

Stock Assessment and Fishery Evaluation Report
for the
KING AND TANNER CRAB FISHERIES
of the
Bering Sea and Aleutian Islands Regions

2000 Crab SAFE

Compiled by

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of the Bering Sea and Aleutian Islands

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Executive Summary

The annual stock assessment and fishery evaluation (SAFE) report is a requirement of the North Pacific Fishery Management Council's *Fishery Management Plan for the Bering Sea/Aleutian Islands King and Tanner Crabs (FMP)*, and a federal requirement at 50 CFR Section 602.12(e) for a SAFE. The SAFE details the current biological and economic status of fisheries, guideline harvest levels (GHL), and analytical information used for management decisions or changes in harvest strategies. The report is assembled by the crab plan team with contributions from the State of Alaska Department of Fish and Game (ADF&G) and the National Marine Fisheries Service (NMFS), and is available to the public and presented to the Council on an annual basis. Additional information on Bering Sea/Aleutian Islands (BSAI) king and Tanner crab is available on the NMFS web page at <http://www.fakr.noaa.gov/sustainablefisheries/crab/default.htm>.

Annually Surveyed Crab Stocks

Table 1 provides summary information on the basic elements of stock condition for the six stocks that are surveyed annually by NMFS. The Federal requirements for determining the status of the stocks are the minimum stock size threshold (MSST) and the maximum fishing mortality threshold (MFMT). These requirements are contained in the FMP and outlined in the following section, overfishing parameters. The MSST is 50% of the mean total spawning biomass (SB = total biomass of mature males and females) for the period 1983-1997, upon which the maximum sustainable yield (MSY) was based. A stock is overfished if the SB is below the MSST. The MFMT is represented by the sustainable yield (SY) in a given year, which is the MSY rule applied to the current SB (the MSY control rule is $F = 0.2$ for king crabs and $F = 0.3$ for Tanner and snow crabs). Overfishing occurs if the harvest level exceeds the SY in one year. GHLs are developed from joint NMFS and ADF&G assessment of stock conditions based on harvest strategies developed by ADF&G. Figures 1-6 show each crab stock's spawning biomass and catch history relative to overfishing.

Table 1. MSST, 2000 spawning biomass (SB), sustainable yield (SY), and 2000/2001 guideline harvest level (GHL) estimates for BSAI king and Tanner crab stocks. Estimated values are in millions of pounds.

Stock	MSST	2000 SB	2000 SY	2000/2001 GHL
Bristol Bay red king	44.8	89.7	17.9	8.35
Pribilof Islands red king	3.3	10.2	2.0	0
Pribilof Islands blue king	6.6	7.4	1.5	0
St Matthew blue king	11.0	5.2	1.0	0
EBS Tanner	94.8	59.1	17.7	0
EBS snow	460.8	472.7	141.8	27.3

As well as the Federal requirements, survey results for five stocks (Pribilof blue king crab, St. Matthew blue king crab, Bristol Bay red king crab, eastern Bering Sea Tanner crab, and eastern Bering Sea snow crab) are compared to thresholds established in State of Alaska harvest strategies and regulations. ADF&G uses these thresholds to determine if a fishery should be opened and to calculate the GHL. Please refer to the report "Status of King Crab Stocks in the Eastern Bering Sea in 2000" (Zheng and Kruse 2000), contained in this SAFE, for more detail on the population estimations for Bristol Bay red king crab, Pribilof Islands red and blue king crab, and St. Matthew blue king crab.

Bering Sea Tanner crab
(*Chionoecetes bairdi*):

The survey estimate of spawning biomass in 2000 declined to 59.1 million pounds from the 1999 estimate of 70.1 million pounds. In 1997, the survey estimated spawning biomass of Tanner crab at 64.2 million pounds, which was below the MSST of 94.8 million pounds, thus NMFS declared this stock overfished. ADF&G closed the fishery in 1997 and will reopen the fishery when the female biomass is above the threshold and the fishery GHL is above the minimum identified in the rebuilding harvest strategy. The Council took final action on a rebuilding plan developed for this stock at its October 1999 meeting. NMFS approved the rebuilding plan in June, 2000 (65 FR 38216). Although legal males are at an historic low, the survey indicates some moderate recruitment of juveniles.

The Tanner crab fishery has three thresholds against which survey data must be compared (Table 2; ADF&G 1999): one for a fishery opening; one for increasing the exploitation rate on mature males; and a minimum GHL to assure manageability. The minimum stock threshold for a fishery opening is 21 million pounds of females > 79-mm carapace width (CW). The 2000 estimate for Tanner crab females > 79-mm CW is below the threshold at 15.9 million pounds. When the female biomass is above the threshold, the GHL will be based on the harvest rate of 20% of molting mature males when the biomass of females >79 mm CW is ≥ 45.0 million pounds. The GHL will be based on the harvest rate of 10% of molting mature males when the biomass of females is >79 mm CW is ≥ 21.0 million pounds and < 45.0 million pounds. The legal harvest rate cap will be 50% of exploitable males.

Table 2. Threshold Values in State of Alaska Harvest Strategies for Bering Sea King and Tanner Crabs (estimates in millions of pounds)

Pribilof blue king crab	
<u>Stock threshold for fishery opening</u>	<u>2000 estimate</u>
0.77 million crab $\sigma > 119$ -mm CL	.64 million crab ^a
St. Matthew blue king crab	
<u>Stock threshold for fishery opening</u>	<u>2000 estimate</u>
2.9 million $\sigma > 104$ - mm CL	4.5 ^a
<u>Stock threshold for increasing exploitation rate on molting mature males</u>	<u>2000 estimate</u>
[(B-2.9)/8.7]*0.1+0.1 when $11.6 > B \geq 2.9$ million lbs. 0.2 when $B \geq 11.6$ million lbs.	4.5 ^a
<u>GHL threshold for fishery opening</u>	<u>Computed GHL for 2000 season</u>
2.5	0.0
Bristol Bay red king crab	
<u>Stock threshold for fishery opening</u>	<u>2000 estimate</u>
• 8.4 million $\sigma > 89$ - mm CL and • 14.5 million pounds effective spawning biomass	18.68 million crab ^b 39.9 ^b
<u>Stock threshold for increasing exploitation rate on $\sigma > 119$ - mm CL from 10% to 15%</u>	<u>2000 estimate</u>
55 million pounds effective spawning biomass	39.9 ^b
<u>GHL threshold for fishery opening</u>	<u>Computed GHL for 2000 season</u>
4	8.35
Eastern Bering Sea Tanner crab (<i>bairdi</i>)	
<u>Stock threshold for fishery opening</u>	<u>2000 estimate</u>
21 million pounds of $\sigma > 79$ - mm CW	15.9 ^c
<u>Stock threshold for increasing exploitation rate on molting mature σ from 10% to 15%</u>	<u>2000 estimate</u>
45 million pounds of $\sigma > 79$ - mm CW	15.9 ^c
<u>GHL threshold for fishery opening</u>	<u>Computed GHL for 2000 season</u>
4	0.0
Eastern Bering Sea snow crab (<i>opilio</i>)	
<u>Stock threshold for fishery opening</u>	<u>2000 estimate</u>
230.4 million pounds of spawning biomass	472.7 ^c
<u>Stock threshold for increasing exploitation rate on molting mature males</u>	<u>2000 estimate</u>
0.75*0.3 = 22.5%, for $SB \geq 921.6$ 0.75*22.5% = 16.875%, for $SB \geq 460.8$ and $SB < 921.6$ (SB/460.8)*16.875%, for $SB \geq 230.4$ and $SB < 460.8$	472.7 ^c
<u>GHL threshold for fishery opening</u>	<u>Computed GHL for 2000 season</u>
25	27.3

^a Catch-survey analysis estimate

^b Length-based analysis estimate

^c Area swept estimate

The minimum GHL for a fishery is 4 million pounds to ensure manageability, which prevents exceeding the GHL. The first year the stock is above the female threshold, the estimated GHL will need to be 8 million pounds in order for the fishery to be opened.

Bering Sea snow crab (*Chionoecetes opilio*):

The 2000 survey estimate was 472.7 million pounds of spawning biomass, a 67% increase from the 1999 survey estimate of 283.5 million pounds. The 2000 spawning biomass estimate is slightly above the MSST of 460.8 million pounds of spawning biomass. NMFS identified the stock as overfished on September 24, 1999 because the stock was below the MSST in 1999. The stock will be considered ‘rebuilt’ when the spawning biomass is above the MSY biomass (B_{msy}) of 921.6 for 2 consecutive years. The Council adopted a rebuilding plan in June 2000.

No model has been developed for snow crab, so the status of the population uses the current survey area-swept estimates only. The GHL for the 1999 fishery was 196 million lbs, estimated using a 58% harvest rate on male crab over 101 mm. Since the 1999 mature biomass survey estimate was below the MSST, a reduced exploitation rate of about 22% was used on a biomass of 131 million pounds of male crab over 101 mm, resulting in a GHL of 28.5 million pounds for 2000 fishery. The harvest strategy adopted by the Alaska Board of Fisheries in March 2000 was used to estimate the GHL for 2001. For 2001, the snow crab GHL will be 27.3 million pounds, of which 2,047,500 pounds are available to the CDQ fishery.

In March 2000, the Alaska Board of Fisheries adopted a rebuilding harvest strategy for snow crab. The new harvest strategy determines a GHL for snow crabs by the application of three rules: an exploitation rate that is applied to mature male biomass; a 50% cap on the removals of “exploitable legal males”, and a minimum GHL for fishery opening of 25 million pounds. Relative to the previous harvest rate, the new harvest strategy is much more conservative, particularly at low stock sizes, and would be expected to help maintain long term stock productivity, as well as increase the probability of stock rebuilding.

Exploitation rate on mature males. The harvest strategy applies an exploitation rate to the estimated biomass (B) of mature male snow crab. The exploitation rate that is applied to the mature male biomass varies with the estimated spawning biomass (SB) according to:

- 0.75×0.3 = 22.5%, for $SB \geq 921.6$ million pounds
- 0.75×22.5% = 16.875%, for $SB \geq 460.8$ million pounds and $SB < 921.6$ million pounds
- $(SB/460.8) \times 16.875\%$, for $SB \geq 230.4$ million pounds and $SB < 460.8$ million pounds
- 0% (fishery closed), when $SB < 230.4$ million pounds.

The spawning biomass benchmarks, 921.6 and 460.8 million pounds, for determining the exploitation rate are the MSY biomass (B_{msy}) and minimum stock size threshold (MSST), respectively, for eastern Bering Sea snow crab as specified in the FMP; 230.4 million pounds is one-half the MSST. Overfishing is avoided under this harvest strategy by applying an exploitation rate < 30% only to the mature male biomass portion of the SB. Avoidance of overfishing is further assured by a maximum exploitation rate on mature male biomass of 75% of 30% -- when the SB reaches or exceeds B_{msy} . When the SB falls below B_{msy} , but exceeds MSST, the exploitation rate is reduced by an additional 25% to 16.875%. The exploitation rate on mature male biomass decreases linearly from 16.875% when SB is below MSST to an exploitation rate of 8.4375% when SB falls to one-half MSST. Below one-half MSST the directed snow crab fishery is closed.

50% removal cap on “exploitable legal males”. Besides the determining an exploitation rate on mature male biomass, the harvest strategy also caps the removals of “exploitable legal males” to 50%. The 50% value is based on the 50% removal cap on “exploitable legal males” that was developed for the harvest

strategy in the eastern Bering Sea Tanner crab rebuilding plan (Zheng and Kruse 1999). The cap assures that removals from a single sex-size class is controlled over all population and size-frequency scenarios, avoids the sorting that can accompany high harvest rates on a single sex-size class, and adjusts for the disproportionately high harvest of new-shell males. “Exploitable legal males” for snow crab are defined for this harvest strategy on the basis of carapace width (CW) and shell age. The minimum size of “exploitable legal male” snow crabs is defined by the 4-in (102-mm) CW industry standard for processing Alaska snow crab (Morrison et al. 1999); note, however, that the minimum legal size is 3.1-in (79-mm) CW (ADFG 1999). A shell-age component to the “exploitable legal male” definition reflects the disproportionate harvest of new-shell males relative to their representation in stock assessment survey data. Hence, “exploitable legal males” for eastern Bering Sea snow crab are defined as 100% of the population estimate of new-shell males >4-in CW plus 25% of the old-shell males >4-in CW. The discounting of old-shell males in the definition of “exploitable legal males” was computed using the proportion of new-shell animals estimated for males >4-in CW in the snow crab population during the preseason surveys and the proportion of new-shell crabs in sampled deliveries for the 1991 through 1999 seasons.

25 million pound minimum GHL. The fishery season will not be opened if the GHL is less than 25 million pounds. The minimum GHL addresses the inability to adequately manage the fishery towards a low GHL under the current fleet size, pot limit conditions, in-season data collection, and end-of-season gear requirements.

Bristol Bay red king crab (*Paralithodes camtschaticus*):

The 2000 survey estimate of spawning biomass was 89.7 million pounds, a decrease from the 1999 survey estimate of 111.7 million pounds of spawning biomass. The 2000 survey indicated some recruitment to the immature stock that should recruit to the mature stock in the next two years. The model used for red king crab was the same as in the 1998 SAFE. The Bristol Bay red king crab survey data must be examined relative to three thresholds (Table 2; ADF&G 1999): one for a fishery opening; one for increasing the exploitation rate on mature-sized males; and a minimum GHL to assure manageability. With length-based analysis (LBA) estimates of 18.68 million females > 89-mm CL and of 39.9 million pounds of effective spawning biomass for 2000, the Bristol Bay red king crab stock is well above the threshold for a fishery opening.

A 10% harvest rate is applied to the mature male abundance for the 2000 GHL, since the effective spawning biomass is below the target level of 55 million pounds. The 2000 GHL is 8.35 million pounds of legal males. The harvest rate would be 15% of mature male abundance if the effective spawning biomass is above 55 million pounds. Finally, the computed guideline for the 2000 Bristol Bay red king crab fishery season exceeds the minimum 4 million pounds necessary for a fishery opening.

Pribilof Islands red king crab (*Paralithodes camtschaticus*):

The 2000 spawning biomass estimate from the survey was 10.2 million pounds, a decrease from the 1999 survey estimate of 12.8 million pounds of spawning biomass. MSST is 3.3 million pounds of spawning biomass. In the NMFS trawl survey, crabs were highly concentrated and therefore the survey index has a very low precision. Low precision in the survey index means that we are not confident that the 2000 spawning biomass is really as large as 10.2 million pounds. The Pribilof red king crab fishery is concurrent with the Pribilof blue king crab. Due to the low and declining abundance of Pribilof Island blue king crab, the low precision of the abundance estimates, and the poor fishery performance in recent years, the Pribilof king crab fishery will remain closed in 2000. Survey and fishery data indicate a long term decline.

Pribilof Islands blue king crab (*Paralithodes platypus*):

The 2000 survey biomass estimate of spawning biomass was 7.4 million pounds, a decrease from the 1999 survey estimate of 9.2 million pounds of spawning biomass. MSST is 6.6 million pounds of spawning biomass. Under the harvest strategy developed for the Pribilof blue king crabs, fisheries are not opened unless the stocks exceed a threshold level of abundance (Pengilly and Schmidt 1995). The thresholds established for Pribilof Islands blue king crab is 0.77 million males > 119-mm carapace length (CL). The 2000 catch-survey analysis (CSA) estimate for Pribilof Islands blue king crab > 119-mm CL is 0.64 million crab, therefore the fishery will remain closed in 2000. The fishery was also closed in 1999 because the stock did not exceed the threshold level of abundance. Therefore, this population is declining in the absence of fishing pressure. If population trends continue into the next year, this population could fall below MSST within the next two years.

St. Matthew blue king crab (*Paralithodes platypus*):

The 2000 spawning biomass estimate from the survey was 5.2 million pounds, an increase from the 1999 survey estimate of 4.8 million pounds of spawning biomass. This fishery is overfished because the estimate of spawning biomass is below the MSST of 11.0 million pounds. The fishery was closed in 1999 and will remain closed in 2000. The 2000 survey indicated poor prospects for recruitment to mature stock in the near future. The Council adopted a rebuilding plan in June 2000.

ADF&G developed the rebuilding harvest strategy for the St. Matthew Island blue king crab fishery that the Board adopted in March 2000. The harvest strategy includes four components: a stock threshold, a minimum GHL, variable mature harvest rates, and a cap on legal male harvest rate. A stock abundance threshold was set to prevent against future instances of stock declines to "overfished" status. A minimum GHL was chosen because small GHLs are not manageable given the current size of the fishing fleet. A maximum legal harvest rate cap was set to prevent high removal rates of legal crabs when most mature males are sublegal size such as would be the case when a strong year class has yet to recruit to the fishery. The harvest strategy is closely based on NMFS technical guidance for implementing precautionary harvest strategies and rebuilding plans of Restrepo et al. (1998). The harvest strategy is detailed in the ADF&G report "Overview of Stock Assessment and Recommended Harvest Strategy for St. Matthew Island Blue king Crabs" (Zheng and Kruse 2000).

The harvest strategy's four components are:

Minimum stock threshold: 2.9 million lbs of mature male (105 mm carapace length) biomass. This is 25% of the equivalent mature male biomass capable of producing maximum sustainable yield (B_{msy}=11.6 million lbs).

Minimum GHL: 2.5 million lbs.

Directed mature male harvest rates:

1. 0.0 when mature male biomass (B) < 2.9 million lbs,
2. $[(B-2.9)/8.7]*0.1+0.1$ when $11.6 > B \geq 2.9$ million lbs, and
3. 0.2 when $B \geq 11.6$ million lbs.

Cap of legal male harvest rate: 0.4.

The harvest strategy is conservative, particularly at low stock sizes, and would be expected to help maintain long term stock productivity, as well as increase the probability of stock rebuilding.

Crab Stocks With No Annual Survey

Stock status for the following stocks is unknown due to no survey biomass estimates: Pribilof Islands golden king crab (*Lithodes aequispinus*); Saint Lawrence Island blue king crab; Northern District golden king crab; *C. bairdi* Tanner crab (Western Aleutian); Aleutian Islands scarlet king crab (*Lithodes couesi*); Bering Sea triangle Tanner crab (*Chionoecetes angulatus*); Eastern Aleutian Islands triangle Tanner crab; Eastern Aleutian Islands grooved Tanner crabs (*Chionoecetes tanneri*); Western Aleutian Islands grooved Tanner crabs; Bering Sea grooved Tanner crabs. The permit fisheries for the species identified in Table 3 are by ADF&G commissioner's permit only with observer requirements. Most of these species are generally taken as bycatch in other crab fisheries. Estimation of MSST for these stocks is not possible at this time because of insufficient data on the basic stock abundance. The ADF&G Gulf of Alaska Marine Resource Assessment Survey is a triennial trawl survey east of 170°W that provides some information on Dutch Harbor red king crab, Aleutian Islands golden king crab, Aleutian Islands scarlet king crab, E. Aleutian Islands Tanner crab, and E. Aleutian Islands grooved crab.

Table 3. 2000/2001 Guideline harvest levels (GHL), status of the fishery, and MSY estimates for BSAI king and Tanner crab stocks not annually surveyed. Estimated values are in millions of pounds. (NA indicates that insufficient data exists at this time to estimate the value)

Stock	GHL	Fishery/Season	MSY
Adak red king	0	closed	1.5
Dutch Harbor red king	0	closed	NA
Norton Sound red king	.336	7/1-9/3:11/15-5/15	0.5
St Lawrence blue king	NA	permit	0.1
Aleutian Is. golden king	5.7	8/15	15.0
Pribilof Is. golden king	0.15	permit	0.3
St. Matthew golden king	0.015	permit	0.3
Aleutian Is. scarlet king	NA	permit	NA
EBS scarlet king	NA	permit	NA
E. Aleutian Is. Tanner	0	closed	0.7
W. Aleutian Is. Tanner	0	closed	0.4
E. Aleutian Is. angulatus	NA	permit	1.0
EBS angulatus	NA	permit	0.1
E. Aleutian Is. tanneri	.05 to 0.2	permit	1.8
EBS tanneri	.05 to 0.2	permit	1.5
W. Aleutian Is. tanneri	NA	permit	0.2

Aleutian Islands red king crab (Adak and Dutch harbor red king crab stocks): The Adak stock has not been surveyed since 1977 and the eastern portion of the Dutch Harbor stock was surveyed in 1999 by ADF&G. The red king crab population continues to be at historically low levels with little sign of recruitment in 1999. Few red king crab were caught in either the 1995 or 1999 survey of the eastern Aleutians. The eastern portion has been closed since 1983. The western fishery was closed for the 1996/97 and 1997/98 seasons due to poor fishery performance in the 1995/96 season; portions were reopened to limited exploratory fishing for the 1998/99 season. The 1999/2000 season is closed. The GHL for the eastern portion is set based on the triennial-quadrennial trawl survey. GHLs for the western portion are based on the most recent fishery performance. In 1999, the Crab Plan Team identified the need for a standardized survey in areas of historical production prior to reopening the fishery.

Norton Sound red king crab: The 1999 ADF&G trawl survey estimated 4.2 million pounds of legal crab, a significant increase from the 1996 survey estimate of 1.6 million pounds of legal size male crab. This increase in abundance was the result of strong recruitment over the previous three years. Recruitment is not anticipated to be as strong over the next three years. However, the current biomass is the largest biomass estimate produced from a trawl survey since the commercial fishery began. Only the trawl survey conducted in 1976 produced a larger biomass estimate. The Norton Sound crab fishery operates in the summer and in the winter. Due to increasing legal male abundance, a harvest rate of 8% was applied to the legal biomass estimated in 1999. The 2000 GHL is 336,000 lbs, based on the triennial trawl survey stock abundance estimates.

Aleutian Islands golden king crab (Eastern Aleutians (Dutch Harbor) and Adak golden king crab stocks): A standardized triennial pot survey for golden king crab in a portion of the eastern Aleutian Islands (in the vicinity of Amukta, Chagulak, and Yunaska Islands) was initiated in 1997. Preliminary results from the recently completed 2000 survey of that area indicate that catch per unit effort (CPUE) of legal male crabs have dropped by roughly one-third from the 1997 CPUE, whereas female and pre-recruit male CPUEs remained roughly stable at their 1997 levels. Analysis of 1996-99 golden king crab fishery performance and observer data from the entire area east of 174° W longitude, on the other hand, indicate that the golden king crab stock has remained stable in that larger area. The 2000/2001 GHL for the Aleutian Islands has again been set 5.7 million pounds, with 2.7 million pounds for the area west of 174°W, and 3.0 million pounds for the area east of 174°W.

Eastern Aleutian Islands *C. bairdi* Tanner crab: The fishery has been closed since 1995 due to declining stock size estimated from surveys and poor fishery performance. In the 1999 survey, prerecruit and recruit sized Tanner crabs increased substantially in the Eastern Aleutian District, resulting in a population estimate of 6.2 million crabs, an increase from 2.1 million crabs in 1995. The 1995 survey estimates of the number of crabs were 29,000 legal males and 135,000 females. 2000 survey data is not available at this time.

Overfishing Parameters

The FMP identifies the following overfishing definitions to provide objective and measurable criteria for identifying when the BSAI crab fisheries are overfished or overfishing is occurring, as required by the Magnuson-Stevens Fishery Conservation and Management Act. Table 4 provides the MSST, MSY, OY and MSY control rule estimates for the BSAI king and Tanner crab stocks. The Crab Plan Team will reevaluate these estimates every five years or when environmental conditions indicate a regime shift.

Table 4. MSST, MSY, OY, and the MSY control rule estimates for BSAI king and Tanner crab stocks.
Estimated values are in millions of pounds.
(NA indicates that insufficient data exists at this time to estimate the value)

Stock	MSST	MSY	OY range	MSY control rule
Adak red king	NA	1.5	0 - 1.5	0.2
Bristol Bay red king	44.8	17.9	0 - 17.9	0.2
Dutch Harbor red king	NA	NA	NA	0.2
Pribilof Islands red king	3.3	1.3	0 - 1.3	0.2
Norton Sound red king	NA	0.5	0 - 0.5	0.2
Pribilof Islands blue king	6.6	2.6	0 - 2.6	0.2
St Matthew blue king	11.0	4.4	0 - 4.4	0.2
St Lawrence blue king	NA	0.1	0 - 0.1	0.2
Aleutian Is. golden king	NA	15.0	0 - 15.0	0.2
Pribilof Is. golden king	NA	0.3	0 - 0.3	0.2
St. Matthew golden king	NA	0.3	0 - 0.3	0.2
Aleutian Is. scarlet king	NA	NA	NA	0.2
EBS scarlet king	NA	NA	NA	0.2
TOTAL king crab		43.9	0 - 43.9	
E. Aleutian Is. Tanner	NA	0.7	0 - 0.7	0.3
EBS Tanner	94.8	56.9	0 - 56.9	0.3
W. Aleutian Is. Tanner	NA	0.4	0 - 0.4	0.3
TOTAL Tanner crab		58.0	0 - 58.0	
EBS snow	460.8	276.5	0 - 276.5	0.3
TOTAL snow crab		276.5	0 - 276.5	
E. Aleutian Is. angulatus	NA	1.0	0 - 1.0	0.3
EBS angulatus	NA	0.3	0 - 0.3	0.3
E. Aleutian Is. tanneri	NA	1.8	0 - 1.8	0.3
EBS tanneri	NA	1.5	0 - 1.5	0.3
W. Aleutian Is. Tanneri	NA	0.2	0 - 0.2	0.3
TOTAL other Tanners		4.8	0 - 4.8	

Maximum sustainable yield (MSY) is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions. MSY is estimated from the best information available. Proxy stocks are used for BSAI crab stocks where insufficient scientific data exists to estimate biological reference points and stock dynamics are inadequately understood. MSY for crab species is computed on the basis of the estimated biomass of the mature portion of the male and female population or total spawning biomass (SB) of a stock. A fraction of the SB is considered sustained yield (SY) for a given year and the average of the SYs over a suitable period of time is considered the MSY.

Overfishing: The term “overfishing” and “overfished” mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce MSY on a continuing basis. Overfishing is defined for king and Tanner crab stocks in the BSAI management area as any rate of fishing mortality in excess of the maximum fishing mortality threshold, F_{msy} , for a period of 1 year or more. Should the actual size of the stock in a given year fall below the minimum stock size threshold, the stock is considered overfished. If a stock or stock complex is considered overfished or if overfishing is occurring, the Secretary will notify the Council to take action to rebuild the stock or stock complex.

MSY control rule means a harvest strategy which, if implemented, would be expected to result in a long-term average catch approximating MSY. The MSY control rule for king and Tanner crabs is the mature biomass of a stock under prevailing environmental conditions, or proxy thereof, exploited at a fishing mortality rate equal to a conservative estimate of natural mortality. Sustainable yield (SY) in a given year is the MSY rule applied to the current spawning biomass. Overfishing occurs if the SY is exceeded for more than one year.

MSY stock size is the average size of the stock, measured in terms of mature biomass of a stock under prevailing environmental conditions, or a proxy thereof. It is the stock size that would be achieved under the MSY control rule. It is also the minimum standard for a rebuilding target when remedial management action is required. For king and Tanner crab, the MSY stock size is the average mature biomass observed over the past 15 years, from 1983 to 1997.

Maximum fishing mortality threshold (MFMT) is defined by the MSY control rule, and is expressed as the fishing mortality rate. The MSY fishing mortality rate $F_{msy} = M$, is a conservative natural mortality value set equal to 0.20 for all species of king crab, and 0.30 for all *Chionoecetes* species.

Minimum stock size threshold (MSST) is whichever is greater: one half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock or stock complex were exploited at the maximum fishing mortality threshold. The minimum stock size threshold is expressed in terms of mature biomass of a stock under prevailing environmental conditions, or a proxy thereof.

Community Development Quota Crab Fisheries

The Magnuson-Stevens Act mandates that the Council and NMFS establish a Community Development Quota (CDQ) program under which a percentage of the total allowable catch for Bering Sea and Aleutian Island crab fisheries is allocated to the CDQ program (16 U.S.C. 1855 (i)(1)(A)). The Council and NMFS deferred management authority of the BSAI king and Tanner crab fisheries, including the CDQ fisheries, to the State, with federal oversight. The State/Federal cooperative management regime established in the FMP specifies three categories of management measures which provide the framework for Federal/State management of the crab fisheries, including the determination of the GHs and fishery seasons. Additionally, the FMP authorizes the State to allocate the crab CDQ reserve among CDQ groups and to manage crab harvesting activity of the BSAI CDQ groups (§8.1.4.2 of the FMP).

Table 5. CDQ program percent allocation by group.

<u>Fishery</u>	<u>APICDA</u>	<u>BBEDC</u>	<u>CBSFA</u>	<u>CVRF</u>	<u>NSEDC</u>	<u>YDFDA</u>
Bristol Bay red king crab	20	20	0	20	20	20
Pribilof red & blue king	0	0	100	0	0	0
St. Matthew blue king	50	12	0	12	14	12
Norton Sound red king	0	0	0	0	50	50
Tanner crab	10	19	19	17	18	17
Snow crab	10	19	19	17	18	17

Table 6. 2000/2001 CDQ reserve (in pounds).

<u>Fishery</u>	<u>CDQ</u>
Bristol Bay red king crab	626,250
Pribilof red & blue king	0
St. Matthew blue king	0
Norton Sound red king	25,200
Tanner crab	0
Snow crab	2,047,500

Sixty-five communities along the Bering Sea are eligible for the CDQ program. These villages aligned into six CDQ groups: Aleutian Pribilof Island Community Development Association (APICDA), Bristol Bay

Economic Development Corporation (BBEDC), Central Bering Sea Fishermen’s Association (CBSFA), Coastal Villages Regional Fund (CVRF), Norton Sound Economic Development Corporation (NSEDG), and Yukon Delta Fisheries Development Association (YDFDA). The CDQ reserve is 7.5% of the GHF for the following Bering Sea fisheries: Bristol Bay red king crab, Pribilof red and blue king crab, Norton Sound red king crab, snow crab, and Tanner crab. ADF&G divides the 7.5% reserve among the six CDQ groups.

License Limitation Program

Fishing under the crab license limitation programs (LLP) began in January 2000. Table 7 shows the number of crab LLP licenses and interim licenses issued as of September 2000. Updated statistics on the crab LLP licenses are available on the NMFS web page. Interim licenses were issued to any applicant that had a valid moratorium qualification for crab in 1999. Interim licenses are temporary and the total numbers of licenses will decrease as interim licenses either are denied or licenses granted. Interim licenses are issued if any part of a person’s claim is contested. Interim licenses remain interim until final NMFS action. Also, the number of licenses may change as a result of a small number of new licenses issued from late filed claims. Licenses that are not interim expire December 31, 2000. Before the licenses expire, NMFS(RAM) will issue new licenses with the same endorsements, conditions, etc. These new licenses will only be valid for 2001, as the program is still being modified and the implementing regulations may change in 2001. NMFS will notify license holders of any changes in the regulations and provide opportunity to challenge changes to an individual’s license.

The implementing regulations may change because of an amendment recommended by the Council in 1998 that included changes to the basic eligibility criteria for crab. This amendment (Amendment 10 to the crab FMP) would require recent participation

in the BSAI king and Tanner crab fisheries in order to qualify for a license under the crab LLP. The recent participation requirement would apply to the general licenses only; if a vessel satisfies the recent participation criteria, the owner would receive the original license and all of the species/area endorsements for

which it qualified under the original criteria. No new species/area endorsements could be earned during the recent qualification. The Secretary has yet to approve Amendment 10 or its implementing regulations. The total number of crab licenses will decrease if the Secretary approves Amendment 10.

Table 7: Crab Licenses Limitation Program: number of licenses issued as of September 2000			
Number of crab licenses: 470 (224 of which are interim)			
Number of crab licenses with specific endorsements, by crab fishery:			
<u>Endorsement</u>	<u>Licenses</u>	<u>Interim Licenses</u>	<u>Total</u>
Aleutian Is. golden king	15	41	56
Aleutian Is. red king	17	47	64
EBS Tanner	184	189	373
Bristol Bay red king	186	179	365
Norton Sound king	47	27	74
Pribilof Is. king	76	88	167
St. Matthew Is. blue king	107	110	217
Notes: A crab license may contain more than one endorsement. EBS Tanner endorsements included both snow crab (<i>C. opilio</i>) and Tanner crab (<i>C. bairdi</i>).			

American Fisheries Act Crab Sideboards

In 1998, Congress passed the American Fisheries Act (AFA) to establish a new allocation scheme for the BSAI pollock fishery. The AFA required harvest restrictions (commonly known as “sideboards”) on the pollock fishermen who received exclusive harvesting privileges under the AFA to protect the interests of fishermen who are not directly benefitted by the AFA. The sideboards for the AFA vessels to participate in the crab fisheries are as follows.

Under regulations implementing the AFA, a vessel is ineligible to participate in any BSAI crab fishery unless that specific vessel participated in a specific crab fishery during certain qualifying years. AFA vessel permits could be endorsed for the Bristol Bay red king crab, snow crab, *C. bairdi* Tanner crab, St. Matthew blue king crab, Pribilof Islands king crab, Aleutian Islands red king crab, and Aleutian Islands golden king crab fisheries. To participate in a BSAI crab fishery, the operator of an AFA vessel would have to have a valid LLP license for

that crab fishery as well as an AFA vessel permit containing an endorsement for that crab fishery.

In addition to the historic participation requirements,

there is a cap on the amount of Bristol Bay red king crab and *C. bairdi* Tanner crab that the AFA vessels can harvest. The Bristol Bay red king crab harvest cap is based on the aggregate 5-year (1991-1997, excluding 1994-1995) weighted average share. Under this cap, AFA vessels may harvest up to 10.81% of

the regular commercial GHL, which equals 834,937 pounds for the 2000 fishery. The amount of the harvest cap may change if the number of AFA vessels with Bristol Bay red king crab endorsements changes. An aggregate harvest cap will be established for *C. bairdi* Tanner crab once the stock rebuilds. This harvest cap will be based on the aggregate historic catch of the endorsed *C. bairdi* Tanner crab vessels for 1995-1996. Management and implementation of these crab harvest cap sideboards is deferred to the State of Alaska.

Table 8: Participation requirements for AFA catcher vessels to determine eligibility to harvest crab species. An AFA vessel must have participated in the directed crab fishery below during the participating years listed in order to be eligible to participate in that fishery in the future.

<u>Fishery</u>	<u>Participating years</u>
Bristol Bay red king	Made landings of BSAI king or Tanner crab species in 1996, 1997, <i>or</i> on or before February 7, 1998
St. Matthew blue king	1995, 1996, <i>or</i> 1997
Pribilof Islands king	1995, 1996, <i>or</i> 1997
Aleutian Is. golden king	1997/1998 <i>and</i> 1998/1999
Aleutian Is. red king	1995/1996 <i>and</i> 1998/1999
Snow crab	Made landing in each of four or more years from 1988-1997
<i>C. bairdi</i> Tanner	1995 <i>or</i> 1996

Table 9: Number of AFA vessels eligible to harvest crab and 2000 harvest cap for AFA vessels, by crab fishery:

<u>Fishery</u>	<u>AFA Endorsements</u>	<u>2000 Harvest Cap</u>
Aleutian Is. golden king	0	-
Aleutian Is. red king	0	-
<i>C. bairdi</i> Tanner	28	NA
Bristol Bay red king	40	834,937 pounds
Snow crab	7	-
Pribilof Is. king	2	-
St. Matthew Is. blue king	1	-

Note: NA indicates a harvest cap is not applicable because the fishery is closed for 2000.

Survey Methods

NMFS Annual Eastern Bering Sea Trawl Survey: NMFS has performed annual trawl surveys of the eastern Bering Sea since 1968. Two vessels, each equipped with an eastern otter trawl with 83 ft headrope and 112 ft footrope, conduct this multispecies, crab-groundfish survey during summer. Stations are sampled in the center of a systematic 20 X 20 nm grid overlaid in an area of »140,000 nm². The towed area is estimated, and fish and invertebrate catches from each station are sampled, enumerated, measured and weighed. An update of Stevens et al. (2000) will be published to provide details on the 2000 survey results for: Bristol Bay and Pribilof Islands red king crabs, St. Matthew and Pribilof Islands blue king crabs, and eastern Bering Sea Tanner, snow, and hair crabs.

Two surveys were conducted for Bristol Bay red king crab in 2000: standard survey about two weeks earlier than the past surveys and resurvey of 31 stations with high female density. Differences in area-swept estimates of abundance between the standard survey and resurvey of these 31 stations can be attributed to survey measurement errors. The size distribution of females was significantly larger in the resurvey than during the standard survey because most mature females had not molted prior to the standard survey. Therefore, data from both surveys was used to assess male abundance but only the resurvey data plus the standard survey data outside the 31 stations to assess female abundance.

King and Tanner crab stock surveys regularly performed by ADF&G in the BSAI: ADF&G performs four regularly scheduled stock assessment surveys: a pot survey for blue king crab in the St. Matthew Island area; a trawl survey for red king crab in Norton Sound; a pot survey for golden king crab in the Aleutians between 170° and 172° W. longitude; and, a trawl survey for red king crab and Tanner crab in the eastern Aleutians. Each of the surveys is performed on a triennial basis. Trawl survey data is used to generate area-swept population estimates of abundance. Pot survey data, on the other hand, cannot be used at present to generate population estimates, but can serve to provide population indices. The St. Matthew pot survey was first performed in 1995 and was performed again in 1998. That survey is performed south of St. Matthew Island in an area of relatively shallow waters that supports most of the blue king commercial fishery and the mature female population, but which is not accessible to the annual NMFS trawl survey. ADF&G began performing a triennial trawl survey for red king crab in Norton Sound in 1996, after NMFS removed the Norton Sound area from its triennial trawl survey schedule. Norton sound was again surveyed by ADF&G in 1999. A pot survey of Aleutians golden king crab in the area between 170° and 172° W. longitude was first performed by ADF&G in 1991 and was established as a standardized triennial survey in 1997. The eastern Aleutians are surveyed for Tanner crab and red king crab on a triennial basis as an extension of the annual Westward Region bottom trawl survey of Kodiak Island and the south Alaska Peninsula. The area covered by that survey includes waters encompassing Unalaska Island and eastern Umnak Island and Akun and Akutan Bays. Due to survey conflict, the scheduled 1998 trawl survey of the eastern Aleutians was not performed, but was rescheduled for and performed in 1999.

Analytical Methods

Detailed descriptions of the analytical methods are contained in the attached documents, “Status of King Crab Stocks in the Eastern Bering Sea in 2000” (Zheng and Kruse 2000), and Appendix: Crab Model Structures and Model Fits, prepared by ADF&G.

Overview. The annual trawl survey is an essential data-gathering tool on the status of crab stocks in the eastern Bering Sea. Yet, year-to-year variation in oceanographic conditions leads to changes in species distributions and availability to survey gear. These changes and other measurement errors can lead to unexpected shifts in area-swept abundance estimates unrelated to true changes in population size. Estimates from previous years’ surveys and commercial catches provide valuable auxiliary information to help decipher real population changes from survey measurement errors. Population estimation models were developed to incorporate crab size, sex, and shell condition data from annual surveys, commercial catches and catch samples. Model estimates based on multiple years of data and multiple data sources are generally more accurate than area-swept estimates from current-year survey data alone. ADF&G uses these estimates for fishery management of the modeled stocks.

Because the quantity and quality of data vary among crab stocks, no single analytical model is ideally suited for all situations. Therefore, the following approaches were developed for use with eastern Bering Sea king crabs that are tailored to differing levels of information: *length-based analysis (LBA)* for stocks with high-quality size composition data; and *catch-survey analysis (CSA)* for stocks lacking detailed size composition data or where the survey catchability coefficient is unknown (Zheng et al. 1997; Collie and DeLong 1998). LBA is applied to Bristol Bay red king crabs and *C. bairdi* Tanner crabs, and CSA to St. Matthew and Pribilof Islands blue king crabs. A brief description of these two methods and their application to king crab stocks in the eastern Bering Sea follows.

Length-based Analysis. The LBA is an analytical procedure to estimate annual abundance of crab stocks for which extensive high-quality data are available. The LBA makes use of detailed annual data on size, sex, and shell condition from trawl surveys, onboard and dockside catch samples, and annual commercial harvests. Males and females are modeled separately by 5 mm carapace length (CL) intervals as newshell (i.e., those that molted within the past year) and oldshell crabs (i.e., those that have not molted within the past year). The annual abundance of crabs at each length group is a combined result of recruitment, growth, natural mortality, and harvest. Note that this is a size-based analysis, not an age-based analysis that is commonly used for fish stocks. An overview of the approach is provided in Zheng et al. (1996), Zheng et al (1998), and Zheng and Kruse (1999). The LBA is used to estimate annual abundance of Bristol Bay red king crab and *C. bairdi* Tanner crab.

Benefits of the LBA are that it provides relatively precise abundance estimates for male and female crabs for fishery management, yields information needed to estimate Stock-Recruit relationships, and provides a means to analyze alternative harvest strategies. Another benefit of the LBA is that it smooths out measurement error in the survey. Often, high measurement errors were caused by an extremely high catch in one or two survey stations. By smoothing out survey measurement errors, the LBA provides a more consistent interpretation of stock changes over time than do survey area-swept estimates.

Catch-survey Analysis. Collie and DeLong (1998) updated the two-stage CSA model (Collie and Kruse 1998) to a three-stage (i.e., three age-size groups) approach. As with the LBA, the CSA estimates survey measurement errors and “true” stock abundance. The CSA model is less complex, is only applied to male crabs, and requires less detailed size composition data than the LBA. Instead of tracking multiple 5 mm size groups as the LBA does, CSA considers only three age-size groups of crabs: *prerecruits*, mature crabs that are one molt away from attaining legal size; *recruits*, mature newshell crabs that molted to legal size within the past year; and *postrecruits*,

crabs that have been legal for more than one year. The previous two-stage CSA considered only recruit and postrecruit crabs. In the three-stage version, mature and legal abundance and associated 95% confidence intervals can be estimated each year. These improvements are important because GHs for eastern Bering Sea king crabs are based on estimates of both mature and legal crabs. The updated model provides a new series of abundance estimates over the years that the St. Matthew and Pribilof Islands stocks have been surveyed.

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