

A TANNER CRAB HARVEST STRATEGY
FOR KODIAK, CHIGNIK, AND THE SOUTH PENINSULA DISTRICTS,
A REPORT TO THE BOARD OF FISHERIES

By

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EXECUTIVE SUMMARY

New harvest strategies are proposed for the Tanner crab *Chionoecetes bairdi* fisheries in the Chignik and South Peninsula Districts and in the eight sections within the Kodiak District. The proposed harvest strategies would bring Tanner crab management in these areas into compliance with BOF regulations on harvest strategies for Tanner crab and with the BOF Policy on King and Tanner Crab Resource Management. The proposed harvest strategies are similar to the framework and rationale of the harvest strategy that is proposed for Bering Sea Tanner crab. Minimum abundance thresholds for fishery openings are established for each area considered here, as are reference values for defining the populations as “rebuilding” or “rebuilt”. Under the proposed harvest strategies, rebuilding populations are managed more conservatively than are populations that are rebuilt. The proposed harvest strategy is more conservative than historic management practices. Applying proposed harvest strategies to historic abundance levels, fisheries would have likely been closed in more years and when open, guideline harvest levels would have been lower. Additional precautionary measures are incorporated into the proposed harvest strategies to protect against errors in pre-season abundance estimates.

INTRODUCTION

This report presents the Tanner crab *Chionoecetes bairdi* harvest strategy proposed for the Chignik and South Peninsula Districts and for each of the sections within the Kodiak District (Figure 1). The current Tanner crab harvest strategy in regulation (5 AAC 35.080, ADF&G 1998) and the policy of the Board of Fisheries (BOF) on King and Tanner Crab Resource Management (90-04-FB, March 23, 1990, ADF&G 1998) contain mandates that are not currently being implemented. The proposed strategy conforms more closely to the BOF policy.

The current Tanner crab management strategy is relatively simple. Fisheries are managed by a fixed exploitation rate for males above a minimum legal harvest size. Only males with a carapace width (CW) 5 ½ inches or greater can be harvested. The minimum legal size was established to allow males the opportunity to mate one or two times prior to harvest (Donaldson and Donaldson 1992). Unpublished Alaska Department of Fish and Game (ADF&G) policy established the exploitation rate at 40% for legal crab. Season dates (5 AAC 35.510, ADF&G 1998) were set to avoid sensitive molting and mating periods and to assure product quality.

The harvest strategies proposed here establish minimum thresholds for fishery openings in each area for which adequate historic data on long-term population abundance estimates are available. Populations as used in this report, refers simply to the number of crab in a given management area. Fisheries have been closed in the Kodiak, South Peninsula, and Chignik Districts based on low population abundance since at least the early 1990’s. However, prior to the development of the proposed strategies, no formal

guidelines have existed for determining when areas should remain closed or when they can be reopened to fishing.

These proposed harvest strategies also replace the current fixed exploitation rate on legal males with variable exploitation rates. Use of the constant 40% exploitation rate on legal Tanner crab had been supported by a yield-per-recruit analysis (Somerton 1981). However, Tanner crab populations are known to undergo wide, quasi-periodic fluctuations in population abundance (Zheng and Kruse *in press*). Under such conditions a fixed exploitation rate may not be the most effective strategy for implementing the BOF policies on managing Tanner crab populations. Recent analyses have compared the performance of the fixed 40% exploitation rate with a strategy in which the exploitation rate on legal crab varies with stock productivity (Zheng and Kruse 1999). When coupled with an appropriate population threshold and a maximum exploitation rate, the variable exploitation rate strategy provides a better balance between long-term yield, variation in yield, and conservation of reproductive potential.

ELEMENTS OF THE PROPOSED MANAGEMENT STRATEGY

The harvest strategies proposed for Kodiak, Chignik, and South Peninsula District Tanner crab follow the framework and rationale developed in the proposed harvest strategy for Bering Sea Tanner crab (Zheng and Kruse 1999). The important elements in the harvest strategy are:

- 1) a minimum stock threshold for fishing to occur;
- 2) two tiers of harvest regimes, with a more conservative exploitation rate when stocks are rebuilding and a higher exploitation rate when stocks are rebuilt;
- 3) a guideline harvest level (GHL) that is determined by an exploitation rate applied to legal males that varies with the abundance and shell-age composition of all mature males, but which is capped by a maximum allowable exploitation rate on legal males.

Thresholds

Minimum population thresholds were developed for the Chignik and South Peninsula Districts and for each of the sections within the Kodiak District, with the exception of the Semidi Island and South Mainland Sections. The threshold values are based on the number of mature males (defined as males >114 mm CW). Thresholds were defined for each area as one-half of the long-term average abundance of mature males, using the historical abundance estimates provided in Urban and Vining (1999) as basis for the computation. Urban and Vining considered the time period of 1973 to 1998 for the Kodiak Sections and 1974 to 1998 for the Chignik and South Peninsula Districts. As explained in that report, this starting point was determined by the start of pot surveys for

Tanner crab and the full development of the fisheries. Table 1 provides the long-term average and one-half the long-term average of those estimates.

No thresholds were established for the Semidi Island and South Mainland sections because of the paucity of fishery and stock abundance data available from those stocks. Historically, these two sections opened when adjacent areas opened, and closed when those adjacent areas closed. It is proposed that strategy would continue.

Stair-step Harvest Regime

Under the proposed harvest strategies, a population that is above threshold but with mature male abundance that is below the long-term average abundance will be considered to be “rebuilding.” A stock will be considered to be “rebuilt” when mature male abundance exceeds the long-term average. Stocks in rebuilding condition will be harvested more conservatively than rebuilt stocks.

GHL Determination

GHLs will be determined following the strategy proposed by Zheng and Kruse (1999). Depending on the rebuilding status of the stocks, a specific harvest rate is applied to the estimated number of the “molting mature males”. Molting mature males are defined as 100% of the new-shell crab and 15% of the old-shell crab that are greater than the size of maturity. For the stocks considered here, we use 115-mm CW as the size of maturity. When a population is increasing and comprised largely of new-shell crab, the molting mature male population would be considered greater than when the population is declining and is dominated by old-shell crab. To compute the GHL in terms of pounds, the product of the harvest rate and estimated number of molting mature males would be multiplied by the average weight of legal-sized crabs. Note that the proposed harvest strategy contains additional precautionary measures (see below) that can restrict harvest below the GHLs as computed here. Figure 2 summarizes these elements of the proposed harvest strategy.

Stocks Below Threshold

When the estimate of mature male abundance is less than one-half the long-term average, the stock will be considered below threshold and remain closed to commercial fishing for the season.

Stocks In Rebuilding Condition

The stock will be considered to be rebuilding when the estimate of mature male abundance is greater than one-half the long-term average but less than the long-term average. Under these conditions a 10% harvest rate will be applied to the estimated number of mature molting males to determine the GHL harvest level of legal crab. The harvest of legal crab is, however, capped at 30% of the number of legal sized crab. See Additional Precautionary

Measures (below) for conditions that can restrict the harvest below the GHL as computed here.

Rebuilt Stocks

The stock will be considered rebuilt when the estimate of molting mature male abundance is greater than the long-term average. Under these conditions a 20% harvest rate will be applied to the estimated number of mature molting males to determine the GHL of legal crab. As in rebuilding populations, the harvest of legal crab would be capped at 30%. See Additional Precautionary Measures (below) for conditions that can restrict the harvest below the GHL as computed here.

Additional Precautionary Measures

The harvest strategies proposed for the Kodiak, Chignik, and South Peninsula Districts contain three additional precautionary measures. The first pertains to any stock that has been closed and is in its first season above threshold. The second precautionary measure will only apply to the Kodiak District and the third relates to management considerations.

- 1) When a stock is reopened to fishing after having been closed to all commercial fishing in the preceding season, the GHL for that stock in that season will be reduced to one-half of the value as computed in GHL Determination.
- 2) No management section in the Kodiak District will be open to commercial fishing in a season unless two or more sections in the District are above threshold, excluding the South Mainland and Semidi Island Sections.
- 3) The Chignik or South Peninsula Districts, or any Section of the Kodiak District will not open for a GHL below 100,000 pounds.

DIFFERENCES BETWEEN THE BERING SEA AND GULF OF ALASKA TANNER CRAB STRATEGIES

The information available for Bering Sea Tanner crab is much more comprehensive than that available for Tanner crab in the Gulf of Alaska. For this reason, different indices exist between the Bering Sea and the Gulf of Alaska for determining the thresholds and step levels for the stair step harvest regime. The Bering Sea threshold level and the second step rate were based partly on a stock-recruit curve for spawning biomass. Development of this curve requires a long and consistent time series of information on both male and female crab populations which simply does not exist in the GOA.

The National Marine Fisheries Service (NMFS) has generated population estimates for Tanner crab from annual trawl surveys in the eastern Bering Sea since 1976 (Stevens et

al. 1998). Survey efforts in the Gulf of Alaska by the ADF&G concentrated on pot surveys until as recently as 1987. Pot surveys do not capture female Tanner crabs as effectively as trawl surveys. For this reason, the stepped harvest rates in the GOA were based on the mature male population and the development of a stock-recruit curve was not attempted. The long-term average mature male population was used as a proxy for when a stock was considered rebuilt and capable of sustaining the higher harvest rate. One-half the long-term average was considered a proxy for the minimum threshold needed to conduct the fishery. These proxies have been recommended by the National Marine Fisheries Service for use in implementing the Magnuson Stevens Act in data poor situations (NMFS 1996).

In addition to differences in the quality of information available, important differences exist in the ecosystems of the Bering Sea and Gulf of Alaska. While the Bering Sea consists of one or possibly two stocks of Tanner crab spread across a broad continental shelf, the GOA continental shelf is relatively narrow and many populations occur in isolated bay systems. As a result, the fisheries of the Bering Sea and GOA are prosecuted differently and the populations differ in their susceptibility to localized depletions.

Bering Sea fishers have room to move from areas of old-shell crab in search of areas of new-shell “school” crabs where they hope the catch per pot will be higher. Surveys consistently show higher percentages of old-shell crab than show up in the Bering Sea commercial catch indicating a non-random nature to the fishery (Zheng and Kruse 1999). Accordingly, Zheng and Kruse (1999) define the crabs actually harvested as “exploitable legal males” and calculate the number as 100% of newshell and 32% old-shell crabs with a carapace greater than 137 mm. They proposed a harvest cap on the exploitable legal males of 50%. In the GOA, the more constricted fishing grounds leave less room to move from old-shell areas, and the differences in old-shell percentages between the surveys and commercial catch is less definitive. It is proposed that the GOA cap be placed on legal crab without regard to shell age.

The proposed Bering Sea cap on legal crab harvest of 50% is, however, not considered conservative enough in the Gulf. The longer period of depressed population levels, the isolated and vulnerable nature of the stocks, and poorer quality of the survey data make it advisable to be even more risk adverse in the GOA. A 30% cap on the legal harvest is proposed to protect against localized depletions and also to achieve the BOF policy of maintaining “stocks comprised of various size and age classes of mature animals” (ADF&G 1998). In addition, to safeguard against survey error it is proposed that the first year a fishery is above threshold, the GHL will be only 1/2 the computed amount (1/2 the molting mature male abundance times the applicable harvest rate). The minimum GHL of 100,000 pounds is necessary to insure manageable fisheries.

COMPARISONS OF THE PROPOSED STRATEGIES WITH HISTORIC MANAGEMENT PRACTICES

We have not attempted to reconstruct the historic stock levels and harvests that would have occurred had the proposed strategy been implemented at some time in the past. Here we provide year-by-year comparisons of what the proposed harvest strategy would have meant at a given stock level relative to what occurred under past management practices. Two important aspects of competing harvest strategies are the abundance levels at which fisheries are closed, and the GHLS that the strategies produce for a given stock level.

The frequency with which fishery closures would have occurred under the proposed thresholds is compared to the actual frequency of closures in Table 1. The comparison is limited to the period for which trawl surveys provided area-swept estimates of abundance, generally 1987 to the present. In Figure 3 through 6 the GHLS based on the proposed strategies are compared with GHLS based on 40% of estimated legal crab abundance and with actual fishery harvests. Note that the additional precautionary measures (reduction in GHLS if not fished the previous year, requirement of at least two Kodiak sections above threshold, and a minimum GHLS) have not been applied in this exercise.

Using historic population estimates, the comparisons indicate that the new strategies are more likely to result in fishery closures than are historic management practices. For population levels since the early 1990s, a year-by-year comparison of GHLS under the proposed strategies with the actual harvests (Figures 3-6) shows that the proposed strategies agreed with the actual fishery closures and in addition resulted in some additional closures given the population levels estimated for the late-1980s and early 1990s.

It is notable that the 1998 population estimates for the Northeast and Eastside Sections in the Kodiak District were above the proposed thresholds. Those fisheries remained closed for the 1998/99 season, however, because formal thresholds for reopening the fisheries had not yet been developed by ADF&G and reviewed by the BOF. Figure 6 shows that harvests would have been allowed in 1989 and 1990 in the Chignik District. Fishery managers recognized the potential for a commercial harvest, but the South Peninsula fishery was closed at this time and it was felt that the large influx of that fleet to the Chignik fishery would have not been manageable at the proposed GHLS.

When fisheries are opened by the proposed harvest strategies the GHLS produced by the strategy are lower than would result from a constant 40% harvest rate (Figures 3 through 6). This is mainly due to the harvest rate being applied to the mature molting male estimate, rather than the 30% cap on harvest of legal crabs. The 30% cap on harvest of legal crabs came into play in only two of all the cases shown in Figures 3 through 6 (Northeast Section of Kodiak District in 1998 and Eastside Section of Kodiak District in 1990). In several cases the GHLS from the proposed strategy is closer to the actual

historic harvest than is a GHM based on a 40% of the estimated number of legal crabs (e.g., Northeast Section of Kodiak District in 1989 and 1991).

CONCLUDING REMARKS

The harvest strategies proposed here should evolve with the accumulation of new data, reassessment of old data, changes in fishery practices, and new insights into the population biology of Tanner crabs and the management of fisheries. They provide a framework that can incorporate any future improvements in determination of stock thresholds, reference levels for rebuilding and rebuilt stocks, operational criteria for defining mature males, optimal harvest rates, and caps on the harvest of legal crabs. If the proposed harvest strategies are approved by the BOF, any future changes to the harvest strategies should be well documented and, as required by 5 AAC 35.075 (ADF&G 1998), would be reviewed by the BOF prior to implementation.

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Table 1. Number of mature crabs required to open the fishery and for the population to be considered rebuilt, with the percent of years when a fishery would have remained closed under current and proposed harvest strategies. Percent closure was computed for years with recent trawl surveys.

District	Section	Historic Number of Mature Crabs (x1000)		Fishery Closure %	
		Long-term Average (Population Rebuilt)	1/2 Long-term Average (Opening Threshold)	Old Strategy	New Strategy
KODIAK					
	Northeast	2,246	1,123	41.7%	75.0%
	Eastside	3,103	1,552	38.5%	46.2%
	Southeast	1,466	733	66.7%	75.0%
	Southwest	2,472	1,236	58.3%	83.3%
	Westside	1,528	764	66.7%	91.7%
	North Mainland	2,938	1,469	69.2%	69.2%
CHIGNIK		1,947	973	100.0%	80.0%
SOUTH PENINSULA		2,749	1,375	90.0%	90.0%

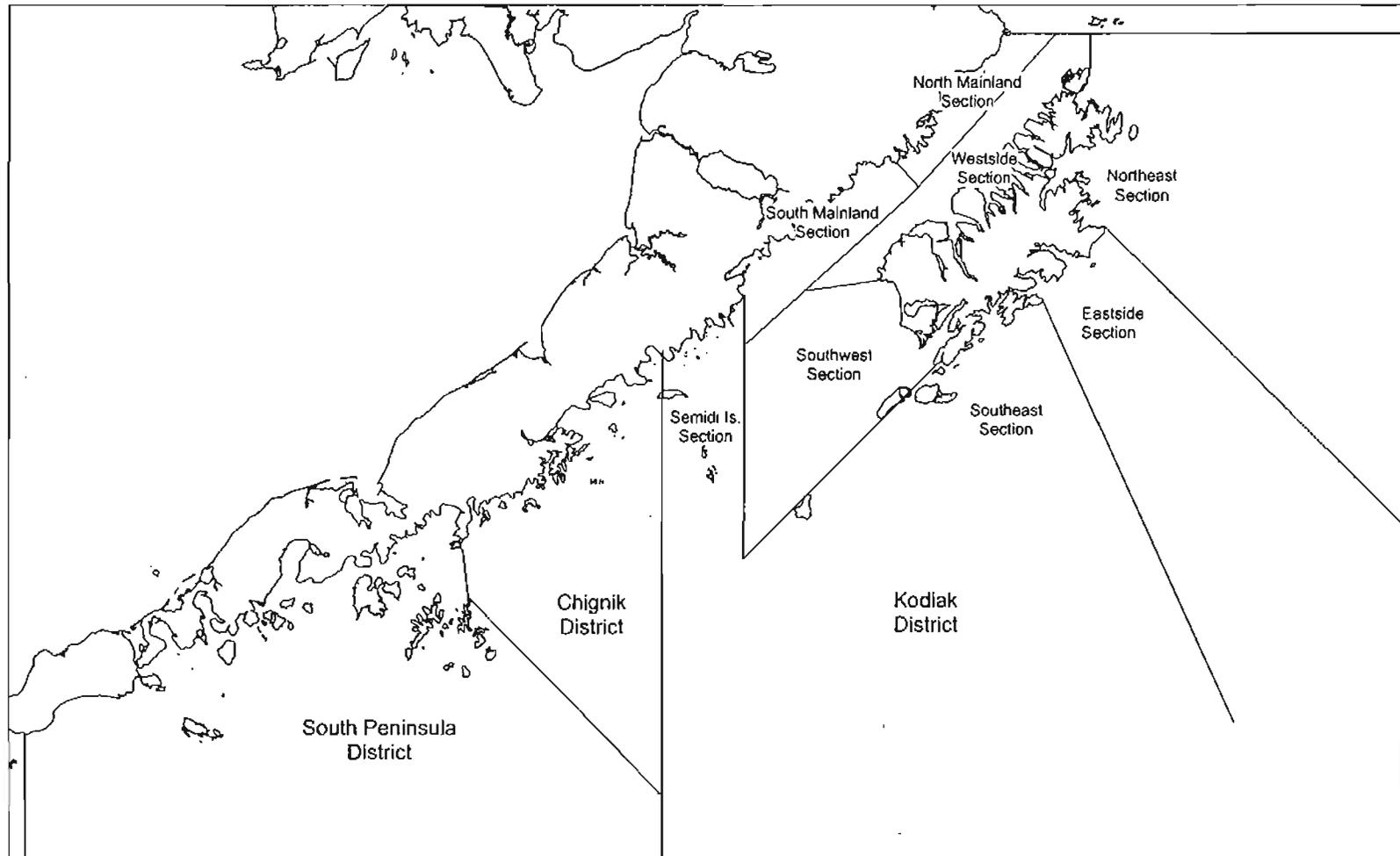
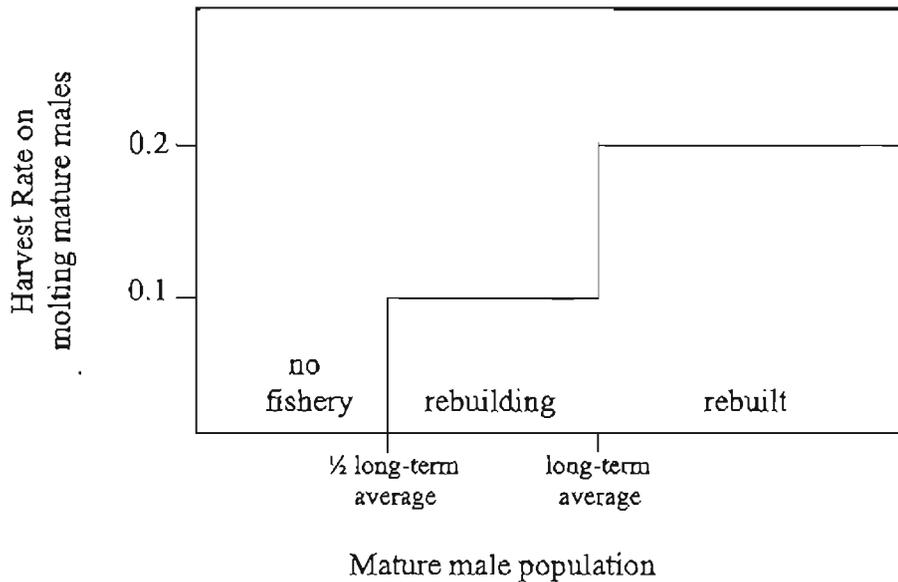


Figure 1. Tanner crab management Districts and Sections.

Figure 2. Elements of the proposed Tanner crab management strategy for the Kodiak, Chignik and South Peninsula Districts.

1. A two step approach to setting harvest rates.



2. Fishery threshold for opening is $\frac{1}{2}$ the long-term average mature male population.
3. Fishery “rebuilding” between populations of $\frac{1}{2}$ long-term average and the long-term average, harvest rate of 0.1.
4. Fishery “rebuilt” when above long-term average, harvest rate of 0.2.
5. When calculating Guideline Harvest Levels, harvest rates are applied to molting mature males, defined as 100% of mature crab with new shells and 15% of mature old-shell crabs. (Mature crabs are larger than 114 mm CW)
6. A 30% cap is placed on legal crab harvest.
7. The first year a fishery re-opens, the guideline harvest level is set at $\frac{1}{2}$ the calculated guideline harvest level.
8. In the Kodiak District, at least 2 sections must be above threshold for any section to open in order to spread effort, South Mainland and Semidi I. Sections excluded.
9. A minimum GHLL of 100,000 pounds is required for the Chignik or South Peninsula District, or for any Section of the Kodiak District.

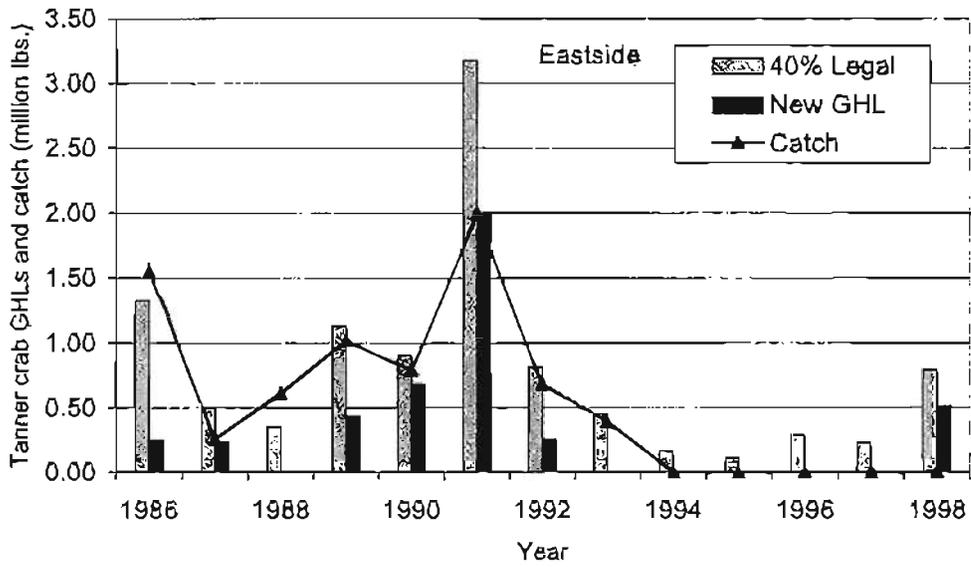
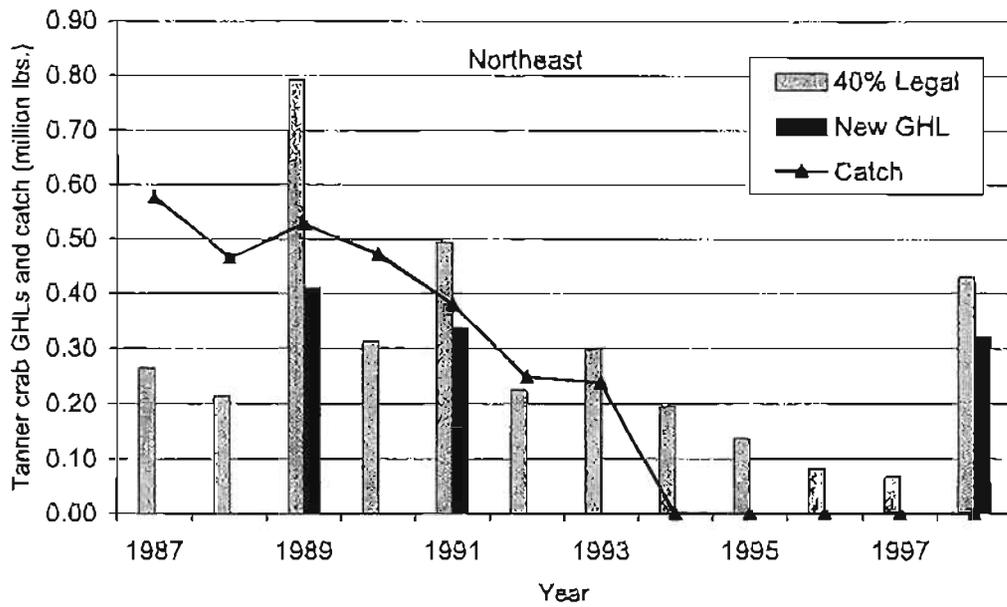


Figure 3. GHLs based on 40% harvest of estimated legal population size and the proposed new strategy compared with actual historic harvests for the Northeast and Eastside Sections of the Kodiak District

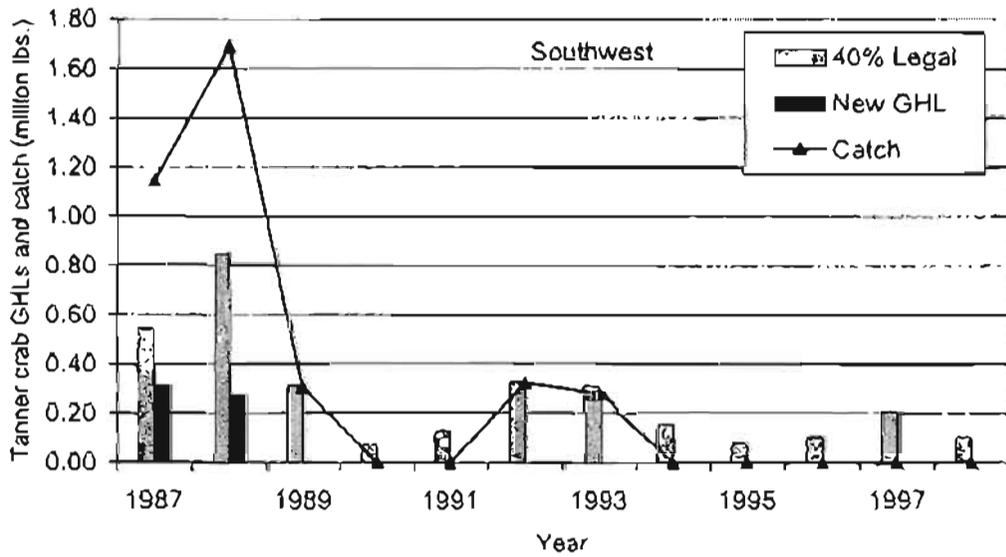
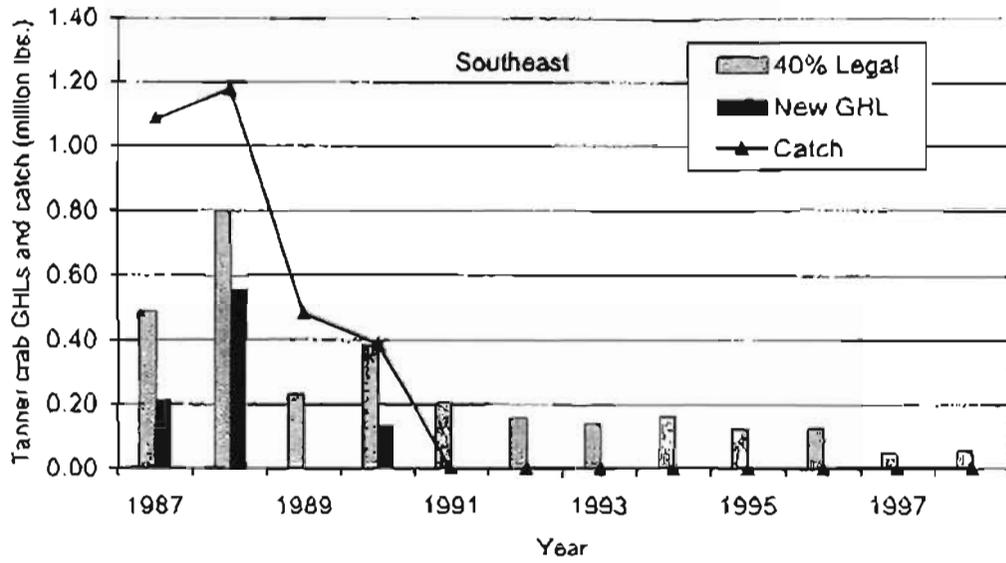


Figure 4. GHLs based on 40% harvest of estimated legal population size and the proposed new strategy compared with actual historic harvests for the Southeast and Southwest Sections of the Kodiak District

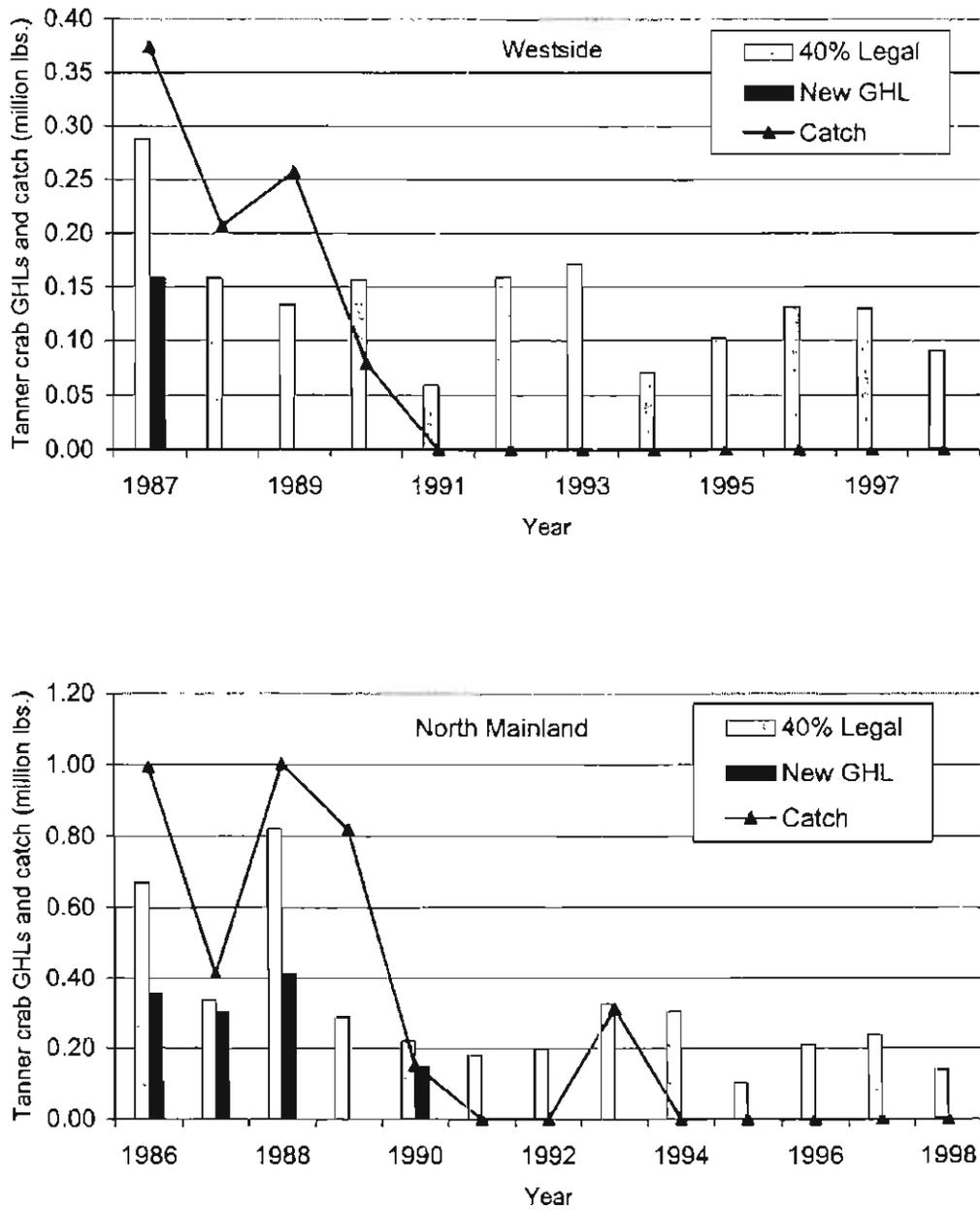


Figure 5. GHLs based on 40% harvest of estimated legal population size and the proposed new strategy compared with actual historic harvests for the Westside and North Mainland Sections of the Kodiak District

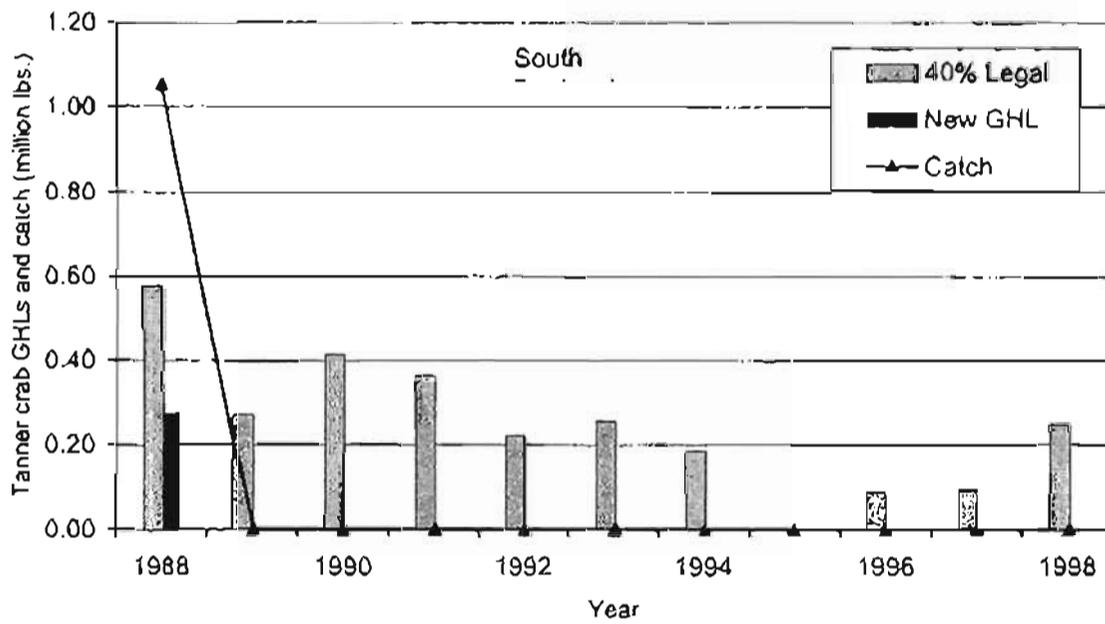
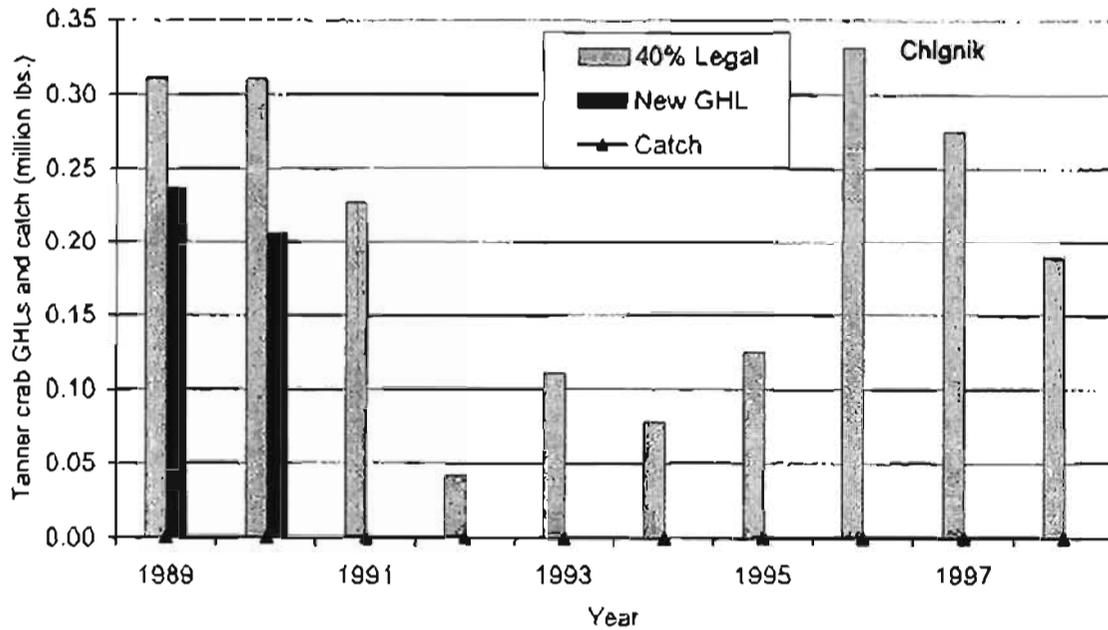


Figure 6. GHLs based on 40% harvest of estimated legal population size and the proposed new strategy compared with actual historic harvests for the Chignik and South Peninsula Districts

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