Department of Fish and Game

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2023 Recommended Harvest Strategy for Southeast Alaska Golden King Crab (*Lithodes aequispinus*)

by

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BACKGROUND

The Alaska Department of Fish and Game (department) golden king crab (*Lithodes aequispinus*, GKC) fishery in Southeast Alaska is a data-limited fishery that is managed based on a 3-S management system (sex, size, and season). The management system has been further developed by limiting the number of participants and gear, establishing guideline harvest levels (GHLs) that are set within guideline harvest ranges (GHRs) for each management area (Table 1), and closing of management areas if there are stock health concerns. The majority of GKC harvest occurs in the commercial sector where the fishery extends across seven management areas (Northern, Icy Strait, North Stephens Passage, East Central, Mid-Chatham Strait, Lower Chatham Strait, and Southern). The department annually evaluates stock status and establishes GHLs for each management area using fishery dependent data (Stratman et al. 2017; Olson et al. 2018). Management area GHRs were examined in 2015 for their biological relevance due to declines in fishery performance and results were used in establishing current GHRs since 2018 (K. Palof and A. Olson, 2017, unpublished data). The goal of this analysis was to establish a biological-based maximum sustainable yield (MSY) from historical fisheries catch and effort data using biomass dynamic models. Biomass dynamic models are a simple fisheries model that applies basic population dynamics to harvest data. They are not ideal models for most assessments and management due to their many assumptions and caveats; however, they are useful because the only data needed is a time series of harvest and an index of abundance, which is generally fishery catch per unit of effort (CPUE). These models assume that catch is related to available biomass, meaning that harvest is not limited by GHLs or number of days. Another major assumption is that the population remains in a similar "state of growth" during the entire time period. There is only one parameter estimated for growth of the population, or production of the population, this parameter incorporates all aspects of production – recruitment, growth of individuals, and mortality. When many of the assumptions are not met these models are considered non-conservative and often provide over inflated estimates of MSY. Because of this, the MSY estimates obtained from these models are treated as an upper limit (i.e., upper end of the GHR) of sustainable harvest for each area. A GHL is a preseason estimated level of allowable harvest that will not jeopardize the sustained yield of the stock.

The Southeast commercial GKC fishery rapidly developed after the collapse of the Southeast red and blue king crab fisheries in the early 1980s (Messmer et al. 2017; Stratman et al. 2017). Harvest subsequently peaked in the late 1980s and early 2010s, experiencing a period of collapse in the 1990s (Figure 1). Fishery performance has steadily declined and

has remained at historically low levels in many of the management areas while other areas have shown signs of recovery in recent seasons (Stratman et al. 2017; Olson et al. 2018; Stratman 2020).

Table 1.–Golden king crab guideline harvest ranges for Registration Area A [5 AAC 34.115].

Management Area	Guideline Harvest Range (lbs)
Northern	0–145,000
Icy Strait	0–55,000
North Stephens Passage	0–25,000
East Central	0–225,000
Mid-Chatham Strait	0–150,000
Lower Chatham Strait	0–50,000
Southern	0–25,000
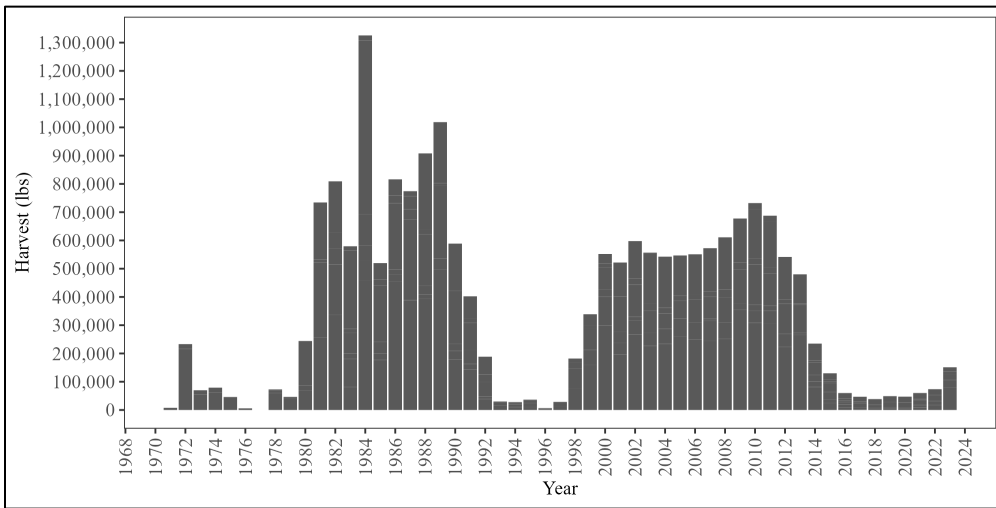
Figure 1.–Commercial GKC harvest (1971–Present).

BIOLOGY

Golden king crab are relatively long-lived slow growing species that have an asynchronous 20-month reproductive cycle (Somerton and Otto 1986; Long and Van Sant 2016), morphometric maturity at approximately 8 years of age (Koeneman and Buchanan 1985; Paul and Paul 2001; Hebert et al. 2008), and lecithotrophic larvae that remain at depth (Sloan 1985; Shirley and Shijie 1997; Long and Van Sant 2016). Golden king crab exhibit spatial variability in size at maturity across the North Pacific and among the seven management areas within Southeast Alaska where size at maturity increases with increases in latitude (Jewett et al. 1985; Somerton and Otto 1986; Nizyaev 2005; Olson et al. 2018). Certain aspects of this species' life history are well documented whereas other critical components such as, growth rates, age at maturity, longevity, etc. are unknown.

PURPOSE

The purpose of this document is to establish the framework for a consistent and transparent inseason and postseason approach to determine GHLs and close fisheries when warranted. The harvest strategy described herein remains consistent with the Alaska Board of Fisheries' Board Policy on King and Tanner Crab Resource Management (90-04-FB, March, 1990) [5 AAC 34.080], the Southeast Alaska Golden King Crab Management Plan [5 AAC 34.114], and will be treated as a guideline for managing GKC and not a prescriptive step by step approach. Many factors and sources of information play into determining GHLs or closing fisheries that cannot be captured in a prescriptive framework.

MANAGEMENT GOALS AND OBJECTIVES

The primary goal is to develop a harvest strategy for Southeast Alaska GKC to improve and stabilize fishery performance using transparent and repeatable metrics (and their rationale) by evaluating stock health and measuring fishery performance for more consistent inseason and postseason management. Objectives include maintaining various size and age compositions of stocks in order to maintain long-term reproductive viability and reducing dependency on annual recruitment.

Harvest strategies have been implemented for the GKC fisheries in the Aleutian Islands and Pribilof Islands to improve fisheries management and sustainability. These harvest strategies are comprised of biological, fishery dependent and independent reference points (i.e., mature male biomass, CPUE, annual recruitment, etc.) that are used in recommending the total allowable catch (TAC) or GHL for a given management area and season (Daly et al. 2019; Daly and Jackson 2020; Siddeek et al. 2020).

HARVEST STRATEGY

This section describes a harvest strategy for GKC in Southeast Alaska that helps guide inseason and postseason management using fishery dependent performance indicators and management decision rules.

Performance Indicators

The primary performance indicator used in this harvest strategy is commercial catch rate defined as logbook entry catch of GKC per unit of effort (CPUE):

$$CPUE_{le} = \frac{catch}{effort} \qquad (1)$$

where *CPUE* is the catch of legal size male GKC per unit of *effort (pot lifts)* for each logbook entry (*le*). Equation (1) is then applied to all logbook entries and averaged for a given management area and season where:

$$\overline{CPUE_{a,s}} = \frac{\sum CPUE_{le}}{n} \qquad (2)$$

where *a* is a given management area, *s* is a given season, and *n* is the total number of logbook entries. Future iterations will incorporate soak time (2020–Present) in order to standardize CPUE.

Due to the GKC and Tanner crab fishery occurring concurrently, it is difficult to differentiate between GKC that are harvested as bycatch or directly targeted. GKC that are harvested as bycatch can bias logbook CPUE and consequently trigger management actions during and after the season. The department examined proportion of catch between GKC and Tanner crab logbooks and applied a 60% or greater proportion to identify logbooks as directed GKC effort (2000-2022). This approach allows for a repeatable metric to aid in determining influence of Tanner crab effort, however, provides less data for analyses and is used to aid inseason and postseason management decisions.

To evaluate this concern a proportion of ≥ 60% will be applied to GKC catch from commercial logbooks:

$$catch_{le}^{\geq 0.6} = \frac{crab_{gkc}}{(total\ crab_{gkc+tc})} \qquad (3)$$

where *catch* is for a given logbook entry (*le*), *gkc* is golden king crab and *tc* is Tanner crab. Then subsequently Equations (1) and (2) will be applied to calculate CPUE.

Secondary performance indicators include biological, local ecological knowledge (LEK), and other anecdotal information that may not be captured quantitatively in this harvest strategy framework.

- Biological information will be evaluated by analyzing carapace length (CL) mm frequencies by management area and season for recruit classes of GKC sampled during commercial landings. Size of GKC is defined as the CL measurement. Recruit class is used as an indicator of shell age and is defined as recruit (new shell and a CL of 151–166mm) and postrecruit (new or old shell and a CL ≥ 167 mm). Crab infected with *Briarosaccus auratum* parasite will be excluded from length frequency analysis due to the parasite's ability to suppress crab growth and bias data.
- LEK is information from fishermen and the fishing industry about the stock and natural environment as it pertains to GKC. LEK will be evaluated and reviewed through permit holder comments in logbooks, communication with permit holders and industry representatives, and discussion at annual industry meetings (Ainsworth 2011; Beaudreau and Levin 2014). Examples of LEK include, but are not limited to, specific numbers of crab (recruits, females, and undersized), females with full clutches, prevalence of soft or light shelled crab, sand fleas, bad weather, large tides, and parasitized crab.

Reference Points

The primary indicator Target Reference Point (RP_{targ}) for each management area is set at the average logbook CPUE for the years 2000–2022 because these years capture when logbooks became required for the fishery in 2000 and represents contrasting data (highs and lows) in fishery performance. The exceptions to this include North Stephens Passage (excludes 2000) and Lower Chatham Strait (excludes 2013) due to having substantial outliers in those given years that influence the Target Reference Point. The Upper Trigger Reference Point (RP_{upper_trig}) is set at 125% of the RP_{targ} and is set at the level at which stocks are considered more resilient to increased fishing pressure. The Lower Trigger Reference Point (RP_{lower_trig}) is set between the Target and Limit Reference Point that prompts management actions and is set at 75% of the RP_{targ}. The Limit Reference Point (RP_{lim}) is set at the level at which stocks are considered in a danger zone and are no longer resilient to fishing pressure and is set at 50% of the RP_{targ}.

MONITORING STRATEGY

This section describes a monitoring strategy with associated decision rules for inseason and postseason management of GKC.

Decision Rules

The primary performance indicator for this fishery is CPUE due to being the most readily available estimate and will be used to help guide inseason and postseason management decisions.

Inseason

Fishery performance will be assessed biweekly and/or with a minimum requirement of 500 pot lifts before taking management action whichever is the least restrictive under the following guidelines:

- If logbook CPUE is ≥ RP_{targ} manage to GHL.
- If logbook CPUE is ≥ RP_{lower_trig} but < RP_{targ} manage to GHL and monitor closely.
- If logbook CPUE is < RP_{lower_trig} close management area early.

GHLs will not be changed inseason and are only subject to change per postseason decision rules.

Postseason

- *Increase in a GHL*
    - **If the most recent logbook CPUE is > than the previous season the GHL will remain the same or be increased under the following conditions:**
        - If the most recent logbook CPUE is > than the RP_{upper_trig} the GHL may increase up to a maximum of 35% the following season.
        - If the most recent logbook CPUE is > than the most recent previous season and is ≤ RP_{upper_trig} and > RP_{targ} the GHL may increase up to a maximum of 20% the following season.

- If the most recent logbook CPUE is $>$ than the most recent previous season and $\leq$ RP$_{targ}$ and $>$ RP$_{lower\_trig}$ the GHL may increase up to a maximum of 10% the following season.
- If the most recent logbook CPUE is $>$ than the most recent previous season and is $\leq$ RP$_{lower\_trig}$ and $>$ RP$_{limit}$ the GHL may increase up to a maximum of 5% the following season.
- New GHLs may not exceed respective management area GHRs.

- *Decrease in a GHL*
  - **If the fishery closed short of a GHL inseason due to poor fishery performance or the most recent CPUE is $<$ than the previous season the GHL may be decreased under the following conditions:**
    - If CPUE is $<$ than the most recent previous season and is $>$ RP$_{lower\_trig}$ and $\leq$ RP$_{targ}$ the GHL may be decreased up to a maximum of 40% the following season.
    - If CPUE is $<$ than the most recent previous season and is $>$ RP$_{lim}$ and $\leq$ RP$_{lower\_trig}$ the GHL may be decreased up to a maximum of 60% the following season.

- *Closure and Re-opening*
  - If logbook CPUE is $<$ the RP$_{lim}$ further management action may be required by implementing an area closure of a minimum of 1 year to reduce the risk of localized depletion.
  - Upon re-opening an area after a closure, the GHL will be 5-10% of the maximum area respective GHR (e.g., 10% of the East Central maximum GHR is 22,500 lbs).

- *No Change*
  - If CPUE is $<$ than the most recent previous season and is $\geq$ RP$_{upper\_trig}$ the GHL may remain unchanged.
  - If CPUE is $<$ than the most recent previous season and is $\geq$ RP$_{targ}$ and $<$ RP$_{upper\_trig}$ the GHL may remain unchanged.
  - If a minimum requirement of 500 pot lifts has not occurred within a given fishery management area and the GHL has not been harvested within the current season, the GHL will not change the following season due to limited information to make an informed management decision.

Review of GHLs or Decision Rules

When new information suggests that the harvest strategy framework and GHL setting decision rules are not consistent with the Board's policy of managing a sustainable GKC resource, the decision rules will be reviewed and the reference points will be adjusted accordingly.

Other Considerations for Management and Future Recommendations

Logbook CPUE currently lacks a soak time data field and cannot be standardized for comparison across years. Soak time was introduced as a reporting field in logbooks for the 2020 fishing season and will be used to inform this harvest strategy in future iterations.

This harvest strategy may be amended in future iterations as more information and tools become available.

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MANAGEMENT AREA REPORTS

Each management area report will provide an overview of seasonal trends in fishery performance through the most recent season. This includes comparing harvest (lbs) to corresponding GHLs, comparing logbook CPUE to reference points (i.e., upper trigger, target, lower trigger, and limit), and reviewing Tanner crab harvest influence and spatial distribution of incidental catch during the annual Tanner crab stock assessment survey in Holkham Bay. **Data provided in this report is through April 26th, 2023.**

NORTHERN

Season Overview

The Northern management area was closed from 2019–2020 and reopened in 2021. In 2021, poor fishery performance and stock health concerns continued resulting in a closure for the 2022 season. For the 2023 season the Northern management area opened at a GHL of 10,150 lbs.
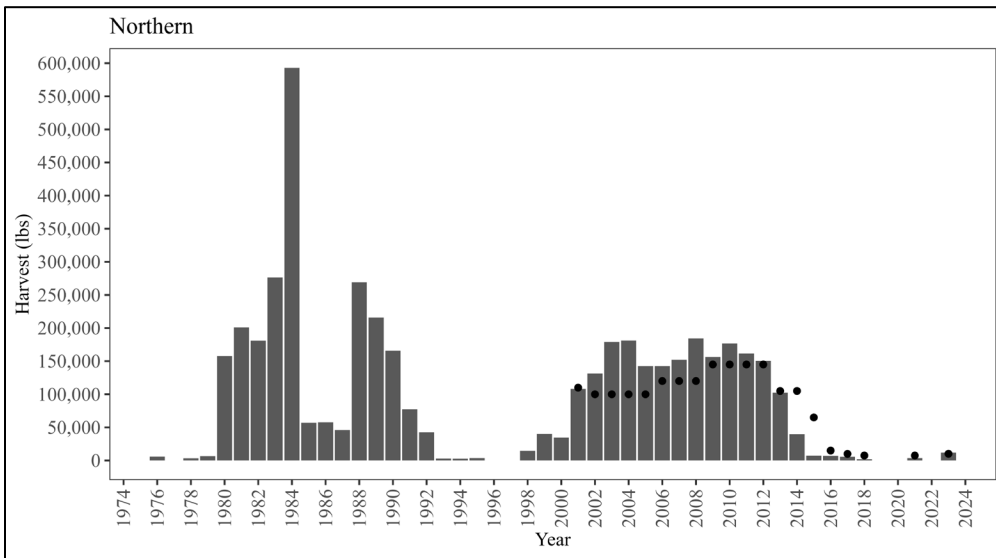
Figure 2.–Commercial GKC fishery harvest from the Northern management area. Dots represents the GHL in a given season (2001–Present).

Reference Points

Table 2.–Golden king crab logbook catch per unit of effort (CPUE) reference points.

Indicators	Reference Point	Description
Upper Trigger Reference Point	3.1 crab/pot	125% of the Target Reference Point
Target Reference Point	2.5 crab/pot	Average Commercial Logbook CPUE from 2000–2022
Lower Trigger Reference Point	1.8 crab/pot	75% of the Target Reference Point
Limit Reference Point	1.2 crab/pot	50% of the Target Reference Point
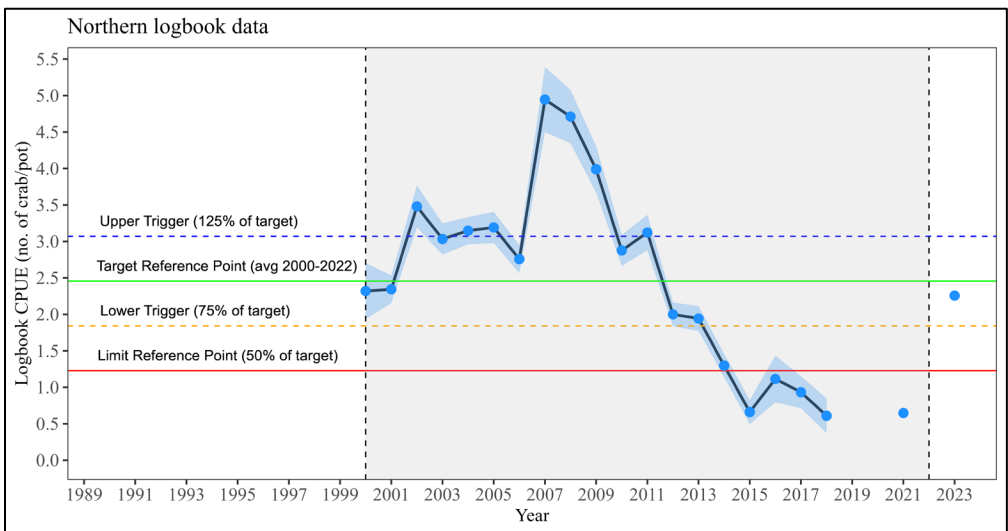
Figure 3.–Northern golden king crab reference points (Upper Trigger, Target, Lower Trigger, and Limit) and fishery performance utilizing logbook CPUE per industry request.
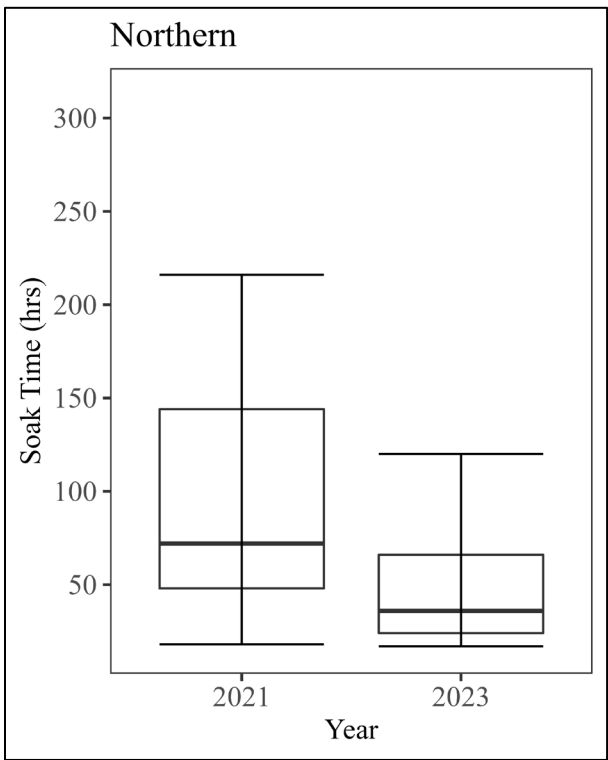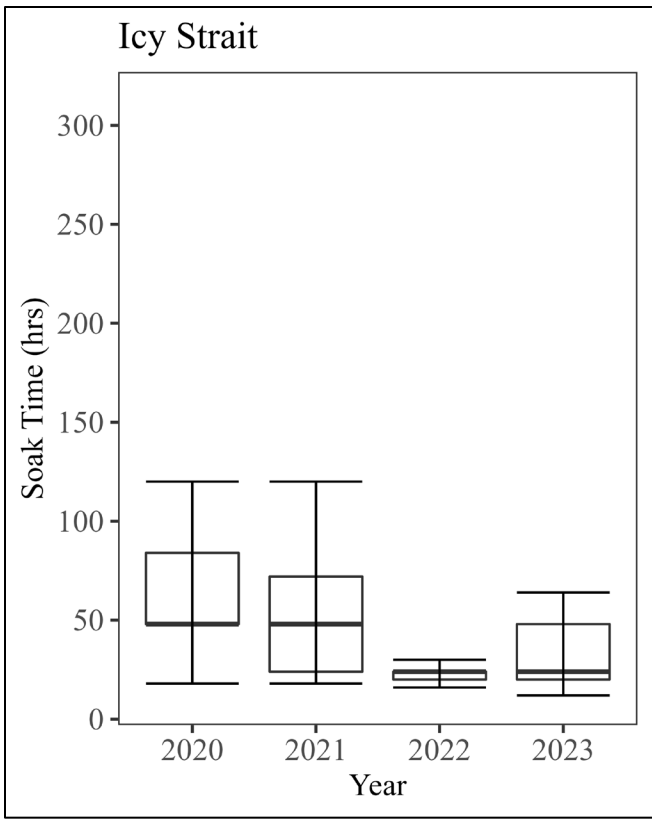

Figure 4.–Northern golden king crab soak time (hrs) utilizing fishery logbooks.
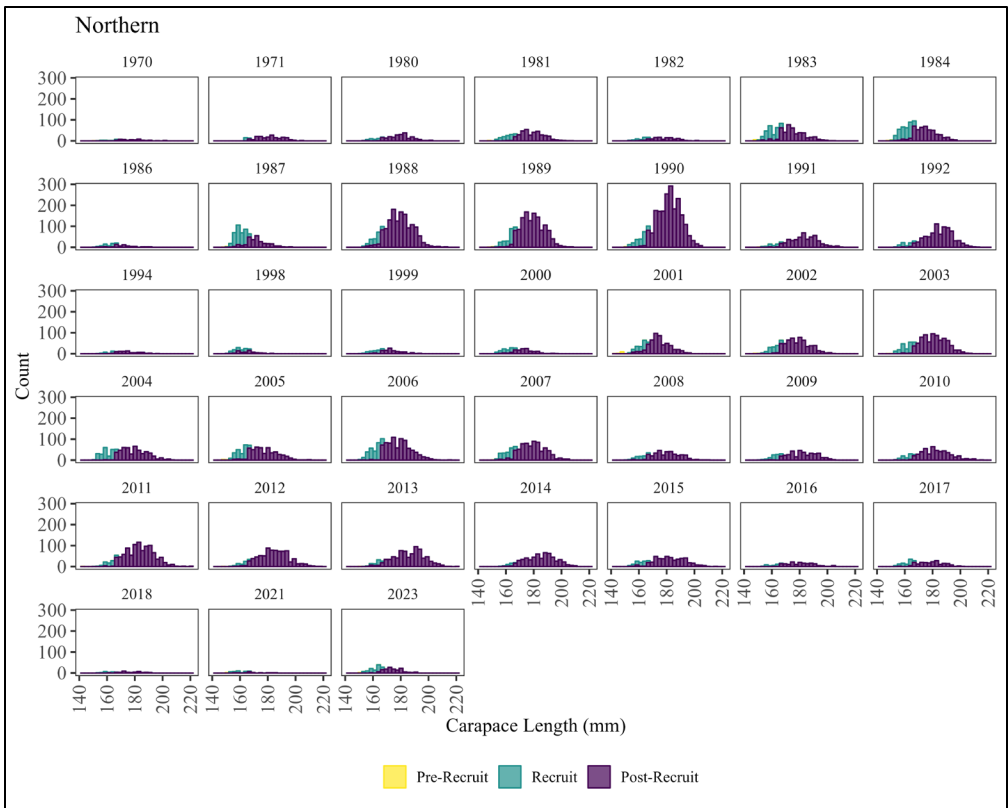
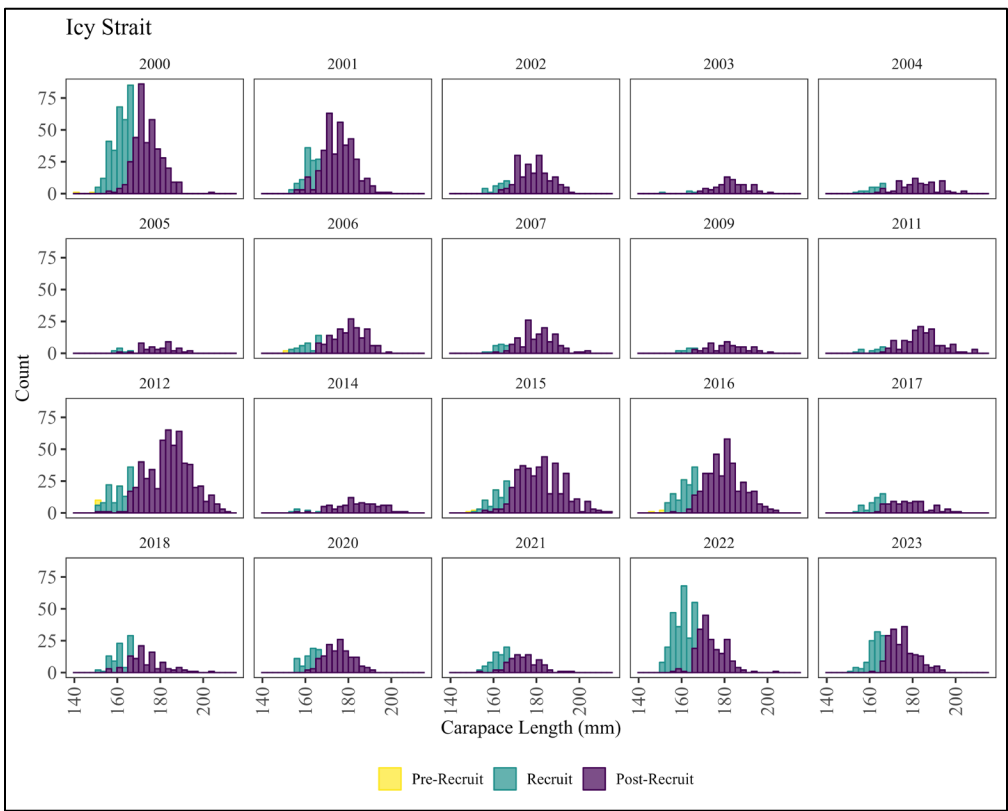Figure 5.–Northern golden king crab length frequencies of sampled commercial catch by recruit class from 1970-Present.

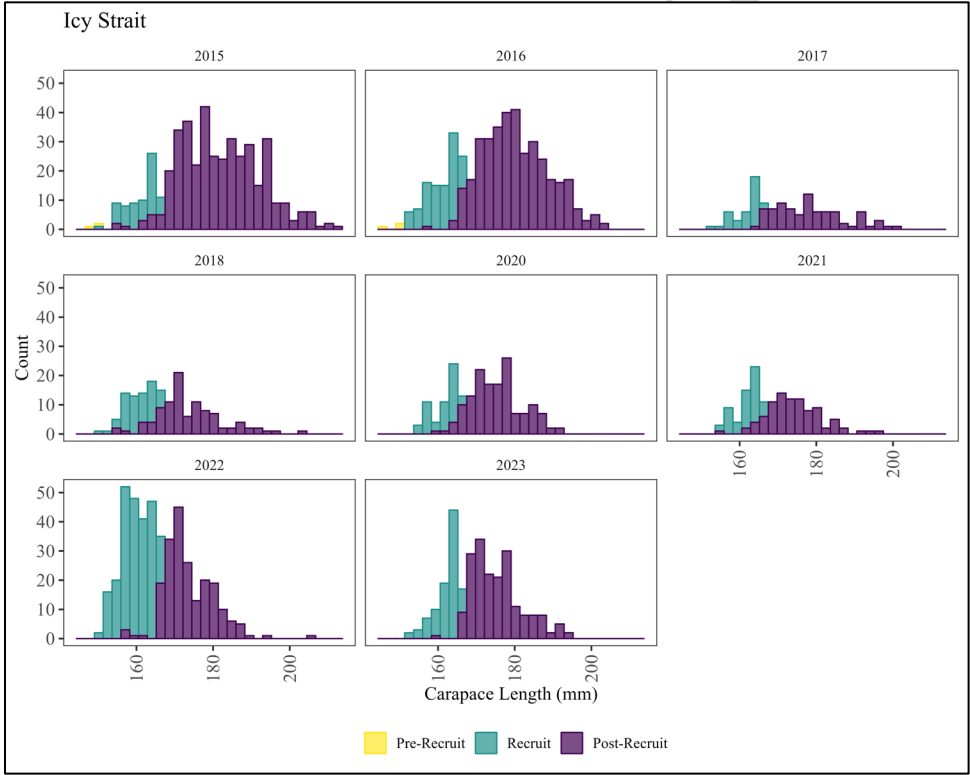Figure 6.–Northern golden king crab length frequencies of sampled commercial catch by recruit class from 2000-Present.

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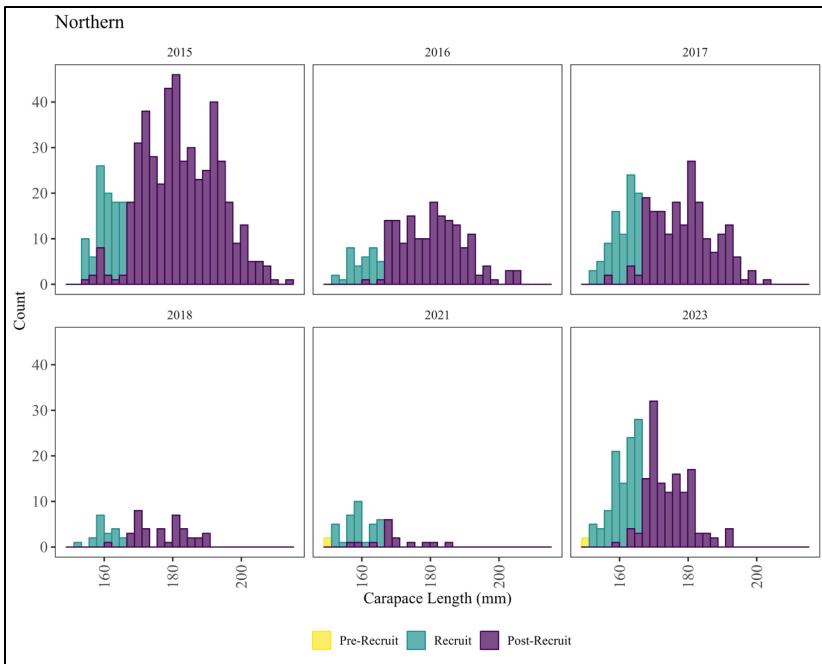
Figure 7. ―Northern golden king crab length frequencies of sampled commercial catch by recruit class from 2015-Present.

Icy Strait

Season Overview

The Icy Strait management area's GHL was 7,500 lbs for the 2019-2021 seasons and 8,250 lbs for the 2022 season. For the 2023 season the Icy Strait management area opened at a GHL of 11,138 lbs.
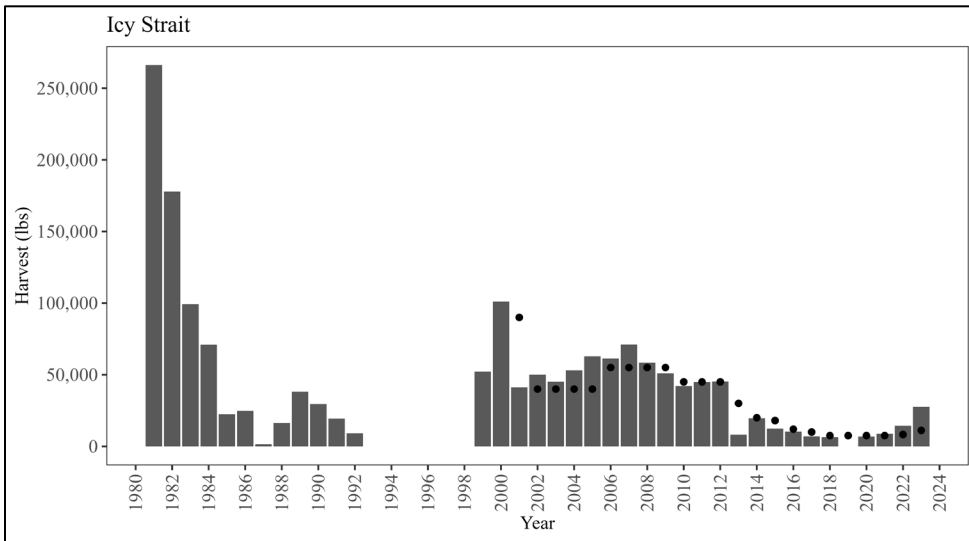
Figure 8.–Commercial GKC fishery harvest from the Icy Strait management area. Dots represents the GHL in a given season (2001–Present).

Reference Points

Table 3.–Golden king crab logbook catch per unit of effort (CPUE) reference points.

Indicators	Reference Point	Description
Upper Trigger Reference Point	2.6 crab/pot	125% of the Target Reference Point
Target Reference Point	2.1 crab/pot	Average Commercial Logbook CPUE from 2000–2022
Lower Trigger Reference Point	1.6 crab/pot	75% of the Target Reference Point
Limit Reference Point	1.0 crab/pot	50% of the Target Reference Point
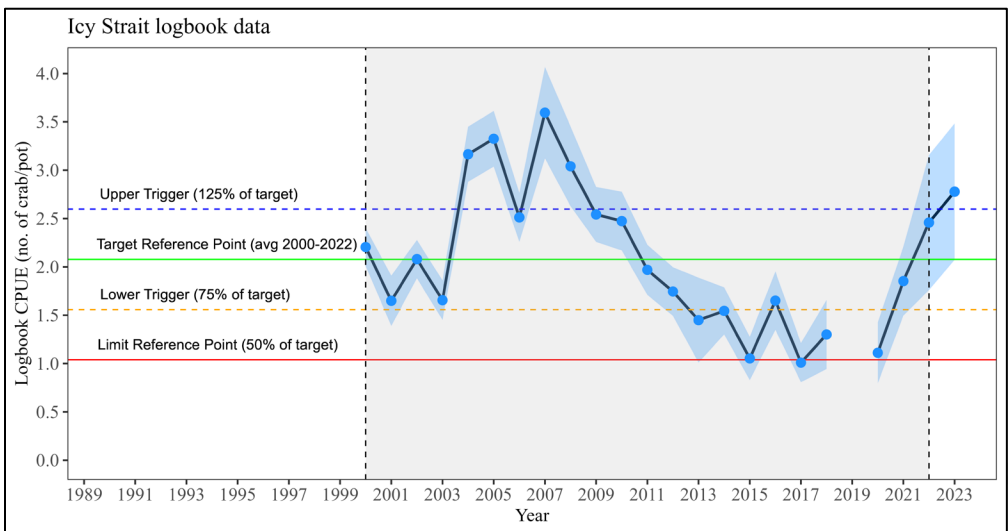
Figure 9.–Icy Strait golden king crab reference points (Upper Trigger, Target, Lower Trigger, and Limit) and fishery performance utilizing logbook CPUE.
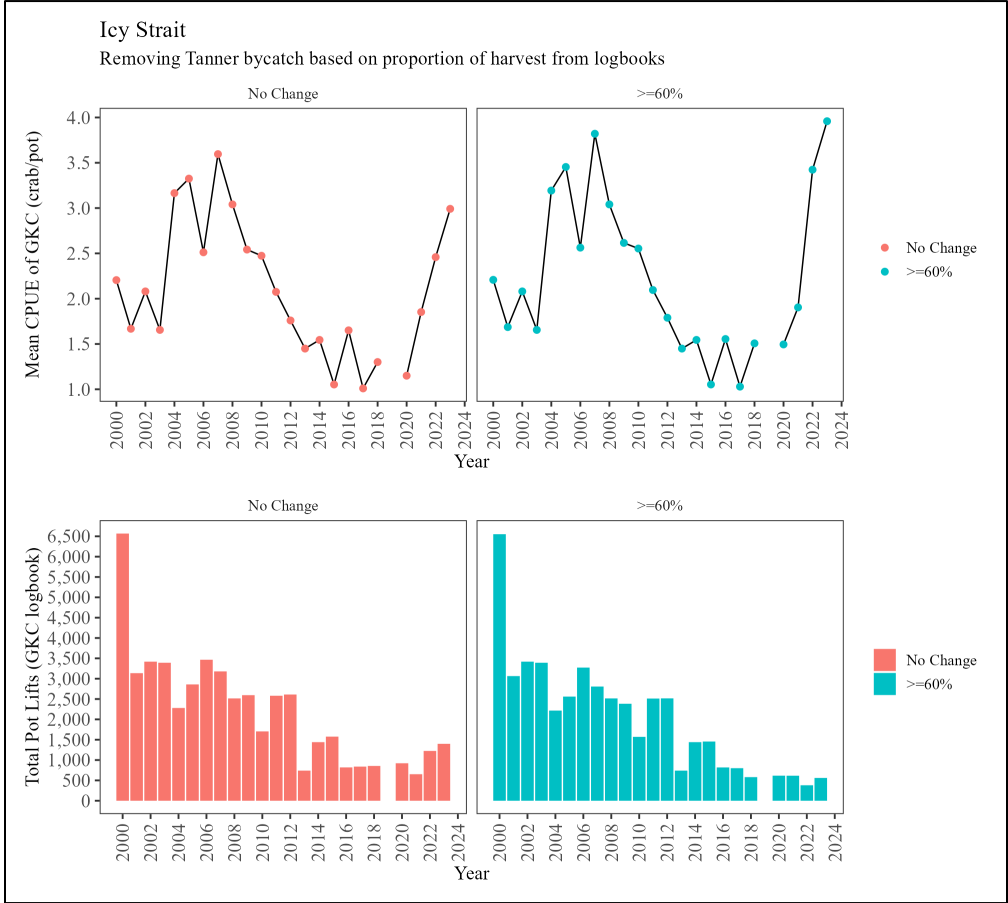
Figure 10.–Icy Strait golden king crab logbook CPUE and pot lift proportions based on reduction of Tanner crab harvest influence.

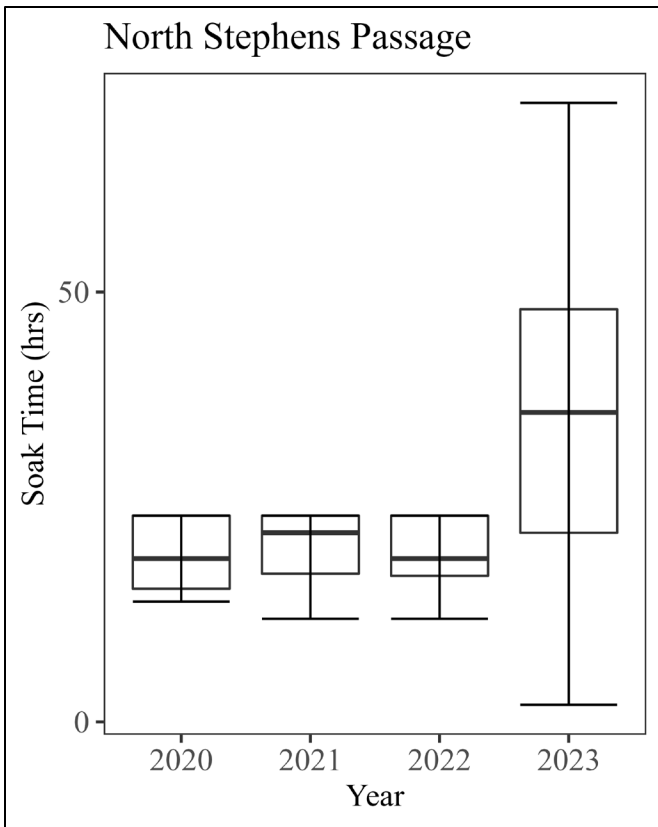Figure 11.–Icy Strait golden king crab soak time (hrs) utilizing fishery logbooks.
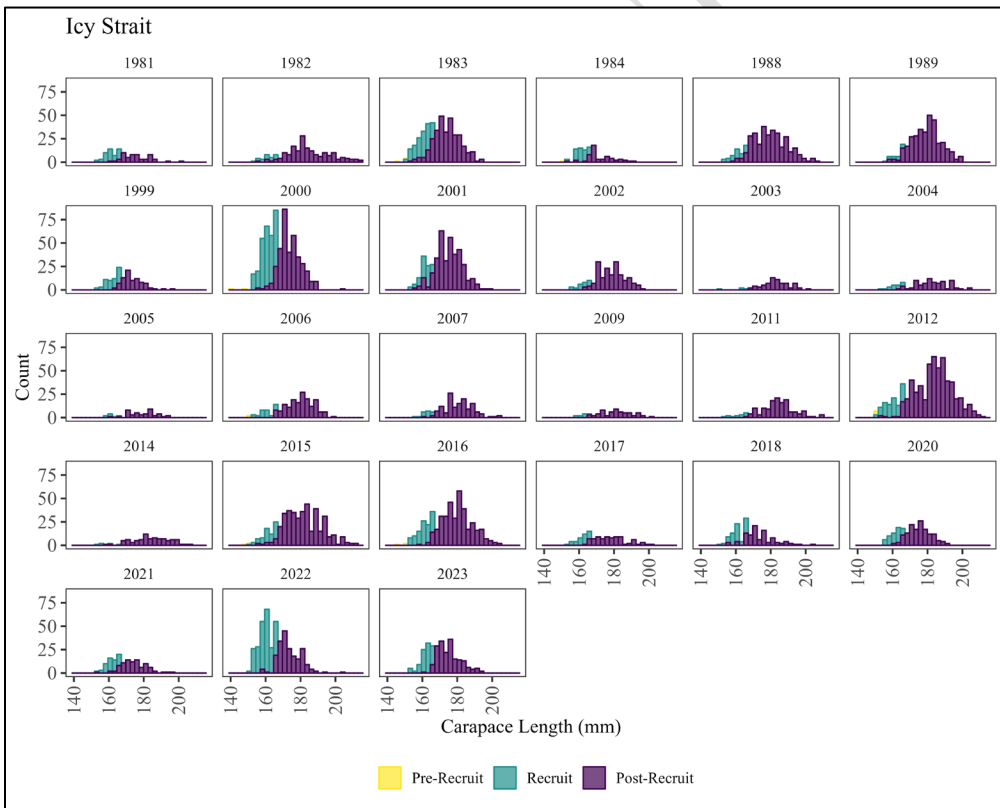
Figure 12.–Icy Strait golden king crab length frequencies of sampled commercial catch by recruit class from 1981-Present.

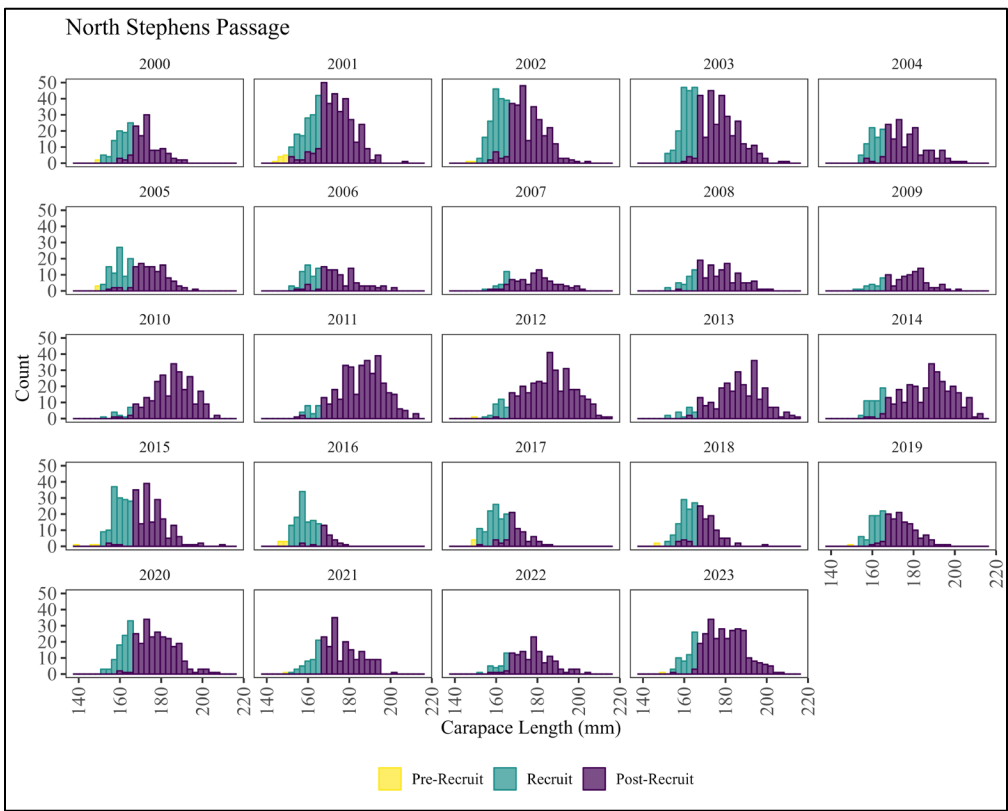Figure 13.–Icy Strait golden king crab length frequencies of sampled commercial catch by recruit class from 2000-Present.

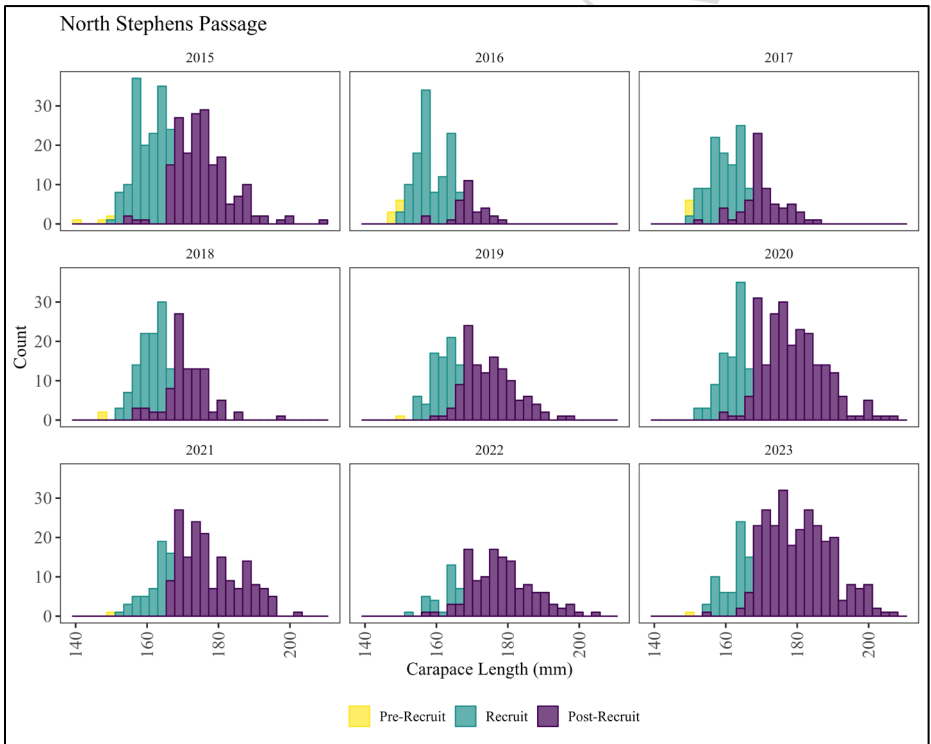Figure 14.–Icy Strait golden king crab length frequencies of sampled commercial catch by recruit class from 2015-Present.

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NORTH STEPHENS PASSAGE

Season Overview

The North Stephen's Passage management area's GHL was 11,000 lbs, 13,000 lbs, 15,000 lbs, 18,000 for the 2019, 2020, 2021, and 2022 seasons respectively. For the 2023 season the North Stephen's Passage management area opened at a GHL of 18,000 lbs.
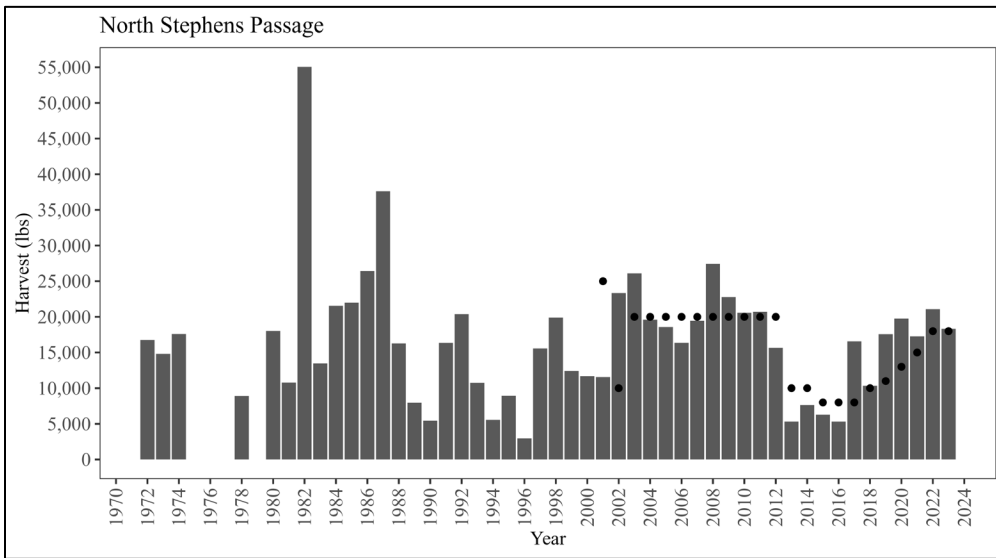
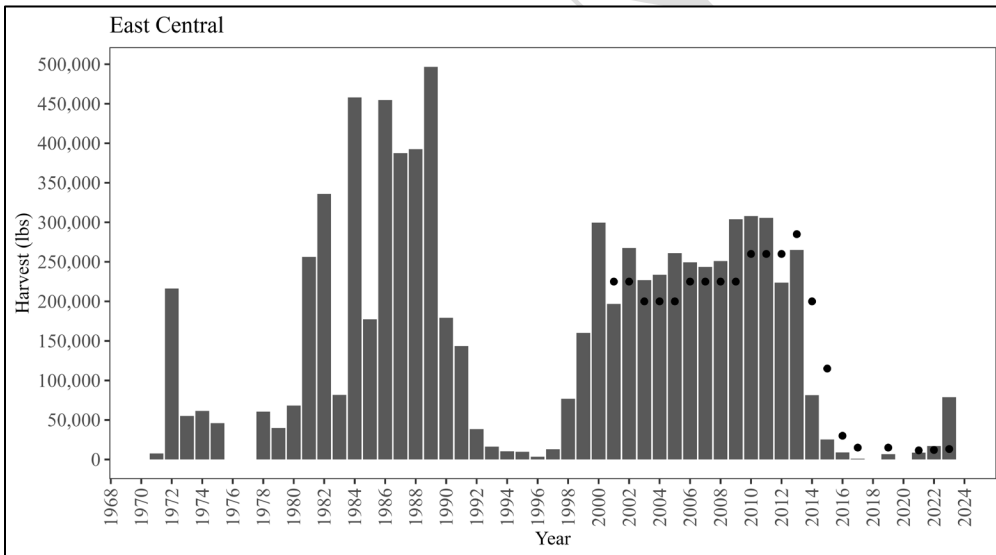Figure 15.–Commercial GKC fishery harvest from the North Stephens Passage management area. Dots represents the GHL in a given season (2001–Present).

Reference Points

Table 4.– Golden king crab logbook catch per unit of effort (CPUE) reference points.

Indicators	Reference Point	Description
Upper Trigger Reference Point	2.1 crab/pot	125% of the Target Reference Point
Target Reference Point	1.6 crab/pot	Average Commercial Logbook CPUE from 2001–2022 (excluding 2000)
Lower Trigger Reference Point	1.2 crab/pot	75% of the Target Reference Point
Limit Reference Point	0.8 crab/pot	50% of the Target Reference Point
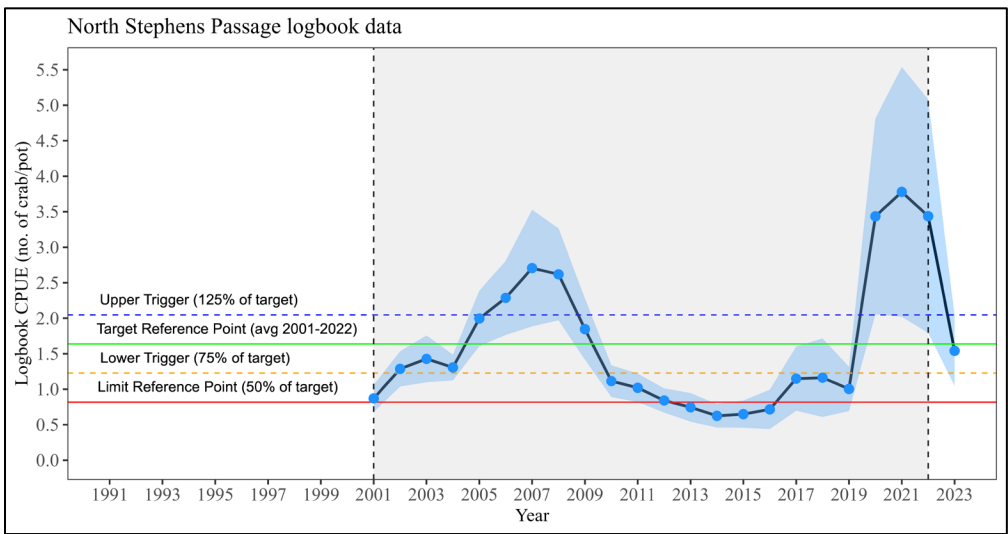
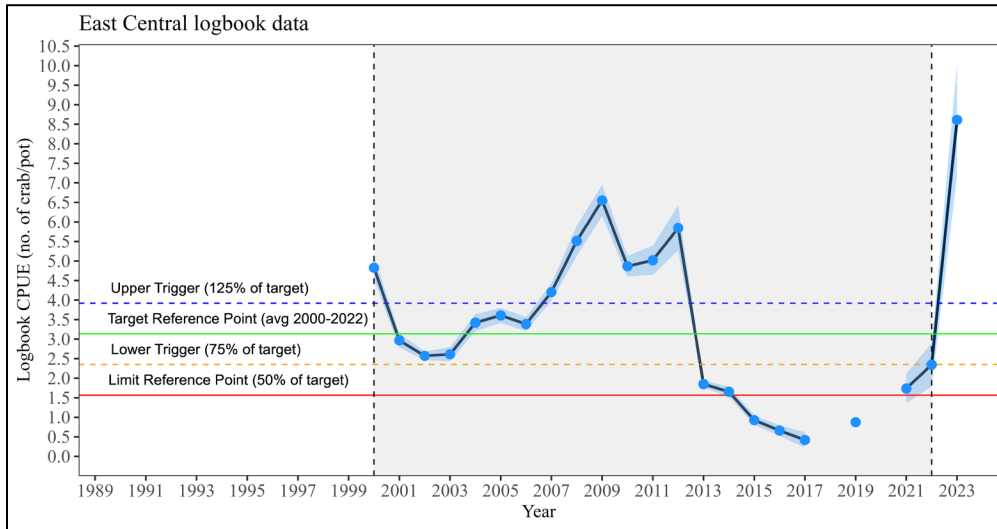Figure 16.–North Stephens Passage golden king crab reference points (Upper Trigger, Target, Lower Trigger, and Limit) and fishery performance utilizing logbook CPUE (excludes 2000 outlier).
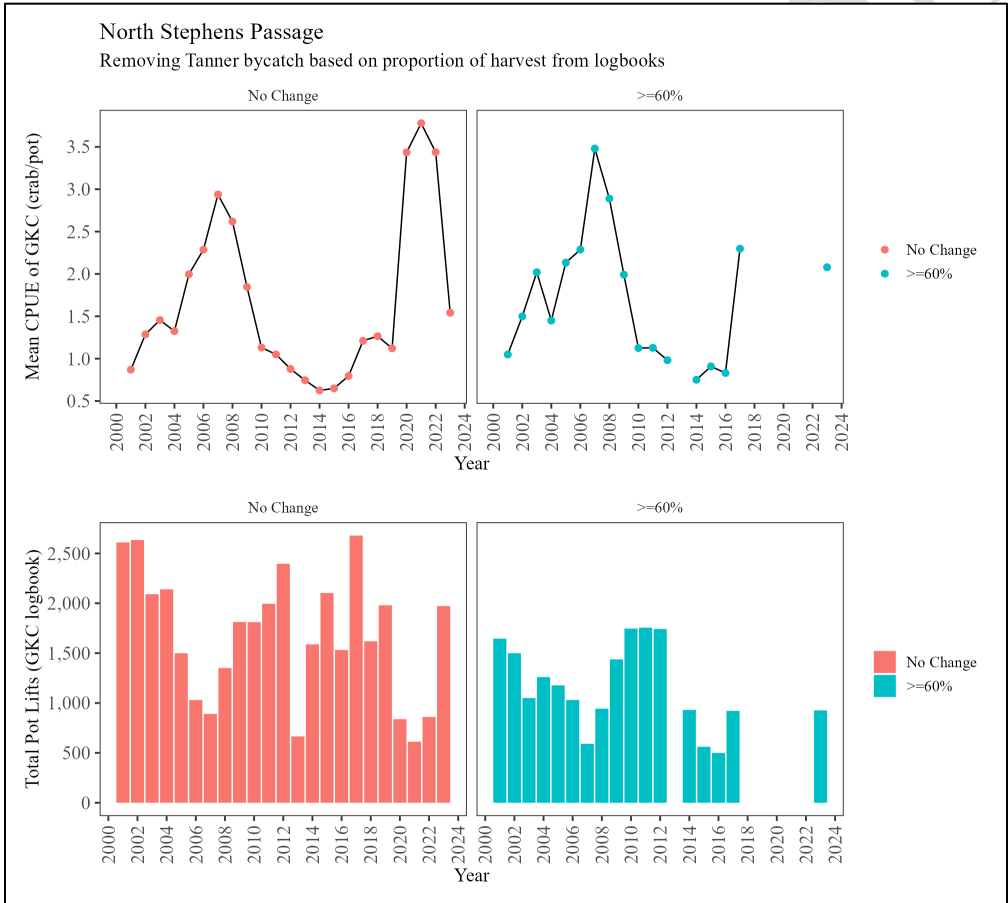
Figure 17.–North Stephens Passage golden king crab logbook CPUE and pot lift proportions based on reduction of Tanner crab harvest influence.

Figure 18.–North Stephens Passage golden king crab soak time (hrs) utilizing fishery logbooks.
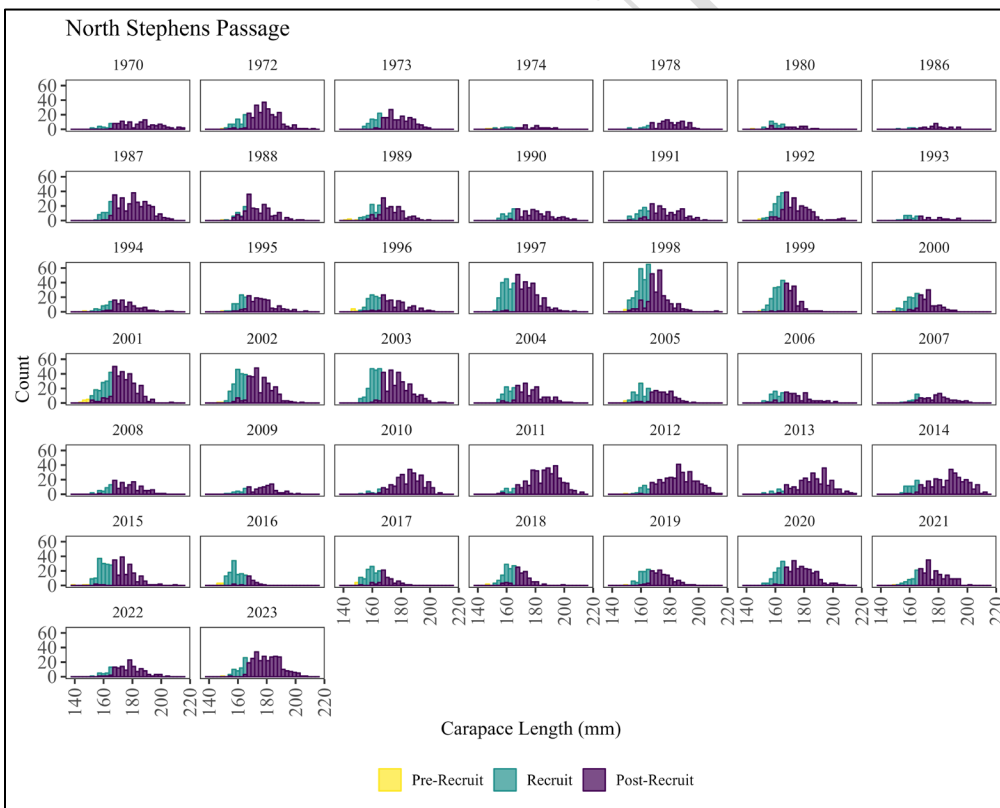
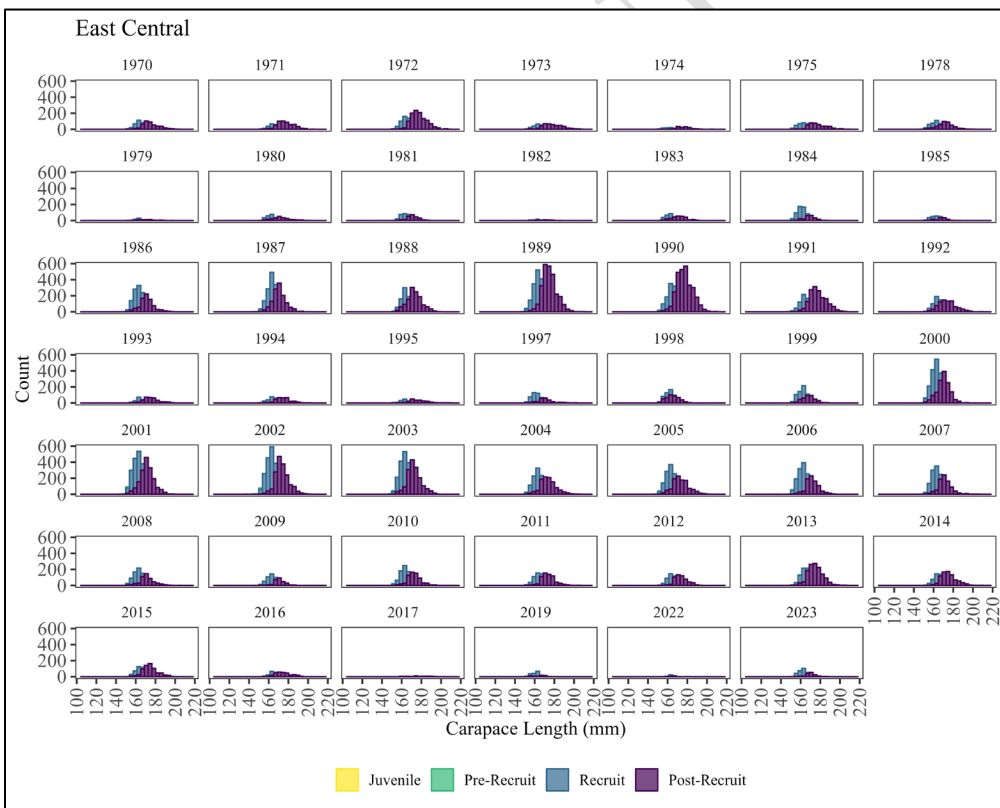Figure 19.–North Stephens Passage golden king crab length frequencies of sampled commercial catch by recruit class from 1970-Present.

Figure 20.—North Stephens Passage golden king crab length frequencies of sampled commercial catch by recruit class from 2000-Present.

Figure 21.—North Stephens Passage golden king crab length frequencies of sampled commercial catch by recruit class from 2015-Present.

Information from Annual Tanner Crab Stock Assessment Survey

The Department conducts an annual stock assessment survey in Holkham Bay where GKC have been caught incidentally. Data presented here includes spatial distribution and quantity of catch and by sex and recruit status.
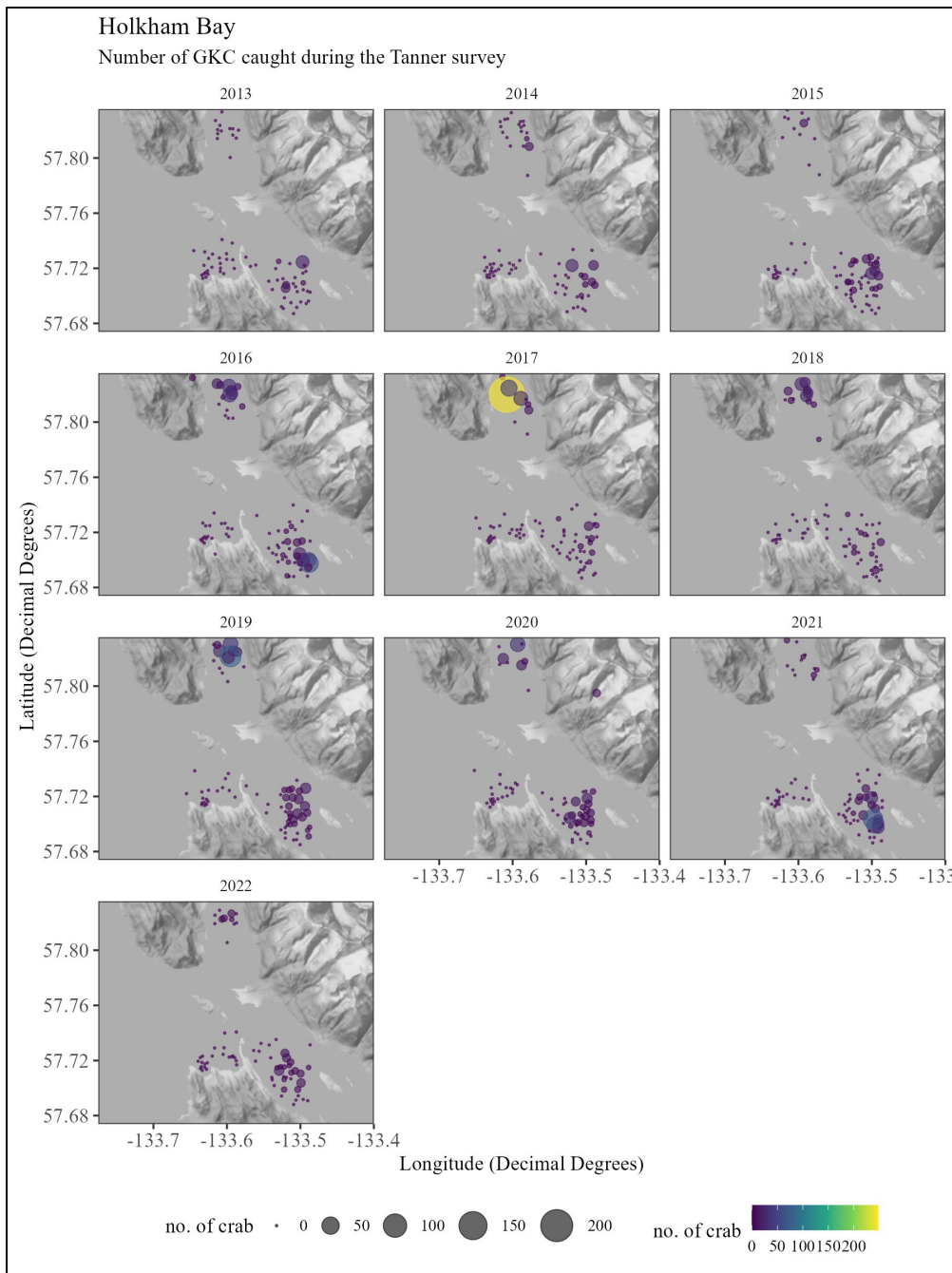
Figure 22.–Number of golden king crab caught during the annual Tanner crab stock assessment survey in Holkham Bay (2013–2023).
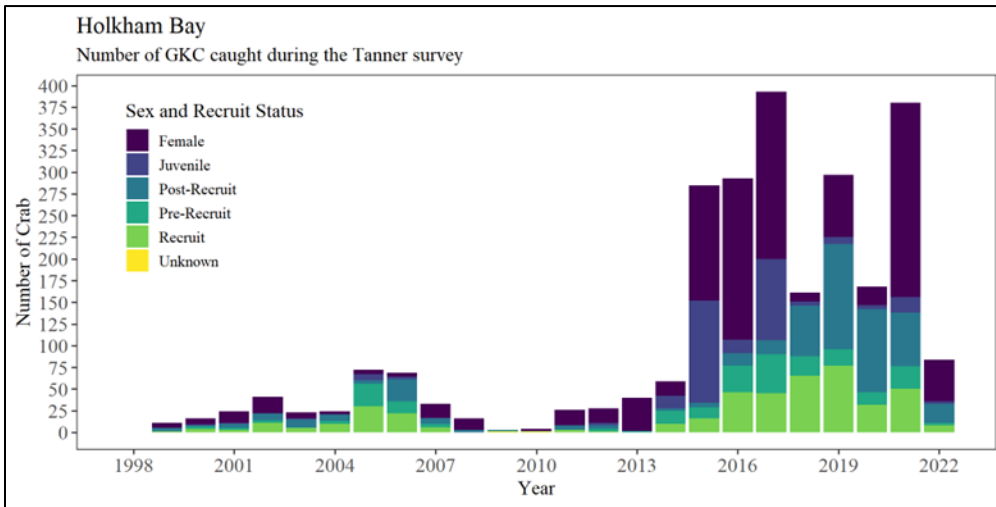
Figure 23.–Number of golden king crab caught during the annual Tanner crab stock assessment survey in Holkham Bay by sex and recruit status (1999–2022).

EAST CENTRAL

Season Overview

The East Central management area was closed for the 2020 season and re-opened for the 2021 season at a GHL of 11,500 lbs. The fishery closed early due to poor fishery performance and stock health concerns. For the 2022 season, the East Central management area opened at a GHL of 12,050 lbs and for the 2023 season opened at a GHL of 13,255 lbs.
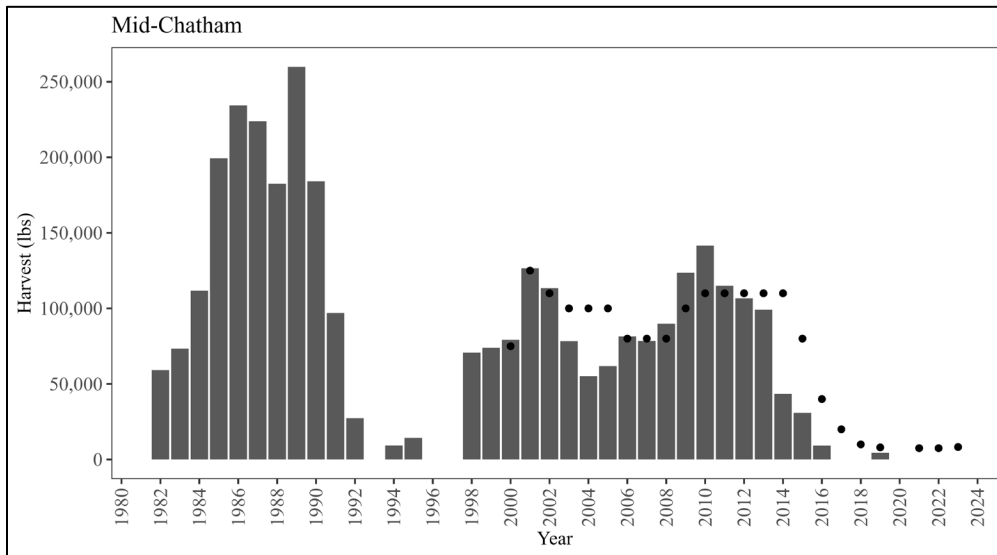

Figure 24.–Commercial GKC fishery harvest from the East Central management area. Dots represents the GHL in a given season (2001–Present).

Reference Points

Table 5.– Golden king crab logbook catch per unit of effort (CPUE) reference points.

Indicators	Reference Point	Description
Upper Trigger Reference Point	3.9 crab/pot	125% of the Target Reference Point
Target Reference Point	3.1 crab/pot	Average Commercial Logbook CPUE from 2000–2022
Lower Trigger Reference Point	2.4 crab/pot	75% of the Target Reference Point
Limit Reference Point	1.6 crab/pot	50% of the Target Reference Point

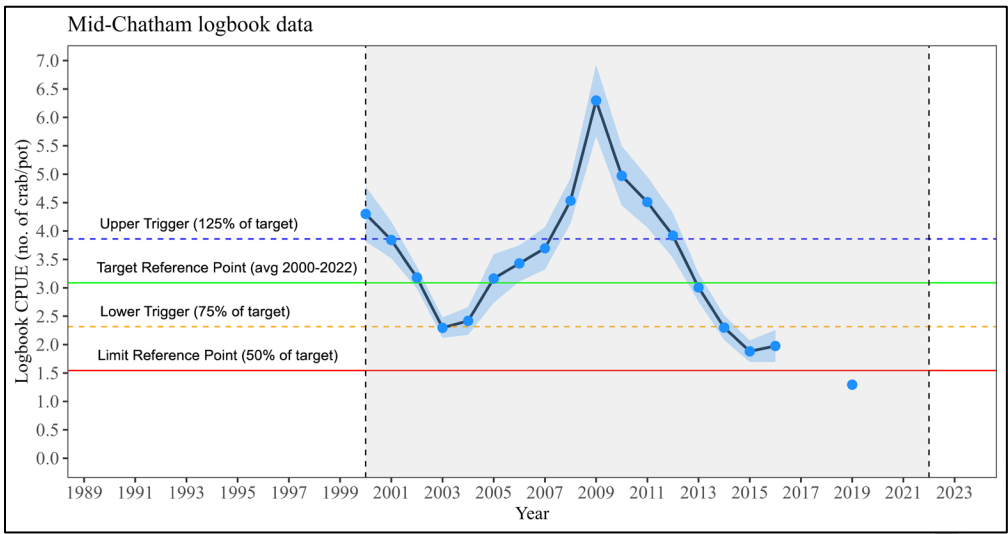

Figure 25.–East Central golden king crab reference points (Upper Trigger, Target, Lower Trigger, and Limit) and fishery performance utilizing logbook CPUE.
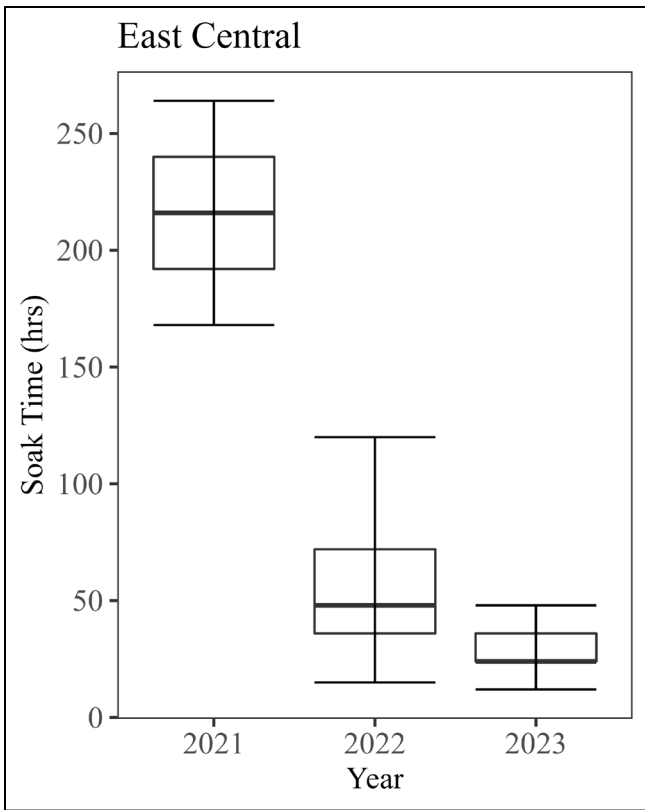
Figure 26.–East Central golden king crab soak time (hrs) utilizing fishery logbooks.

Figure 27.–East Central golden king crab length frequencies of sampled commercial catch by recruit class from 1970-Present.
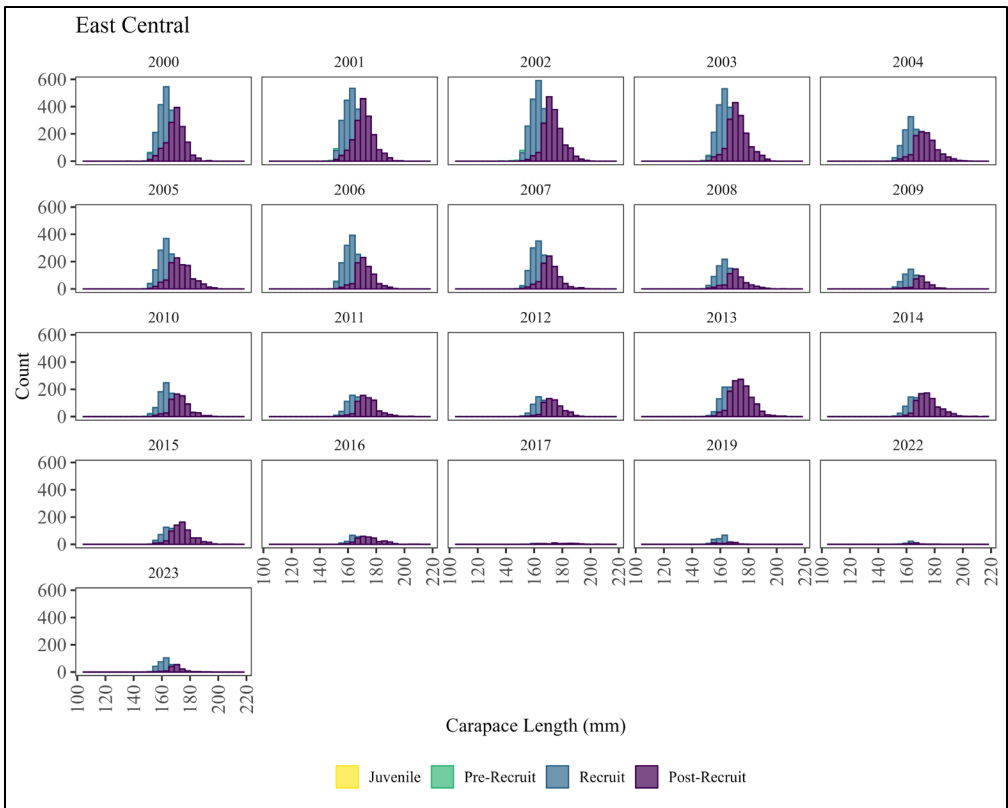
Figure 28.–East Central golden king crab length frequencies of sampled commercial catch by recruit class from 2000-Present.
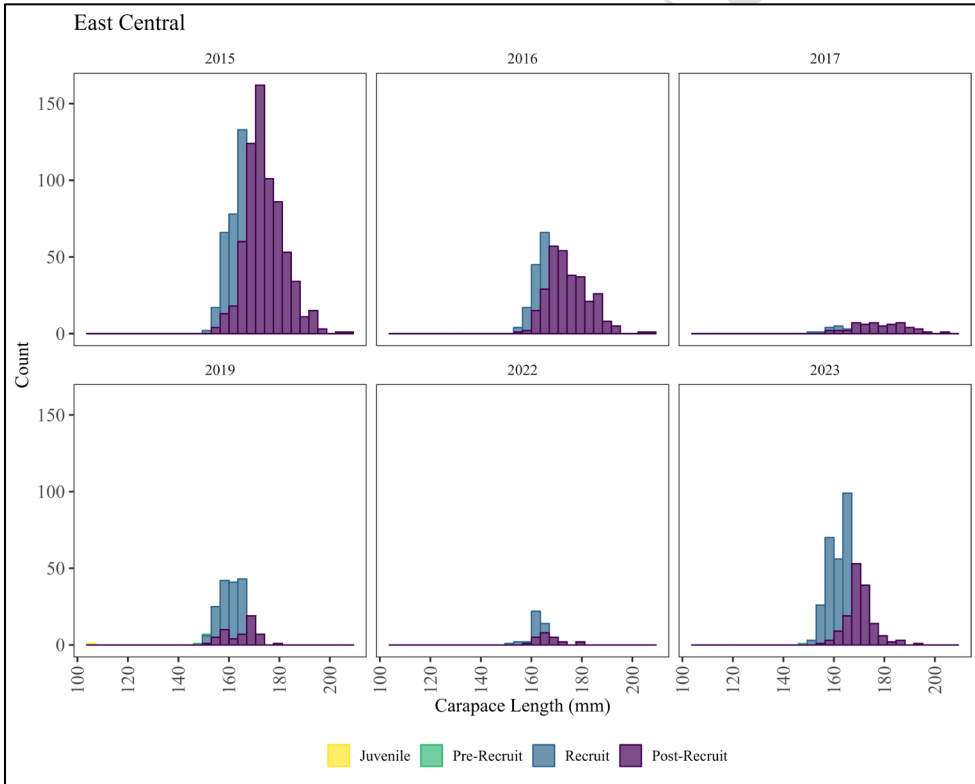
Figure 29. –East Central golden king crab length frequencies of sampled commercial catch by recruit class from 2015-Present.

MID-CHATHAM STRAIT

Season Overview

The Mid-Chatham Strait management area was closed for the 2020 season and re-opened for the 2021 season at a GHL of 7,500 lbs. For the 2022 season the Mid-Chatham Strait management area opened at a GHL of 7,500 lbs and for the 2023 season at a GHL of 8,250 lbs.

Figure 30.–Commercial GKC fishery harvest from the Mid-Chatham Strait management area. Dots represents the GHL in a given season (2000–Present).

Reference Points

Table 6.– Golden king crab logbook catch per unit of effort (CPUE) reference points.

Indicators	Reference Point	Description
Upper Trigger Reference Point	3.9 crab/pot	125% of the Target Refence Point
Target Reference Point	3.1 crab/pot	Average Commercial Logbook CPUE from 2000–2022
Lower Trigger Reference Point	2.3 crab/pot	75% of the Target Reference Point
Limit Reference Point	1.5 crab/pot	50% of the Target Reference Point

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Figure 31.–Mid-Chatham Strait golden king crab reference points (Upper Trigger, Target, Lower Trigger, and Limit) and fishery performance utilizing logbook CPUE.
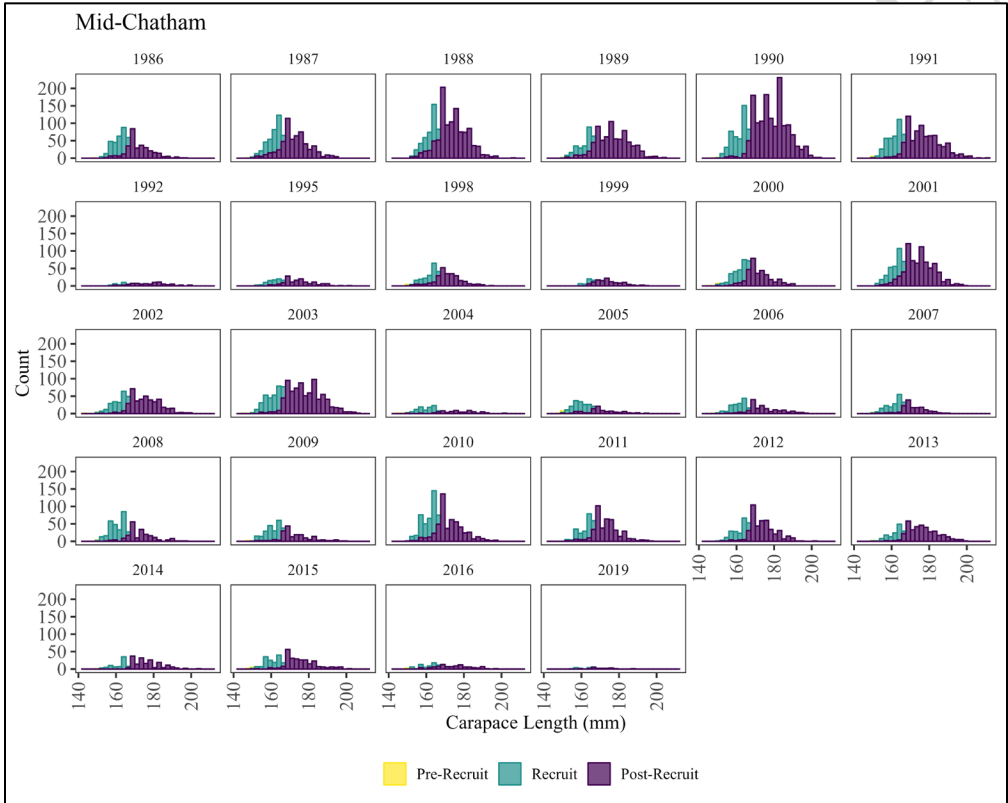
Figure 32.–Mid-Chatham Strait golden king crab length frequencies of sampled commercial catch by recruit class from 1986-Present.
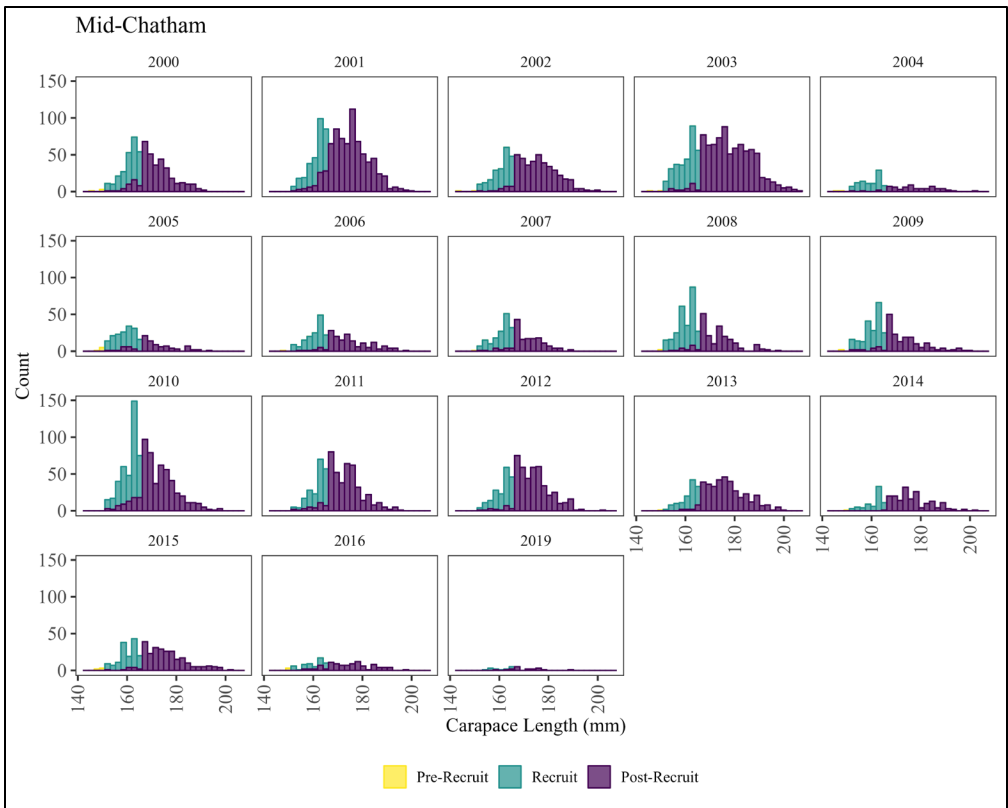
Figure 33.–Mid-Chatham Strait golden king crab length frequencies of sampled commercial catch by recruit class from 2000-Present.
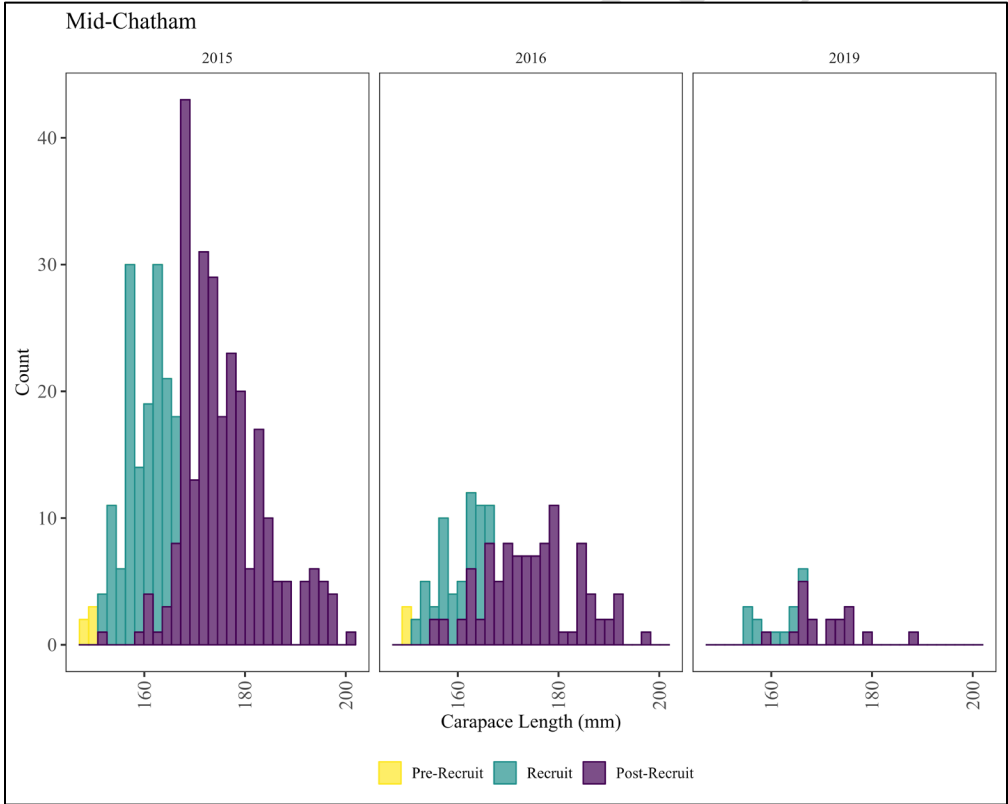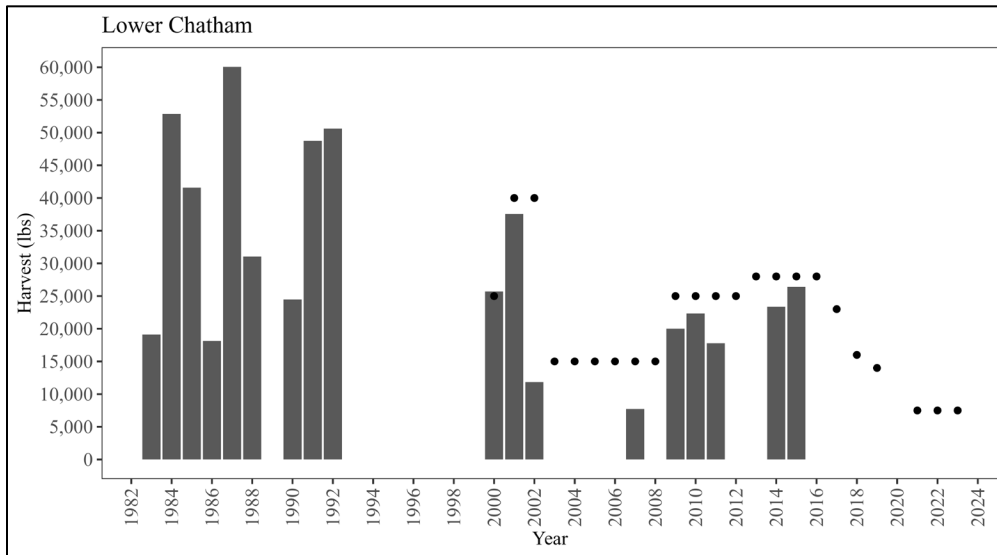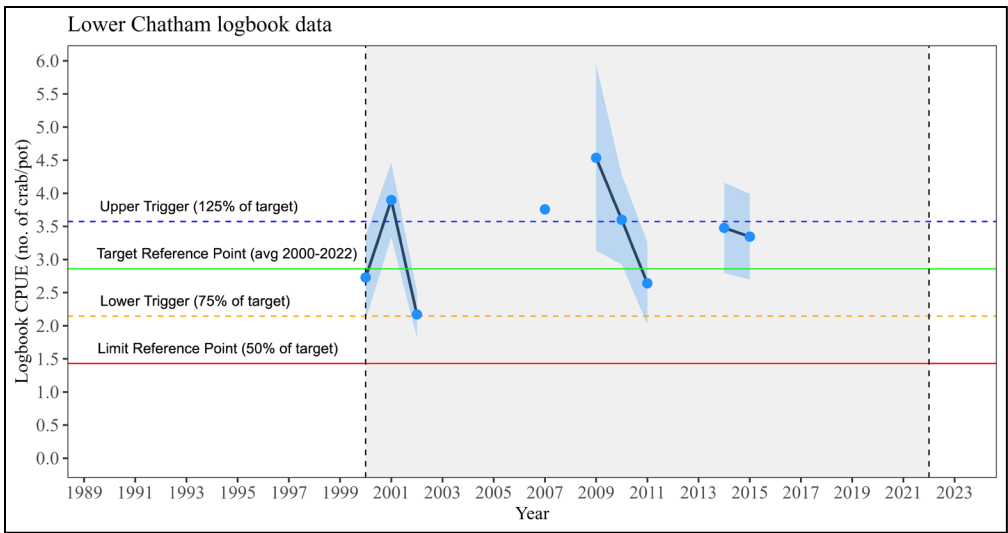

Figure 34.–Mid-Chatham Strait golden king crab length frequencies of sampled commercial catch by recruit class from 2015-Present.

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LOWER CHATHAM STRAIT

Season Overview

The Lower Chatham Strait management area was closed for the 2020 season and re-opened at a GHL for the 2021 season at a GHL of 7,500 lbs for the 2021, 2022, and 2023 seasons.

Figure 35.–Commercial GKC fishery harvest from the Lower Chatham Strait management area. Dots represents the GHL in a given season (2000–Present).

Reference Points

Table 7.– Golden king crab logbook catch per unit of effort (CPUE) reference points.

Indicators	Reference Point	Description
Upper Trigger Reference Point	3.6 crab/pot	125% of the Target Reference Point
Target Reference Point	2.9 crab/pot	Average Commercial Logbook CPUE from 2000–2022 (excluding 2013)
Lower Trigger Reference Point	2.1 crab/pot	75% of the Target Reference Point
Limit Reference Point	1.4 crab/pot	50% of the Target Reference Point

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Figure 36.–Lower Chatham Strait golden king crab reference points (Upper Trigger, Target, Lower Trigger, and Limit) and fishery performance utilizing logbook CPUE (excludes 2013 outlier).
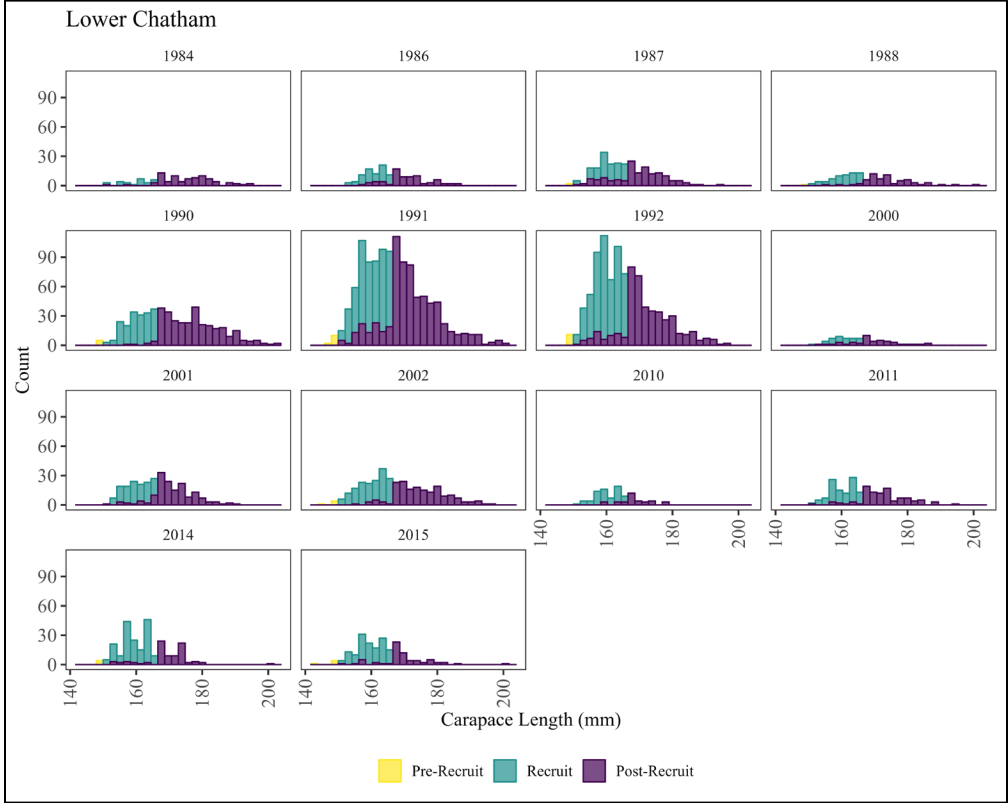

Figure 37.–Lower Chatham Strait golden king crab length frequencies of sampled commercial catch by recruit class from 1984-Present.
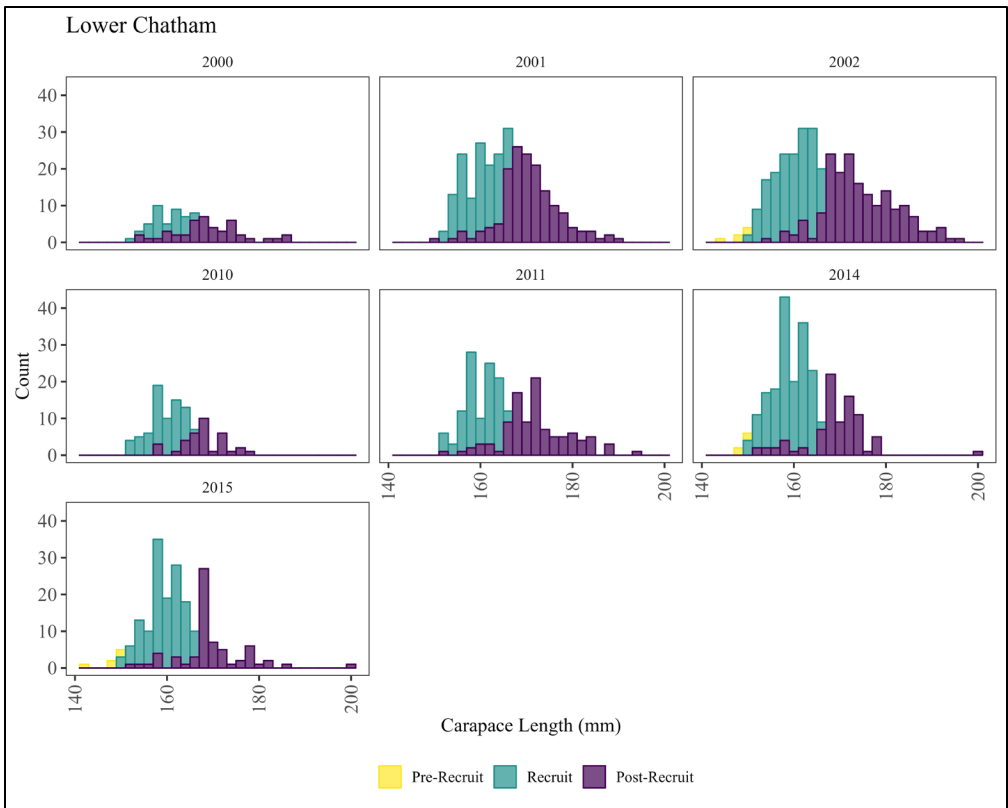
Figure 38.–Lower Chatham Strait golden king crab length frequencies of sampled commercial catch by recruit class from 2000–Present.
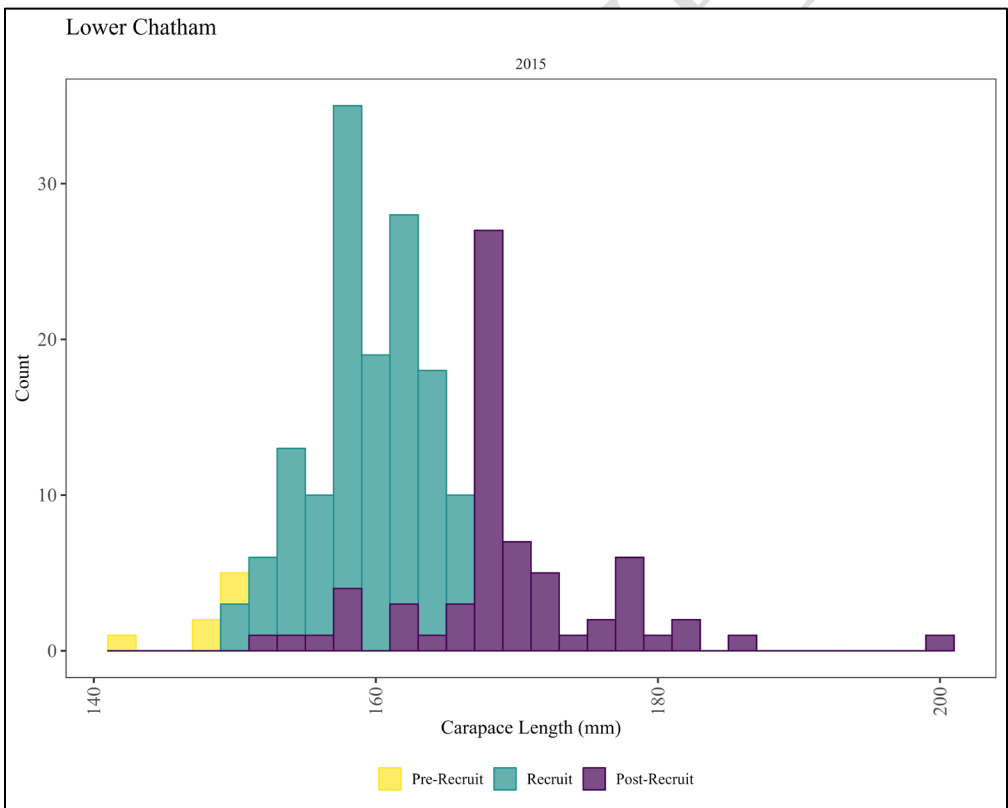

Figure 39.–Lower Chatham Strait golden king crab length frequencies of sampled commercial catch by recruit class from 2015-Present.

SOUTHERN

Season Overview

The Southern management area's GHL was 20,500 lbs, 21,000 lbs, and 20,000 lbs respectively for the 2019, 2020, and 2021 seasons. For the 2022 and 2023 seasons the Southern management area opened at a GHL of 22,000 lbs.
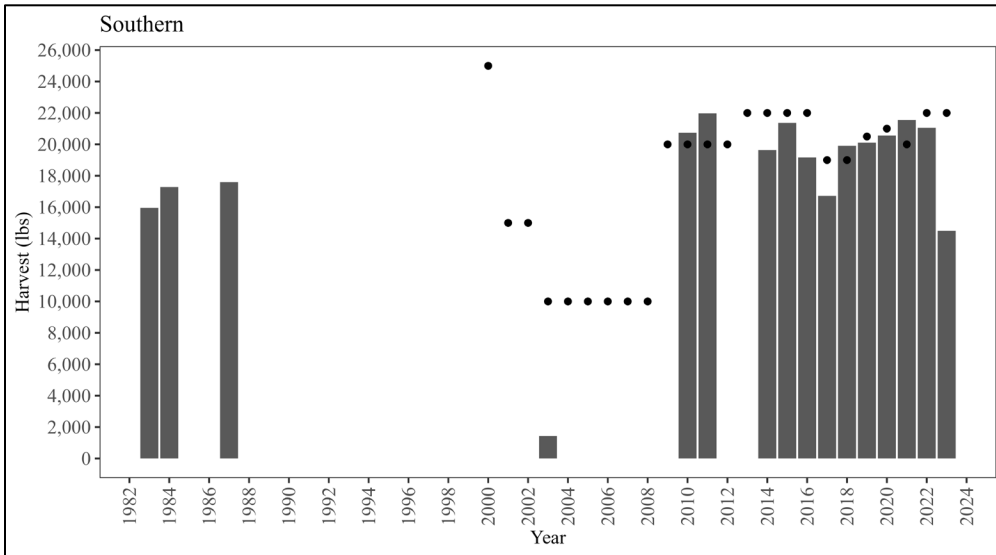
Figure 40.—Commercial GKC fishery harvest from the Southern management area. Dots represents the GHL in a given season (2000–Present).

Reference Points

Table 8.—Golden king crab logbook catch per unit of effort (CPUE) reference points.

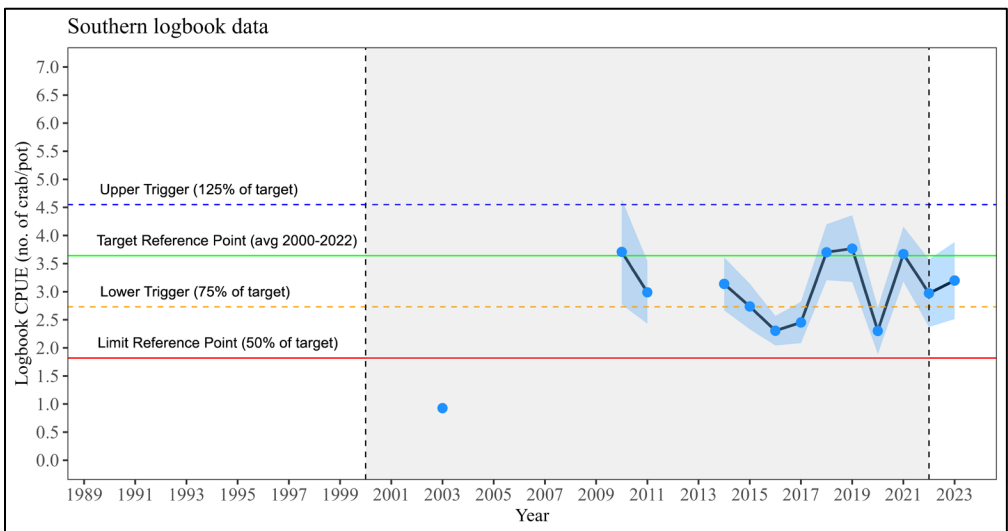| Indicators	Reference Point	Description
Upper Trigger Reference Point	4.6 crab/pot	125% of the Target Reference Point
Target Reference Point	3.6 crab/pot	Average Commercial Logbook CPUE from 2000–2022
Lower Trigger Reference Point	2.7 crab/pot	75% of the Target Reference Point
Limit Reference Point	1.8 crab/pot	50% of the Target Reference Point

Figure 41.–Southern golden king crab reference points (Upper Trigger, Target, Lower Trigger, and Limit) and fishery performance utilizing logbook CPUE.
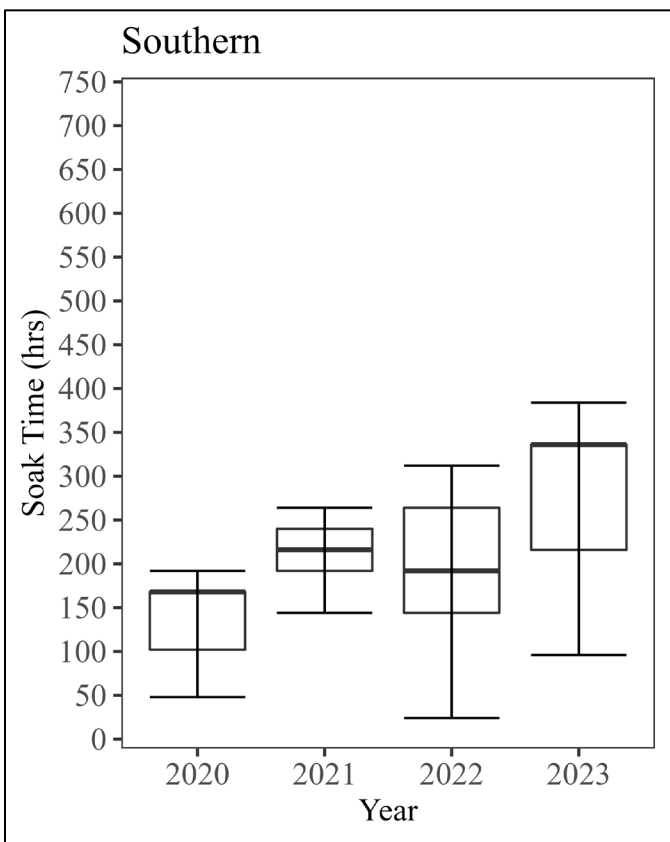

Figure 42.–Southern golden king crab soak time (hrs) utilizing fishery logbooks.
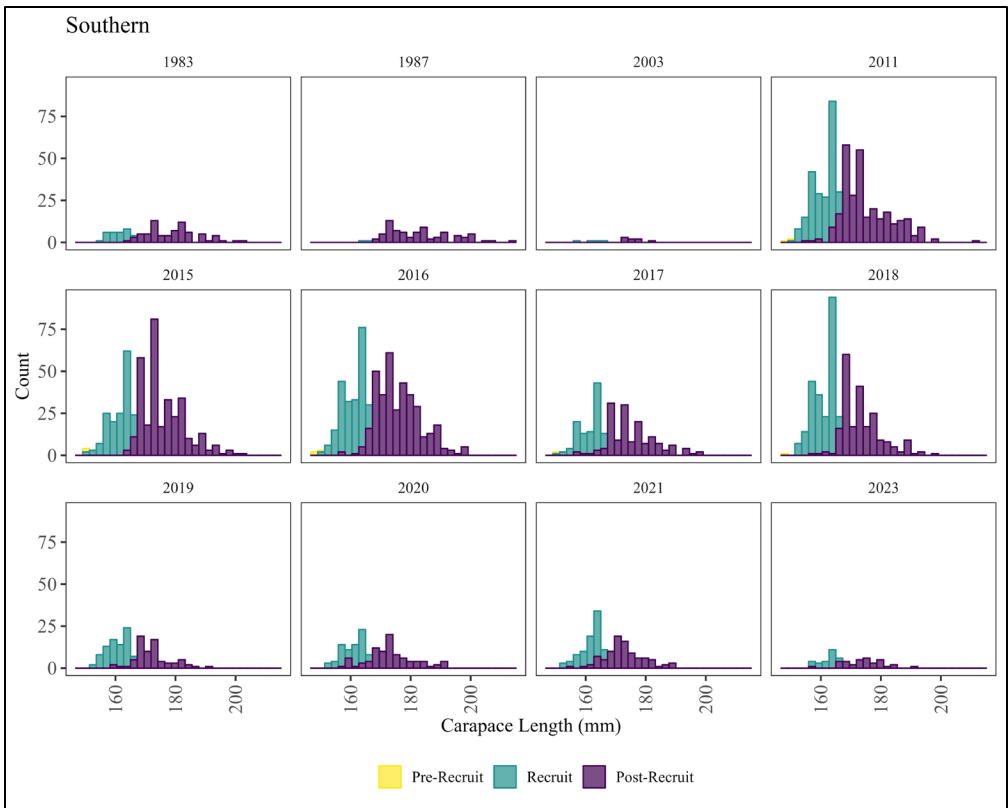
Figure 43.–Southern golden king crab length frequencies of sampled commercial catch by recruit class from 1983-Present.
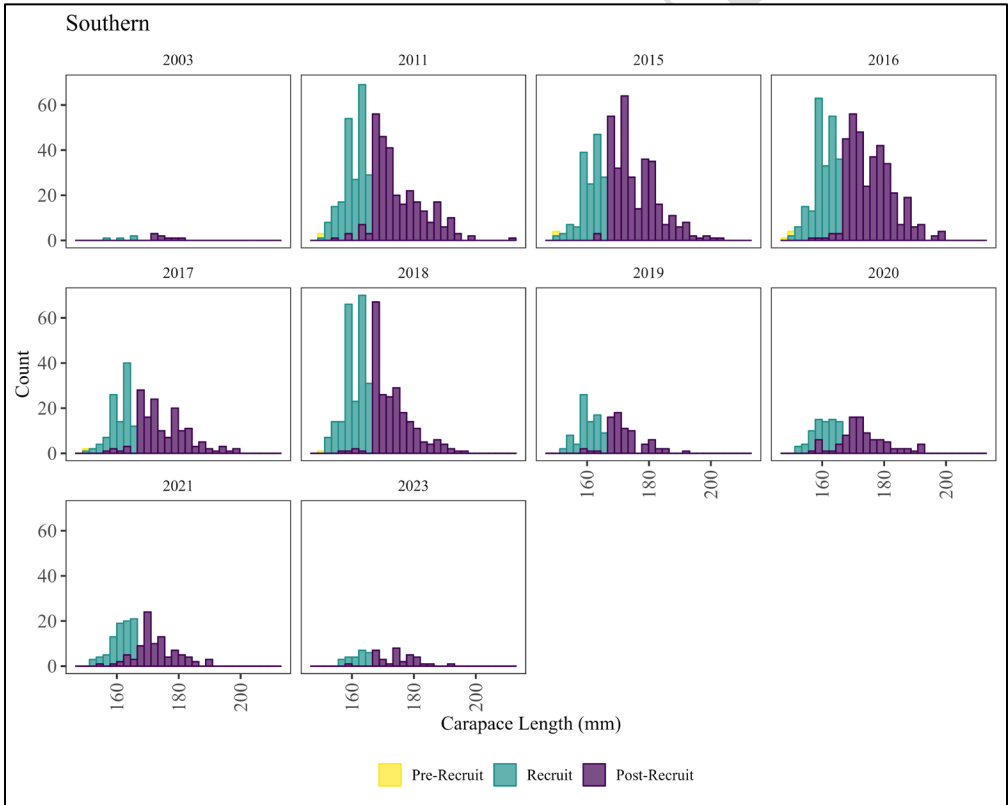
Figure 44.–Southern golden king crab length frequencies of sampled commercial catch by recruit class from 2000-Present.
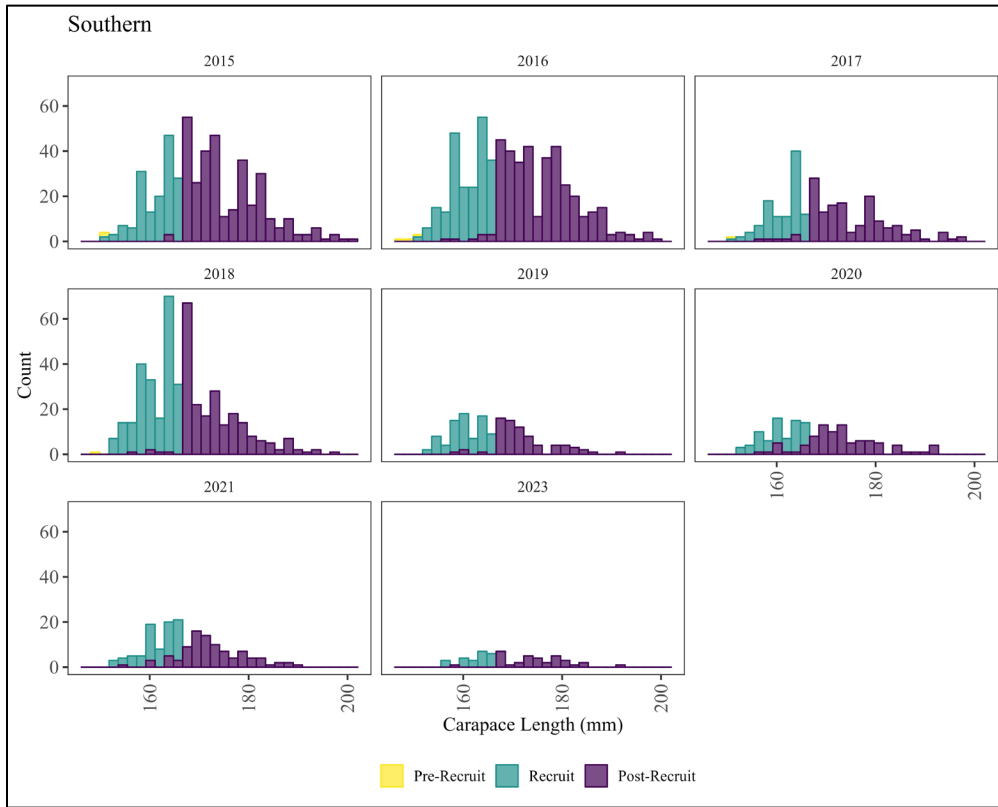

Figure 45.–Southern golden king crab length frequencies of sampled commercial catch by recruit class from 2015-Present.