Science, Service, Stewardship

Draft 2010 Biological Opinion: Supporting Documents

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Status of Stocks and Multispecies Assessment
Resource Ecology and Fisheries Management
Alaska Fisheries Science Center

NOAA FISHERIES SERVICE

Outline of presentation

- Biomass projections cited in Chapter 8 “Reasonable and Prudent Alternatives”
- Atka mackerel research
  - Tagging estimates of movement and abundance
  - Food web model estimates of production and consumption
- Sea lion fishery and oceanographic analysis

Biomass projections

- White papers by Ianelli, et al.
  - "Projections of Atka mackerel and Pacific cod catch reductions"
  - "Aleutian Islands trawl survey biomass summary"
- Examine how much biomass of Aleutian Islands Atka mackerel and Pacific cod could increase as a result of reductions in commercial catch

Methods

- Projection model from groundfish stock status determinations (100 replicates, 100 years)
- Assumptions
  - Population dynamics within NPFMC management areas are the same as region-wide dynamics
  - No fish migration between areas
  - Biomass of other groundfish species (e.g., rockfish, flatfish) does not change
- Initial population biomass from 2009 SAFE
- Projections apportioned into NPFMC areas based on 2002-2006 trawl survey data

Survey biomass estimates
Western Aleutians (543)

Groundfish species	2002	2004	2006	Average
Pacific ocean perch	202,124	212,639	281,946	232,236
Atka mackerel	255,115	376,414	100,693	244,074
Northern rockfish	134,519	146,179	101,276	127,324
Pacific cod	23,802	9,637	19,734	17,724
Arrowtooth flounder	14,343	17,400	13,343	15,029
Northern rock sole	10,575	10,434	12,768	11,259
Walleye pollock	12,442	6,605	6,514	8,520
Shortraker rockfish	3,947	16,333	2,471	7,584
Shortspine thornyhead	8,246	12,002	11,116	10,454
Other	40,026	59,387	43,170	47,528
Total	705,139	867,029	593,030	721,733

Summer bottom-trawl survey estimates of groundfish biomass (t) by year and average for the Aleutian Islands region 543.

Survey biomass estimates Western Aleutians (543)

Groundfish species	2002	2004	2006	Average
Pacific ocean perch	29%	25%	48%	34%
Atka mackerel	36%	43%	17%	32%
Northern rockfish	19%	17%	17%	18%
Pacific cod	3%	1%	3%	3%
Arrowtooth flounder	2%	2%	2%	2%
Northern rock sole	1%	1%	2%	2%
Walleye pollock	2%	1%	1%	1%
Shortraker rockfish	1%	2%	0%	1%
Shortspine thornyhead	1%	1%	2%	1%
Other	6%	7%	7%	7%

Summer bottom-trawl survey estimates of groundfish biomass proportions by year and average for the Aleutian Islands region 543.

Survey biomass projections, no fishing Western Aleutians (543)

Groundfish species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Pacific ocean perch	232.2	232.2	232.2	232.2	232.2	232.2	232.2	232.2	232.2	232.2	232.2	48%
Atka mackerel	244.1	222.9	240.5	259.3	279.1	298.1	316.7	332.7	343.9	352.3	358.7	362.2
Northern rockfish	127.3	127.3	127.3	127.3	127.3	127.3	127.3	127.3	127.3	127.3	127.3	119%
Pacific cod	17.7	20.1	25.3	29.5	32.8	34.1	36.1	37.0	37.9	38.5	38.5	38.8
Arrowtooth flounder	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Northern rock sole	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Walleye pollock	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Shortraker rockfish	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
Shortspine thornyhead	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Other	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5
Total	721.7	702.9	725.7	748.7	771.8	792.1	812.7	829.6	841.7	850.7	857.2	861.0
Relative %	100%	97%	101%	104%	107%	110%	113%	115%	117%	118%	119%	119%

Average Pacific cod and Atka mackerel Aleutian Islands bottom-trawl survey biomass estimates projected from the BSAI-wide and Aleutian Islands-wide (respectively) models under no fishing. The other species groundfish biomass (kt) values are set equal to their averages. Data are from the 2002, 2004 and 2006 surveys for region 543.

Survey biomass estimates
Central Aleutians (542)

Groundfish species	2002	2004	2006	Average
Atka mackerel	322,556	269,320	278,036	289,971
Pacific ocean perch	140,356	152,840	170,942	154,712
walleye pollock	108,244	11,627	18,482	46,118
northern rockfish	38,772	27,050	70,834	45,552
giant grenadier	7,818	57,304	29,672	31,598
Pacific cod	24,327	20,709	22,033	22,356
northern rock sole	22,935	22,343	37,159	27,479
Kamchatka flounder	20,088	19,255	12,263	17,202
arrowtooth flounder	12,950	18,426	8,312	13,230
other	47,703	55,624	58,919	54,082
Total	745,747	654,496	706,650	702,298

Survey biomass estimates
Central Aleutians (542)

Groundfish species	2002	2004	2006	Average
Atka mackerel	43%	41%	39%	41%
Pacific ocean perch	19%	23%	24%	22%
Walleye pollock	15%	2%	3%	6%
Northern rockfish	5%	4%	10%	6%
giant grenadier	1%	9%	4%	5%
Pacific cod	3%	3%	3%	3%
northern rock sole	3%	3%	5%	4%
Kamchatka flounder	3%	3%	2%	2%
arrowtooth flounder	2%	3%	1%	2%
Other	6%	8%	8%	8%

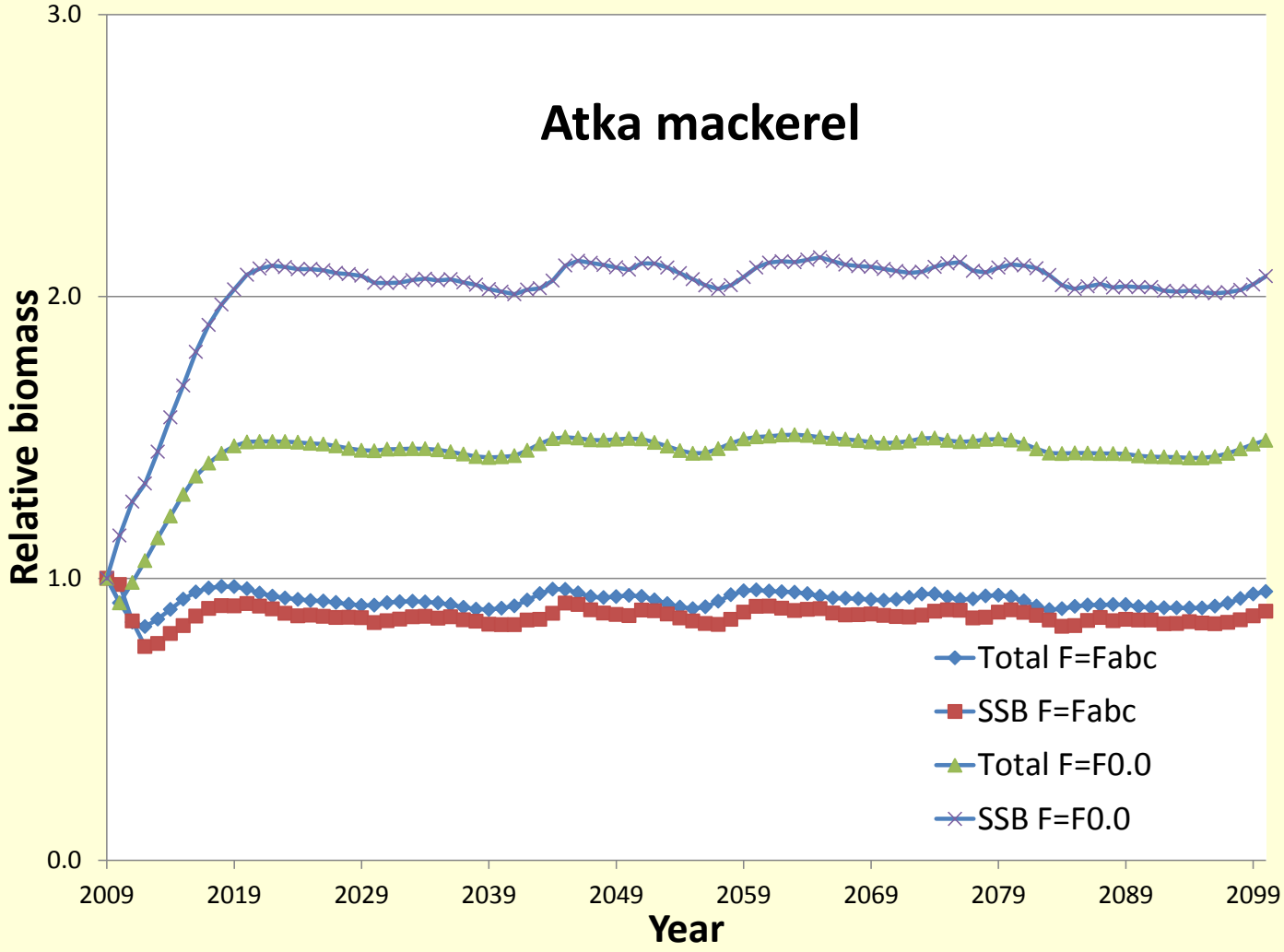
Summer bottom-trawl survey estimates of groundfish biomass proportions by year and average for the Aleutian Islands region 542.

Survey biomass projections fishing at 50% max. permissible Central Aleutians (542)

Groundfish species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Atka mackerel	290.0	264.8	264.0	269.6	280.1	292.0	304.6	314.9	321.3	325.2	326.9	326.2
Pacific ocean perch	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7	12%
Walleye pollock	46.1	46.1	46.1	46.1	46.1	46.1	46.1	46.1	46.1	46.1	46.1	46.1
Northern rockfish	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6
Giant grenadier	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	59%
Pacific cod	22.4	25.3	30.6	34.0	36.0	35.5	36.0	35.7	35.8	35.8	35.6	35.5
northern rock sole	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
Kamchatka flounder	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2
arrowtooth flounder	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
other	54.1	54.1	54.1	54.1	54.1	54.1	54.1	54.1	54.1	54.1	54.1	54.1
Total	702.3	680.1	684.5	693.6	706.0	717.4	730.5	740.6	747.1	750.9	752.5	751.7
Relative %	100%	97%	97%	99%	101%	102%	104%	105%	106%	107%	107%	107%

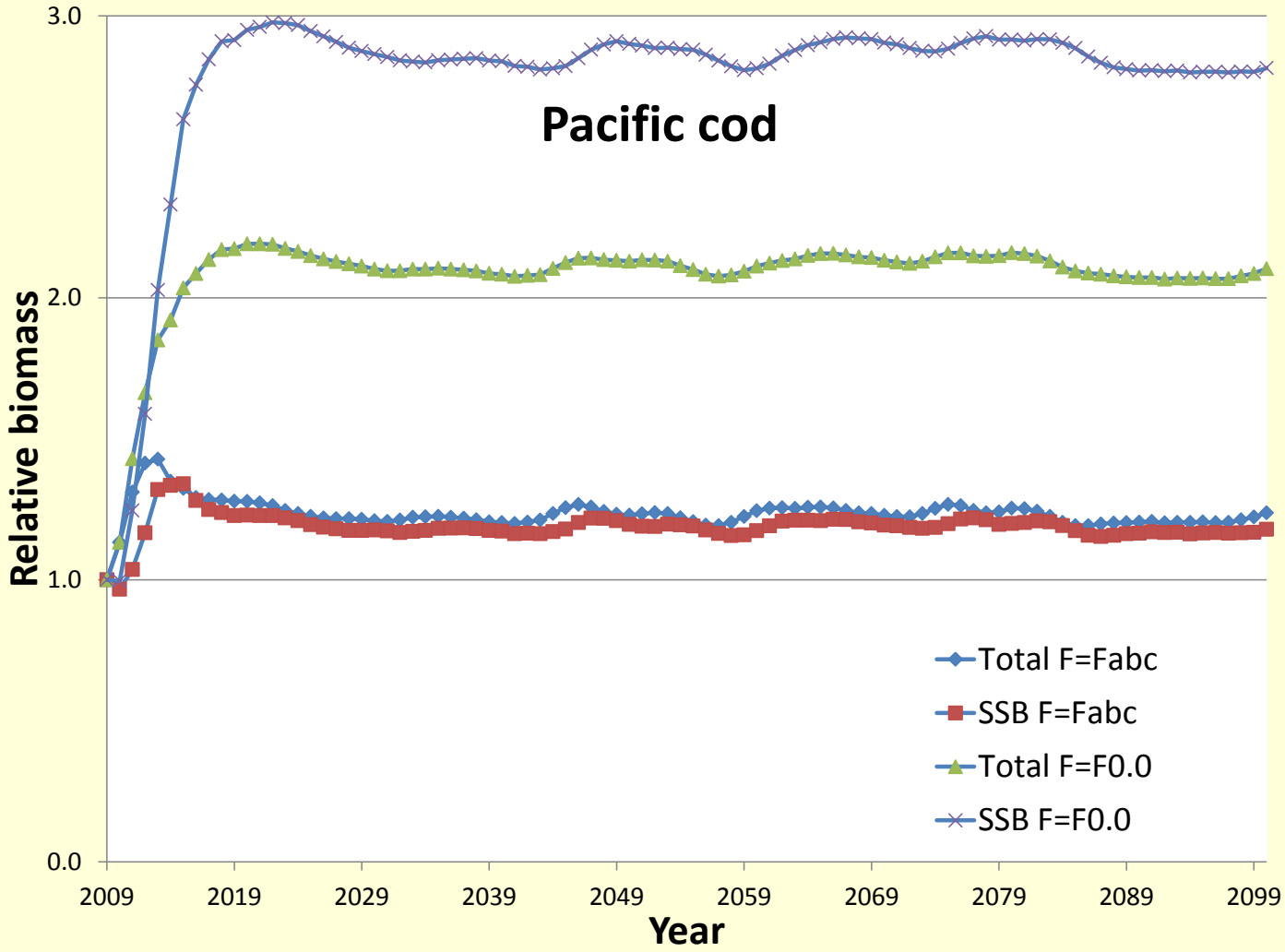
Average Pacific cod and Atka mackerel Aleutian Islands bottom-trawl survey biomass estimates projected from the BSAI-wide and Aleutian Islands-wide (respectively) models under fishing at half of maximum permissible rate. The other species groundfish biomass (kt) values are set equal to their averages. Data are from the 2002, 2004 and 2006 surveys for region 542.

Results



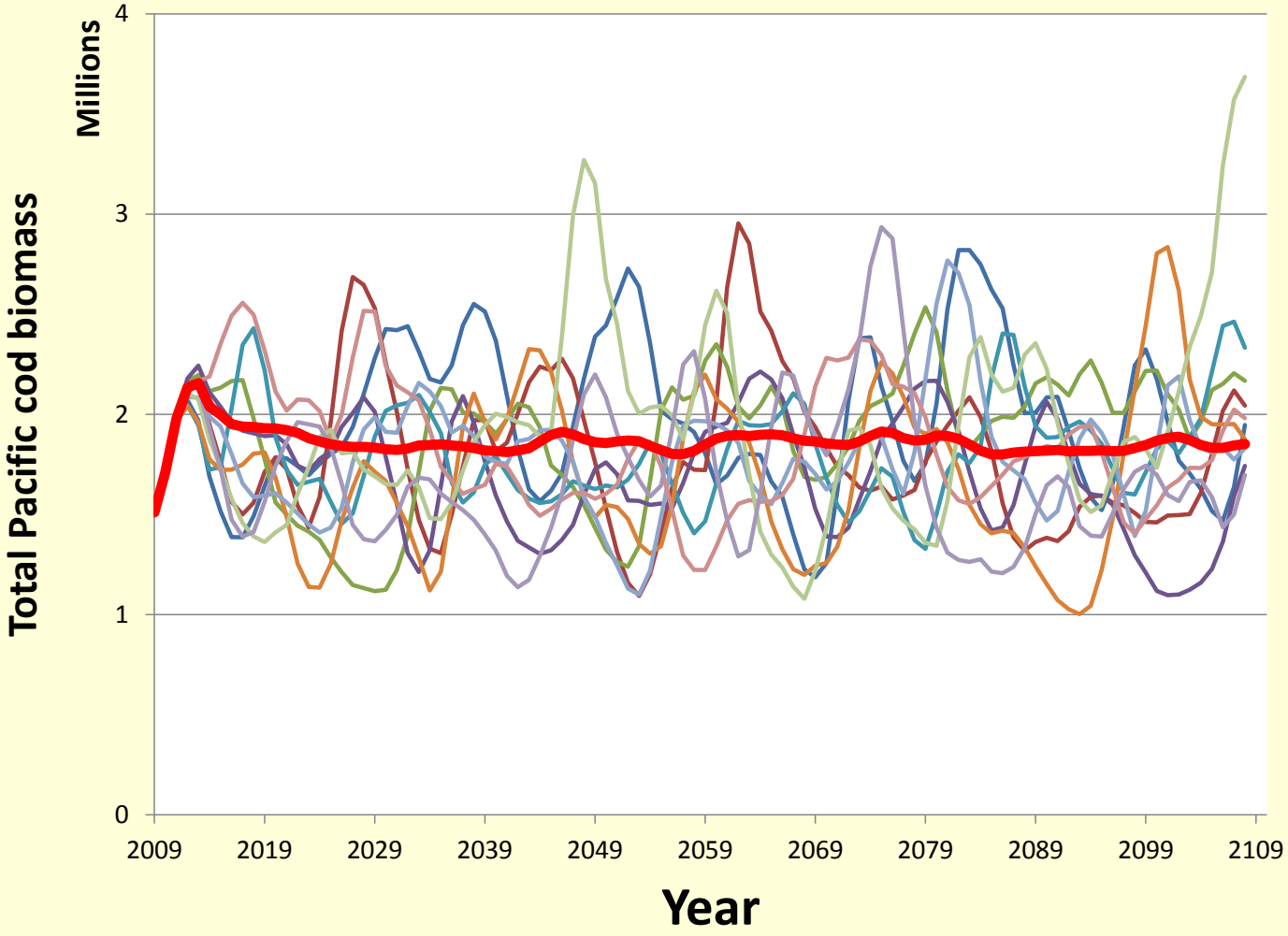
Mean biomass relative to 2009 estimates under no fishing (F=F0.0) and fishing at maximum permissible levels (F=*FABC*).

Results



Mean biomass relative to 2009 estimates under no fishing (F=F0.0) and fishing at maximum permissible levels (F=*FABC*).

Results

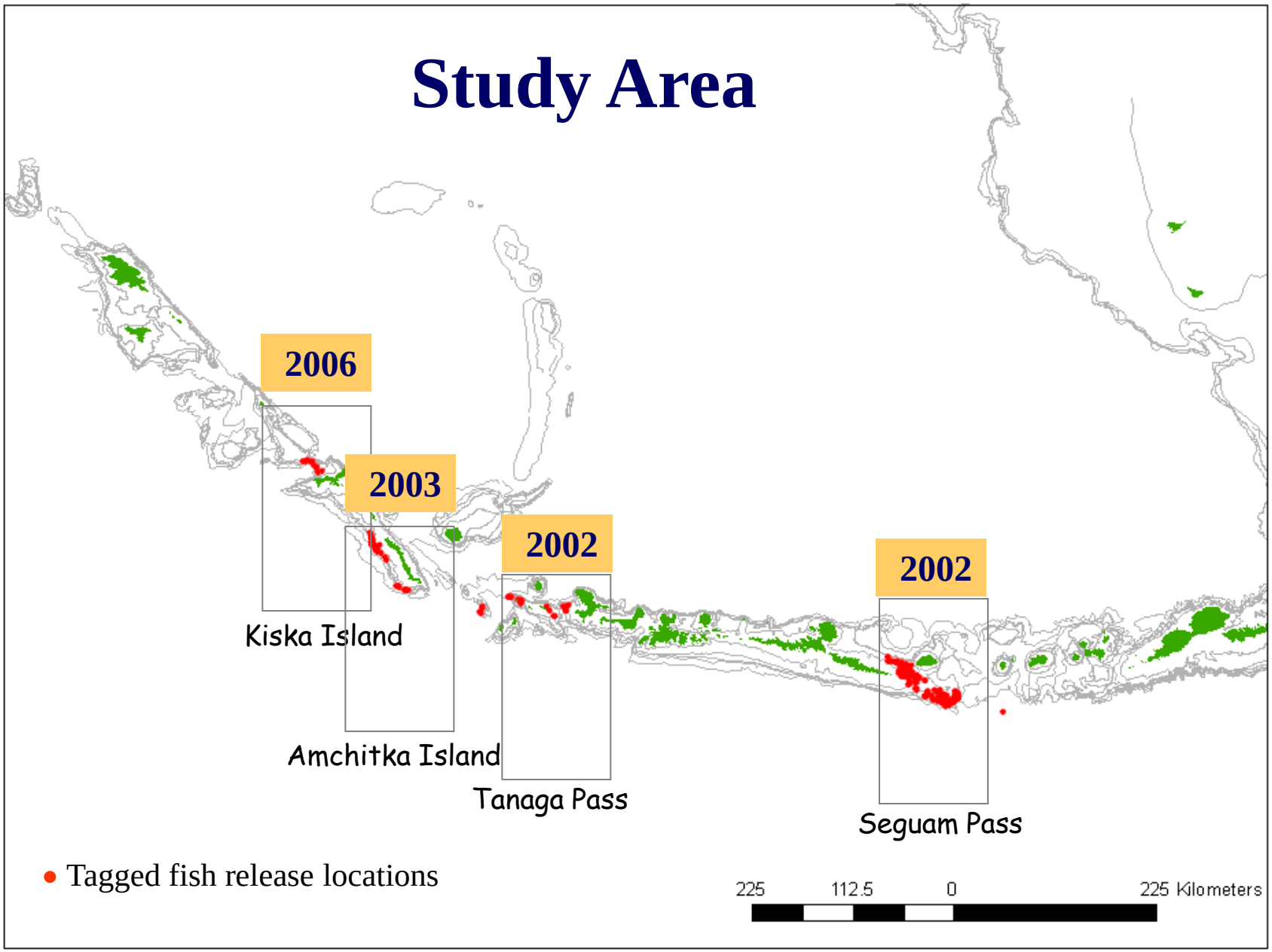


Mean total biomass over simulations (solid thick line) compared to some of the Monte Carlo realizations (no fishing).

Atka mackerel Tagging project overview

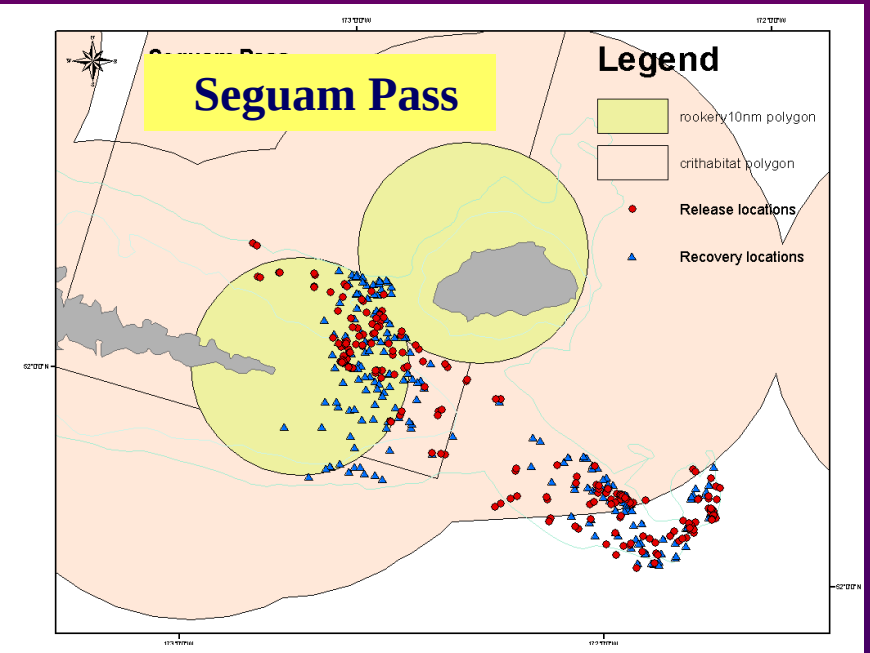
- P.I.s
  - Susanne McDermott and Libby Logerwell
- Evaluate efficacy of trawl exclusion zones
  - Do fish move from inside to outside?
  - What is the abundance of fish inside?
- Auxiliary studies
  - Physical oceanographic characteristics of habitat
  - Food habits
  - Reproductive biology
  - Zooplankton sampling

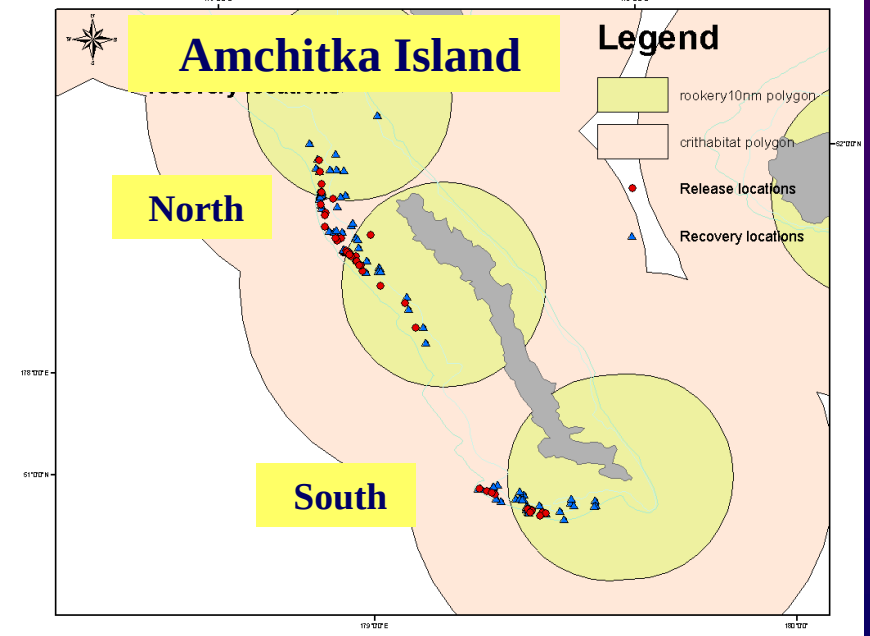
Study Area

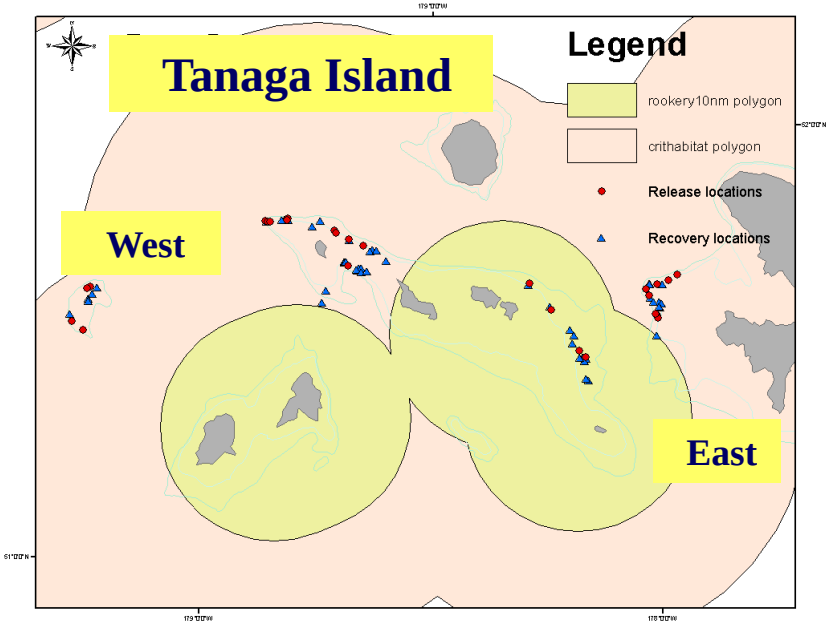


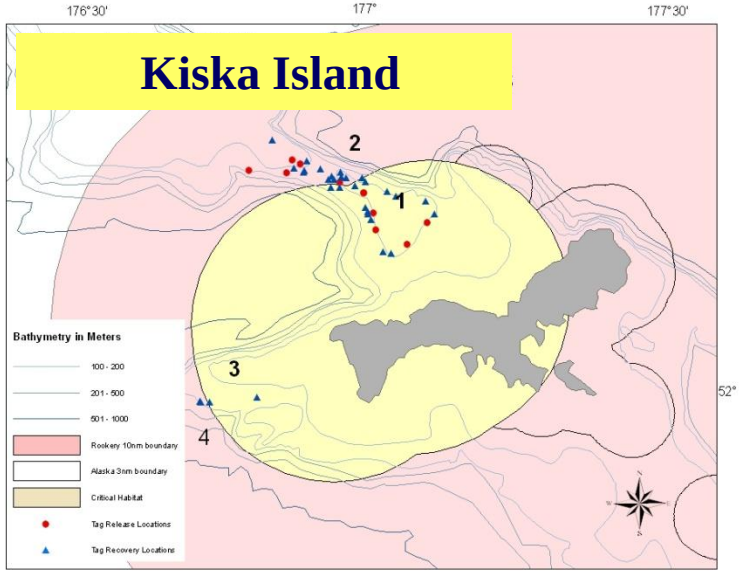
- Tagged fish release locations

Tag release and recovery locations





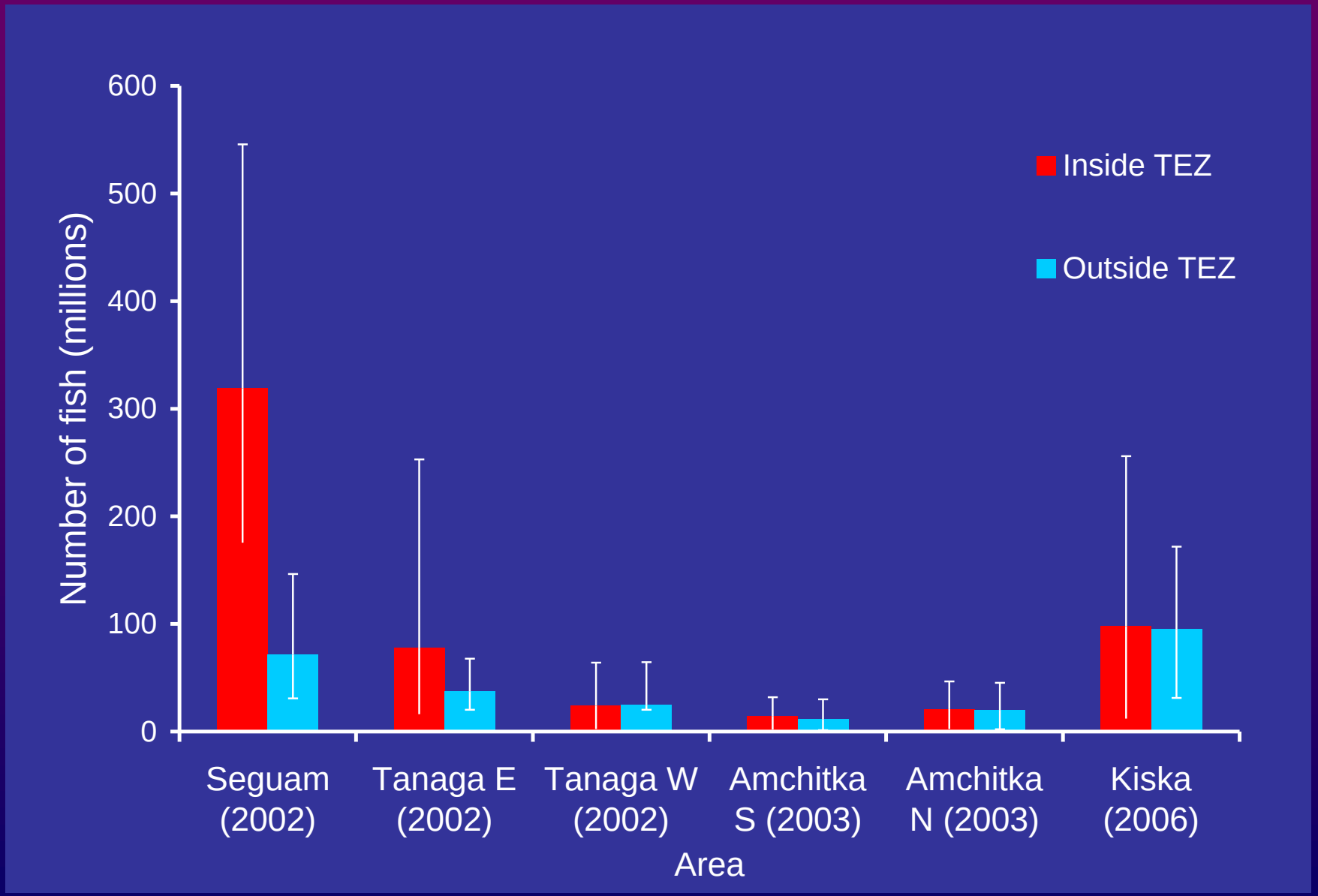




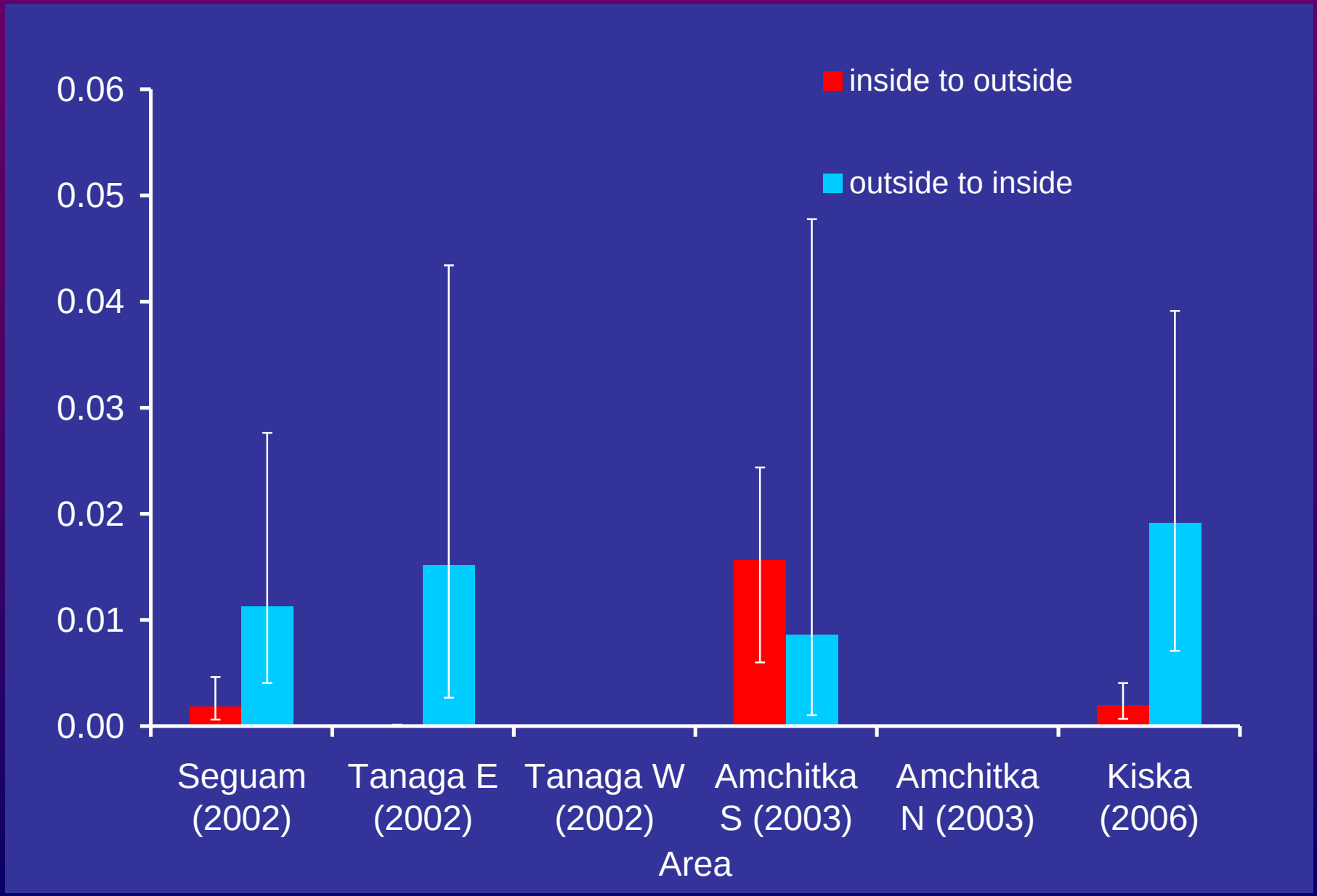
Methods

- Model structure:
  - Integrated tagging model using maximum likelihood Estimates
  - 4 different data sources
  - Several likelihoods combined in joint likelihood (admodelbuilder)
  - MCMC estimation procedure

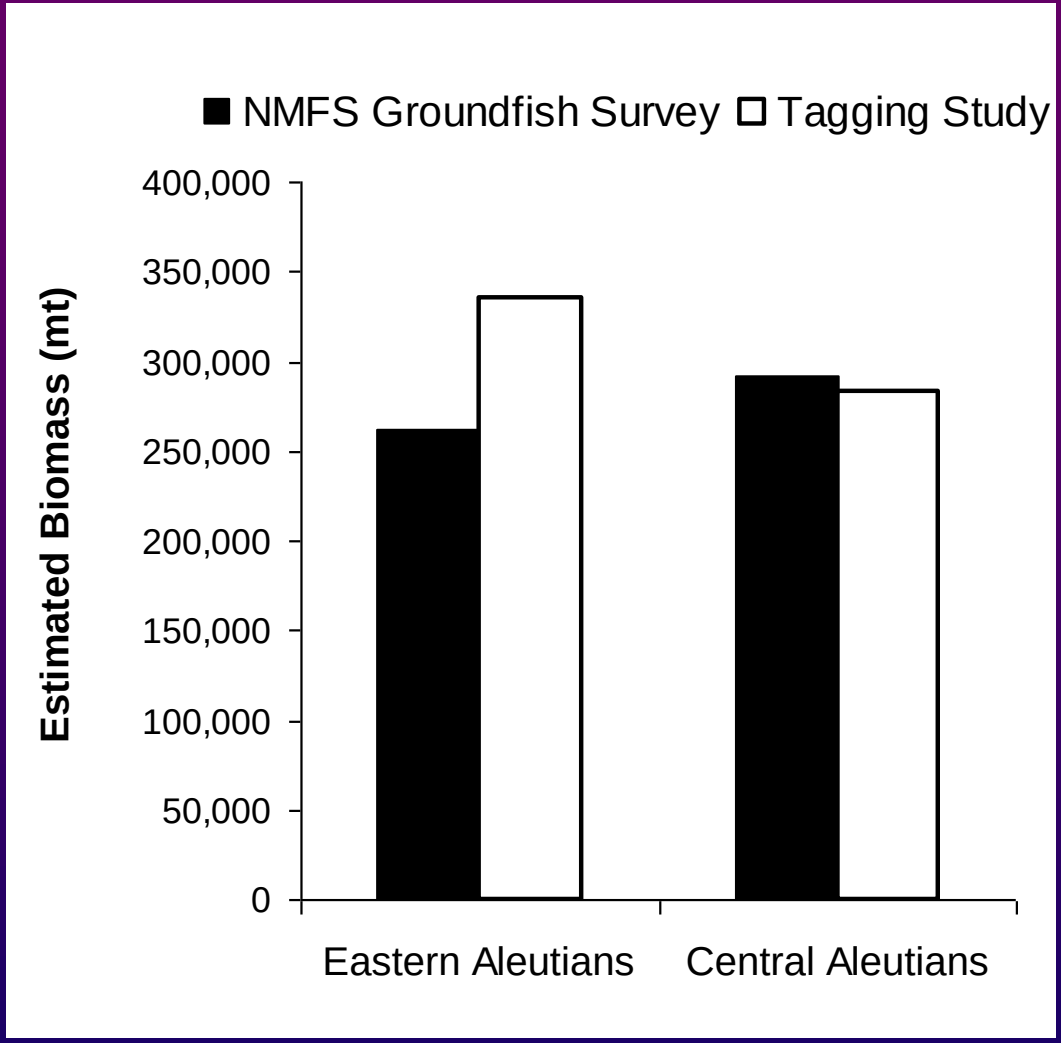
Abundance estimates



Movement rate

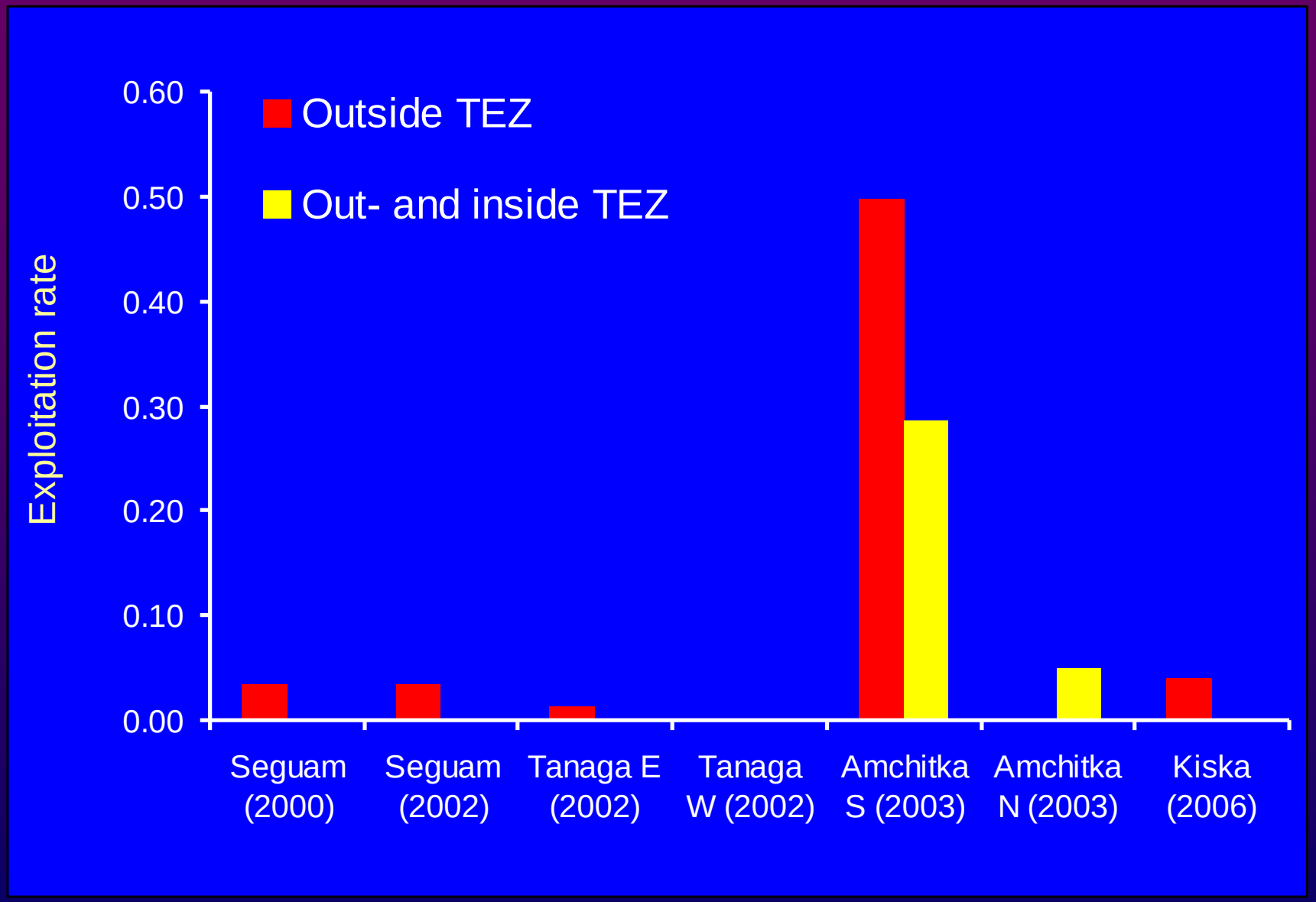


Biomass in all areas combined



Biomass estimates of the National Marine Fisheries Service groundfish survey (averaged by area over the years 2002-2006) and the current tagging study.

Exploitation rate

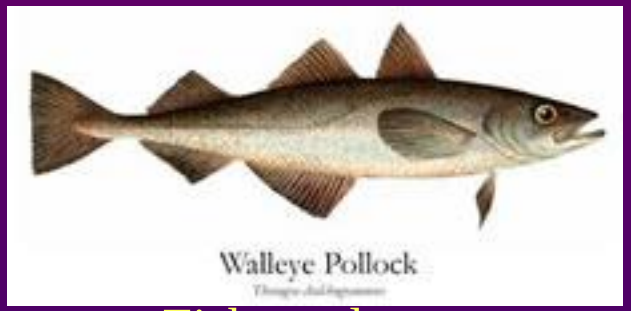


Small-scale food web model

- White paper “Efficacy of trawl exclusion zones for preserving Atka mackerel” by Ivonne Ortiz and E. Logerwell
- Is there enough Atka mackerel production inside Trawl Exclusion Zones (TEZs) to support Steller sea lions?
- Construct a food web model for each TEZ

Small-scale food web model

Steller sea lions

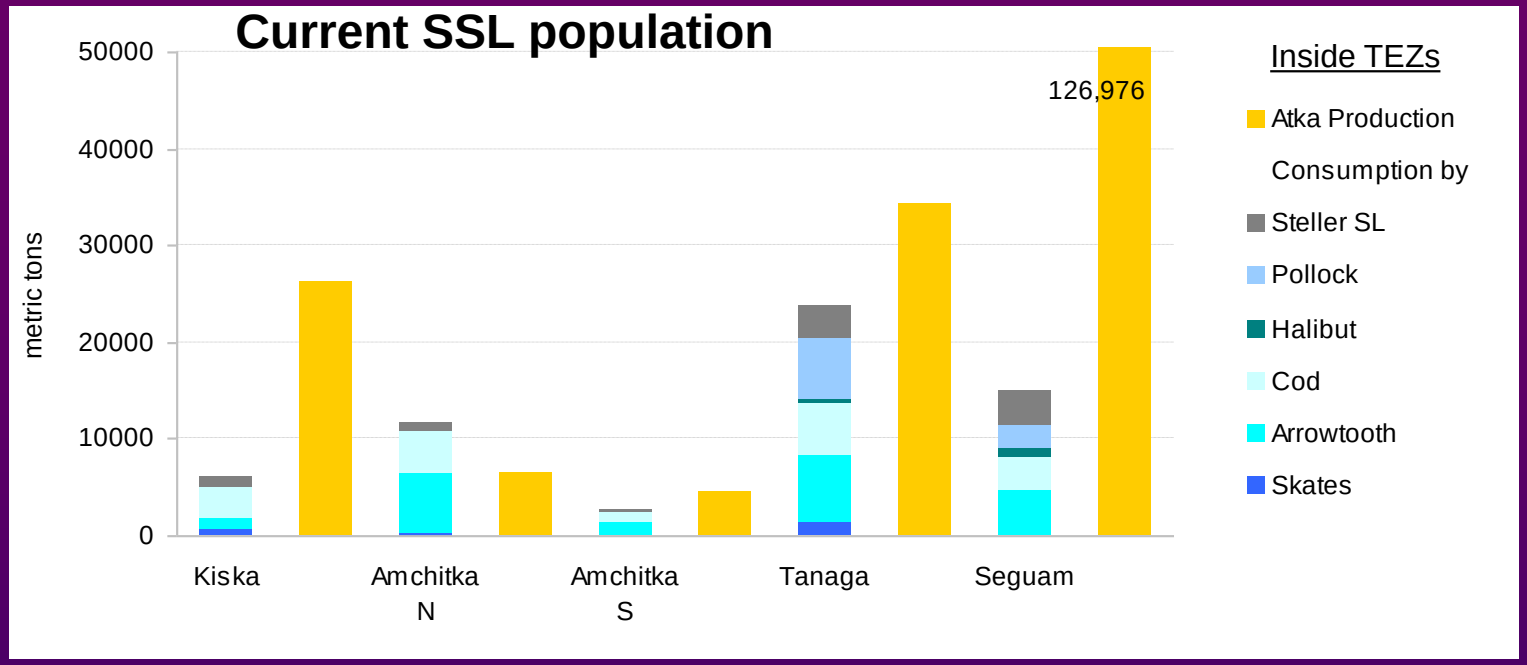


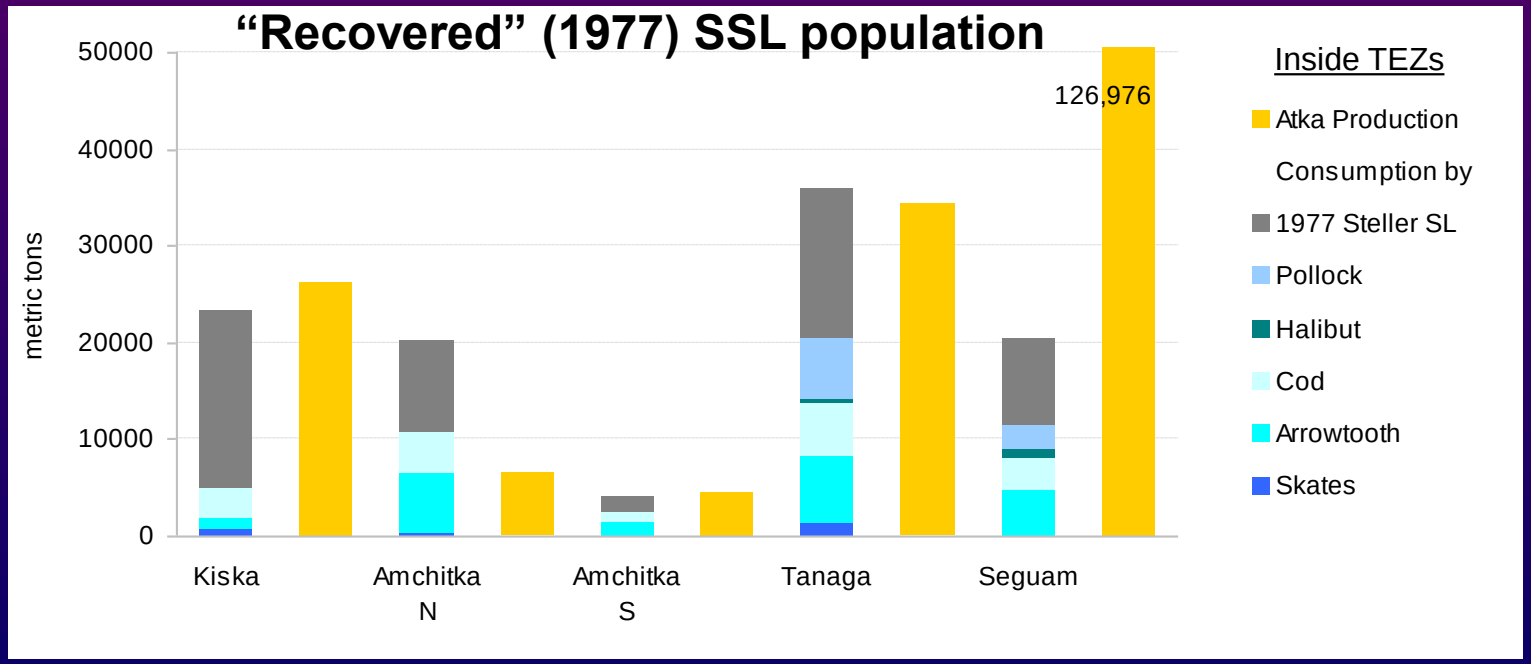
Fish predators:
Pollock
Halibut
Pacific cod
Arrowtooth Flounder
Skates

Atka mackerel
Production

Small-scale food web model Data

- Atka mackerel
  - Biomass from tag model
  - Production rate (P/B) from Aleutian EcoPath model
- Steller sea lions
  - Biomass from derived counts, age-structure, sex ratio, pregnancy rate, and weight-at-age
  - Diet from scat collections
  - Consumption rate (Q/B) from Aleutian EcoPath model
- Fish predators
  - Biomass from trawl survey
  - Diet from trawl survey collections
  - Consumption rate (Q/B) from Aleutian EcoPath model


Current SSL population
50000
40000
30000
20000
10000
0
metric tons
126,976
Kiska
Amchitka N
Amchitka S
Tanaga
Seguam
Inside TEZs
Atka Production
Consumption by
Steller SL
Pollock
Halibut
Cod
Arrowtooth
Skates


“Recovered” (1977) SSL population
50000
40000
30000
20000
10000
0
metric tons
126,976
Kiska
Amchitka N
Amchitka S
Tanaga
Seguam
Inside TEZs
Atka Production
Consumption by
1977 Steller SL
Pollock
Halibut
Cod
Arrowtooth
Skates

Future Atka mackerel research

- Special issue *Marine and Coastal Fisheries*
  - S.McDermott
  - Fall 2010
- NPRB grant for tagging in western Aleutian Islands
  - Summer 2011
  - Collaborate with North Pacific Fisheries Foundation

Contact information

http://www.afsc.noaa.gov/refm/stocks/fit/FIT.htm

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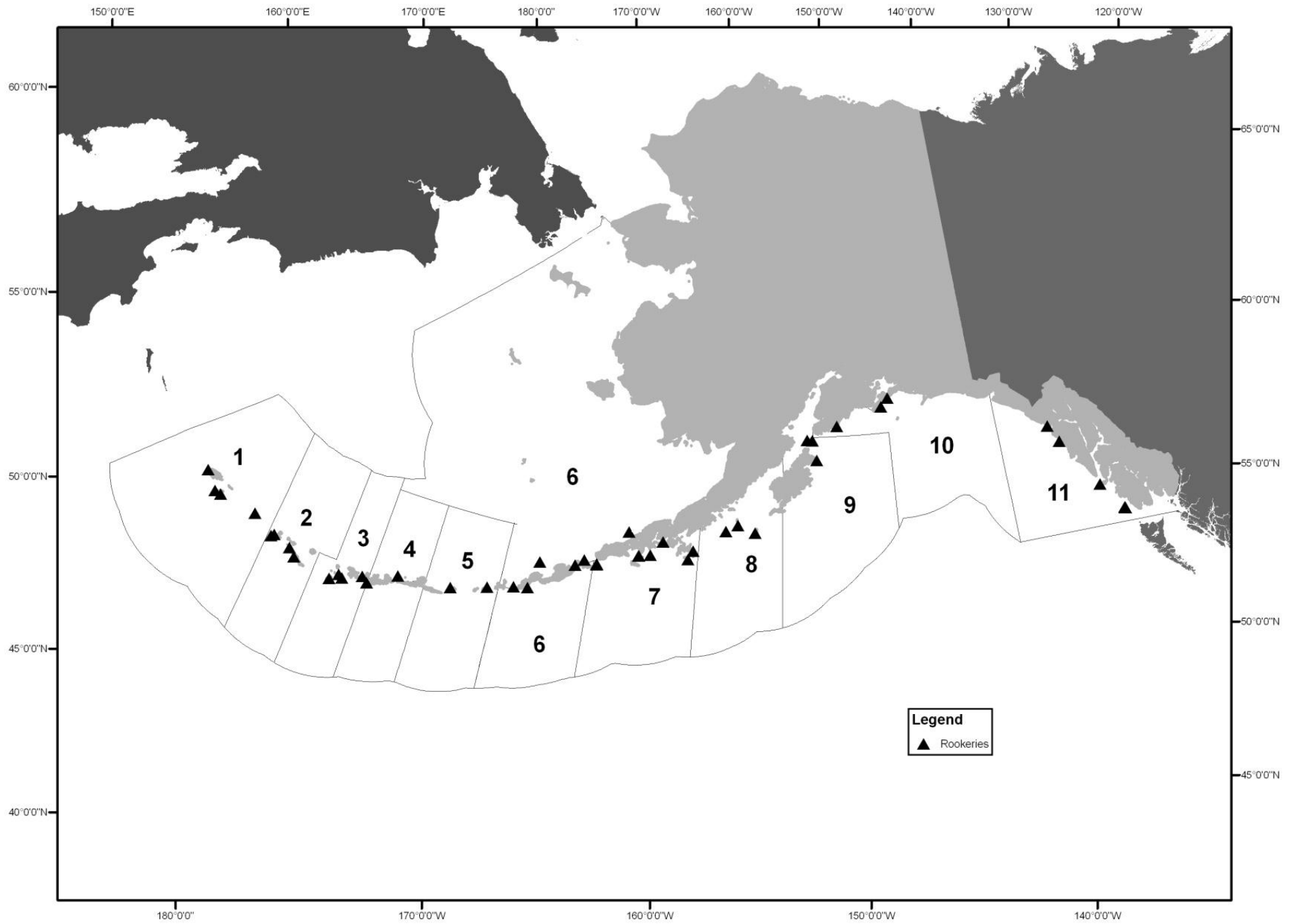
Fishery Footprint Analysis

- White paper “Steller sea lion fishery and oceanographic analysis BiOp 2010” by Fritz and Logerwell
- Examine relationships between:
  - Adult and juvenile SSL counts at rookery and haul-out sites
  - Biomass and catch estimates of Atka mackerel, pollock, Pacific cod and arrowtooth flounder
  - Oceanographic variables
- 1991-2008
- Regional spatial scale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45°0'0"N
180°0'0"
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160°0'0"W
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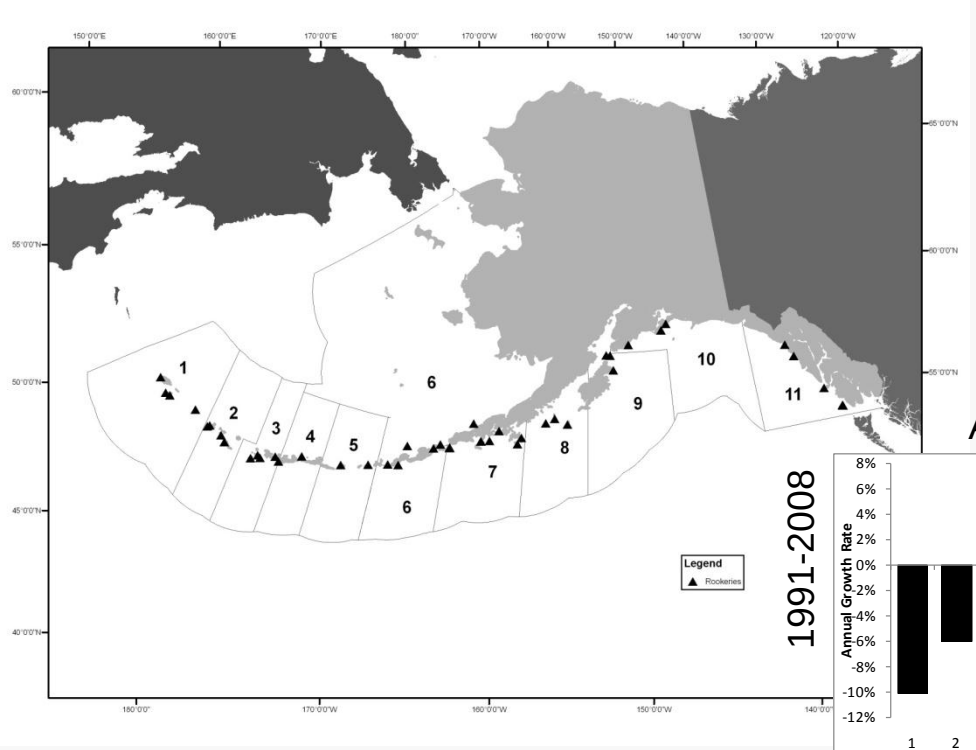
Legend
Rookeries



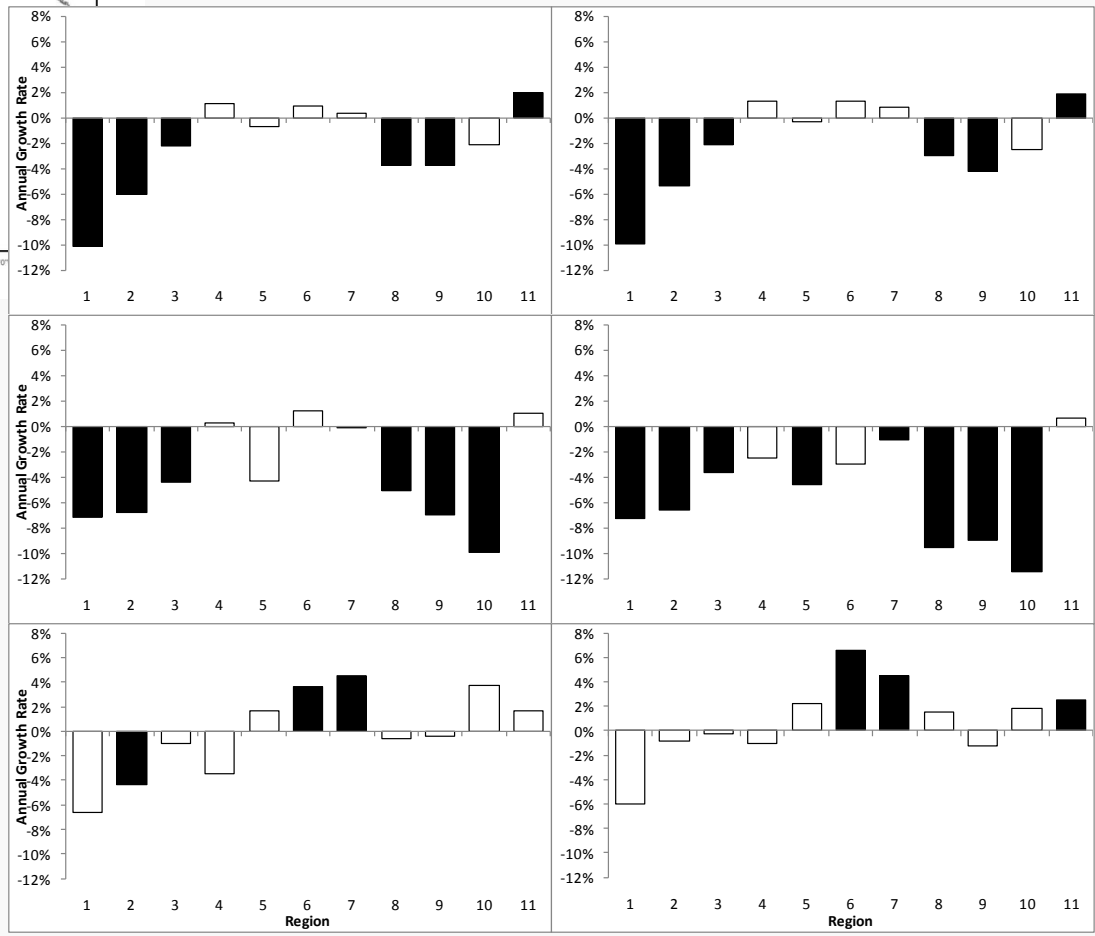
ALL TREND SITES

ROOKERY TREND SITES

1991-2008

1991-1998

2000-2008



Spatial distribution of groundfish catch

- Observed catch expanded to total catch for each haul location
- Estimated catches assigned to regions

Spatial distribution of groundfish biomass

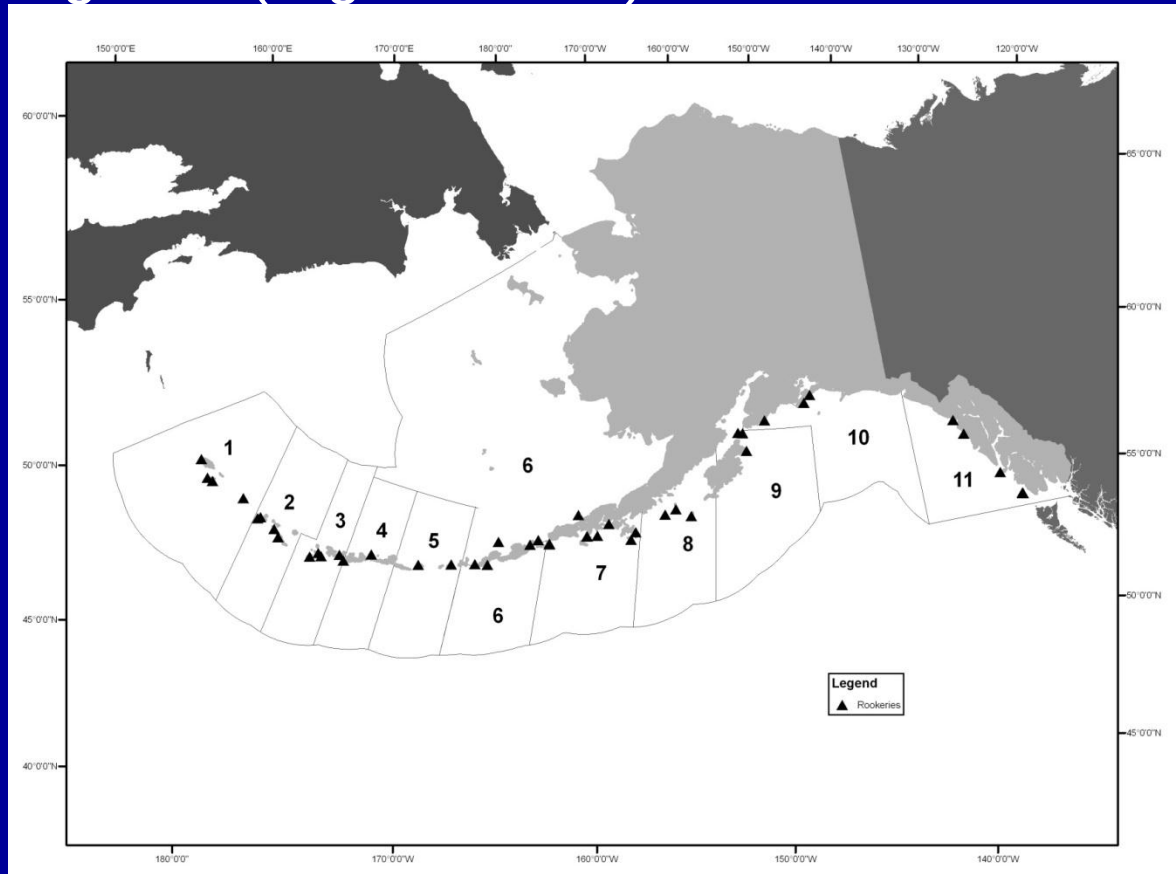
- Aleutian Islands
  - AFSC bottom trawl survey
    - Proportion of survey biomass in each region, each year
    - Linear interpolation between survey years
    - Stock assessment biomass multiplied by regional proportion
  - 16% of BSAI P. cod
  - No arrowtooth flounder
- Gulf of Alaska
  - AFSC bottom trawl survey
  - Winter hydroacoustic survey (pollock)
  - No Atka mackerel
- Bering Sea
  - Bering Sea and Bogoslof pollock
  - 84% of BSAI P. cod
  - 82% of BSAI arrowtooth
  - No Atka mackerel

Harvest rate

- Each region
- Average catch ÷ average biomass
- Three time periods
  - 1991 to 2008
  - 1991 to 1999
  - 2000 to 2008

Statistical analyses

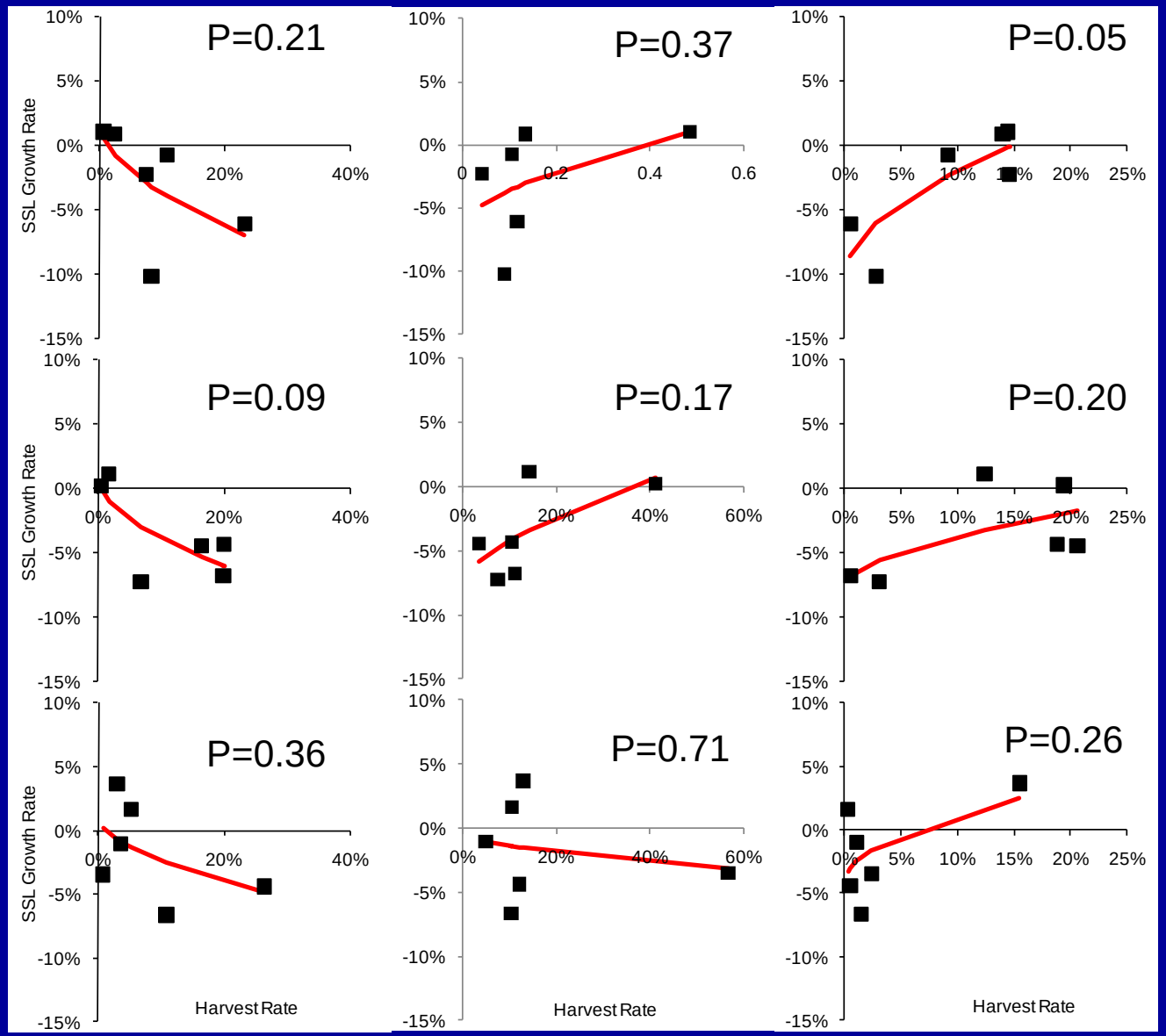
- Linear regression, P<0.25
- Aleutian Islands – Bering Sea (regions 1-6)
- Gulf of Alaska – Bering Sea (regions 6-11)
- Non-pups
- All SSL trend sites
- Rookery trend sites



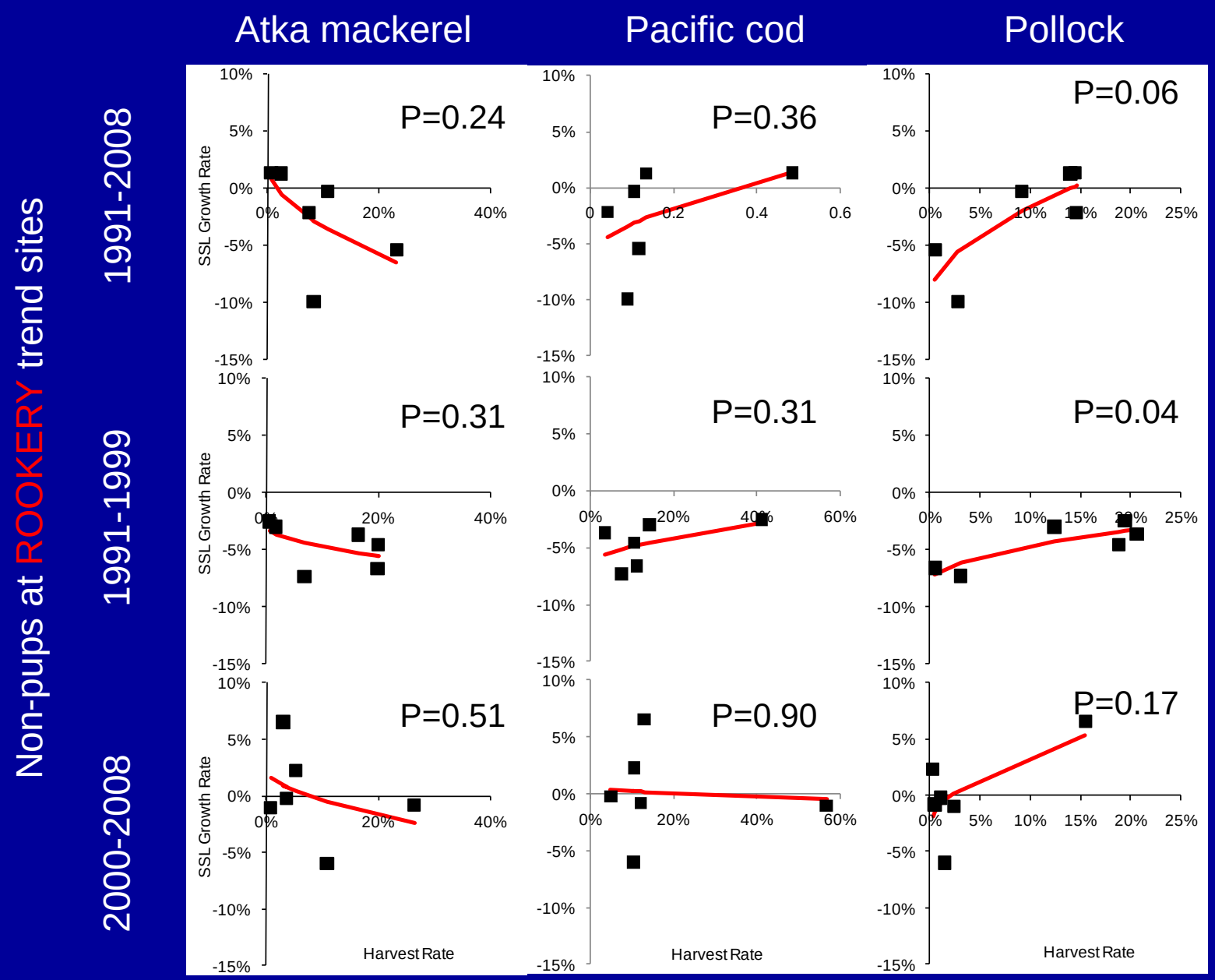
Bering Sea – Aleutian Is.

Non-pups at ALL trend sites

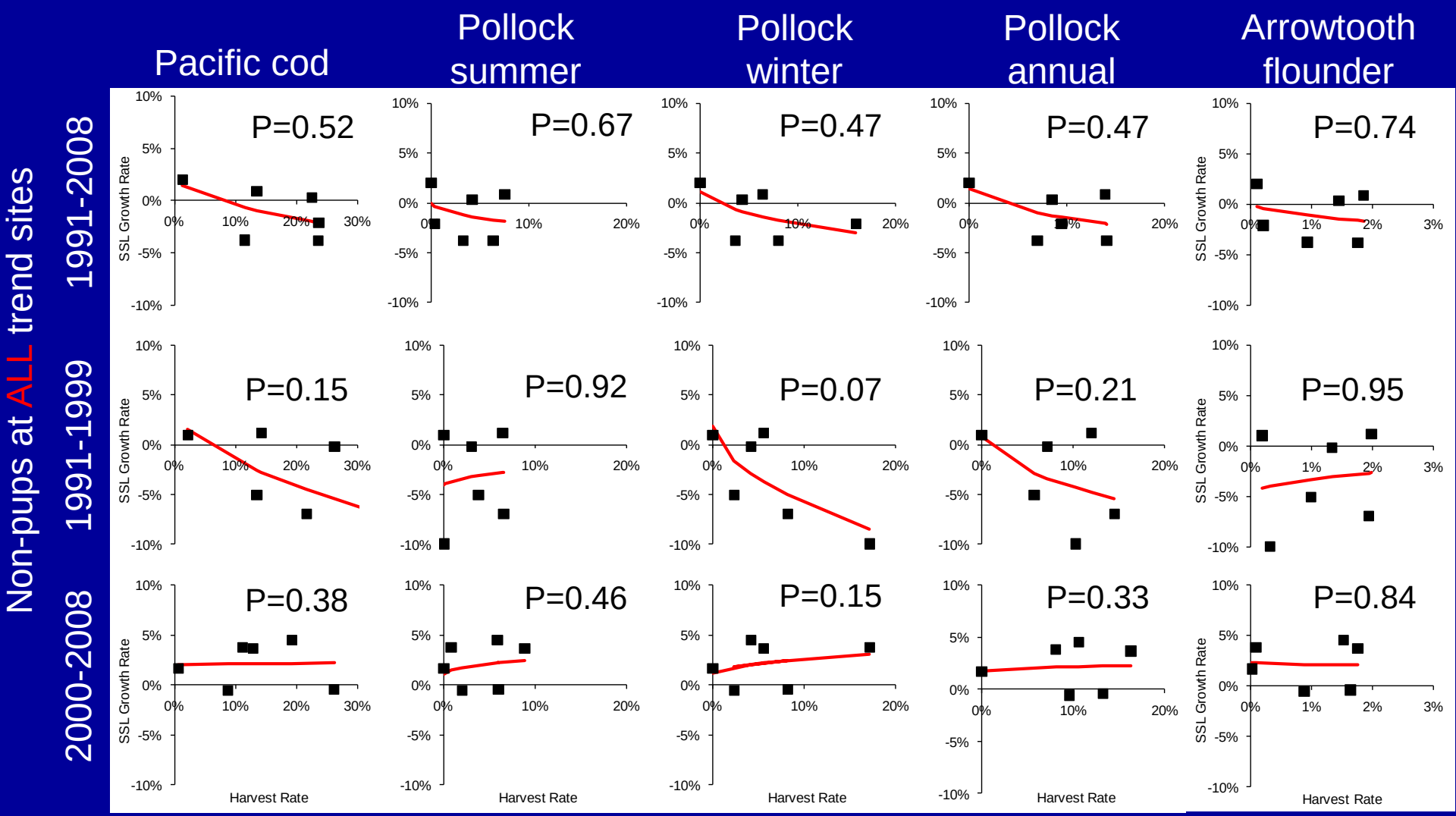
	Atka mackerel	Pacific cod	Pollock
1991-2008	P=0.21	P=0.37	P=0.05
1991-1999	P=0.09	P=0.17	P=0.20
2000-2008	P=0.36	P=0.71	P=0.26



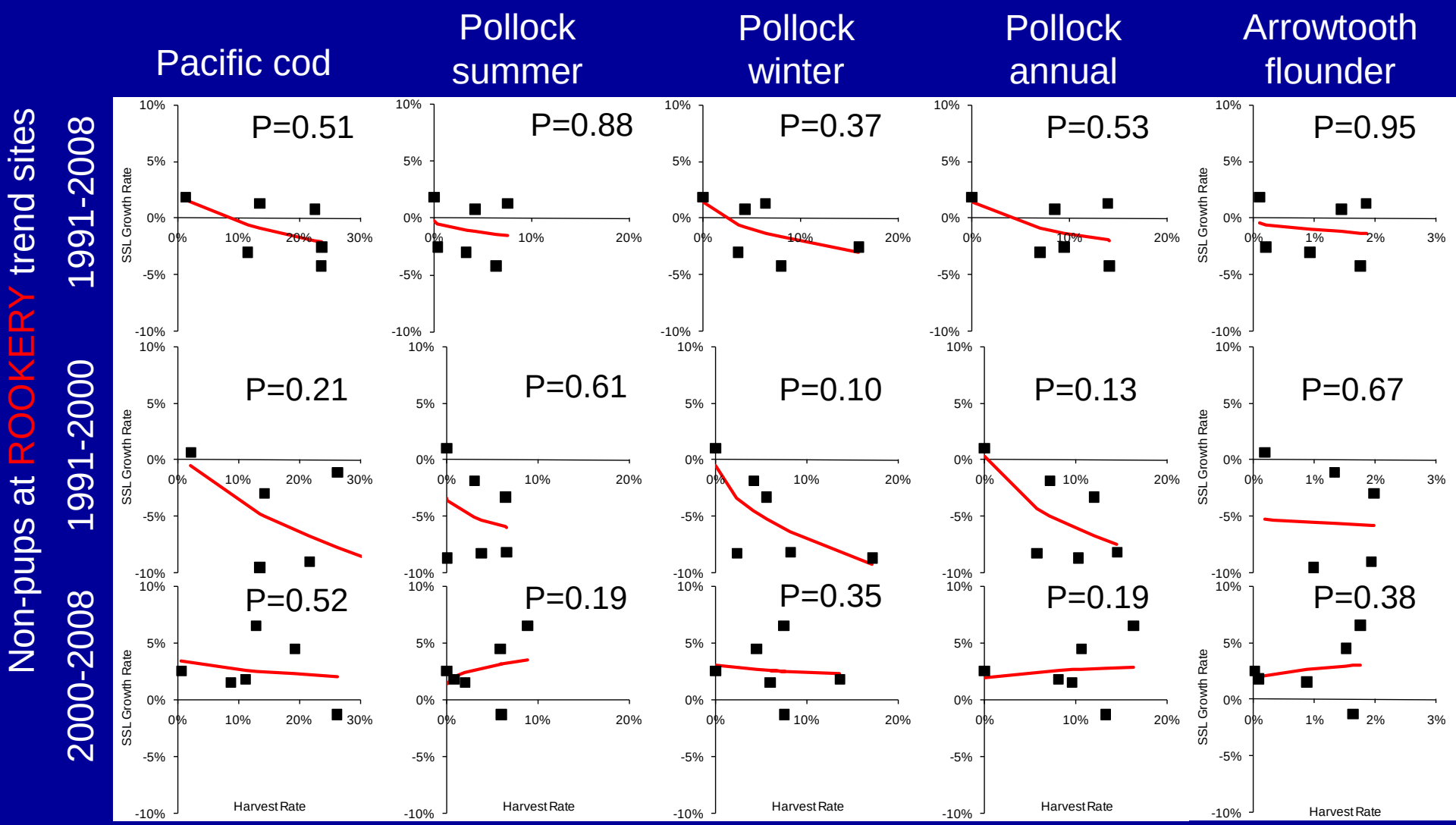
Bering Sea – Aleutian Is.



GOA – Bering Sea



GOA – Bering Sea



Conclusions – Groundfish harvest rate

- No association between harvest rates and SSL population growth rates where prey species has a low frequency of occurrence in SSL diets and where harvest rates were relatively low
  - arrowtooth flounder in the GOA-BS
  - 5 of 6 associations for summer Pollock in the GOA-BS
- Positive associations between harvest rates and SSL population growth rates where prey species has a low frequency of occurrence in annual SSL diets, where SSL consumption of the prey species may be seasonal, or where harvest rates for the prey species were low
  - 5 of 6 associations for Pollock in the AI-BS
  - 1 of 6 associations for Pacific cod in the AI-BS

Conclusions – Groundfish harvest rate (cont.)

- Negative associations between harvest rates and SSL population growth rates where prey species has a high frequency of occurrence in SSL diets and where there was contrast between SSL regions in fishery harvest rates
  - 3 of 6 associations for Atka mackerel in the AI-BS
  - 5 of 12 for Pollock in the GOA-BS
  - 2 of 6 associations for Pacific cod in the GOA-BS
- Predominantly in the 1990s

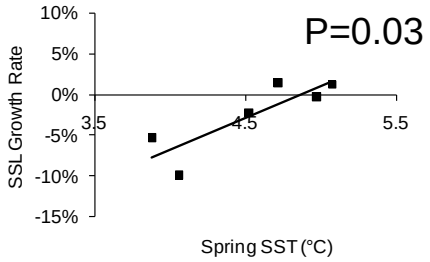
Oceanographic variables

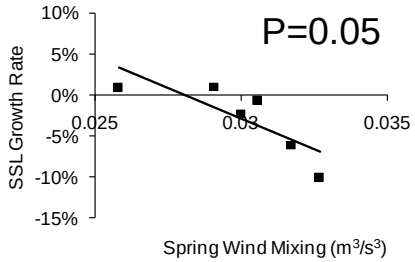
- Spring (May-June) and summer (Aug-Sept)
  - Sea surface temperature
  - Wind mixing
  - Sea surface height (fronts and eddies)
  - Chlorophyll
- Winter (Nov-Mar)
  - Surface air temperature (storminess)
  - Sea surface height
- Regional means for each time period calculated

Aleutian Islands
Spring and summer

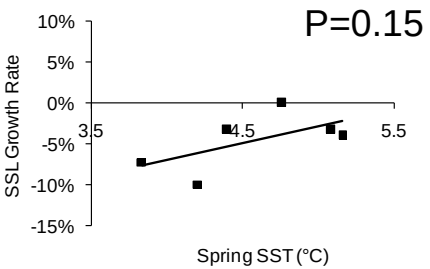
Non-pups ALL trend sites

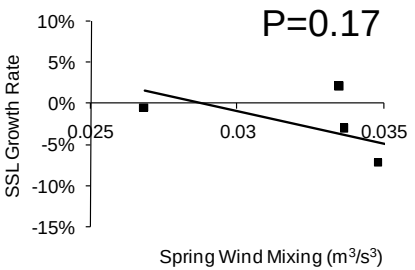
1991-2008



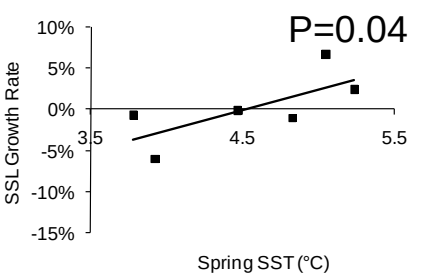


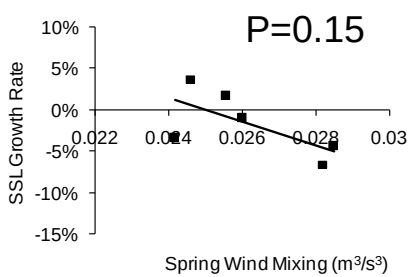
1991-2000

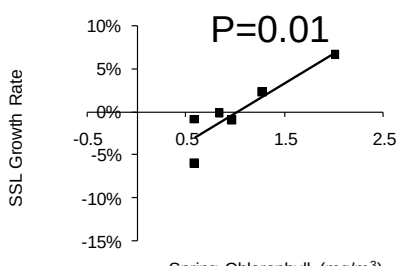


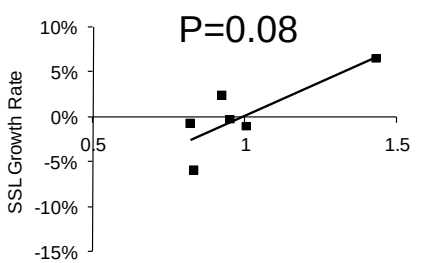


2000-2008





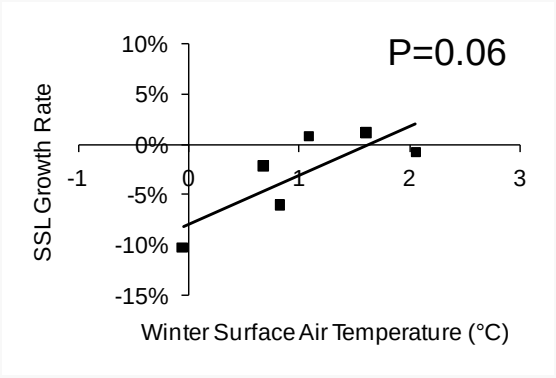




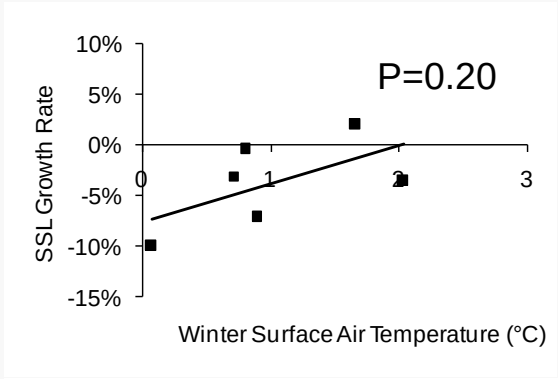
Aleutian Islands Winter

Non-pups ALL trend sites

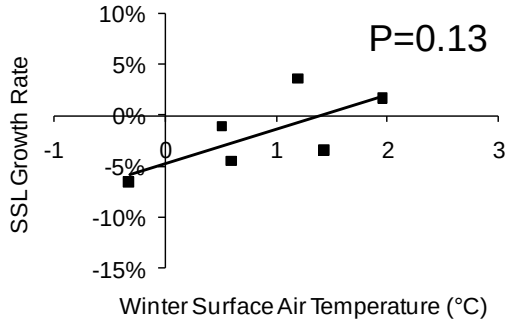
1991-2008

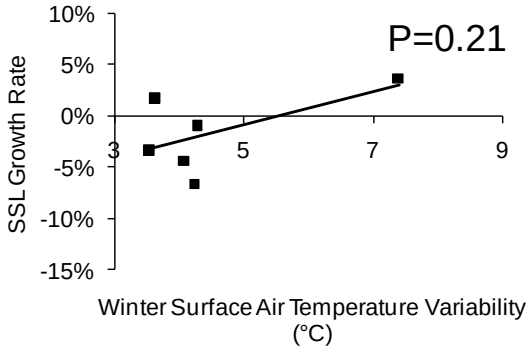


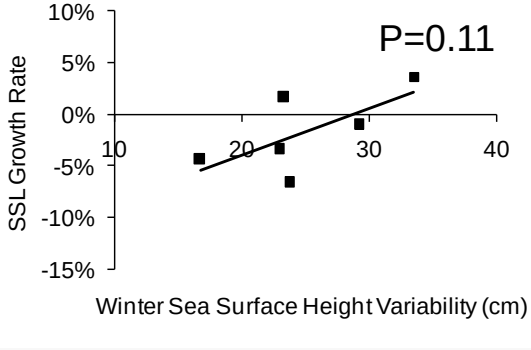
1991-2000



2000-2008



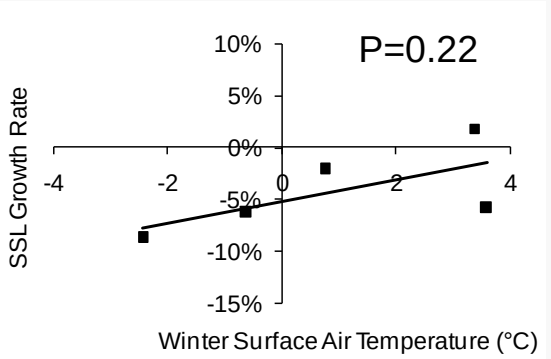




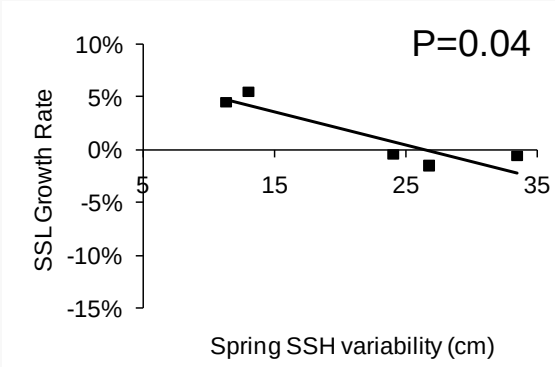
Gulf of Alaska

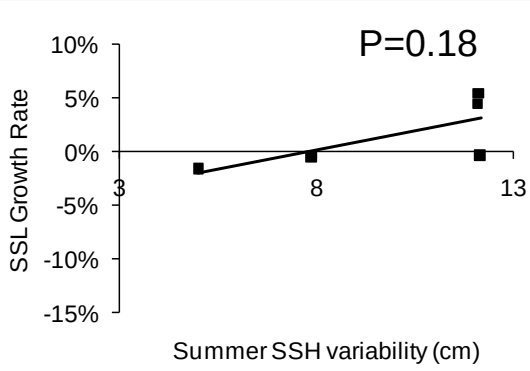
Non-pups ALL trend sites

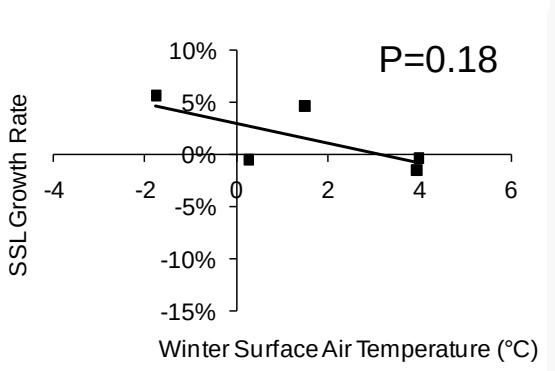
1991-2000

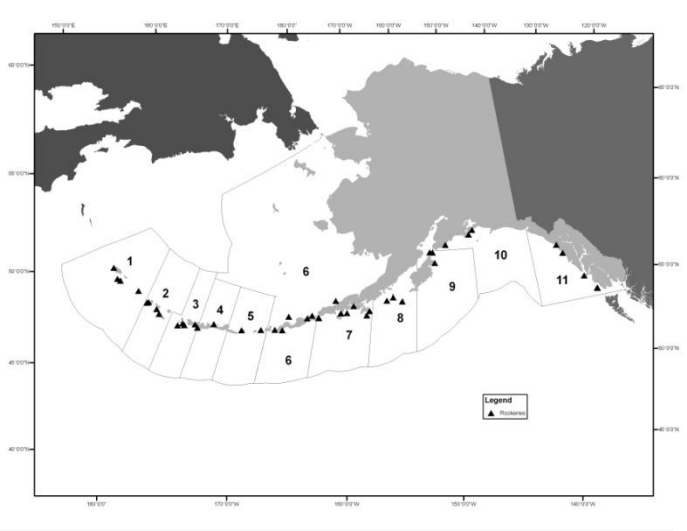


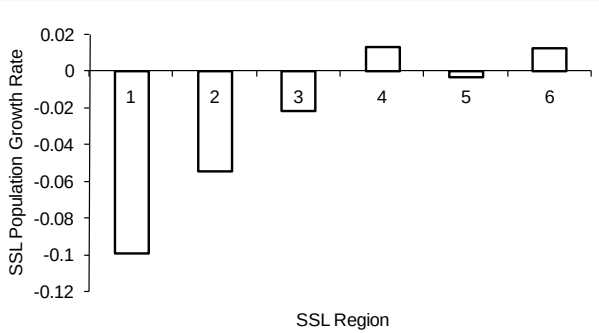
2000-2008



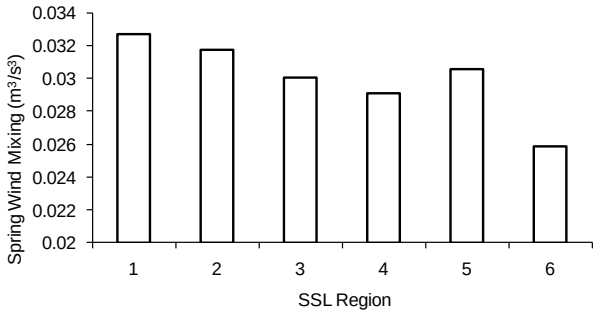


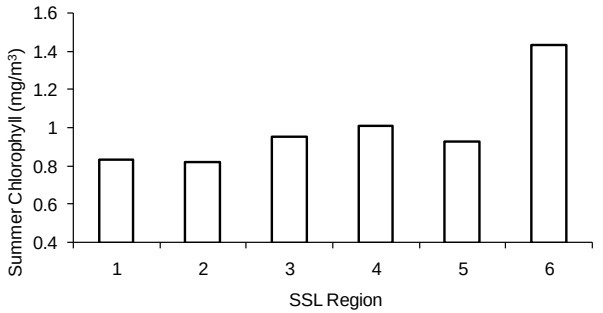


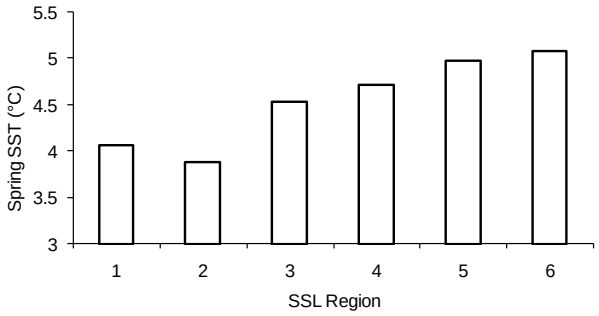

1
2
3
4
5
6
6
7
8
9
10
11
Legend
Rookeries

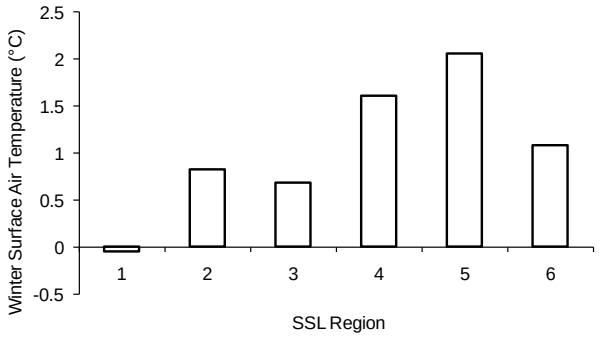

SSL Population Growth Rate
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
1
2
3
4
5
6
SSL Region

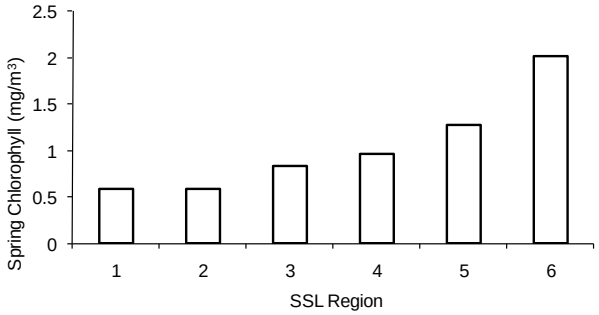

SSL Population Growth Rate
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
1
2
3
4
5
6
SSL Region


Spring Wind Mixing (m³/s³)
0.034
0.032
0.03
0.028
0.026
0.024
0.022
0.02
1
2
3
4
5
6
SSL Region


Summer Chlorophyll (mg/m³)
1.6
1.4
1.2
1
0.8
0.6
0.4
1
2
3
4
5
6
SSL Region


Spring SST (°C)
5.5
5
4.5
4
3.5
3
1
2
3
4
5
6
SSL Region


Winter Surface Air Temperature (°C)
2.5
2
1.5
1
0.5
0
-0.5
1
2
3
4
5
6
SSL Region


Spring Chlorophyll (mg/m³)
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
SSL Region

Conclusions – Oceanography

- Aleutian Islands
  - Spring and summer ocean production was related to SSL population growth rates
  - Oceanographic prey aggregating mechanisms, such as fronts and eddies
  - Winter storminess
- Gulf of Alaska
  - Few oceanographic variables examined showed associations to SSL population growth rates and the patterns were difficult to interpret.

Conclusions – Oceanography (cont.)

- Oceanographic processes may be more important to SSL population growth rates in the Aleutians Islands than in the GOA, and that the western Aleutians may be a particularly unproductive and harsh environment for sea lions.