STATUS OF KING CRAB STOCKS IN THE EASTERN BERING SEA IN 2001

By

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ABSTRACT

We applied population estimation models to eastern Bering Sea trawl survey, catch sampling, and commercial catch data for red king crabs in Bristol Bay during 1972-2001, red king crabs off the Pribilof Islands during 1988-2001, blue king crabs off St. Matthew Island during 1978-2001, and blue king crabs off the Pribilof Islands during 1975-2001. A length-based analysis (LBA) was applied to male and female red king crabs in Bristol Bay and a four-stage catch-survey analysis (CSA) was applied to males only for the other three king crab stocks. The Bristol Bay red king crab mature male abundance estimate decreased to 11.0 million crab in 2001, while the mature female abundance increased to 21.1 million crab. This provided a GHL of 7.15 million pounds. For St. Matthew Island blue king crabs, mature male abundance increased to 1.4 million crabs, but the commercial fishery remained closed for 2001 under the criteria of the harvest strategy for this stock. Mature male abundance of Pribilof Islands blue king crabs declined to 0.4 million crabs, a value below the fishery threshold. Therefore, there will be no Pribilof blue king crab fishery in 2001. Similar to 2000, no small-sized crabs and few prerecruits of blue king crabs were caught this year in the Pribilof Island area during the eastern Bering Sea trawl survey. Pribilof Islands red king crabs mature male population appears to be increasing, with an estimated mature males abundance of 1.8 million crabs. However, given declining abundance and depressed condition of blue king crabs, concern for bycatch of blue king crabs, and low precision of abundance estimates for red king crabs, the fishery will be closed for both Pribilof Islands blue and red king crab stocks in 2001. None of the king crab stocks considered show signs of significant recruitment in the near future.

Keywords: red king crab, blue king crab, stock abundance, modeling, guideline harvest level.

EXECUTIVE SUMMARY

We applied population estimation models to eastern Bering Sea trawl survey, catch sampling, and commercial catch data for red king crabs in Bristol Bay during 1972-2001, red king crabs off the Pribilof Islands during 1988-2001, blue king crabs off St. Matthew Island during 1978-2001, and blue king crabs off the Pribilof Islands during 1975-2001. A length-based analysis (LBA) was applied to male and female red king crabs in Bristol Bay and a four-stage catch-survey analysis (CSA) was applied to males only for the other three king crab stocks.

For Bristol Bay red king crabs, abundance of large-sized crabs in 2001 decreased from last year because the above-average 1990 year class had entered the legal-sized population by 2000. Abundance of mature males decreased from 12.1 million in 2000 to 11.0 million in 2001, and legal male abundance decreased from 8.0 to 7.2 million. Mature female abundance increased from 19.0 million to 21.1 million crabs from 2000 to 2001, and effective spawning biomass was steady at 40.2 to 40.6 million pounds. The effective spawning biomass is below the target rebuilding level of 55 million pounds; thus, a 10% harvest rate is applied. By multiplying the 10% harvest rate times mature male abundance times an average weight of 6.5 pounds per legal crab, an overall preseason guideline harvest level (GHL) of 7.15 million pounds was set. A total of 7.5% of the GHL or 536 thousand pounds is reserved for the community development quota (CDQ) fishery resulting in a GHL of 6.614 million pounds for the open-access fishery. The open-access fishery opened October 15, 2001.

For St. Matthew Island blue king crabs, CSA estimates the abundance of prerecruit (sublegal males) and legal-sized male crabs. Compared to 2000, prerecruit and mature population abundances increased slightly. Prerecruit abundance increased to 0.9 million crabs from 0.7 million in 2000, and mature male abundance increased from 1.2 million to 1.4 million. Although the stock is above the fishery threshold of 2.9 million pounds of mature male biomass, the GHL determined by the harvest strategy is below the minimum GHL of 2.5 million pounds for a fishery opening. Though there was some increase in abundance, this stock is still depressed and will be closed in 2001.

For Pribilof Islands blue king crabs, changes from last year included continued decline in mature male abundance from 0.6 to 0.4 million crabs, below the fishery threshold of 0.77 million, and a decrease in legal male abundance from 0.5 to 0.4 million crabs. Similar to 2000, no small-sized crabs and few prerecruits were caught this year. For Pribilof Islands red king crabs, the mature population appears to be increasing with estimated mature males at 1.4 million in 1998 and 1.8 million in 2001. Given declining abundance and depressed condition of blue king crabs, concern for bycatch of blue king crabs, and low precision of abundance estimates for red king crabs, the fishery will be closed for both Pribilof Islands blue and red king crab stocks in 2001.

INTRODUCTION

The National Marine Fisheries Service (NMFS) conducts annual trawl surveys of crab abundance in the eastern Bering Sea. For each crab stock, the Alaska Department of Fish and Game (ADF&G), in consultation with NMFS, sets preseason guideline harvest levels (GHLs). For most commercially exploited stocks in the Bering Sea, abundance is estimated by area-swept methods and reported annually by NMFS (e.g., Stevens et al. 2000). For some stocks, ADF&G developed population estimation models to minimize the effects of annual survey measurement errors on current-year abundance estimates by incorporating survey and fishery data from prior years into the estimation process. Abundance estimates from these models are used to manage the crab fisheries and to set annual crab bycatch limits in the groundfish fisheries.

The goal of this report is to provide concise information on stock status of Bering Sea king crab stocks. This provides the industry and public access to information used by the agencies to evaluate status of stocks as estimated by population models. In this report we briefly review estimation methods, current stock status, implications for crab fishery management and regulation of crab bycatch in groundfish fisheries, and a brief outlook for the future. Trawl survey data used in this year's analyses were provided by Drs. Bob Otto, Louis Rugolo, and Brad Stevens of NMFS, Kodiak, Alaska.

METHODS

Survey Methods

NMFS has performed annual trawl surveys of the eastern Bering Sea since 1968. Two vessels, each equipped with an eastern otter trawl with an 83-ft headrope and a 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 nm^2. 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 2001 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. Status of Bering Sea groundfish stocks also assessed by this survey will be reported in an update to NPFMC (2000).

Analytical Methods

Overview

The annual trawl survey is an essential data-gathering tool on the status of crab stocks in the eastern Bering Sea. However, 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). We apply LBA to Bristol Bay red king crabs and CSA to St. Matthew and Pribilof Islands blue king crabs and Pribilof Islands red 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, such as Bristol Bay red king crabs. 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 old shell 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, handling mortality, bycatch mortality, and harvest. Collie and Kruse (1998) estimated the trawl survey catchability coefficient *(q)* to be near unity for legal-sized red king crabs in Bristol Bay, and $q = 1$ is assumed for area-swept and LBA methods. An overview of the approach is provided in Zheng et al. (1996).

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. Zheng and Kruse (2000a) extended it to a four-stage CSA by adding a second prerecruit size group. 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 four age-size groups of crabs: *prerecruit two*, immature crabs that are one molt away from mature; *prerecruit one*, 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 three-stage CSA considered only prerecruit one, recruit, and postrecruit crabs. In the four-stage version, more historical data are used to smooth abundance estimates of the current 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.

CURRENT STOCK STATUS

Bristol Bay Red King Crabs

LBA estimates of Bristol Bay red king crab abundance and 95% bootstrap confidence limits for 2001 are shown in Table 1. Historical changes in mature male and female abundance are graphed in Figure 1. As most of the male crabs from an above average year class (termed as the 1990 year class in this report) had entered the legal-sized population during the preceding three years (1998-2000), abundance of large-sized groups have decreased from last year. However, there was an increase in the number of smaller-sized crabs. Prerecruit male abundance increased from 5.8 million to 6.8 million crabs, mature male abundance decreased slightly from 12.1 million to 11.0 million crabs, and legal males decreased from 8.0 million to 7.2 million from 2000 to 2001. Abundance of mature female crabs in 2001 (21.2 million) had increased from 19.0 million crabs in 2000. Effective spawning biomass[1] (ESB) in 2001 (40.6 million pounds) was about the same as that in 2000 (40.2 million pounds, Table 1).

Insights into changes in annual survey results can be gained by examining the size frequency distributions over the past five years (Figure 2). Area-swept estimates suggest a substantial decrease in abundance of males between 95-mm and 110-mm CL and males >155-mm CL from 1997 to 1998. The dominant mode of males at 95 to 110-mm CL in 1997 grew in size to 110 to 130-mm CL in 1998 as expected, but abundance unexpectedly declined sharply despite relatively low estimated natural mortality for that year. Area-swept estimates of male abundance in 2001 show a greater decrease in abundance of mature-sized and legal-sized males crabs than would be expected from 1998, 1999, and 2000. The LBA attributes some of that trend to measurement error. Accordingly, estimates of mature male abundance are increased by the LBA for 2001 and decreased by the LBA for 1998-2000 relative to the area-swept estimates (Figure 1).

For females**,** the model did not fit the 1998 data very well. The large increase in abundance of mature females estimated by the survey in 1998 was not anticipated. The dominant mode of females shifted from 97.5-mm CL in 1997 to 107.5-mm CL in 1998 to 117.5-mm CL in 2000 to 122.5-mm CL in 2001 as crabs molted to larger sizes (Figure 2). However, in 1998, survey catches of females >117.5-mm CL (larger than those in the 1990 year class) increased about 70% from those >112.5-mm CL in 1997, yet survey catches of females >97.5-mm CL (including the 1990 year class) in 1999 fell 53% from those >92.5-mm CL in 1998. Changes in natural mortality typically do not fully account for such increases and decreases; it appears that survey measurement errors were substantial for females in both 1998 and 1999. The LBA attempts to account for measurement errors, so the LBA estimate of mature females is lower than the area-swept estimate in 1998 and higher in 1999 (Figure 1). For 2001, however, the LBA and area-swept estimates of mature female abundance show agreement.

Abundance estimates of juvenile males <95-mm CL and females <90-mm CL have large variances and are inconsistent over time and thus are not included in the LBA. However, size frequency modes of juvenile crabs tracked the strong 1990 year class that is apparently now fully recruited to the mature stock (Figure 2). The 1999 size frequency distributions of both males and females showed a mode centered about 67.5-mm CL, which seems to have grown to a mode centered at

[1] ***Effective spawning biomass*** is the estimated biomass of mature female crabs that the population of mature male crabs successfully mate in a given year.

82.5-mm CL in 2000 and to 97.5-mm CL in 2001 (Figure 2). Females from that cohort appear to be largely recruited to the mature size class. Males from this cohort will likely enter the fishery in the next two to three years. However, whereas this cohort (likely the 1994 year class) appears to have produced the second highest recruitment during the last 10 years, it has not developed to the level seen for the 1990 year class in 1997 (Table 1, Figure 2).

Just as historical survey results enter into the LBA and modify the interpretation of data from 2001, the 2001 survey results also provide additional information about reconstructed stock size in recent years. This is a common feature of contemporary estimation procedures for fish and invertebrate populations. Thus, historical abundance estimates generated with data from 1972-2001 (Table 1) differ somewhat from estimates generated with data from 1972-2000 (see Table 1 in Zheng and Kruse 2000b). Estimates for recent years change the most; older estimates remain most stable. Likewise, next year's assessment will bring new data to bear on the status of the stock in 2001.

Pribilof Islands Red King Crabs

The survey precision is very low for Pribilof Islands red king crabs because a large majority of crabs are usually caught in one or a few tows. As a result, the survey abundance by length class is not consistent over time. For example, large number of prerecruit-2 crabs in 1990 and postrecruit crabs in 1993 and 1995 were caught, but low numbers of prerecruit-1 crabs in 1991 and recruit crabs in 1992 were caught during the survey. Because of such inconsistencies, the CSA model and area-swept estimates of mature males peaked at different times: 1991 for the CSA model estimates and 2001 for the area-swept estimates (Figure 3). Based on the model results, the mature male abundance has increased during the last four years from 1.0 million in 1997 to 1.8 million in 2001. Likewise, the legal abundance has increased in the last three years from 0.8 million in 1998 to 1.2 million in 2001 (Table 2). Interpretation of such trends must be tempered by the low precision of abundance estimates (as indicated by the 95% confidence intervals) for the current year (Table 2) and previous years (e.g., Zheng and Kruse 1999, 2000b)

St. Matthew Island Blue King Crabs

Owing to extremely low survey abundances in 1999, 2000 and 2001, poor in-season fishery performance in 1998, and low catch rates from the ADF&G nearshore pot survey in 1999, we suspect that natural mortality may have increased (between the 1998 and 1999 surveys). To deal with this high natural mortality, we estimated two natural mortality parameters using CSA: M=1.50 for year 1998/99 (that is, the year between the 1998 and 1999 surveys) and M=0.26 for all other years. We also conducted a CSA under a model that estimated constant natural mortality for all years. The two models produced disparate estimates of mature male abundance in 1996-2000, but little difference in estimates of mature male abundance between the two models in 2001 (Figure 4).

Estimates of St. Matthew Island blue king crab abundance and 95% confidence limits for 2001 using a CSA model with two natural mortality parameters are shown in Table 3. Prerecruit and mature male population abundances have continued to increase slightly since 1999. Prerecruit male (90-119-mm CL) abundance increased from 0.7 million in 2000 to 0.9 million crabs in 2001, and mature male (≥105-mm CL) abundance increased from 1.2 million to 1.4 million crabs; those differences in annual abundance estimates are slight relative to the magnitude of the 95%

confidence limits, however. CSA estimates of mature male abundance are lower than area-swept estimates in 1996-98 and 2001, and higher in 1999 and 2000 (Figure 4). The constant natural mortality scenario (M = 0.33) attributes about half of the sharp drop in 1999 to survey measurement errors whereas the scenario with two natural mortality parameters (M = 1.50 for 1998/99 & M = 0.26 for all other years) fits the data best (Figure 4). Based on the best fit of the data, we chose the scenario with two natural mortality parameters as the best representation of population abundance trends. The low abundances across all size groups of males continues from 1999 through 2001, with no sign of significant recruitment (Figure 5).

Pribilof Islands Blue King Crabs

For blue king crabs off the Pribilof Islands, changes from 2000 included a continued decline in mature male (≥120-mm CL) abundance from 0.6 to 0.4 million crabs and a decrease in legal male (≥135-mm CL) abundance from 0.5 to 0.4 million crabs (Table 3, Figure 4). Estimated abundance of legal males is the lowest since 1990, and estimated abundance of mature males is the lowest since 1989. Estimated abundance of pre-recruit males and males newly recruited to legal size are particularly low, providing no suggestion of significant recruitment to the mature or legal male size classes in the near future (Table 3, Figure 5).

FISHERY MANAGEMENT IMPLICATIONS

Bristol Bay Red King Crabs

Directed Crab Fishery

The Alaska Board of Fisheries harvest strategy for Bristol Bay red king crabs sets a GHL by harvest rate coupled to a fishery threshold (ADF&G 2000). When the stock is not above the threshold of 8.4 million mature females (>89 mm CL) and 14.5 million pounds of ESB, the fishery is closed. When the stock is above threshold, GHL is determined by the ESB and abundance of mature and legal-sized males. A mature male harvest rate of 10% is applied to promote stock rebuilding when ESB is below the target rebuilding level of 55 million pounds. Once the stock is at or above 55 million pounds of ESB, a 15% harvest rate is applied to mature male abundance. To prevent a disproportionate harvest of large male crabs, the GHL is capped so that no more than 50% of the legal male crabs may be harvested in any one year.

In 2001 the estimates of mature female abundance and ESB were 21.2 million crabs and 40.6 million pounds, respectively – both above the thresholds needed to conduct a directed commercial fishery. Because ESB is below the target rebuilding level of 55 million pounds, a 10% harvest rate is applied. Applying this harvest rate times mature male abundance of 10.998 million results in a harvest of 1.0998 million crabs. Because 1.0998 million is only 15.2% of the legal abundance, the 50% cap is not required. By multiplying 1.0998 million crabs times an average weight of 6.5 pounds per legal crab, a preseason GHL of 7.15 million pounds was established for the 2001 fishery. A total of 7.5% of the GHL or 536 thousand pounds is reserved for the community development quota (CDQ) fishery, resulting in a GHL of 6.614 million pounds for the "open-

access" fishery. The actual CDQ harvest level will be based on a percentage of the total catch from the open-access commercial fishery.

Implications on the Bering Sea Groundfish Trawl Fisheries

Prohibited species catch (PSC) limits for red king crabs caught during groundfish trawl fisheries are set annually as a function of estimated ESB of Bristol Bay red king crabs. When ESB exceeds 14.5 million pounds but is less than 55 million pounds, the PSC is 97,000 crabs. When ESB exceeds 55 million pounds, the PSC is 197,000 crabs. Given the estimate of 40.6 million pounds of ESB for 2001, the red king crab PSC limit for the Bering Sea will be set at 97,000 crabs for groundfish trawl fisheries in 2002.

A portion of the year-round closure to non-pelagic trawling in the Red King Crab Savings Area (162^{o} to 164^{o} W, 56^{o} to 57^{o} N) is open to the rock sole fishery in years when there is a red king crab fishery in Bristol Bay (Witherell and Roberts 1996). Thus, the portion of the Red King Crab Savings Area bounded by 56^{o} to 56^{o} 10' N latitude will remain open to the rock sole fishery in 2002. A separate bycatch limit is established for this area not to exceed 35% of the red king crab PSC limits apportioned to the rock sole fishery by the NPFMC.

St. Matthew Island Blue King Crabs

For St. Matthew Island, the Alaska Board of Fisheries adopted a new harvest strategy in March 2000 (ADF&G 2000). The new harvest strategy has four components: (1) a minimum stock threshold of 2.9 million pounds of mature male (≥105 mm CL) biomass, (2) a minimum GHL of 2.5 million pounds, (3) variable mature male harvest rates based on the mature male biomass level, and (4) a cap of legal male harvest rate at 40% (Zheng and Kruse 2000a). The mature male biomass was estimated at 4.9 million pounds in 2001, above threshold. However, the estimated GHL according to the harvest strategy is 0.72 million pounds, which is below the minimum GHL for a fishery opening. Thus, the fishery for this stock will be closed in 2001.

Pribilof Islands Blue and Red King Crabs

For the Pribilof Islands, the fishery management plan specifies a threshold of 0.77 million mature male blue king crabs (≥120 mm CL); no threshold is specified for red king crabs (Pengilly and Schmidt 1995). During 1995-1998, trends in survey and fishery performance data were used to set an aggregate GHL for a combined blue and red king crab fishery to avoid bycatch problems that would occur if each stock were harvested with separate fisheries and to address concerns in precision of population estimates. The fishery for these two stocks was closed in 1999 based on a number of factors: declining abundance, low level of prerecruits, low precision of abundance estimates, and past fishery performance below expectations (Zheng and Kruse 1999). In 2000, the blue king crab fishery was closed due to the stock being below threshold and the red king crab fishery was closed due to concerns about bycatch of blue king crabs and poor precision of abundance estimates (Zheng and Kruse 2000b). The mature male abundance of Pribilof Islands blue king crabs was 0.44 million in 2001, below the fishery threshold, so the fishery for this stock will be closed in 2001. The fishery for Pribilof red king crabs will also be closed in 2001, again due

to concerns about bycatch of the depressed blue king crab stock and low precision of abundance estimates for red king crabs.

FUTURE OUTLOOK

The future outlook for the Bristol Bay red king crab stock is not optimistic. Almost all red king crabs from the 1990 year class have entered the mature population, and their abundance will continue to decrease due to natural mortality and fishery removals. The 1994 year class does not appear to provide as strong recruitment to the mature size classes as did the 1990 year class. Females from the 1994 year class largely recruited to maturity in 2001 and there is little evidence for strong recruitment of mature females in 2002 (Figure 2). Hence, some decline in ESB is expected for 2002. Recruitment of mature-sized males in 2002 and 2003 can be expected from the 1994 year class. At this time it is difficult to determine how large that recruitment will be relative to loss of mature males due to natural mortality and fishery removals.

The status of both eastern Bering Sea blue king crab stocks is depressed. The mature biomass based on area-swept estimates of both males and females was estimated as 9.0 million pounds for the St. Matthew blue king crab stock (NPFMC 2001). This is the third year in a row below the overfished level (minimum stock size threshold, MSST) of 11.0 million pounds established in the federal fishery management plan for Bering Sea/Aleutian Islands king and Tanner crabs (NPFMC 1998). Although we are still not certain about the level of high natural mortality from 1998 to 1999 for the St. Matthew stock, the low survey abundance this year greatly strengthens the argument for the high natural mortality. The mature biomass for the Pribilof Islands blue king crab stock was estimated as 7.0 million pounds, just above the MSST of 6.6 million lbs (NPFMC 2001). Based on trends in prerecruits and recruits for blue king crabs at the Pribilof Islands, the stock could drop below the MSST next year and is not expected to improve in the near future.

It appears that the mature population of Pribilof Islands red king crabs is increasing, although not to the level estimated by the area-swept methods. However, the high abundance of red king crabs in this year trawl survey estimate within the Pribilof Islands areas was due to the catch at one station, resulting in low precision of estimates and making it difficult to interpret any stock trends.

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Table 1. Annual abundance estimates (millions of crabs), effective spawning biomass (ESB, millions of pounds), and 95% confidence intervals for 2001 of red king crabs in Bristol Bay estimated by length-based analysis from 1972-2001. Size measurements are in mm CL.

	Males					Females		
Year	Recruits (to model)	Small (95-109)	Prerec. (110-134)	Mature (>119)	Legal (>134)	Recruits (to model)	Mature (>89)	ESB (M lbs)
1972	NA	13.719	15.275	18.783	10.150	NA	59.787	56.292
1973	33.134	22.121	27.805	23.296	10.745	33.160	69.926	65.040
1974	21.744	15.362	36.710	35.427	15.051	28.216	71.264	96.615
1975	33.140	22.118	37.399	42.598	21.066	21.885	65.794	116.341
1976	47.791	31.954	47.496	50.445	25.906	34.057	74.624	128.438
1977	55.727	37.678	63.219	64.147	30.704	72.325	118.273	169.748
1978	20.440	15.570	60.586	77.237	40.257	46.886	119.588	199.868
1979	12.646	9.026	37.242	74.227	47.689	19.028	92.714	166.657
1980	24.599	16.258	26.154	59.170	43.649	36.105	93.350	166.119
1981	17.327	12.061	17.295	18.263	9.405	13.787	71.310	58.868
1982	23.258	15.572	16.338	10.359	2.944	17.588	30.017	24.290
1983	13.098	9.324	13.633	9.044	2.509	4.663	9.872	16.527
1984	18.528	12.386	12.980	8.287	2.381	11.727	13.442	16.850
1985	10.527	7.486	10.868	7.035	1.839	5.125	7.450	11.157
1986	6.342	4.651	12.967	11.857	4.330	4.078	9.323	14.829
1987	6.843	4.729	11.414	13.837	6.611	9.598	16.179	25.470
1988	6.490	4.520	10.389	14.412	8.123	5.818	17.219	28.786
1989	5.300	3.743	9.549	15.388	9.528	5.585	17.753	30.959
1990	1.434	1.216	7.188	14.870	9.998	0.913	13.462	25.978
1991	4.144	2.730	5.122	11.815	8.417	3.642	13.184	25.536
1992	6.220	4.190	6.227	9.893	6.638	3.212	12.535	24.529
1993	2.379	2.101	7.090	10.034	5.900	2.110	10.976	22.163
1994	1.109	0.993	5.544	8.653	4.789	0.411	8.180	17.848
1995	2.929	2.013	4.756	9.367	6.131	1.585	9.341	20.618
1996	3.257	2.382	5.238	10.151	6.994	4.394	13.239	27.326
1997	12.522	8.187	8.835	11.521	7.203	15.899	28.415	38.510
1998	2.737	3.000	12.391	14.332	7.444	1.685	28.478	48.560
1999	1.301	1.046	8.133	14.766	8.588	0.624	20.811	44.525
2000	3.526	2.389	5.786	12.130	8.025	4.205	18.961	40.227
2001	6.467	4.454	6.768	10.998	7.216	7.775	21.191	40.595
				95% Confidence Limits in 2001				
Lower	4.533	NA	NA	8.699	NA	NA	17.654	NA
Upper	12.300	NA	NA	13.005	NA	NA	28.129	NA

Table 2. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2001 male red king crabs off the Pribilof Islands by 4-stage catch-survey analysis from 1988-2001. Size measurements are in mm CL.

Year	PreRec II (105-119)	PreRec I (120-134)	Mature (≥120)	Recruit newshell (135-149)	Post oldshell (≥135)	Legal (≥135)
1988	0.289	0.045	0.068	0.023	0.000	0.023
1989	0.487	0.229	0.299	0.049	0.021	0.070
1990	2.069	0.277	0.498	0.151	0.070	0.221
1991	1.936	1.631	2.130	0.314	0.198	0.512
1992	0.719	0.648	2.093	0.928	0.504	1.432
1993	0.683	0.209	1.810	0.371	1.229	1.599
1994	0.604	0.463	1.643	0.162	1.020	1.181
1995	0.344	0.227	1.372	0.277	0.866	1.143
1996	0.194	0.153	1.166	0.138	0.874	1.012
1997	0.713	0.070	0.993	0.091	0.832	0.923
1998	0.929	0.583	1.380	0.099	0.697	0.796
1999	0.721	0.430	1.446	0.377	0.636	1.013
2000	0.841	0.344	1.507	0.287	0.869	1.157
2001	1.807	0.507	1.778	0.264	0.986	1.249
			95% Confidence Intervals			
Lower	NA	NA	0.766	NA	NA	0.522
Upper	NA	NA	2.790	NA	NA	1.976

Table 3. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2001 male blue king crabs off St. Matthew and Pribilof Islands by 4-stage catch-survey analysis from 1978-2001 and 1975-2001 respectively. The estimates for the St. Matthew Island stocks are from the CSA model with two natural mortalities. Size measurements are in mm CL.

St. Matthew Island Blue King Crab Males						Pribilof Islands Blue King Crab Males					
Year	PreRec (90-119)	Mature (≥105)	Recruit newshell (120-133)	Post oldshell (≥120)	Legal (≥120)	Year	PreRec (105-134)	Mature (≥120)	Recruit newshell (135-148)	Post oldshell (≥135)	Legal (≥135)
1975	NA	NA	NA	NA	NA	1975	7.134	12.439	3.723	4.378	8.101
1976	NA	NA	NA	NA	NA	1976	4.107	10.603	1.612	5.964	7.576
1977	NA	NA	NA	NA	NA	1977	4.895	8.180	1.399	5.124	6.523
1978	2.571	3.250	1.164	0.575	1.739	1978	4.838	7.652	1.013	4.338	5.351
1979	3.608	3.588	1.078	1.058	2.136	1979	2.548	7.062	1.434	3.478	4.912
1980	4.507	5.303	1.131	1.663	2.794	1980	1.434	5.201	1.229	3.124	4.353
1981	3.462	6.666	1.760	2.225	3.984	1981	1.081	3.206	0.516	2.106	2.622
1982	2.430	5.665	1.769	2.358	4.127	1982	0.973	1.844	0.359	1.027	1.386
1983	1.785	4.064	1.017	1.720	2.737	1983	0.827	1.303	0.276	0.596	0.872
1984	1.129	2.287	0.815	0.620	1.435	1984	0.449	1.060	0.252	0.454	0.706
1985	1.052	1.511	0.504	0.471	0.975	1985	0.184	0.875	0.204	0.514	0.718
1986	1.012	1.375	0.348	0.383	0.731	1986	0.055	0.642	0.102	0.487	0.589
1987	1.243	1.398	0.434	0.413	0.846	1987	0.016	0.464	0.034	0.417	0.451
1988	1.454	1.738	0.432	0.488	0.919	1988	0.003	0.278	0.011	0.264	0.275
1989	2.344	1.951	0.639	0.503	1.142	1989	1.272	0.211	0.002	0.208	0.210
1990	2.787	3.116	0.718	0.719	1.436	1990	1.526	1.075	0.066	0.159	0.225
1991	2.576	3.627	1.291	0.867	2.158	1991	1.236	1.426	0.595	0.204	0.798
1992	2.593	3.698	1.126	1.139	2.265	1992	1.241	1.582	0.415	0.627	1.041
1993	2.742	3.946	1.086	1.370	2.456	1993	0.994	1.716	0.343	0.806	1.148
1994	2.772	4.169	1.115	1.446	2.561	1994	0.929	1.622	0.323	0.886	1.209
1995	3.092	4.109	1.175	1.372	2.547	1995	0.974	1.575	0.236	0.927	1.163
1996	3.272	4.582	1.211	1.491	2.702	1996	0.753	1.397	0.218	0.753	0.971
1997	2.794	4.875	1.430	1.629	3.059	1997	0.409	1.164	0.202	0.646	0.849
1998	2.119	4.414	1.324	1.675	2.999	1998	0.306	0.896	0.130	0.595	0.724
1999	0.589	1.104	0.288	0.507	0.795	1999	0.198	0.691	0.066	0.497	0.563
2000	0.713	1.212	0.232	0.626	0.857	2000	0.144	0.555	0.041	0.428	0.469
2001	0.876	1.387	0.267	0.675	0.943	2001	0.088	0.443	0.025	0.356	0.381
95% Confidence Intervals											
Lower	NA	0.811	NA	NA	0.558	Lower	NA	0.248	NA	NA	0.193
Upper	NA	1.963	NA	NA	1.327	Upper	NA	0.637	NA	NA	0.569

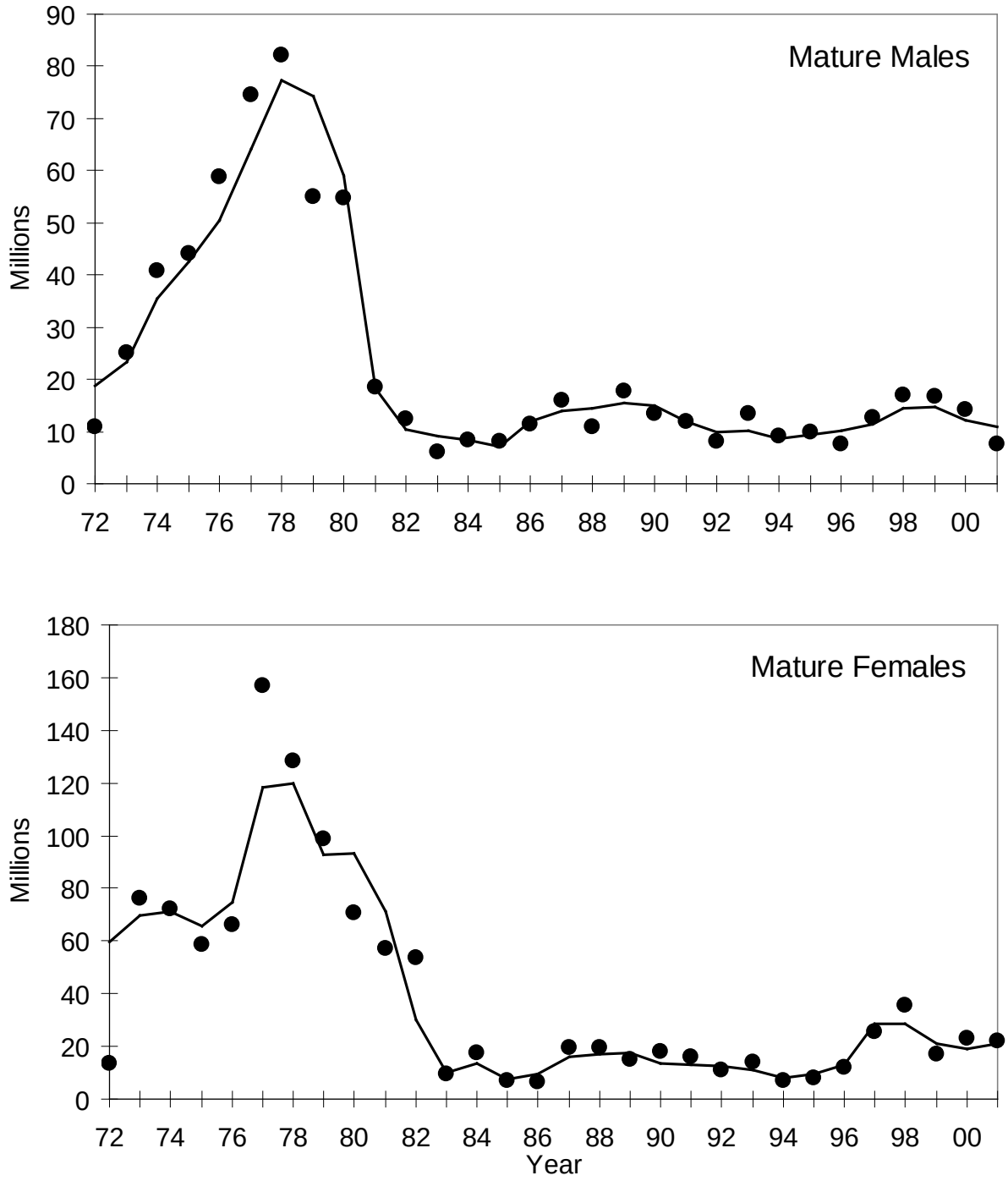

Figure 1. The length-based analysis fit (line) to area-swept estimates (dots) of mature male (top panel) and mature female (bottom panel) Bristol Bay red king crab abundance (millions of crabs).

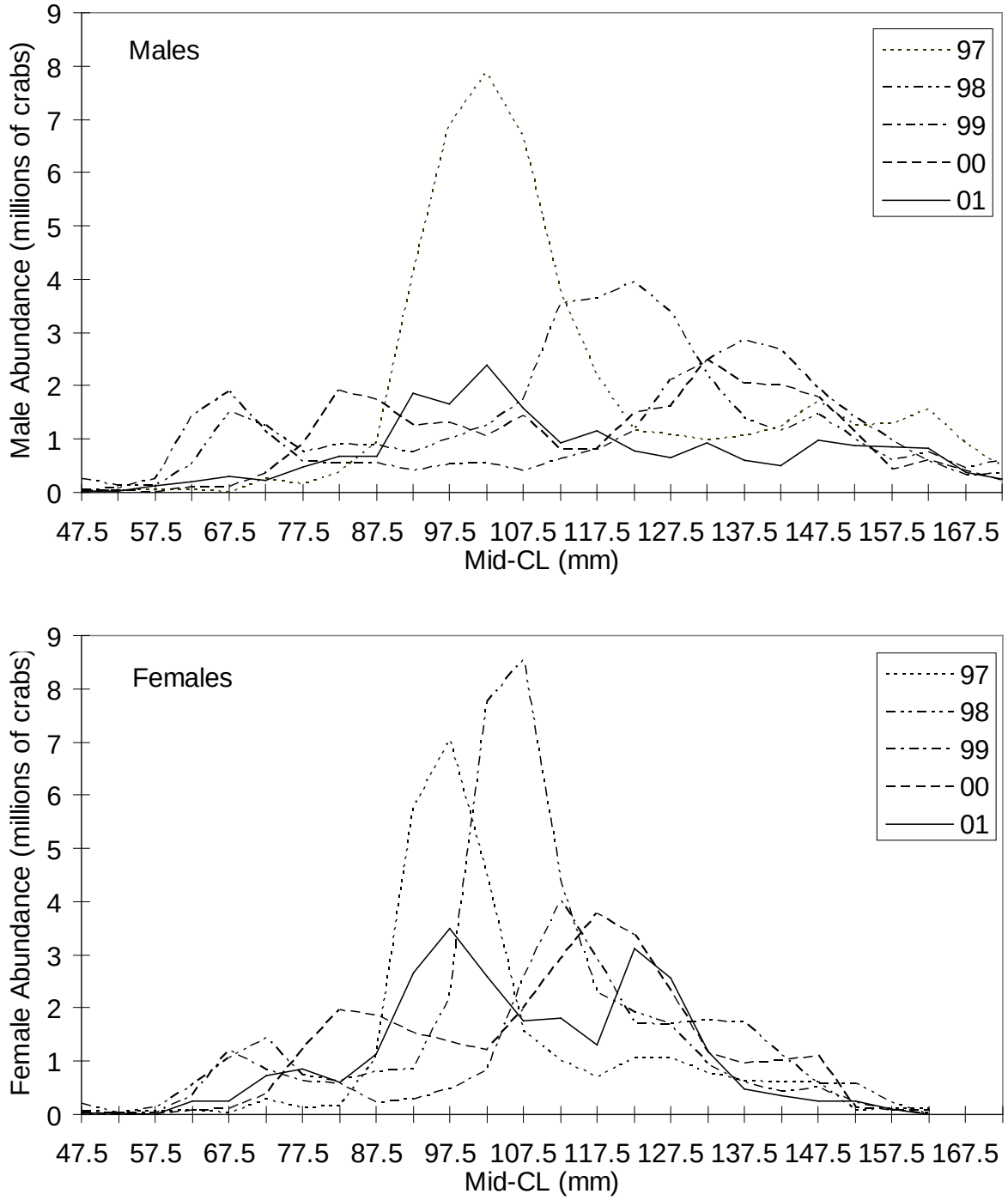

Figure 2. Length frequency distributions of male (top panel) and female (bottom panel) red king crabs in Bristol Bay from NMFS trawl surveys during 1997-2001. For purposes of these graphs, abundance estimates are based on area-swept methods not LBA because the LBA is confined to males ≥95 mm CL and females ≥90 mm CL.

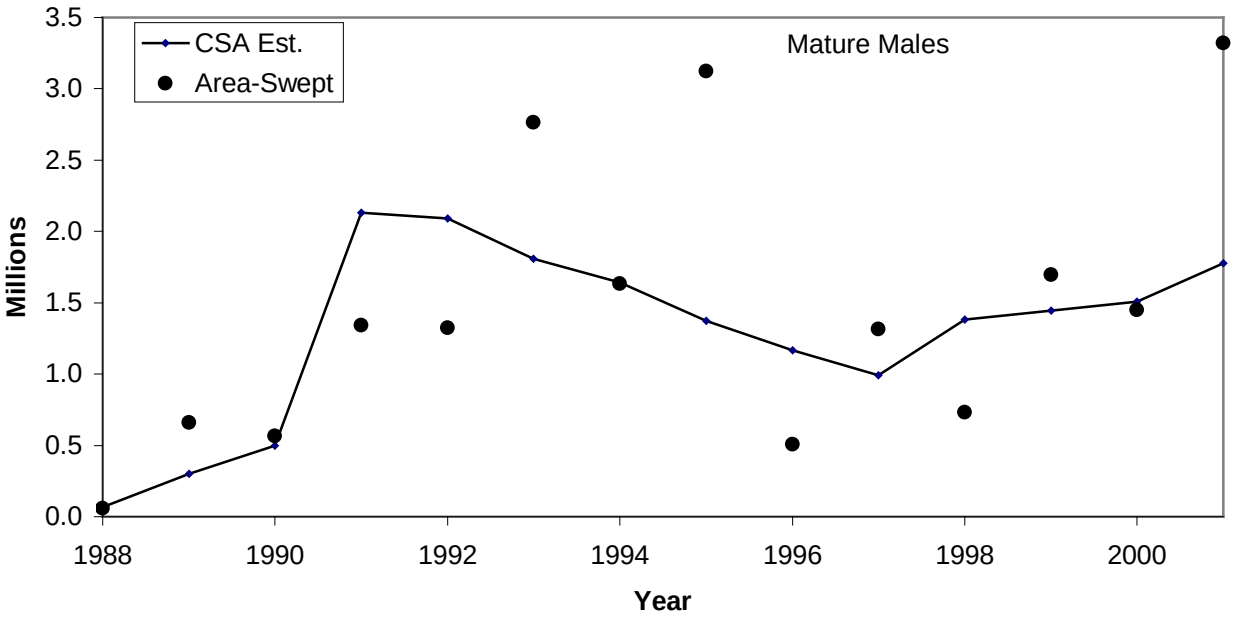

Figure 3. The catch survey analysis fit (line) to area-swept etimates (dots) of mature male red king crab abundance (millions of crabs) for Pribilof Islands stock.

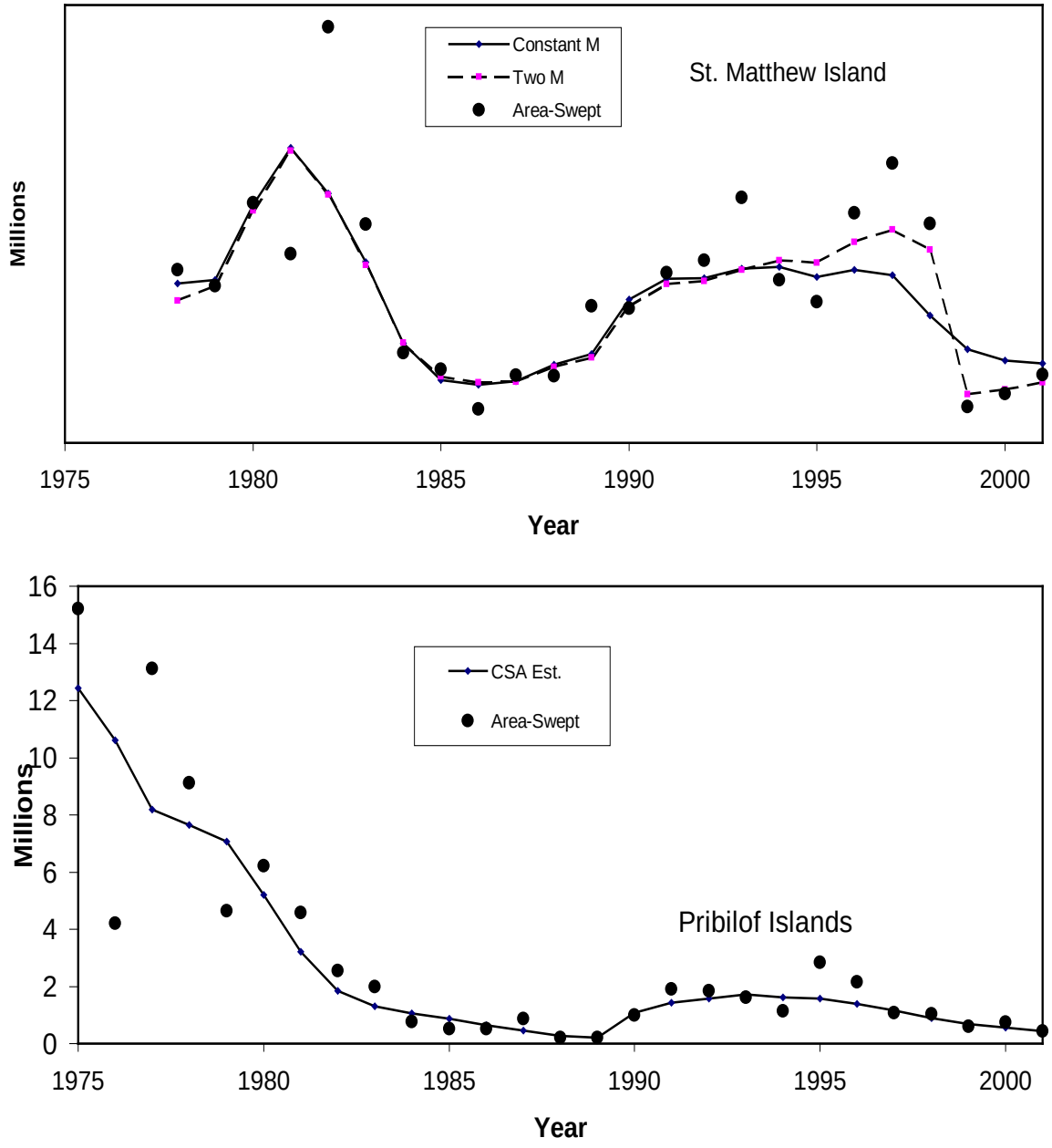

Figure 4. The catch-survey analysis fit (lines) to area-swept estimates (dots) of mature male blue king crab abundance (millions of crabs) for St. Matthew (top panel) 1978-2001 and Pribiliof Islands (bottom panel) 1975-2001 stocks. The "Constant M" is a single natural mortality estimated by the CSA model, and the "Two M" is when the CSA model estimates a natural mortality for all years except between 1998-1999 and a second natural mortality for between 1998-1999.

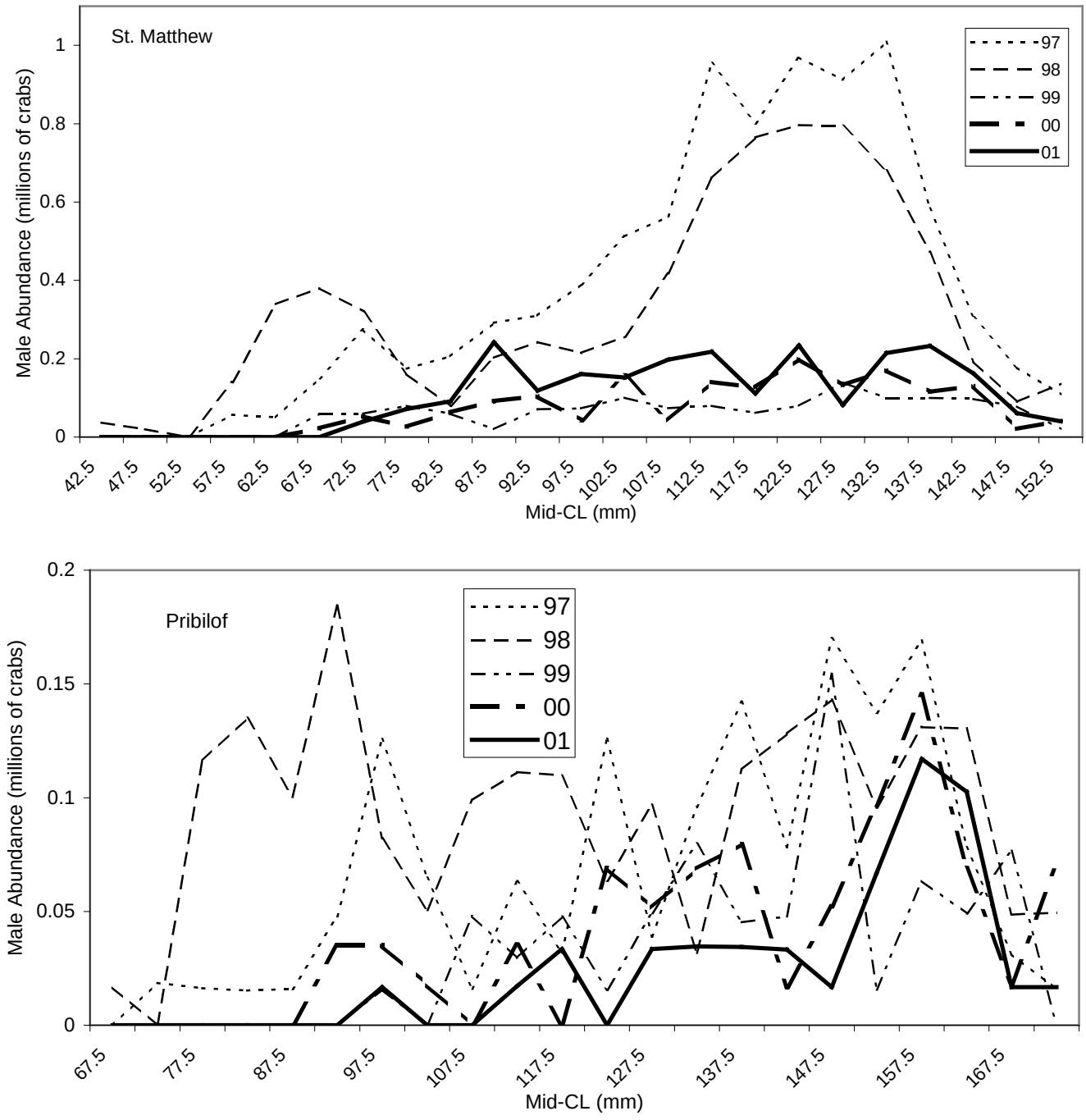

Figure 5. Length frequency distributions of male blue king crabs for St. Matthew (top panel) and Pribilof Islands (bottom panel) from NMFS trawl surveys during 1997-2001. Abundance estimates are based on area-swept methods.