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Science Center

# Eastern Bering Sea Shelf Bottom Trawl Survey: Walleye Pollock CIE Review

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## Walleye pollock CIE review

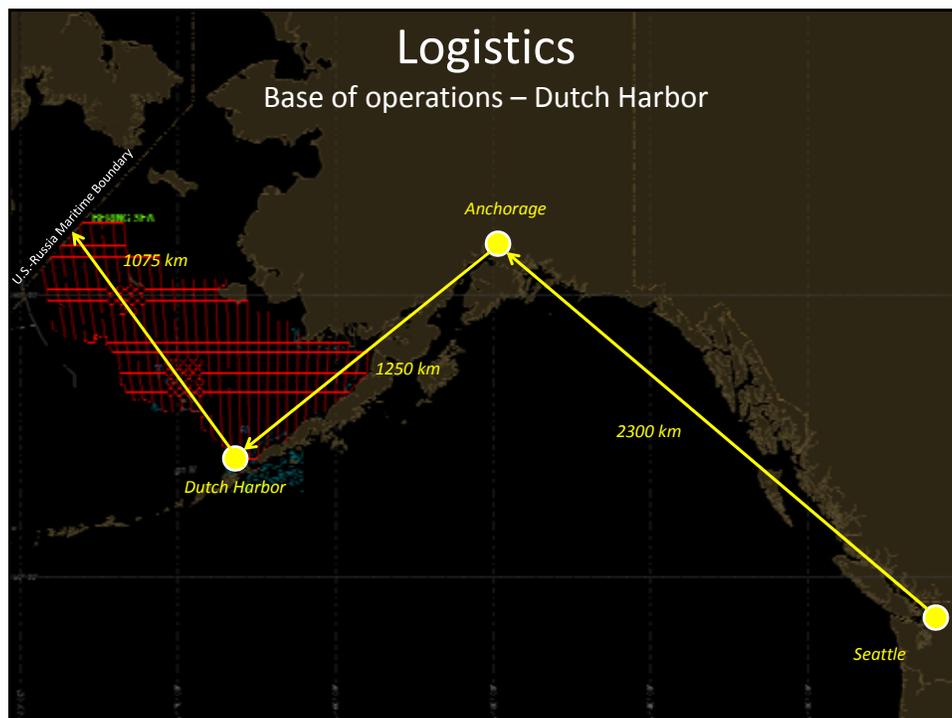
### Presentation outline

- Eastern Bering Sea (EBS) shelf bottom trawl survey
  - Purpose
  - Logistics, methods, design, sampling
  - Environment
- Products
- Density dependent trawl efficiency
- Availability of pollock to survey trawl
  - Vertical
  - Spatial

## EBS shelf bottom trawl survey

### Multi-purpose and multi-species survey

- Assessment and management
  - Commercial fish species  
(14 species & 9 taxonomic groups)
  - Commercial crab stocks  
(7 commercial crab stocks)
- Biological & oceanographic data  
(e.g., age, growth, food habits, spatial distribution, maturity, acoustic backscatter, genetics, systematics, pathology, EFH, CTD, light intensity, etc.)
- Ecosystem assessment & modeling



## Survey charter vessels

### Past and present

<p>University of Washington RV <i>Alaska</i> 1983 – 1992 10 years</p>			<p>NOAA Ship <i>Chapman</i> 1982 – 1984 3 years</p>
<p>FV <i>Aldebaran</i> 1993 – 2005 2007-2012 <b>19 years</b></p>			<p>FV <i>Arcturus</i> 1993 – 2009 <b>17 years</b></p>
<p>FV <i>Alaska Knight</i> 2010 -present 6 years</p>			<p>FV <i>Vesteraalen</i> 2014 -present 2 years</p>

Contracted through 2018

## Survey personnel

### \*Lead positions

- Six scientists
  - Field Party Chief\*
  - Deck Lead\*
  - Crab Lead\*
  - IPHC, ADF&G, Stomachs
- Six vessel crew
  - Captain
  - Engineer
  - Lead Fisher
  - Fishers
  - Cook




## Research bottom trawl

83-112 Eastern

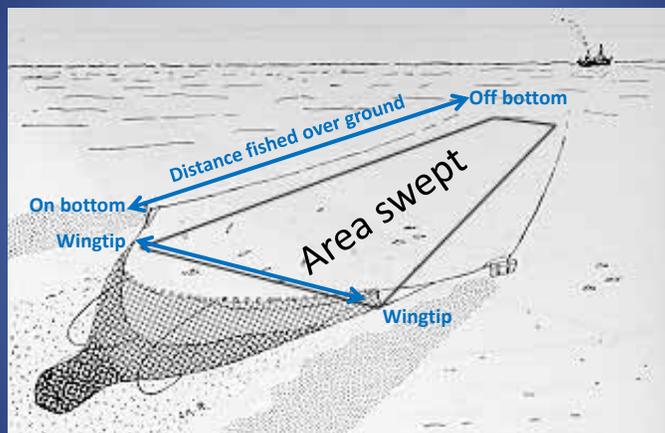


- Specifications for standardized survey trawl construction:

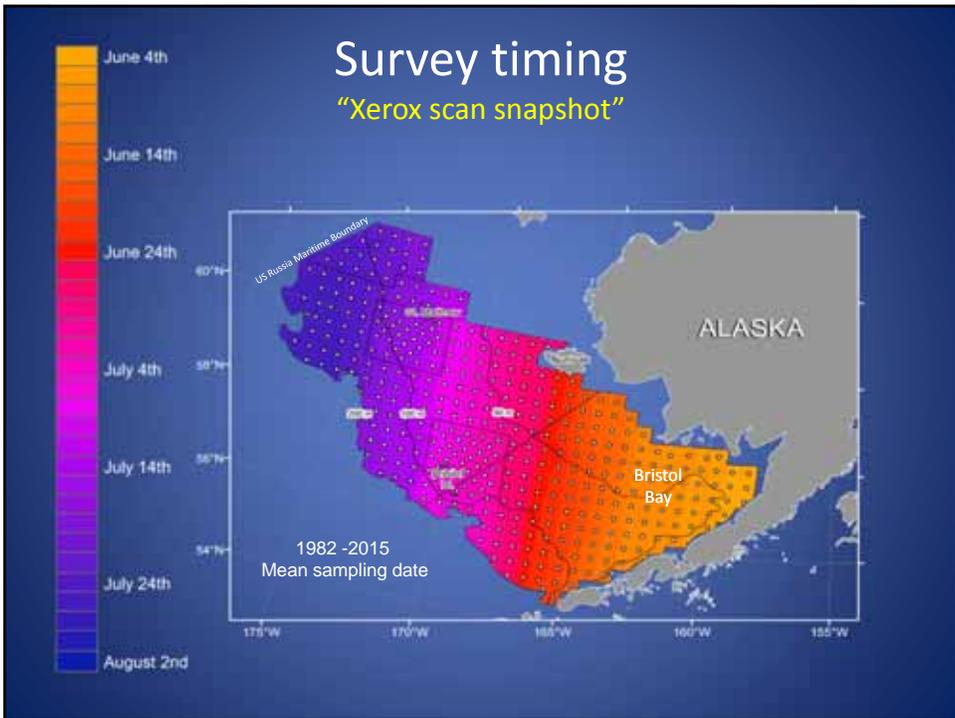
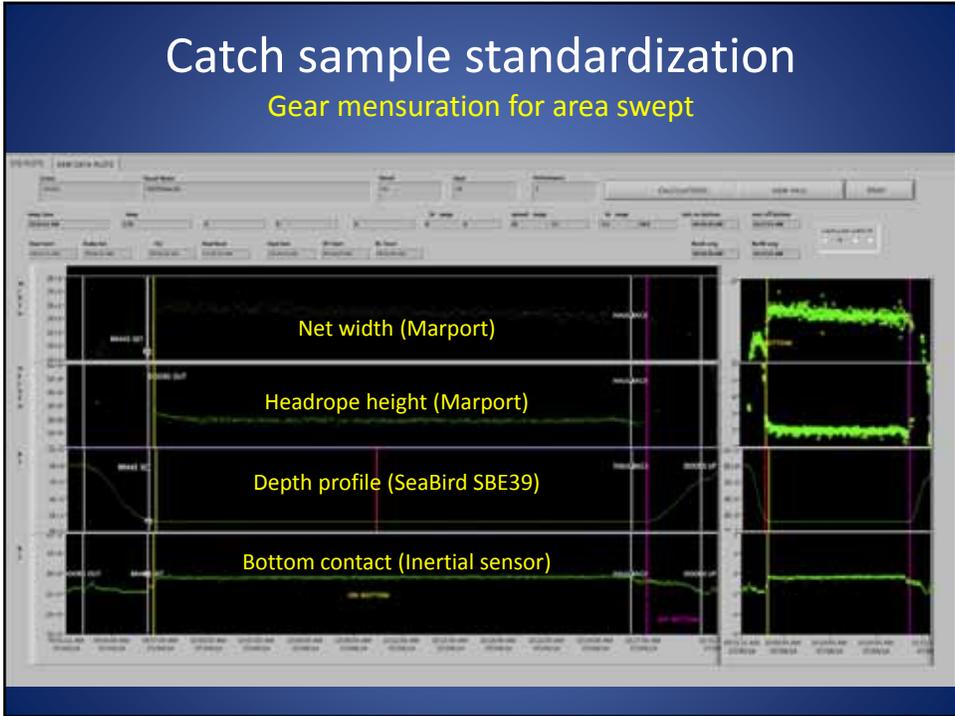
Stauffer, G. (compiler). 2004. NOAA protocols for groundfish bottom trawl surveys of the Nation's fishery resources. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-65, 205 p.

## Catch sample standardization

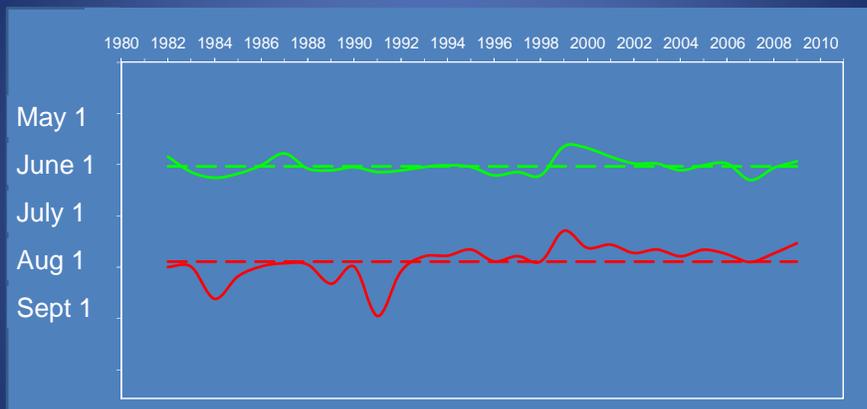
Area swept



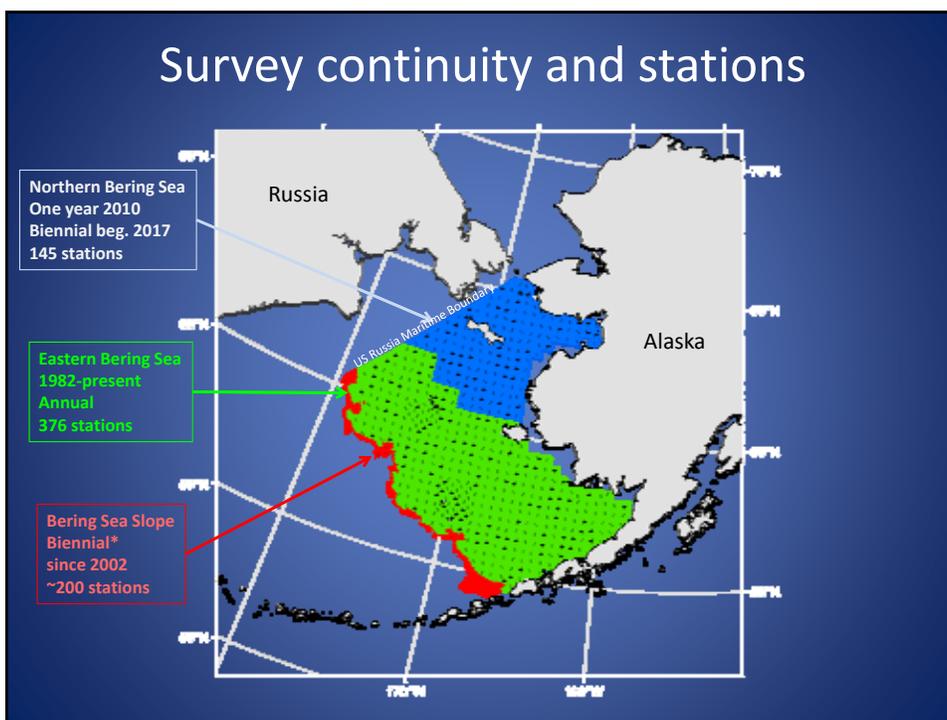
- Standard tow is 30 minutes (brakeset to haulback) at towing speed 3 knots over ground
- Protocols for standardized towing procedures: Stauffer 2004



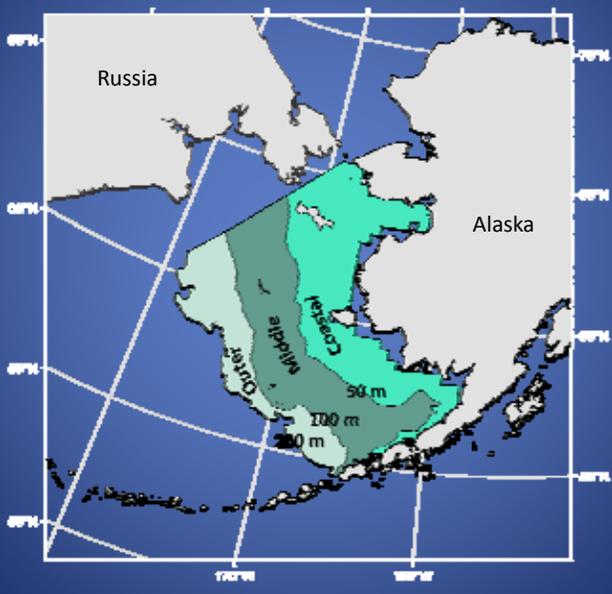
## Survey start/end dates



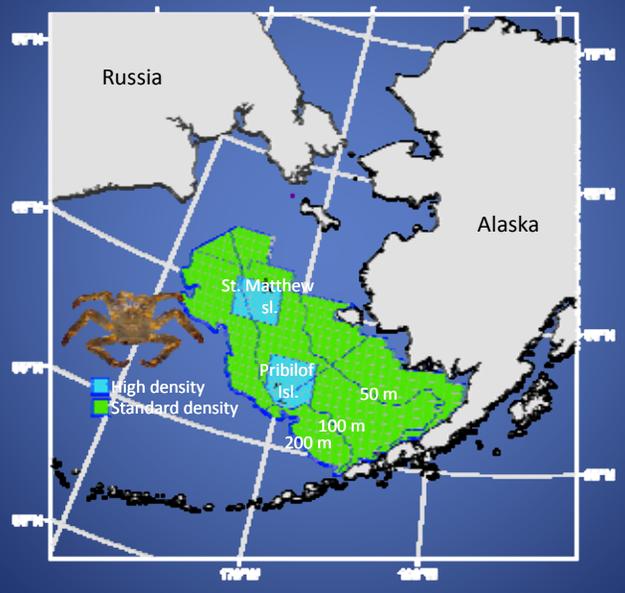
## Survey continuity and stations



### EBS shelf domains

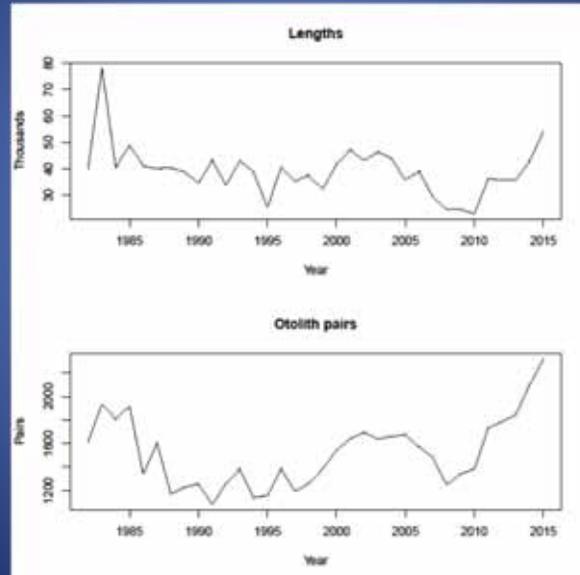


### Strata & sampling density



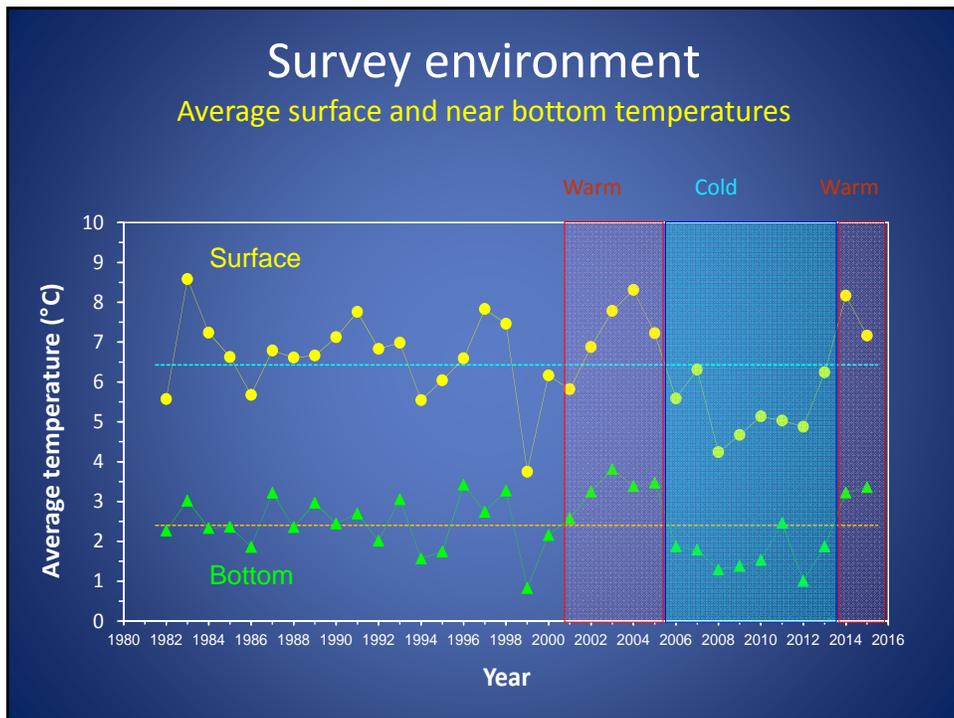
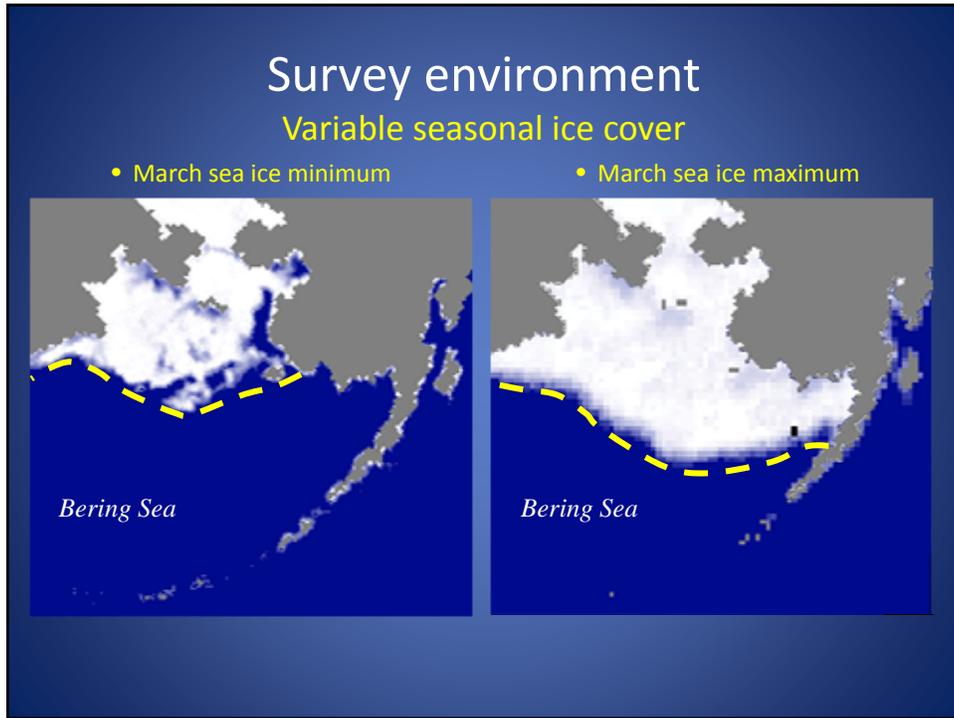
## Catch sampling

### Lengths and otolith pairs

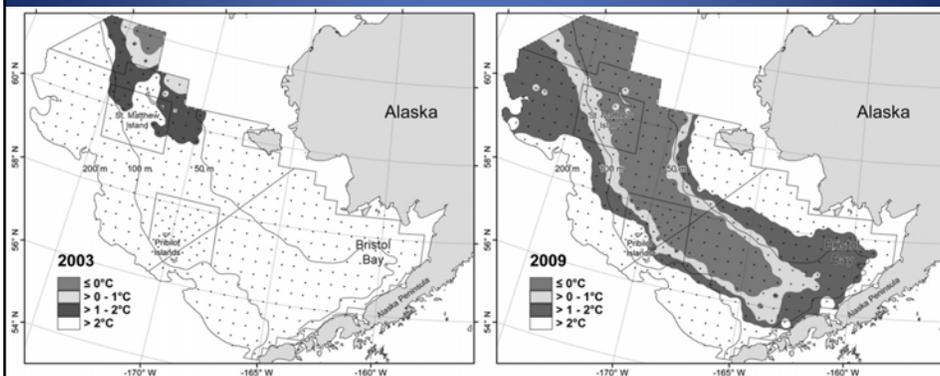


## Analysis

- Systematic design with fixed starting point
- Analytical procedures follow those of a Stratified RD
- Variance does not take into account spatial autocorrelation nor variability in sampling efficiency
- Alternative variance estimator investigated to (D'Orazio 2003)
  - resulted in lower variance estimate for most years
  - ignores other process errors (e.g., sampling efficiency, sampling process, density dependence, etc.)



## Survey environment

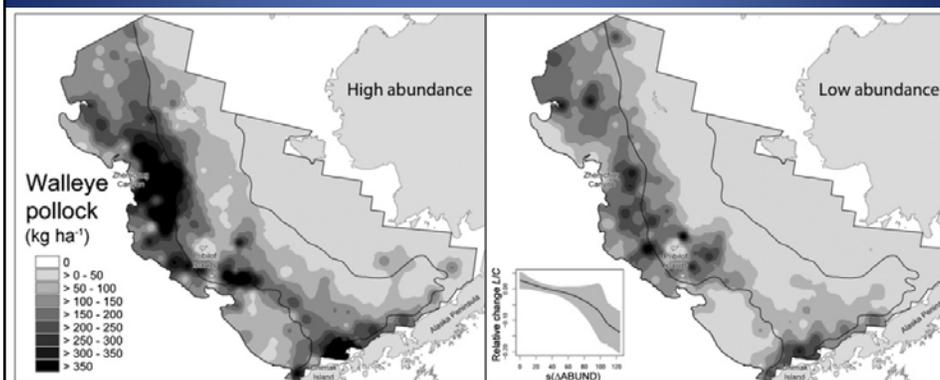


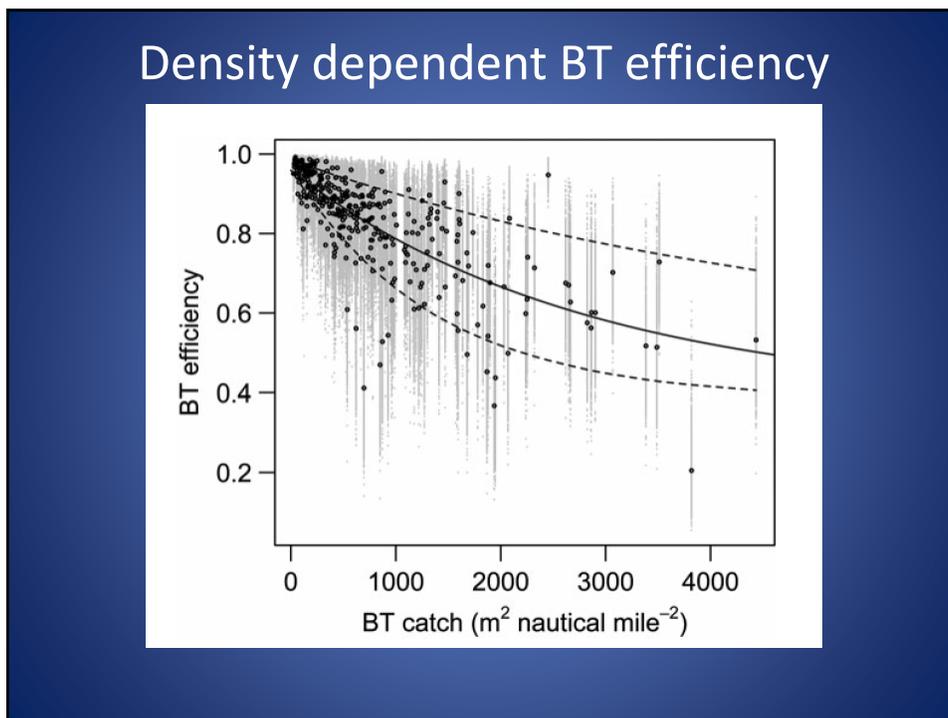
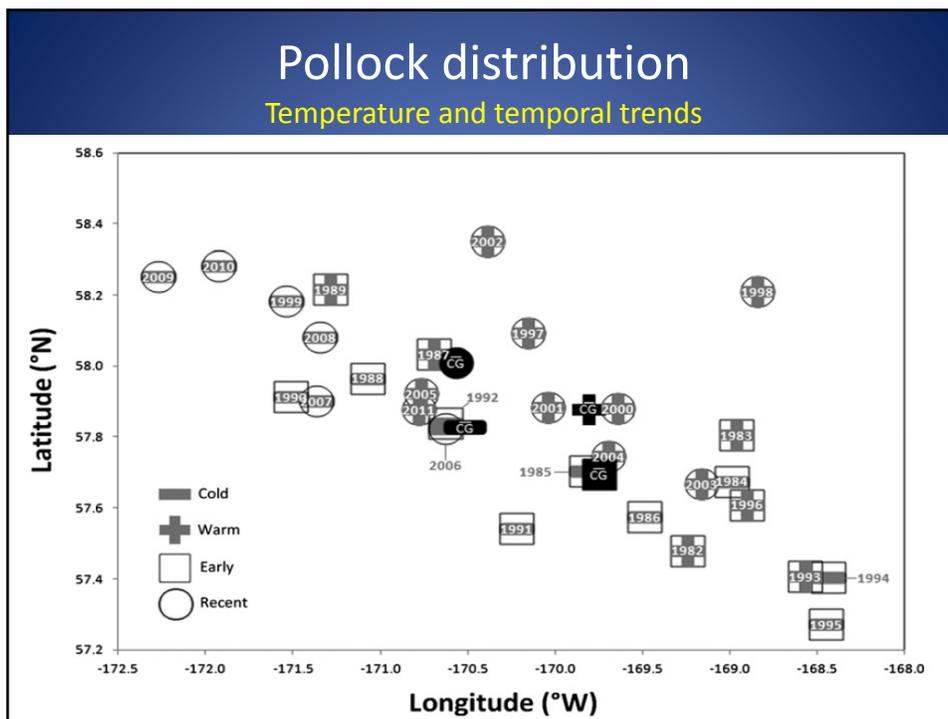
### Potential temperature effects:

- Survey trawl sampling efficiency
- Pollock spatial distribution
- Migration patterns
- Recruitment success
- Growth patterns (size-at-age)
- Reproductive maturity

## Pollock distribution

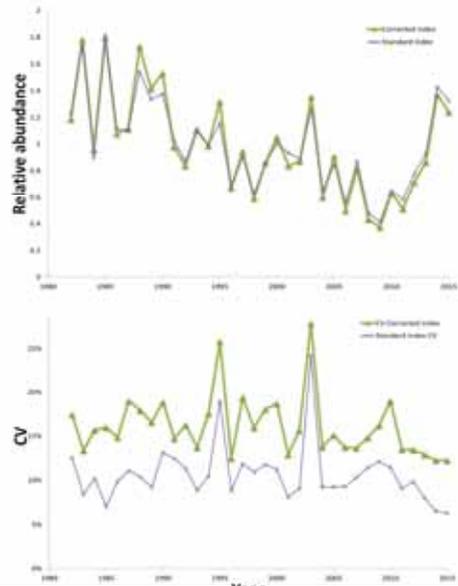
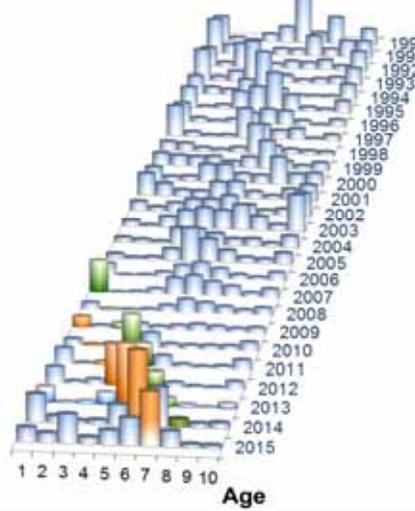
### Environmental effects



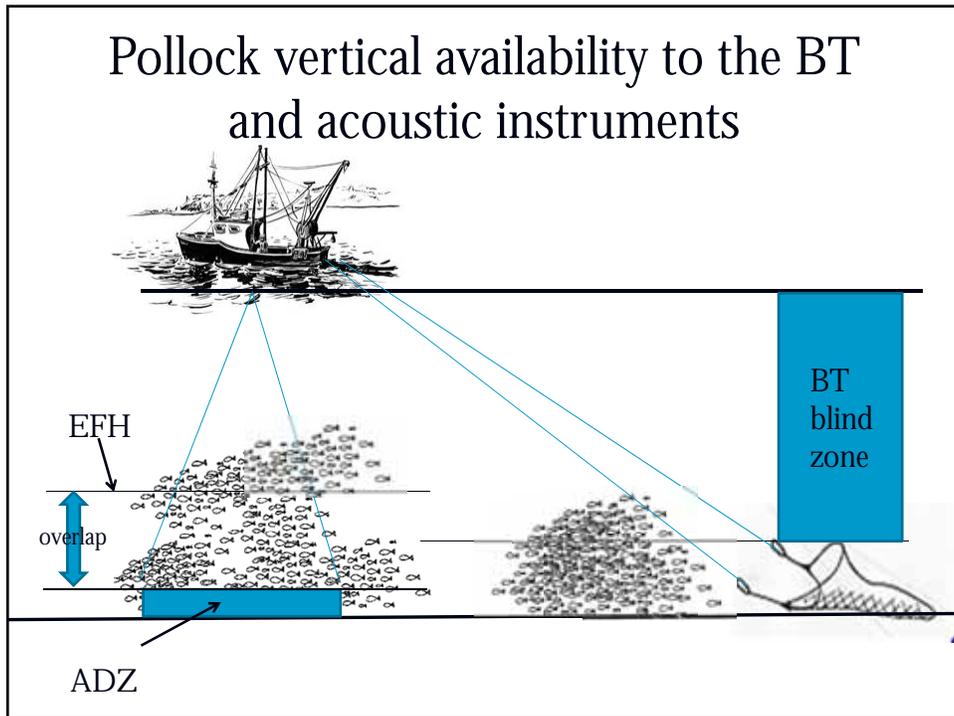


# Products

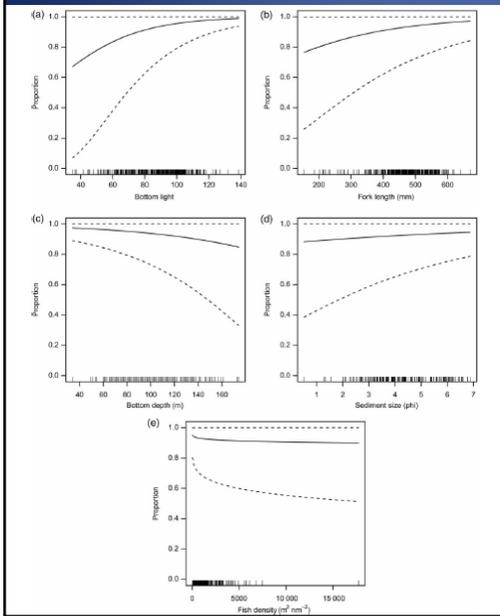
Bottom trawl survey numbers-at-age



## Pollock vertical availability to the BT and acoustic instruments

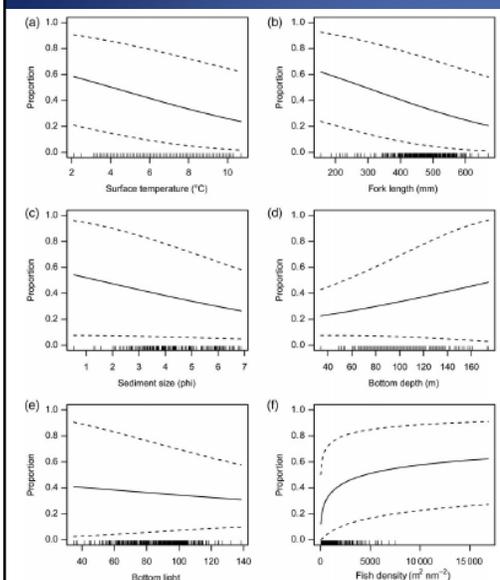


## Pollock availability to the BT



**Effective fishing height** - Indicates vertical herding – on average 16m above the bottom

## Pollock availability to the acoustics



**Currently acoustic estimates encompass vertical layer between 3m off bottom and 14m below surface.**

## Spatial availability



Thanks

Slides below are just in case if  
there are questions.

**Combine a subset of acoustic and  
BT data to estimate BT efficiency  
parameters and ADZ correction.**

### General shape of the model

Bottom trawl catch

Effective fishing height

$$S_{A,BT_i} = r_q \left( \sum_{0.5}^{EFH} s_A + ADZ \right) e^\epsilon$$

Overlap      Acoustic backscatter      Acoustic dead zone correction

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### General shape of the model

Bottom trawl catch

Effective fishing height

$$S_{A,BT_i} = r_q \left( \sum_{0.5}^{EFH} s_A + ADZ \right) e^\epsilon$$

Overlap      Acoustic backscatter      Acoustic dead zone correction

$$S_{A,BT_i} = \left( \frac{1}{r_q \left( \sum_{0.5}^{EFH} s_A + ADZ \right)} + \frac{1}{a} \right)^{-1} e^\epsilon$$

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## Bottom trawl efficiency parameters

### Density dependent efficiency of the survey BT (“ $a$ ”)

- Indicated hyperstability of BT survey CPUE and non-stationary catchability

### Effective fishing height (“EFH”) ~16 m

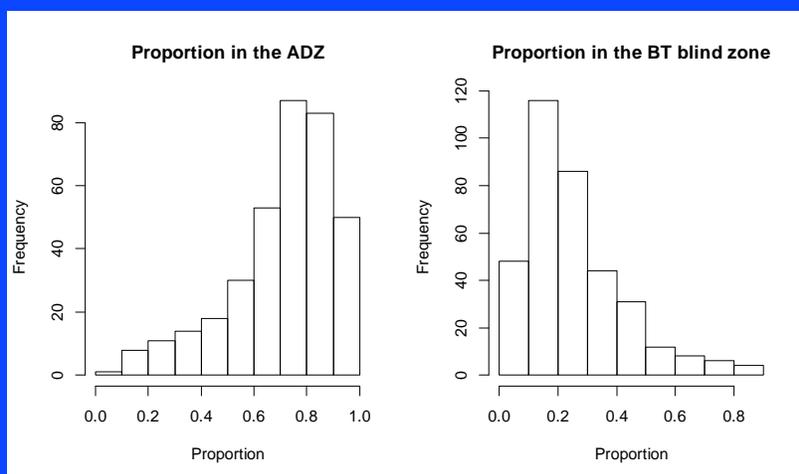
- Indicated vertical herding

### Catchability ratio (“ $r_q$ ”) ~0.96

- Indicated that density data from both surveys are comparable
- Indicated absence of horizontal herding by bottom trawl.

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## Proportion in blind zones (expected bias; $1-q$ )



Mean 0.71  
Median 0.75

Mean 0.26  
Median 0.21

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## Correct BT survey catch per unit effort (CPUE) estimates for density dependent efficiency of the BT trawl.

$$q = q_e q_a$$

$q_e$

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## Correcting for density dependence – why?

- Could result in hyperstable index
  - Bias stock assessment
- Could produce false trends
  - Bias stock assessment or any other study
- Implies non-stationary survey catchability in space and time
  - Errors in spatial dynamic studies and ecological modeling.

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## Correcting for density dependence – how?

- with acoustic data

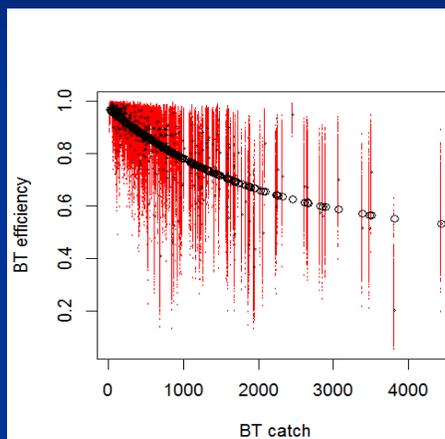
$$q_{e,i} = \frac{ar_q}{a + r_q \left( \sum_{0.5}^{EFH} s_{A,i} + ADZ_i \right)}$$

- without acoustic data

$$q_{e,i} = f(BT)$$

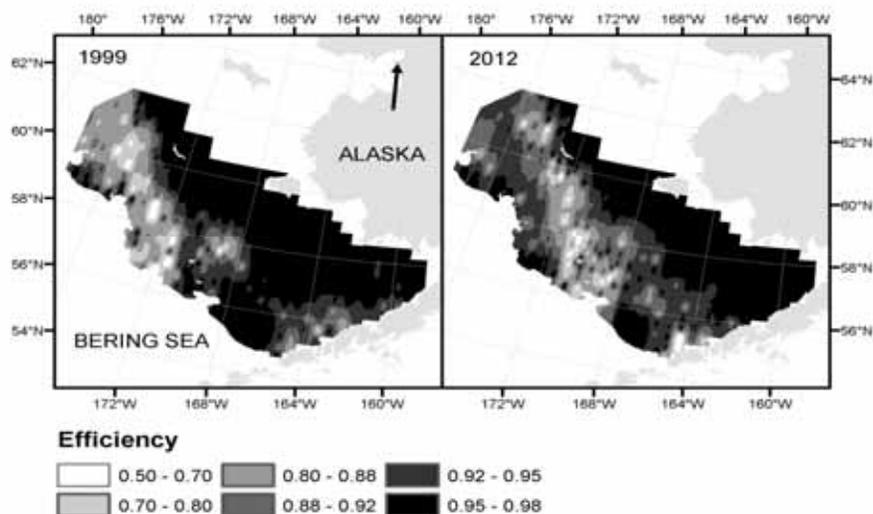
- corrected CPUE

$$CPUE_{corr,i} = CPUE_i / q_{e,i}$$



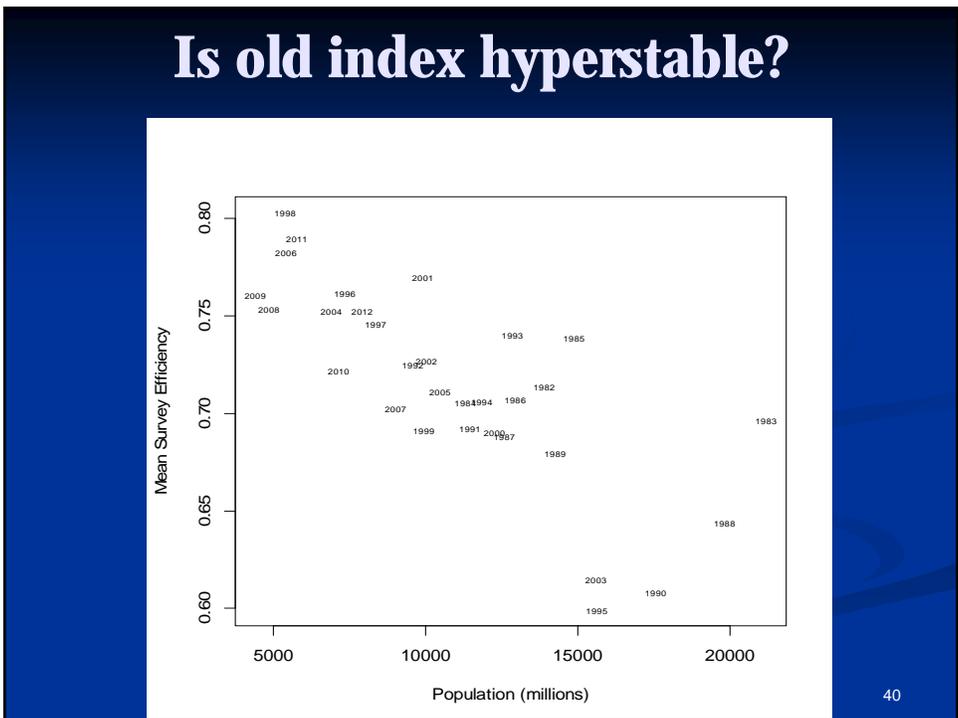
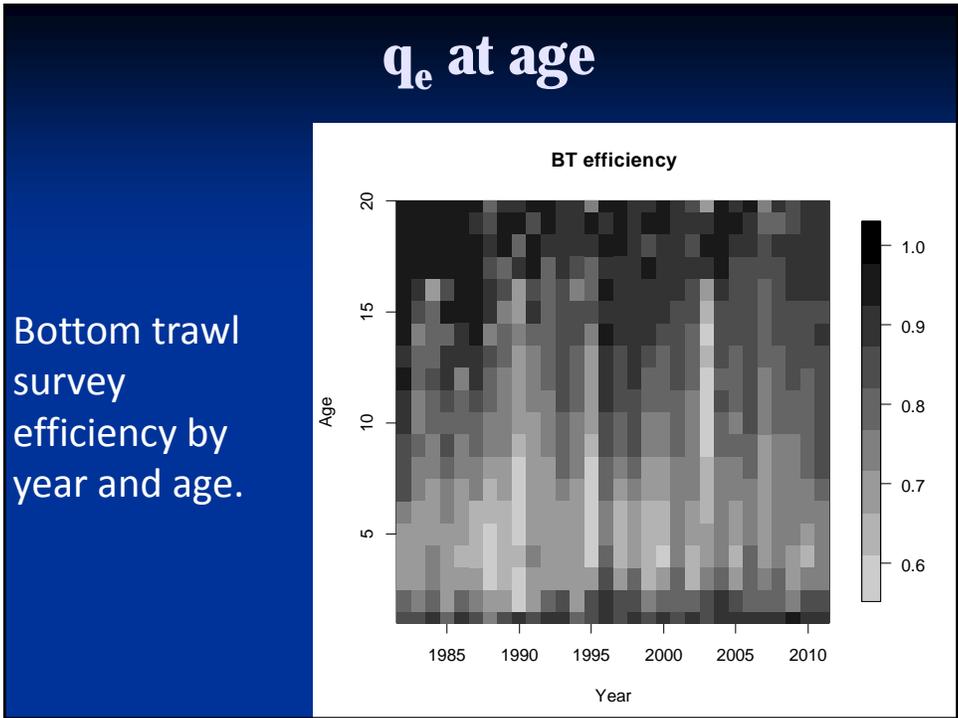
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## $q_e$ in space



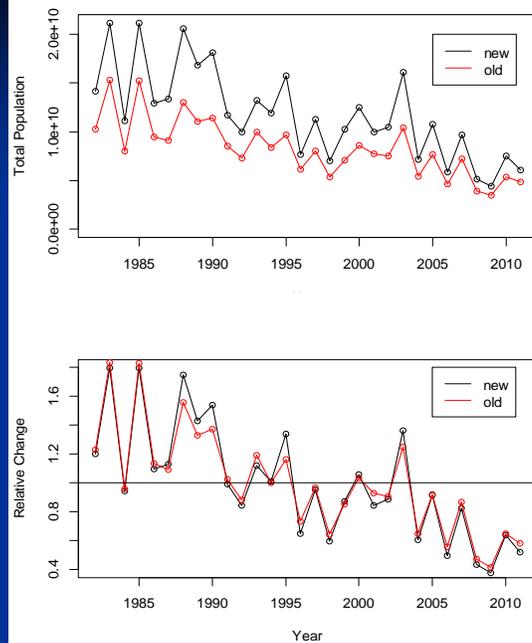
Examples of distribution of  $q_e$  from years 1999 and 2012.

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## Population estimates

- New relative estimates are larger than old when abundance is high and lower than old when abundance is low
- Old index was underestimating change



## Main points

- Correct for density dependence to avoid hyperstability
- More realistic estimate of variance
- Age structure can be corrected for bias associated with density dependent BT efficiency
- Distribution can be corrected for variable efficiency