ESTIMATING THE ECONOMIC IMPACT OF THE STELLER SEA LION CONSERVATION AREA

Alan Haynie, NMFS Economist and UW Economics PhD Candidate, Alan.Haynie@noaa.gov
&
David Layton, UW Evans School of Public Affairs, dflayton@u.washington.edu

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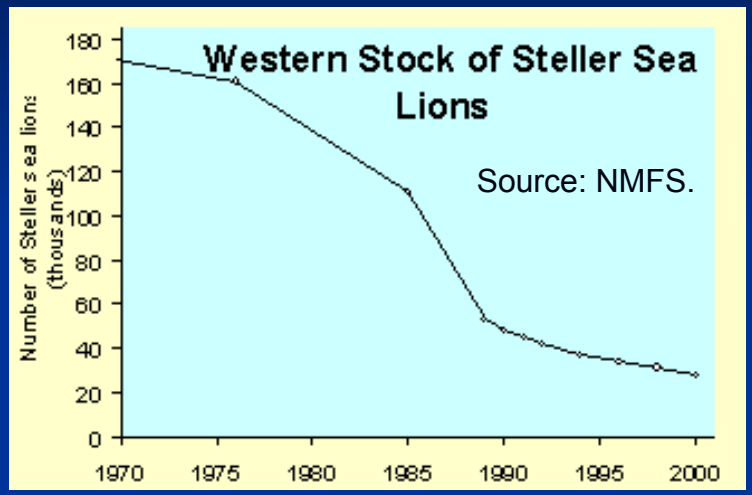
Basic Big Picture Problem that we're trying to address:

What's the economic impact of spatial management and what steps can we take to mitigate those costs?

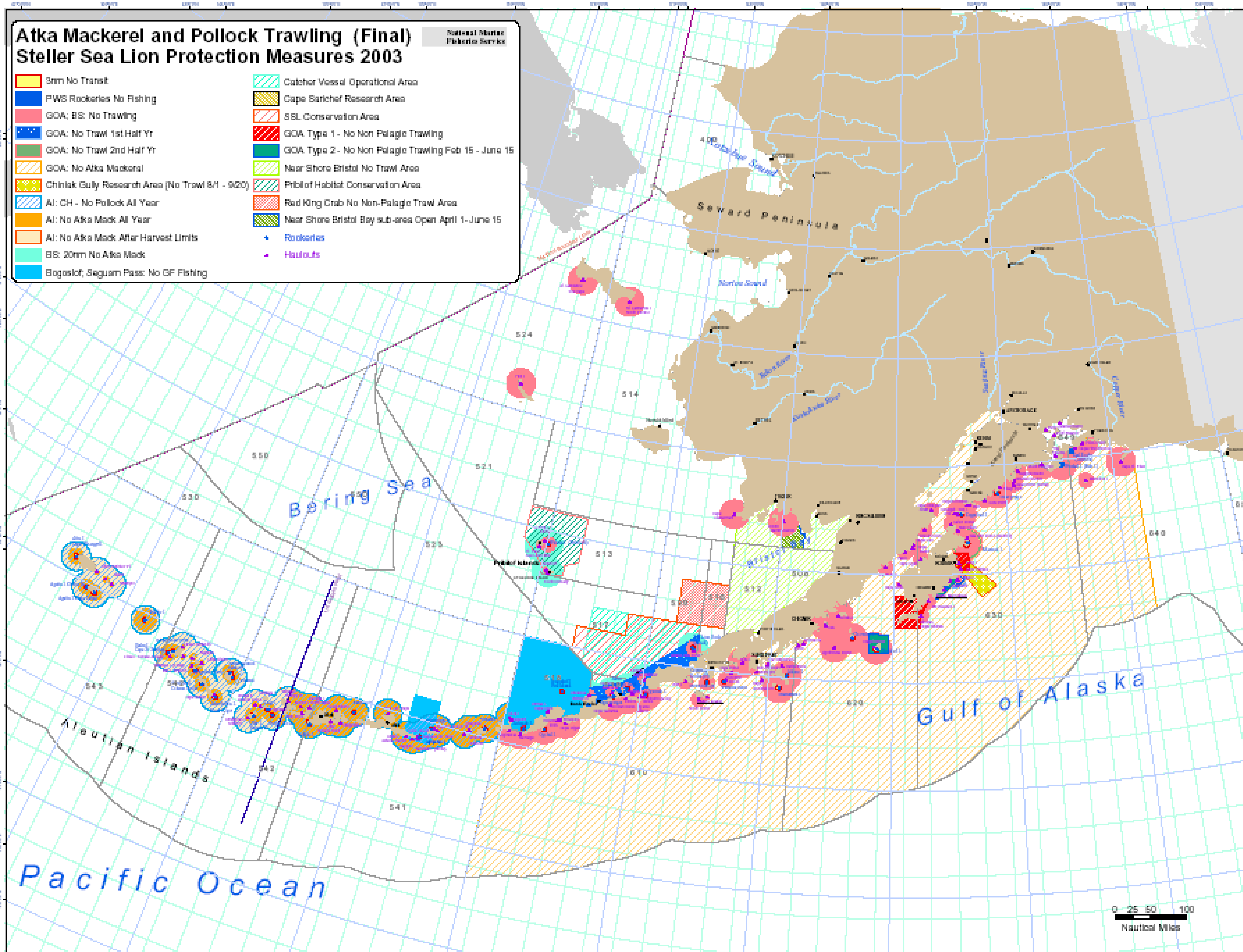
Pollock

- Pollock make up approximately 30 percent of the fish and shellfish landed in the US
- About 75% of Alaska groundfish fishery

Steller Sea Lions in Decline

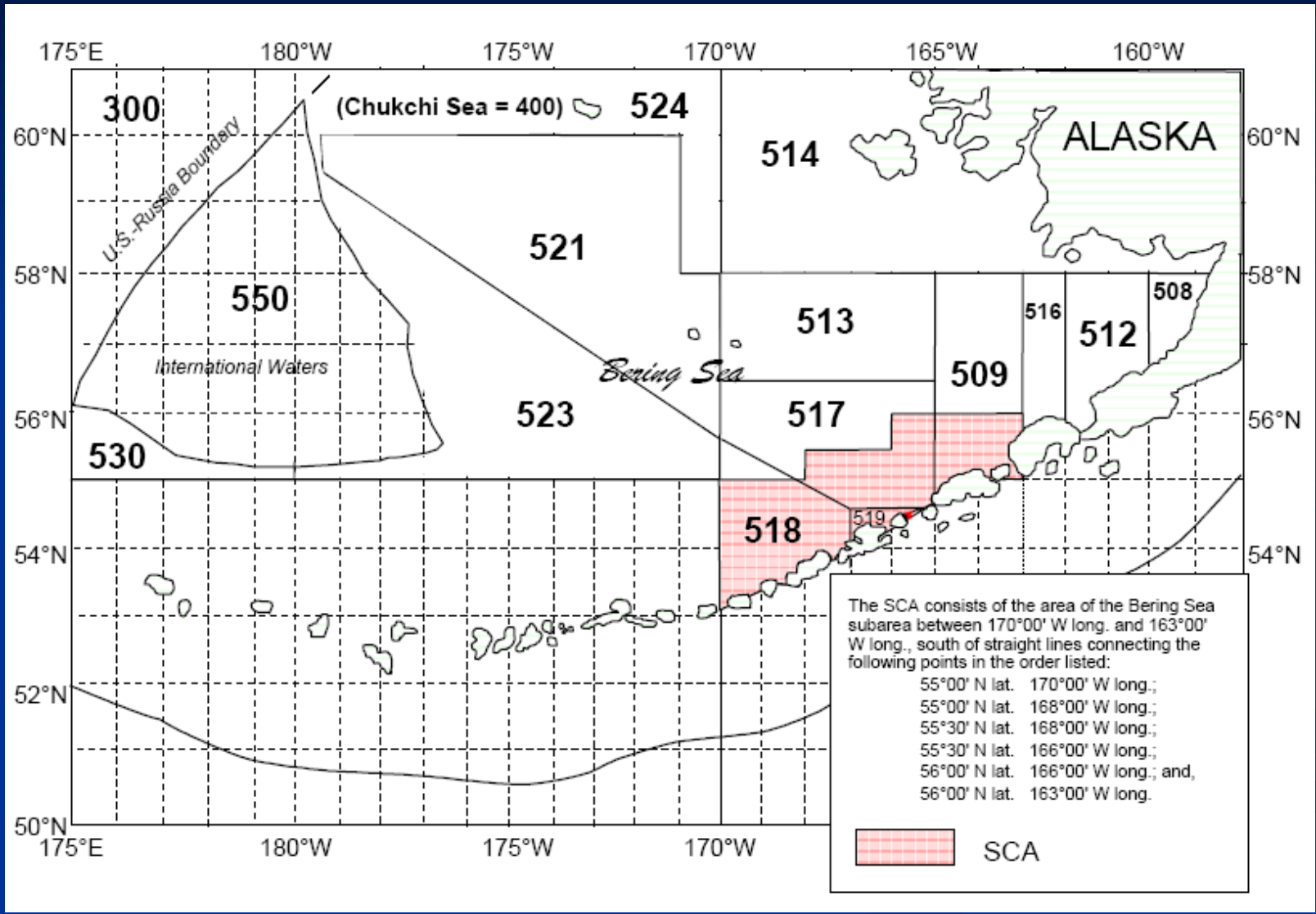


- Stellers were declared endangered in 1990



Atka Mackerel and Pollock Trawling (Final)
Steller Sea Lion Protection Measures 2003
National Marine Fisheries Service
3nm No Transit
PWS Rookeries No Fishing
GOA; BS: No Trawling
GOA: No Trawl 1st Half Yr
GOA: No Trawl 2nd Half Yr
GOA: No Atka Mackerel
Chiniak Gully Research Area (No Trawl 8/1 - 9/20)
AI: CH - No Pollock All Year
AI: No Atka Mack All Year
AI: No Atka Mack After Harvest Limits
BS: 20nm No Atka Mack
Bogoslof; Seguam Pass: No GF Fishing
Catcher Vessel Operational Area
Cape Sarichef Research Area
SSL Conservation Area
GOA Type 1 - No Non Pelagic Trawling
GOA Type 2 - No Non Pelagic Trawling Feb 15 - June 15
Near Shore Bristol No Trawl Area
Pribilof Habitat Conservation Area
Red King Crab No Non-Pelagic Trawl Area
Near Shore Bristol Bay sub-area Open April 1- June 15
Rookeries
Haulouts
Seward Peninsula
Bering Sea
Aleutian Islands
Pacific Ocean
Gulf of Alaska
Pribilof Islands
550
530
521
524
514
513
523
517
509
516
512
508
543
542
541
610
620
630
640
650
0 25 50 100
Nautical Miles

Steller Sea Lion Conservation Area (SCA)

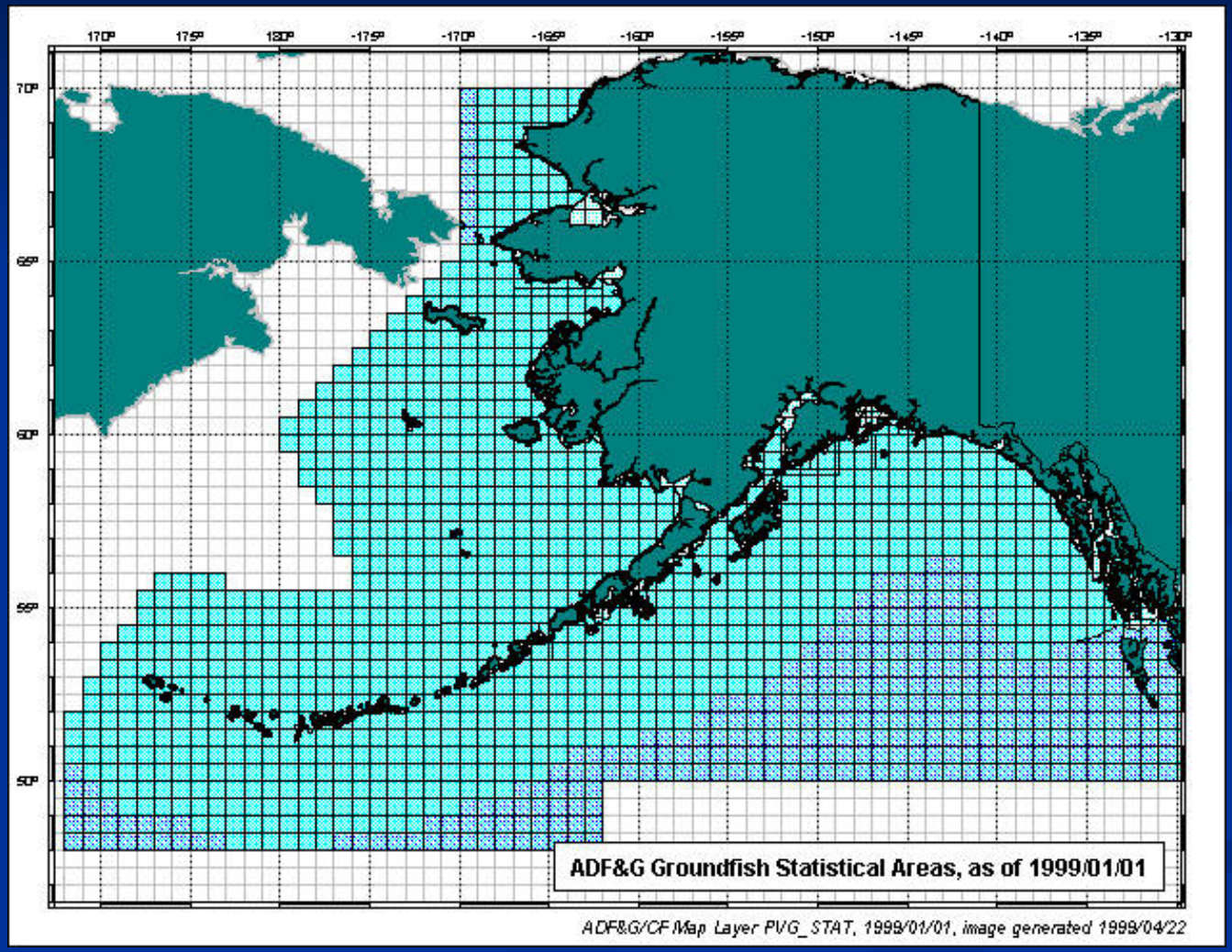


Summer Catcher boat trips in/out of SCA per year

SCA	1995	1996	1997	1998	1999	2000	2001	2002
Outside	1	3	0	60	253	654	30	0
Inside	583	543	539	539	324	86	761	847
% Inside	99.8	99.5	100.0	90.0	56.2	11.6	96.2	100.0

SCA seasonally closed during 1999 and 2000.

STAT6 Areas in the Bering Sea



Standard Discrete Choice Formulation

- Fishers (i = 1…n) choose the zone (j = 1…n) with the highest utility

$$U_{ij} = X_{ij}\beta + \nu_{ij}$$

- Usually a conditional or nested logit is employed. For example, for a binomial conditional logit model:

$$\Pr(Y = 1) = \frac{e^{\left(\frac{X_{i1}\ \beta}{\sigma_\varepsilon}\right)}}{e^{\left(\frac{X_{i1}\ \beta}{\sigma_\varepsilon}\right)} + e^{\left(\frac{X_{i2}\ \beta}{\sigma_\varepsilon}\right)}}$$

- Two-stage expected catch (or revenue) is typically employed

Expected Profit Model (EPM)

- Main idea: jointly endogenously estimate expected catch/profit
- Because of the fact that we actually observer prices and b/c of the separability of the discrete portion of likelihood, all parameters are potentially identifiable.

$$\ell_j = \underbrace{\frac{1}{\sigma_{\nu_j}\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{Y_{ij} - \alpha_j}{\sigma_{\nu_j}}\right)^2\right]}_{c} \underbrace{\frac{e^{\left(\frac{P_j\alpha_j + X_j\beta}{\sigma_\varepsilon}\right)}}{\sum_k e^{\left(\frac{P_{ik}\alpha_k + X_{ik}\beta}{\sigma_\varepsilon}\right)}}}_{d}$$

$Y_{ij} = \alpha_j + \nu_{ij}$

EPM Assumptions

$$Y_{ij} = \alpha_j + \nu_{ij} \qquad \nu_{ij} \sim Normal\ (0, \sigma_j)$$

$$E(\pi_{ij}) = P\ \alpha_j + X_{ij}\beta + \varepsilon_{ij}$$

$$\varepsilon_{ij} \sim TYPE\ I\ EV\ (0, \sigma_\varepsilon)$$

ε_{ij}, ν_{ij} *are independent*

Different methods to evaluate closures

- Zonal discrete choice model
- Conditional logit based on expected catch for each zone
- Expected profit model with joint estimation and discrete data

Summary of Data

- Data for years 1995-2000 (summer season)
  - 1995-1998 data used to predict impact for 1999-2000 closures
  - 2247 trips
- Observer data on catch and location for all hauls in the Bering Sea (haul observations are used to find the centroid of hauls on a trip)
- Hauls are grouped into discrete half-degree zones
- Miles from port to catch sites
- Annual Prices

Model Predictions for 2000 SCA closure

	1995-1998							2000d (post-closure)						
Zone	% of Actual Trips	Logit estimate % trips	EPM estimate % trips	Y-AVG estimate % trips	Logit 9598 MSE	EPM 9598 MSE	YAVG 9598 MSE	% of Actual Trips	Logit estimate % trips	EPM estimate % trips	Y-AVG estimate % trips	Logit 2000d MSE	EPM 2000d MSE	YAVG 2000d MSE
1	0.53	0.52	0.15	7.96	0.000	0.2	55		0	0	0			
2	8.19	7.56	6.72	4.95	0.394	2.2	10		0	0	0			
3	0.67	0.60	0.26	3.26	0.005	0.2	7		0	0	0			
4	0.67	0.60	0.22	0.83	0.005	0.2	0	23.5	28.11	32.6	10.8	21	82	163
5	24.17	25.34	23.69	11.49	1.379	0.2	161		0	0	0			
6	0.27	0.27	0.05	17.13	0.000	0.0	284		0	0	0			
7	46.19	46.32	58.09	8.52	0.016	141.4	1419		0	0	0			
8	8.32	7.77	6.24	6.66	0.302	4.3	3		0	0	0			
9	1.56	1.44	0.78	1.97	0.014	0.6	0		0	0	0			
10	0.40	0.36	0.11	0.64	0.001	0.1	0	51.0	17.04	16.2	8.3	1152	1212	1822
11	3.29	3.51	1.56	7.31	0.046	3.0	16		0	0	0			
12	0.85	0.92	0.18	7.55	0.006	0.4	45		0	0	0			
13	2.40	2.45	1.27	8.74	0.002	1.3	40		0	0	0			
14	0.58	0.56	0.15	4.39	0.000	0.2	14		0	0	0			
15	0.40	0.35	0.09	3.80	0.003	0.1	12	0.5	16.39	13.9	49.5	253	180	2399
16	0.53	0.49	0.17	0.75	0.002	0.1	0	19.9	22.88	24.8	9.8	9	25	
17	0.62	0.60	0.21	2.38	0.000	0.2	3		0.0	0	0			
18	0.36	0.33	0.08	1.67	0.001	0.1	2	5.1	15.59	12.5	21.7	109	55	272
Total	100	100	100	100	2.2	154.8	2072	100	100	100	100	1544	1553	4656

Percentage of trips in the included zones

	Year				
	95-98	1999	2000c	2000d	2001-02
trips in included zones	2247	538	133	413	1617
total trips	2268	577	182	558	1638
% of trips included	99%	93%	73%	74%	99%

SCA seasonally closed during 1999 and 2000.

$E\left(MAX\left(U_{ij}, j=1:m1\right)\right) - E\left(Max\left(U_{ij}, j=1:M\right)\right) = W$

EPM Welfare Calculations

- The big advantage of the EPM is that we can directly calculate changes in welfare from area closures

$$E\left(MAX\left(U_{ij},\ j=1:m1\right)\right) - E\left(Max\left(U_{ij},\ j=1:M\right)\right) = W$$

$$E\left(Max\left(U_{ij},\ j=1:M\right)\right) = \sigma_{\varepsilon}\ \ln\left(\sum_{j=1}^{j=M} \exp^{V_{ij}/\sigma_{\varepsilon}}\right) - \sigma_{\varepsilon} \times 0.57721$$

EPM Welfare Results
(2000 Summer Season cost per trip)

Expected profit or net revenue (per trip)	$/Trip
Before SCA closure	56,170
With SCA closure	48,947
Net loss from closure	7,223

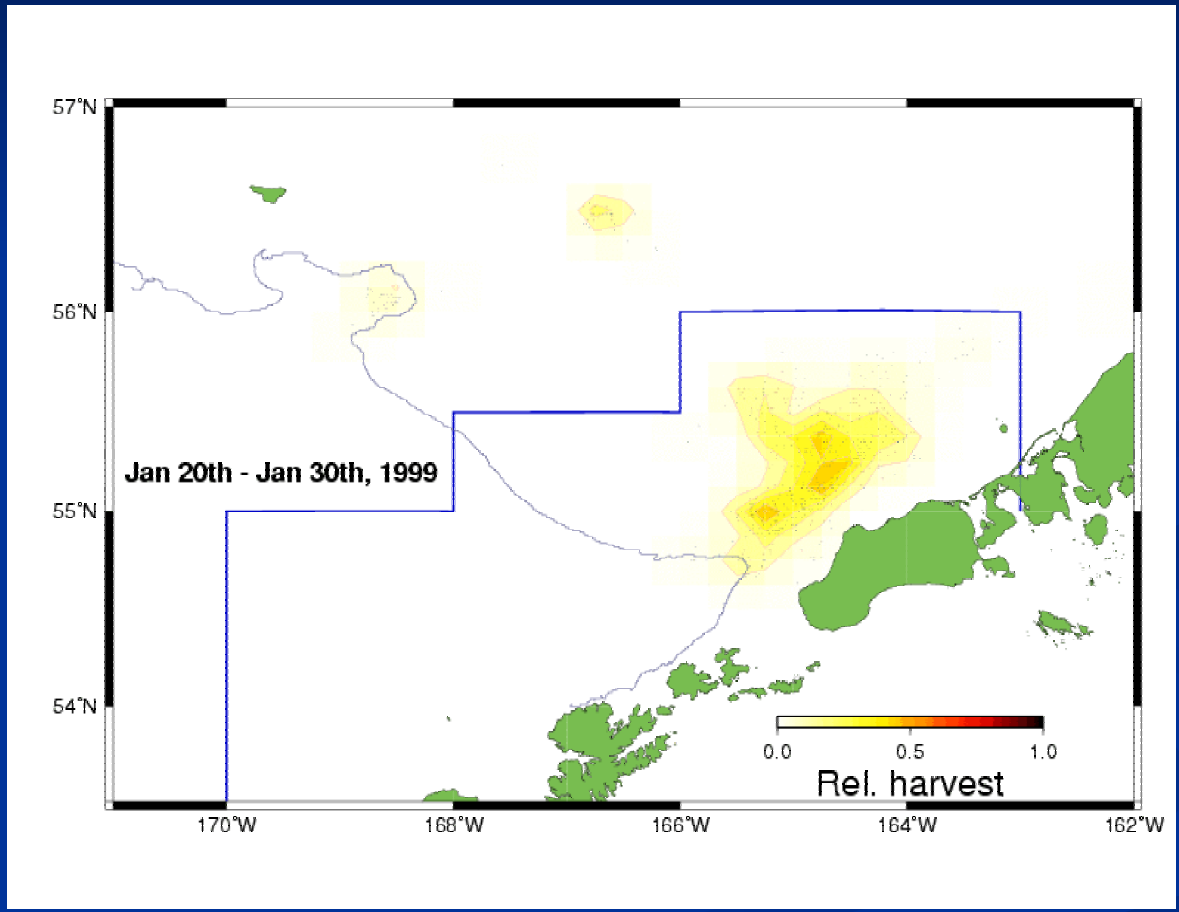
Estimation Issues

- Assumption of no correlation among errors is questionable; will test in Monte Carlo experiments
- Issues in scaling – proper scaling required to make the model work
- Boat characteristics not significant in current formulation
- Parameterization of our alphas would allow evaluation of complex area closures

Welfare questions

- This is a seasonal model of the summer season, but really we need to understand the winter season, both from an economic and a biological point of view
- How important is it to include costs?
  - While model suggests travel costs are small relative to net revenues, they may represent a larger portion of the welfare lost

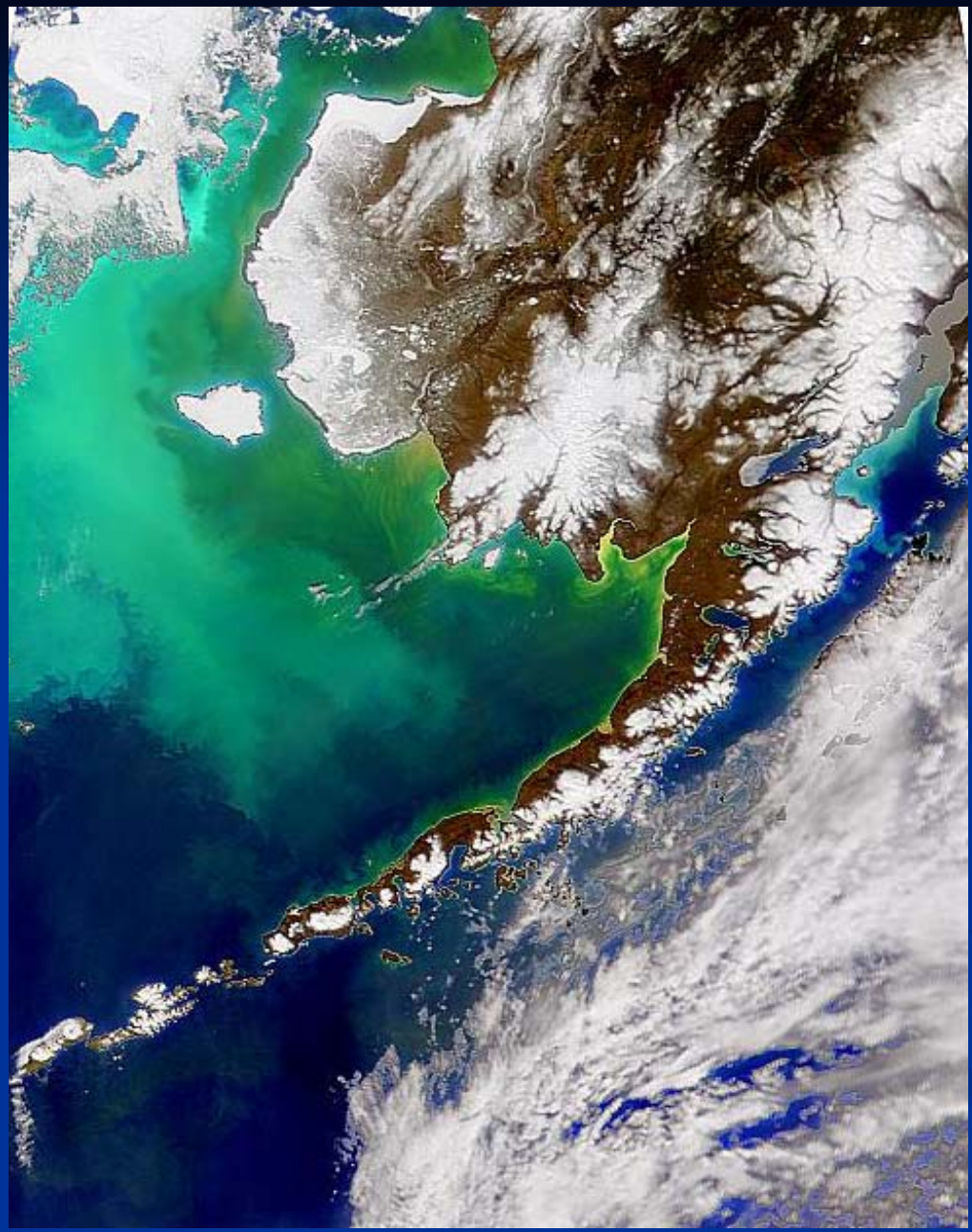
1999 Winter Season



Beyond pollock

- Different issues exist when we are attempting to look at the choice of what fishery to fish, and the fish/no-fish decision

- The nature of motion
  - How migratory is the species?
  - What is the value of information?



The End