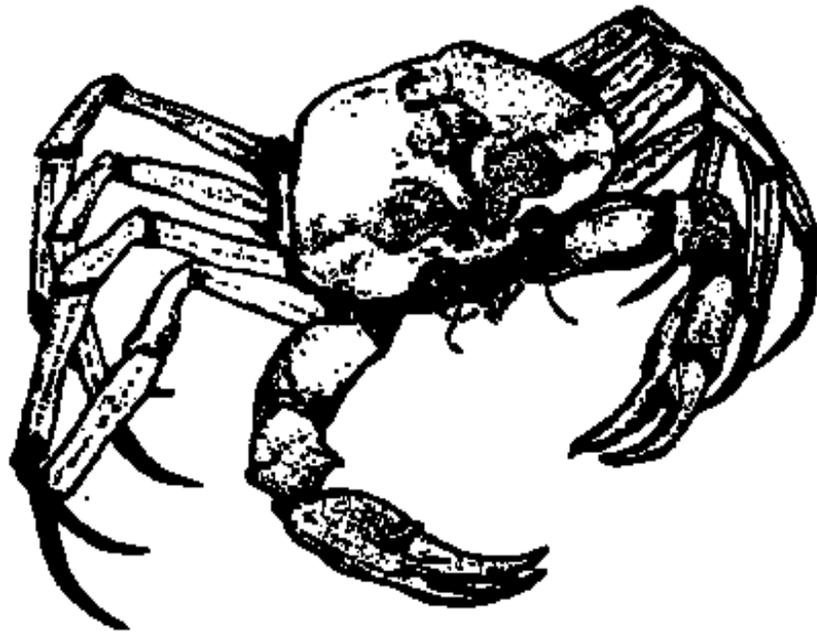


SAFE Report for the Golden Crab Fishery of the
South Atlantic Region - 2004



National Marine Fisheries Service
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702

SUMMARY OF CHANGES IN THE SOUTH ATLANTIC GOLDEN CRAB SAFE REPORT

Relative to the May 1999 SAFE report, the following changes have been made in this report:

History of Management Update

The Golden Crab Fishery Management Plan (FMP) became fully effective October 28, 1996. This FMP: 1) Established a controlled access program that included eligibility criteria for vessel permits, restricted fishing zones, and procedures for appeals, transfers, and renewal of permits; 2) specified authorized gear types, dimensions, configuration, and identification requirements for the fishery including mandatory escape panels; 3) prohibited sale of female golden crabs; 4) established permit and reporting requirements for fishermen and dealers; and 5) established a framework regulatory adjustment procedure for the fishery.

Permits were allocated among three zones. The Northern Zone included the EEZ north of the 28° N latitude to the North Carolina/Virginia border. The Middle Zone included the EEZ between the 28° N latitude and the 25° N latitude. The Southern Zone included the EEZ south of the 25° N latitude to the southernmost border of the South Atlantic Fishery Management Council's jurisdiction. Only data from the Middle and Southern Zones were available for this SAFE report and the 1999 SAFE report.

Framework Seasonal Adjustment #1 became effective October 28, 1998. It revised the vessel size limitations applicable when a vessel permit is transferred to another vessel and extended through December 31, 2000, the authorization to use wire cable for a mainline attached to a golden crab trap.

Amendment 1 became effective July 14, 2000. It was part of the Council's Comprehensive Amendment addressing Essential Fish Habitat (EFH) in FMPs of the South Atlantic Region. This amendment defined and described EFH for golden crab in the South Atlantic.

The approved portions of Amendment 2 became effective December 2, 1999. This amendment was a part of the Council's Comprehensive Amendment addressing Sustainable Fishery Act definitions and other required provisions in FMPs of the South Atlantic Region. The description of fisheries and communities was approved, as was bycatch reporting. The remaining items for golden crab were disapproved because the stock status determination criteria were incomplete.

Amendment 3 became effective June 3, 2002. This amendment was developed to minimize gear and area conflicts among fishermen. The main benefits arose from allowing changes in fishing gear and the use of larger fishing vessels, removing a minimum harvest requirement, allowing two additional permits in the Northern Zone, and eliminating conflict by establishing sub-zones within the Southern Zone with different fishing regulations for large (>65 feet) and small vessels (= 65 feet). Authorization to use wire cable for a mainline was extended through December 31, 2002. Definitions of MSST and MFMT were also adopted.

Fishery Status and Stock Assessment

1. The monthly golden crab catches, number of traps hauled by fishing zone per month, and number of vessels reporting catches per year have been updated through September 2003. This information was derived from the NMFS Logbook Database.
2. Monthly measurements of individual crab carapace width have been updated through September 2003. This information is derived from the Trip Interview Program Database (TIP).
3. The non-equilibrium production model, developed in 1999, was updated with data through January 2000.

Table 1: Number of permitted golden crab vessels and the number that reported landings, 1996-2003. Permit year begins November 1 of the previous year. Source: Sadler 2004 and NMFS Logbook Database.

Permit Year	Number Issued Northern Zone	Number Fished Northern Zone	Number Issued Middle Zone	Number Fished Middle Zone	Number Issued Southern Zone	Number Fished Southern Zone	Total Number Issued	Total Number Fished
1996	2	0	6	3	26	0	34	3
1997	1	0	5	4	20	9	26	13
1998	0	0	3	4	8	7	11	11
1999	0	0	3	4	7	2	10	6
2000	0	0	3	3	7	5	10	8
2001	0	0	3	3	7	1	10	4
2002	1	0	3	4	7	1	10	5
2003	3	0	3	4	0	0	13	4

Participation in the Fishery

This SAFE report adds 11 months of data to the May 1999 SAFE Report. Thirty-four permits were issued in permit year 1996, but during that year only three vessels landed golden crab (Table 1). More vessels landed golden crab in permit years 1997 and 1998 (13 and 11, respectively) (Table 1). There was then a decline to five or less vessels reporting landings during each of permit years 2001-2003. Although at least 10 permits have been issued annually since 1996, at most 50% of permit holders actually fished for golden crab in a given year from 2001 to 2003 (Table 1). By 2003 there were three permits issued for the Northern Zone (after the

addition of two permits in Amendment 3), but no fishermen have reported landing golden crab there since the beginning of the permit process in 1996 (Table 1). Of the five companies processing golden crab in 1995, only one was still processing in 2002 (Antozzi 2002, Appendix 4). Antozzi (2002, Appendix 4) thought that implementation of Amendment 3 may encourage permit holders to re-enter the fishery, but the number of fishermen participating in the fishery has been fairly stable from 2001 through 2003.

Landings and Effort

Middle Zone

Eighty-seven months of landings and effort data were added (from May 1996 to August 2003), reflecting 426 additional trips (Appendix 1). Overall, catches continued to occur primarily in the Middle Zone (Figure 1). Landings fell by 40% from 2000 to 2003, from 587,330 lbs to 351,987 lbs (Figure 1). Monthly catches generally decreased from January to July, then increased beginning in August (Figure 2a). This trend did not hold in 2001, when landings started out very high but decreased consistently over most of the year.

Annual CPUE has been fairly consistent from 1995 to 2003, ranging from 39 to 59 lbs per trap (Figure 3). CPUE in 2003 was the highest since records began in 1995 (Figure 3).

Monthly CPUE has been relatively consistent during the last five years (Figure 4a). Record high CPUE in 2001 was primarily due to unusually high CPUE from January through May. CPUE in 2003 was higher than in most other years measured, during the months for which data were available (Figure 4a).

Southern Zone

Forty-eight months of data were added (from June 1998 to May 2002), reflecting 120 additional trips (Appendix 1). No data were available from 2003. Southern Zone landings made up approximately 30% of the total across zones for the first five years (1997-2001), but only 10% of the total in 2002 (data available for January through May) (Figure 1). Southern Zone landings were relatively stable over each year at about 20,000-30,000 lbs/month, except in 1999 when no golden crab were landed until May, followed by unusually high landings greater than 40,000 lbs/month in July and August (Figure 2b).

In contrast to the Middle Zone, CPUE in the Southern Zone decreased from 1999 to 2002, stabilizing at about 22-25 lbs per trap from 2000 to 2002 (Figure 3). CPUE has been lower in the Southern compared to the Middle Zone in every year but 1999 (Figure 3). CPUE in the Southern Zone was approximately 50%-60% of CPUE in the Middle Zone from 2000 to 2002 (Figure 3).

Southern Zone CPUE for the first five months of 2002 was at or below average for the period 1999-2002 (Figure 4b). Monthly CPUE has been more variable in this zone compared to the Middle Zone (Figure 4b).

TIP Sampling

The 1999 SAFE report presented size data through December 1997. This report includes samples collected through December 2003 (Appendix 2). In the interim, 12,269 crabs were measured, bringing the total measured from May 1995 to December 2003 to 17,187. Mean monthly size has been variable, and there have been no obvious trends in size by month across years (Figure 5). In addition, there has been little evidence of annual trends in mean size, although crabs were smaller in the first five months of 1999 than in other years (Figure 5e), and in 1997, crabs were larger in most months than they were in other years (Figure 5c).

In contrast to mean monthly size, the length distribution of golden crabs sampled in the TIP survey has been remarkably consistent from 1995 to 2003 (Figure 6). Except for 1999 (Figure 6e), the modal length appears to be very close to 150 mm in all years, and the breadth of sizes observed has also been similar (Figure 6a-d,f-i). The modal length was notably smaller in 1999 than in other years (Figure 6e).

Production Model Analysis

Catch and estimated effort data were fit with a non-equilibrium production model to estimate stock status relative to MSY levels. The model was fit to both quarterly and annual estimates of catch and effort. Two paired annual observations of catch and effort were added to the new analysis (1999 and 2000), increasing the number of paired observations to 5 and increasing confidence in the model to some extent (Harper et al. 2000, Appendix 3). Seven quarterly estimates of catch and effort were added to the analysis (May 1998 through January 2000). Harper et al. (2000) concluded that fitting the model with the five annual catch and effort observations resulted in less certain, although similar, estimates of stock status than did use of quarterly observations.

The Harper et al. (2000) assessment concluded that, as of 2000, golden crab were neither overfished nor undergoing overfishing. Current biomass was slightly less than B_{MSY} , but above MSST (Table 2). Current F was nearly equal to F_{MSY} and MFMT (Table 2). The 2003 Status of Stocks report (NMFS 2004) also indicated the stock was not overfished or undergoing overfishing in 2003.

Table 2: Stock assessment parameters from the non-equilibrium production model (Harper et al. 2000, attached as Appendix 3).

Parameter	Value - 2000 quarterly analysis
B_{CURR}	818,140 lbs
B_{MSY}	837,400 lbs
$MSST (0.9B_{MSY}, \text{ where } M=0.1)$	753,660 lbs
$MSY \text{ (lbs)}$	684,000 lbs
F_{CURR}	0.20
F_{MSY}	0.21
$MFMT \text{ (Annual Median } F_{MSY})$	0.21

Economic Analysis

Five years of data have been added to the golden crab landings and value, through 2003.

The overall annual price paid per pound (obtained by dividing the total annual value by the total pounds landed) decreased from 1998 to 2002, from \$1.11 to \$0.81 (Figure 7). The price then jumped to an all-time high of \$1.31 in 2003. In contrast, landings increased from 1998 until 2000, then decreased through 2003 (Figure 7). The average ex-vessel price was 26% higher in 2003 (\$1.31/lb) than the five-year average value from 1998 to 2003 (\$0.98/lb) (Figure 7). In contrast, landings were at an all-time low of 341,000 lbs. The high value could be related to the relatively low value of Alaskan snow crab compared to previous years, and to the low landings of Alaskan snow crab that began in 2000, which could have resulted in greater demand for golden crab. Alaskan snow crab and golden crab fulfill similar seafood markets (Antozzi 2002). In addition, low landings of golden crab could have lead to more competitive pricing for this species.

Biological, Environmental, and Ecological Information

A brief review of literature relevant to golden crab, but not previously summarized in the 1999 SAFE report, is provided below.

South Atlantic Research

Erdman and Blake (1987) described the golden crab fishery of southeast Florida. Reproductive biology, size and weight relationships, trap design, and catch per unit effort were examined as part of an investigation of the commercial potential of this species.

Erdman and Blake (1988) examined the reproductive biology of golden crab caught from the southeastern coast of Florida. They described the annual reproductive cycle and season, fecundity, egg size, and size at sexual maturity.

Wenner and Barans (2001) conducted submersible surveys of the upper- and middle-continental slope near the Charleston Bump. Golden crab were most abundant in low-outcrop habitats, characterized by relatively flat ooze scattered with low-relief rocks.

Relevant Research from Other Areas: Gulf of Mexico

Henry et al. (1990) examined the general physiology of the golden crab in the eastern Gulf of Mexico. The authors described the structure and function of the gills, as well as oxidative and protein metabolism.

Lockhart et al. (1990) described the distribution and population characteristics of golden crab in the eastern Gulf of Mexico. This species was found adjacent to peninsular Florida, but not along the northern Gulf slope. Abundance increased southward, while the proportion of females increased counter-clockwise in the Gulf of Mexico.

Erdman et al. (1991a) sampled golden crabs in the northeast Gulf of Mexico. They determined the location and timing of spawning events, length of the brood cycle, and spawning frequency in this area.

Erdman et al. (1991b) determined the oxygen consumption of deep-sea golden and red crabs in the eastern Gulf of Mexico. They found that oxygen consumption rates declined with increasing depth due to temperature changes, and that these rates were comparable to those of similar sized shallow water decapod crustaceans that occurred at equivalent temperatures.

Perry et al. (1991) described the geographic, seasonal, and bathymetric distributions of golden crab larvae for the northeastern Gulf of Mexico through planktonic sampling.

Perry et al. (1995) examined the bycatch within commercial golden crab traps in the north central Gulf of Mexico. The giant isopod *Bathynomus giganteus* was the primary bycatch species. Various crabs, as well as some finfish including hagfish, deepwater shark, and hake, were collected in small numbers.

Trigg et al. (1997) described the demographics of golden crabs in the eastern Gulf of Mexico. Length and weight relationships and sexual dimorphism were examined. The authors found that the relationship between carapace length and width was similar between the Gulf of Mexico and Atlantic populations of this species.

Essential Fish Habitat Information

No additional information about essential fish habitat for golden crab was available as of June, 2004.

Literature Cited

Antozzi, W.O. 2002. Economic status of the golden crab fishery (SERO-ECON-01-06). NMFS Southeast Regional Office. St. Petersburg, Florida.

Erdman, R.B., N.J. Blake, F.D. Lockhart, W.J. Lindberg, H.M. Perry, and R.S. Waller. 1991a. Comparative reproduction of the deep-sea crabs *Chaceon fenneri* and *C. quinquegens* (Brachyura: Geryonidae) from the northeast Gulf of Mexico. *Invertebrate Reproduction and Development* 19(3): 175-184.

Erdman, R.B., N.J. Blake, and J.J. Torres. 1991b. Oxygen consumption of the deep-sea crabs *Chaceon fenneri* and *C. quinquegens* (Brachyura: Geryonidae). *Comparative Biochemistry and Physiology* 99A(3): 383-385.

Erdman, R.B. and N.J. Blake. 1988. Reproductive ecology of female golden crabs, *Geryon fenneri* Manning and Holthius, from southeastern Florida. *Journal of Crustacean Biology* 8(3): 392-400.

Erdman, R.B. and N.J. Blake. 1987. The golden crab (*Geryon fenneri*) fishery of southeast Florida. Proceedings of the 12th Annual Tropical and Subtropical Fish Conference of America. *Sea Grant College Report* 92: 95-106.

Harper, D.E., P.B. Eyo and G.P. Scott. 2000. Updated golden crab fishery trends and production model analysis based on trip report logbook and trip interview data collection programs. Contribution Number PRD-99/00-12. NMFS Southeast Fisheries Science Center. Miami, Florida.

Henry, R.P., H.M. Perry, C.B. Trigg, H.L. Handley, and A. Krarup. 1990. Physiology of two species of deep-water crabs, *Chaceon fenneri* and *C. quinquegens*: Gill morphology, and hemolymph ionic and nitrogen concentrations. *Journal of Crustacean Biology* 10(3): 375-381.

Lockhart, F.D., W.J. Lindberg, N.J. Blake, R.B. Erdman, H.M. Perry, and R.S. Waller. 1990. Distributional differences and population similarities for two deep-sea crabs (Family Geryonidae) in the northeastern Gulf of Mexico. *Canadian Journal of Fisheries and Aquatic Sciences* 47: 2112-2122.

National Marine Fisheries Service. 2004. Annual Report to Congress on the Status of U.S. Fisheries – 2003. U.S. Department of Commerce, NOAA, Natl. Mar. Fish. Ser., Silver Spring, MD. 24 pp.

Perry, H., R. Waller, C. Trigg, J. McBee, R. Erdman, and N. Blake. 1995. A note on bycatch associated with deepwater trapping of *Chaceon* in the northcentral Gulf of Mexico. *Gulf Research Reports* 9(2): 139-142.

Perry, H.M., R. Waller, L. Stuck, K. Stuck, R. Erdman, N. Blake, F. Lockhart, and W. Lindberg. 1991. Occurrence of *Chaceon* larvae in plankton samples from slope waters of the northeastern Gulf of Mexico. *Gulf Research Reports* 8(3): 313-315.

Sadler, R. 2004. Personal communication. NMFS, Southeast Regional Office, Sustainable Fisheries Division. St. Petersburg, Florida.

Trigg, C., H. Perry, and W. Brehm. 1997. Size and weight relationships for the golden crab, *Chaceon fenneri*, and the red crab, *Chaceon quinque-dens*, from the eastern Gulf of Mexico. *Gulf Research Reports* 9(4): 339-343.

Wenner, E.L. and C.A. Barans. 2001. Benthic habitats and associated fauna of the upper- and middle-continental slope near the Charleston Bump. *American Fisheries Society Symposium* 25: 161-176.

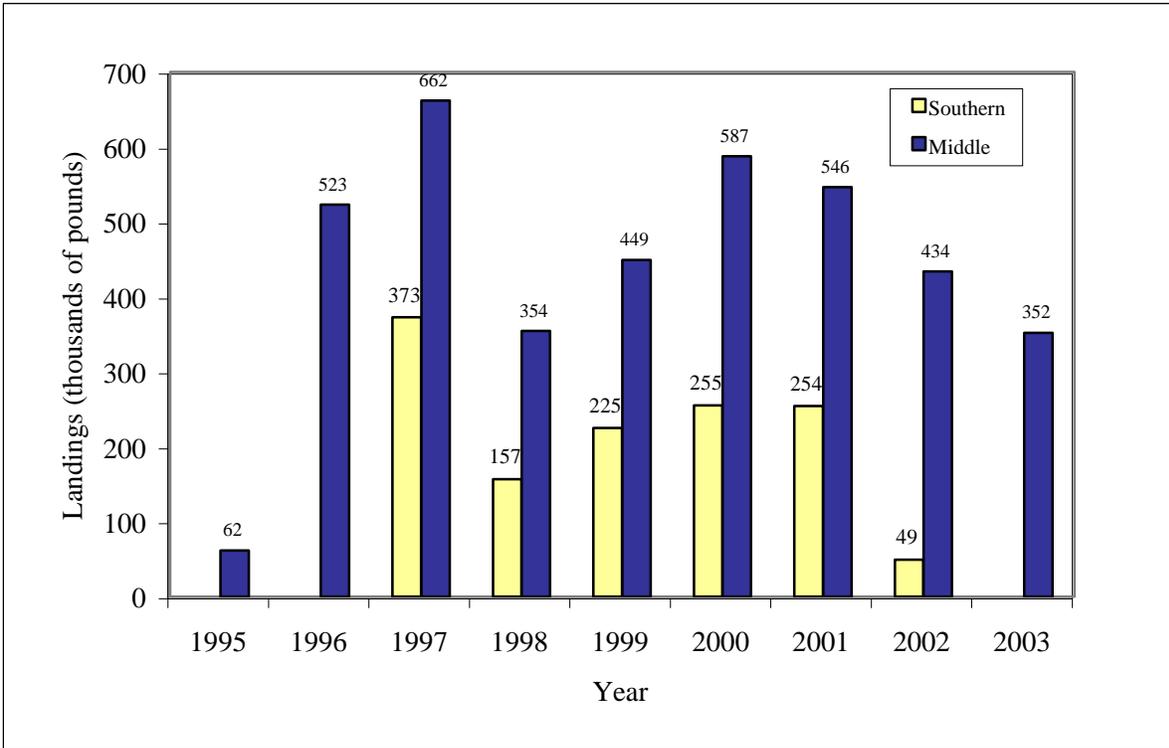


Figure 1: Total golden crab landings by year, Middle and Southern Zones.

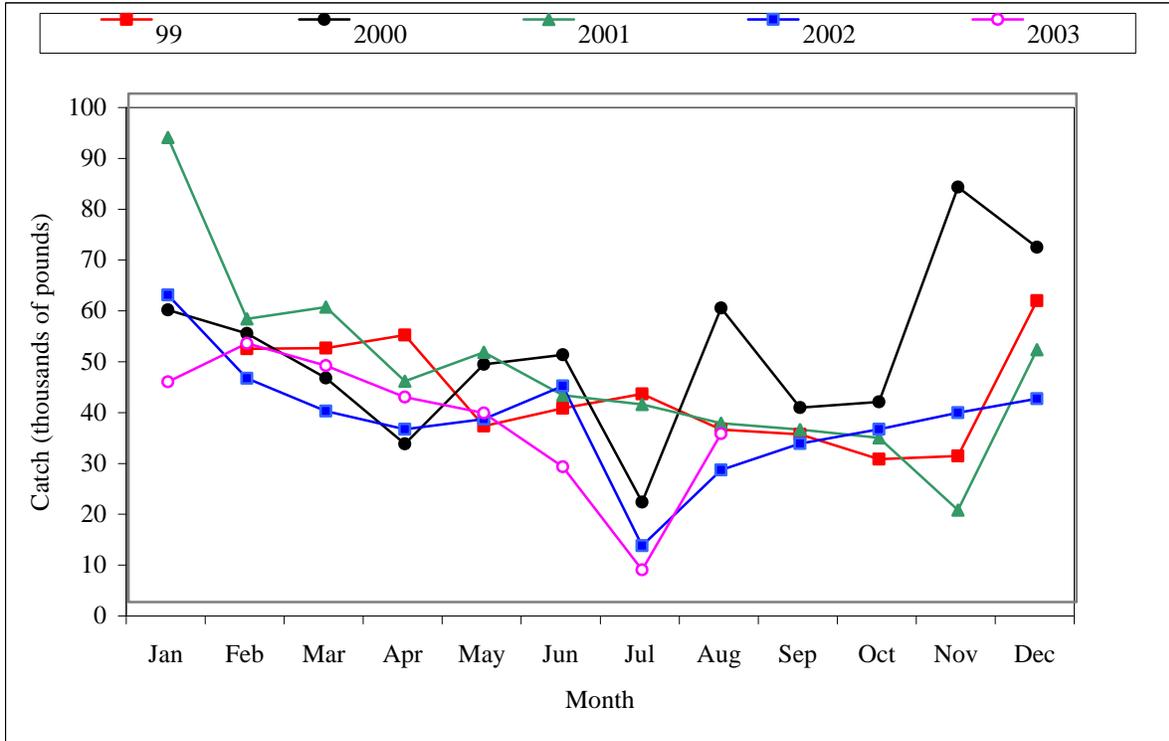


Figure 2a: Monthly catch of golden crab by year, Middle Zone.

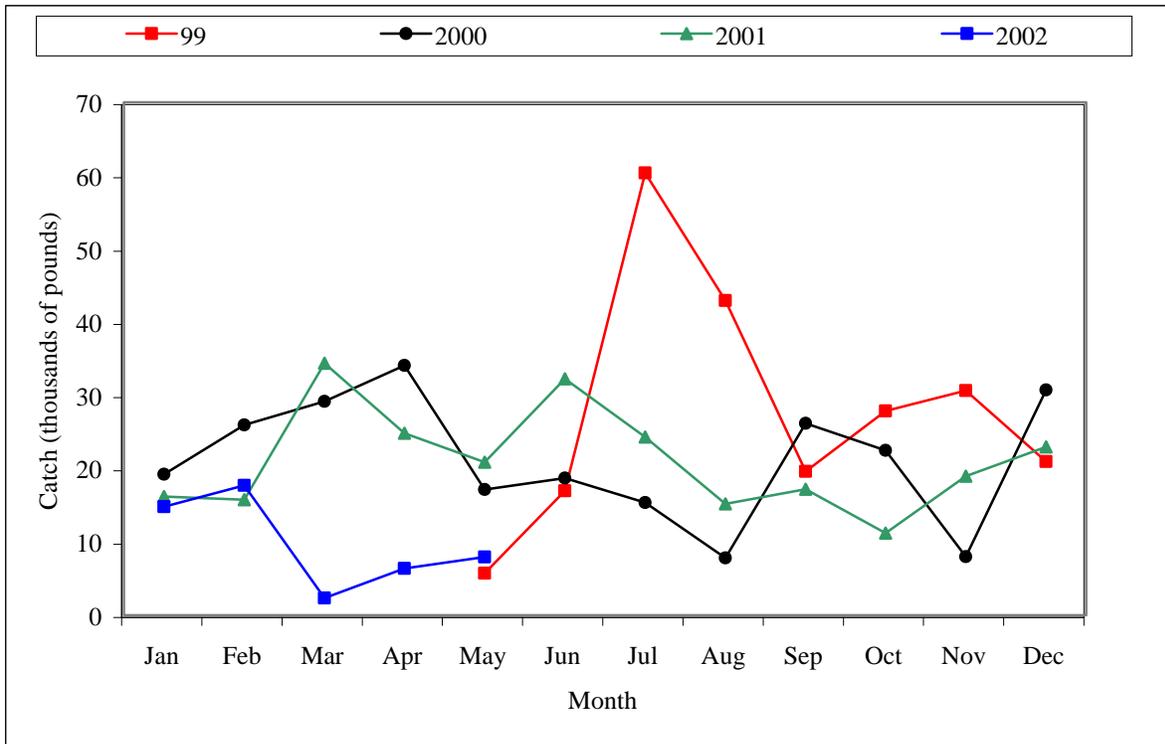


Figure 2b: Monthly catch of golden crab by year, Southern Zone.

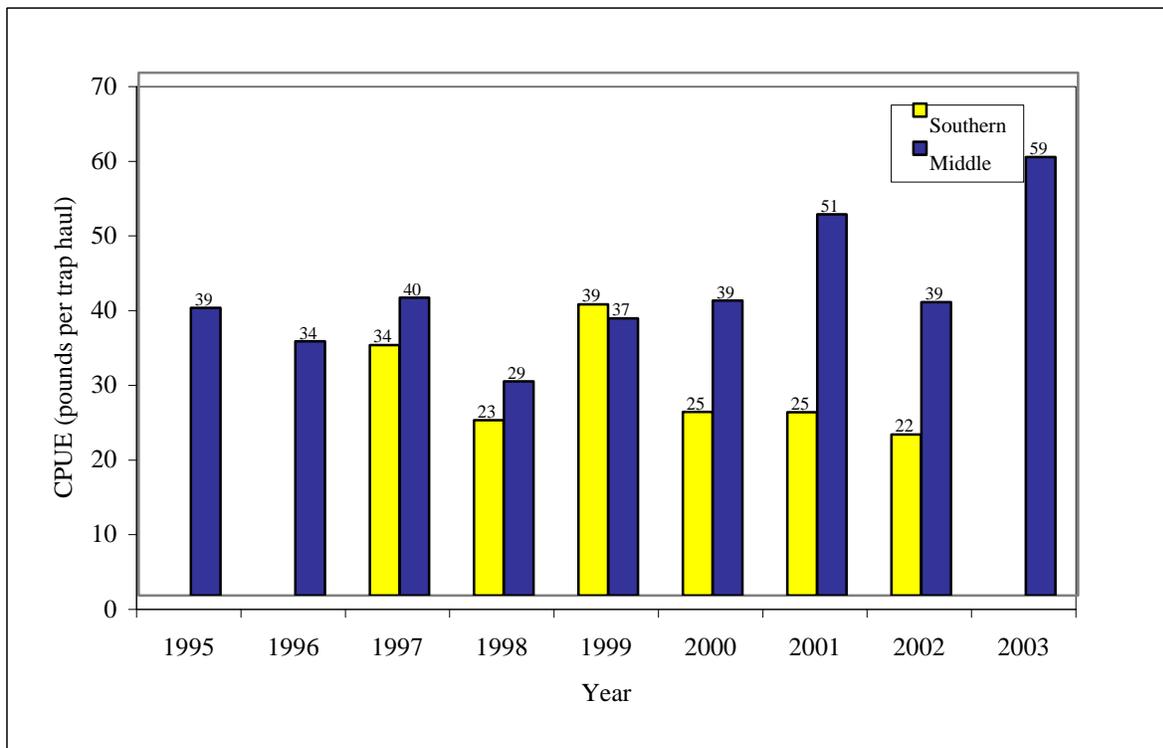


Figure 3: Golden crab CPUE by year and zone.

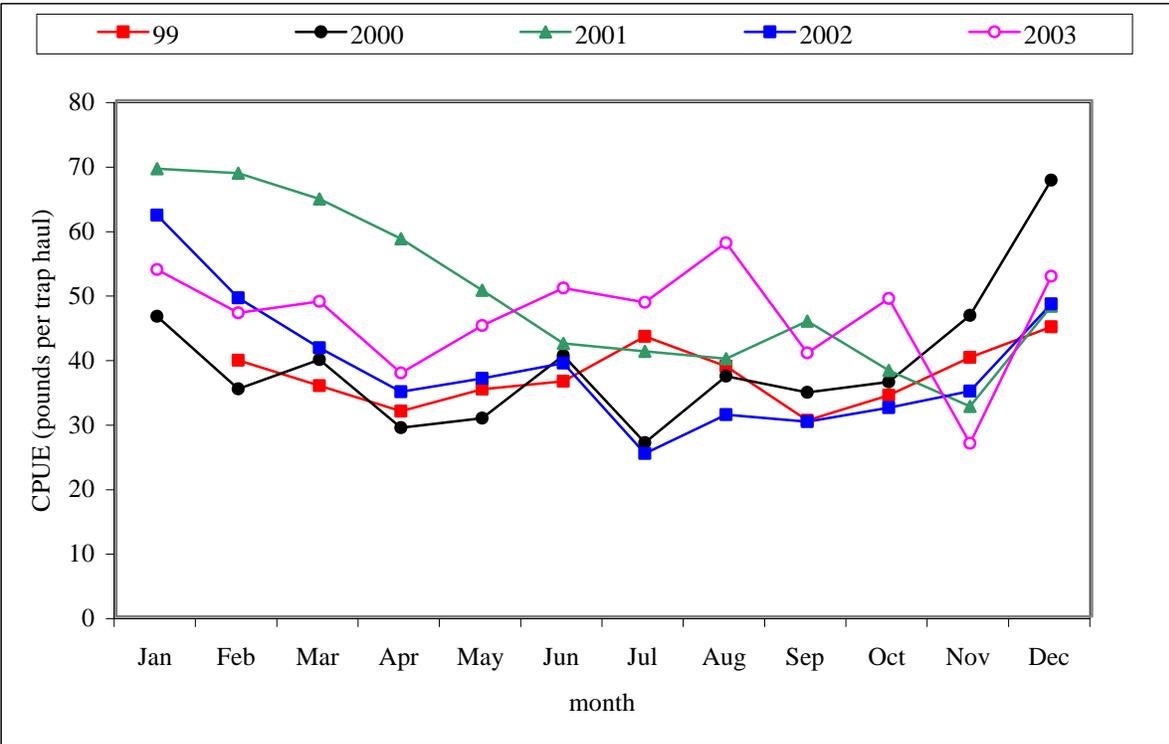


Figure 4a: Monthly CPUE of golden crab by year, Middle Zone.

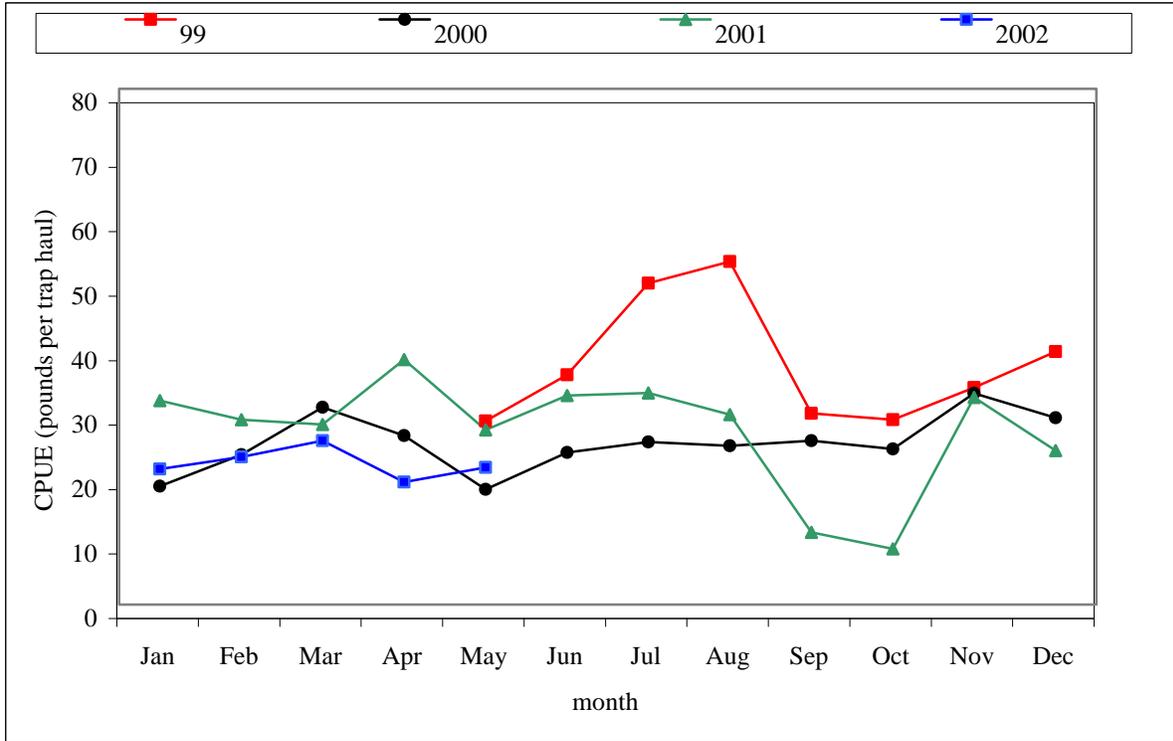


Figure 4b: Monthly CPUE of golden crab by year, Southern Zone.

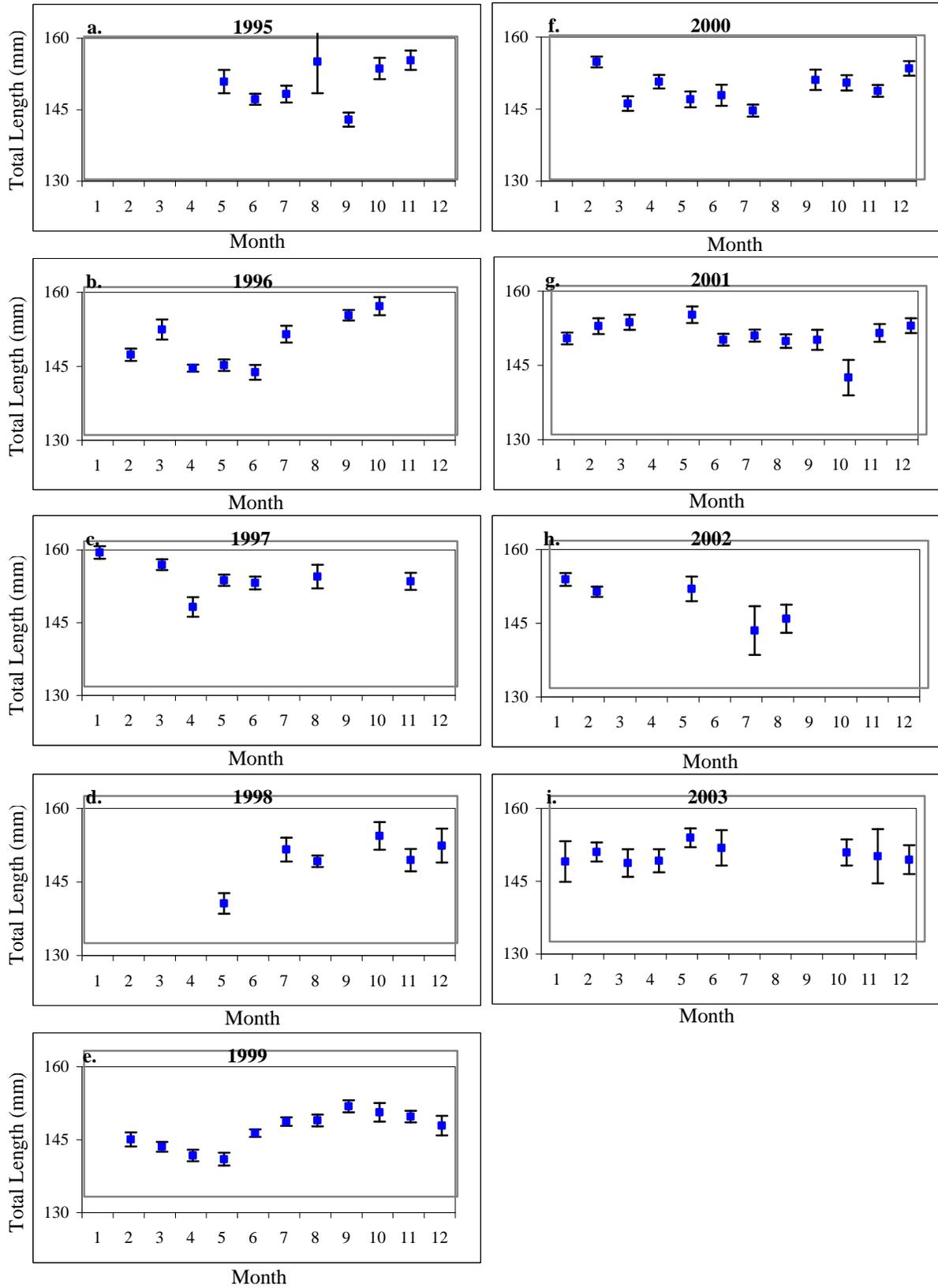


Figure 5: Mean monthly size of golden crab by year, with 95% C.I.

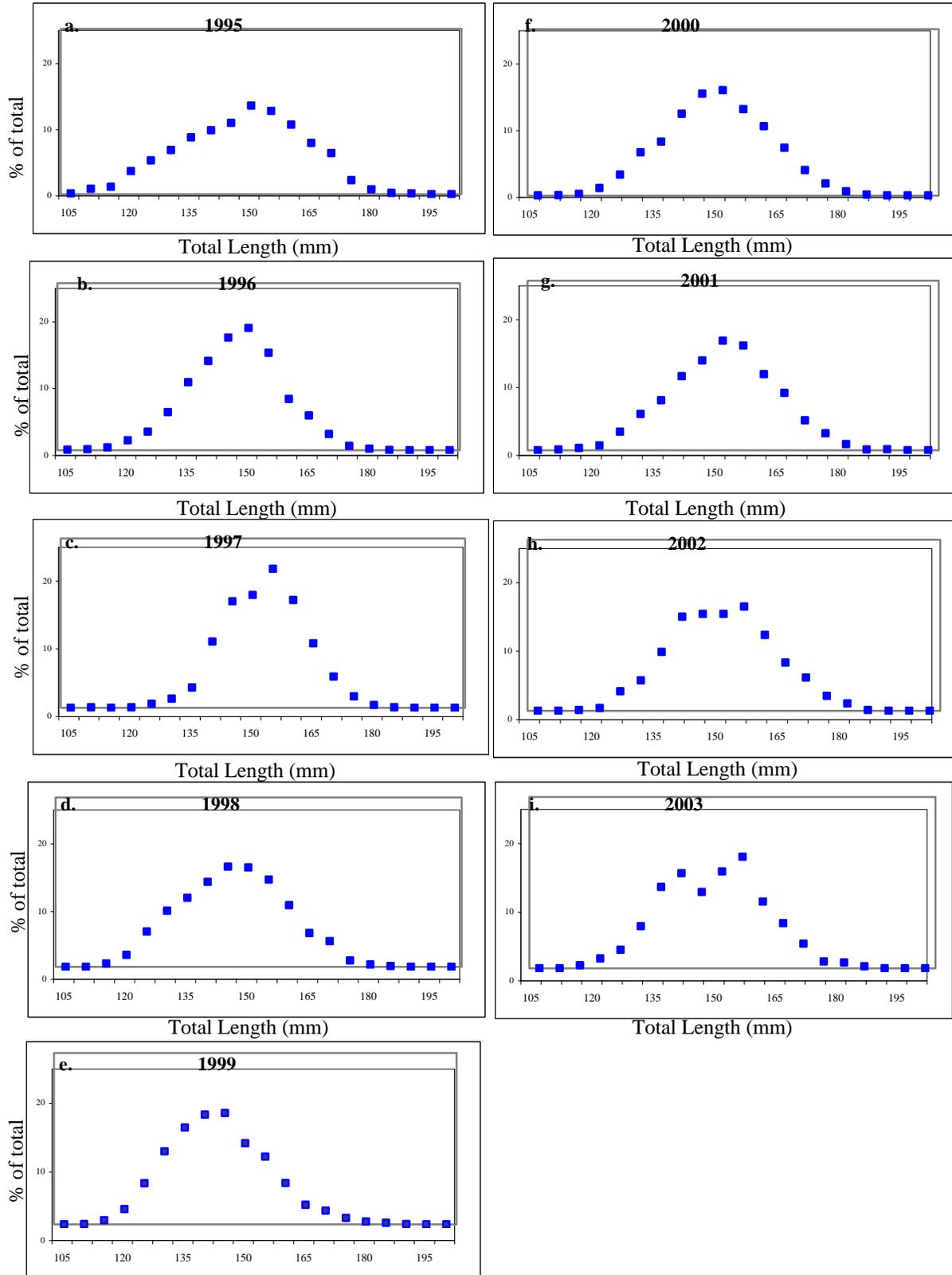


Figure 6: Length frequency of golden crabs measured in the TIP survey, 1995-2003.

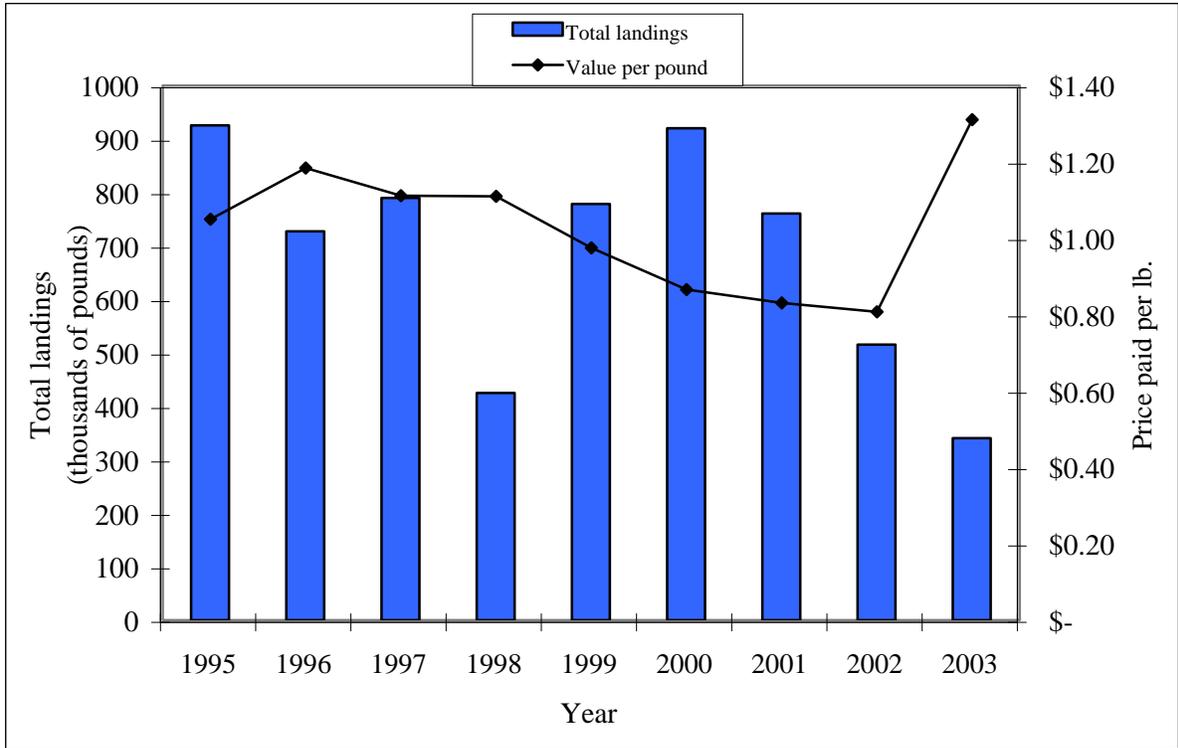


Figure 7: Total annual landings and value of golden crab, 1995 - 2002.