



4

Crab fisheries in Alaska



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Presentations



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Questions

This module will cover three main areas:

1. Biology
2. Fishing methods
3. Management

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At the end of each of the areas there are self-check quizzes to make sure that you understand the basic student learning outcomes for each area.



By the end of this module you should be able to:

1. Describe each stage of crab life-history
2. Describe differences in the biology of Red king, Blue king, Brown king, Tanner, Snow and Dungeness crabs
3. Describe the gear types used fishing for crab
4. List factors that have led to a decline in King crab catch
5. List the agencies responsible for limiting crab catch in Alaska
6. Define the “Race for Crab” and “Crab Rationalization”
7. Describe the positive and negative impacts of Crab Rationalization
8. Describe how fisheries management agencies make decisions about how to best manage crab species



## Fisheries Technology

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Read pages 311-322 in  
Crab.pdf in iBooks



Read pages 1-6 in  
Crab2.pdf in iBooks



## Fisheries Technology

About the Presenter

Ben Daly, National Oceanic and Atmospheric Administration

Biology

Red king, Brown king, Blue king, Tanner, Snow and Dungeness crab species (12 minutes)

Fishing methods

Gear types, boats, fleet (10 minutes)

Management

Management agencies, setting catch limits, Crab Rationalization, future issues (35 minutes)



## Benjamin Daly

Research Fishery Biologist

NOAA/NMFS/AFSC/RACE/Kodiak Lab

301 Research Ct.

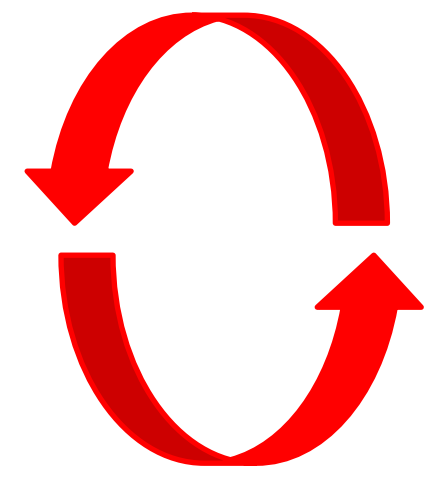
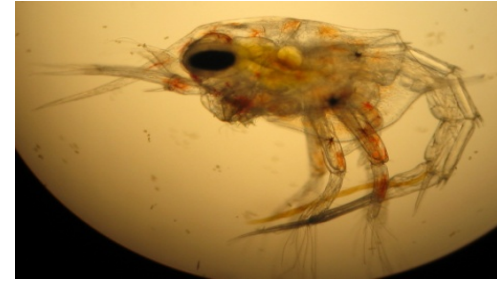
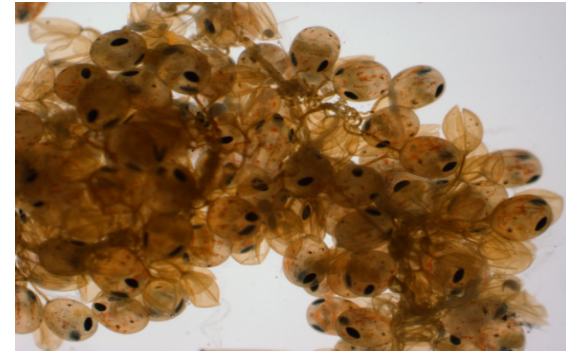
Kodiak, Alaska 99615

Phone: 907 481-1725

Fax: 907 481-1701



# Life Cycle





Kingdom: **Animalia**

Phylum: **Arthropoda**

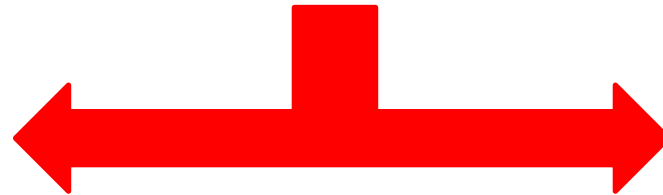
Subphylum: **Crustacea**

Class: **Malacostraca**

Order: **Decapoda**

Infraorder

**Anomura**



**Brachyura**







# Biology: Anomurans vs. Brachyurans

## Anomurans (king crabs)

- No age structures
- No terminal molt
  - Females molt yearly
  - Males may molt
- No sperm retention
  - Males must be present at fertilization
- Podding behavior

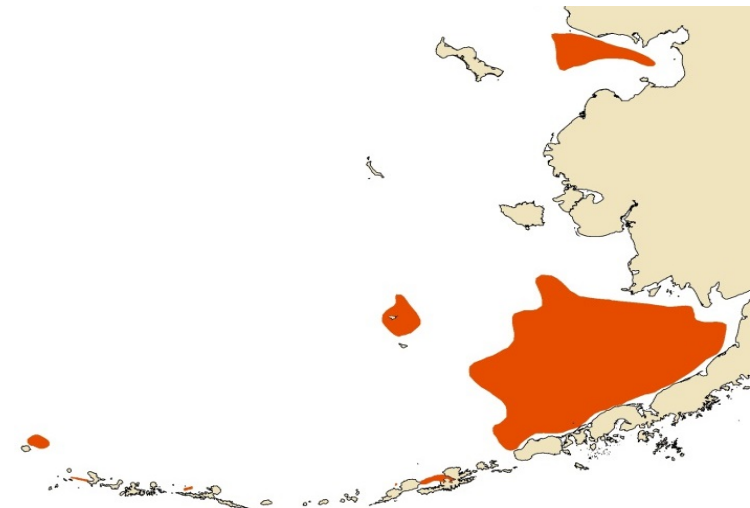
## Brachyurans (snow, Tanner, Dungeness)

- No age structures
- Terminal molt
  - Females (maturity)
  - Males (some species)
- Sperm retention
  - Males not present at fertilization



# Red King Crab (*Paralithodes camtschaticus*)

- Young-of-of-the the-year live
- <50 m in high-relief habitat
- Juveniles form aggregations (pods)
- Young molt several times per year through age 3
- After age 3, molting is annual
- In Bristol Bay, 50% maturity is reached by 120 mm CL (males) and 90 mm CL (females), about age 7
- Females produce 43,000 – 500,000 eggs
- Males are recruited to the fishery at ages ~8-9 years



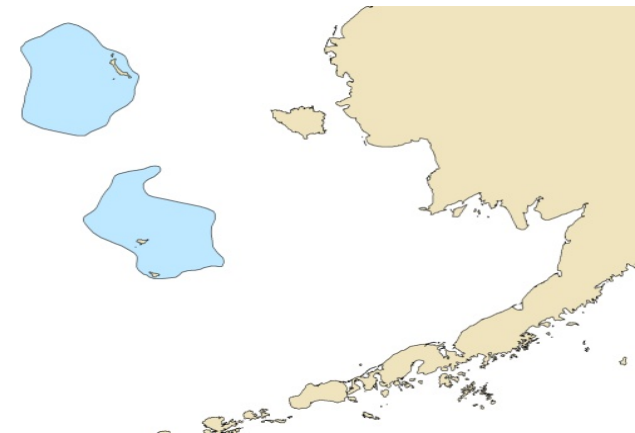
# Red King Crab Pods





# Blue king Crab (*Paralithodes platypus*)

- Young-of-the-year live in high-relief habitat, like RKC
- Biology and ecology is similar to red king crabs, except:
  - Different growth rates – e.g., off Pribilof Islands, 50% maturity for females is reached by 96 mm CL (~ age 5) and 81 mm CL off St. Matthew Island
  - Biennial reproductive cycle and 14-mo embryonic period
  - Juveniles do not form pods





# Golden King Crabs (*Lithodes aequispinus*)

- Live in deep water (200-1,000 m)
- Prefer high-relief habitats
- Females produce 4,000 – 27,000 eggs
- Larvae are lecithotrophic
- Related species – scarlet king crab





# Tanner Crabs (*Chionoecetes bairdi*)

- Prefer soft sediments
- Females stop molting at maturity (terminal molt); most males likewise stop molting after maturity
- In Bristol Bay, 50% maturity is reached by 110 mm CL
  - (males) and 90 mm CL (females), about age 6
- Females produce 50,000 to 400,000 eggs
- Males recruit to fishery at age ~7 years
- Fertilization is internal; sperm may be retained 3 years
- Females form mounds – aggregative mating

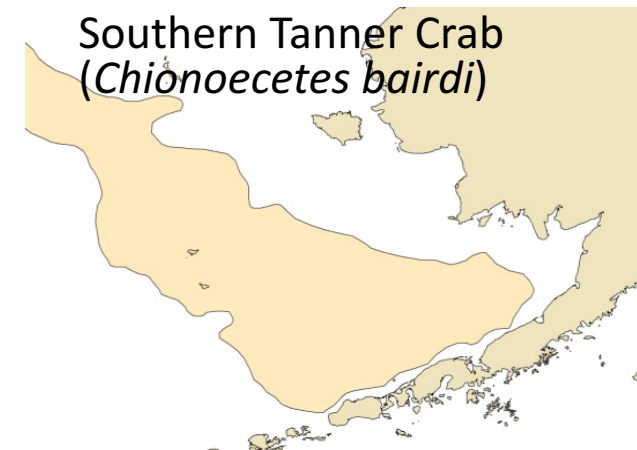


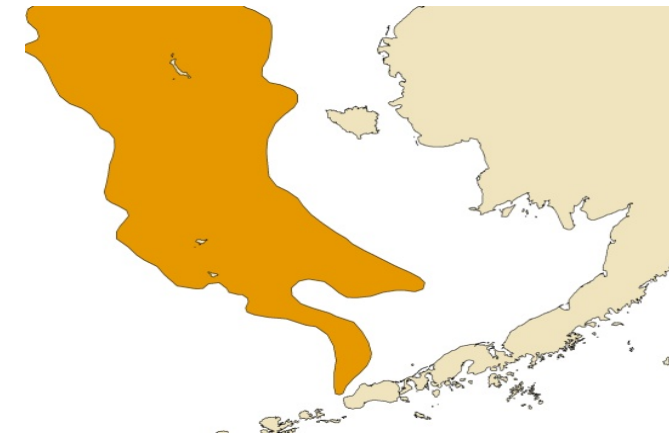


Photo: B. Stevens, NMFS



# Snow Crab (*Chionoecetes opilio*)

- Prefer soft sediments
- Males and females experience a terminal molt
- Size of 50% maturity is 65 mm CL (males) and 50 mm CL (females), about age 4-6
- Females produce 5,500 to 150,000 eggs
- Fertilization is internal; sperm may be retained 3 years
- Related species – grooved Tanner crab and Triangle Tanner crab

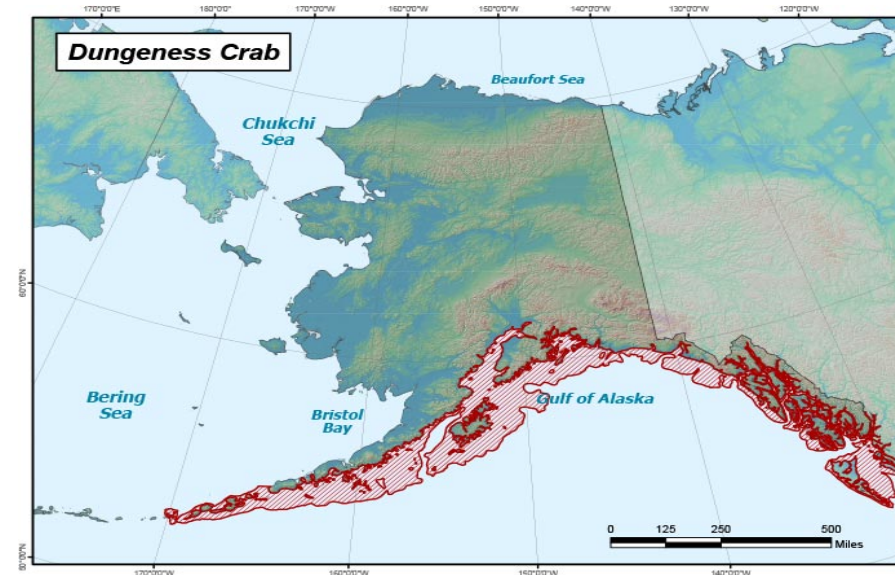






# Dungeness Crab (*Cancer magister*)

- Prefer soft sediments
- Females produce up to 2,500,000 eggs
- Fertilization is internal; sperm may be retained 2 years
- Related species – Jonah crab, rock crab



What is the name for the planktonic stage for crab that allow dispersal throughout Alaskan waters

- Megalops
- Zoea
- Schizopluteus
- Pleurobranchia

## Biology

*Quiz - 5 questions*

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# Crab Fishing Vessels



# Crab Fishing Vessels







## Pots







# St. Paul Trident Plant: largest crab processing facility in world

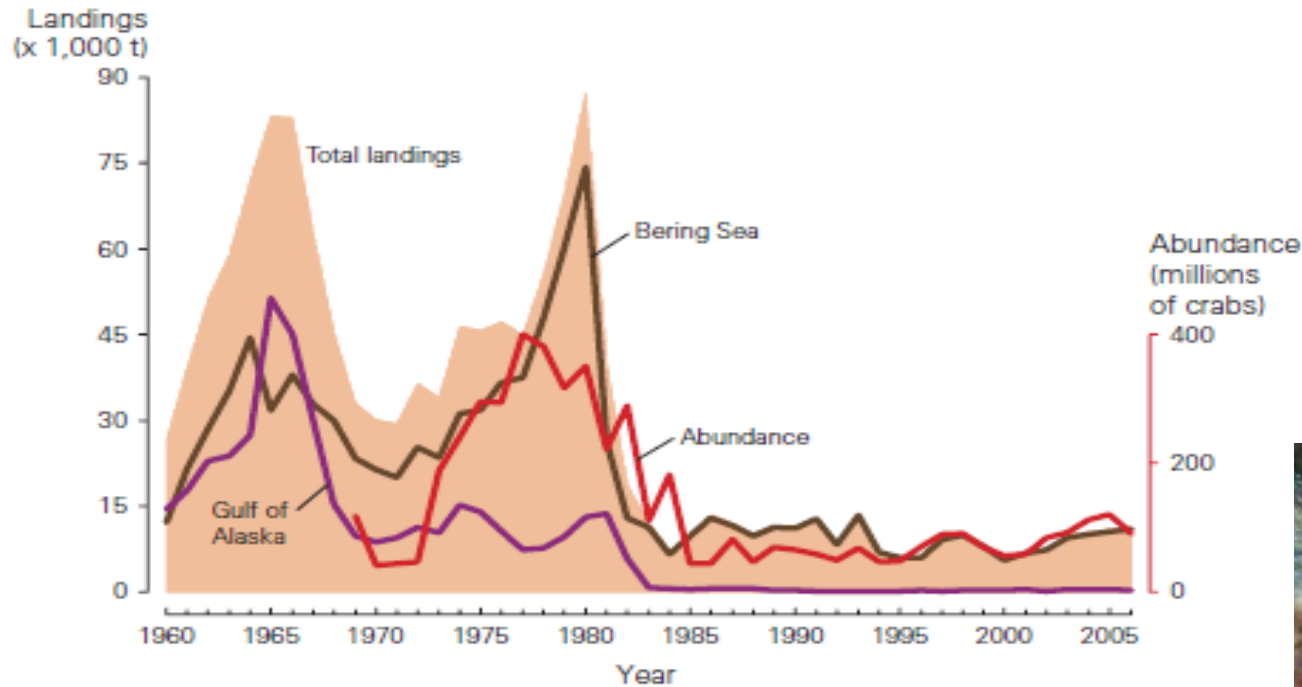




# Product: Frozen legs



## King Crab Fisheries

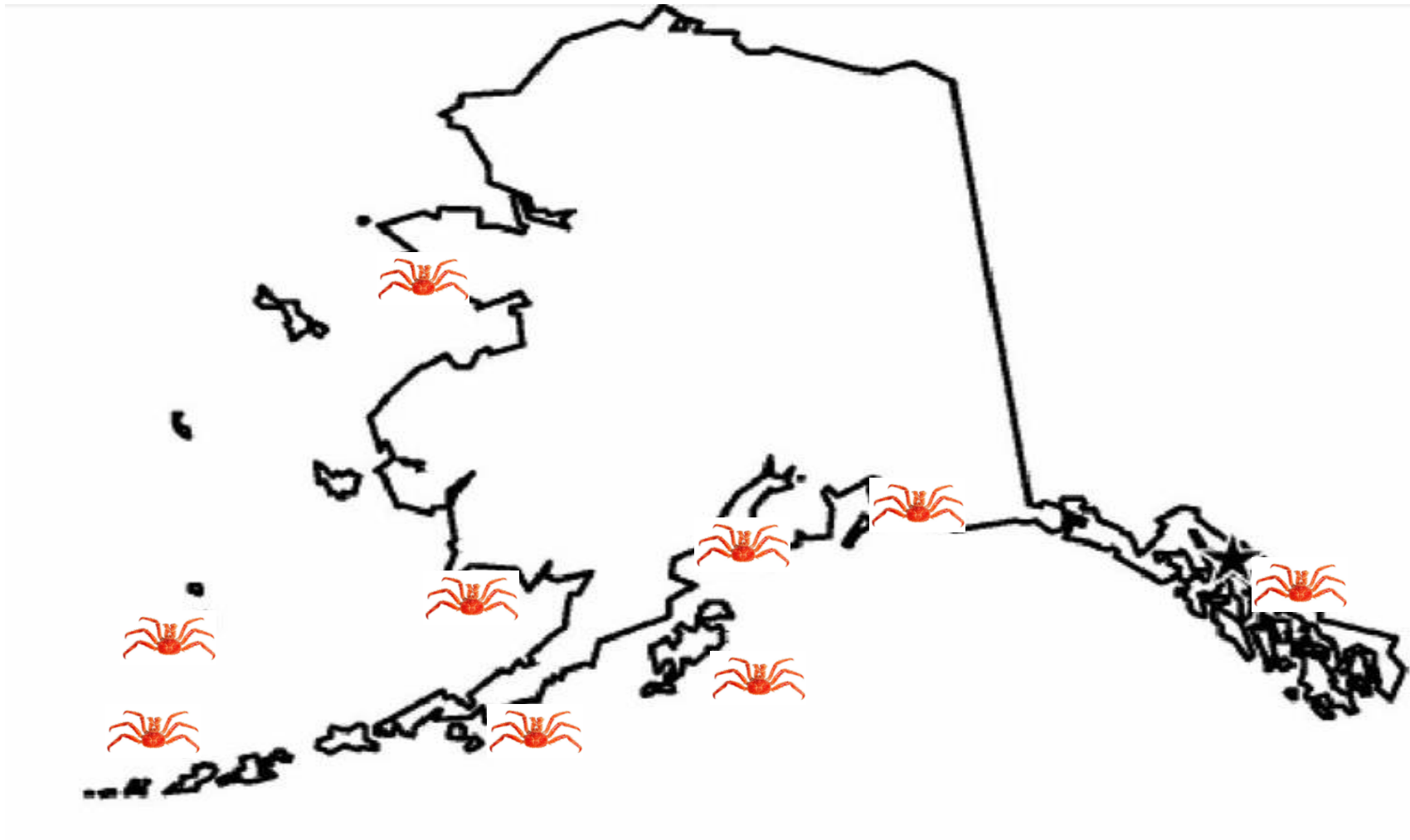


King crab landings in metric tons (t) for the Gulf of Alaska and Bering Sea, 1960–2006. Abundance trends are for Bering Sea red, Pribilof Island blue, and Saint Matthews Island blue king crab stocks combined.



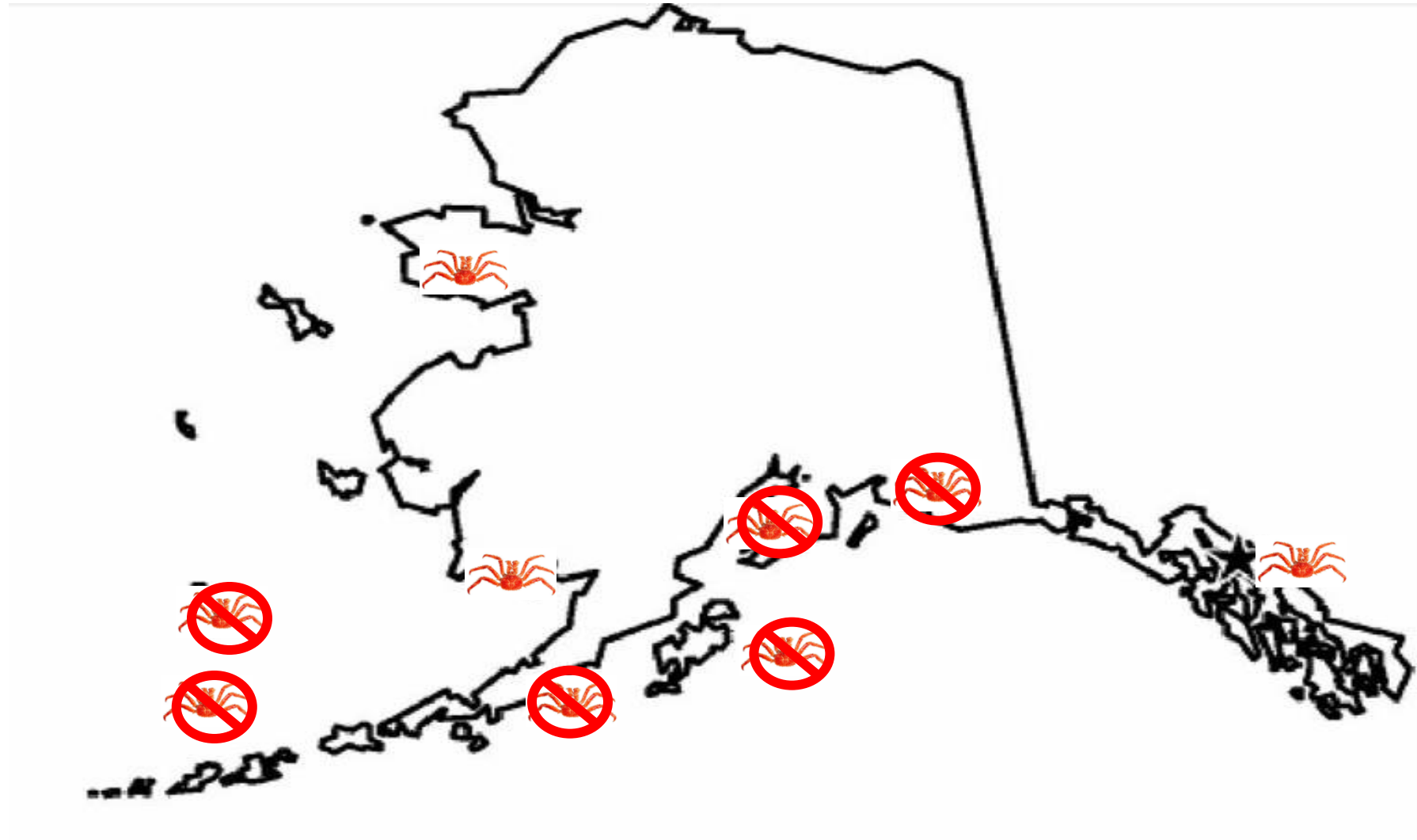


# Red King Crab Fishery



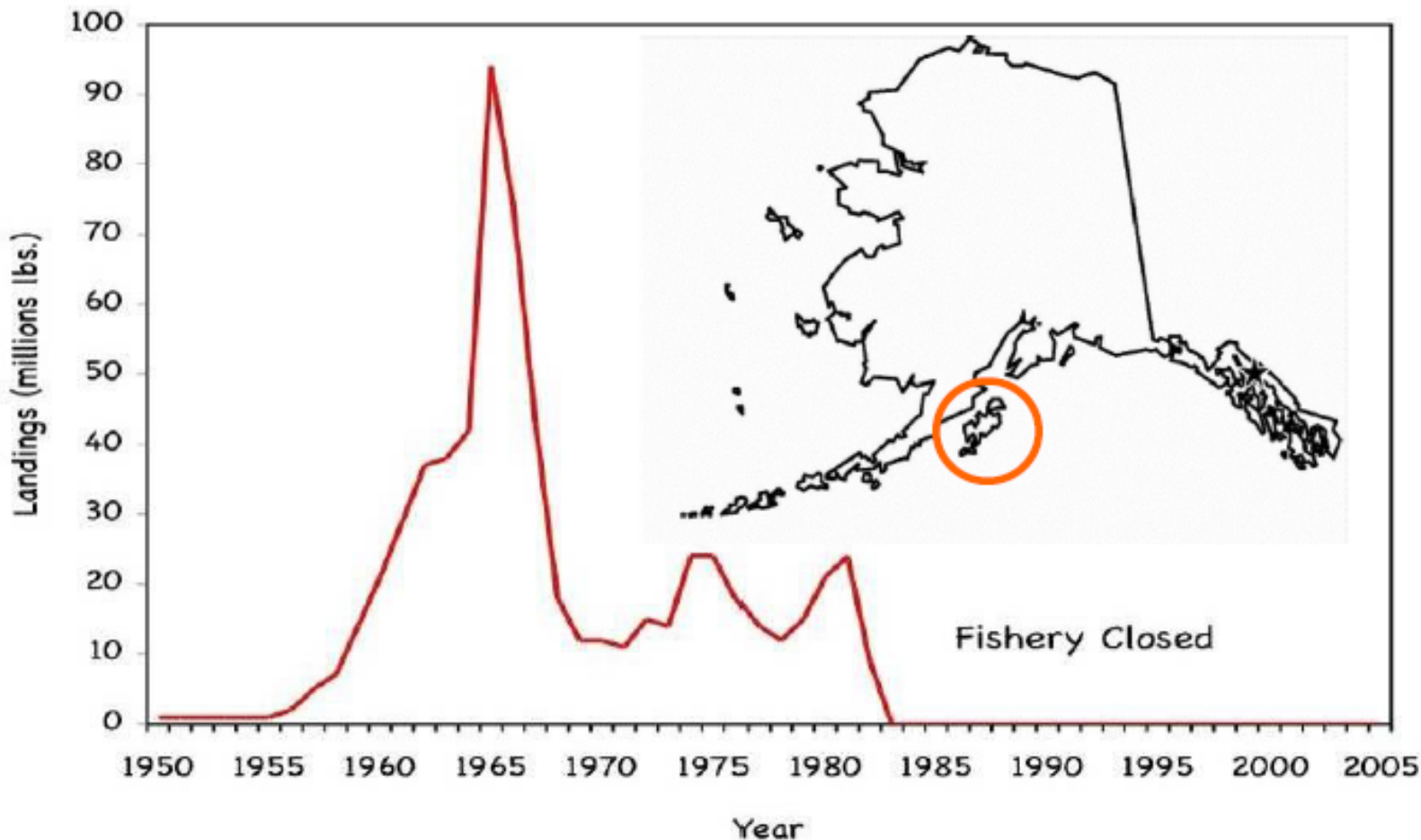


# Red King Crab Fishery





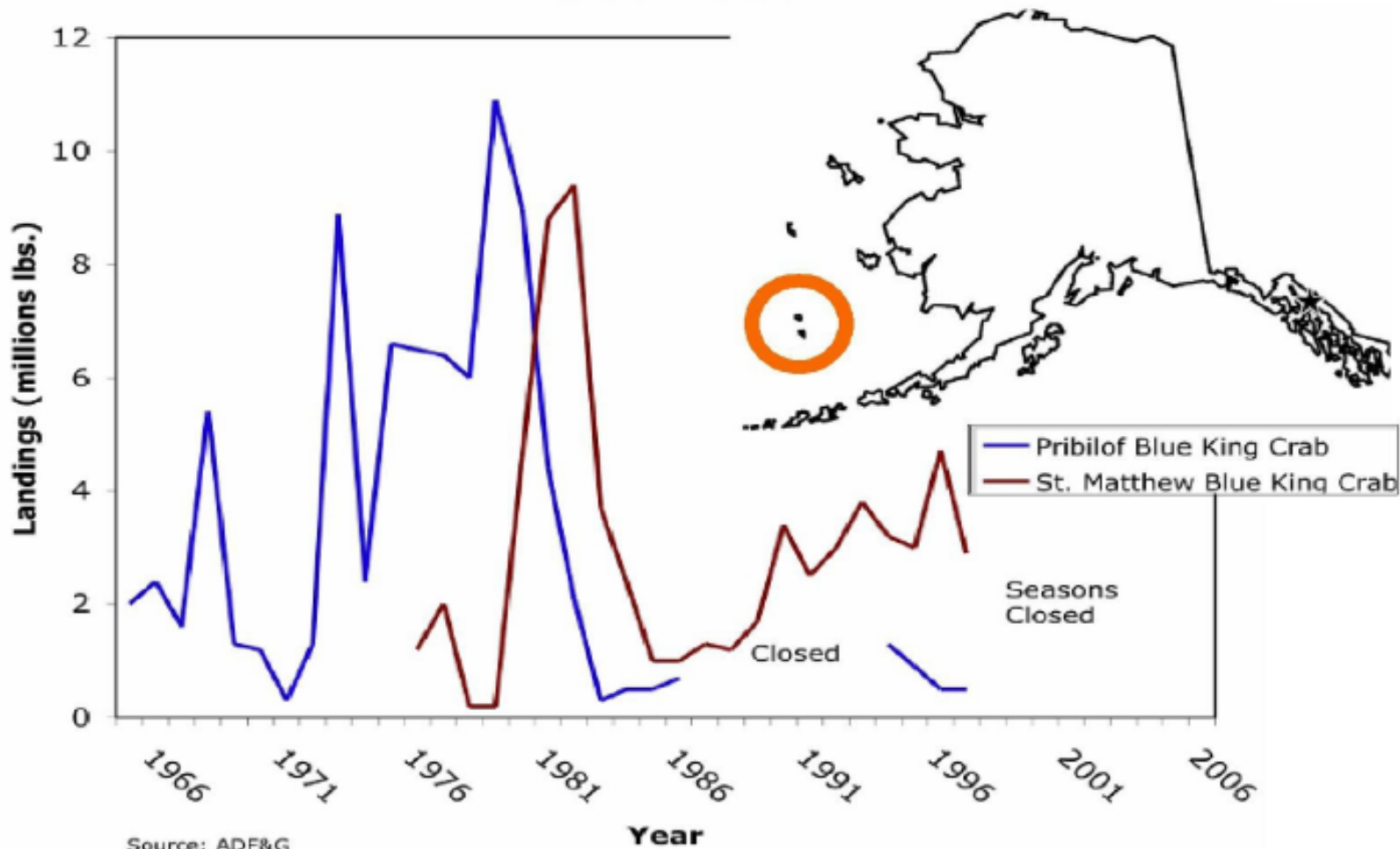
## Kodiak Red King Crab Commercial Harvest 1950-2006



Source: William Bechtol, UAF/SFOS; ADF&G



## Pribilof & St. Matthew Blue King Crab Harvests 1966-2006

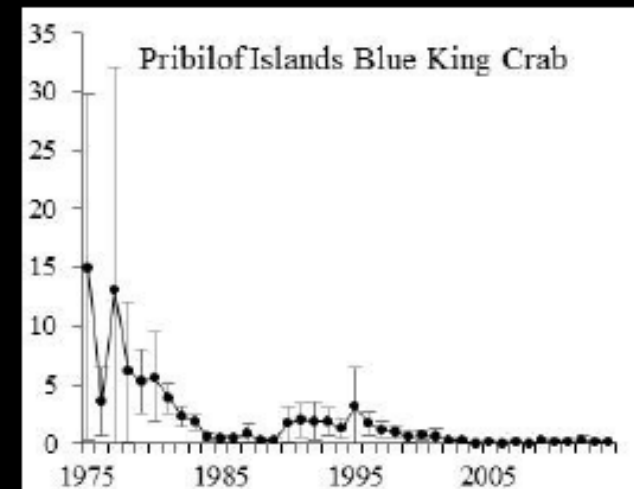




## Blue King Crab

Pribilof blue king crab is considered “overfished”

- Despite fishery closure
- Only crab species in Bering Sea overfished
- Unfavorable environmental conditions limiting recruitment





# Tanner Crab Fishing History

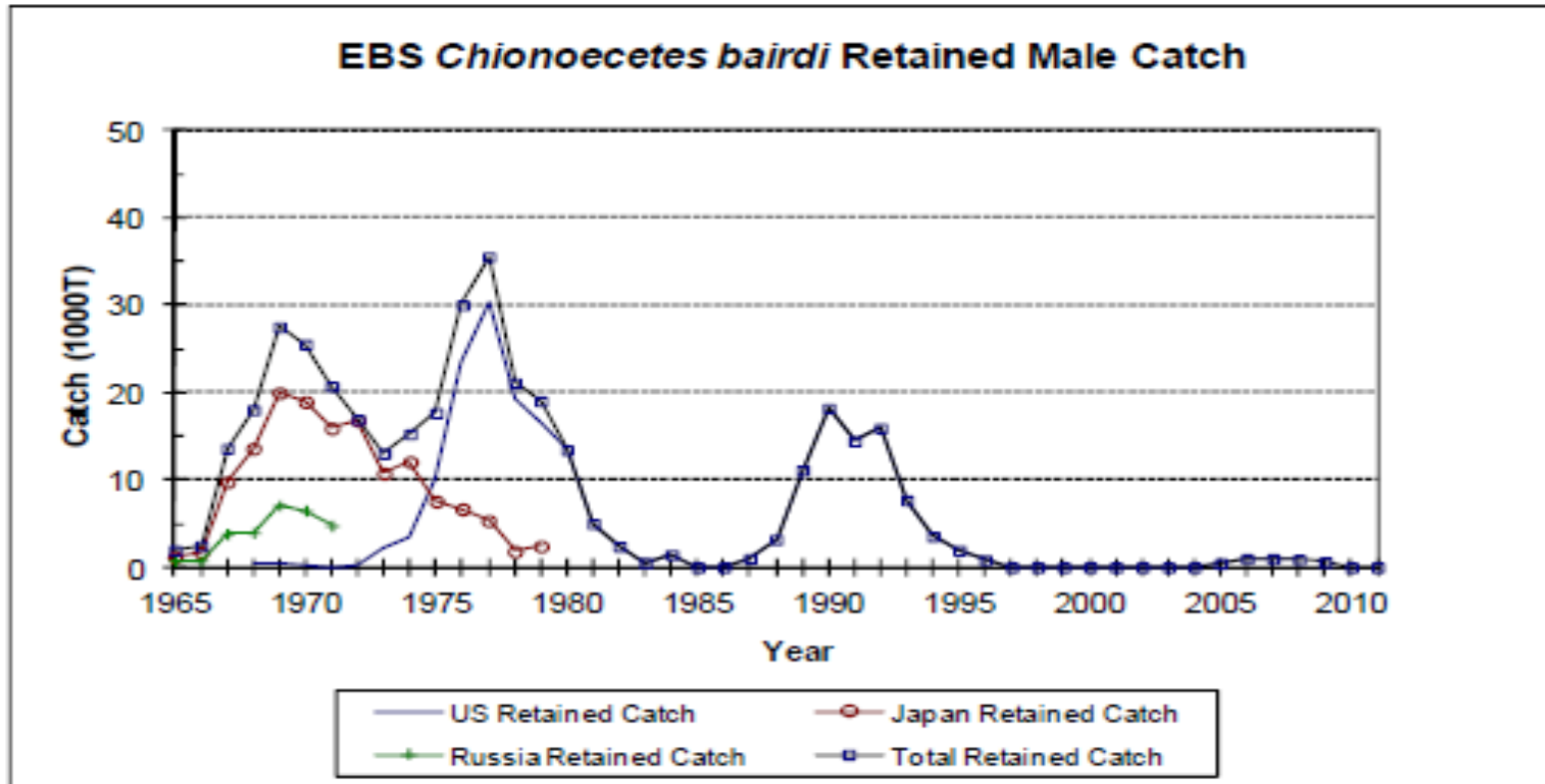


Figure 9. Eastern Bering Sea *C. bairdi* retained male catch in the directed United States, Russian and Japanese fisheries, 1965/66-2011/12.





## ALASKA DEPARTMENT OF FISH AND GAME DIVISION OF COMMERCIAL FISHERIES NEWS RELEASE



*Cora Campbell, Commissioner  
Jeff Regnart, Director*



Contact:  
Heather Fitch, BSAI Area Management Biologist  
Phone: (907) 581-1239  
Fax: (907) 581-1572

Dutch Harbor Office  
P.O. Box 920587  
Dutch Harbor, AK 99692

Date Issued: 10/07/2014

### BERING SEA TANNER CRAB SEASON OPENS OCTOBER 15 TOTAL ALLOWABLE CATCH ANNOUNCED

Alaska Department of Fish and Game (ADF&G) and National Marine Fisheries Service (NMFS) have completed analysis of 2014 NMFS trawl survey results for Bering Sea Tanner crab. Based on area-swept estimates, mature female biomass for Bering Sea District Tanner crab is above the minimum threshold for fishery opening. The 2014/15 Bering Sea Tanner crab fisheries will open October 15, 2014 and close March 31, 2015.

Bering Sea District Tanner crab is managed east and west of 166° W long, with a separate total allowable catch (TAC) for each area. Biomass estimates of mature male Tanner crab east and west of 166° W long are above the long-term average. The TACs are apportioned as follows:

	East of 166° W long (EBT)	West of 166° W long (WBT)
Individual Fishing Quota (IFQ)	7,632,000 pounds	5,962,500 pounds
Community Development Quota (CDQ)	848,000 pounds	662,500 pounds
<b>Total</b>	<b>8,480,000 pounds</b>	<b>6,625,000 pounds</b>



# Snow Crab Fishing History

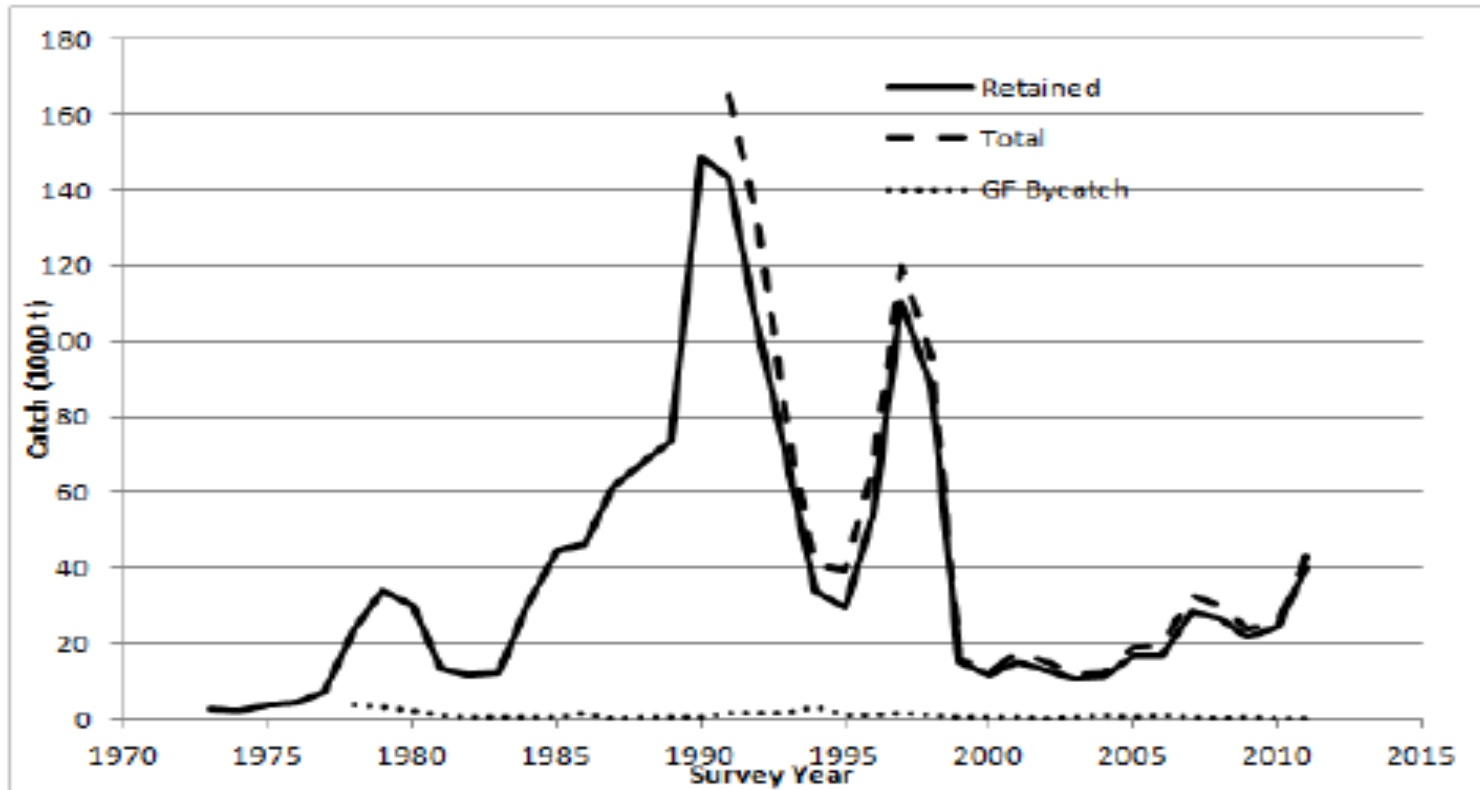


Figure 1. Catch (1000 t) from the directed snow crab pot fishery and groundfish trawl bycatch. Total catch is retained catch plus discarded catch after 50% discard mortality was applied. Trawl bycatch is male and female bycatch from groundfish trawl fisheries with 80% mortality applied.

Which crab is usually captured in small rounded pots?

- Red king crab
- Dungeness crab
- Tanner crab
- Scarlet king crab

## Fisheries

*Quiz - 4 questions*

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# Bering Sea-Aleutian Island Crab Management

Cooperative management between federal and state agencies

Federal

NPFMC: develops regulations, management plans

NMFS: surveys to estimate population abundance, fishery research

State

BOF: makes allocative decisions, establishes policy for management

ADF&G: implements fishery regulations and harvest strategies



## Gulf of AK Crab Management

- Managed solely by the state of AK
- No federal fishery management plan (FMP)
- Generally conforms to BSAI FMP
- ADG&G conducts annual trawl and pot population assessment surveys
  - Determines harvest guidelines
- Most GoA crabs stock are closed to commercial fishing due to low population abundances



## 3S Harvest Strategy

**Sex** - Males only

- Protects eggs in population
- Males can mate with multiple females
- Males are bigger, longer legs

**Size** - One molt above maturity

- Ensures opportunity to mate at least once before entering fishery

**Season** – Avoid biologically sensitive periods

- Molting: vulnerable to handling (deadloss)
- Mating: disrupt fertilization
- Later harvests allows meat to “fill out”



## Other Management Measures

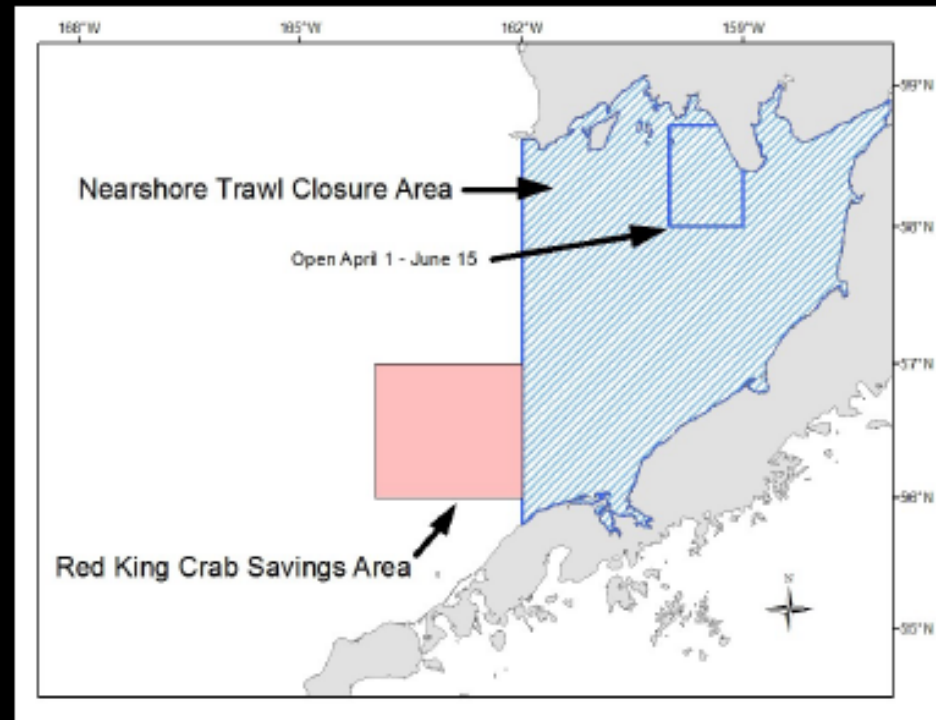
- Legal Gear
- Permit Requirements
- Reporting Requirements
- Observer Requirements
- Limited Access
- Area Closures (protect habitat, bycatch, etc.)
- Pot Limits, gear modifications
- Bycatch Limits



## Area Closures and Bycatch Controls

Nearshore Trawl Closure Area – protects juvenile red king crab habitat

Closure of Red King Crab Savings Area – protects adult male red king crab



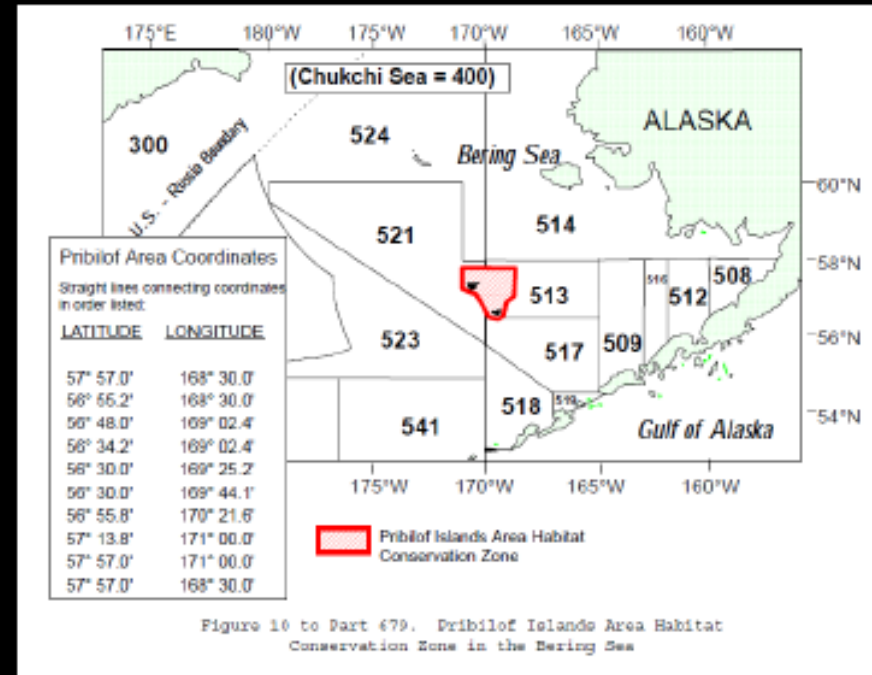




## Area Closures and Bycatch Controls

### Pribilof Islands Area Habitat Conservation Zone

- No trawling
- No pot fishing
  - crab or cod
- Eliminate bycatch of BKC





## Fishery Management Concepts

- Reduced harvest rates provide for more conservation, increased stock productivity, less volatile catches, reduced probability of fishery closures, and increased market and price stability.
- Bycatch caps and area closures constrain negative impacts by trawl fleet on crab stocks and habitats.



## Pre- 2005: Derby Style Fishery

- “Race for crab” - catch crab as quickly as possible to maximize profits
- Led to short seasons (sometimes only days)
- Compromised vessel human and safety
- Forced processors to process crab as quickly as possible
  - Reduced product quality and increased deadloss
- Increased ghost fishing: lost gear
- Reduced ability to precisely monitor Total Allowable Catch (TAC)
  - The TAC was sometimes exceeded because in-season monitoring could not keep pace with harvests



## Crab Rationalization Program

- **Share-based management program**
  - Implemented in 2005
  - Allocates harvest among users (harvesters, processors, communities)
- **Quota shares (QS):** captains + vessel owners
- **Processor shares (PS):** processors
- **Community development quotas (CDQ):** rural Alaska communities
  - Minimize negative social and economic impacts by promoting fishery involvement and economic development



# Crab Rationalization Program

## Individual allocation quota:

- percentage of the total catch *based on historic landings from specific periods* (depending on the fishery)
- Fisherman get **IFQ (individual fishing quota)**
- Based on quota share and total harvest:

$$QS \times TAC = IFQ$$



## Effects of Crab Rationalization

### **Reduction in fishing effort**

- Fewer vessels in fleet, fewer people with quota shares
- Increased profits for remaining vessels

### **Extended season:** greater flexibility in selecting fishing time + location

- Safer: reduced Coast Guard search and rescue cases
- Less bycatch: longer soak times allow escapement of small crabs

### **Less gear, decreased pot lifts, less ghost fishing**

- Better crab conservation



## Effects of Crab Rationalization

Fishermen form cooperatives: improves efficiency

- At end of season fisherman to consolidate remaining shares to single vessel
- Little un-harvested crab: maximizes TAC
- Efficient coordination with processors causes less down time between deliveries for processing crews
- More precise landings



## Socioeconomic Impacts

- Reduction in fleet decreases available jobs in coastal communities
- Restricts ability for young people to enter fishery
- Questions about “fairness”
  - Does limited access privatize a public resource?
- Long-term social impacts
  - Loss of: identity, meaningful lifestyle, connection to the surrounding environment for some individuals





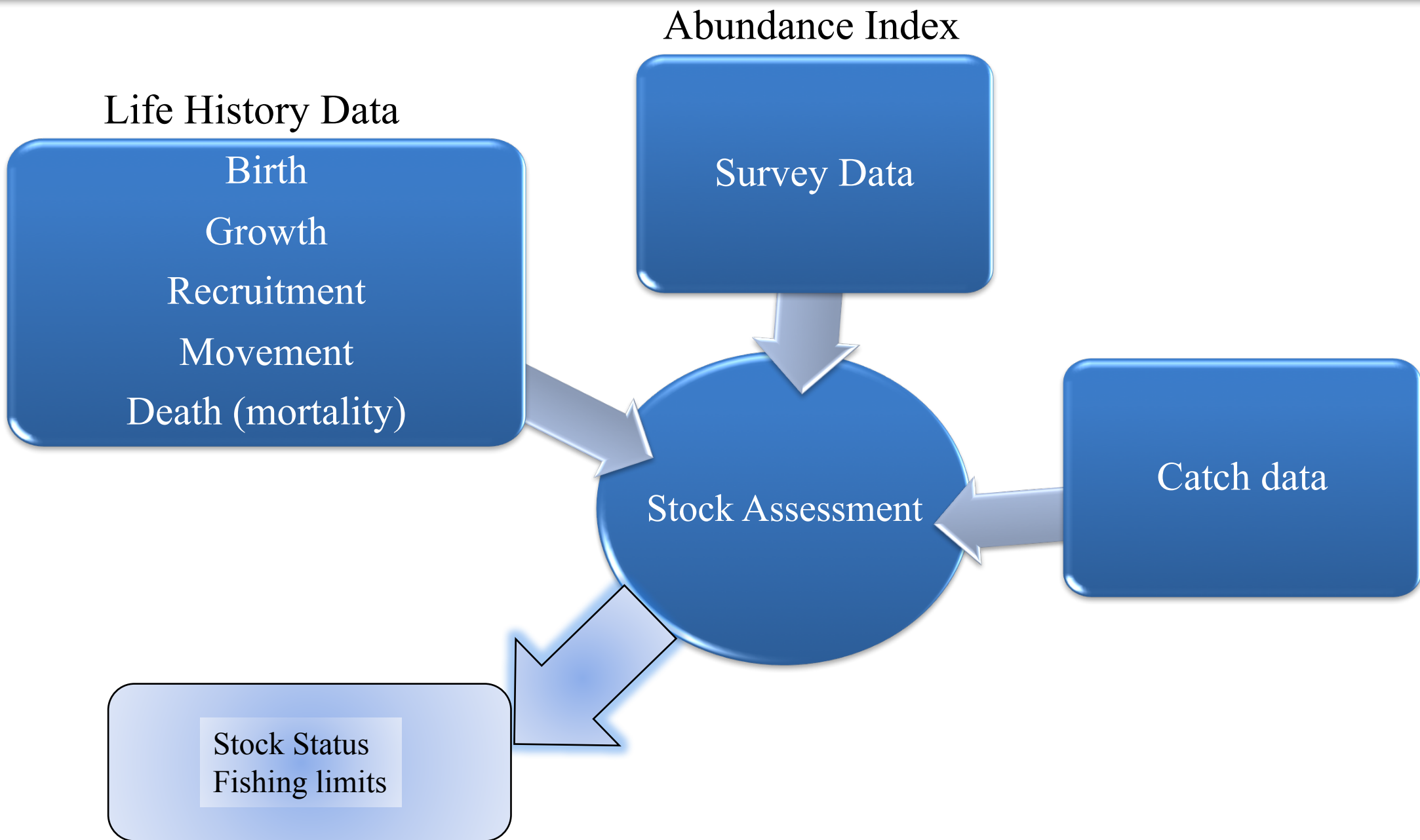
## List of rationalized Crab Fisheries

- Bristol Bay red king crab
- Western Aleutian Islands (Adak) golden king crab (west of 174 W)
- Eastern Aleutian Islands (Dutch Harbor) golden king crab (east of 174 W)
- Western Aleutian Islands (Adak) red king crab (west of 174 W)
- Pribilof Islands blue king crab and red king crab
- St. Matthew Island blue king crab
- Bering Sea snow crab
- Eastern Bering Sea Tanner crab (east of 166 W)
- Western Bering Sea Tanner Crab (west of 166 W)



## How do agencies make management decisions?

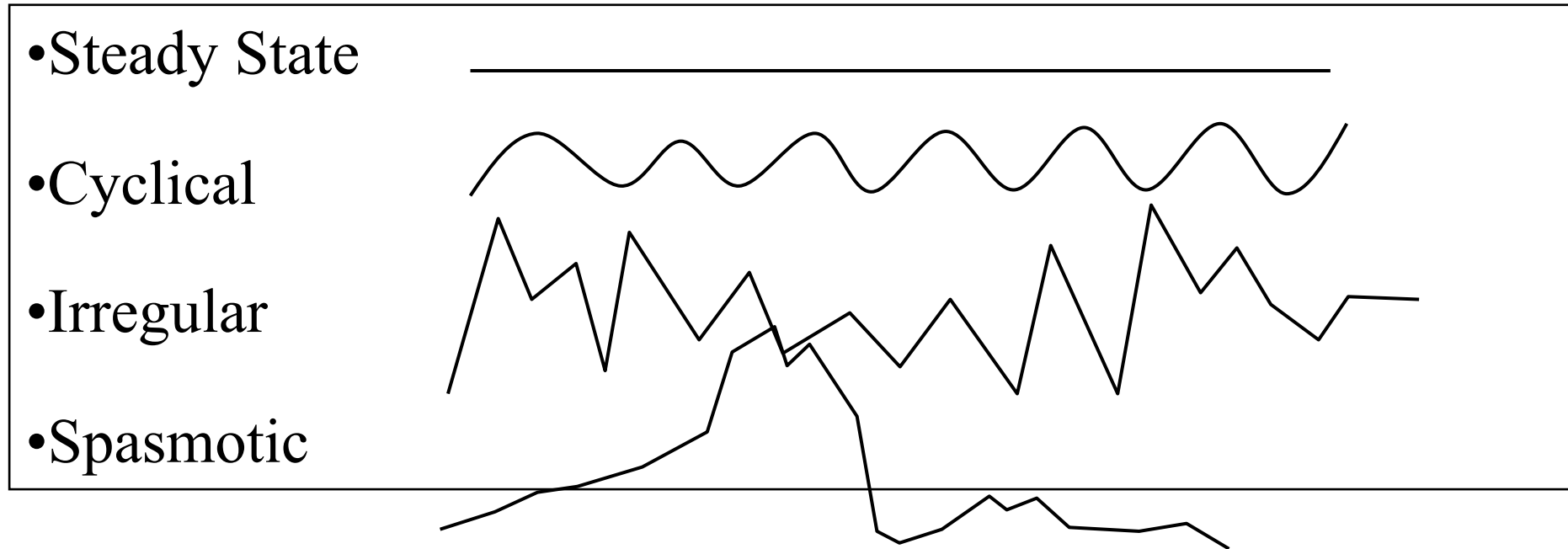
- Stock Assessment Models: quantitative predictions about crab populations
- Length-based analysis: reduces uncertainty in annual abundance estimates
- MSY: Maximum sustainable Yield
- TAC: Total Allowable catch
- OFL: Over Fishing Limits





## Stock Assessment

Population trends over time



How does a model fit all this change over time??

# Surveys

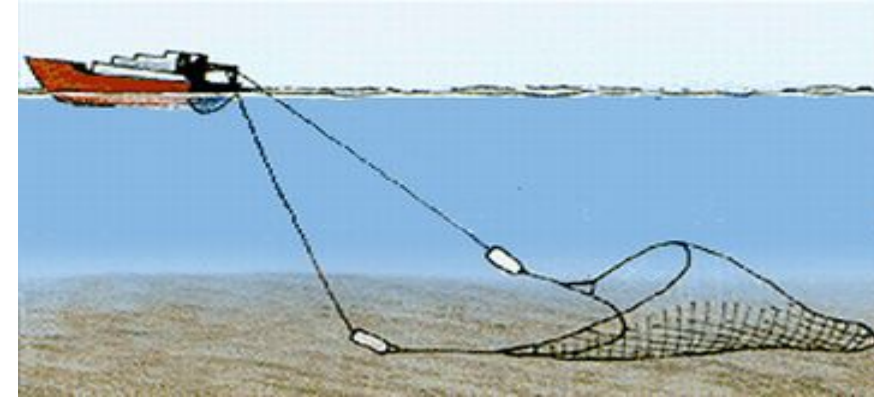




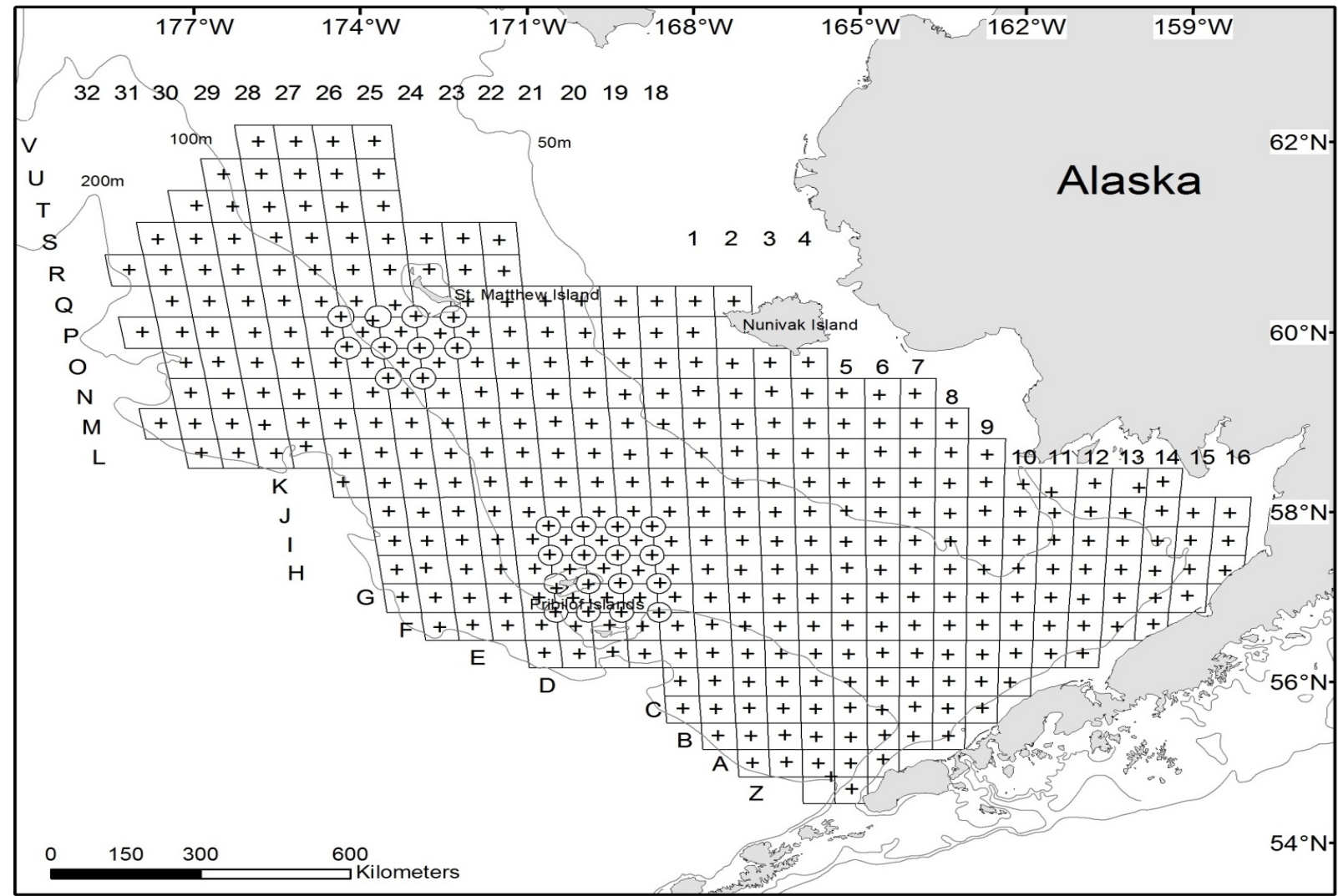
## Bottom Trawl Surveys



The chartered fishing vessel *Vesteraalen*. (Photo by Jay Orr)



# National Marine Fisheries Service



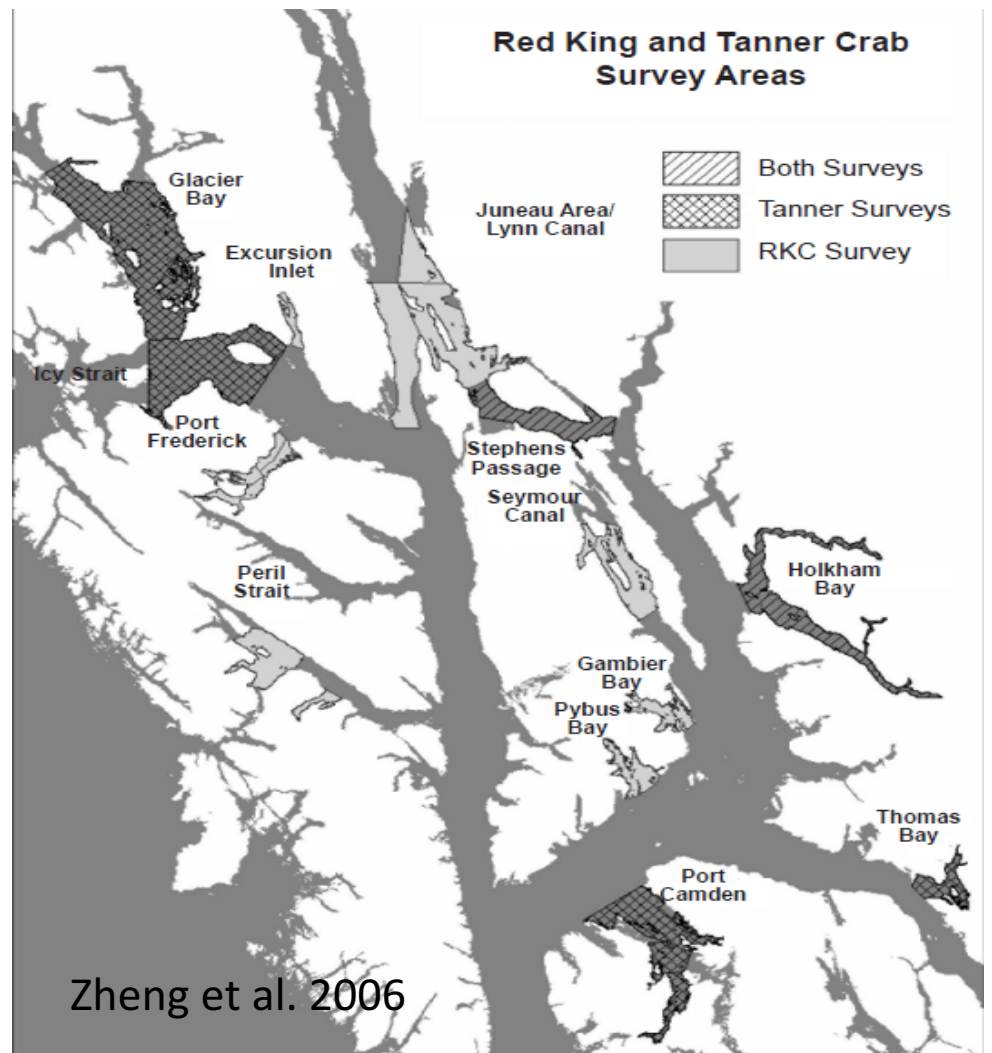








# ADF&G Pot Surveys





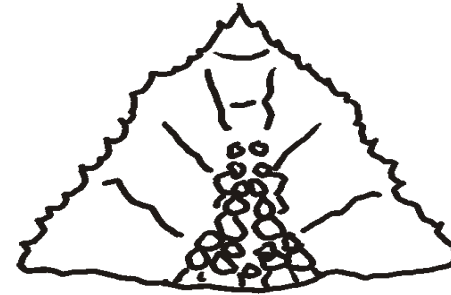
# Biological Data Collection: Sex

Female

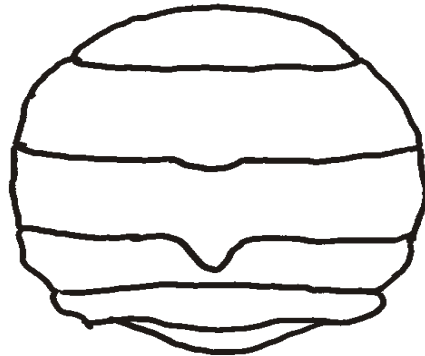


King

Male

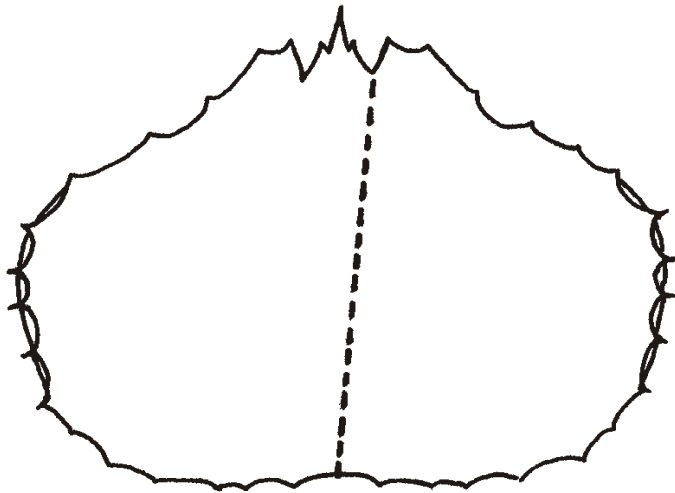


Snow  
Tanner  
Dung.



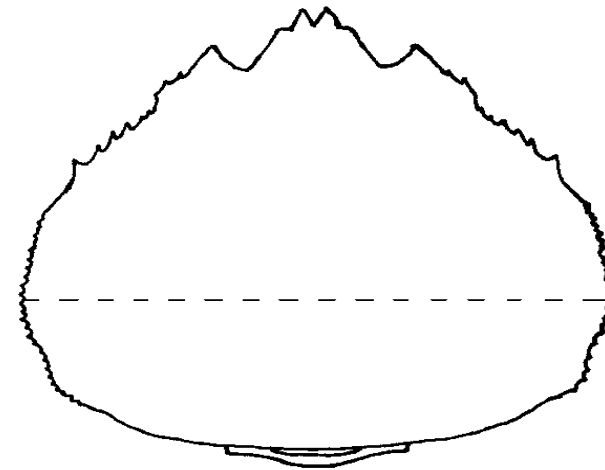
# Biological Data Collection: Size

Carapace length



King crabs

Carapace width



Snow, Tanner, Dungeness



# Biological Data Collection

**Shell condition**: proxy for age

- 0 Molting
- 1 Soft
- 2 Hardshell (new, clean)
- 3 Oldshell (slightly worn)
- 4 Oldshell (worn)
- 5 Very Oldshell





# Biological Data Collection: Egg Codes

## Egg Condition

- 0 No eggs
- 1 Uneyed eggs
- 2 Eyed eggs
- 3 Dead eggs
- 4 Empty egg cases

## Egg color

- 0 No eggs
- 2 Purple
- 3 Brown
- 4 Orange
- 5 Purple-brown
- 6 Pink

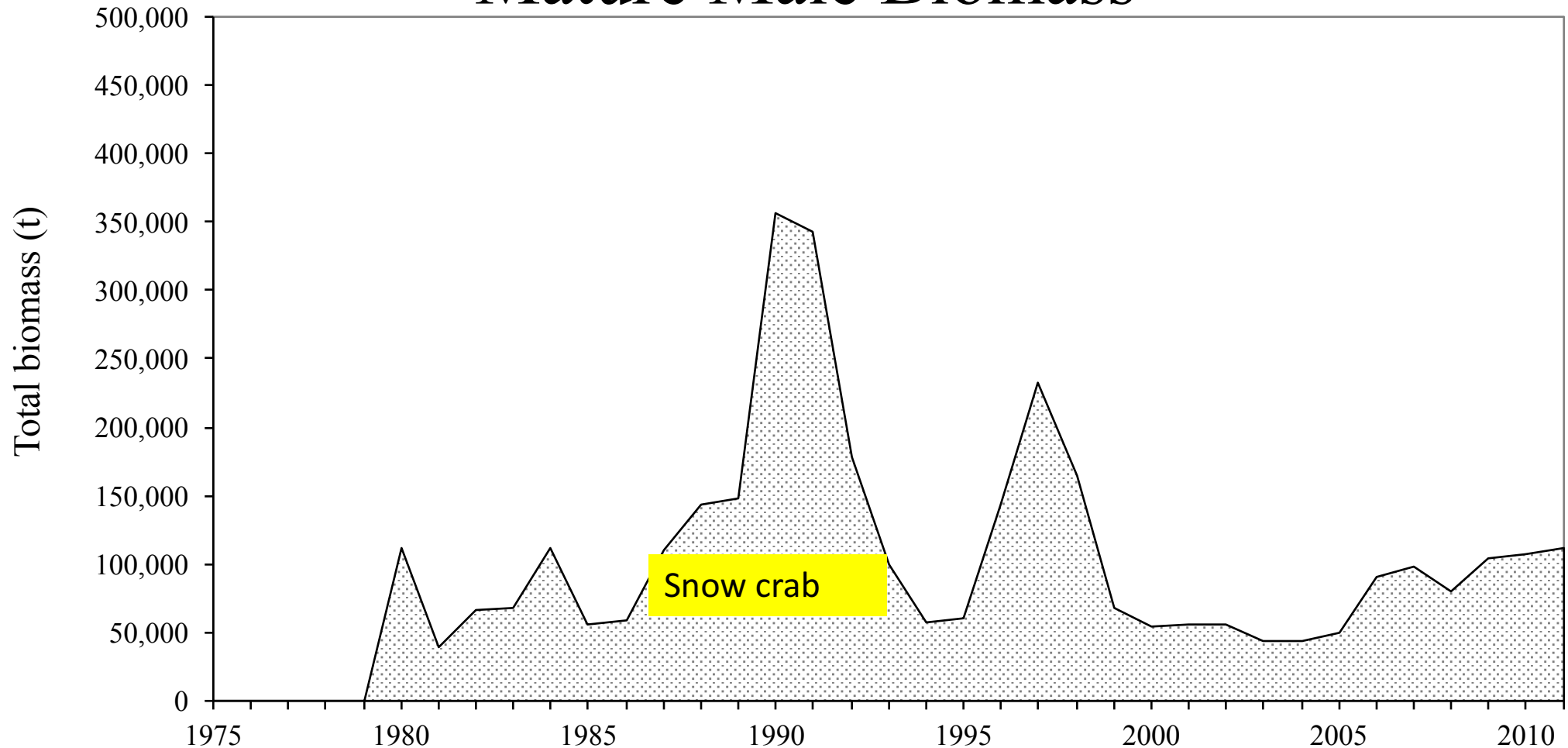
## Clutch size

- 0 Immature
- 1 Mature, no eggs
- 2 Trace
- 3  $\frac{1}{4}$  full
- 4  $\frac{1}{2}$  full
- 5  $\frac{3}{4}$  full
- 6 Full



# Eastern Bering Sea Crab Stocks

## Mature Male Biomass

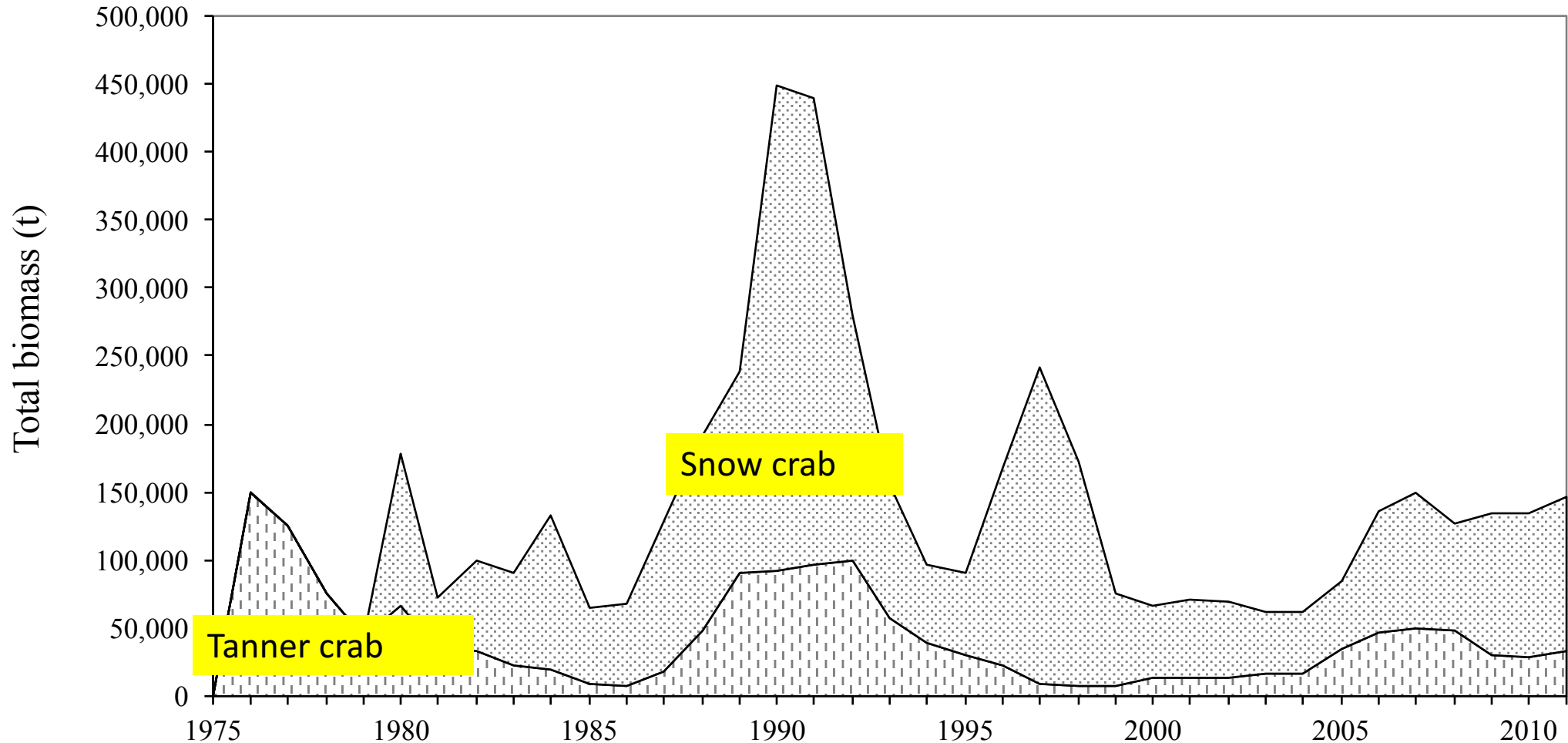






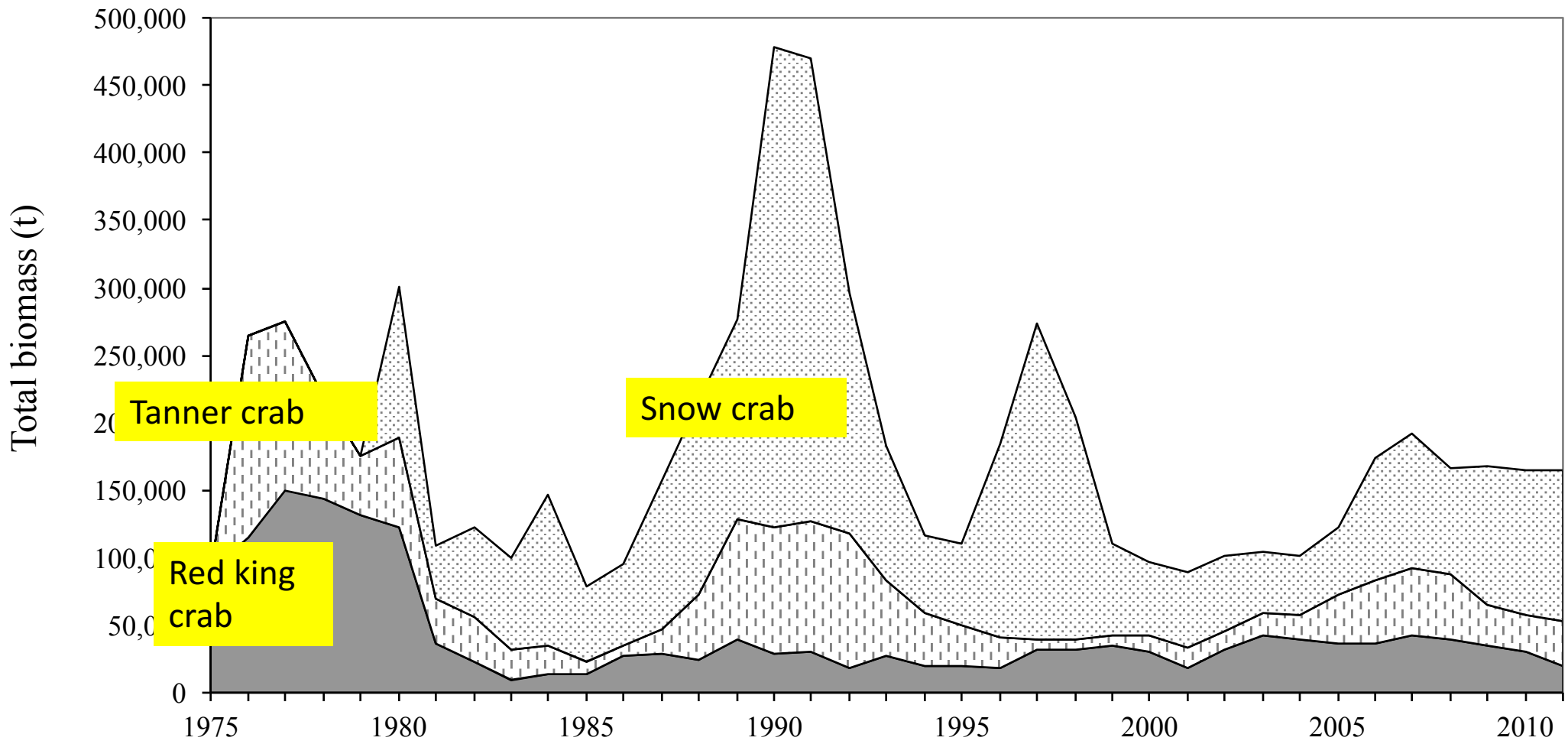
# Eastern Bering Sea Crab Stocks

## Mature Male Biomass



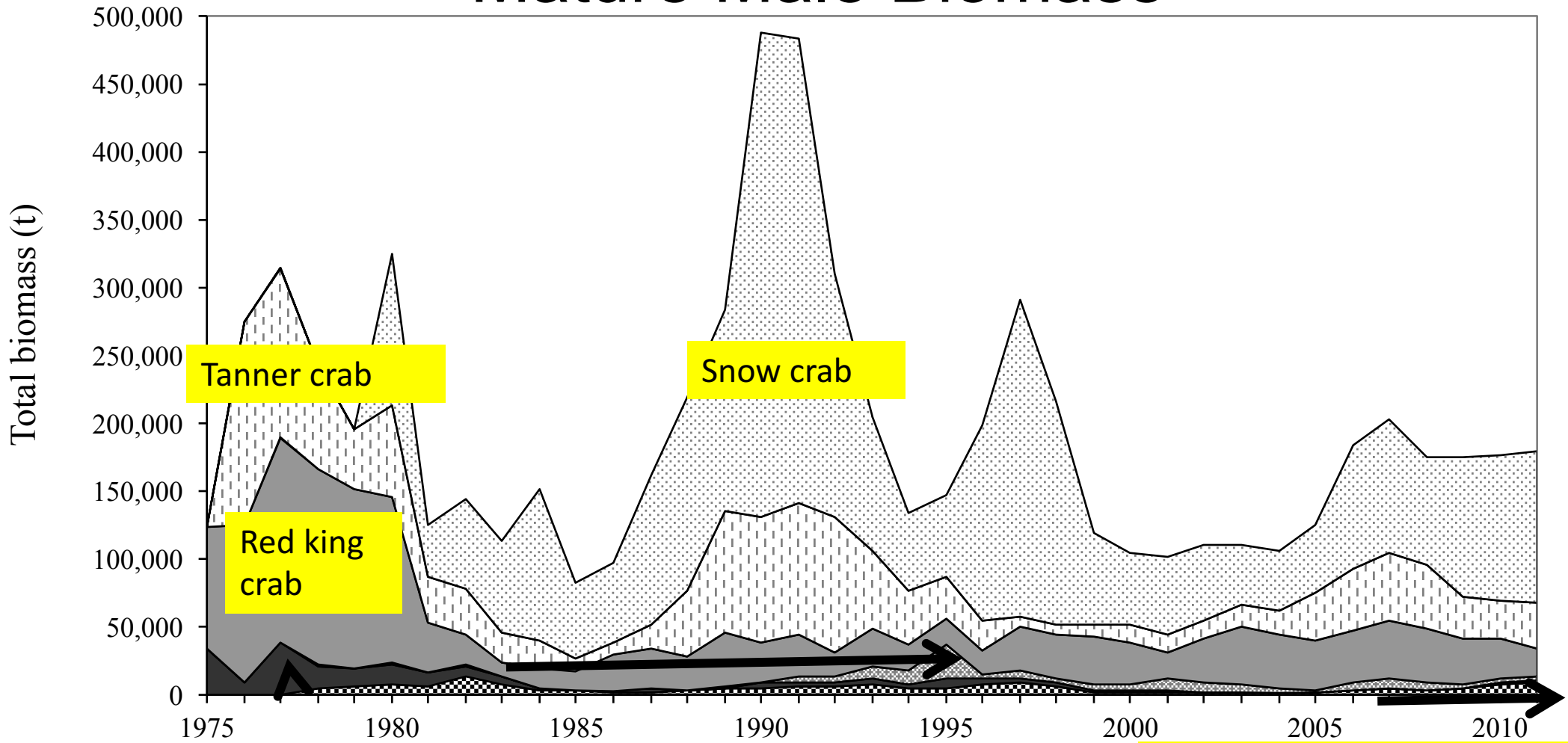
# Eastern Bering Sea Crab Stocks

## Mature Male Biomass



# Eastern Bering Sea Crab Stocks

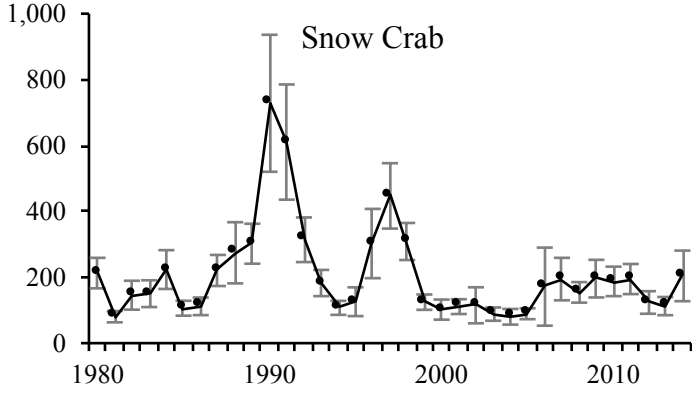
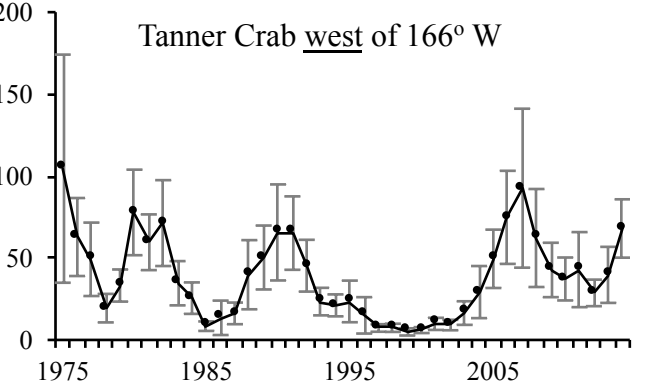
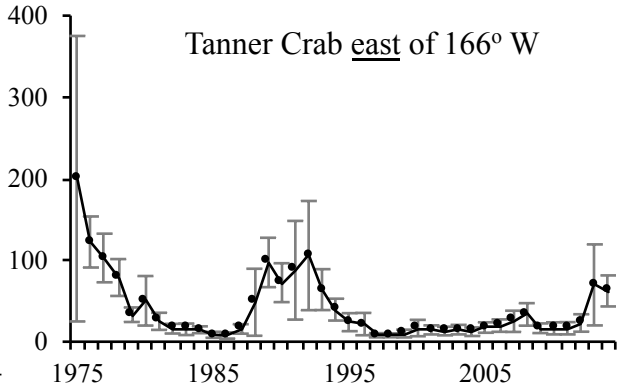
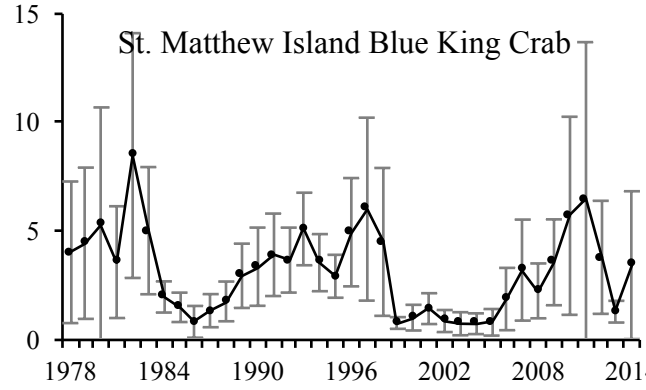
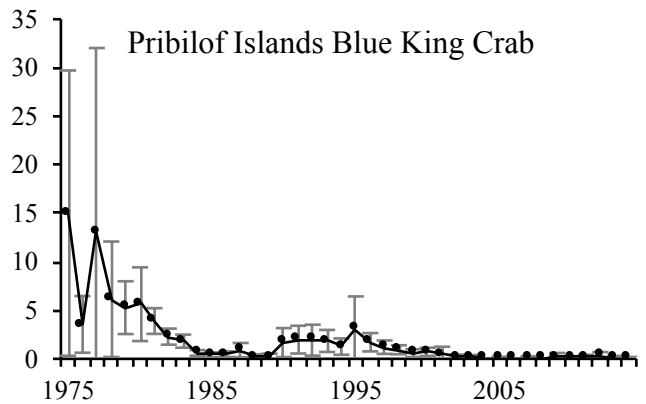
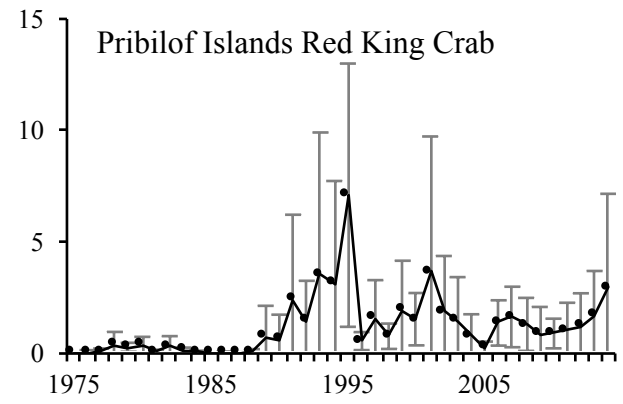
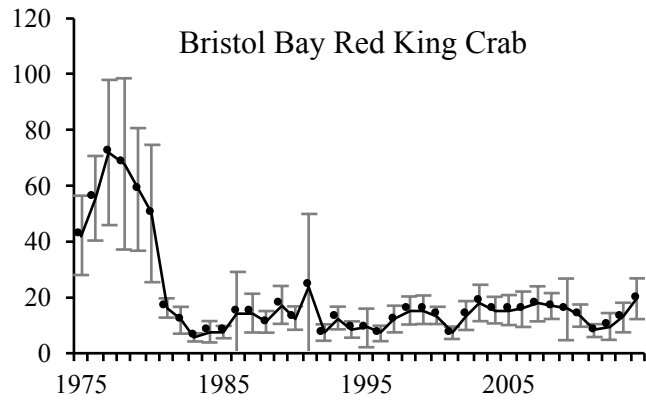
## Mature Male Biomass



Pribilof Islands blue and red king crab

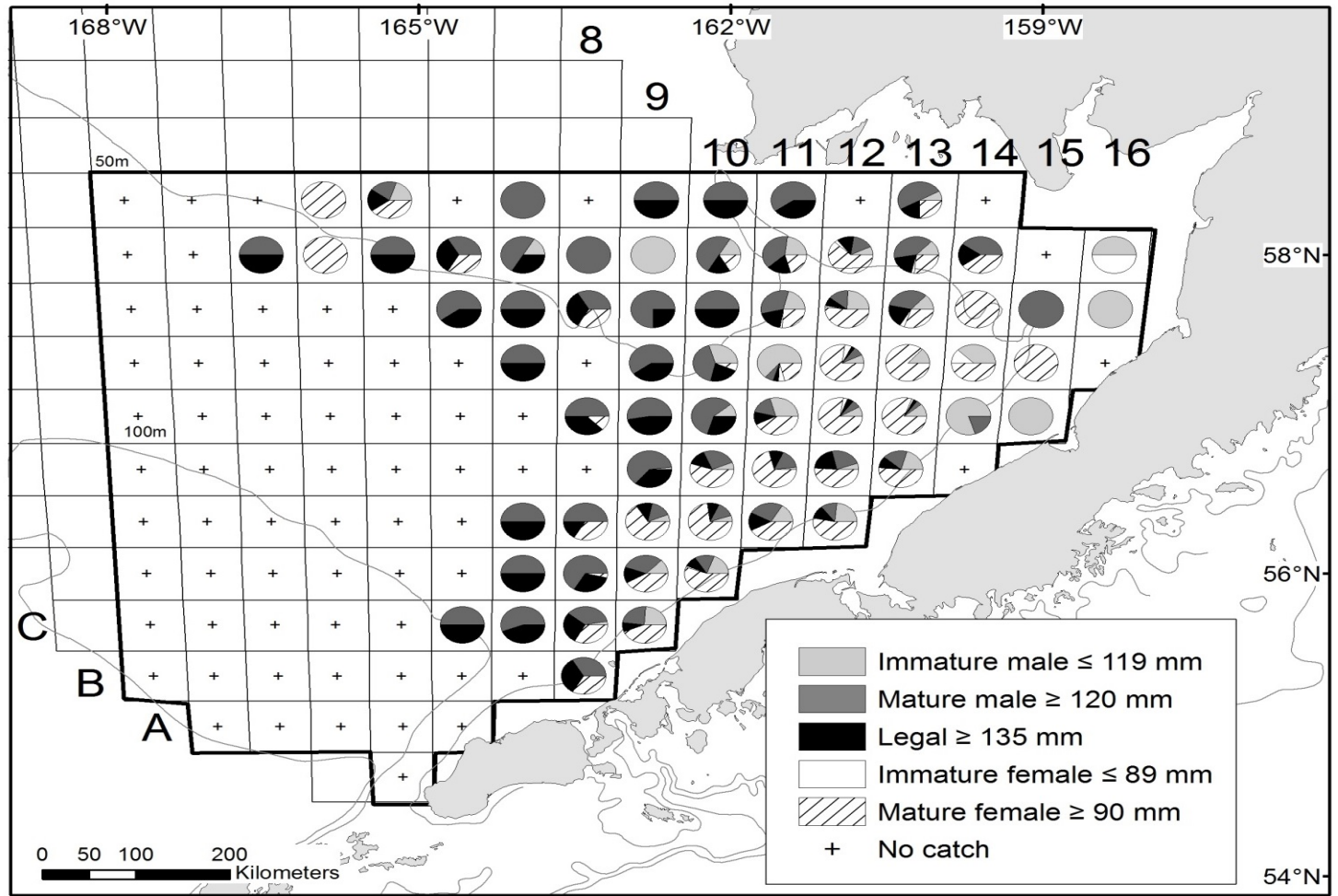
St. Matthew blue king crab

# Management



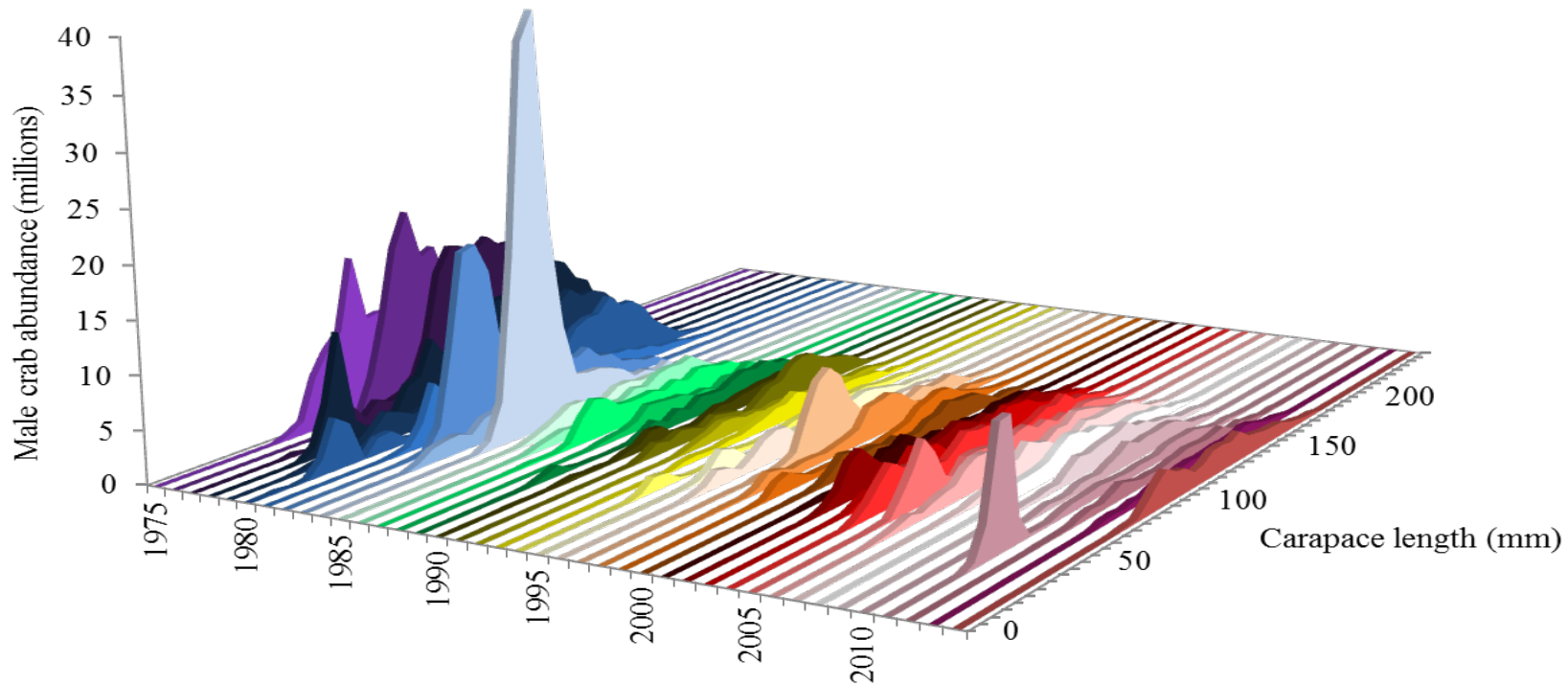
Historical mature male abundance (millions) for six commercial species caught on National Marine Fisheries Service eastern Bering Sea bottom trawl surveys.

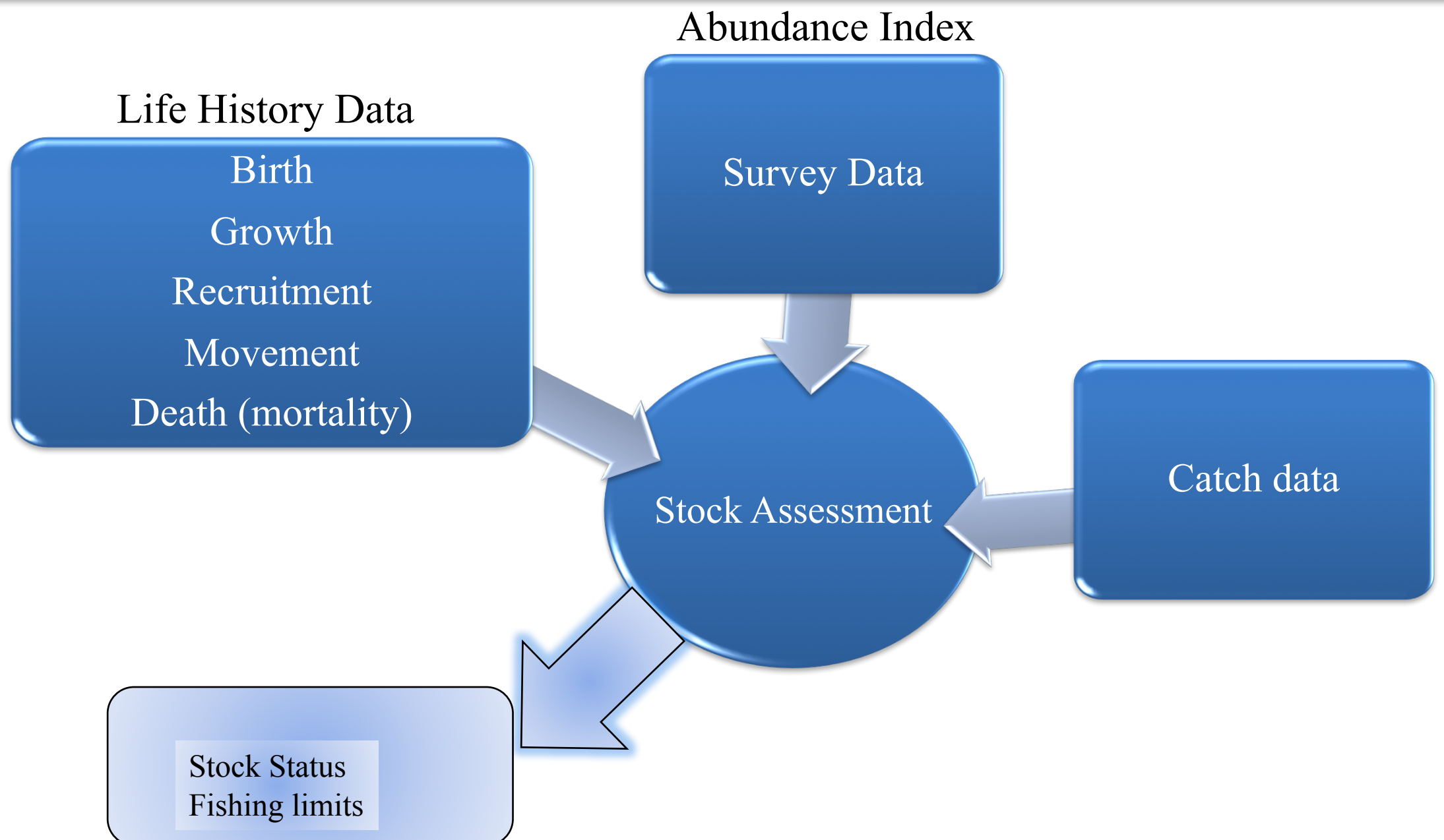
# Spatial Distribution: e.g., Bristol Bay Red King Crab





# Size Distribution: e.g., Bristol Bay Red King Crab





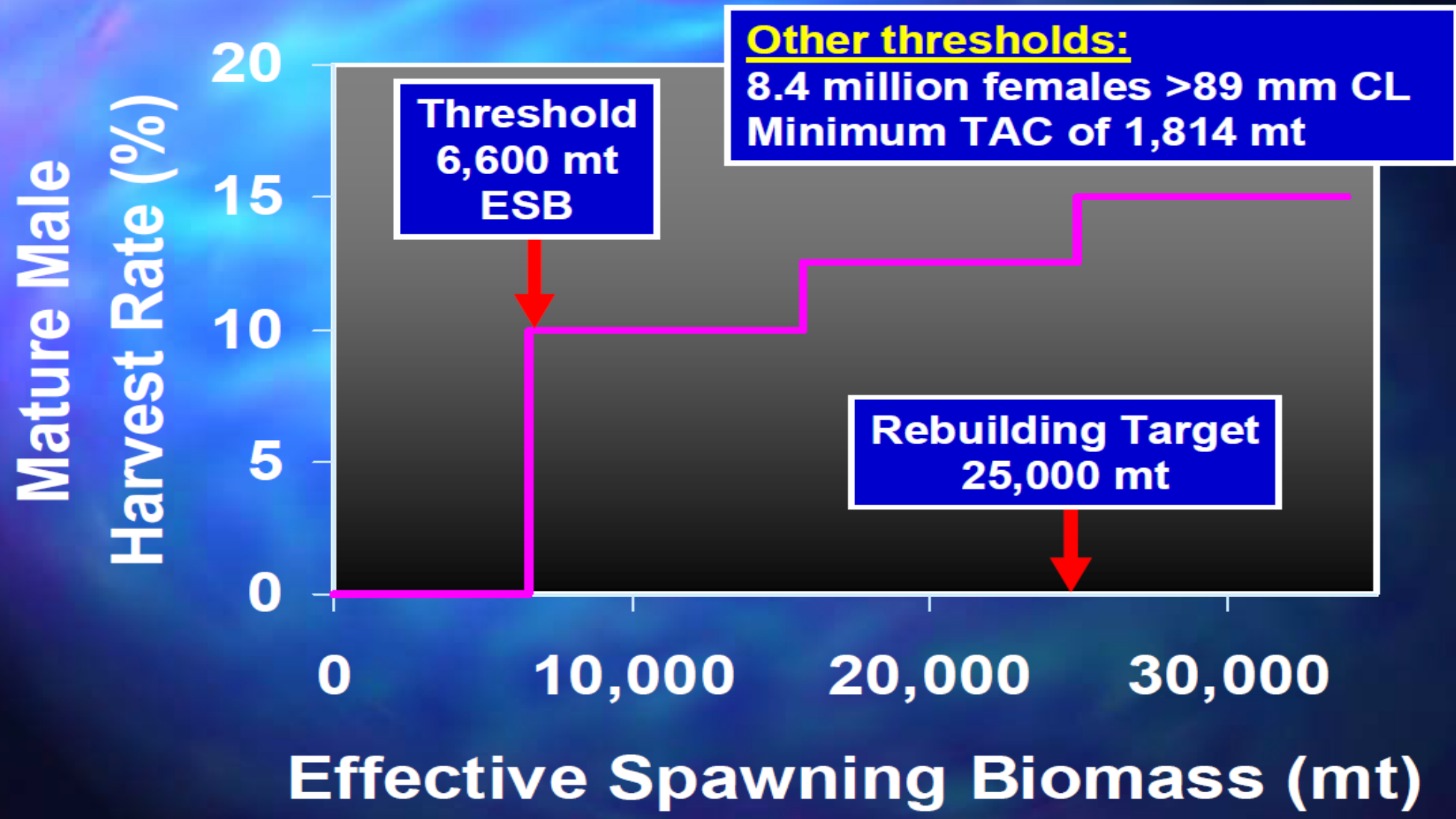


## Survey Data

- Estimate abundance, biomass, and size distribution
- Population above critical thresholds?
  - Used as benchmark for harvesting a given stock
  - Exploitation rates then applied to estimate of population abundance to calculate TAC



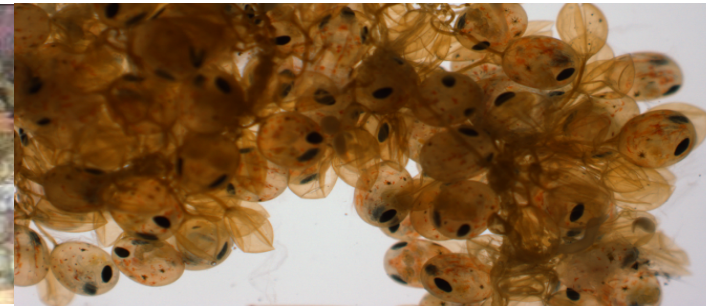
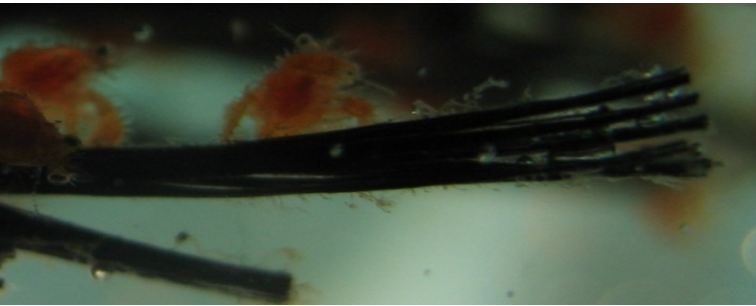
# Bristol Bay RKC Harvest Strategy





## Other Data for Stock Assessment Models

- Observer data: (e.g., size, sex)
- Dockside sampling (e.g., size, shell condition)
- Landings (# crabs, total weight)





## Current and Future Issues

Impacts of climate change: ecosystem issues

- How will crabs adapt to changing environment?
- Temperature increases, ocean acidification, range expansions, etc.

Continued depressed status of many crab stocks

- Gulf of Alaska stocks, Prib BKC

Stock enhancement through release of artificially cultured juveniles

- Viable option for stock rehabilitation?



Thank you



In terms of federal management, what do the three S's stand for with reference to setting catch limits?

- Size
- Sex
- Season
- Selectivity

## Management

*Quiz - 4 questions*

Last Modified: Jun 23, 2015 at 09:17 AM

### PROPERTIES

- On passing, 'Finish' button: [Goes to Slide](#)
- On failing, 'Finish' button: [Goes to Slide](#)
- Allow user to leave quiz: [After user has completed quiz](#)
- User may view slides after quiz: [At any time](#)
- Show in menu as: [Single item](#)



Edit in Quizmaker



Edit Properties



## Fisheries Technology



Is crab enhancement similar to salmon enhancement?



What about releases of cultured crab to the wild?



What happens to the females after they are brought in to the hatchery?



Could you hatch eggs in the wild?





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Juvenile Red king crab pod in Dutch Harbor, Alaska in 7 feet of water(video by R. Brewer)



Subsistence diving for Red king crab in Dutch Harbor, Alaska in 30 feet of water (video by R. Brewer)



