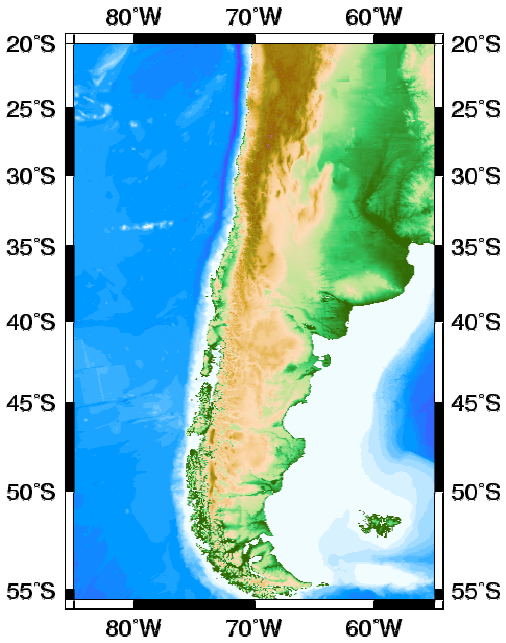
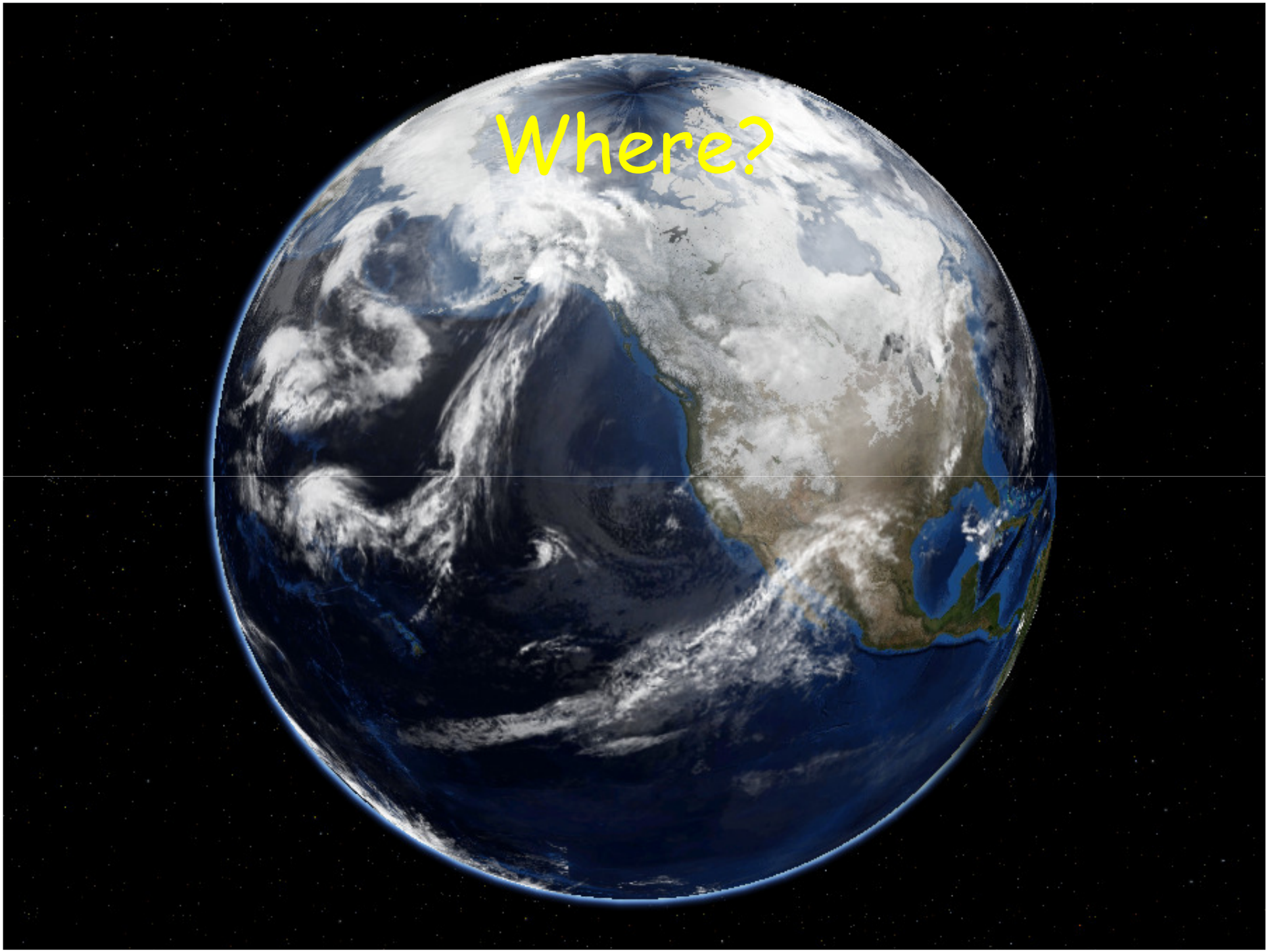
Chilean Jack Mackerel Workshop

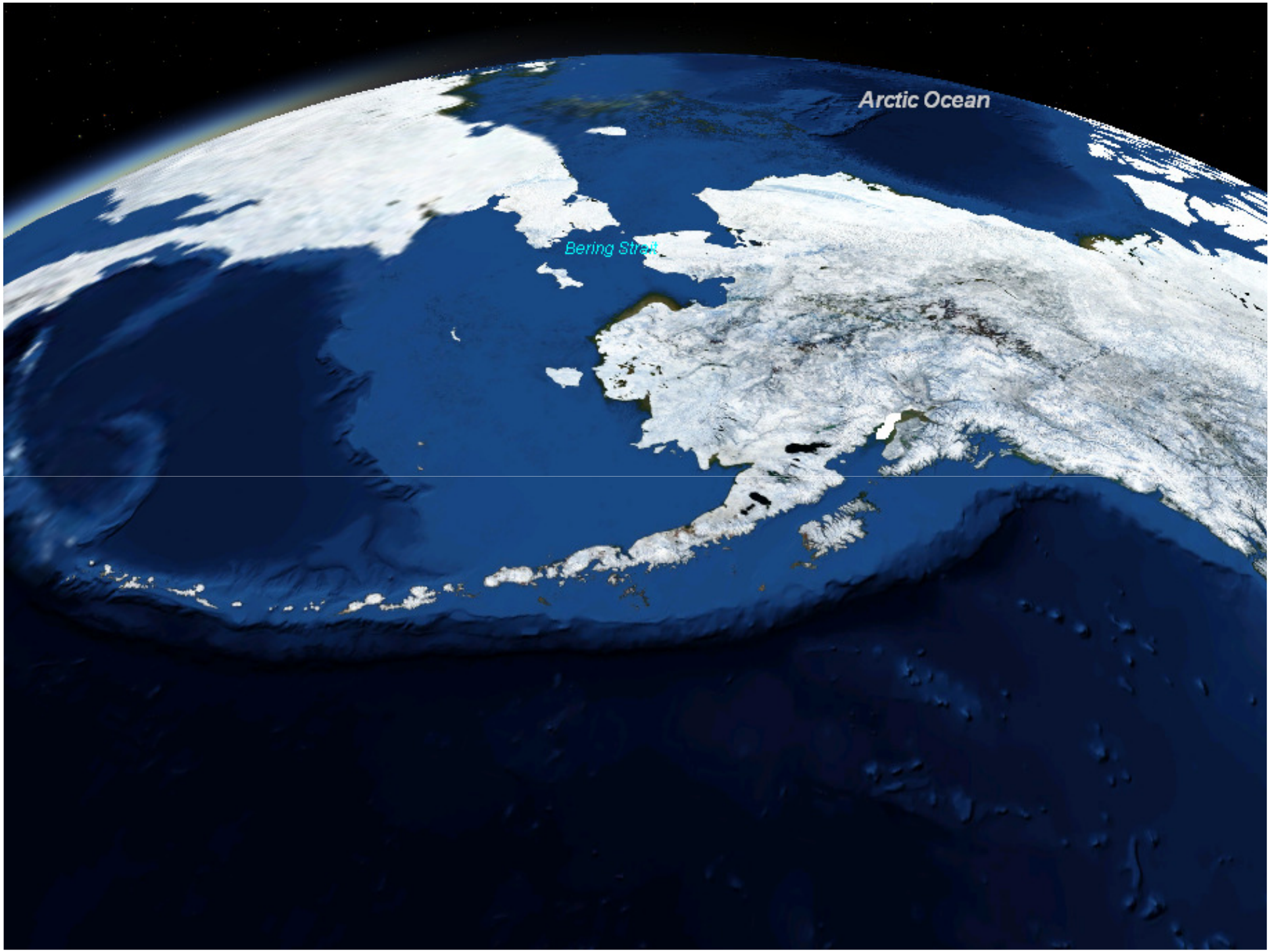
Assessment approaches when spatial distribution adds uncertainty to stock structure

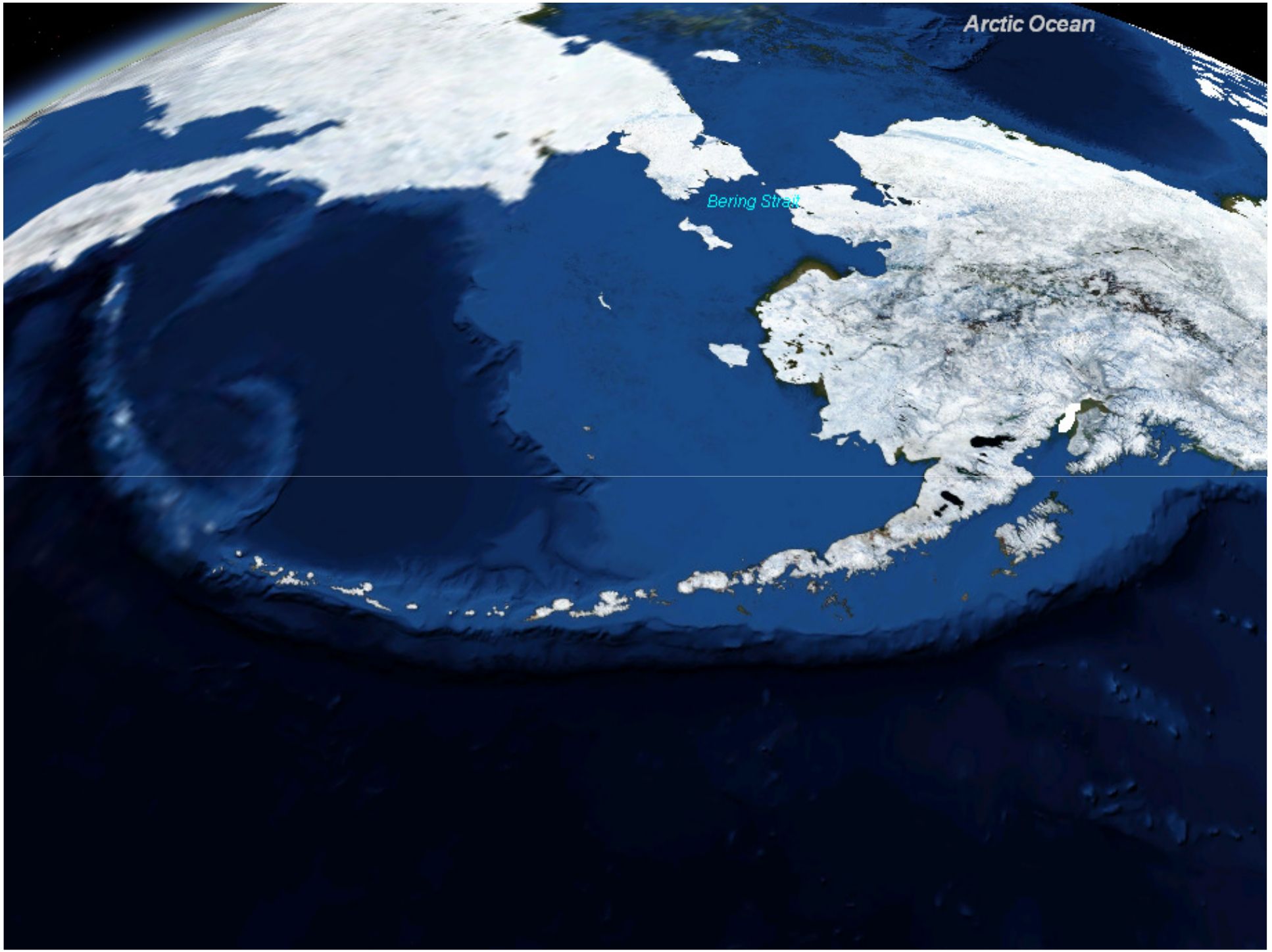
Jack Mackerel Workshop
June30-July 4th 2008

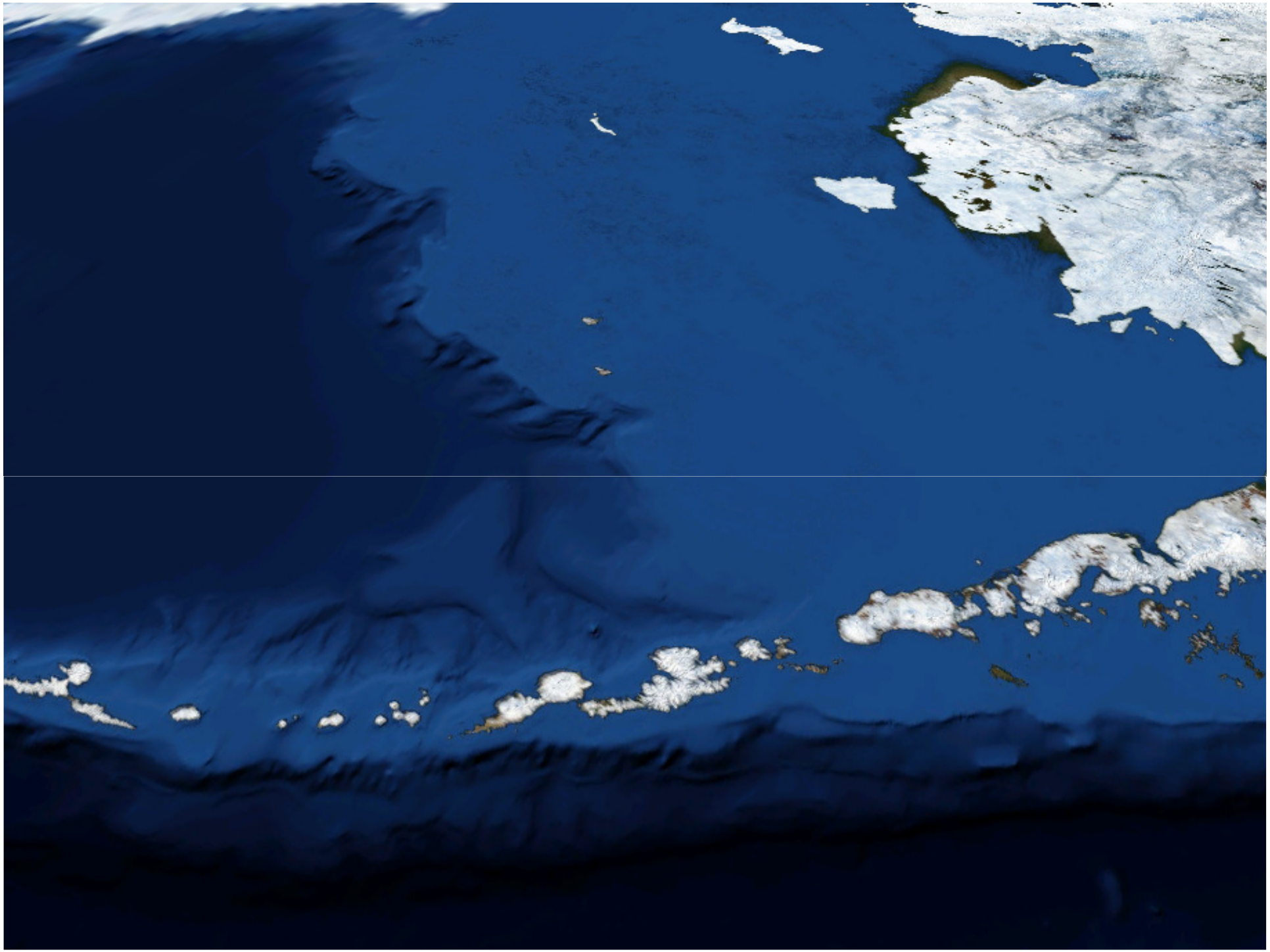


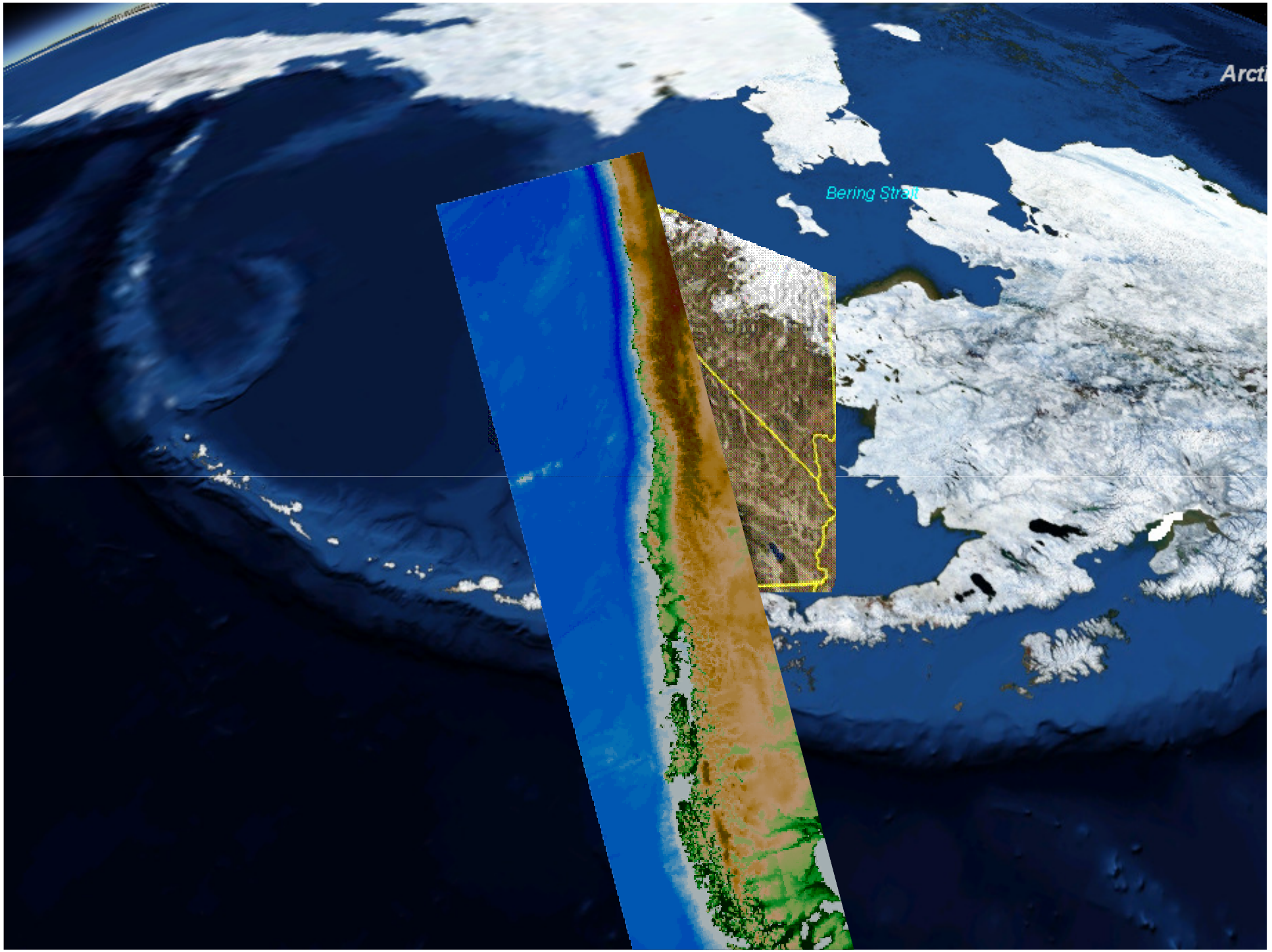
James N. Ianelli
Alaska Fisheries Science Center
Seattle, WA


Where?


Arctic Ocean
Bering Strait


Arctic Ocean
Bering Strait




Bering Strait

What fish?

- Alaska pollock (mainly)
- Pacific hake (briefly)

Key differences

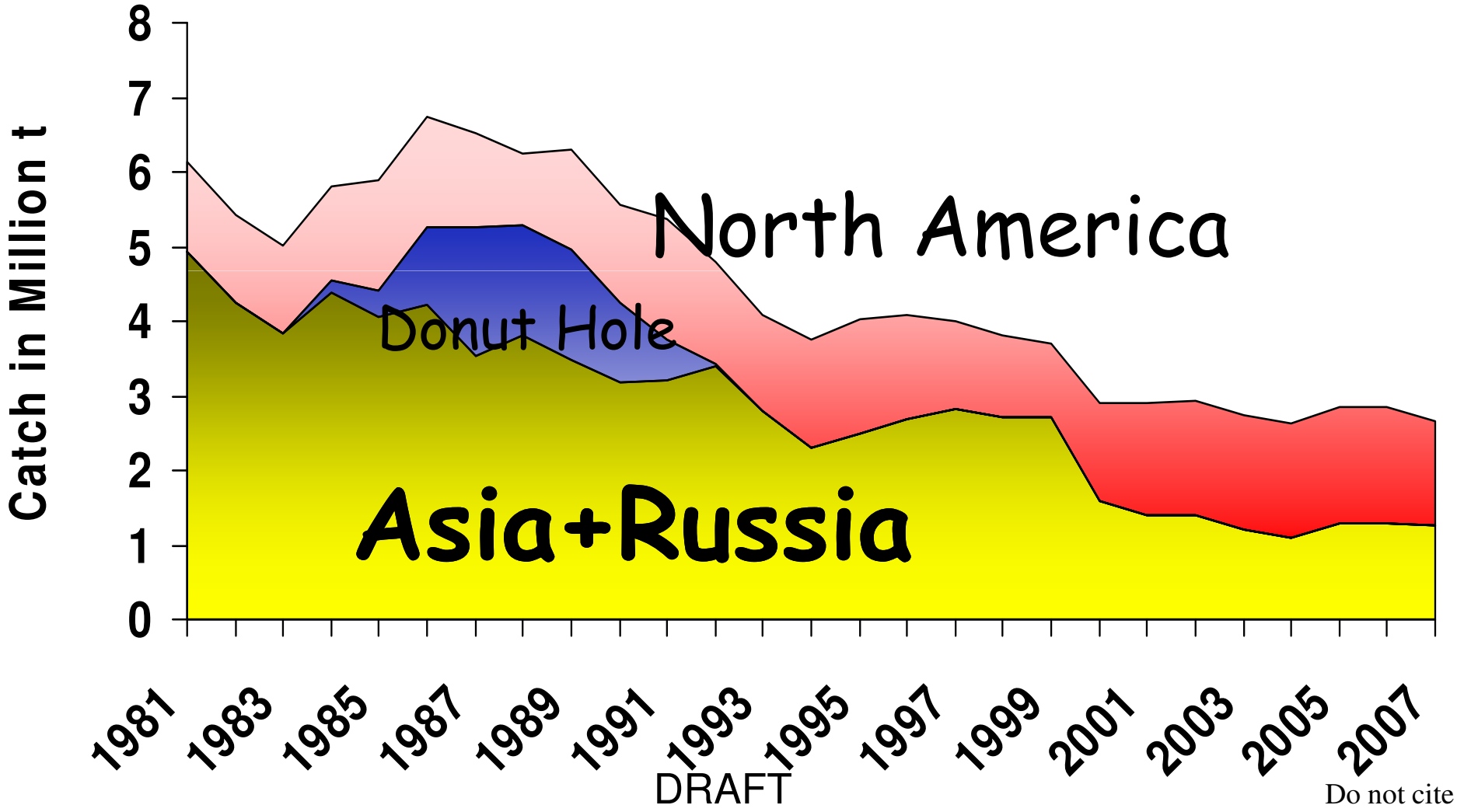
Between jack mackerel and Alaska pollock

- **Size of areas**
- **Oceanographic conditions**
  - Pollock relatively stable, at least for "core" area
- **Active management systems**
- **Agreements**

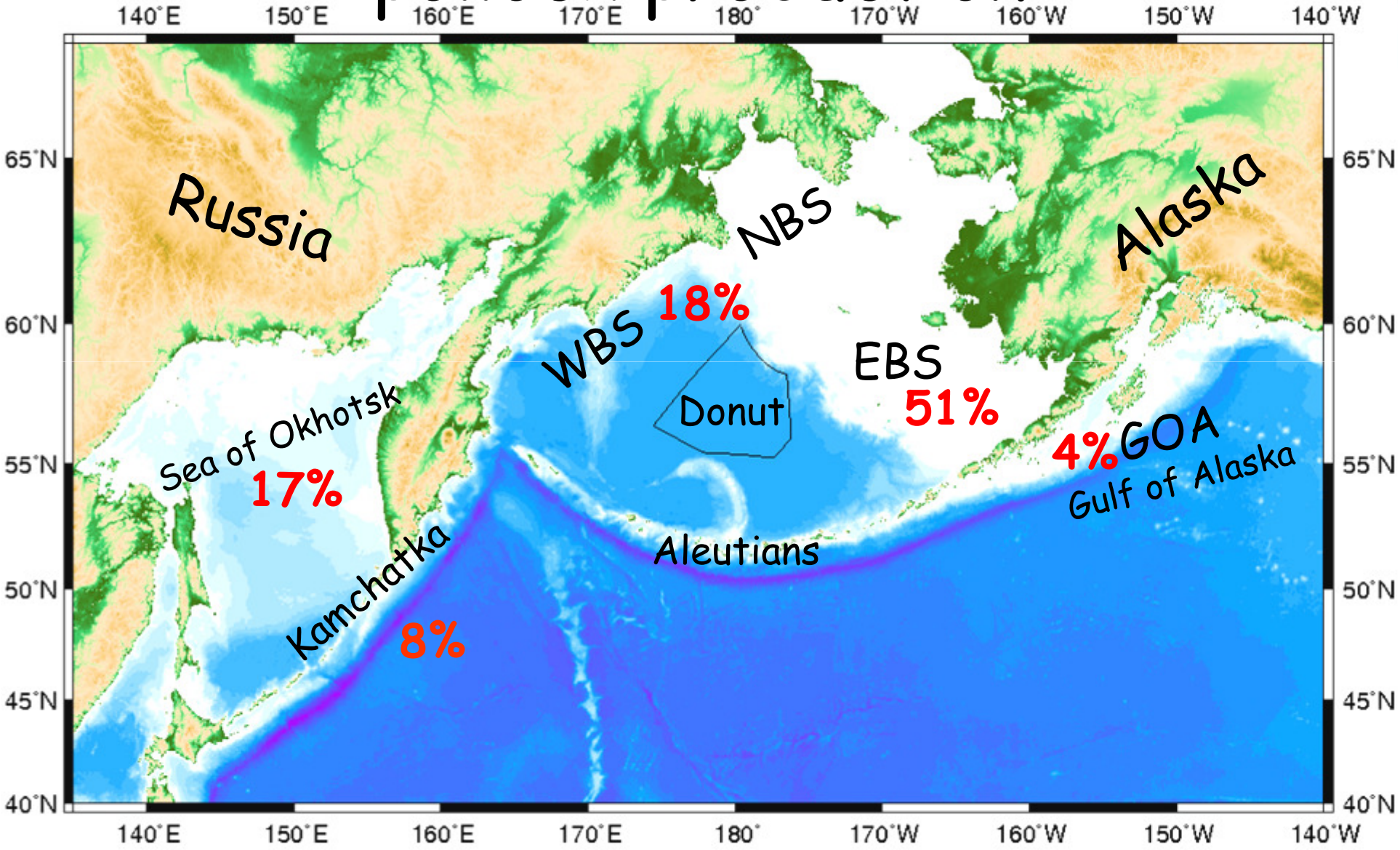
Key similarities

- **Productive stocks**
- **Demographic characteristics**
- **Stock plasticity**
  - Ability to occupy favorable habitats
- **Smaller pockets of older and larger fish in geographically distinct areas**
- **Hypotheses on stock structure/migration controversial**
- **International implications**

Pollock Catch 1981-2007

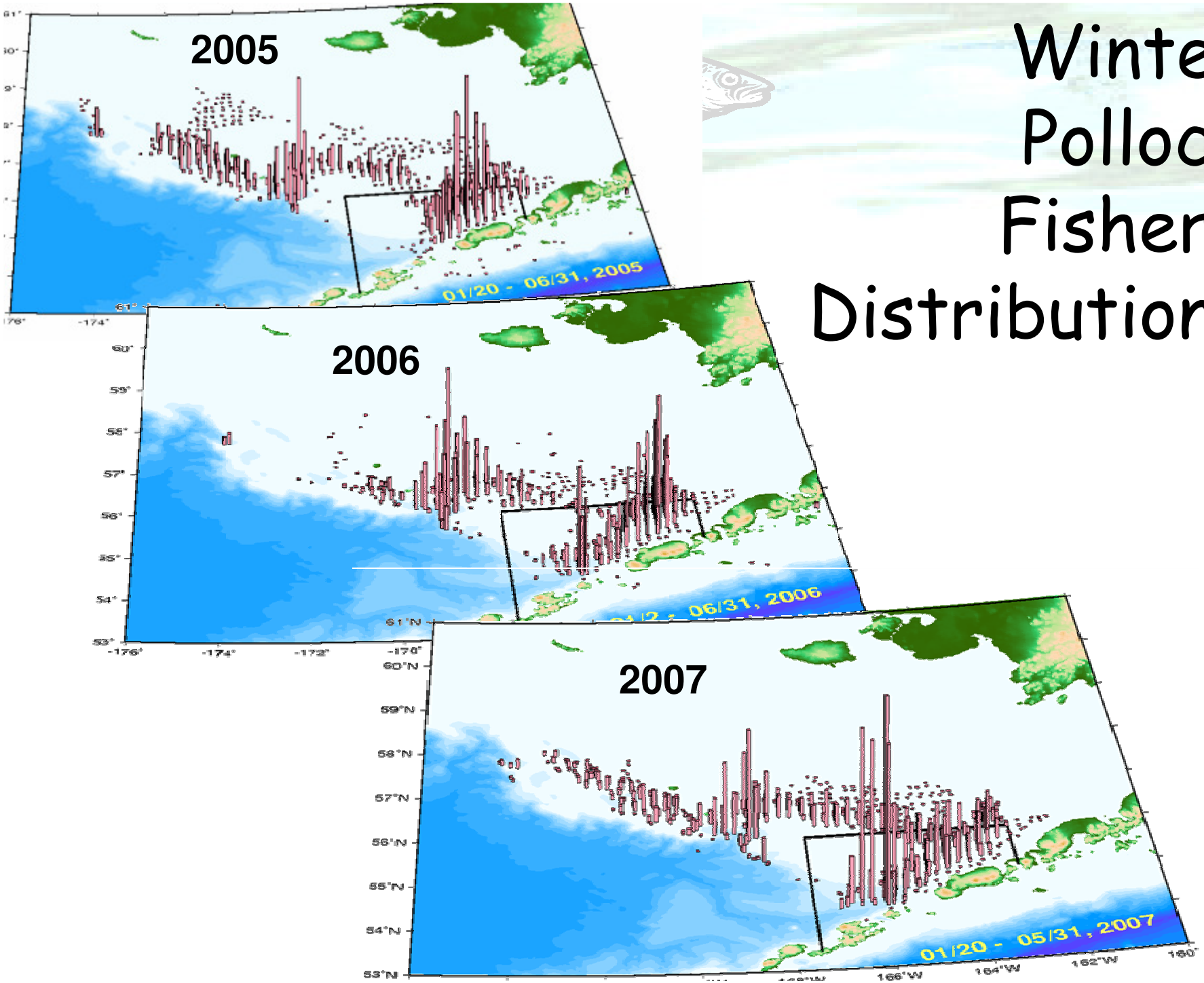


Fishery Areas and approximate pollock production

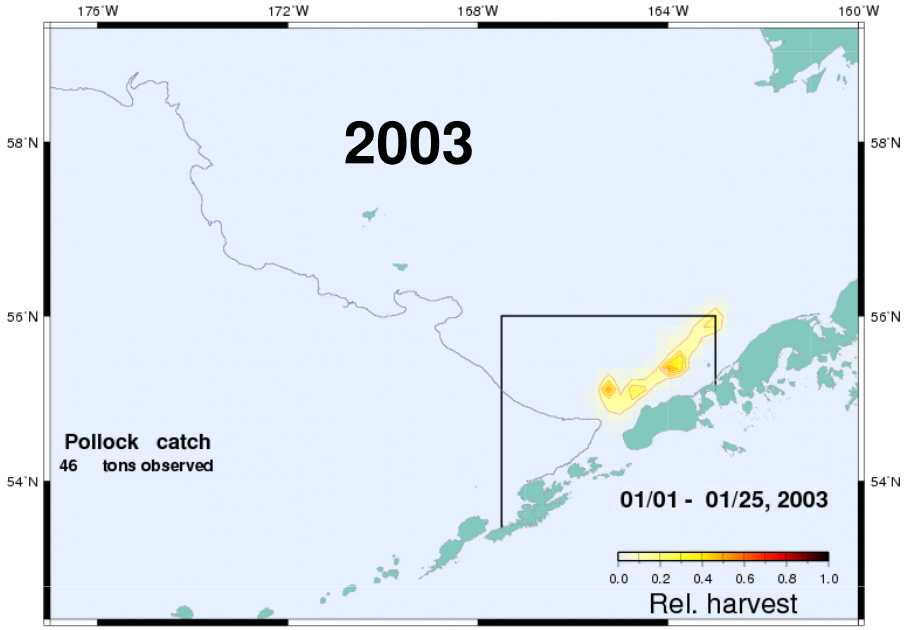


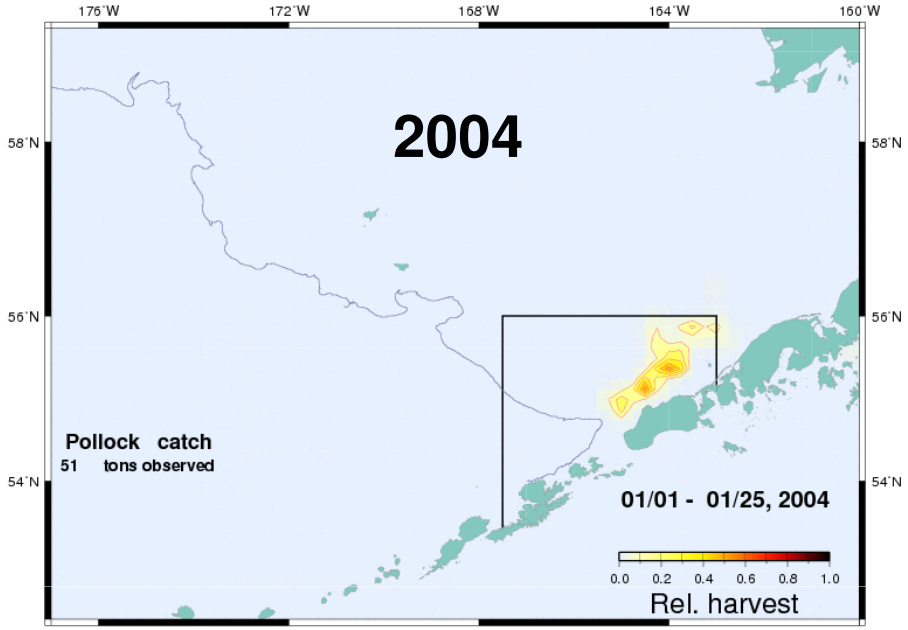
Assessment analyses within US zone

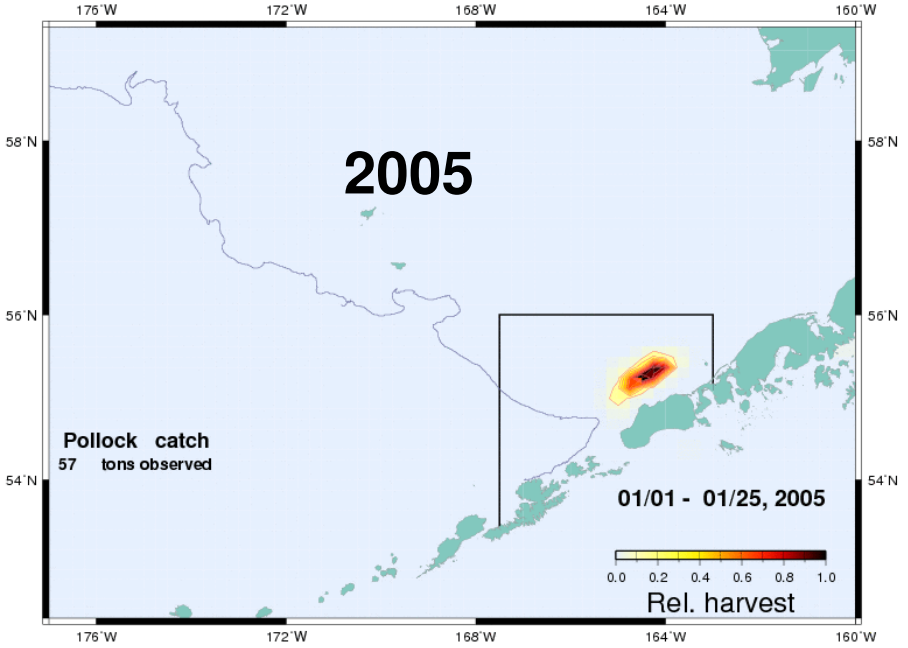
Winter Pollock Fishery Distributions

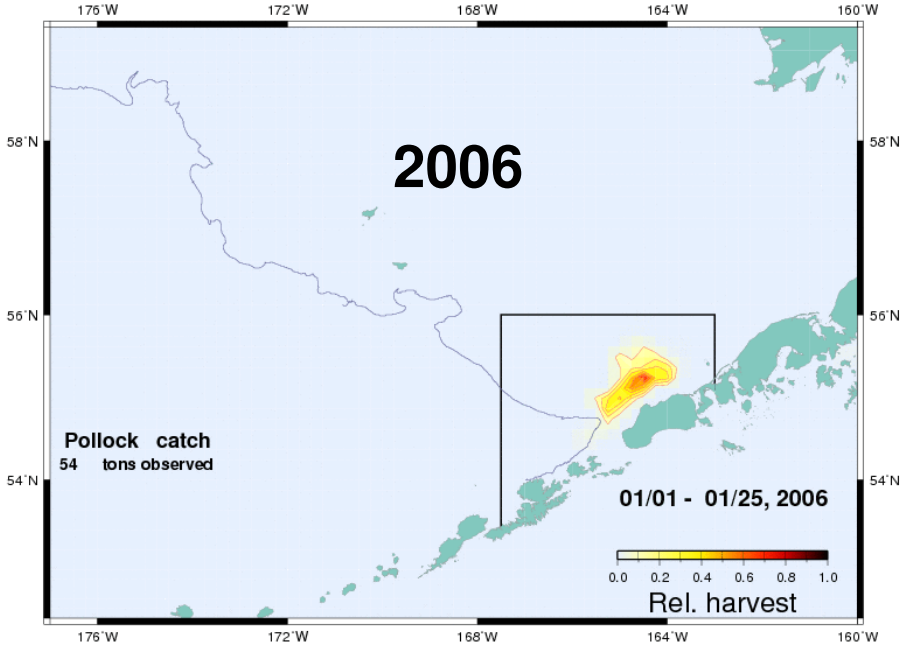


Pollock A season, 2003-2006

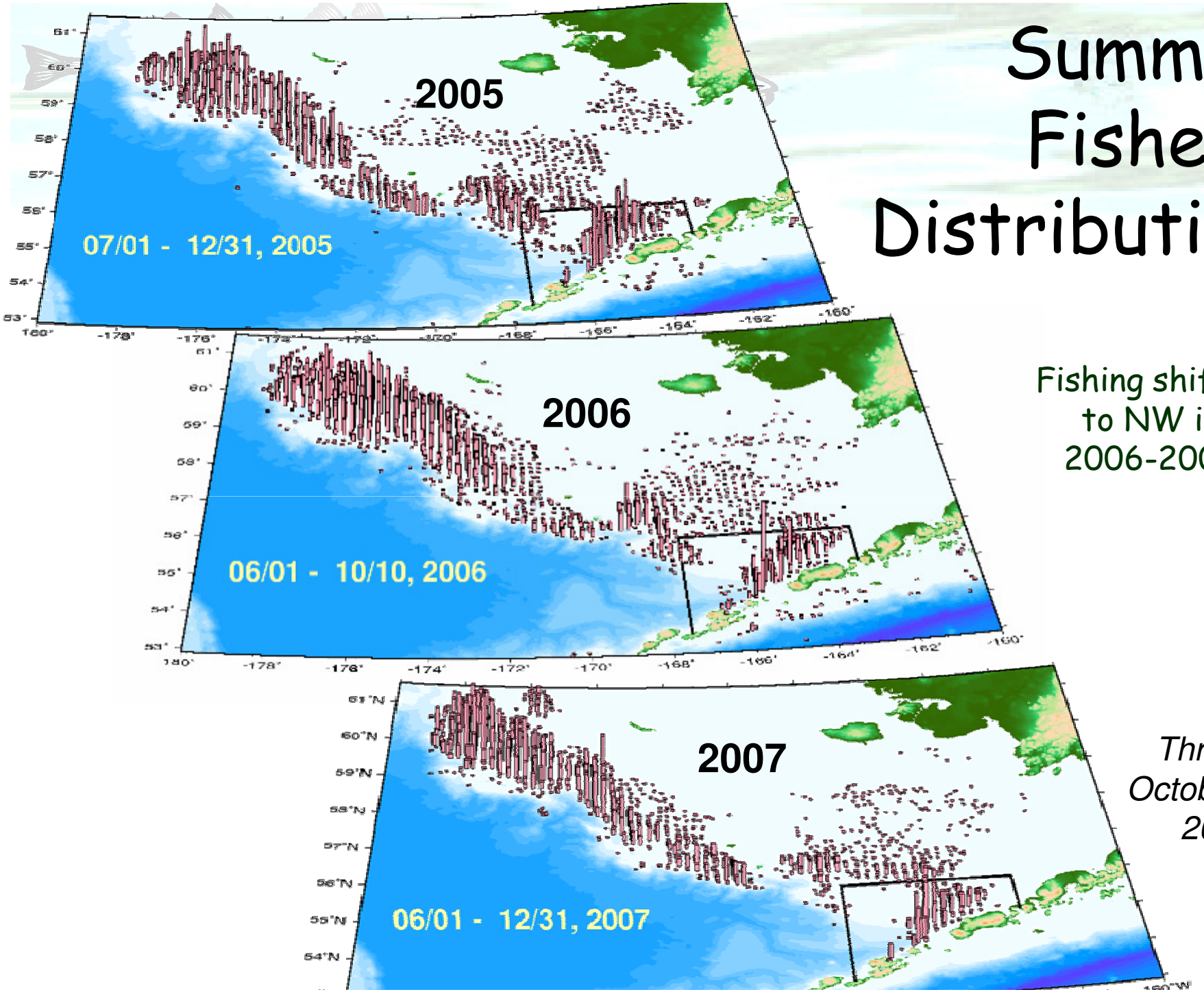








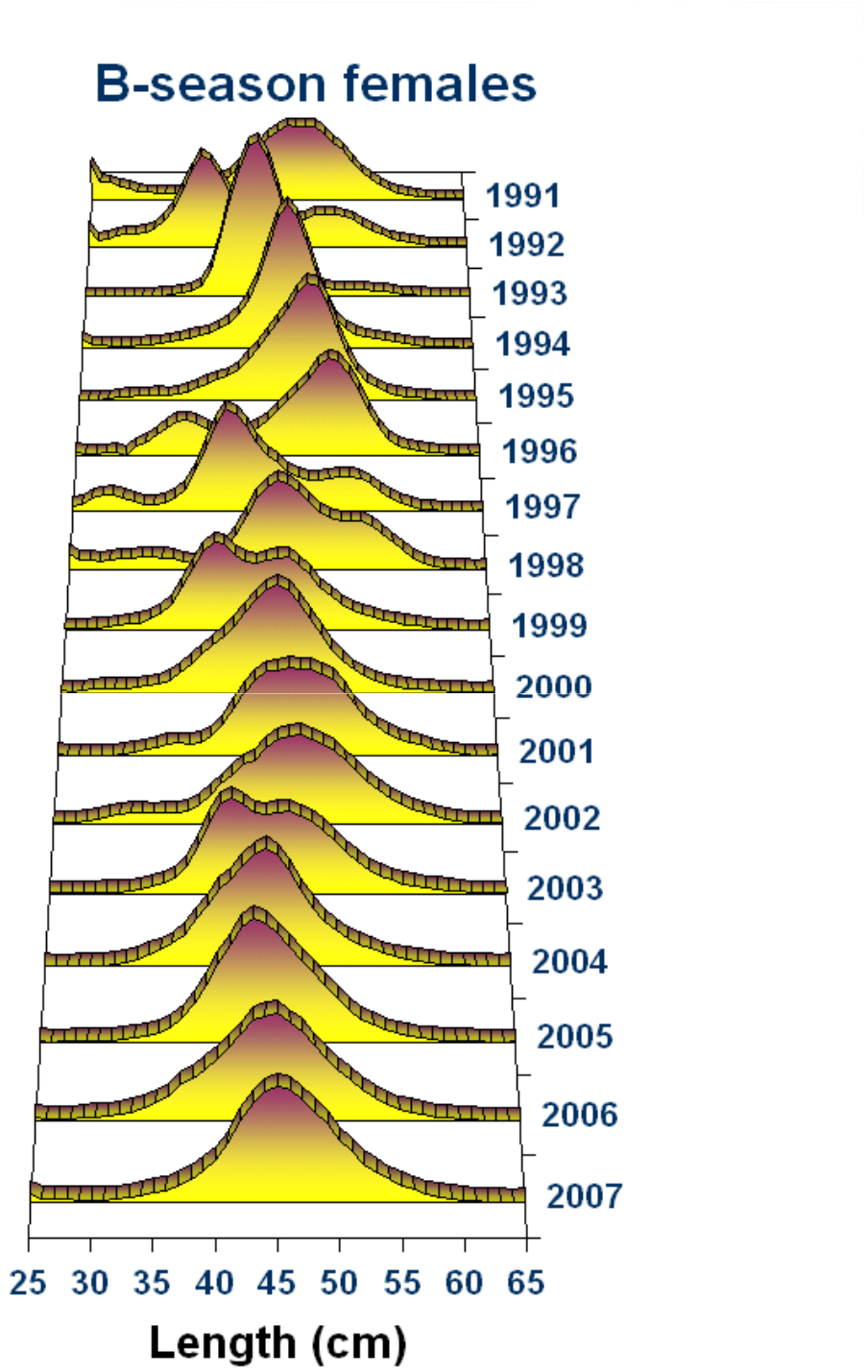
Summer Fishery Distribution



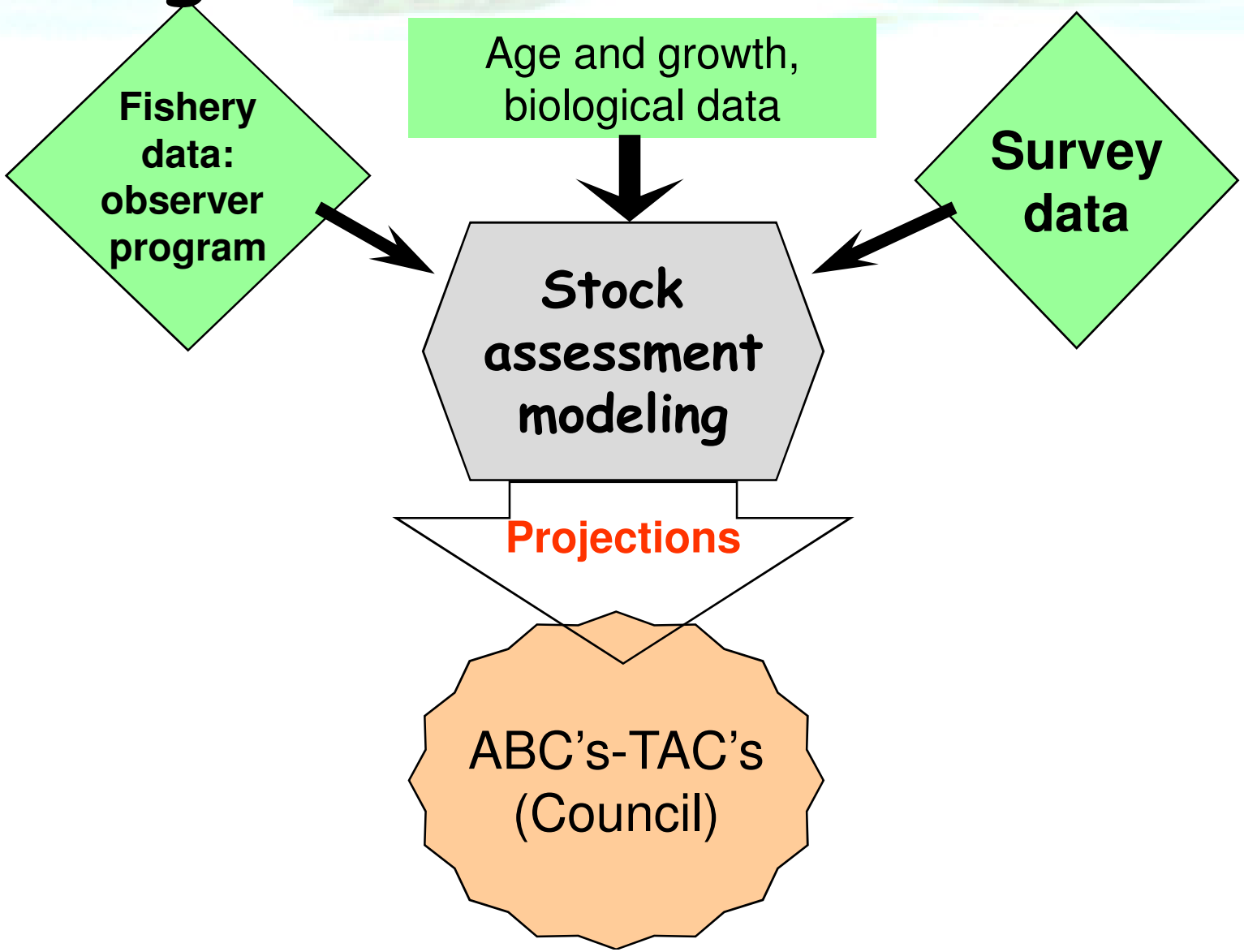
Fishing shifted to NW in 2006-2007

Through October 12th 2007

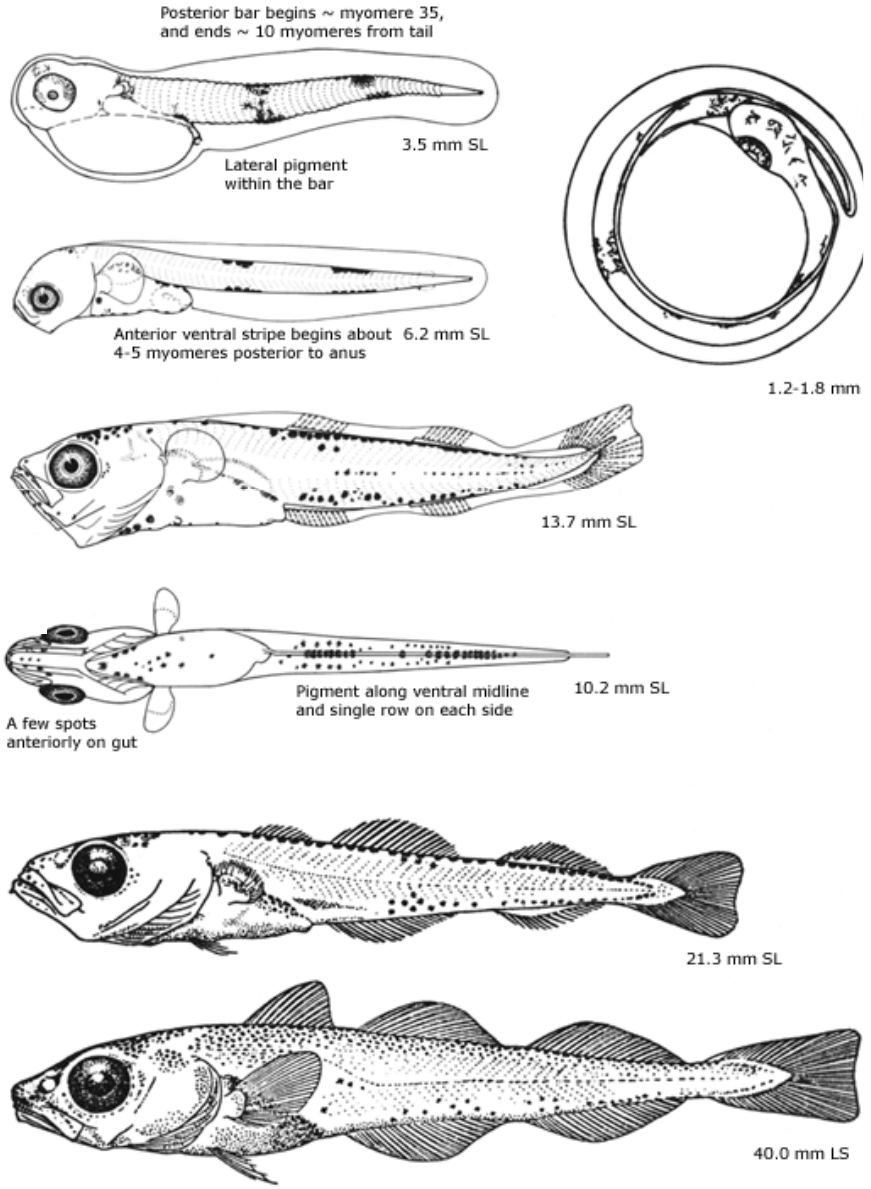
Extensive observer data



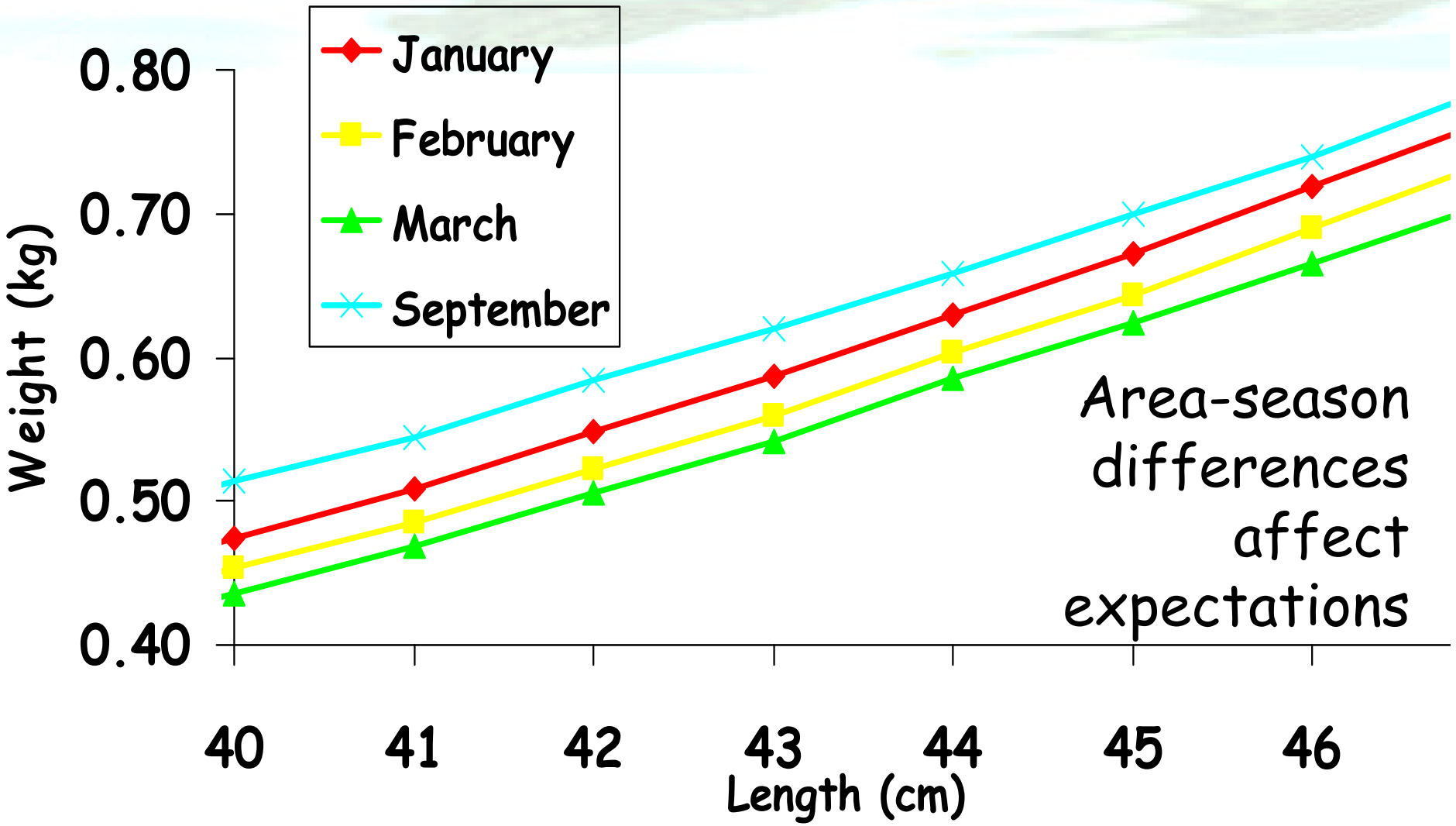
Stock assessment in practice: integrated statistical model



Biology

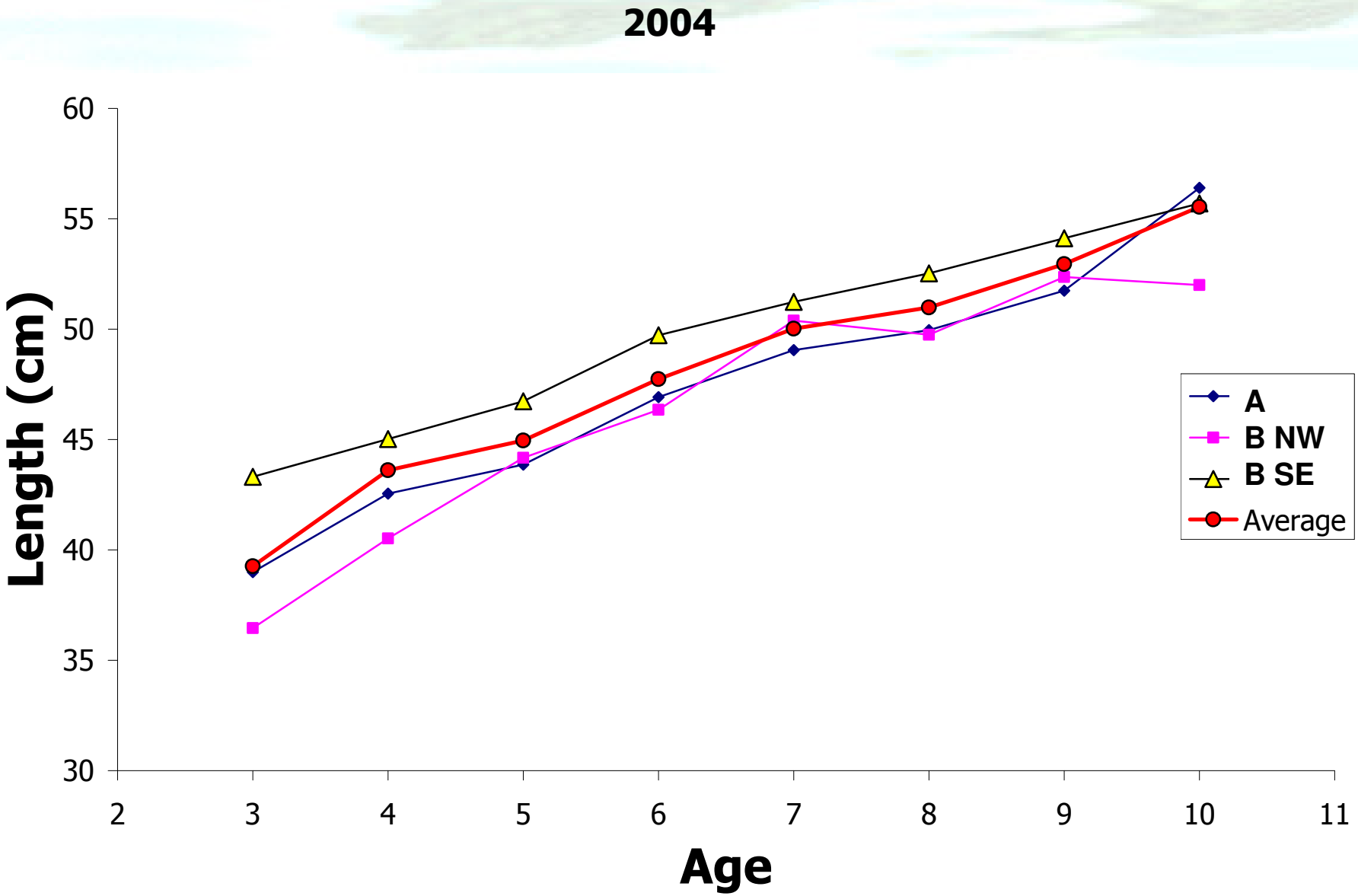

Posterior bar begins ~ myomere 35,
and ends ~ 10 myomeres from tail
3.5 mm SL
Lateral pigment
within the bar
Anterior ventral stripe begins about 6.2 mm SL
4-5 myomeres posterior to anus
1.2-1.8 mm
13.7 mm SL
Pigment along ventral midline
and single row on each side
10.2 mm SL
A few spots
anteriorly on gut
21.3 mm SL
40.0 mm LS

Body-mass loss/gain

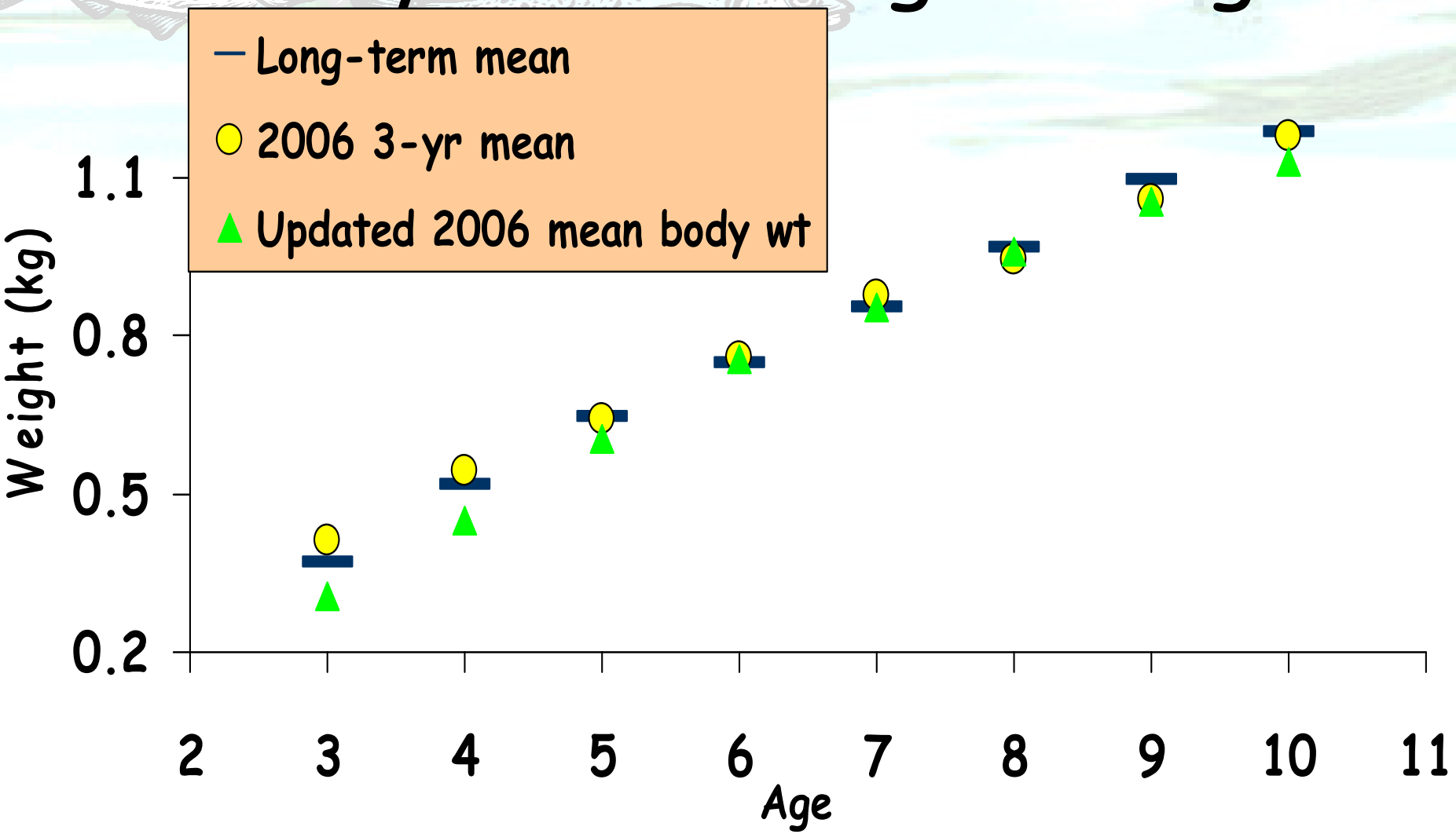


Based on average for males E of 170W, 1991-2006

Fishery length-at-age by strata

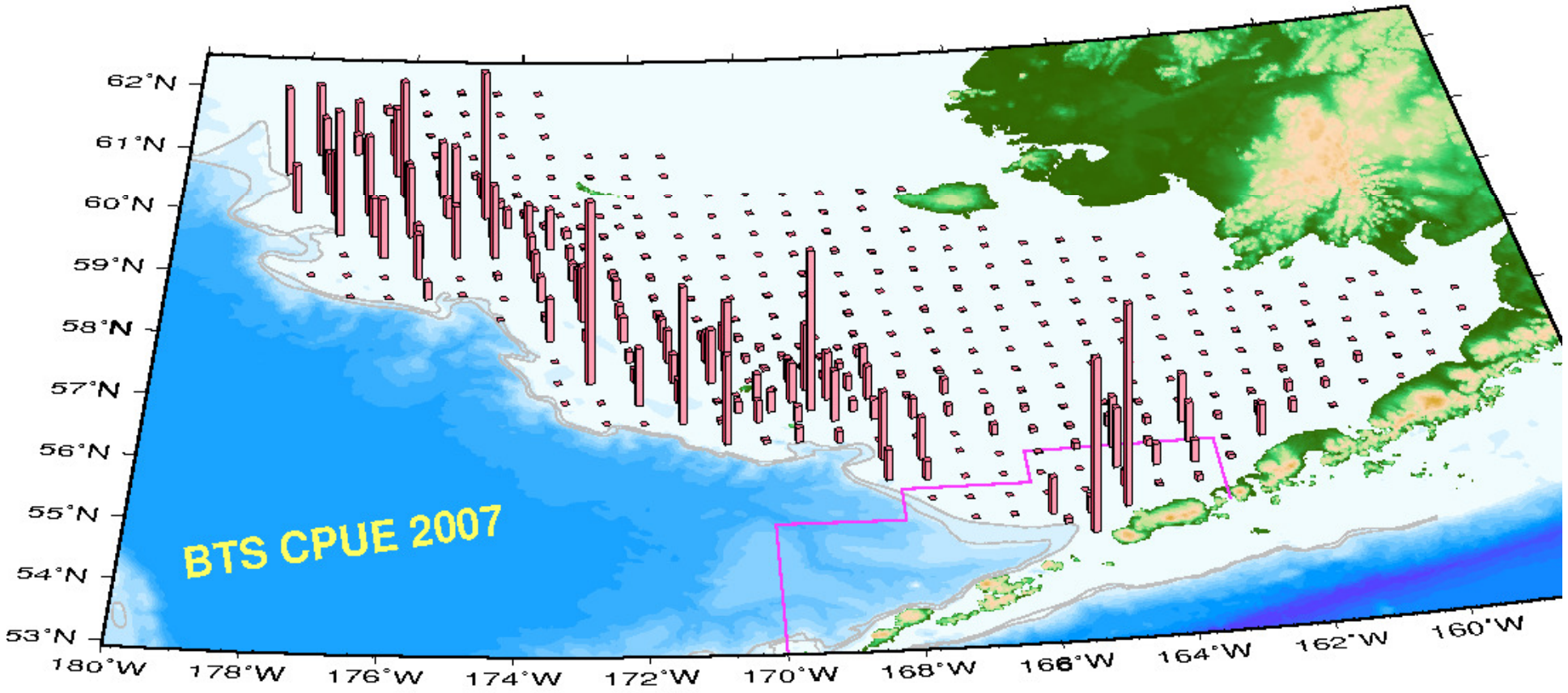


Body mass-at-age changes



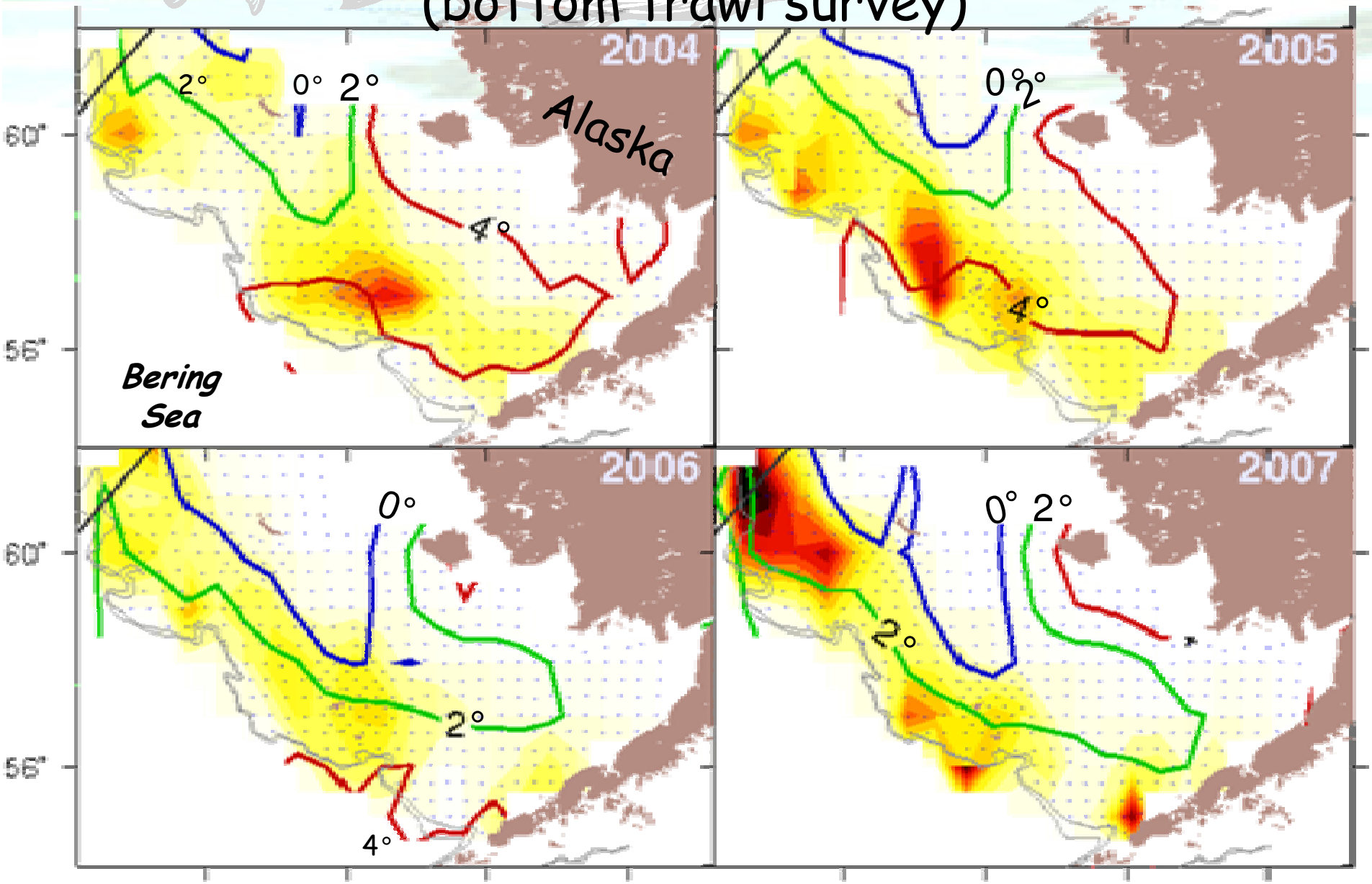
Lower body mass consistent with some indicators of oceanic production in 2006

2007 Bottom Trawl Survey
4.34 million t estimated



Bottom Temperature and Pollock Density

(bottom trawl survey)

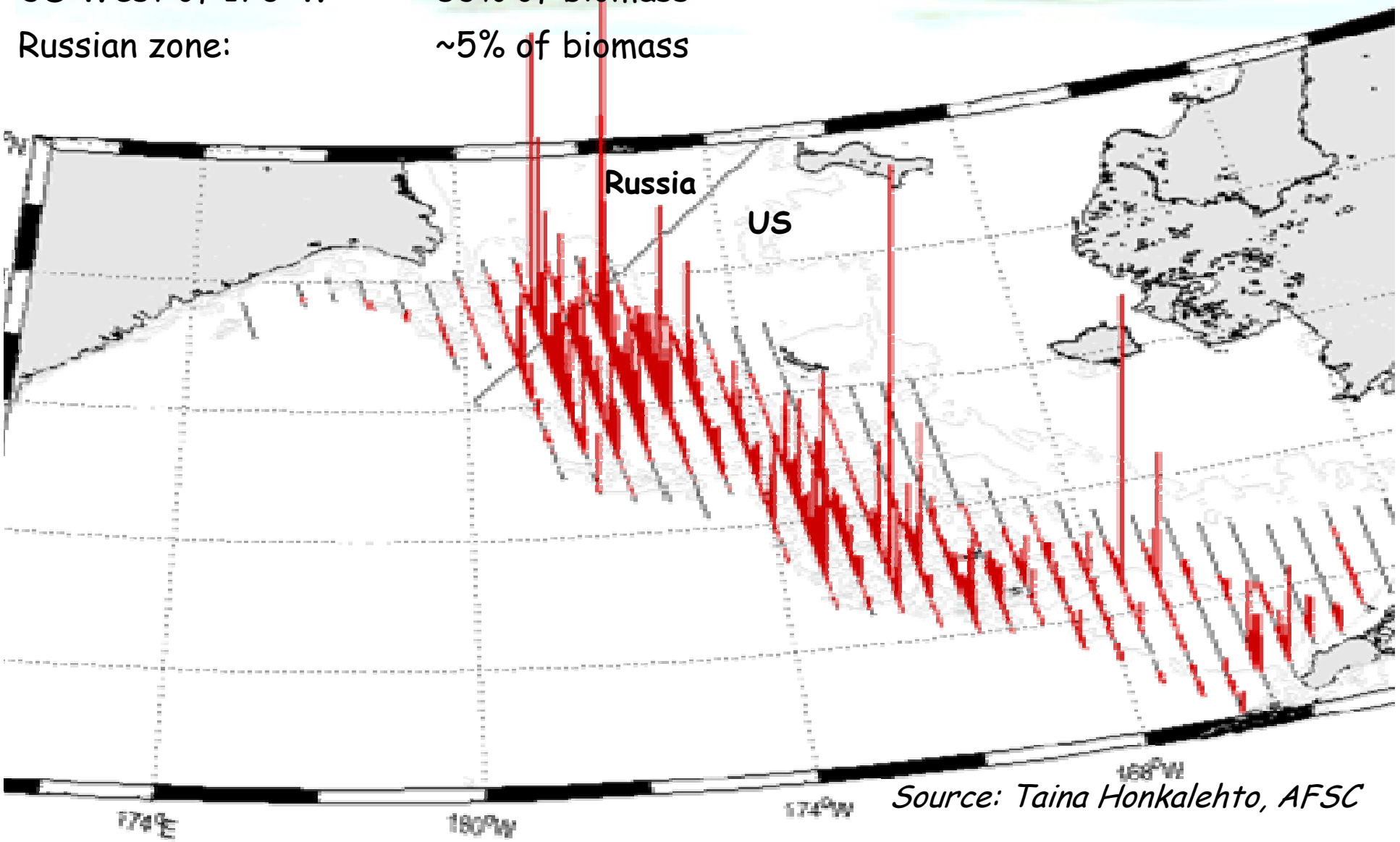


2007 midwater acoustic-trawl survey

US East of 170°W: 12% of biomass

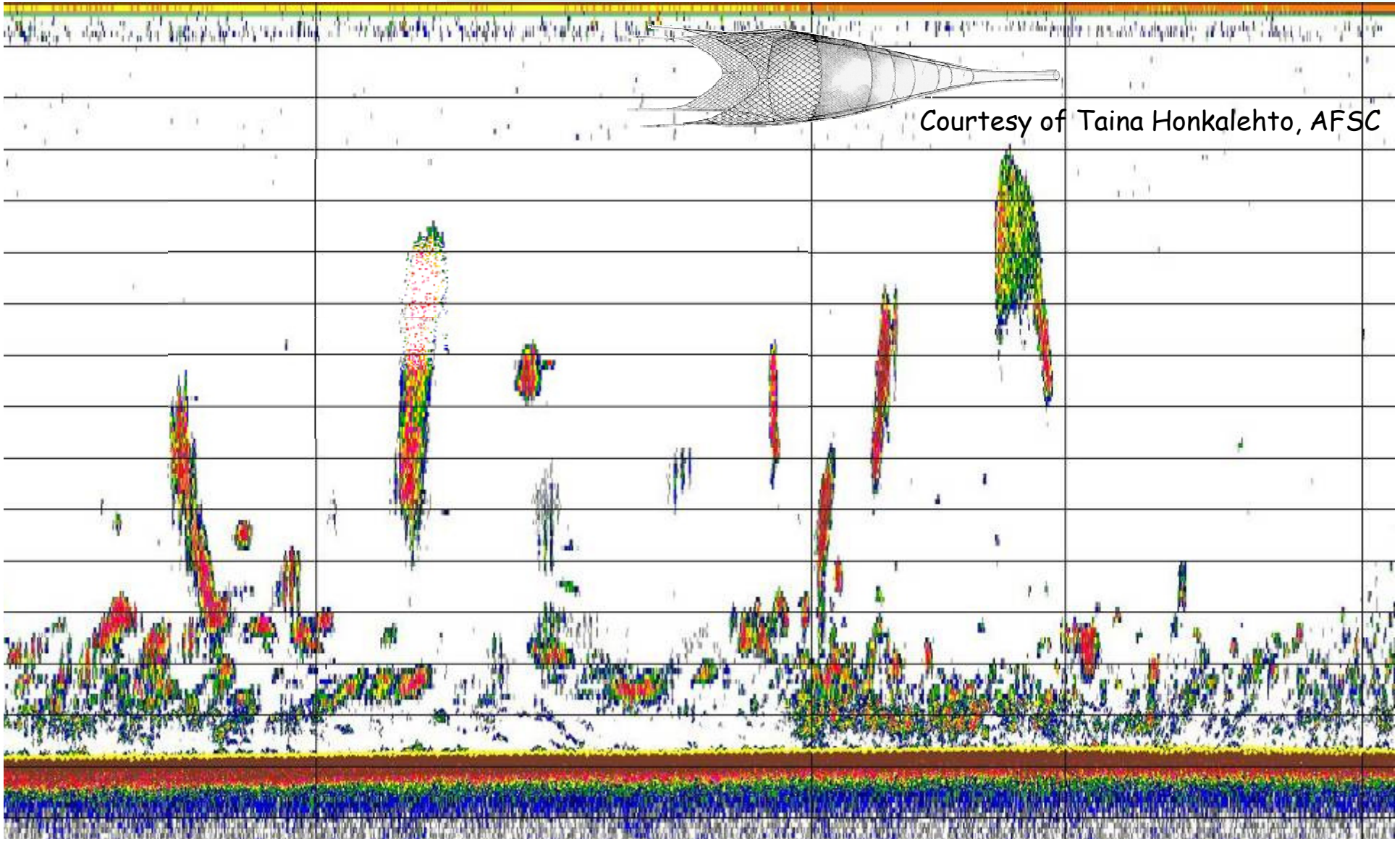
US West of 170°W: 83% of biomass

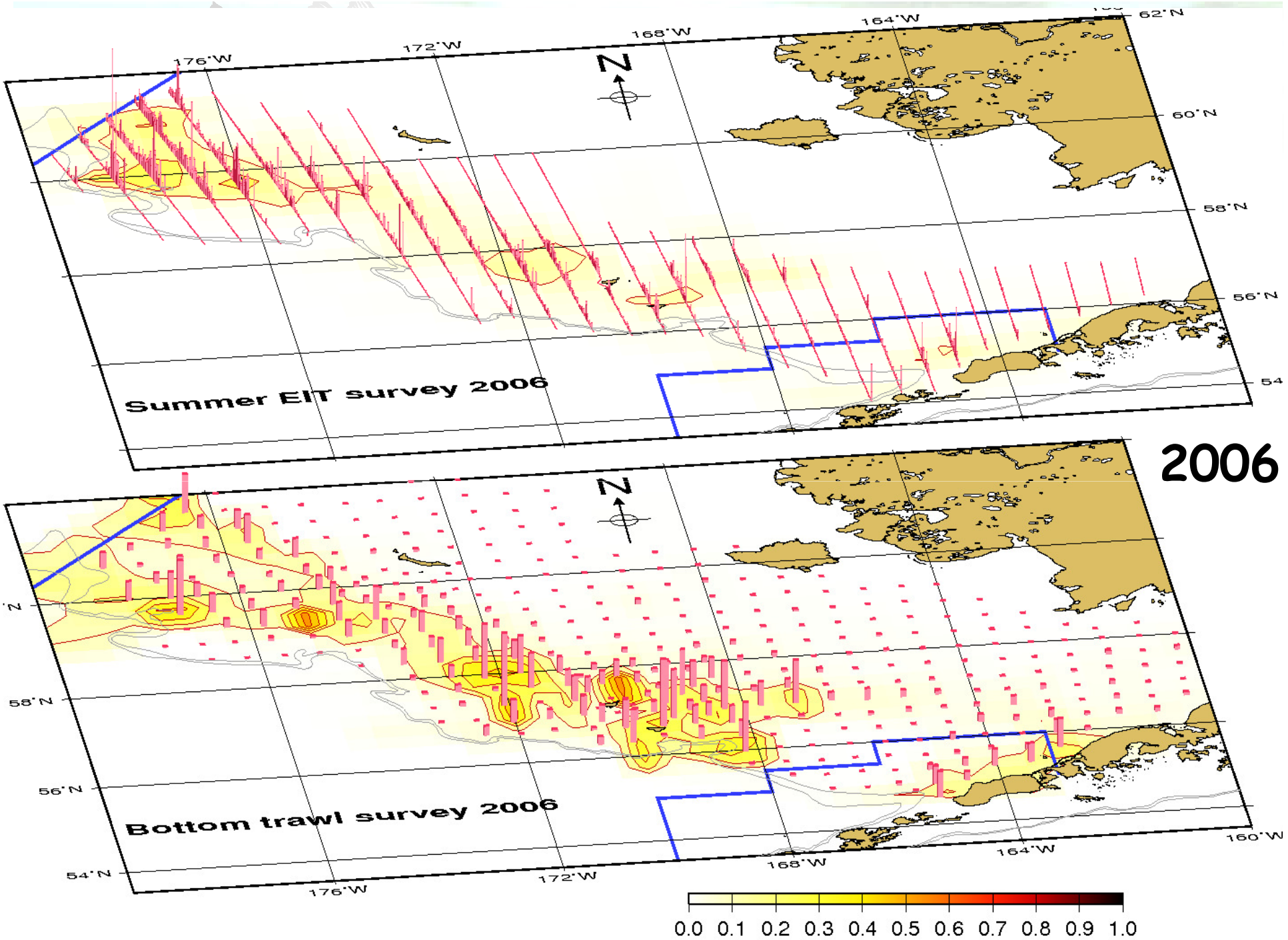
Russian zone: ~5% of biomass

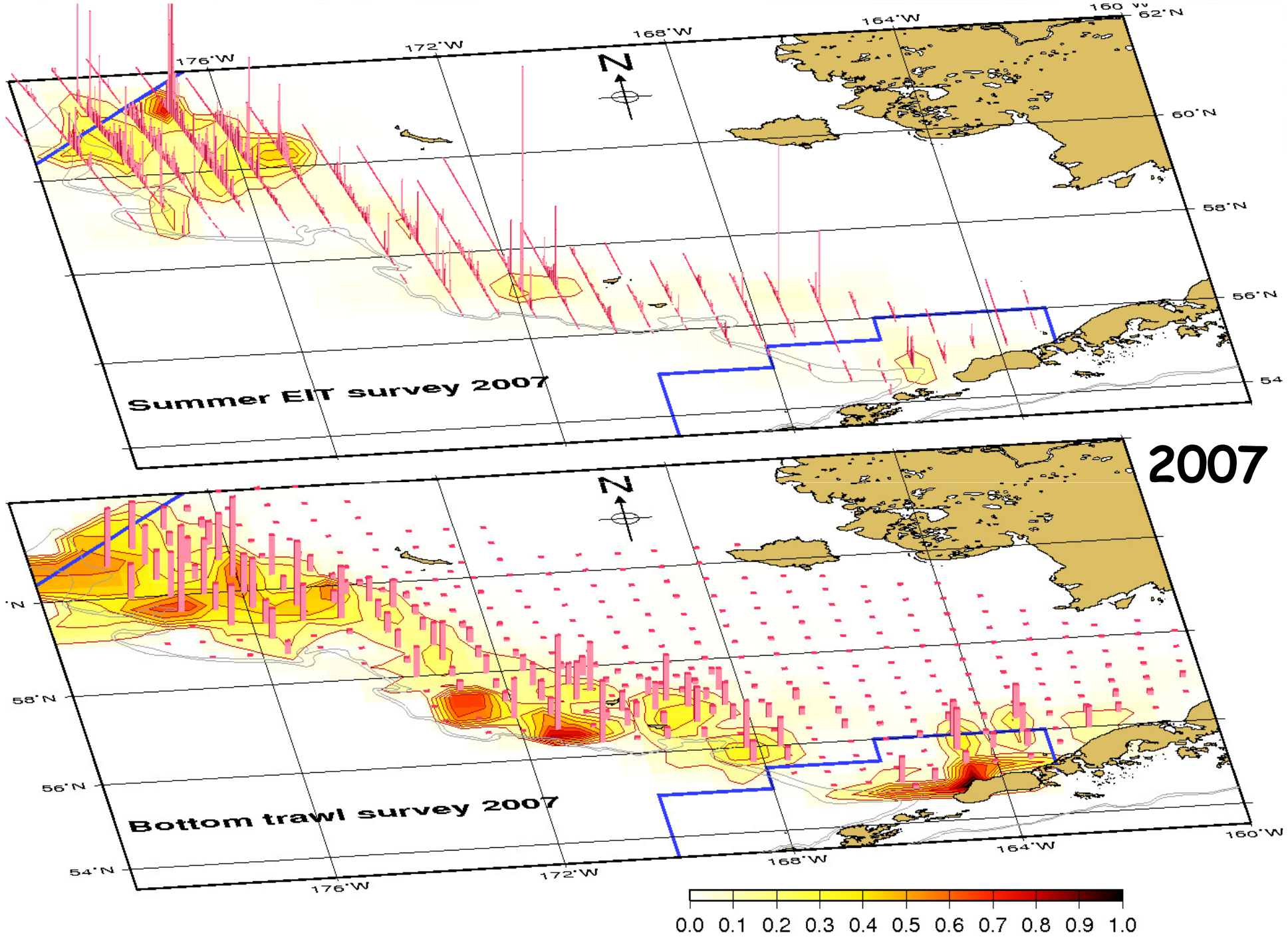


Source: Taina Honkalehto, AFSC

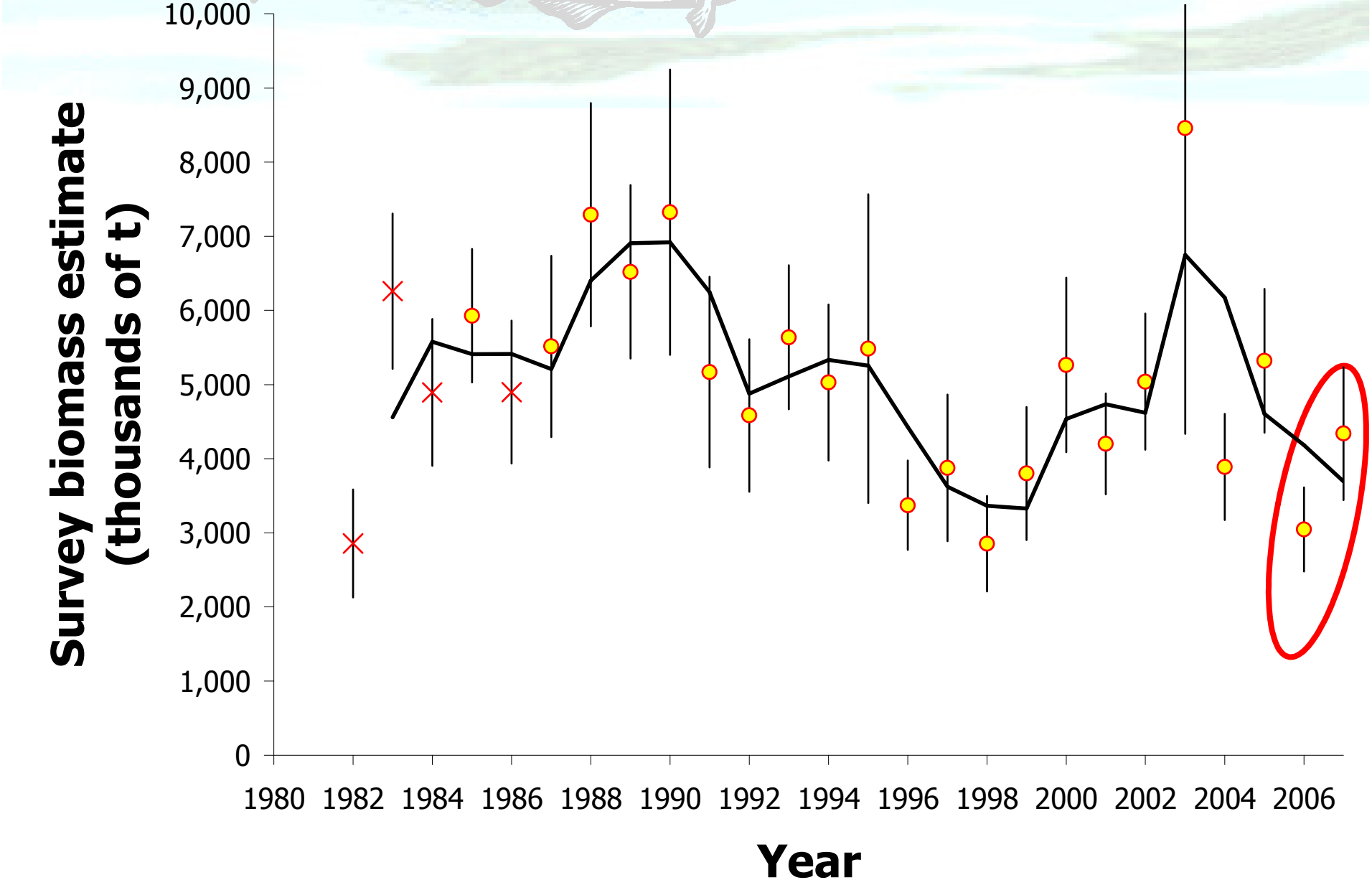
Acoustic survey biomass estimates are expansions based on backscatter-pollock relationship, transect area, and level of acoustic signal




Summer EIT survey 2006
Bottom trawl survey 2006
2006
N
176°W
172°W
168°W
164°W
160°W
62°N
60°N
58°N
56°N
54°N
54
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

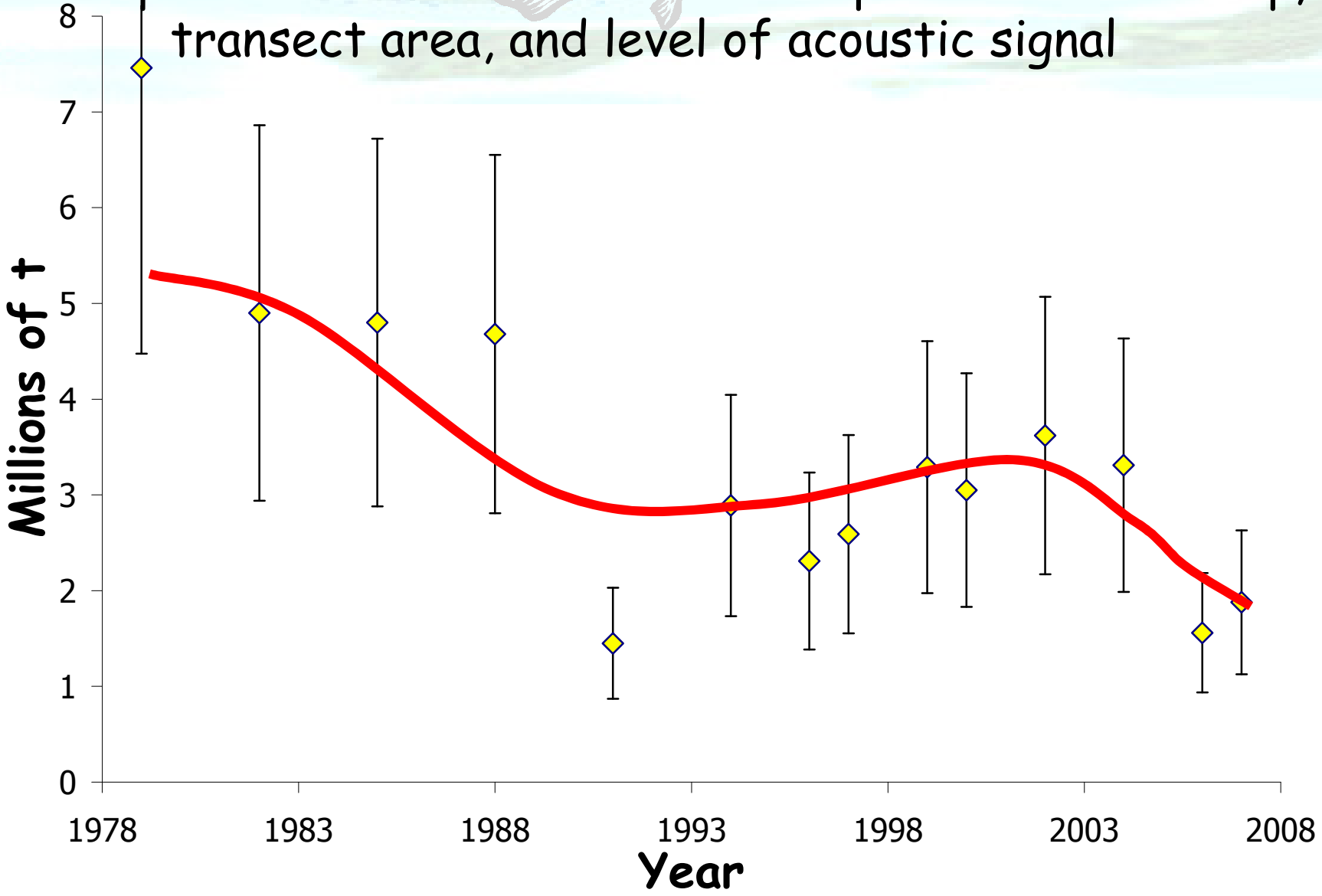

Summer EIT survey 2007
Bottom trawl survey 2007
2007
N
176°W
172°W
168°W
164°W
160°W
62°N
60°N
58°N
56°N
54°N
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

Bottom-trawl survey biomass



Hydro-acoustic survey biomass estimates

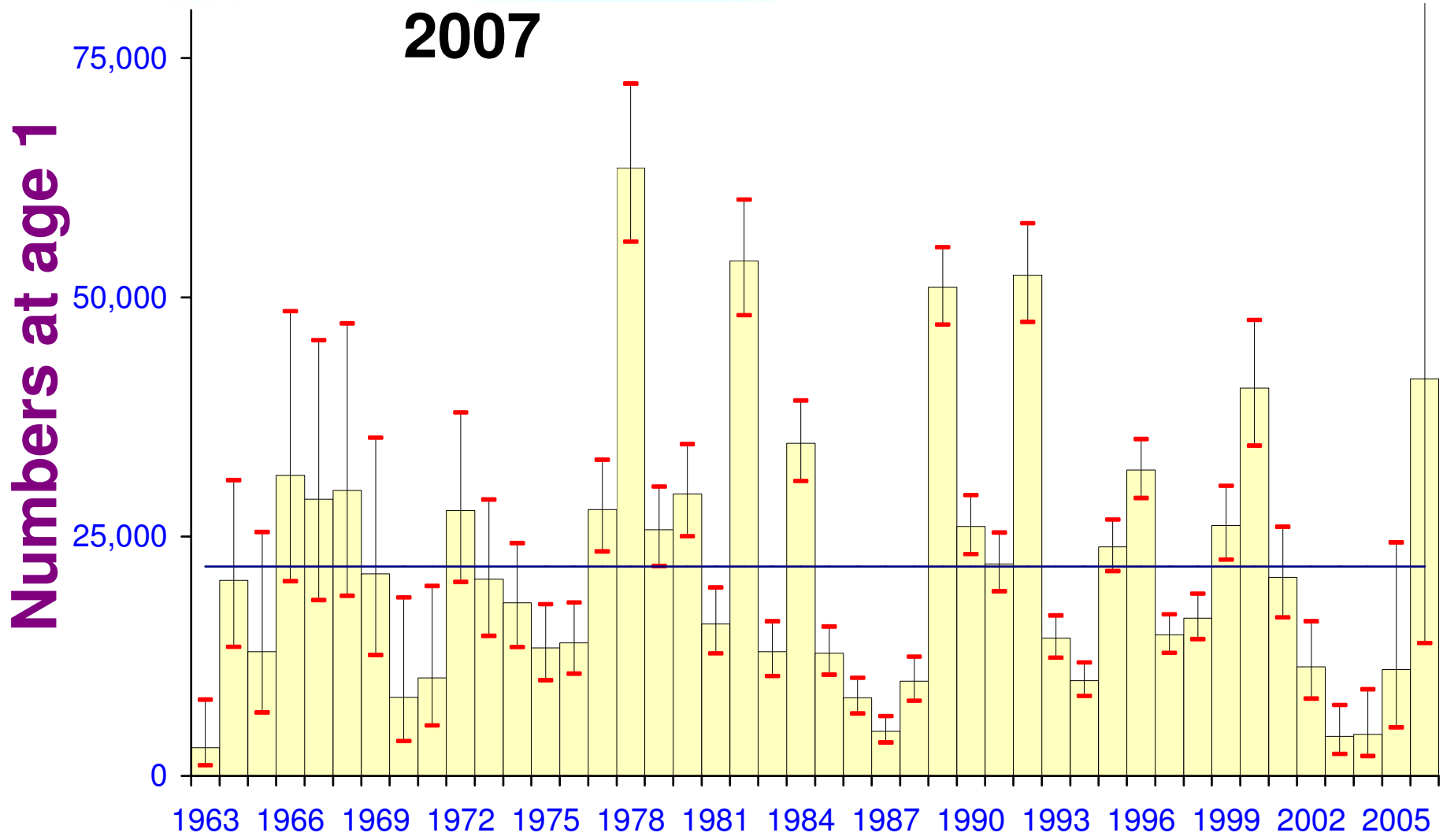
Are expansions based on backscatter-pollock relationship, transect area, and level of acoustic signal



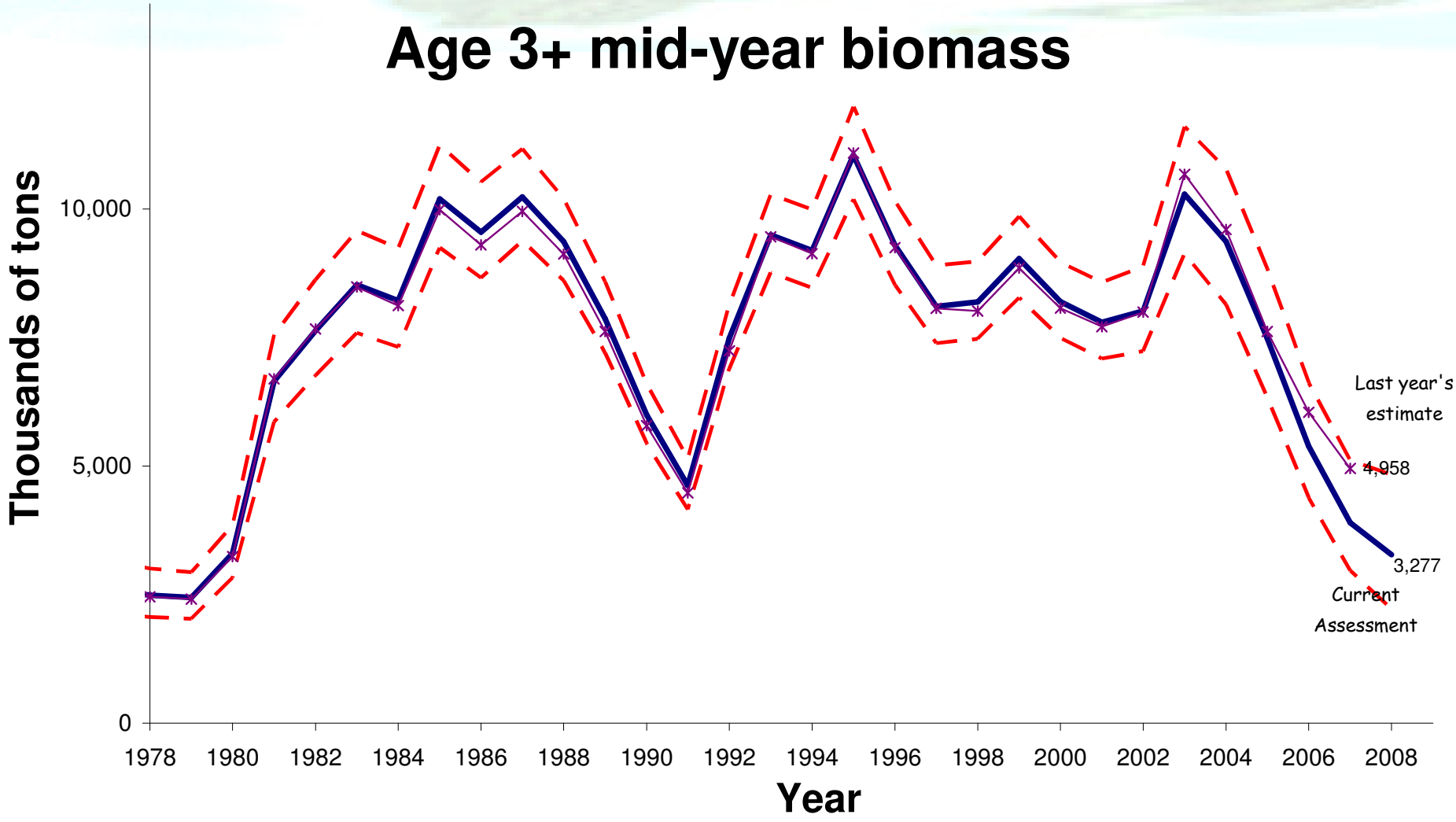
3 m off bottom to near surface

± 2 standard errors (assumed)

Integrated model results: Recruitment



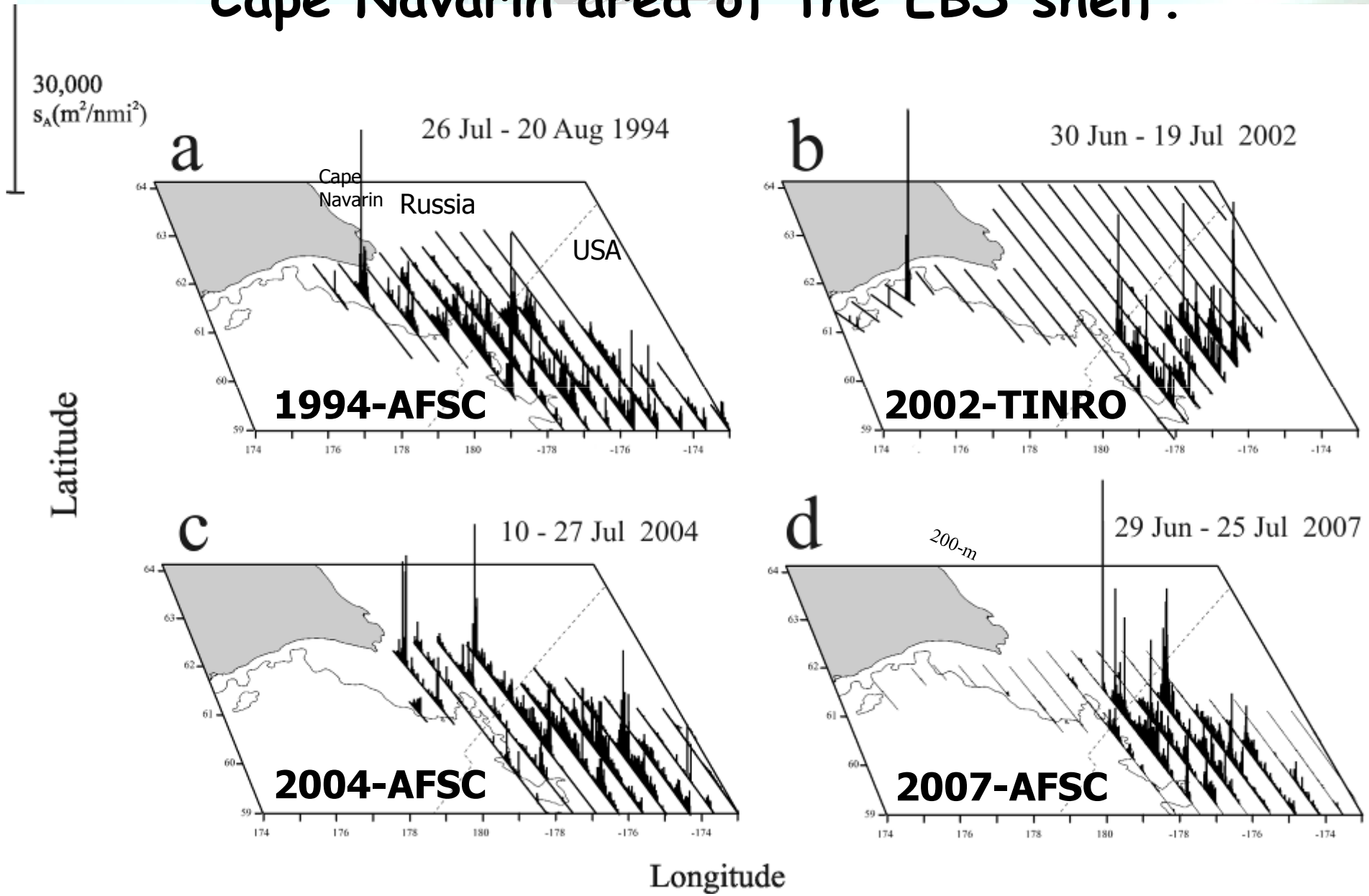
Relative biomass



Transboundary issues

US-Russia convention line

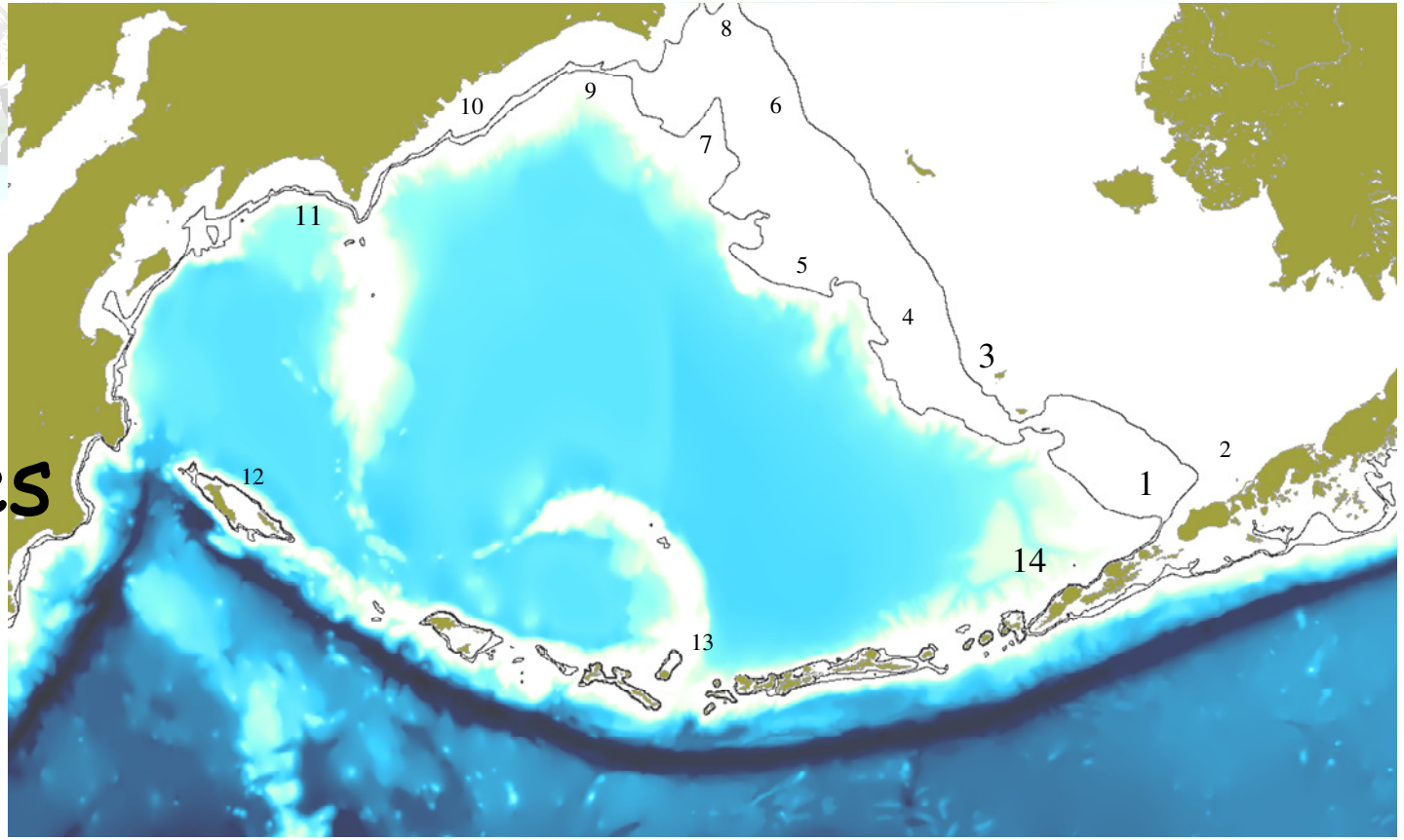
Pollock acoustic backscatter from the Cape Navarin area of the EBS shelf.



US-Russia

- **In 2003 and 2005 Assessment model included estimates of Russian catches for Navarin region (northern area) as a sensitivity**
  - Results inflated total biomass
    - Since within-zone survey trends were the same
  - Council decided to exclude Russian catches
    - Since result appears to be more risk averse

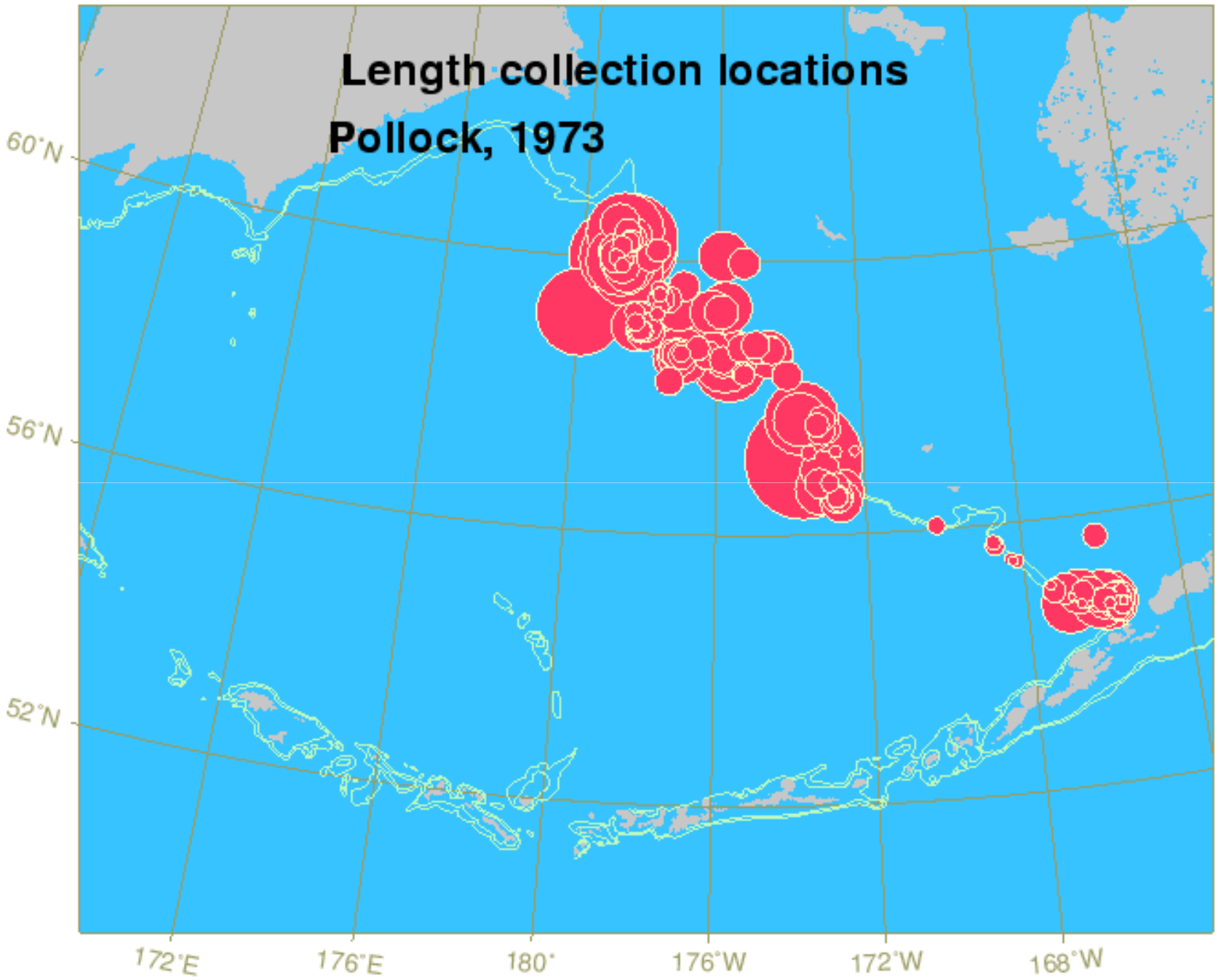
Spawning Location Hypotheses



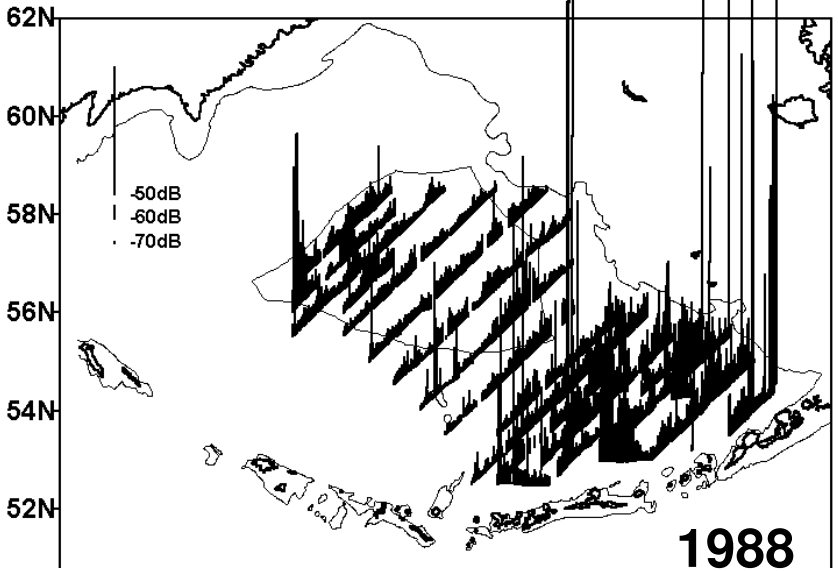
ID	*Location*	*Aggregation size*	*Depth*	*Timing*	*Age composition*
1	Unimak Island	Large	Shelf	March-May	Mixed
2	Amak Island	Small	Shelf	Feb-March	Oldest
3	Pribilof Island	Large	Shelf/coastal	March-May	Young/older
4	Zemchug Canyon	Small	Shelf	April-May	Mixed
5	Pervenetz Canyon	Small	Shelf	April-May	Mixed
6	Navarin shelf	Small	Shelf	April-May	Mixed
7	Navarin Canyon	Small/Medium	Shelf	May-June	Mixed
8	Anadyr Bay	Small	Shelf/coastal	July	Older
9	Koryak coast	Small	Shelf/coastal	April-May	Mixed
10	Koryak coast	Small	Shelf	April-May	Mixed
11	Olyutorskiy Bay	Large	Shelf	April-May	Mixed
12	Commander Isl.	Small	Slope	March-April	Mixed
13	Kanaga Pass	Small	Slope	March	Oldest
14	Bogoslof	Large	Deep/slope	March	Older

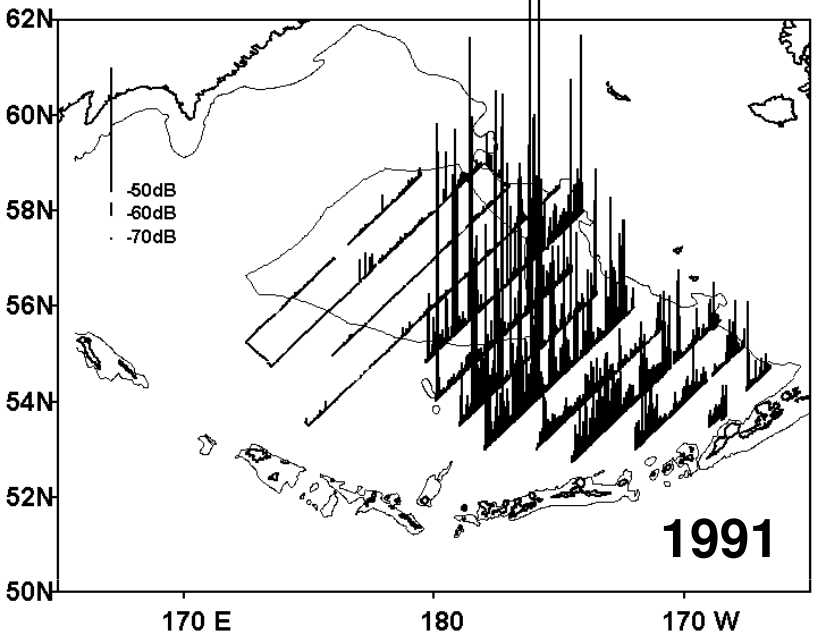
International zone

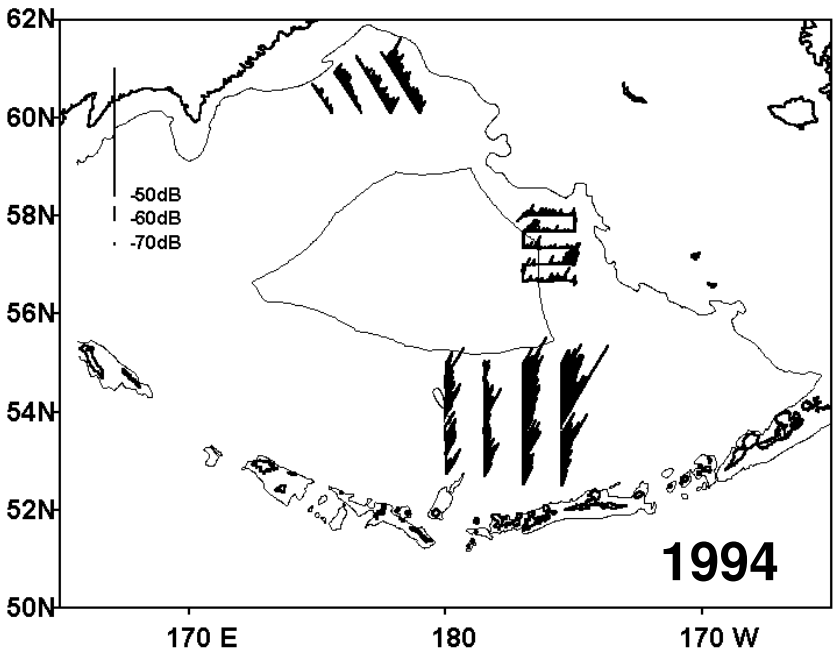
- **Donut Hole**
  - A brief fishery
  - Many catches apparently near borders
  - Indications that were derived from "Basin" spawners
    - Off Bogoslof Island in US EEZ


Length collection locations
Pollock, 1973
60°N
56°N
52°N
172°E
176°E
180°
176°W
172°W
168°W

Horizontal SA distribution (summer)







Biomass estimates:

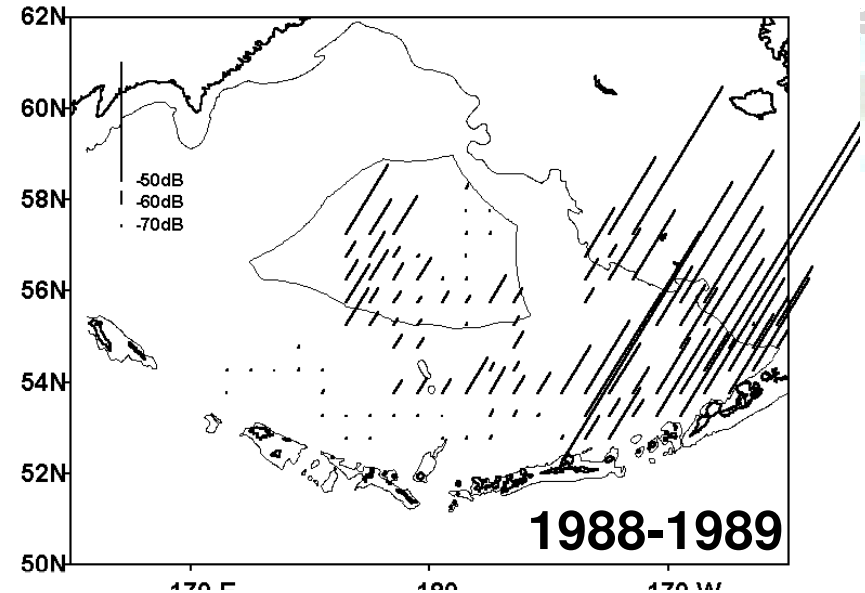
1988: 1.00 million tons

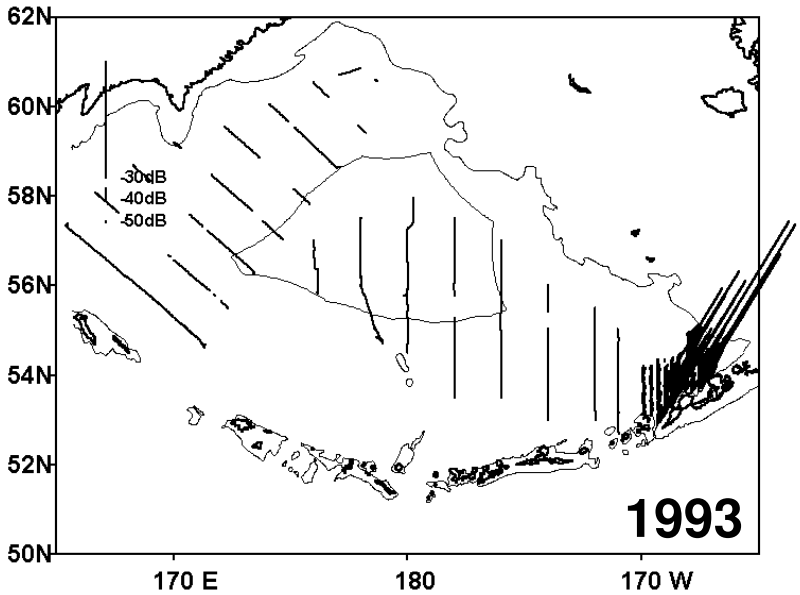
1991: 0.77 million tons

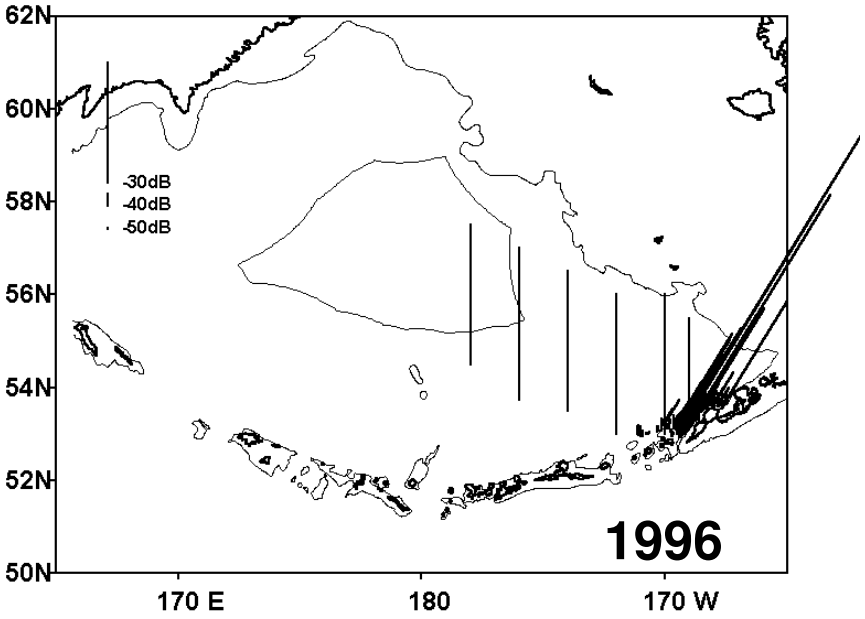
1994: 0.17 million tons

Source: Akira et al. 2001

Horizontal SA distribution (Winter)







Biomass estimates:

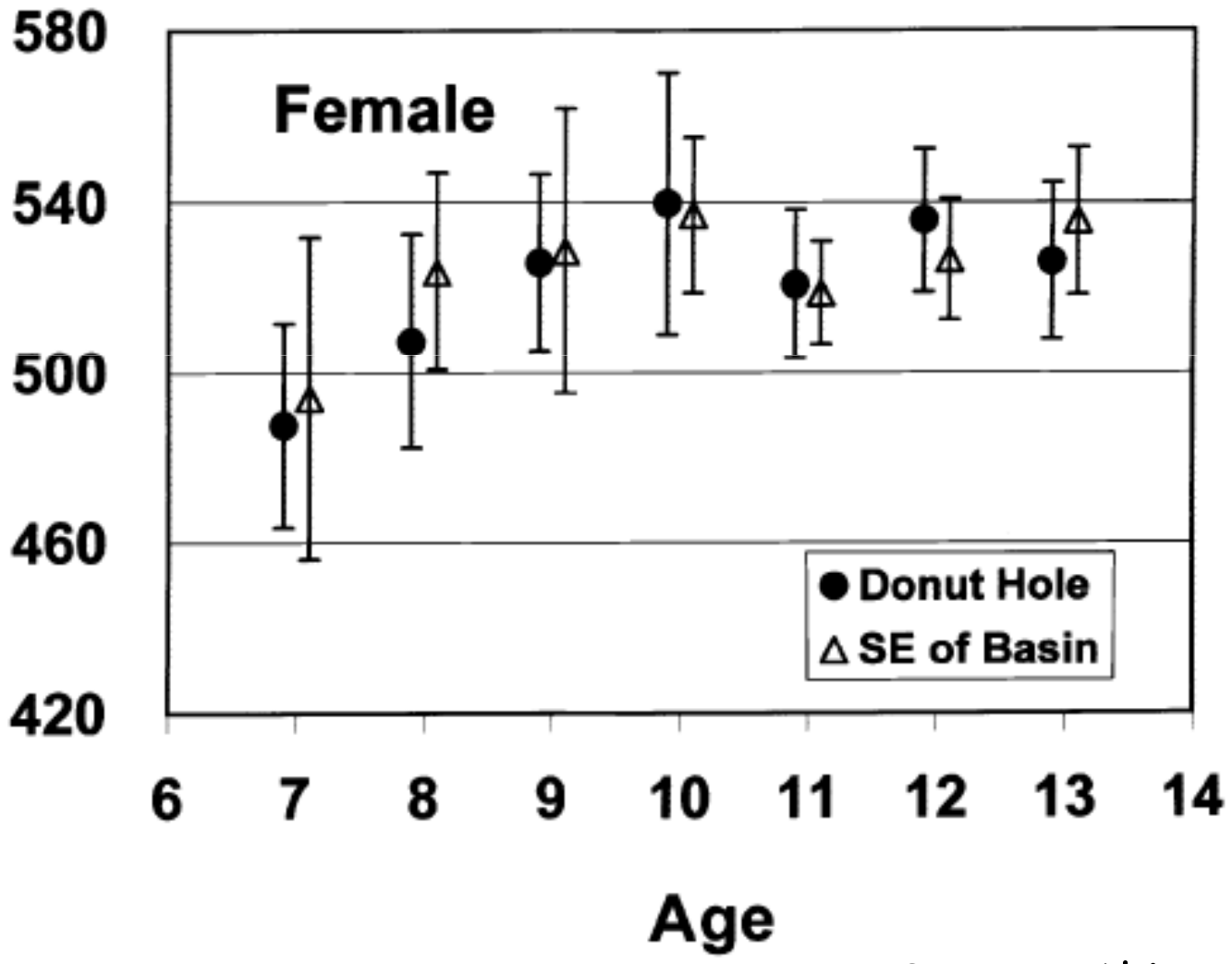
1988-1989: 3.29 million t

1993: 0.6 million t

1996: 0.52 million t

Source: Akira et al. 2001

Donut hole versus SE Bering Sea



Source: Akira et al. 2001

Donut Hole Convention

CONVENTION
ON THE CONSERVATION AND MANAGEMENT OF
POLLOCK RESOURCES IN THE CENTRAL
BERING SEA

The Parties to this Convention,

Recognizing the urgent necessity to cooperate in taking measures for the conservation and management of pollock resources in the central Bering Sea consistent with international law, and

Noting the adoption of the United Nations Convention on the Law of the Sea in 1982,

Have agreed as follows:

ARTICLE II

The objectives of this Convention shall be:

1. to establish an international regime for conservation, management, and optimum utilization of pollock resources in the Convention Area;

2. to restore and maintain the pollock resources in the Bering Sea at levels which will permit their maximum sustainable yield;

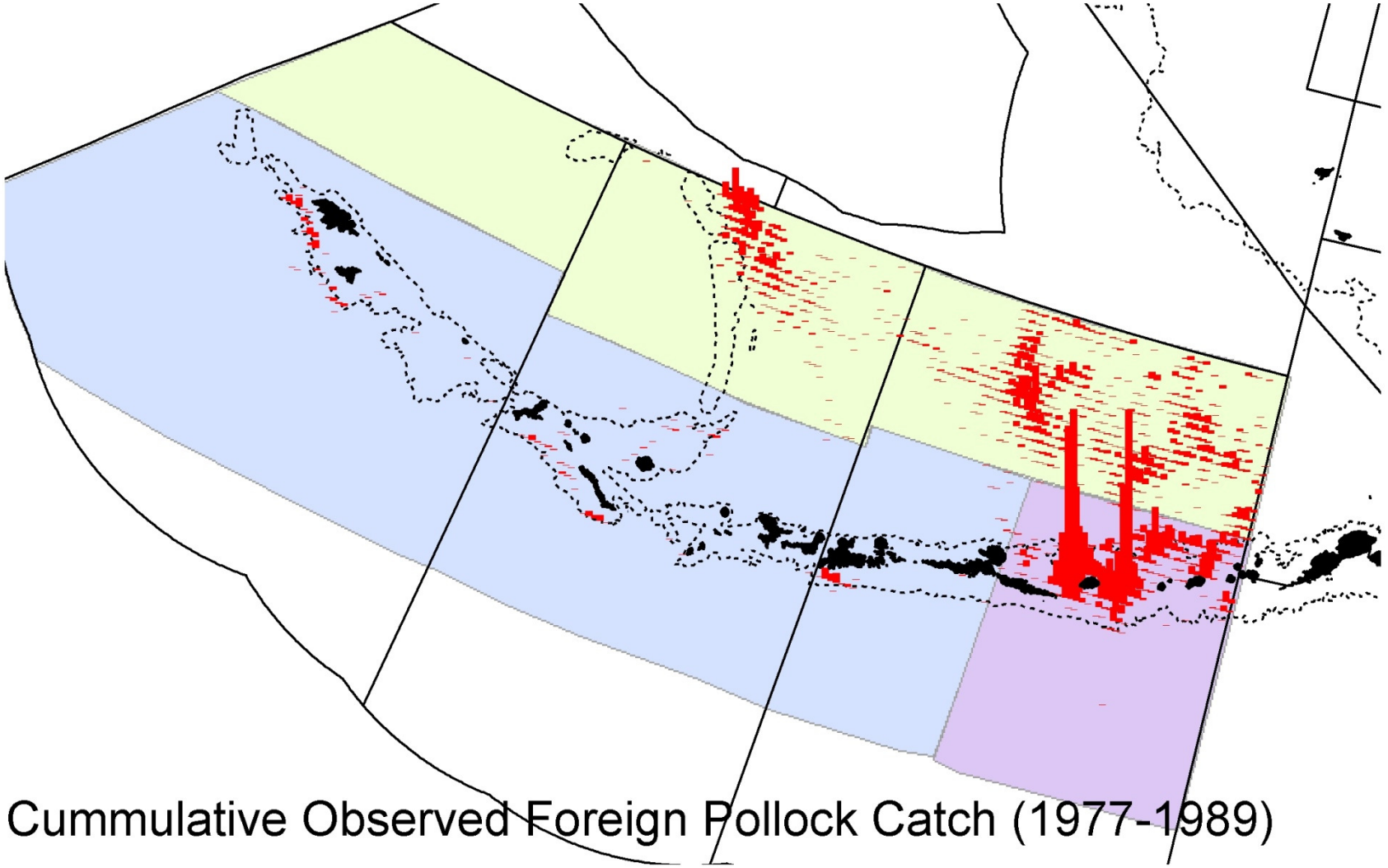
3. to cooperate in the gathering and examining of factual information concerning pollock and other living marine resources in the Bering Sea; and

4. to provide, if the Parties agree, a forum in which to consider the establishment of necessary conservation and management measures for living marine resources other than pollock in the Convention Area as may be required in the future.

Within US zone issues

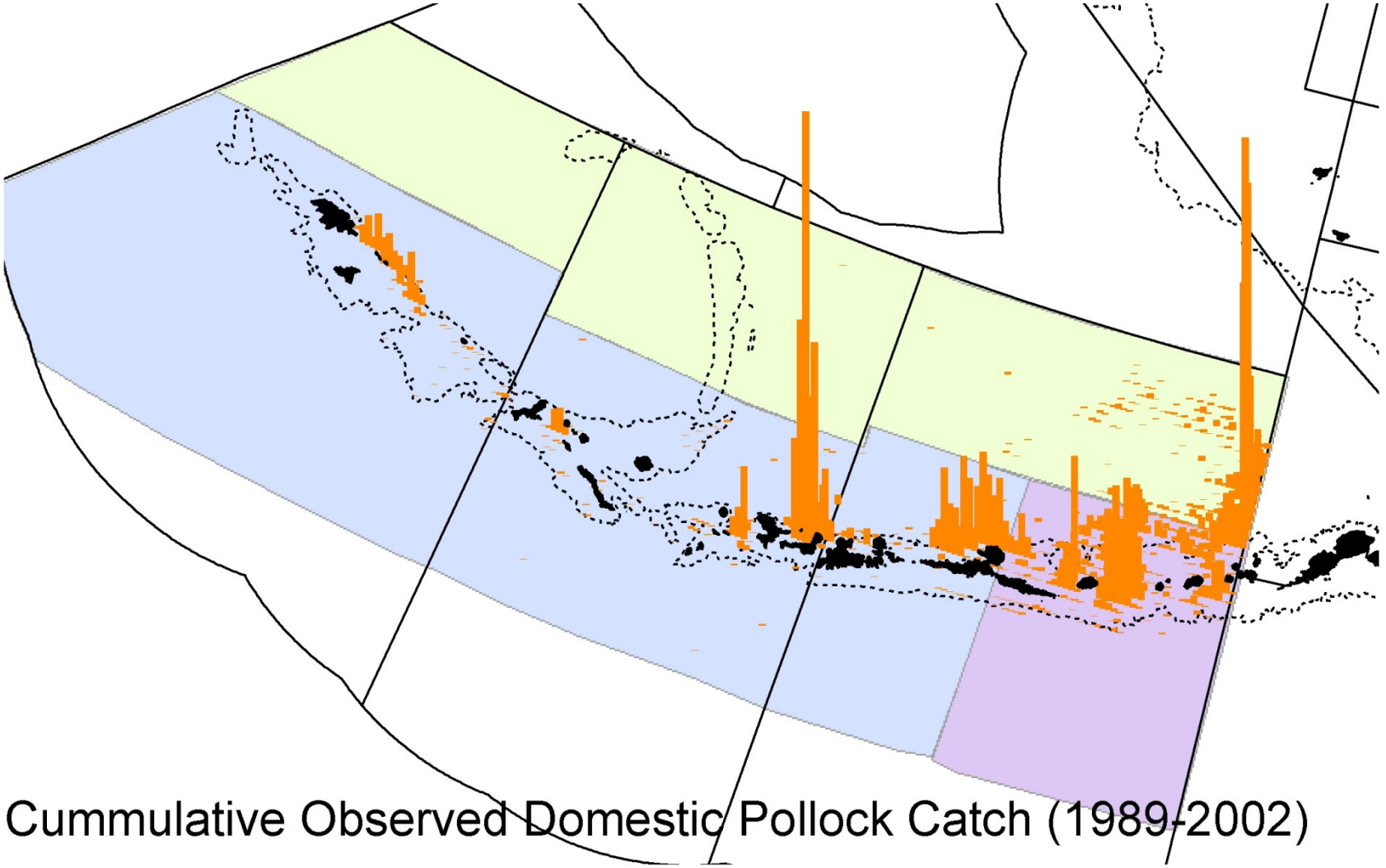
- **Seasonal and spatial allocation of quota is common**
  - Mitigate against uncertain stock structure
- **For Bering Sea, relationship with the Aleutian Islands region uncertain**

Aleutian Islands region pollock



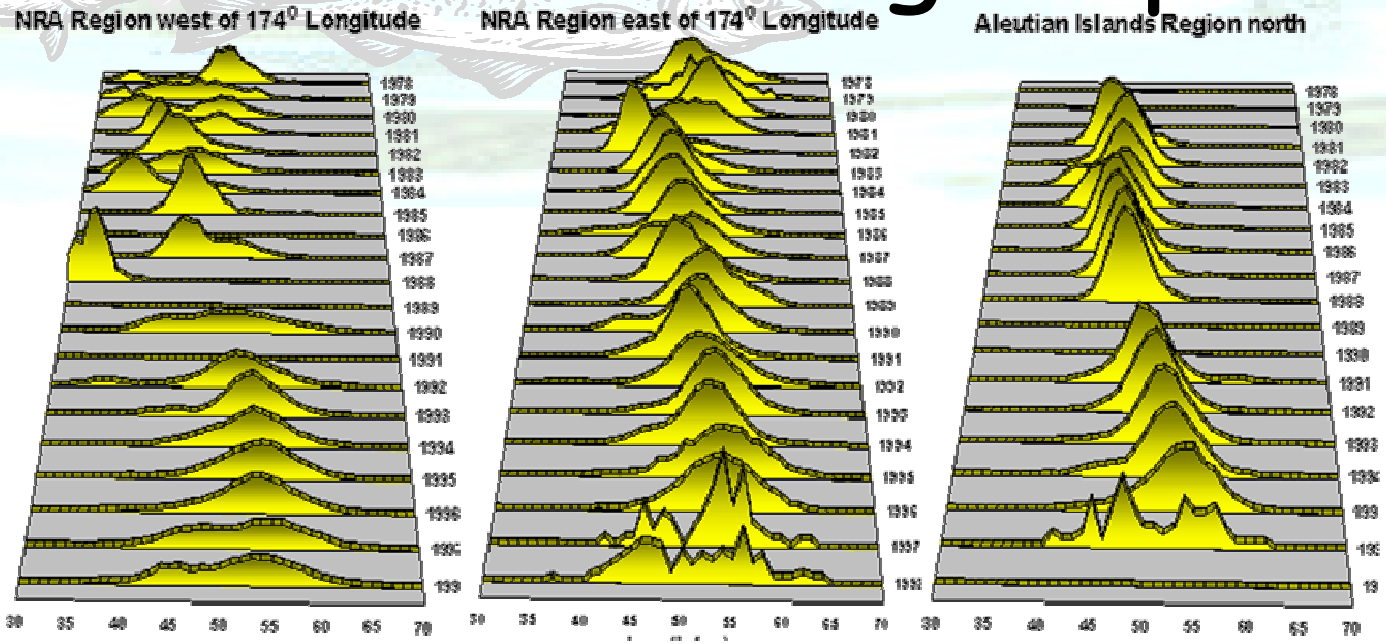
Cummulative Observed Foreign Pollock Catch (1977-1989)

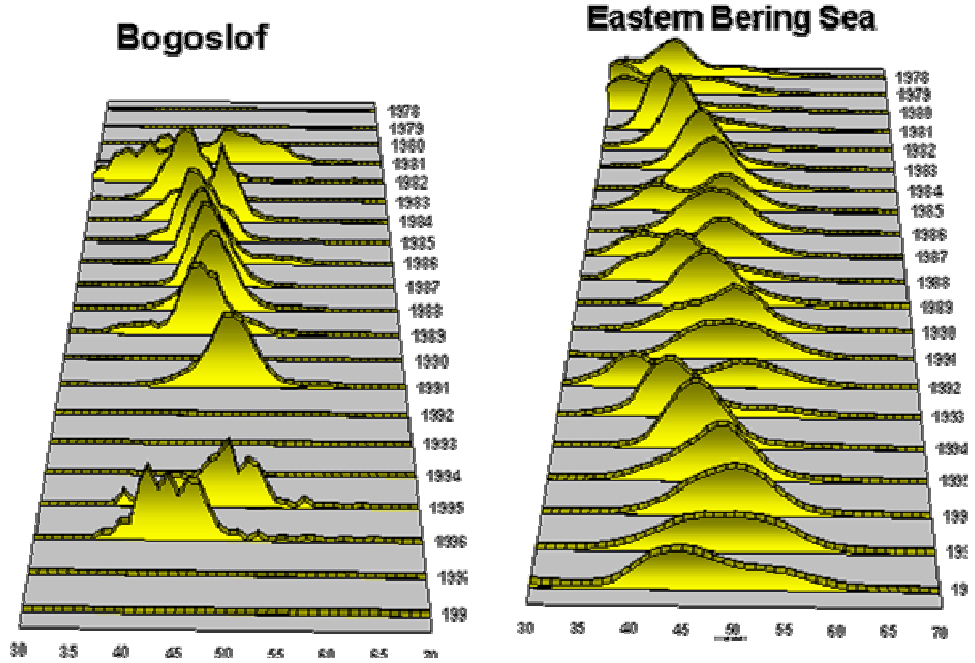
Aleutian Islands region pollock



Cummulative Observed Domestic Pollock Catch (1989-2002)

Aleutian Islands region pollock





How do stock structure uncertainties and environmental variability affect risk averse policies?

Tactics from our management guidelines…

1) Information available: *Reliable point estimates of B, B_{msy} and a reliable pdf of F_{msy}.*

1a. Stock status: $B/B_{msy} > 1$

$F_{OFL} = \mu_A$, *the arithmetic mean of the pdf for* F_{msy}

$F_{ABC} = \mu_H$, *the harmonic mean of the pdf for* F_{msy}

Translation: *the higher the variance, the lower the upper limit on TAC*

1b. Stock status: $\alpha < B/B_{msy} \leq 1$

$F_{OFL} = \mu_H \left(B / B_{msy} - \alpha \right) / \left(1 - \alpha \right)$

$F_{ABC} = \mu_H \left(B / B_{msy} - \alpha \right) / \left(1 - \alpha \right)$

1c. Stock status: $B/B_{msy} \leq \alpha$

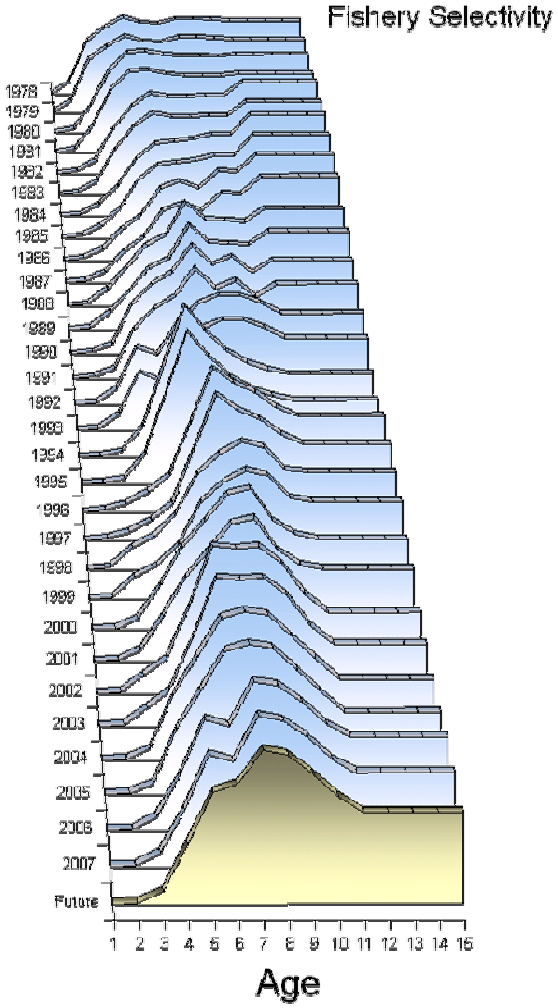
$F_{OFL} = 0$

$F_{ABC} = 0$

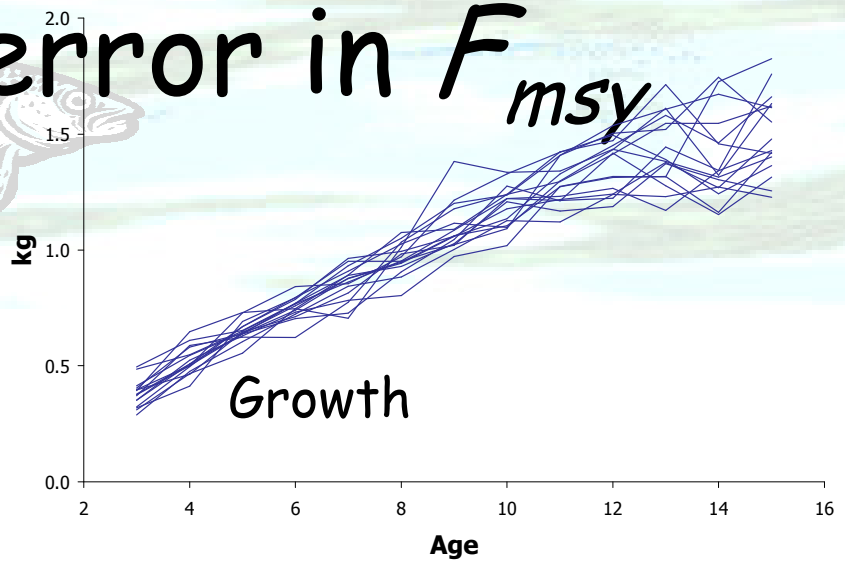
Formally risk averse

Some sources of error in F_{msy}

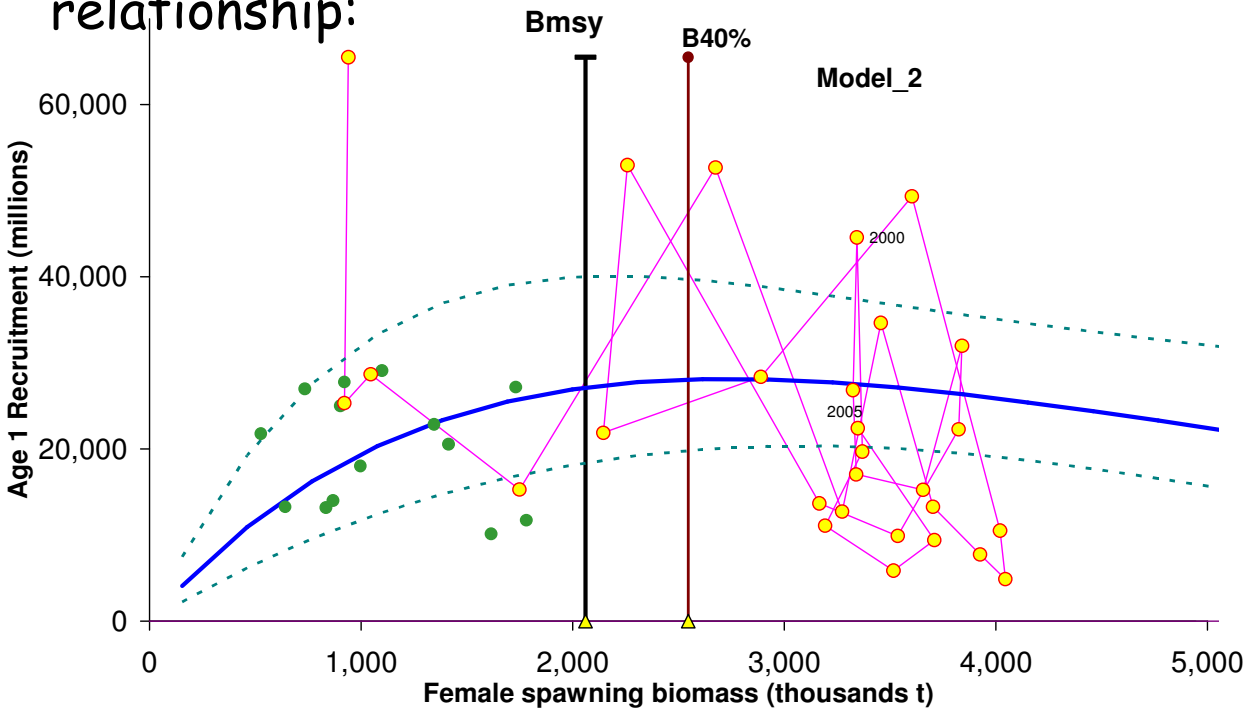
Selectivity



Natural mortality



Stock-recruitment relationship:

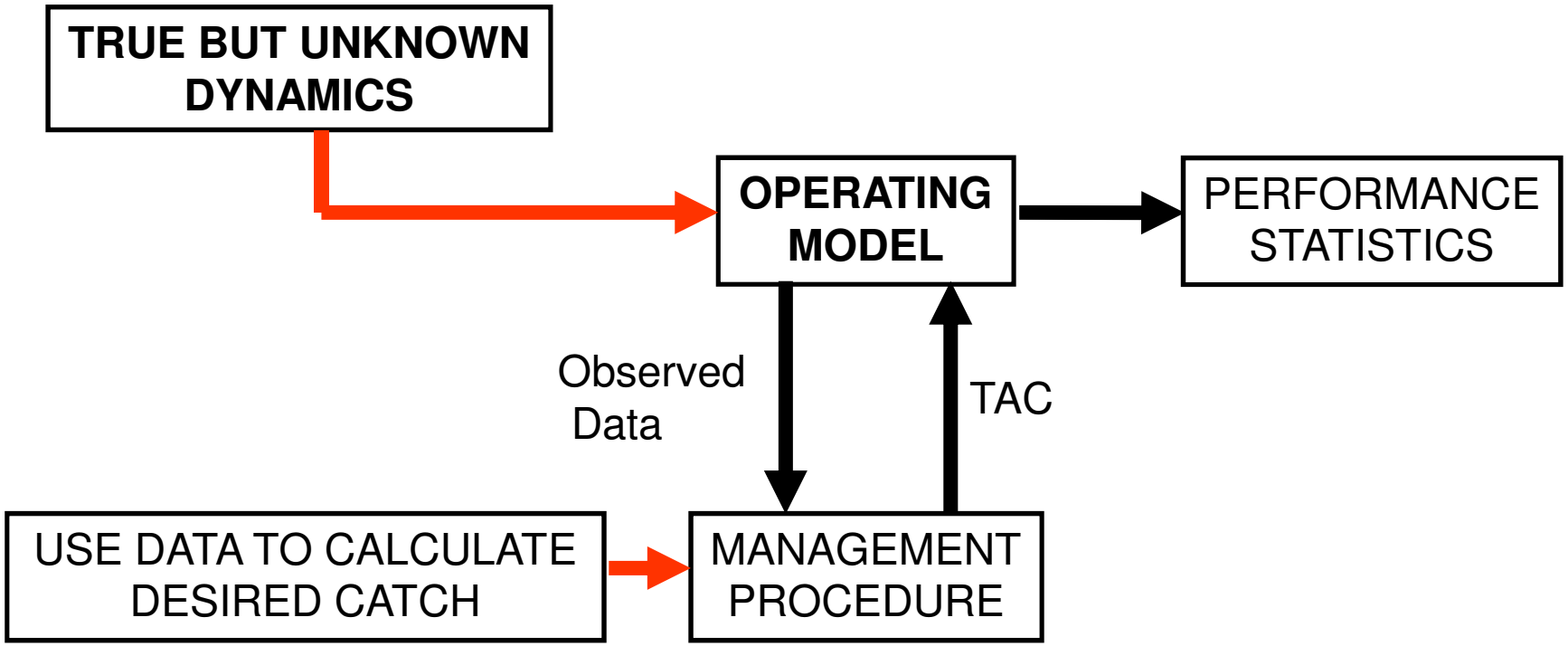


Why does this matter?

- **Unknown stock components contribute to this uncertainty**
  - Adds to productivity variability
- **Directly by adjusting the maximum permissible harvest level**
  - TAC level would be considerably higher under the following
    - Fixed selectivity
    - Deterministic mean-mass-at-age
    - Fixed natural mortality
    - Greater certainty in recruitment prediction

Testing hypotheses: Management strategy evaluations

Management Strategy Evaluation



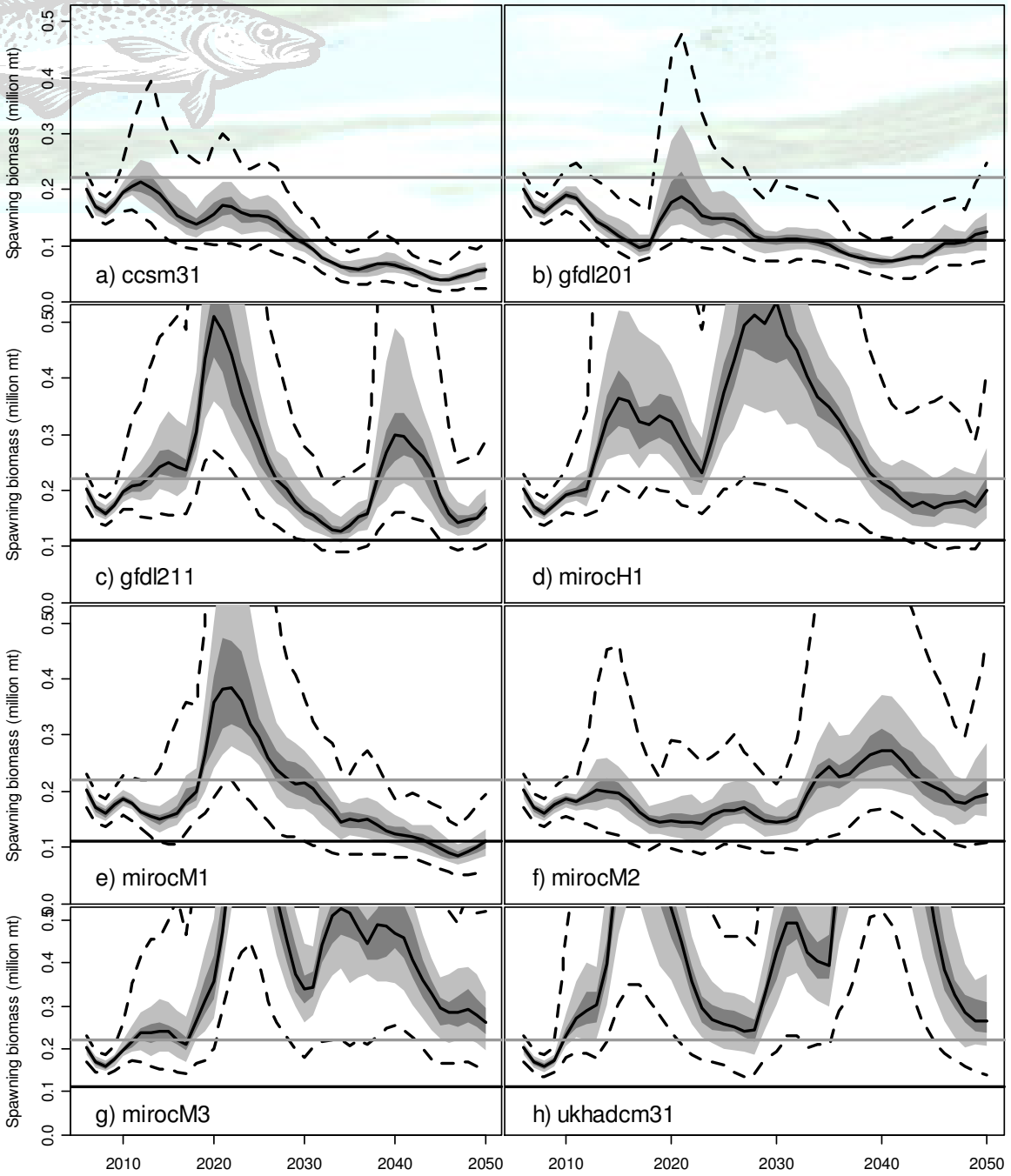
- Uncertainties reflected by different operating models for “reality”
- Management strategy must produce satisfactory performance across a range of plausible operating models

Operating model provides the key to evaluate hypotheses

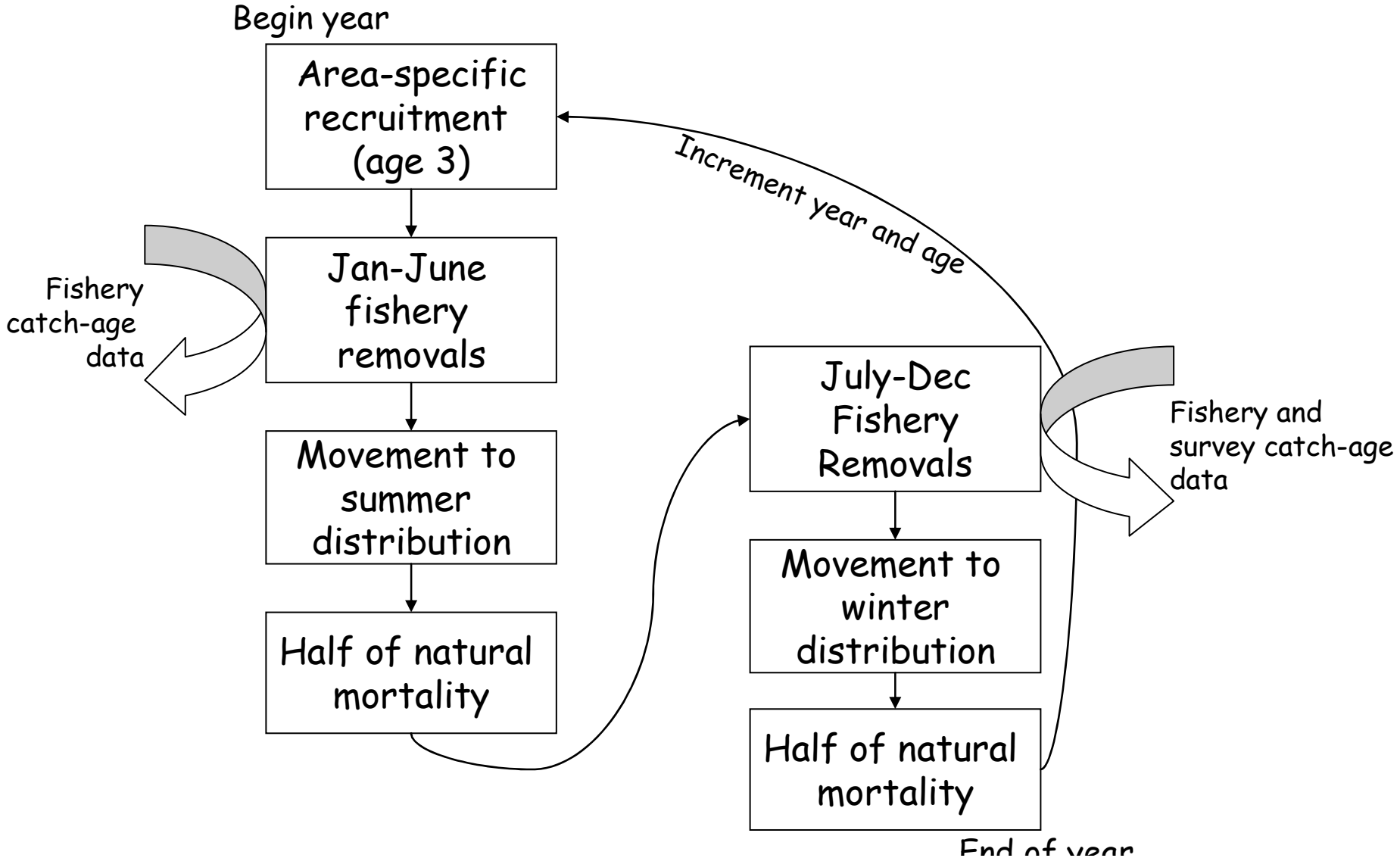
- **Direct incorporation of alternative hypotheses**
  - Applies all research fields
    - Oceanographic conditions
    - Biological variability
    - Stock structure hypothesis

Linking Environment to MSE

A'mar et al. 2008. The impact on management strategy performance of climate variability on age-1 abundance for the Gulf of Alaska walleye pollock. ICES/PICES symposium, Gijon Spain.



Area and seasonally disaggregated operating model



Modeling Alternative hypotheses

Hypotheses about EBS pollock spatial processes

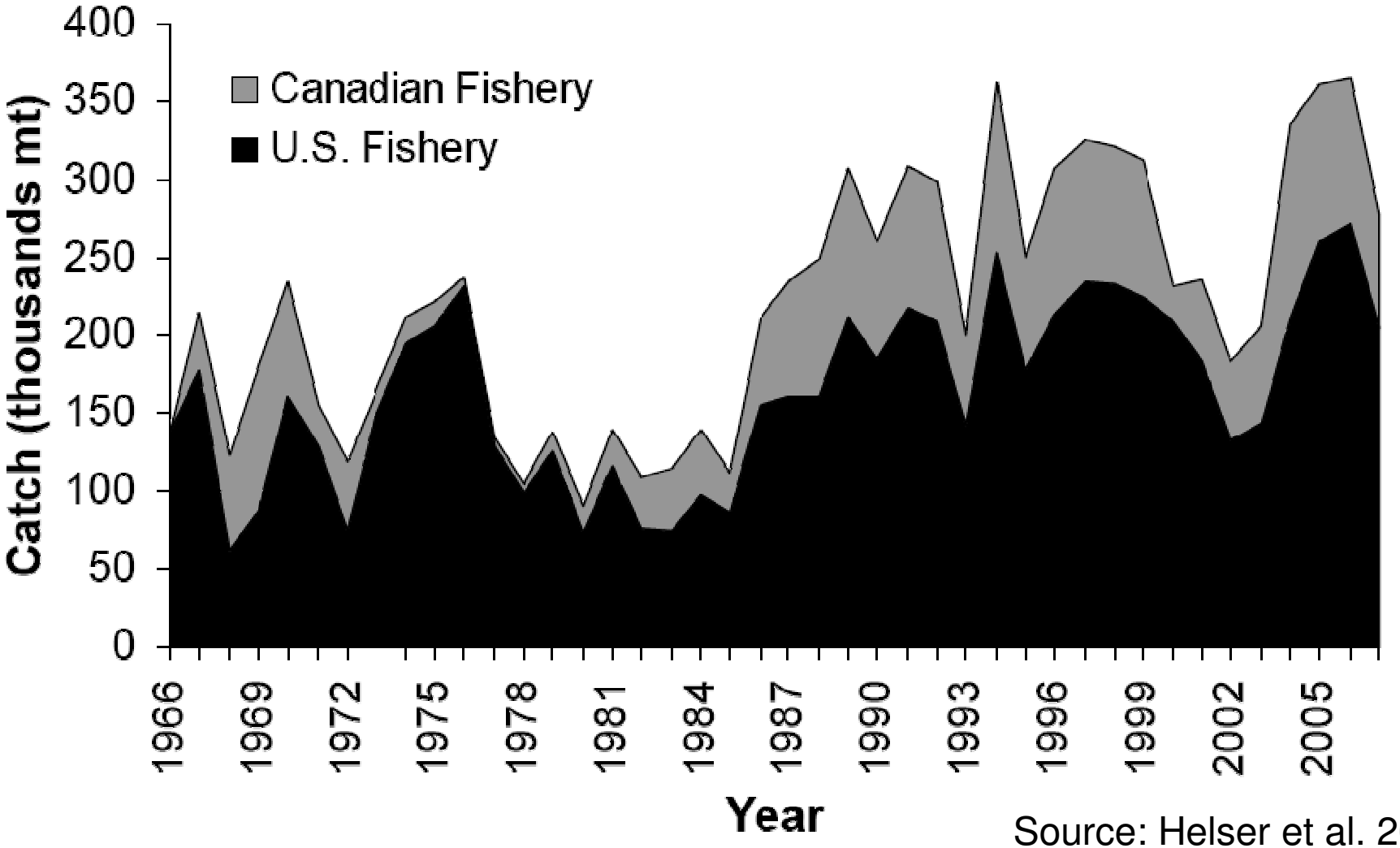
Hypothesis	Post 1st season residency (θ_B)		Post 2nd season residency (θ_A)		Age-specific movement pattern	Relative recruitment (ϕ)	Area-specific Recruitment variability (ε)
	NW	SE	NW	SE			
Discrete stocks	1	1	1	1	-	50:50	No
H_1	80%	30%	10%	90%	0.8, 0.9	65:35	Estimated
H_2	80%	30%	10%	90%	0.8, 0.9	65:35	No
H_3	Est	Est	Est	Est	0.8, 0.9	65:35	Estimated
H_4	80%	30%	10%	90%	0.8, 0.9	Est	No
One stock Equal mixing?	50%	50%	50%	50%	1.0, 1.0	50:50?	No

Other MSE developments

- **Should account for retrospective biases**
- **Can be used for "minor" details**
  - Period over which to use age-based schedules:
    - selectivity estimates
    - Mean weight-at-age
    - Maturity
  - Decisions on natural mortality
  - Direct implementation of acknowledged environmental/ecosystem variability

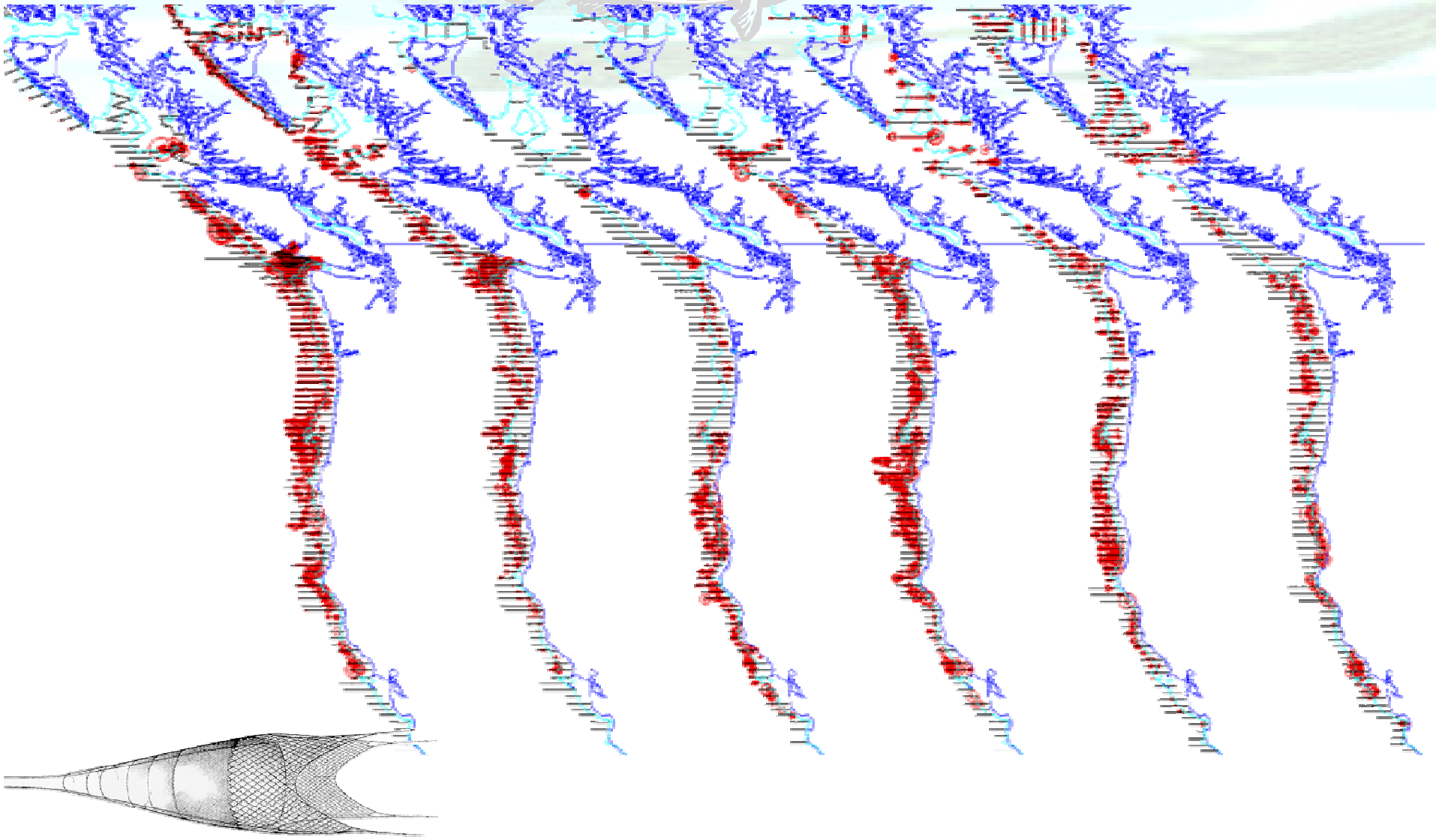
Pacific whiting (hake)

Pacific whiting
2007 catches down from 06



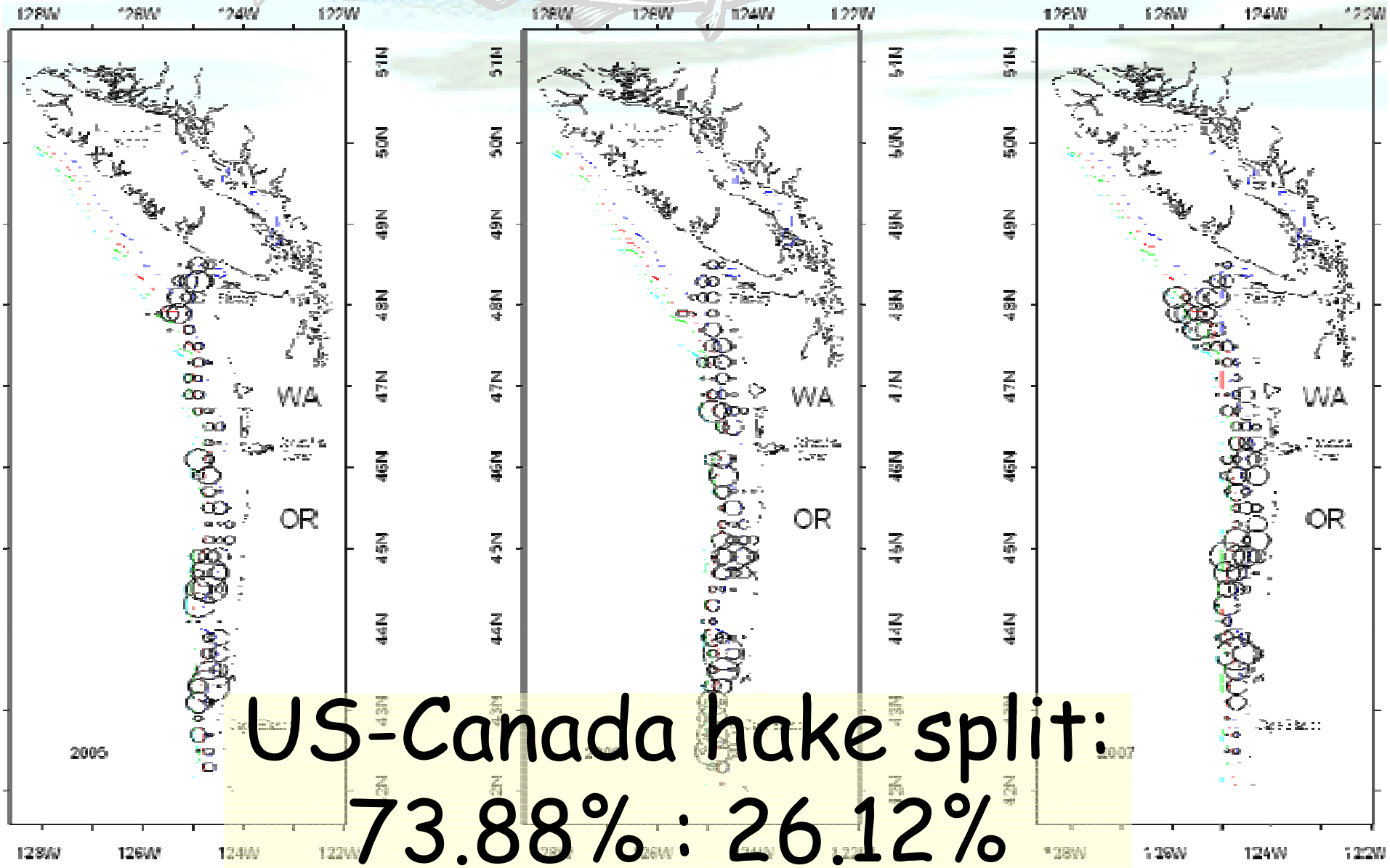
Source: Helser et al. 2008.

Pacific hake survey distribution varies along coast



Source: Helser et al. 2008

US Hake catch distribution 2005-2007



US-Canada hake split:
73.88% : 26.12%

Source: Helser et al. 2008

Summary (1 of 2)

- **Integrated assessment evaluations can entertain a broad range of hypotheses**
  - Should embrace all research programs
- **Developments can lead to operating model**
  - Used in management strategy evaluation
    - With feedback
    - Test robustness of **simple** approach
- **Spatial differences in productivity likely difficult to ascertain**
  - Risk-averse policies may help account for between stock variabilty

Summary (2 of 2)

- **Stock components at "fringe" of range**
  - New Zealand?
  - Recognize as such
  - Provide managers with options
    - E.g., evaluate objectives relative to risks
    - How frequent are recruitment events?