Stock Assessment Report 2008

Gulf of Mexico Shrimp Fishery

by

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INTRODUCTION

The need to better manage the penaeid shrimp stocks of the United States, to ensure that all involved in the fishery may benefit from this common property resource, has prompted this analysis. This stock assessment report deals only with the 1960-2008 commercial catch statistics for brown shrimp (Farfantepenaeus aztecus) and white shrimp (Litopenaeus setiferus) from the U.S. Gulf of Mexico shrimp fishery. This analysis provides the annual update of the status of the shrimp stocks first presented at the Southeast Fisheries Center's Second Stock Assessment Workshop (Nichols, 1984).

METHODS

The same procedures explained at length by Nichols (1984) were used in this stock update analysis. The brief synopsis of the methods presented below was taken from a stock assessment report by Nichols (1986). Only minor updates were made to some statements.

Single stocks of brown and white shrimp throughout their ranges in the Gulf of Mexico were assumed during the analysis. Brown shrimp landings reported in Texas included an unknown quantity of pink shrimp, which was treated as brown shrimp for this analysis. No detailed information was available for shrimp caught and landed in Mexico, so the analyses were conducted as if the ranges of brown and white shrimp stocks ended at the Mexican border.

Computerized 2008 data files for the shrimp landings and effort interviews in the U.S. Gulf of Mexico were obtained from the Southeast Fisheries Science Center, and the Louisiana and Alabama Trip Ticket Programs. These data were subjected to the additional editing criteria developed by the Fisheries Analysis Division, Miami Laboratory as described by Nichols (1984). These edited data were combined with the previously edited 1960-2007 data set for the updated analysis. Estimates of species-directed effort were calculated by the same procedures described by Nance (1992). The only changes to this method being that starting in 2002 the port agent interview data were used to estimate catch depth for all non-interviewed records in the Louisiana and Alabama Trip Ticket data, since depth information is not collected for these records. Interview data

categorized by month, subarea, species, and size were used to allocate similar non-interviewed catch data into the same depth strata. Beginning in 2006 electronic logbook information has also been used to help estimate catch depth for all non-interviewed records. This new allocation method may add a new source of bias to the effort estimation procedures and make the effort values after 2001 difficult to compare to the estimated values from previous years.

No time series data were available for catches not reported through the commercial channels covered by the dealer canvassing program. Although these catches may be sizable, they could not be included in the present analysis. Absence of estimates for unreported catches is probably the greatest potential source of error in this work.

The von Bertalanffy growth curves developed by Parrack (1981) were used as the age-length relationship for brown shrimp. The white shrimp analysis used the seasonally varying growth model developed by Nichols (1981). Necessary length-weight conversions were made using factors reported by Brunenmeister (1980), Parrack (1981), Phares (1980), and Phares (1981, unpublished). Modifications to the t_o parameters, procedures to estimate ages of the sexually dimorphic brown shrimp from size data without sex, details of the catch in weight to catch in numbers by age transformation, and adjustments to the growth relationships for calculating realized yield per recruit remained as described by Nichols (1984).

A natural mortality rate (M) of 0.275 per month was assumed for both brown and white shrimp. Age specific estimates of fishing mortality rates (F) and stock sizes (N) were made using virtual population analysis (VPA). For cohorts considered extinct by December 2008, starting F for the oldest age considered was estimated as:

$$F = qf$$

where q took the value associated with each estimate of M (parameters tabled in Nichols 1984), and f was the directed effort for that month. For cohorts extant in December 2008, age specific estimates of q were calculated as the averages of the

F/f ratios for all Decembers preceding 2008. The starting F was then calculated as the product of each q estimate and fishing effort for December 2008.

Parent stock is defined for brown shrimp as the number of age 7+ (months) shrimp during the November - February time frame. White shrimp parent stock is defined as the number of age 7+ (months) shrimp during the May - August time frame.

As in Nichols (1984, 1985), deterministic population models were produced for both species by linking a Ricker-type yield per recruit model to proposed stock recruitment relationships. Recruitment independent of parent stock was also considered, with recruitment set at the geometric mean over the 1960-2008 year period. Averages of VPA-derived F estimates for 2006-2008 were used as the baseline for "current conditions". Yield estimates were made for all three species for a range of "F-multiplier" values from 0-2 (0.02 increments).

RESULTS AND DISCUSSION

The following results for brown and white shrimp species are for a given calendar year (January through December). Catch both of the shrimp species has varied greatly over the past 49-year period (Figure 1). During most of the period brown shrimp has had the greatest annual yield, followed by white shrimp. Brown shrimp yield reached an apex in 1990 at 103.4 million pounds. Brown shrimp catch dropped from the 1990 apex, reaching a low of 66.3 million pounds in 1997. Catch in 1998 was 79.4 million pounds, which was an increase over all values obtained since 1991. A slight increase to 81.5 million pounds was realized in 1999, with a more substantial increase to 96.8 million pounds in 2000. Brown shrimp catch dropped in 2001 to 88.8 million pounds, and again in 2002 to 74.0 million pounds. An increase in catch at 81.2 million pounds was noted in 2003, with a decrease to 74.3 million pounds in 2004. While these values are both below the 2000 catch level, they still represent an above average catch. Catch dropped in 2005 to 58.0 million pounds, which is below the long-term average level. Catch levels rebounded in 2006 with 85.9 million pounds, but were back down to 70.6 million pounds in 2007, and decreased again in 2008 to 50.6 million pounds. The catch in 2008 was below the long-term average of 73.0 million pounds.

White shrimp experienced its greatest catch in 2006 at 81.5 million pounds (Figure 1). Previously, the maximum catch level was experienced in 2004, with a catch of 72.6 million pounds, with the next highest level in 1986 at 70.7 million pounds. White shrimp catch declined from the 1987 value and was at 49.3 million pounds in 1995, and only 35.9 million pounds in 1996. In 1997, the catch level increased to 39.1 million pounds. In 1998, the catch level again increased to a level of 54.9 million pounds, and remained near this level in 1999. In 2000 the white shrimp catch increased to 70.2 million pounds, while in 2001 it dropped down to 53.4 million pounds. Catch in 2002 was at the 53.0 million pound level, but increased to 61.2 million pounds in 2003. While both these values are both below the 2000 catch level, they still represent an above average catch. White shrimp catch dropped in 2005 to 65 million pounds, from the high of 72.6 million pounds in 2004. This 2005 value is above the long-term average and represents the first time is recent history (1960-2005) that white shrimp catch was above brown shrimp catch. The 2006 catch at 81.5 million pounds is the highest on record for this species. The 2007 catch was down to 64.6 million pounds, while the catch in 2008 equaled 64 million pounds. However, catch in both of these years was above the long-term average.

Effort levels increased steadily from 1960 through 1989 for brown and white shrimp (Figure 2). Brown shrimp effort fell below the 1989 level in 1991, remained very near this level for a seven year period, and declined again in 1998. The 1998 brown shrimp effort value of 124 thousand days fished was the lowest since 1985. A slight increase to 131 thousand days fished was observed in 1999, with an increase to 147 thousand days fished in 2000. The 2001 effort value was 145 thousand days fished. Brown shrimp effort in 2002 was calculated at 161 thousand days fished. This value seems high because of the economic status of the fishery at the time, but interview CPUE values subsantiate the estimate. Brown shrimp effort dropped in 2003 to 132 thousand days fished, and again in 2004 to 100 thousand days fished. This level of effort is similar to the levels experienced in the mid-1970s. These last two effort values seem more in line with levels that reflect the current economic status of the fishery. Brown shrimp effort dropped in 2005 to 68 thousand days fished, and increased slightly in 2006 to 69 thousand days fished. This level of effort is similar to levels experienced in the early 1960s. Brown shrimp effort showed a slight decrease in 2007 to 68 thousand days fished and another decrease in 2008 to 61 thousand days fished.

White shrimp effort has also dropped below the 1989 value, but greater fluctuations are noted in the values (Figure 2). From the high in 1989 a fluctuating decrease in effort was noted until a low of 85 thousand days fished occurred in 1996. A slight increase in effort was noted the next two years (1997 and 1998), with a decrease observed in both 1999 and 2000. Effort increased to 130 thousand days fished in 2001. A decrease was observed in both 2002 and 2003 to 118 thousand days fished. White shrimp effort was at 101 thousand days fished in 2004 and 94 thousand days fished in 2005. A further decrease was noted again in 2006 and 2007 to 87 thousand days fished. In 2008 effort continued to drop to around 73 thousand days fished.

Catch per unit of effort (CPUE; pounds per day fished) is detailed for the two species in Figure 3. Although there are great fluctuations in the data, CPUE generally declined slowly for both species from 1960 to the late 1980's. A general slow fluctuating increase had been observed for the past 16 to 17 years for both brown and white shrimp. The brown shrimp CPUE value was around 638 pounds per day fished in 1998, which was up from 424 pounds per day fished in 1997, and was, until 2000 and 2004, the best CPUE noted since 1985. The 1999 value of 618 pounds per day fished was only slightly lower than the 1998 value, with an increase to 656 pounds per day fished in 2000. The 2001 level was at 612 pounds per day fished, while the 2002 value was at 459 pounds per day fished. An increase in CPUE was noted recently with a value of 612 pounds per day fished in 2003; 741 pounds per day fished in 2004; 847 pounds per day fished in 2005; and a record high value of 1,244 pounds per day fished in 2006. Brown shrimp CPUE was down slightly in 2007 to 1,027 pounds per day fished. CPUE for brown shrimp dropped again in 2008 to 821 pounds per day fished, however, this value is still above the long-term average of 643 pounds per day fished.

White shrimp CPUE reached a low of 192 pounds per day fished in 1989 (Figure 3). Since that time CPUE climbed to 520 pounds per day fished in 1995 and then dropped in both 1996 and 1997. It rebounded in 1998 to a value of 445 pounds per day fished, and again in 1999 to 478 pounds per day fished. In 2000 white shrimp CPUE was at a new high level of 665 pounds per fishing day. This was the best CPUE value observed over the past thirty-six years (1964 through 1999). A drop in CPUE was noted in 2001 with the level established at 409

pounds per day fished, and remained near this level in 2002 at 424 pounds per day fished. CPUE increased in 2003 to 512 pounds per day fished and increased again in 2004 to 714 pounds per day fished. This CPUE level has not been experienced for this species since the early 1960s. The 2005 CPUE level was 689 pounds per day fished. While slightly lower than the 2004 level, this still is above the long-term average. The 2006 CPUE level for white shrimp was at a record high of 931 pounds per days fished. White shrimp CPUE was down to 738 pounds per day fished in 2007, but increased to 875 pounds per day fished in 2008.

Average count (number of shrimp per pound) is illustrated for the two species in Figure 4. White and brown shrimp have generally increased in count over the past 49-year period, but with a noticeable decrease the past several years. Average size of white shrimp landed in both 2000 and 2001 was 74 count. These values are below the 77 count level experienced in 1999. Average count size in 2002 was at 69, but increased to 73 in 2003, and remained near that count level in 2004. Average white shrimp count size was reduced to 66 in 2005, and further reduced to 62 in 2006. White shrimp count size in 2007 was 64. Count dropped again in 2008 to 58.

Brown shrimp size in 2000 was quite small with the average at 80 count, but this was down from the values in the mid to high 80s experienced for the five years previous. Brown shrimp count increased to an average of 84 in 2001, and was at 85 in 2002. A slight increase to 86 count was noted in 2003, with an additional increase to 88 count in 2004. Average brown shrimp count size was reduced to 79 in 2005, and further reduced to 69 in 2006. Average count size in 2007 was 73, and 70 in 2008.

Recruitment of brown shrimp showed a steady increase from 1960 until 1990 (Figure 5). Brown shrimp recruitment dropped in 1991 and remained even lower over the next three years. Recruitment was higher in 1995, with a slight decrease again noted in both 1996 and 1997. Both the 1998 and 1999 recruitment levels increased and were at their highest since 1991. The 2000 recruitment value was even higher than those found in the previous two years. This 2000 value of 14.0 billion shrimp is near the high levels experienced during the late 1980's. Brown shrimp recruitment levels dropped down to 12.9 billion shrimp in 2001 and down to 11.3 billion shrimp in 2002. Recruitment increased to 12.7 billion shrimp

in 2003, with a slight increase in 2004 to 12.8 billion shrimp. The number of recruits in 2005 was estimated at 10.6 billion shrimp, with an increase in 2006 to 13.2 billion shrimp. The 2007 brown shrimp recruitment value was estimated at 10.8 billion shrimp, while the 2008 value at 9.5 billion shrimp.

The recruitment of white shrimp reached a mid-series peak in 1986 (Figure 5). It then experienced a fluctuating level at around 10 billion shrimp from 1987 through 1995. A low recruitment value was reached in 1996 at 7.3 billion shrimp. Since that time white shrimp recruitment has shown a general steady increase, with a peak in 1999 at 16.0 billion shrimp. During 2000 white shrimp recruitment was slightly below the 1999 value, with a continued decrease in 2001 down to the 13.5 billion shrimp level. An increase was observed in both 2002 and 2003 when a new peak was reached at 17.2 billion shrimp. A slight increase in recruitment was noted in 2004, and again in 2005. The 2005 value of 21.5 billion represents the new recruitment peak for white shrimp. In 2006 a decrease in recruitment to 16.4 billion shrimp was noted in the population, with a slight increase in 2007 to 17.7 billion shrimp. Recruitment for white shrimp in 2008 was estimated at 13.7 billion shrimp.

The estimated number of parents during a given monthly period is presented in Figure 6. White shrimp had their lowest parent numbers in the early 1960's, while the lowest brown shrimp parent numbers were found during 1983. White shrimp levels have shown dramatic increases over the past several years. This increase seems to be related to large quantities of over-wintering white shrimp available to the population in the spring. This is an area of interest that will be examined during the coming year. An increase in brown shrimp parents was noted for 2004 through 2007, with a slight decrease this past year. There are no overfishing issues with either brown or white shrimp populations.

Yield curves provide us information about the current status of the fishery (Figure 7). White shrimp curves show that at the current effort levels (F–multiplier = 1.0) yield is at or near the maximum (i.e., the stock is fully exploited for each species). However, brown shrimp yield curves indicate that increases in effort will produce an increase in yield.

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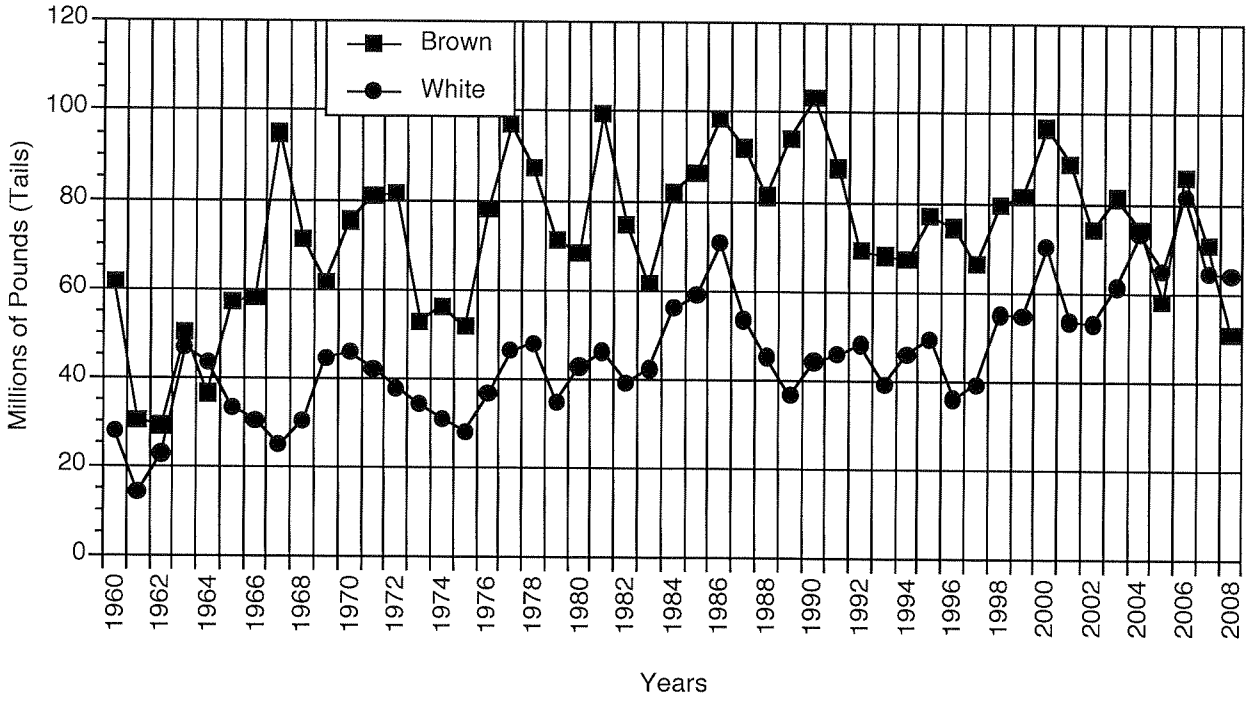

Figure 1. Annual catch data for the Gulf of Mexico shrimp fishery.

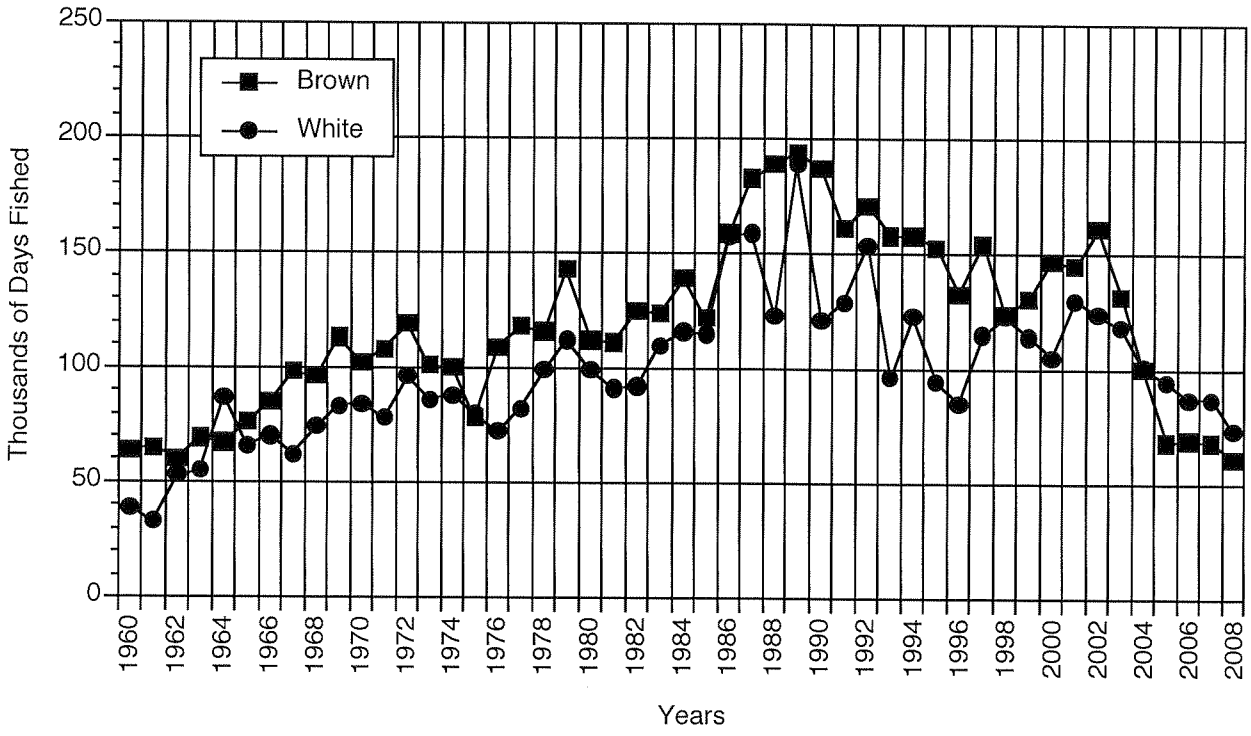

Figure 2. Annual effort data for the Gulf of Mexico shrimp fishery.

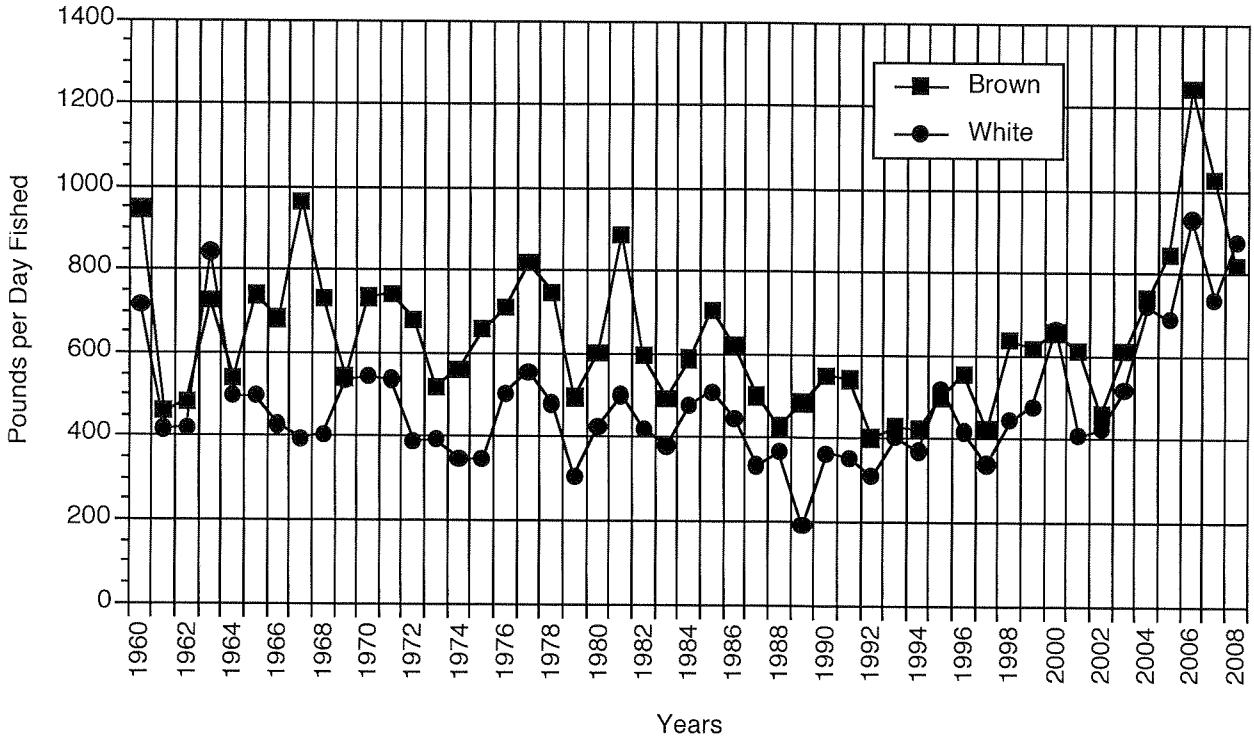

Figure 3. Annual CPUE data for the Gulf of Mexico shrimp fishery.

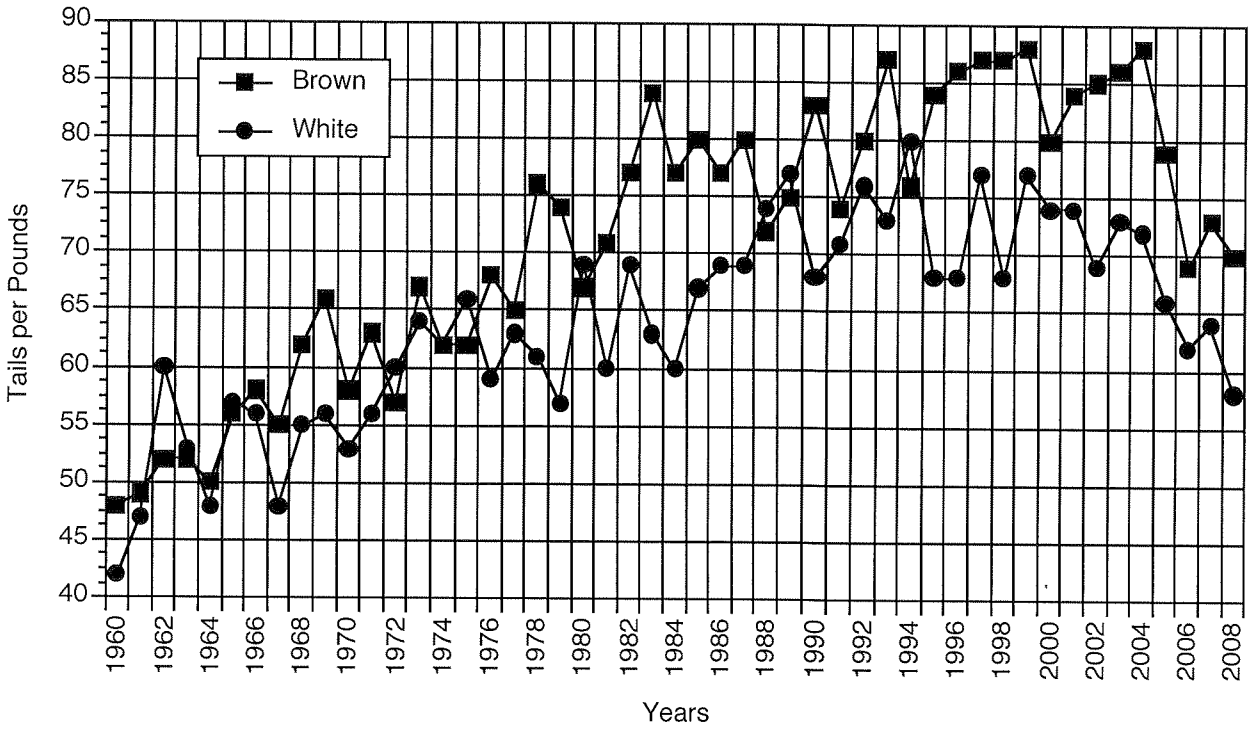

Figure 4. Annual size data for the Gulf of Mexico shrimp fishery.

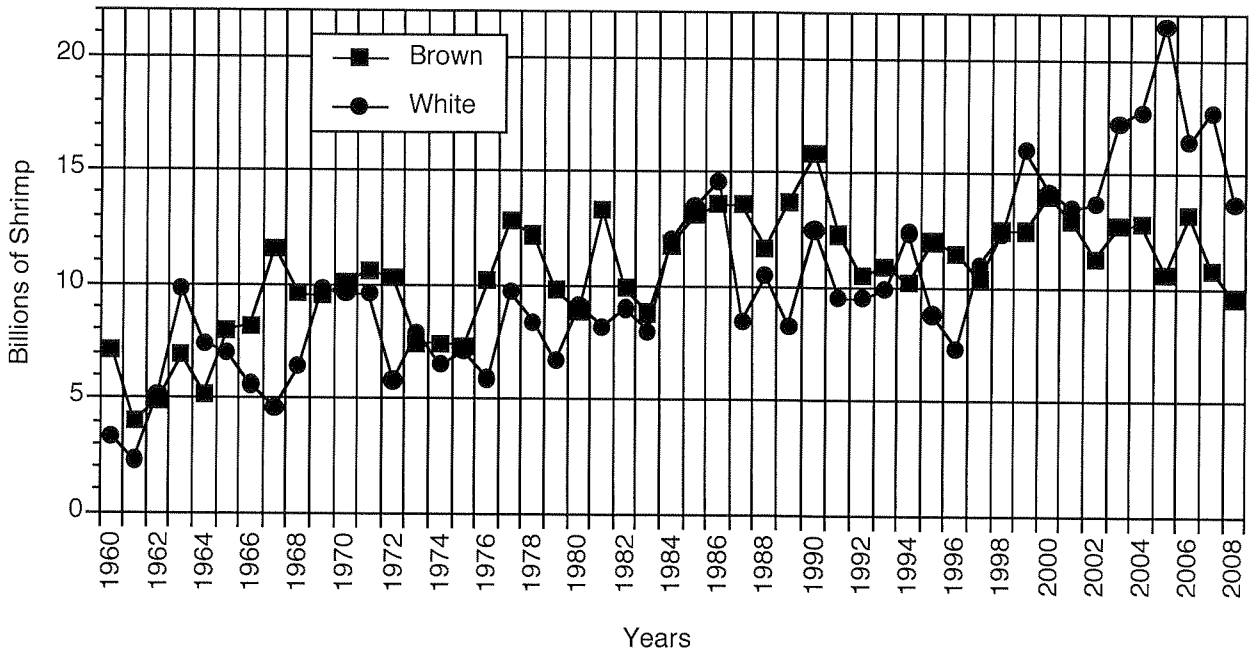

Figure 5. Annual recruitment data for the Gulf of Mexico shrimp fishery.

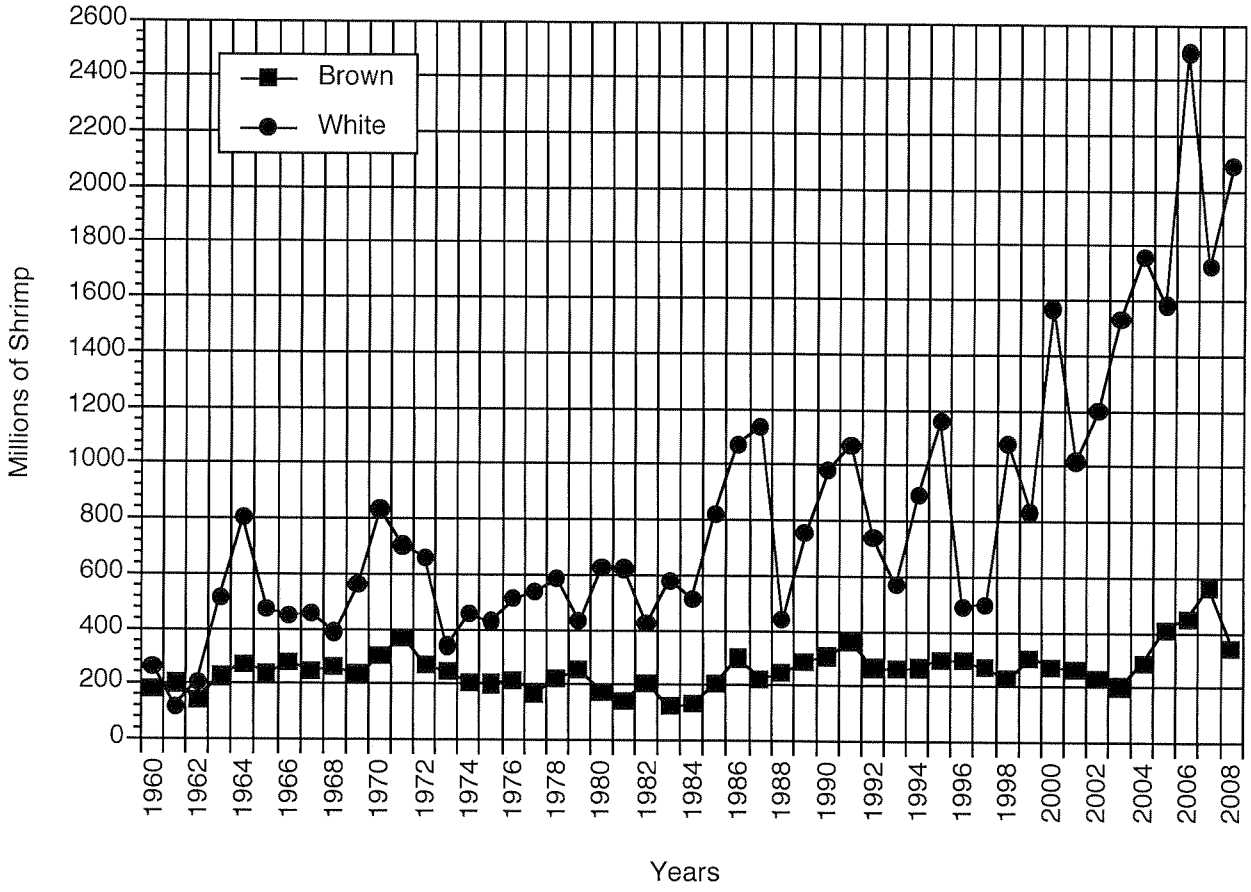

Figure 6. Annual parent data for the Gulf of Mexico shrimp fishery.

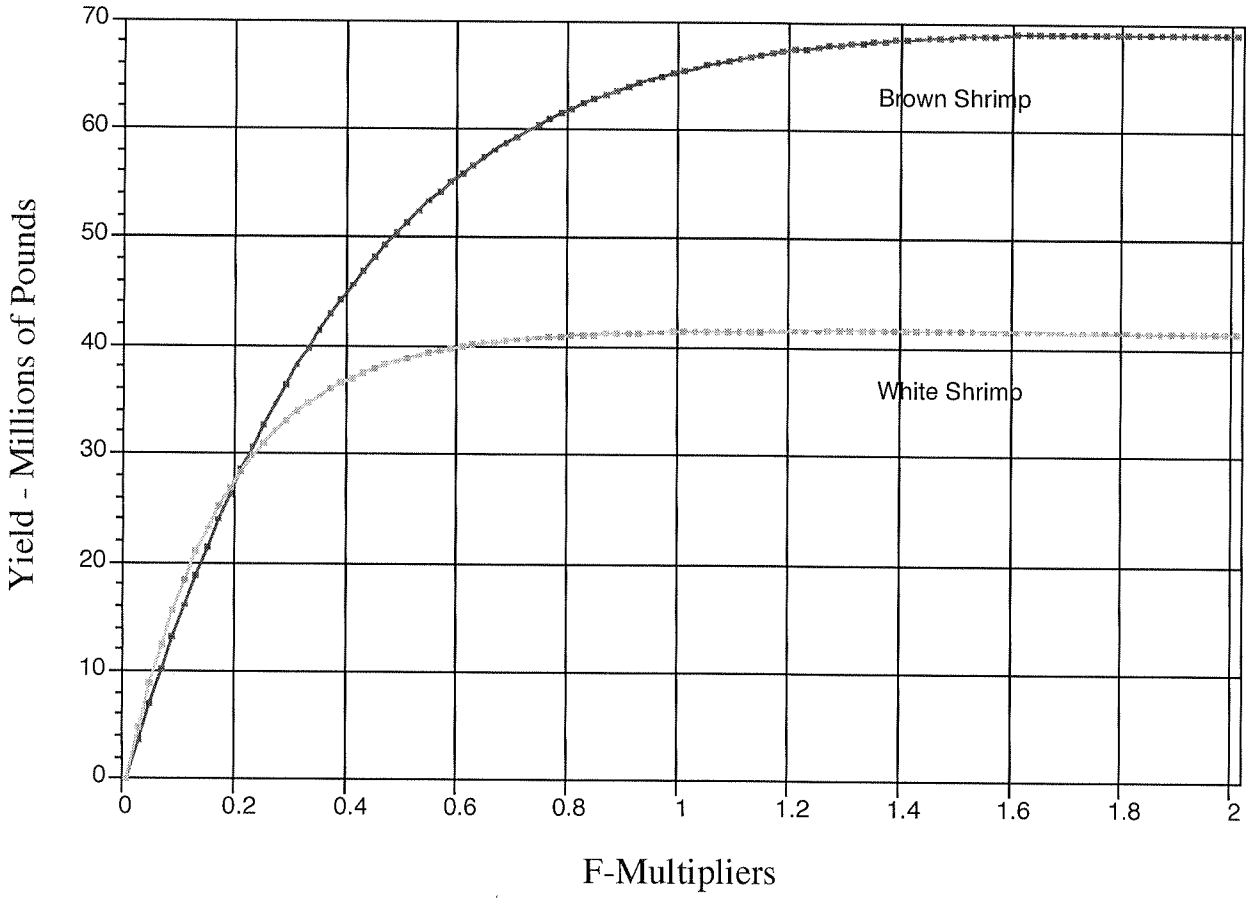

Figure 7. Annual yield data for the Gulf of Mexico shrimp fishery.