king crab occur from the Japan Sea to the northern Bering Sea (approximately 61° N latitude), around the Aleutian Islands, on various sea mounts, and as far south as northern British Columbia (Alice Arm) (Jewett et al. 1985). They are typically found on the continental slope at depths of 300–1,000 m on extremely rough bottom, and are frequently found on coral (NMFS 2004, pages 3–43).

The Pribilof District is part of king crab Registration Area Q (Figure 1). Leon et al. (2017) define those boundaries:

> The Bering Sea king crab Registration Area Q southern boundary is a line from 54° 36'N lat, 168°W long, to 54° 36'N lat, 171°W long, to 55° 30'N lat, 171°W long, to 55° 30'N lat, 173° 30'E long. The northern boundary is the latitude of Point Hope (68° 21'N lat). The eastern boundary is a line from 54° 36'N lat, 168°W long, to 58° 39'N lat, 168°W long, to Cape Newenham (58° 39'N lat). The western boundary is the United States-Russia Maritime Boundary Line of 1990 (Figure 2-4). Area Q is divided into 2 districts: the Pribilof District, which includes waters south of Cape Newenham; and the Northern District, which includes all waters north of Cape Newenham.

The NMFS conducted an eastern Bering Sea continental slope trawl survey on a biennial schedule during 2002–2016 (the 2014 survey was cancelled). Results of this survey from 2002–2016 show that the biomass, number, and density (in number per area and in weight per area) of golden king crab on the eastern Bering Sea continental slope are higher in the southern areas than in the northern areas (Gaeuman 2013a, 2013b; Haaga et al. 2009; Hoff 2013, 2016; Hoff and Britt 2003, 2005, 2009, 2011; Pengilly 2015; Pengilly and Daly 2017). Of the six survey subareas (see Figure 1 in Hoff 2016), biomass and abundance of golden king crab were estimated through 2016 to be highest in the Pribilof Canyon area (survey subarea 2), and most of the commercial fishery catches for golden king crab have occurred there (Neufeld and Barnard 2003; Barnard and Burt 2004, 2006; Burt and Barnard 2005, 2006; Leon et al. 2017).

Results of the 2002–2016 biennial NMFS eastern Bering Sea continental slope trawl surveys showed that a majority of golden king crab on the eastern Bering Sea continental slope occurred in the 200–400 m and 400–600 m depth ranges (Hoff and Britt 2003, 2005, 2009, 2011; Haaga et al. 2009; Hoff 2013, 2016). Commercial fishing for golden king crab in the Bering Sea typically occurs at depths of 100–300 fathoms (183–549 m; Barnard and Burt 2004, 2006; Burt and Barnard 2005, 2006; Gaeuman 2011, 2013c, 2014; Neufeld and Barnard 2003); average depth of pots fished in the most recent Pribilof District golden king crab fishery (2021) was 189 fathoms (346 m), based on observer data.

3. **Evidence of stock structure**: Although highest densities of golden king crab are found in the deep canyons of the eastern Bering Sea continental slope, golden king crab occur sporadically on the surveyed slope at locations between those canyons in the eastern Bering Sea (Hoff and Britt 2003, 2005, 2009, 2011; Gaeuman 2013b, 2014; Hoff 2013, 2016). Stock structure within the Pribilof District has not been evaluated. Fishery and slope survey data suggest that areas at the northern and southern border of the Pribilof District are largely devoid of golden king crab (Pengilly 2015, Pengilly and Daly 2017; Appendix A1), but the stock relationship between golden king crab within and outside of the Pribilof District has not been evaluated.

4. **Description of life history characteristics relevant to stock assessments (e.g., special features of reproductive biology)**: The following review of molt timing and reproductive cycle of golden king crab is adapted from Watson et al. (2002):

> Unlike red king crab, golden king crab may have an asynchronous molting cycle (McBride et al. 1982; Otto and Cummiskey 1985; Sloan 1985; Blau and Pengilly 1994). In a sample of male golden king crab 95–155-mm CL and female golden king crab 104–157-mm CL collected from Prince William Sound and held in seawater tanks, Paul and Paul (2000) observed molting in every month of the year, although the highest frequency of molting occurred during May–October. Watson et al. (2002) estimated that only 50% of 139-mm CL male golden king crab in the eastern Aleutian Islands molt annually and that the intermolt period for males ≥150-mm CL averages >1 year.
>
> Female lithodids molt before copulation and egg extrusion (Nyblade 1987). From observations on embryo development in golden king crab, Otto and Cummiskey (1985) suggested that time between successive ovipositions was roughly twice that of embryo development and that spawning and molting of mature females occurs approximately every two years. Sloan (1985) also suggested a reproductive cycle >1 year with a protracted barren phase for female golden king crab. Data from tagging studies on female golden king crab in the Aleutian Islands are generally consistent with a molt period for mature females of two years or less

and that females carry embryos for less than two years with a prolonged period in which they remain in barren condition (Watson et al. 2002). From laboratory studies of golden king crab collected from Prince William Sound, Paul and Paul (2001b) estimated a 20-month reproductive cycle with a 12-month clutch brooding period.

Numerous observations on clutch and embryo condition of mature female golden king crab captured during surveys have been consistent with asynchronous, aseasonal reproduction (Otto and Cummiskey 1985; Hiramoto 1985; Sloan 1985; Somerton and Otto 1986; Blau and Pengilly 1994; Blau et al. 1998; Watson et al. 2002). Based on data from Japan (Hiramoto and Sato 1970), McBride et al. (1982) suggested that spawning of golden king crab in the Bering Sea and Aleutian Islands occurs predominately during the summer and fall.

The success of asynchronous and aseasonal spawning of golden king crab may be facilitated by fully lecithoatrophic larval development (i.e., the larvae can develop successfully to juvenile crab without eating; Shirley and Zhou 1997). Current knowledge of reproductive biology and maturity of male and female golden king crab was reviewed by Webb (2014).

Note that asynchronous, aseasonal molting and the prolonged intermolt period (>1 year) of mature female and the larger mature male golden king crab likely makes scoring shell conditions very difficult and especially difficult to relate to "time post-molt," posing problems for inclusion of shell condition data into assessment models.

5. **Brief summary of management history**: A complete summary of the management history through 2015 is provided in Leon et al. (2017).

The first domestic harvest of golden king crab in the Pribilof District was in 1981/82 when two vessels fished. Peak retained catch and participation occurred in 1983/84 at a retained catch of 388 t (856,475 lb) landed by 50 vessels (Tables 2 - 1). Since 1984; the fishery has been managed with a calendar-year fishing season under authority of a commissioner's permit and landings and participation have been low and sporadic. Retained catch since 1984 has ranged from 0 lb (0 t) to 341,908 lb (155 t), and the number of vessels participating annually has ranged from 0 to 8, but 1-2 on average since rationalization of other Bering Sea crab fisheries (2005).

The fishery is not rationalized and has been managed inseason to a guideline harvest level (GHL) since 1999. The GHL for 1999 was 200,000 lb (91 t), whereas the GHL for 2000–2014 was 150,000 lb (68 t). Following the reduction of ABC from 82 t for 2014 to 68 t for 2015, the GHL was reduced in 2015 to 130,000 lb (59 t).

Despite confidentiality requirements under SOA statute Sec. 16.05.815, it can be noted, that the 2003 and 2004 fisheries were closed by emergency order to manage the fishery retained catch towards the GHL, whereas the 2005 and 2010–2014 fisheries were not closed by emergency order. With regard to 2004, "Catch rates during the 2004 fishery were among the highest on record, and the fishery was the shortest ever at approximately three weeks in duration" (Bowers et al. 2005).

A summary of relevant fishery regulations and management actions pertaining to the Pribilof District golden king crab fishery is provided below.

Only males of a minimum legal size may be retained. By State of Alaska regulation (5 AAC 34.920 (a)), the minimum legal size limit for Pribilof District golden king crab is 5.5-inches (140 mm) carapace width (CW), including spines. A carapace length (CL) ≥124 mm is used to identify legal-size males when CW measurements are not available (Table 3-5 in NPFMC 2007). Golden king crab may be commercially fished only with king crab pots (as defined in 5 AAC 34.050); pots used to take golden king crab in Registration Area Q (Bering Sea) may be longlined (5 AAC 34.925(f)). Pots used to fish for golden king crab in the Pribilof District must have at least four escape rings of no less than five and one-half inches inside diameter installed on the vertical plane or at least one-third of one vertical surface of the pot composed of not less than nine-inch stretched mesh webbing to permit escapement of undersized golden king crab (5 AAC 34.925 (c)). The sidewall "...must contain an opening equal to or exceeding 18 inches in length... The opening must be laced, sewn, or secured together by a single length of untreated, 100 percent cotton twine, no larger than 30 thread." (5 AAC 39.145(1)). There is a pot limit of 40 pots for vessels ≤125-feet LOA and of 50 pots for vessels >125-feet LOA (5 AAC

34.925 (e)(1)(B)). Golden king crab can be harvested from 1 January through 31 December only under conditions of a permit issued by the commissioner of ADF&G (5 AAC 34.910 (b)(3)). Since 2001, those conditions have included the carrying of a fisheries observer.

D. Data

Summary of new information

Retained catch, directed fishery discards and bycatch during non-directed crab fisheries and groundfish fisheries have been added up through the 2025 season. There has not been updated NMFS Eastern Bering sea slope survey data since 2016.

Data presented as time series

1. The 1981/82-1983/84, 1984-2025 time series of retained catch (number and weight of crab, including deadloss), effort (vessels and pot lifts), CPUE (number of landed crab captured per pot lift), and average weight of landed crab is presented in Table 1 and 2.

2. The 2001-2025 time series of discarded catch and estimated discard mortality during the directed fishery is presented in Table 1 and 2. Observer data on size distributions and estimated catch numbers of discarded catch were used to estimate the weight of discarded catch by applying a weight-at-length estimator (see below). Observers were first deployed to collect discarded catch data during the Pribilof District golden king crab fishery in 2001. Following Siddeek et al. (2014), the bycatch mortality rate of golden king crab captured and discarded during the directed fishery was assumed to be 0.2.

3. The 1990-2025 time series of discarded bycatch in non-directed crab fisheries (i.e., Bering Sea snow crab and Bering Sea grooved Tanner crab fisheries) is presented in Table 1 and 2. Because the Bering Sea snow crab fishery is largely prosecuted between January and May and the Bering Sea grooved Tanner crab fishery is prosecuted within a calendar-year season, discarded catch in the crab fisheries can be estimated on a calendar-year basis to align with Pribilof District golden king crab seasons. Following Foy (2013), bycatch mortality rate of king crab during the snow crab fishery was assumed to be 0.5. The bycatch mortality rate during the grooved Tanner crab fishery was also assumed to be 0.5.

4. The groundfish fishery discarded catch data are grouped into crab fishery years from 1991/92-2008/09, and by calendar years from 2009-2025. The 1991/92-2025 time series of estimated annual weight of discarded catch and total fishery mortality of golden king crab during federal groundfish fisheries by gear type (combining pot and hook-and-line gear as a single "fixed gear" category and combining non-pelagic and pelagic trawl gear as a single "trawl" category) is provided in Tables Table 1 and 2. Following Foy (2013), the bycatch mortality of king crab captured by fixed gear during groundfish fisheries was assumed to be 0.5 and of king crab captured by trawls during groundfish fisheries was assumed to be 0.8. Data from 1991/92-2008/09 are from federal reporting areas 513, 517, and 521, whereas the data from 2009-2025 are from the State statistical areas falling within the Pribilof District.

5. Table 1 and 2 summarizes the available data on retained catch weight and the available estimates of discarded catch weight.

6. **Catch-at-length**: Not used in is assessment; none are presented.

7. **Survey biomass estimates**: NMFS conducted an eastern Bering Sea continental slope bottom trawl survey in 2002, 2004, 2008, 2010, 2012, and 2016. The slope survey was a multi-species survey stratified by subarea and depth (Hoff and Britt 2003, 2005, 2009, 2011; Hoff 2013, 2016), and is the sole fishery independent data source for estimating mature male biomass (MMB) of Pribilof Islands golden king crab (PIGKC, *Lithodes aequispinus*). Results of the 2002–2016 surveys showed that a majority of golden king crab on the eastern Bering Sea continental slope occurred in the 200-400 m and 400-600 m

depth ranges (Hoff and Britt 2003, 2005, 2009, 2011; Hoff 2013, 2016). Biomass, number, and density (in number per area and in weight per area) of golden king crab on the eastern Bering Sea continental slope are higher in the southern areas than in the northern areas, with highest abundance in survey subarea 2 (Pengilly and Daly 2017). For the purpose of this assessment, data are limited to the survey footprint to within the ADF&G Pribilof District Management Area (PDMA, Figs. 1-3, ADF&G 2017).

8. **Survey catch at length**: Survey size data composition by sex of golden king crab were available for the 2008-2016 Bering Sea upper continental slope trawl surveys, but not the 2002 and 2004 surveys.

9. **Other data time series**: None.

Data which may be aggregated over time

1. **Growth-per-molt; frequency of molting, etc. (by sex and perhaps maturity state)**: The author is not aware of data on growth per molt collected from golden king crab in the Pribilof District. Growth per molt of juvenile golden king crab, 2-35 mm CL, collected from Prince William Sound have been observed in a laboratory setting and equations describing the increase in CL and intermolt period were estimated from those observations (Paul and Paul 2001a); those results are not provided here. Growth per molt has also been estimated from golden king crab with CL $\geq$90 mm that were tagged in the Aleutian Islands and recovered during subsequent commercial fisheries (Watson et al. 2002); those results are not presented here because growth-per-molt information does not enter into a this assessment.

   See section C for discussion of evidence that mature female and the larger male golden king crab exhibit asynchronous, aseasonal molting and a prolonged intermolt period (>1 year).

2. **Weight-at length or weight-at-age (by sex)**: Parameters (A and B) used for estimating weight (g) from carapace length (CL, mm) of male and female golden king crab according to the equation, $Weight = A * CL^B$ are: A = 0.0002712 and B = 3.168 for males (ADF&G, unpublished data) and A = 0.0014240 and B = 2.781 for females(from Table 3-5, NPFMC 2007).

3. **Natural mortality rate**: Natural mortality was assumed to be $M = 0.22$ yr^{-1} based on Siddeek et al. (2023), which is also used for AIGKC (Jackson 2026).

Information on any data sources that were available, but were excluded from the assessment

Data on the size and sex composition of retained catch and discarded catch of Pribilof District golden king crab during the directed fishery and other crab fisheries are available but are not presented in this assessment.

E. Analytic Approach

History of modeling approaches for this stock

The CPT (in May 2010) and the SSC (in June 2010) endorsed the use of a total-catch OFL (Tier 5) to establish the OFL for this stock. Only an OFL and ABC is estimated for Tier 5 stocks, where "the OFL represent[s] then average retained catch from a time period determined to be representative of the production potential of the stock" (NPFMC 2007). Although NPFMC (2007) defined the OFL in terms of the retained catch, total-catch OFLs may be considered for Tier 5 stocks for which non-target fishery removal data are available (Federal Register/Vol. 73, No. 116, 33926).

Additionally, NPFMC (2007) states that for estimating the OFL of Tier 5 stocks, "The time period selected for computing the average catch, hence the OFL, should be based on the best scientific information available and provide the required risk aversion for stock conservation and utilization goals." Given that a total-catch OFL is to be used, alternative configurations for the Tier 5 model are limited to: 1) alternative time periods for computing the average total-catch mortality; and 2) alternative approaches for estimating the discarded catch component of the total catch mortality during that period.

With regard to choosing from alternative time periods for computing average annual catch to compute the OFL, NPFMC (2007) suggested using the average retained catch over the years 1993 to 1999 as the estimated OFL for Pribilof District golden king crab. Years post-1984 were chosen based on an assumed 8-year lag between hatching and growth to legal size after the 1976/77 "regime shift". With regard to excluding data from years 1985 to 1992 and years after 1999, NPFMC (2007) states, "The excluded years are from 1985 to 1992 and from 2000 to 2005 for Pribilof Islands golden king crab when the fishing effort was less than 10% of the average or the GHL was set below the previous average catch." In 2008 the CPT and SSC endorsed the approach of estimating OFL as the average retained catch during 1993-1999 for setting a retained-catch OFL for 2009. However, in May 2009 the CPT set a retained-catch OFL for 2010, but using the average retained catch during 1993-1998; 1999 was excluded because it was the first year that a preseason GHL was established for the fishery. In May 2010, the CPT established a total-catch OFL computed as a function of the average retained catch during 1993-1998, a ratio-based estimate of the bycatch mortality during the directed fishery of that period, and an estimate of the "background" bycatch mortality due to other fisheries. Other time periods, extending into years post-1999, had been considered for computing the average retained catch in the establishment of the 2009, 2010, and 2011 OFLs, but those time periods were rejected by the CPT and the SSC. Hence the period for calculating the retained-catch portion of the Tier 5 total-catch OFL for this stock has been firmly established by the CPT and SSC at 1993–1998 (the CPT said "this freezes the time frame…"). For the 2012 and the 2013 OFLs, the CPT and SSC recommended the period 2001–2010 for calculating the ratio-based estimate of the bycatch mortality during the 1993-1998 directed fishery, the period 1994-1998 for calculating the estimated bycatch mortality due to nondirected crab fisheries during 1993-1998, and the period 1992/93-1998/99 for calculating the estimated bycatch mortality due to groundfish fisheries during 1993–1998.

Two alternative approaches for determination of the 2013 OFL were presented to the CPT and SSC in May–June 2013. Alternative 1 was the status quo approach (i.e., the approach used to establish the 2012 total-catch OFL). Alternative 2 was the same as Alternative 1 except that it used updated discarded catch data from crab fisheries in 2011. Alternative 2 was presented specifically to allow the CPT and the SSC to clarify whether the 2013 and subsequent OFLs should be computed using data collected after 2010, or if the time periods for data used to calculate the 2013 and subsequent OFLs should be "frozen" at the years used to calculate the 2012 OFL. The CPT and the SSC both recommended Alternative 1, clarifying that Tier 5 OFLs for future years should be computed using only data collected through 2010. Following that recommendation from CPT and the SSC, only one alternative was presented for computing the 2014–2017 Tier 5 OFLs (i.e., the Alternative 1 that was presented in 2013).

The 2024-2026 Tier 5 OFL recommended here uses the same approach as used for the 2013–2023 Tier 5 OFLs.

Gaeuman (2013a, 2013b), Pengilly (2015), Pengilly and Daly (2017), and Daly and Jackson (2020) presented assessment modelling approaches for this stock to the Crab Plan Team using data from the biennial NMFS EBS continental slope survey. However, this stock continued to be managed as a Tier 5 stock for 2021-2023, as had been recommended by NPFMC (2007) and by the CPT and SSC in 2008-2020. Most recently Jackson and Daly (2023) used NMFS EBS continental slope survey within the state-space random effects model of the R package *rema* (Sullivan et al. 2022). The CPT noted that while the *rema* modelling approach better captured uncertainty in MMB, the lack of recent slope survey data would lead to continually increasing uncertainty in static MMB estimates. The SSC (in June 2023) recommended an approach (termed 'Tier 4/5' in Jackson and Daly 2023, Appendix B) borrowed from the BSAI and GOA groundfish tier system (Tier 5) by with OFL is computed by applying an exploitation rate equal to M to average survey MMB from 2002-2016. This approach used survey estimates of MMB from a more recent time period (2002 – 2016) than the fishery total catch data used in Tier 5 (1993 – 1998). The SSC acknowledged potential concern that survey biomass may change over time due to climate change and would be unknown without future surveys, but still recommended that Tier 4/5 be used, because golden king crab are a deep-water species that may presumably be less affected than shallow water crab species.

Estimation of survey MMB

NMFS provided estimates of total male biomass for all survey years and length composition data for only 2008-2016. For the 2008-2016 surveys, a length-weight regression was applied to size composition data to estimate the weight of each crab measured. MMB was calculated using a maturity size cut-off of 107 mm CL (Somerton and Otto 1986). An area-swept estimate of biomass and of the variance of the biomass estimate was computed for each stratum within a survey subarea and summed over strata within to obtain biomass estimates in aggregate and the variances of those estimates. Since length composition data were not available for 2002 and 2004, MMB estimates were obtained by first estimating total biomass and associated variance for 2002 and 2004, and then multiplying it by the ratio of MMB to total biomass in 2008-2016.

F. Calculation of the OFL

The OFL was specified as Tier 5 (groundfish tier system; NPFMC 2024), total-catch OFL estimated by applying an exploitation rate equal to M to current biomass.

$$\text{OFL} = E \times B \quad (1)$$

where E is exploitation rate equal to natural mortality (M) and B is mature male biomass (MMB). In this case MMB is assumed equal to $\text{B}_{\text{MSY},proxy}$, which was defined as the average MMB from the NMFS EBS continental slope survey 2002 - 2016 (Table 3). The recommended OFL is 112.6 t (248,329 lb).

Stock status relative to overfishing

See table below. Because less than three vessels participated in the 2023, 2024, and 2025 directed fisheries, catch numbers are not reported here under the confidentiality requirements of State of Alaska (SOA) statute Sec. 16.05.815. Although fishery mortality occurred during groundfish fisheries in 2023, 2024, and 2025, this and the fishery mortality in the directed and non-directed crab fisheries (i.e. snow and grooved Tanner crab) did not exceed the corresponding OFL. As such, overfishing did not occur in 2023, 2024, and 2025.

Metric t

Year	Tier	Biomass (MMB)	Reference Years	GHL	Retained Catch	Total Catch	OFL	ABC
2021	5	N/A	1993-1998	59	15.5	21.6	93.0	70.0
2022	5	N/A	1993-1998	59	CF	CF	93.0	70.0
2023	5	N/A	1993-1998	59	CF	CF	93.0	70.0
2024	5 GF	517	2002-2016	59	CF	CF	113.7	85.3
2025	5 GF	517	2002-2016	59	CF	CF	113.7	85.3
2026	5 GF	517	2002-2016	59	CF	CF	113.7	85.3
2027	5 GF	512	2002-2016				112.6	84.5
2028	5 GF	512	2002-2016				112.6	84.5
2029	5 GF	512	2002-2016				112.6	84.5

Million lb

Year	Tier	Biomass (MMB)	Reference Years	GHL	Retained Catch	Total Catch	OFL	ABC
2021	5	N/A	1993-1998	0.130	0.034	0.048	0.205	0.140
2022	5	N/A	1993-1998	0.130	CF	CF	0.205	0.140
2023	5	N/A	1993-1998	0.130	CF	CF	0.205	0.140
2024	5 GF	1.140	2002-2016	0.130	CF	CF	0.251	0.188
2025	5 GF	1.140	2002-2016	0.130	CF	CF	0.251	0.188
2026	5 GF	1.140	2002-2016	0.130	CF	CF	0.251	0.188
2027	5 GF	1.129	2002-2016				0.248	0.186
2028	5 GF	1.129	2002-2016				0.248	0.186
2029	5 GF	1.129	2002-2016				0.248	0.186

G. Calculation of ABC

Previous assessments assumed a 25% buffer on OFL given uncertainties associated with discard and bycatch mortality rates, choice of the total catch reference period, and lack of current biomass estimate. The approach considered here does not take into account catch or bycatch mortality, but uncertainty can be extended to catchability and selectivity of golden king crab in trawl survey gear and absence of recent survey data. The recommended OFL buffer remains at 25%; i.e., ABC = (1 - 0.25)(112.6 t) = 84.5 t (186,247 lb). This is no risk table for this stock.

H. Rebuilding Analyses

Not applicable; this stock has not been declared overfished.

I. Data Gaps and Research Priorities

There are many data gaps in life history characteristics specific to this stock that are discussed elsewhere in this document. The NMFS EBS continental slope survey has not been conducted since 2016. Modernization of the NMFS EBS trawl surveys aims to add stations on the upper continental slope which may overlap golden king crab habitat in the ADF&G Pribilof District Management Area. Further assessment efforts should examine those data to determine whether their utility in informing PIGKC stock status.

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K. Tables

Table 1: Commercial fishery history for the Pribilof District golden king crab fishery: number of vessels, guideline harvest level (GHL; t), pot lifts, retained catch (number, t), fishery catch per unit effort (CPUE; retained crab per pot lift), and bycatch mortality in non-directed crab fisheries (t) and groundfish fisheries (t).'CF' denotes confidential fishery data.

				Retained			Discard	Non-Directed Crab	Groundfish
Year	Vessels	GHL (t)	Pot Lifts	Number	Weight (t)	CPUE	Mortality	Bycatch (t)	Bycatch (t)
1981	2		CF	CF	CF	CF	CF		
1982	10		5,252	15,330	32	2.9			
1983	50		26,035	253,162	388	9.7			
1984	0								
1985	1		CF	CF	CF	CF	CF		
1986	0								
1987	1		CF	CF	CF	CF	CF		
1988	2		CF	CF	CF	CF	CF		
1989	2		CF	CF	CF	CF	CF		
1990	0								
1991	0		0					0.0	4.9
1992	5		798	894		1.12		6.0	8.8
1993	5		15,395	17,643	31	1.15		0.0	8.0
1994	3		1,845	21,477	41	11.64		1.2	2.7
1995	7		9,551	82,489	156	8.64		17.7	1.7
1996	6		9,952	91,947	155	9.24		6.9	0.7
1997	7		4,673	43,305	84	9.27		1.8	1.1
1998	3		1,530	9,205	16	6.02		20.6	3.5
1999	3	91	CF	CF	CF	CF	CF	0.0	2.9
2000	6	68	5,450	29,145	60	5.35		0.0	2.3
2001	6	68	4,262	33,723	70	7.91	3	0.7	1.0
2002	8	68	5,279	34,860	72	6.6	5	0.2	0.4
2003	3	68	CF	CF	CF	CF	CF	4.9	0.3
2004	5	68	CF	CF	CF	CF	CF	2.0	0.4
2005	4	68	CF	CF	CF	CF	CF	0.7	0.1
2006	0	68	0					0.0	0.8
2007	0	68	0					0.0	4.4
2008	0	68	0					0.0	3.2
2009	0	68	0					0.6	3.4
2010	1	68	CF	CF	CF	CF	CF	0.0	1.9
2011	2	68	CF	CF	CF	CF	CF	0.1	1.5
2012	1	68	CF	CF	CF	CF	CF	0.1	1.0
2013	1	68	CF	CF	CF	CF	CF	0.2	2.2
2014	1	68	CF	CF	CF	CF	CF	0.0	0.7
2015	0	59	0					0.0	1.9
2016	0	59	0					0.0	0.2
2017	2	59	CF	CF	CF	CF	CF	1.7	1.2
2018	1	59	CF	CF	CF	CF	CF	0.0	1.3
2019	2	59	CF	CF	CF	CF	CF	0.0	4.0
2020	4	59	2,960	24,301	50	8.21	0	0.0	2.0
2021	4	59	2,361	7,021	16	2.97	4	0.0	2.0
2022	3	59	CF	CF	CF	CF	CF	0.7	2.2
2023	1	59	CF	CF	CF	CF	CF	0.0	2.9
2024	1	59	CF	CF	CF	CF	CF	0.0	1.8
2025	1	59	CF	CF	CF	CF	CF	0.0	0.1

Table 2: Commercial fishery history for the Pribilof District golden king crab fishery: number of vessels, guideline harvest level (GHL; lb), pot lifts, retained catch (number, lb), fishery catch per unit effort (CPUE; retained crab per pot lift), and bycatch mortality in non-directed crab fisheries (lb) and groundfish fisheries (lb).'CF' denotes confidential fishery data.

				Retained			Discard	Non-Directed Crab	Groundfish
Year	Vessels	GHL (lb)	Pot Lifts	Number	Weight (lb)	CPUE	Mortality	Bycatch (lb)	Bycatch (lb)
1981	2		CF	CF	CF	CF	CF		
1982	10		5,252	15,330	69,970		2.9		
1983	50		26,035	253,162	856,475		9.7		
1984	0								
1985	1		CF	CF	CF	CF	CF		
1986	0								
1987	1		CF	CF	CF	CF	CF		
1988	2		CF	CF	CF	CF	CF		
1989	2		CF	CF	CF	CF	CF		
1990	0								
1991	0		0					0.0	10,824.7
1992	5		798	894		1.12		13,147.0	19,488.8
1993	5		15,395	17,643	67,458	1.15		0.0	17,570.8
1994	3		1,845	21,477	89,715	11.64		2,682.1	5,974.5
1995	7		9,551	82,489	344,858	8.64		38,956.1	3,814.0
1996	6		9,952	91,947	341,418	9.24		15,258.8	1,565.3
1997	7		4,673	43,305	184,803	9.27		3,864.9	2,358.9
1998	3		1,530	9,205	36,196	6.02		45,499.3	7,782.3
1999	3	200,000	CF	CF	CF	CF	CF	0.0	6,437.5
2000	6	150,000	5,450	29,145	131,816	5.35		65.5	5,114.7
2001	6	150,000	4,262	33,723	154,103	7.91	5,850	1,554.6	2,270.8
2002	8	150,000	5,279	34,860	159,418	6.6	11,125	331.0	992.1
2003	3	150,000	CF	CF	CF	CF	CF	10,811.4	573.2
2004	5	150,000	CF	CF	CF	CF	CF	4,305.9	859.8
2005	4	150,000	CF	CF	CF	CF	CF	1,438.7	198.4
2006	0	150,000	0					0.0	1,675.5
2007	0	150,000	0					0.0	9,612.1
2008	0	150,000	0					0.0	7,165.0
2009	0	150,000	0					1,236.0	7,451.6
2010	1	150,000	CF	CF	CF	CF	CF	0.0	4,122.6
2011	2	150,000	CF	CF	CF	CF	CF	273.6	3,284.9
2012	1	150,000	CF	CF	CF	CF	CF	321.2	2,248.7
2013	1	150,000	CF	CF	CF	CF	CF	413.5	4,938.3
2014	1	150,000	CF	CF	CF	CF	CF	66.3	1,609.4
2015	0	130,000	0					0.0	4,232.9
2016	0	130,000	0					0.0	529.1
2017	2	130,000	CF	CF	CF	CF	CF	3,779.1	2,557.4
2018	1	130,000	CF	CF	CF	CF	CF	0.0	2,932.1
2019	2	130,000	CF	CF	CF	CF	CF	0.0	8,752.3
2020	4	130,000	2,960	24,301	109,317	8.21	0	0.0	4,453.3
2021	4	130,000	2,361	7,021	34,854	2.97	7,939	0.0	4,387.2
2022	3	130,000	CF	CF	CF	CF	CF	1,510.6	4,872.2
2023	1	130,000	CF	CF	CF	CF	CF	0.0	6,349.3
2024	1	130,000	CF	CF	CF	CF	CF	0.0	3,924.2
2025	1	130,000	CF	CF	CF	CF	CF	0.0	242.5

Table 3: Mature male biomass (MMB) estimates base on areas swept calculations for the NMFS-AFSC EBS slope survey within the Pribilof District Management Area. MMB estimates for 2002 and 2004 are proxies based on total biomass, and the mean ratio of MMB to total biomass in other survey years.

Year	Total Biomass (t)	CV	MMB (t)	CV	Ratio
2002	707	0.27	312	0.29	
2004	1,050	0.38	464	0.40	
2008	969	0.22	556	0.31	0.574
2010	1,632	0.23	646	0.26	0.396
2012	1,167	0.31	355	0.34	0.304
2016	1,492	0.21	736	0.32	0.493
Mean			512		0.442

L. Figures

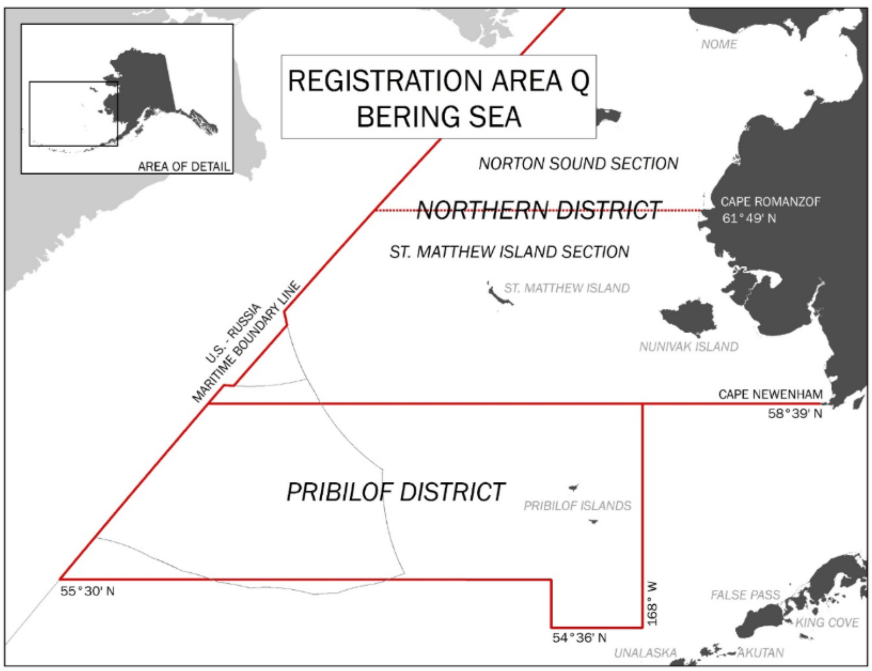

Figure 1: King crab Registration Area Q (Bering Sea), showing borders of the Pribilof District.

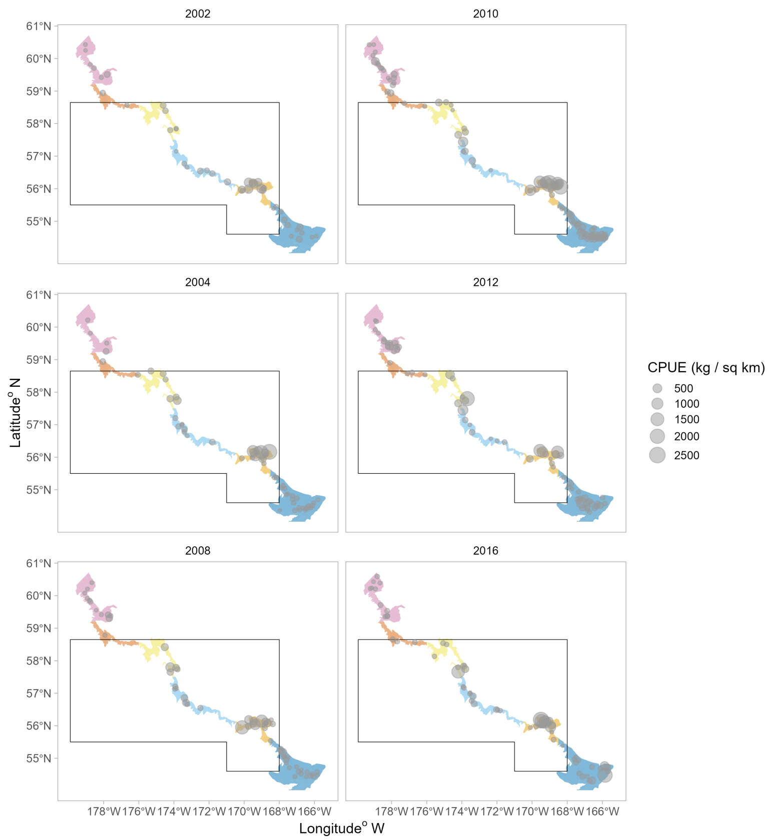

Figure 2: NMFS Eastern Bering sea slope survey CPUE (kg / sq km). Colored areas indicate survey subareas and the black outline is the boundary of the Pribilof District.