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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 1972-1999, blue king crabs off St. Matthew Island during 1978-1999, and blue king crabs off Pribilof Islands during 1975-1999. A length-based analysis (LBA) was applied to male and female red king crabs and a catch-survey analysis (CSA) was applied to male blue king crabs.

For Bristol Bay red king crabs, the above average 1990 year class continued to grow to larger sizes. The majority of female crabs in this year class reached size at maturity in 1997, and most of male crabs from this cohort entered the legal-sized population in 1999. Compared to 1998, abundance of mature males increased from 15.9 to 18.1 million and legal male abundance increased from 7.4 to 9.3 million. Mature female abundance decreased slightly from 23.6 million to 21.9 million crabs, and effective spawning biomass increased slightly from 46.5 to 47.1 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 5.9 pounds per legal crab, an overall preseason guideline harvest level (GHL) of 10.66 million pounds was set. A total of 5% of the GHL or 533,000 pounds is reserved for the community development quota (CDQ) fishery resulting in a GHL of 10.127 million pounds for the open access fishery. The open access fishery will open October 15, 1999, pending the outcome of a legal appeal.

For St. Matthew blue king crabs, CSA estimates the abundance of prerecruit (sublegal mature males) and legal-sized male crabs. Compared to 1998, all segments of the population showed substantial decline in abundance. Prerecruit abundance declined to 0.2 million crabs from 0.9 million in 1998, and legal abundance dropped from 3.0 million to 1.0 million. Although the stock is above the fishery threshold of 0.6 million mature males, mature biomass based on area-swept estimates of both males and females was estimated as 4.6 million pounds, 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. Because of low mature biomass and very depressed population status, the fishery for this stock will be closed in 1999.

For Pribilof Islands blue king crabs, changes from last year included continued decline in mature male abundance from 1.0 to 0.8 million crabs and a decrease in legal male abundance from 0.8 to 0.7 million crabs. All segments of the male population showed decline in abundance, and no small-sized crabs were caught this year. For red king crabs, 1.64 million mature males were estimated by the National Marine Fisheries Service using area-swept methods. Given declining abundance of blue king crabs, low precision of abundance estimates, past fisheries' performance below expectations, and fishery closure for St. Matthew blue king crabs, the fishery will be closed for both Pribilof Islands blue and red king crab stocks in 1999.

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. 1998). For a few 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 and timely information on stock status in advance of upcoming Bering Sea king crab fisheries. 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 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 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 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. (1998) will be published to provide details on the 1999 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 (1999).

Two surveys were conducted for Bristol Bay red king crabs in 1999: 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, we used data from both surveys to assess male abundance but only the

resurvey data plus the standard survey data outside the 31 stations to assess female abundance.

Analytical Methods

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). We apply LBA to Bristol Bay red king 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, 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 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. 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. (1996b).

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 GHLs 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.

CURRENT STOCK STATUS

Bristol Bay Red King Crabs

LBA estimates of Bristol Bay red king crab abundance and 95% bootstrap confidence limits for 1999 are shown in Table 1. Historical changes in mature male and female abundance are graphed in Figure 1. An above average year class, likely from spawning in 1989-1991 (termed the 1990 year class in this report), continued to grow in body size resulting in increased abundance of the larger size groups of the surveyed stock. Mature male abundance increased from 15.9 million to 18.1 million crabs, and legal males increased from 7.4 million to 9.3 million from 1998 to 1999. As most of male crabs from this cohort have entered the legal-sized population, prerecruit abundance decreased from 15.0 million to 11.0 million crabs. Abundance of mature female crabs in 1999 (21.9 million) decreased slightly from 23.6 million crabs in 1998. Effective spawning biomass[1] (ESB) in 1999 (47.1 million pounds) was similar to 1998 (46.5 million pounds). Because of low trawl surveyed abundance in 1999, male and female abundances and ESB in 1998 were re-estimated to be lower than those estimated in 1998. ESB in 1999 is below the target rebuilding level of 55 million pounds. Note that estimates using this year's data also indicate that ESB in 1998 was below – not above -- 55 million pounds.

Abundance by size of male and female crabs as estimated by area-swept methods and the LBA are compared annually to cross check the survey data and model estimation procedures. The comparisons for the past five years are shown in Figure 2. For male crabs, the LBA estimates are similar to or slightly greater than area-swept estimates over most sizes in 1995, 1996 and 1999 but smaller in 1997 and 1998. Abundances of small male crabs (<115 mm CL) and legal crabs appear to be overestimated by the area-swept method in 1997. For female crabs, the LBA estimates are greater than area-swept estimates over most sizes in 1995-1997 and 1999 but much smaller in 1998. This is caused by high survey abundance of large mature females (>100 mm) in 1998 that is

[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.

inconsistent with the abundance in 1995–1997 and 1999. The LBA is intended to address such year-to-year inconsistencies in the survey results. As reported in our 1998 status report (Zheng et al. 1998), a new level of natural mortality was estimated from 1994 to 1999 for both males and females.

Insights into changes in annual survey results can be gained by examining the size frequency distributions over the past five years (Figure 3). 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 lower mortality. Male abundance in 1999 was generally consistent with those in 1995, 1996 and 1998. So, the survey may have overestimated 95-110 mm CL males and legal males in 1997.

For females**,** the survey in 1998 and 1999 produced some unexpected results. The large increase in abundance of mature females estimated by the survey in 1998 was not fully anticipated based on growth alone of the 1990 year class. The dominant mode of females shifted from 97.5 mm CL in 1997 to 107.5 mm CL in 1998 to 112.5 mm CL in 1999 as crabs molted to larger sizes (Figure 3). However, survey abundance of large females (>119 mm CL) increased an average of 70% in 1998 from female abundance (>114 mm CL) in 1997, whereas survey abundance of females >99 mm CL in 1999 fell 53% from the female abundance >94 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).

Abundance estimates of juvenile males <95 mm CL and females <90 mm CL are unreliable and 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 modeled stock (Figure 3). In 1999, abundance of crabs from the 1992 year classes recruiting into the modeled population were among the lowest levels recorded (Table 1).

The 1998 size frequency distribution shows a mode centered about 67.5 to 72.5 mm CL (Figure 3). However, expected growth of this mode was not evident in the 1999 data; thus, the mode may be an artifact caused by survey measurement errors. In 1999, a similar mode centered 67.5 mm CL was observed. Until we see that such a mode moves to progressively larger sizes over time, it is uncertain whether the mode provides evidence of a strong year class.

Just as historical survey results enter into the LBA and modify the interpretation of data from 1999, the 1999 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 1972-1999 (Table 1) differ somewhat from estimates generated with data from 1972-1998 (see Table 1 in Zheng et al. 1998). 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.

Blue King Crabs

St. Matthew Island. Because extremely low survey abundance in 1999, poor in-season fishery performance in 1998, and low catch rates from the 1999 ADF&G near-shore pot survey, we suspect that natural mortality may have increased from 1998 to 1999. Because high natural mortality and survey measurement errors in a single year are confounded, we don't have information to estimate both simultaneously. To deal with this problem, we assumed different levels of natural mortality in year 1998/99 to conduct CSA and chose a level that produces a measurement error in 1999 comparable to those in the past. We settled with a natural mortality in 1998/99 that is three times as high as that in the other years. This high apparent natural mortality will be re-estimated in the future when more survey data are available.

CSA estimates of St. Matthew Island blue king crab abundance and 95% bootstrap confidence limits for 1999 are shown in Table 2. Compared to 1998, all segments of the population showed substantial decline in abundance. Prerecruit abundance (105-119 mm CL) declined to 0.2 million crabs from 0.9 million in 1998, and legal abundance dropped from 3.0 million to 1.0 million. CSA estimates of mature abundance are lower than area-swept estimates in 1996-98 and higher in 1999 (Figure 4). The sharp drop in abundance across all size groups in 1999 is illustrated in Figure 5.

Pribilof Islands. For the Pribilof Islands, changes from last year included continued decline in mature male abundance from 1.0 to 0.8 million crabs and a decrease in legal male abundance from 0.8 to 0.7 million crabs (Table 2, Figure 4). All segments of the male population showed decline in abundance, and no small-sized crabs (<95 mm CL) were caught this year (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 1999). When the stock is at or below threshold of 8.4 million mature females (>89 mm CL) or 14.5 million pounds of ESB, the fishery is closed. When the stock is above these criteria, 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 1999 the estimates of mature female abundance and ESB were 21.9 million and 47.1 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 18.1 million results in a harvest of 1.81 million crabs. Because 1.81 million is only 19.4% of the legals, the 50% cap is not required. By multiplying 1.81 million crabs times an average weight of 5.9 pounds per legal crab, a preseason GHL of 10.66 million pounds was established for the 1999 fishery. A total of 5% of the GHL or 533,000 pounds is reserved for the community development quota (CDQ) fishery resulting in a GHL of 10.127 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 (see Figure 3 in Zheng et al. 1996a). When ESB exceeds 14.5 million pounds but is less than 55 million pounds, the PSC is 100,000 crabs. When ESB exceeds 55 million pounds, the PSC is 200,000 crabs. Given the estimate of 47.1 million pounds of ESB for 1999, the red king crab PSC limit for the Bering Sea will be set at 100,000 crabs for groundfish trawl fisheries in 2000. In addition, the North Pacific Fishery Management Council (NPFMC) adopted a provision in 1998 to reduce red king crab bycatch by an additional 3,000 crabs as part of a regulation prohibiting the use of bottom trawl gear for pollock fisheries. This regulation is expected to be implemented for the fisheries in 2000.

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 2000. 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.

Blue King Crabs

For St. Matthew Island, the fishery management plan specifies a 20% harvest rate when the stock is above the threshold of 0.6 million mature males (Pengilly and Schmidt 1995). The mature male abundance was estimated at 1.2 million crabs in 1999, above threshold. However, mature biomass based on area-swept estimates of both males and females was estimated as 4.6 million pounds, 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). Declines in stock status are also indicated by the poor fishery performance in 1998 and low catch rates from an ADF&G near-shore pot survey in 1999. Because of low mature biomass and very

depressed population status, conservation is a top priority for this stock. Therefore, the fishery for this stock will be closed in 1999.

For the Pribilof Islands, the fishery management plan specifies a threshold of 0.77 million mature male blue king crabs; no threshold is specified for red king crabs (Pengilly and Schmidt 1995). In recent years, trends in survey and fishery performance data have been 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. Based on the CSA estimate, from 1997 to 1999 the abundance of mature male blue king crabs declined from 1.2 to 0.8 million, slightly above the fishery threshold. NMFS area-swept abundance estimates of mature male red king crabs declined from 1.3 in 1997 to 0.6 million in 1999, below the fishery threshold. The fishery for this stock will be closed in 1999 based on a number of factors: declining abundance, low level of prerecruits, low precision of abundance estimates, past fishery performance below expectations, and fishery closure for St. Matthew blue king crabs. The fishery for Pribilof red king crabs will also be closed in 1999, due primarily to the small population, low precision of abundance estimates, and fishery closure for blue 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 it appears that the mature red king crab abundance will decrease in the next few years. A portion of male red king crabs from the 1990 year class have yet to attain legal size; they will likely sustain harvest of Bristol Bay red king crabs in the near future. However, with a decreasing mature population, GHL will likely gradually decrease in the next few years. Several years of poor recruitment appear to follow the 1990 year class as evidenced by very low numbers of recruit male and female crabs to the model. Beyond that, the mode of small crabs around 67.5 mm CL may perhaps signal the leading edge of another sizeable year class but it is too soon to be certain. A similar mode of small crabs around 67.5 and 72.5 mm CL occurred in the 1998 data but was not followed by a mode of larger size this year.

The status of both eastern Bering Sea blue king crab stocks is depressed. For St. Matthew and Pribilof Islands, wide confidence intervals in the mature male abundance estimates and poor information on juveniles and females make predictions difficult. Based on trends in prerecruits and recruits for blue king crabs at the Pribilof Islands, the stock is not expected to improve in the near term. A lot more small red king crabs at the Pribilof Islands were caught by this year's trawl survey than in the past, but they were caught primarily by a single tow. It is not sure whether the high abundance of small red king crabs at the Pribilof Islands is due to survey measurement errors or a strong cohort. It appears that the mature population of Pribilof Islands red king crabs is temporarily stable. There is a great uncertainty for St. Matthew Island blue king crabs. During the next two years, we should be able to tell whether the sharp drop in abundance this year is due to survey measurement errors or high natural mortality. Based on extremely low trawl survey abundance of all sizes and sexes in 1999, poor in-season fishery performance in 1998,

and low catch rates from the 1999 ADF&G near-shore pot survey, the outlook for this stock is not very promising.

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Table 1. Annual abundance estimates (millions of crabs), effective spawning biomass (ESB, millions of pounds), and 95% confidence intervals for 1999 for red king crabs in Bristol Bay estimated by length-based analysis from 1972-1999. Size measurements are mm CL.

	Males					Females		
Year	Recruits	Small	Prerec.	Mature	Legal	Recruits	Mature	ESB
mm→	(to model)	(95-109)	(110-134)	(>119)	(>134)	(to model)	(>89)	
1972	NA	13.508	15.040	18.493	9.993	NA	59.818	55.425
1973	30.701	20.851	26.688	22.754	10.705	33.055	69.940	63.811
1974	20.962	14.955	35.353	34.483	14.861	28.123	71.286	94.509
1975	32.061	21.720	36.353	41.539	20.706	21.878	65.901	116.445
1976	44.684	30.378	45.900	49.303	25.553	34.177	74.898	128.754
1977	52.151	35.783	60.408	62.391	30.349	71.969	118.198	165.867
1978	19.646	15.072	58.582	75.277	39.593	46.570	119.429	199.447
1979	12.529	9.031	36.681	73.116	47.044	19.064	92.822	166.706
1980	24.155	16.217	25.967	58.995	43.614	36.010	93.427	166.156
1981	17.356	12.258	17.183	18.160	9.430	13.616	71.318	58.703
1982	23.250	15.823	16.212	10.201	2.944	17.431	29.972	24.008
1983	13.161	9.516	13.668	8.958	2.484	4.730	9.983	16.693
1984	18.685	12.695	12.982	8.198	2.369	11.932	13.683	16.639
1985	9.497	6.947	10.573	6.894	1.824	5.093	7.485	11.200
1986	6.012	4.453	12.475	11.578	4.277	4.089	9.388	14.918
1987	6.379	4.483	10.998	13.468	6.492	9.530	16.191	25.477
1988	6.040	4.274	9.998	14.059	7.974	5.801	17.272	28.861
1989	4.932	3.538	9.183	15.066	9.407	5.676	17.939	31.244
1990	1.403	1.192	7.005	14.667	9.916	0.911	13.651	26.327
1991	4.091	2.739	5.062	11.765	8.413	3.753	13.468	26.048
1992	6.064	4.153	6.190	9.948	6.719	3.349	12.917	25.214
1993	2.389	2.132	7.155	10.215	6.055	2.186	11.363	22.899
1994	1.124	1.021	5.704	8.980	5.015	0.421	8.499	18.524
1995	2.927	2.043	4.768	9.479	6.239	1.641	9.305	20.464
1996	3.078	2.295	5.098	10.005	6.936	4.208	12.590	25.884
1997	16.015	10.565	9.740	11.352	6.916	13.371	24.697	37.772
1998	3.269	3.037	15.047	15.907	7.441	1.457	23.633	46.498
1999	1.603	1.269	10.960	18.063	9.346	0.603	21.912	47.074
				95% Confidence Limits in 1999				
Lower	1.092	NA	8.709	13.380	6.507	0.369	15.770	NA
Upper	3.204	NA	13.239	22.080	11.956	1.167	30.515	NA

Table 2. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 1999 for male blue king crabs off St. Matthew and Pribilof Islands by 3-stage catch-survey analysis from 1975 to 1999. Survey catchability is fixed at 1.0 for legals. Relative abundance estimates of prerecruits are scaled to area-swept estimates. St. Matthew Island recruits are newshell males of size 120-133 mm CL and Pribilof Island recruits are newshell males of size 135-148 mm CL. All other legal males are postrecruits. Mature crabs include prerecruits plus legals. Size measurements are mm CL. Natural mortality in year 1998/99 was assumed to be three times as high as in other years for the St. Matthew Island stock.

	St. Matthew Island					Pribilof Islands				
Year	Prerec.	Mature	Recruit newshell	Post. oldshell	Legal	Prerec.	Mature	Recruit newshell	Post. oldshell	Legal
mm→	(105-119)	(≥105)	(120-133)	(≥120)	(≥120)	(120-134)	(≥120)	(135-148)	(≥135)	(≥135)
1975	NA	NA	NA	NA	NA	4.099	11.455	3.439	3.917	7.356
1976	NA	NA	NA	NA	NA	1.818	9.758	2.794	5.146	7.940
1977	NA	NA	NA	NA	NA	1.814	8.204	1.239	5.151	6.390
1978	1.860	3.070	0.760	0.450	1.210	3.140	8.430	1.236	4.054	5.290
1979	1.970	4.093	1.611	0.512	2.123	1.693	7.079	2.140	3.246	5.386
1980	2.288	5.385	1.706	1.391	3.097	1.114	5.568	1.153	3.301	4.454
1981	2.605	6.645	1.982	2.058	4.040	0.725	3.562	0.759	2.078	2.837
1982	1.888	6.141	2.256	1.997	4.253	0.358	1.979	0.494	1.127	1.621
1983	1.130	4.286	1.635	1.521	3.156	0.403	1.380	0.244	0.733	0.977
1984	0.494	2.231	0.978	0.759	1.737	0.227	1.004	0.275	0.502	0.777
1985	0.325	1.334	0.428	0.581	1.009	0.157	0.850	0.154	0.539	0.693
1986	0.619	1.234	0.281	0.334	0.615	0.042	0.597	0.107	0.448	0.555
1987	0.872	1.666	0.536	0.258	0.794	0.059	0.465	0.029	0.377	0.406
1988	1.046	2.168	0.755	0.367	1.122	0.012	0.273	0.040	0.221	0.261
1989	1.239	2.685	0.906	0.540	1.446	0.364	0.564	0.008	0.192	0.200
1990	1.442	3.311	1.073	0.796	1.869	0.816	1.211	0.248	0.147	0.395
1991	1.767	3.994	1.249	0.978	2.227	0.659	1.504	0.556	0.289	0.845
1992	1.568	4.071	1.530	0.973	2.503	0.610	1.679	0.449	0.620	1.069
1993	1.618	4.270	1.358	1.294	2.652	0.458	1.657	0.416	0.783	1.199
1994	1.366	4.095	1.401	1.328	2.729	0.397	1.588	0.312	0.879	1.191
1995	1.877	4.297	1.183	1.237	2.420	0.399	1.543	0.271	0.873	1.144
1996	2.133	4.905	1.626	1.146	2.772	0.579	1.555	0.272	0.704	0.976
1997	1.681	4.914	1.847	1.386	3.233	0.188	1.202	0.395	0.619	1.014
1998	0.920	3.871	1.456	1.495	2.951	0.172	0.990	0.128	0.690	0.818
1999	0.215	1.241	0.360	0.666	1.026	0.145	0.808	0.117	0.546	0.663
95% Confidence Limits in 1999										
Lower	NA	1.138	NA	NA	0.685	NA	0.594	NA	NA	0.420
Upper	NA	1.872	NA	NA	1.454	NA	0.929	NA	NA	0.867

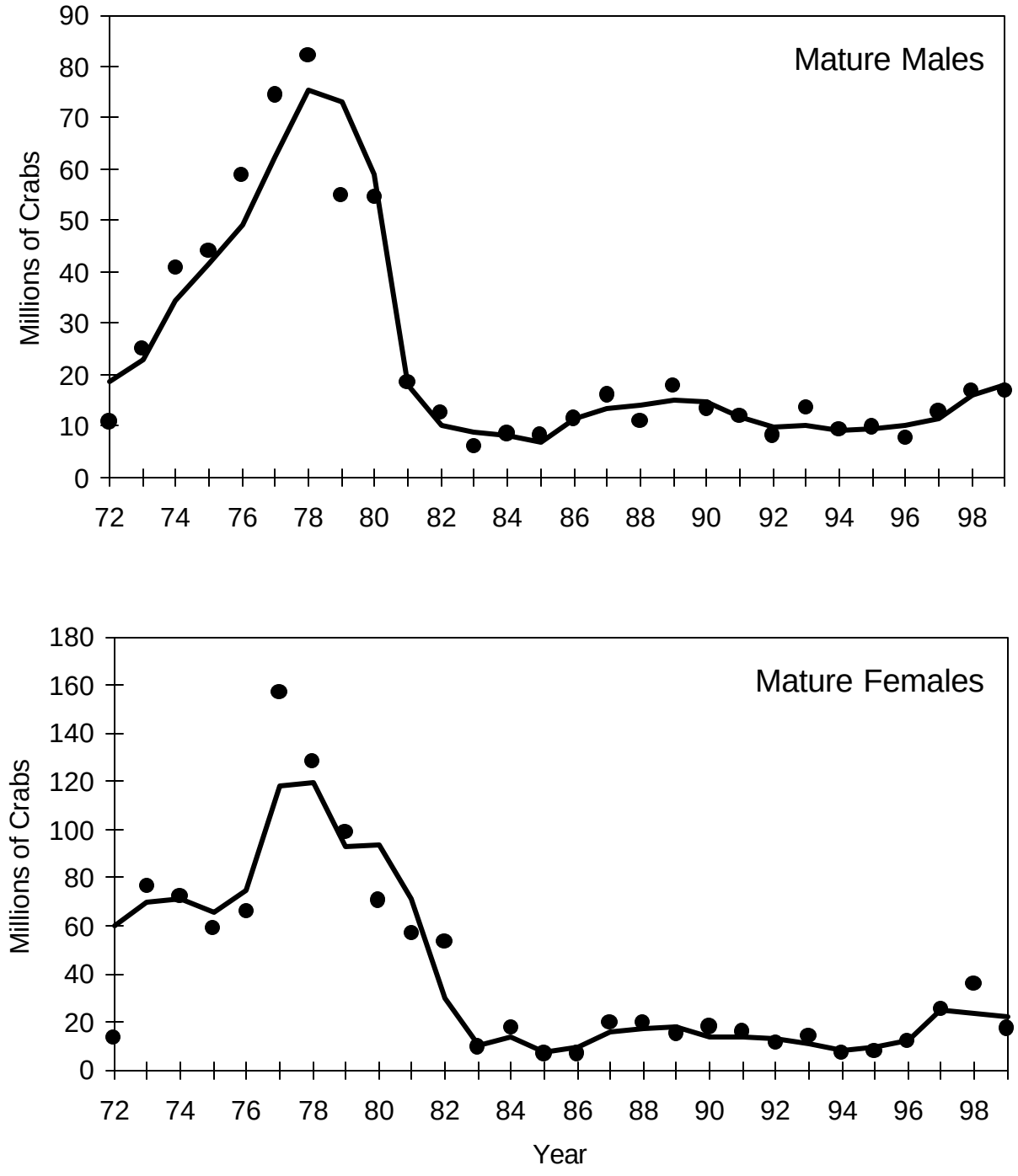

Figure 1. Comparison of abundance estimates (millions of crabs) of Bristol Bay red king crabs from area-swept estimates (dots) and length-based analysis (line) for mature males (top panel) and mature females (bottom panel).

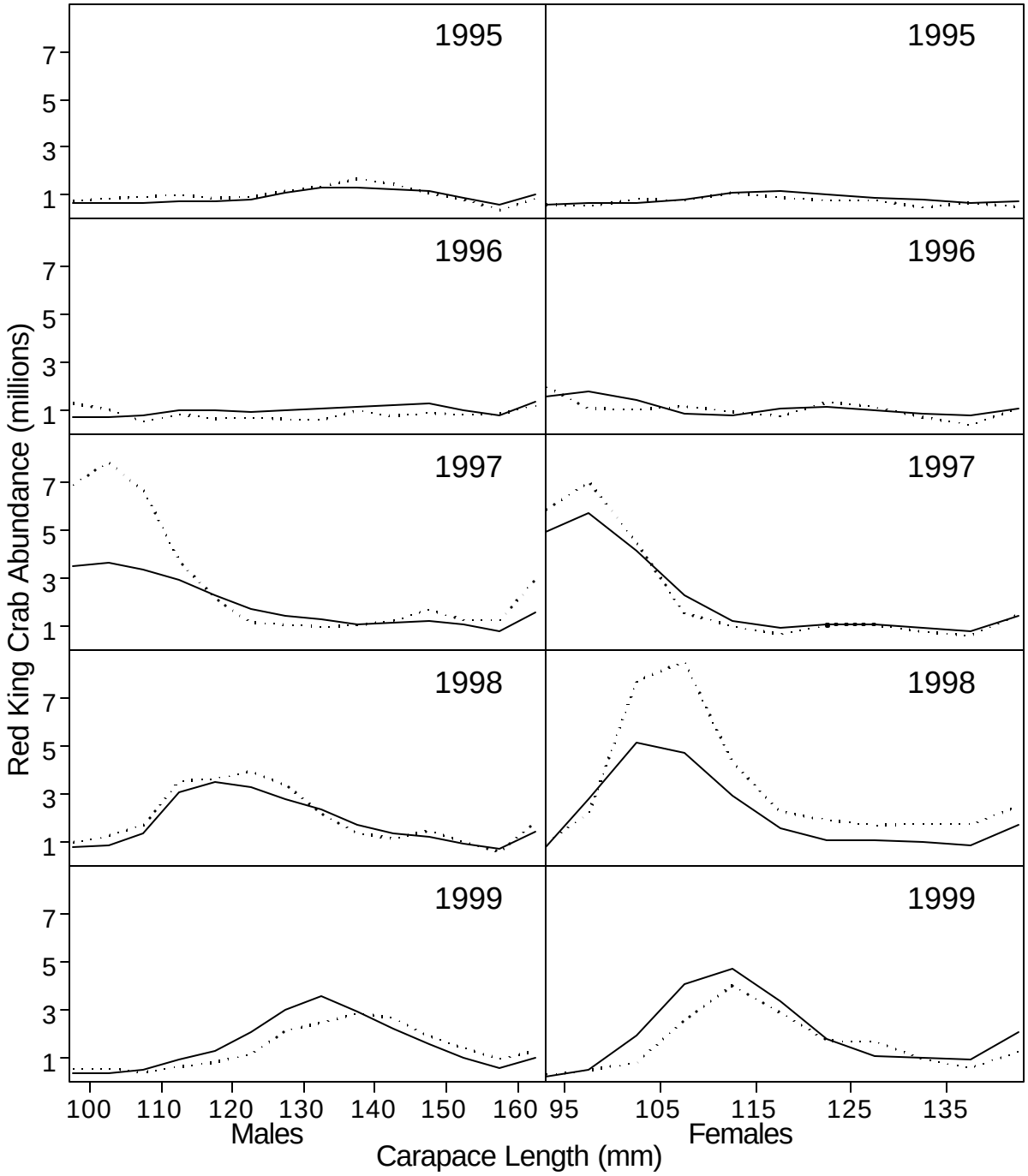

Figure 2. Size-frequency distributions of male and female red king crabs in Bristol Bay, 1994-1999, estimated by area-swept methods (dotted line) and the LBA (solid line).

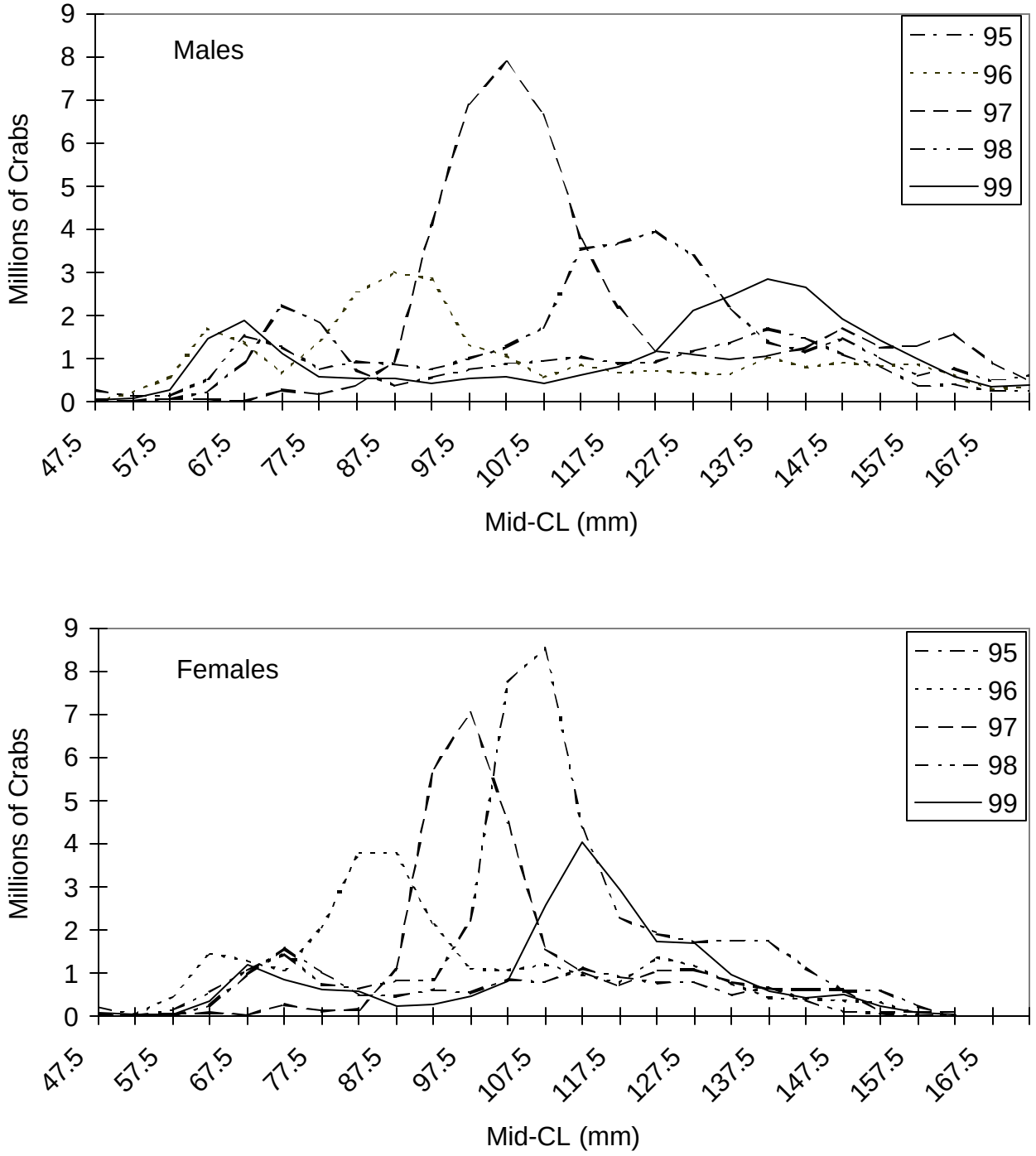

Figure 3. Size frequency distributions of male (top panel) and female (bottom panel) red king crabs in Bristol Bay from NMFS trawl surveys during 1995-1999. For purposes of these graphs, abundance estimates are based on area-swept methods not LBA because the LBA is confined to males ≥95 mm CL and females ≥90 mm CL.

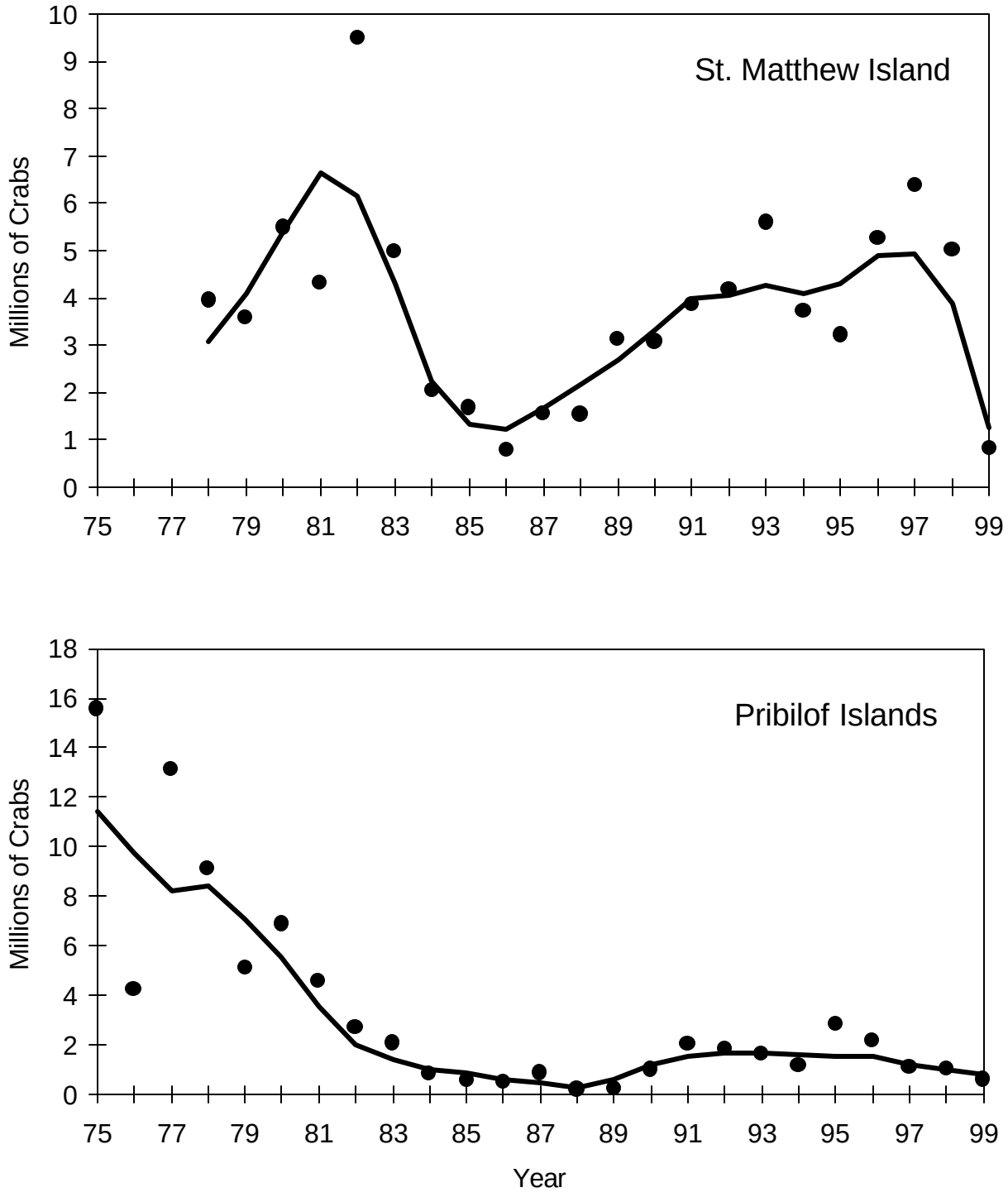

Figure 4. Comparison of abundance estimates (millions of crabs) of mature male blue king crabs from area-swept estimates (dots) and catch-survey analysis (line) for St. Matthew (top panel) and Pribilof Islands stocks (bottom panel).

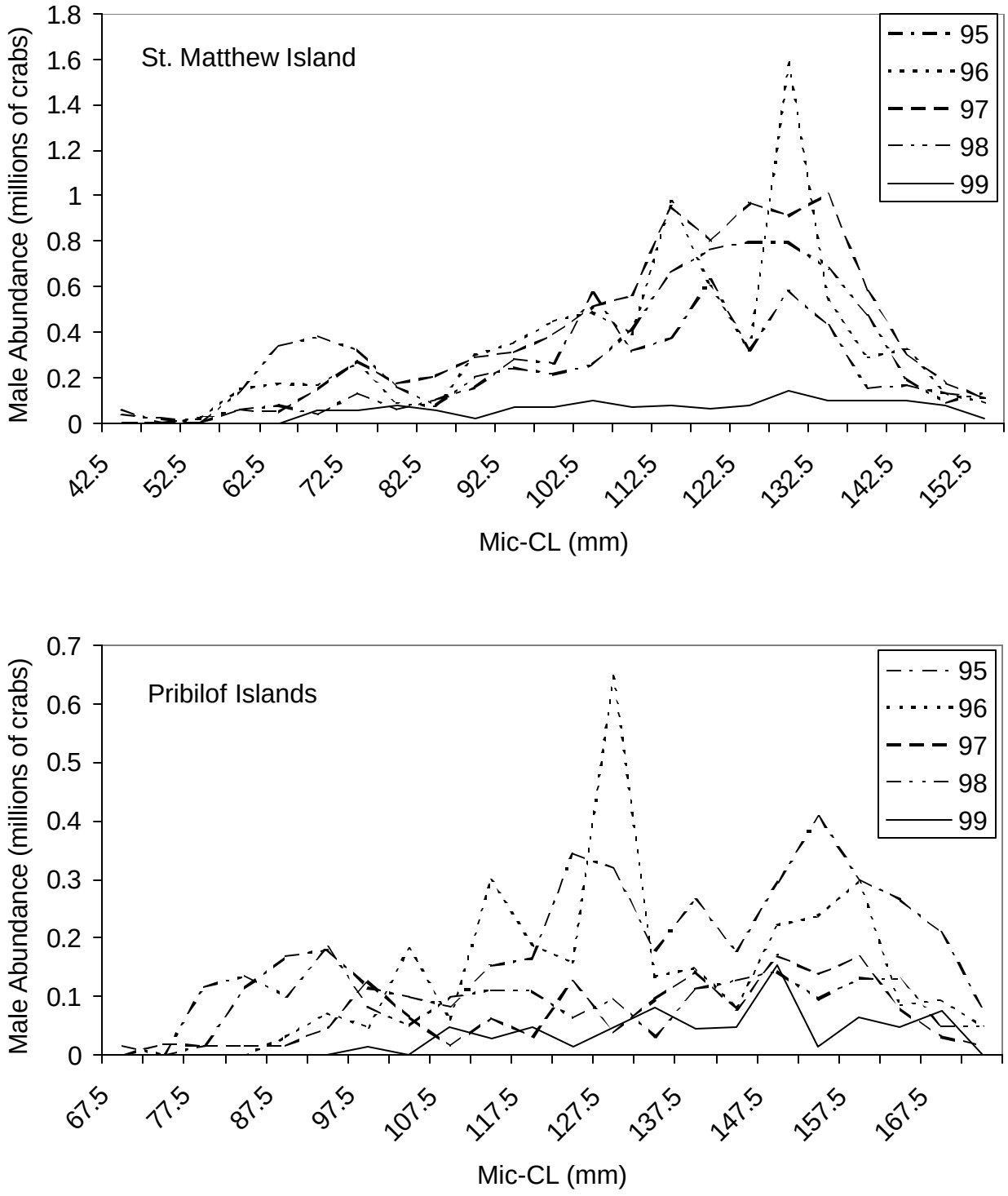

Figure 5. Size frequency distributions of male blue king crabs for St. Matthew (top panel) and Pribilof Islands stocks (bottom panel) from NMFS trawl surveys during 1995-1999. Abundance estimates are based on area-swept methods.