Science, Service, Stewardship

The Fishery Interaction Team: Research Updates

Libby Logerwell

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

NOAA FISHERIES SERVICE

Fishery Interaction Team (FIT)

Past and current FIT research

- Past
  - Kodiak Island pollock localized depletion
  - Cape Sarichef Pacific cod localized depletion
  - Aleutian Islands Atka mackerel tagging
- Current
  - Aleutian Islands cooperative pollock survey
  - Bering Sea Pacific cod tagging
  - BSAI Pacific cod reproductive maturity
  - Aleutian Islands SSL consumption model
  - Fishery Footprint Analysis

Walleye pollock Kodiak project overview

- P.I.s
  - Chris Wilson and Paul Walline (RACE)
  - Anne Hollowed (REFM)
- At-sea experiment to examine localized depletion or disturbance of prey fields due to fishing
- Acoustic surveys before and after the start of commercial fishing in late August
- Sites open (Barnabus) and closed (Chiniak) to fishing
- Manuscript (Walline *et al*.) in preparation

Conclusions

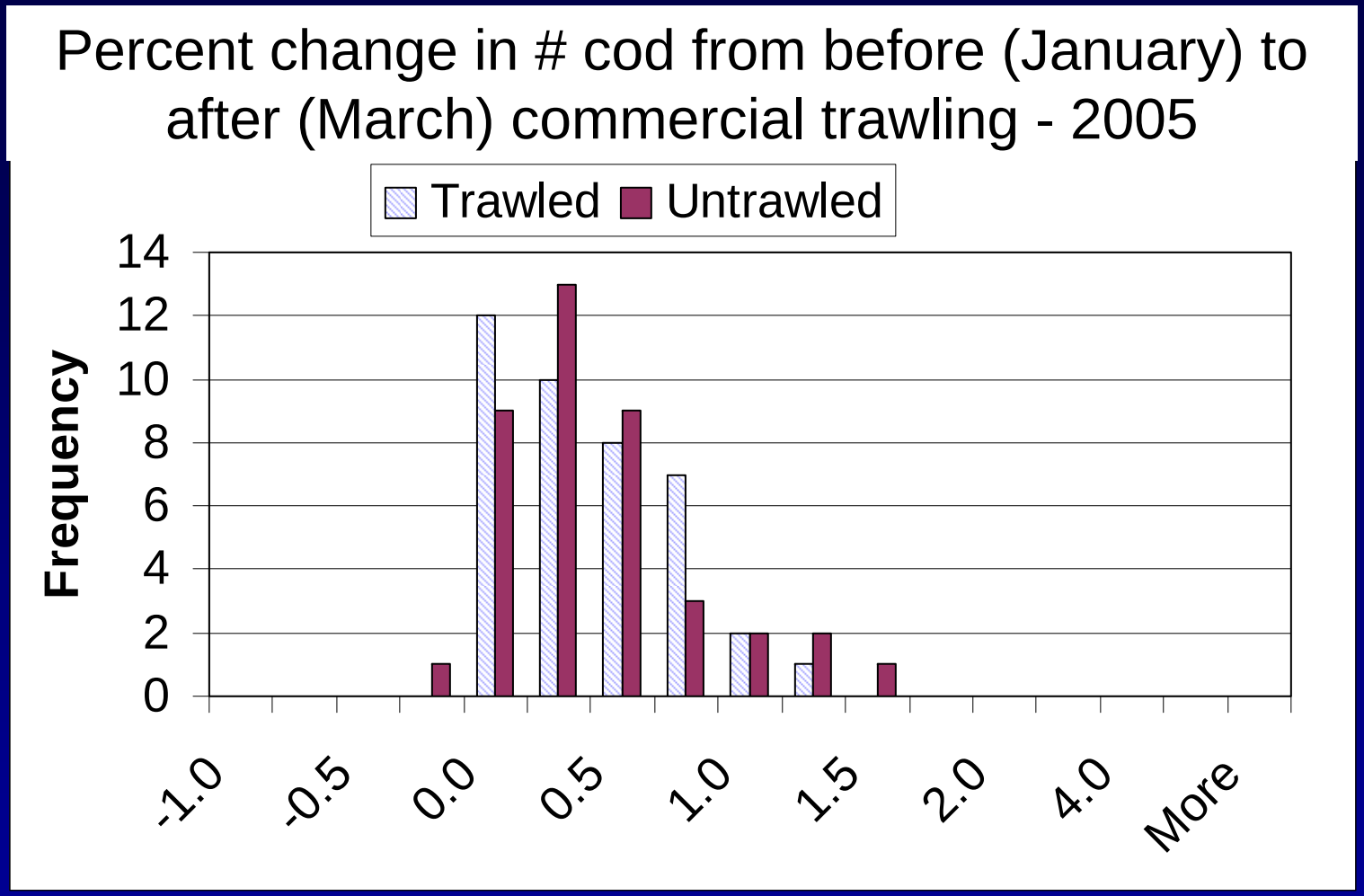
- Pollock abundance estimates for Barnabas Trough in 2001 exhibited high variability, but not in response to fishing.
- Response to fishing could explain the decrease in abundance of adult pollock observed between the pre-fishing and fishing periods in 2004.
- Abundance was not significantly lower during fishing in either trough in 2006. Fishery removals were substantially lower than 2001 and 2004

Pacific cod
Cape Sarichef project overview

- Peter Munro and Liz Conners
- Research pots
- Experimental design
  - Chartered crab pot vessels
  - Before (January) and after (March) most intensive commercial fishing
  - Inside (control) and outside (treatment) trawl exclusion zone at Cape Sarichef

Pacific cod – Project history

- 2001 feasibility and gear development
- 2002 pilot study
- 2003 experiment not fully successful
  - "before" sampling not complete due to weather and equipment problems
  - 6,000 tagged cod released
- 2004, 2005 successful experiments
- Conners and Munro 2008 "Effects of commercial fishing on local abundance of Pacific cod in the Bering Sea" *Fishery Bulletin* 106:281-292



~50% increase in cod abundance, trawled and untrawled

Wilcoxin Rank-Sum Test for difference in means: p=0.807

Power: 75-95% chance of detecting 20% reduction in catch

Possible Reasons for Observed Result:

1. Fishery removals not enough to significantly affect local abundance
2. Effect disperses in <2 weeks
3. Spatial scale of effect larger than scale of experiment
4. Directional migration of fish – spatially displaced effects

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NPRB Project 620: Estimating movement rates of cod in the Bering Sea and the Gulf of Alaska using mark-recapture

Work by Yunbing Shi (co-authors: Urban, Gunderson, and Munro)

Goal: Bring together four data sets and estimate movement using an expanded Brownie Model (Brownie *et al.*, 1993)

Data were too disjointed in time and place to allow estimation of movement rates among regions of the Bering Sea or between EBS and GOA, due to the opportunistic nature of tag releases and dependence on commercial fisheries for tag recoveries.

Qualitative analysis suggests a degree site fidelity on a scale of 100 nm. However, some cod were seen to travel long distances.

The four data sets:

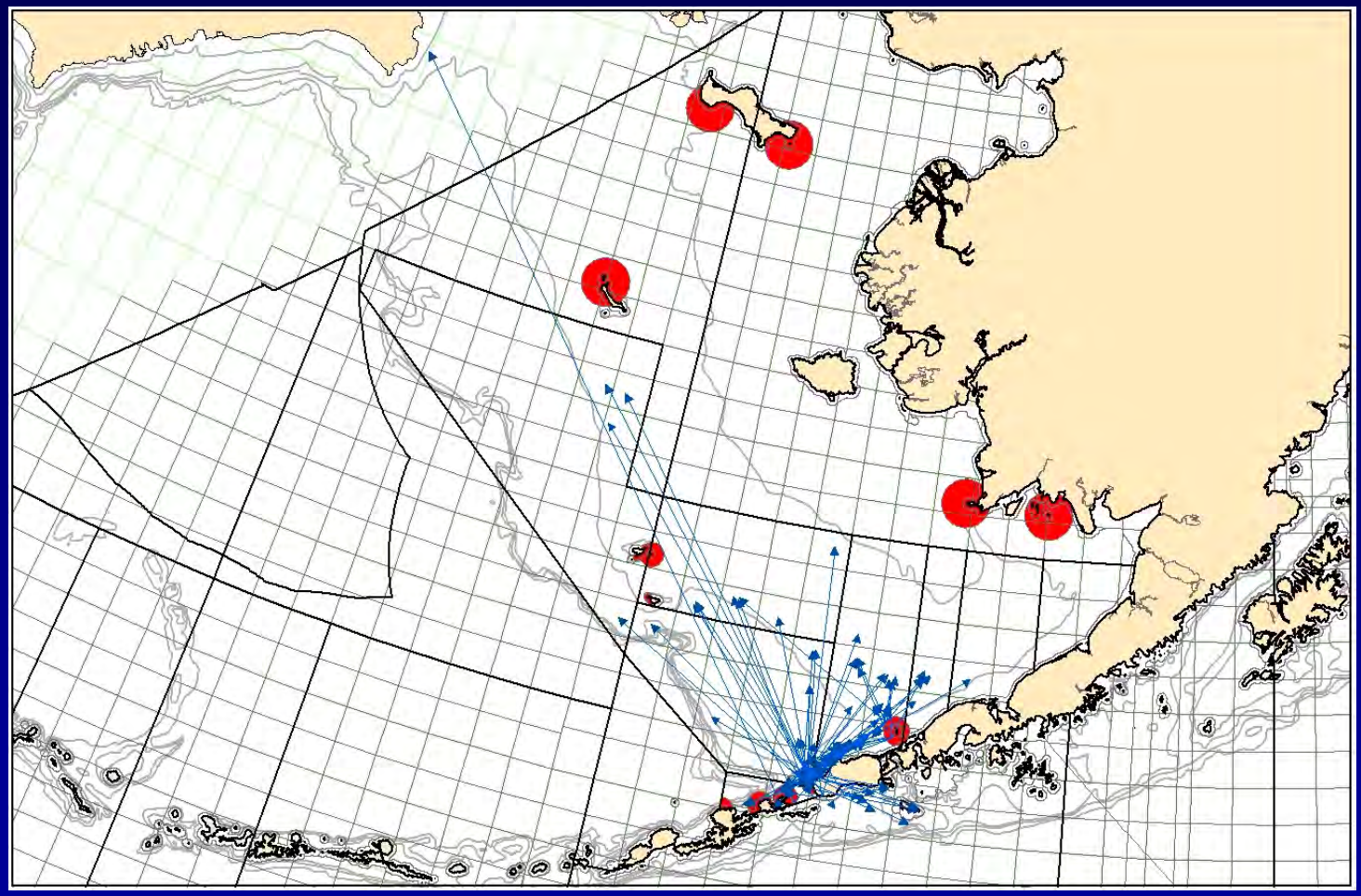
RACE I Released throughout the eastern Bering Sea between 1982 and 1990 as part of the AFSC, RACE Division summer trawl survey (Shimada and Kimura, 1994)

ADF&G Released in the Gulf of Alaska (mostly nearshore and mostly near Kodiak Island) between 1997 and 2006 by the Alaska Department of Fish and Game (D. Urban)

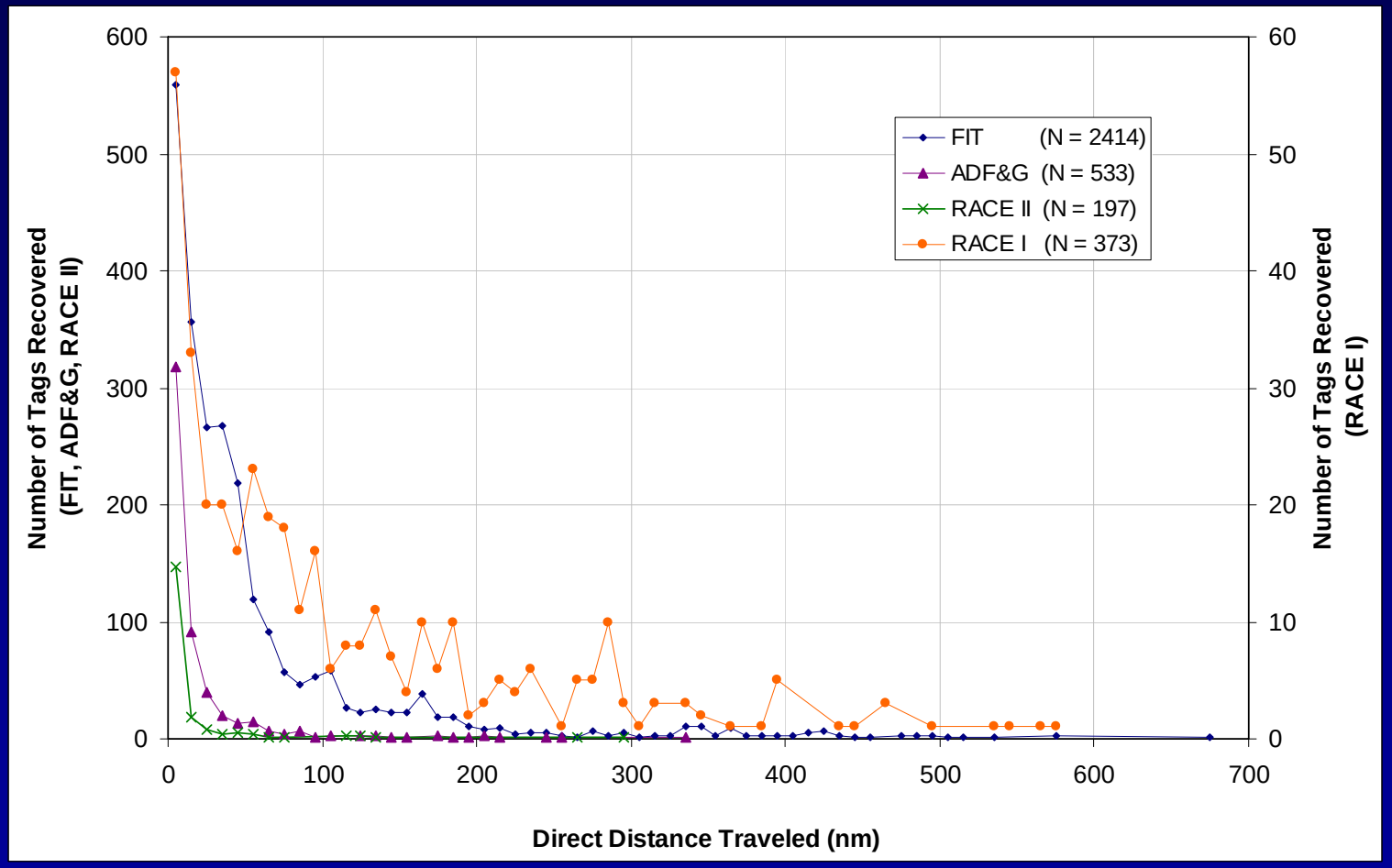
FIT Released near Unimak Pass in 2002 and 2003 as part of AFSC Fisheries Interaction Team experiments on localized depletion of Pacific cod

RACE II Archival tags released near Kodiak Island and near Unimak Pass between 2001 and 2005 by the AFSC RACE Division (Nichol and Chilton, 2006)

Distance and direction between release and recovery in the eastern Bering Sea. (FIT data only)



Number of tags recovered by straight line distance between release and recovery (nm)

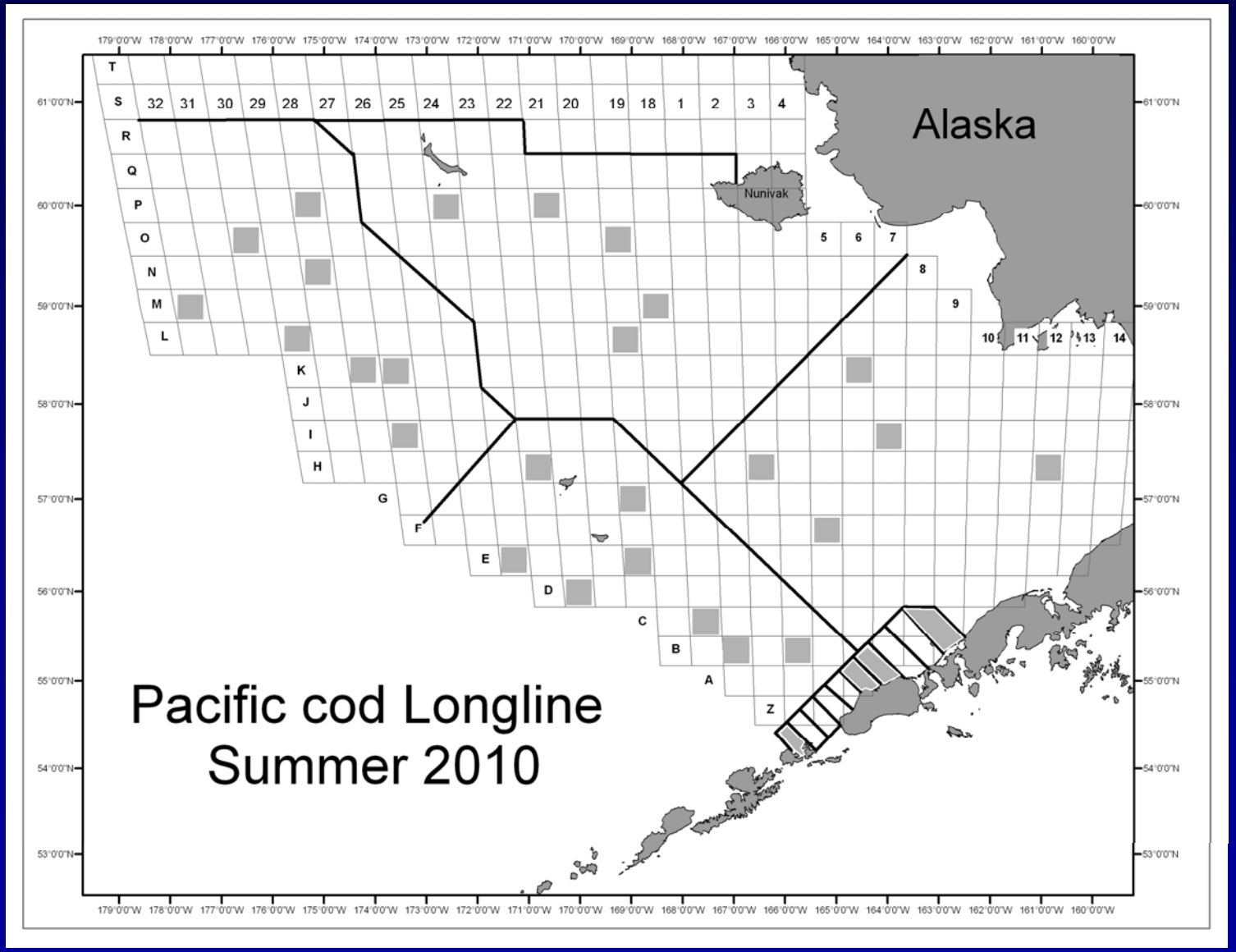


New NPRB Project 815: Estimating movement of cod in the Bering Sea

- Peter Munro, Liz Conners
- Goal: Collect data appropriate for populating the expanded Brownie model.
- Movement among large scale strata
- Movement from summer feeding distribution to winter spawning distribution
- Release tagged cod in summer; allow proper mixing through:
  - random distribution
  - allowing time for mixing (summer release, winter recovery)
- Recover tags through winter fisheries
- Follow-up recovery cruise to validate commercial fishery recovery rates

Strata and summer sampling stations

(other winter sampling stations have been randomly chosen)



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

Atka mackerel – Methods

- Mark-recapture (2000-2006)
  - Inside and outside trawl exclusion zones
  - Fish tagged and released in June-July
  - Fish recovered in September-October
    - Commercial vessels outside zones
    - Chartered vessel inside and outside zones
- Tagging model
  - Maximum likelihood
  - Estimates
    - Population size
    - Probability of moving from in- or outside zones

Conclusions

- Efficacy of trawl exclusion zones at mitigating competition between sea lions and commercial fisheries varies geographically
- Do fish move from inside to outside?
  - Small movement at Seguam, Tanaga and Kiska
  - Large movement at Amchitka
- What is the abundance of fish inside?
  - Large biomass at Seguam, Tanaga and Kiska
  - Small biomass at Amchitka

SSL consumption of Atka mackerel

- Ivonne Ortiz, L. Logerwell
- Is there enough Atka mackerel production inside Trawl Exclusion Zones (TEZs) to support Steller sea lions?
- Construct a small-scale food web model for each TEZ

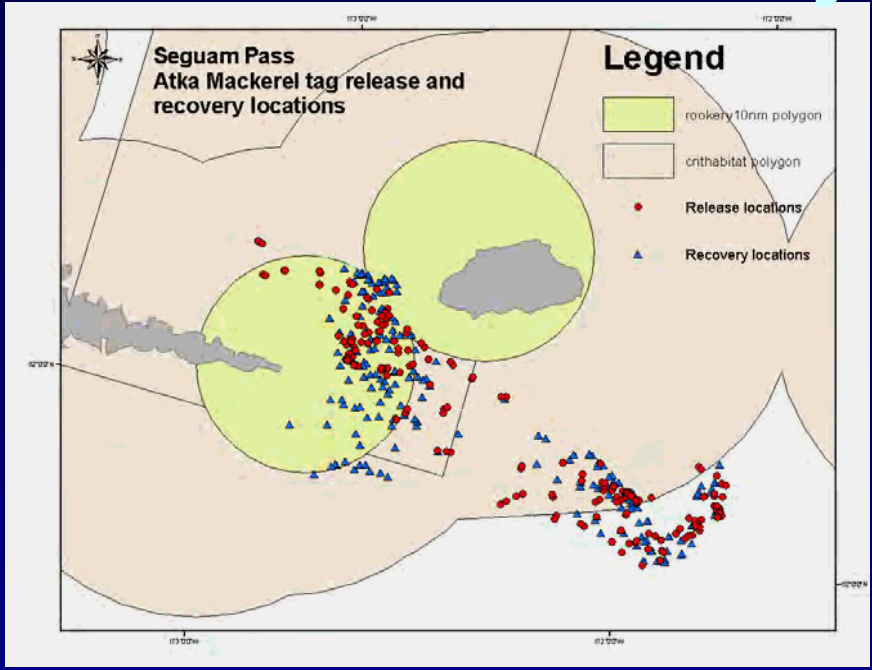
Small-scale food web model

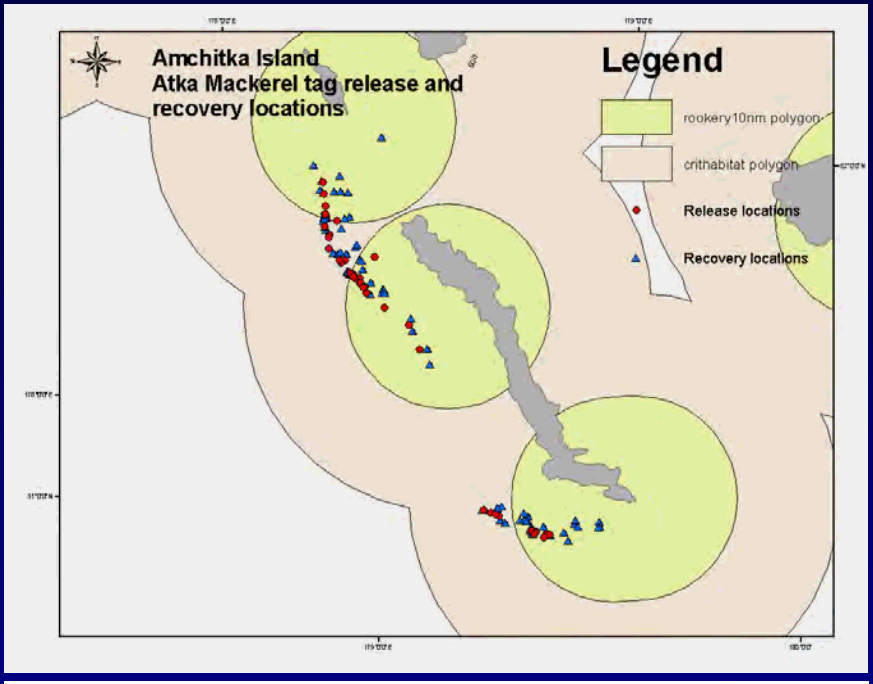
Steller sea lions

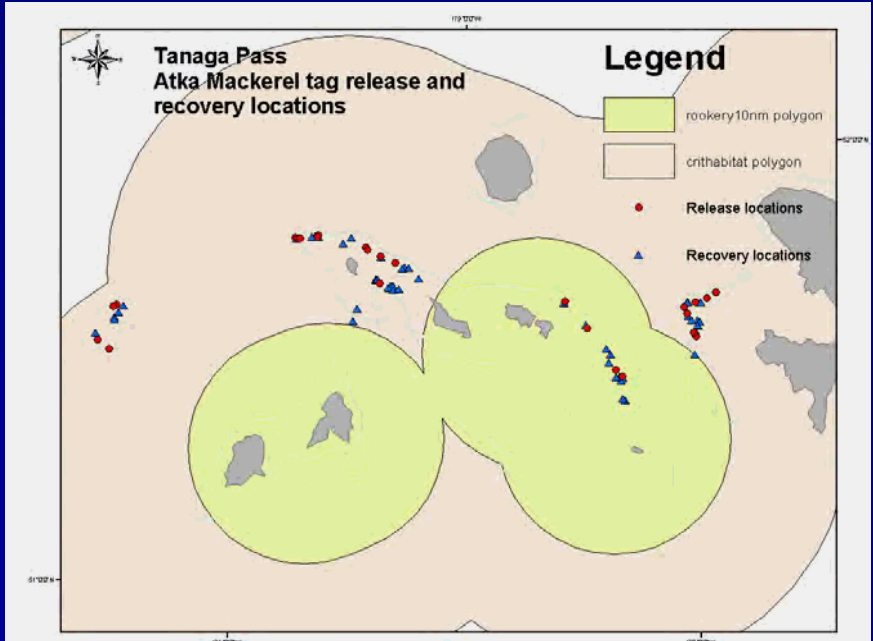
Fish predators:
Pollock
Halibut
Pacific cod
Arrowtooth Flounder
Skates

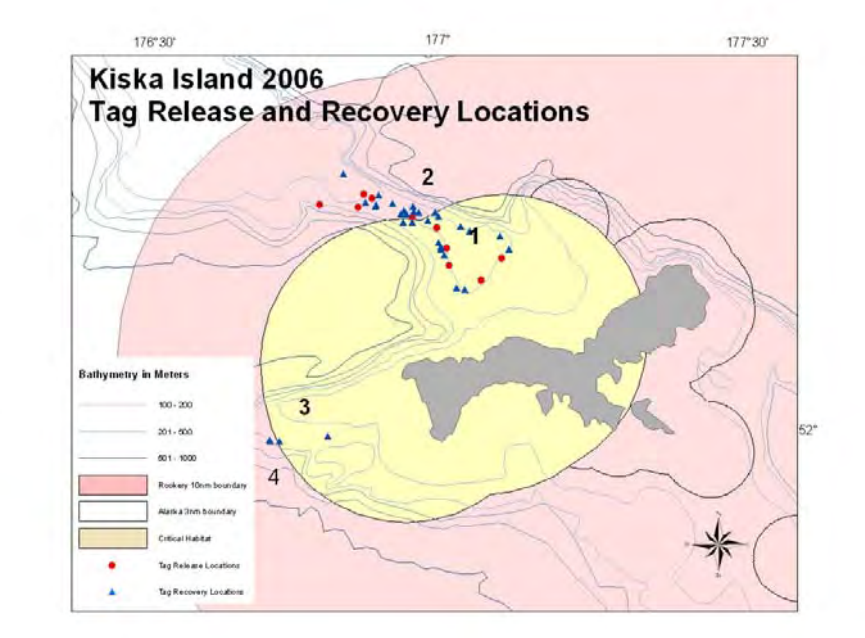
Atka mackerel
Production

Study Areas


Seguam Pass
Atka Mackerel tag release and recovery locations
Legend
rookery10nm polygon
crithabitat polygon
Release locations
Recovery locations

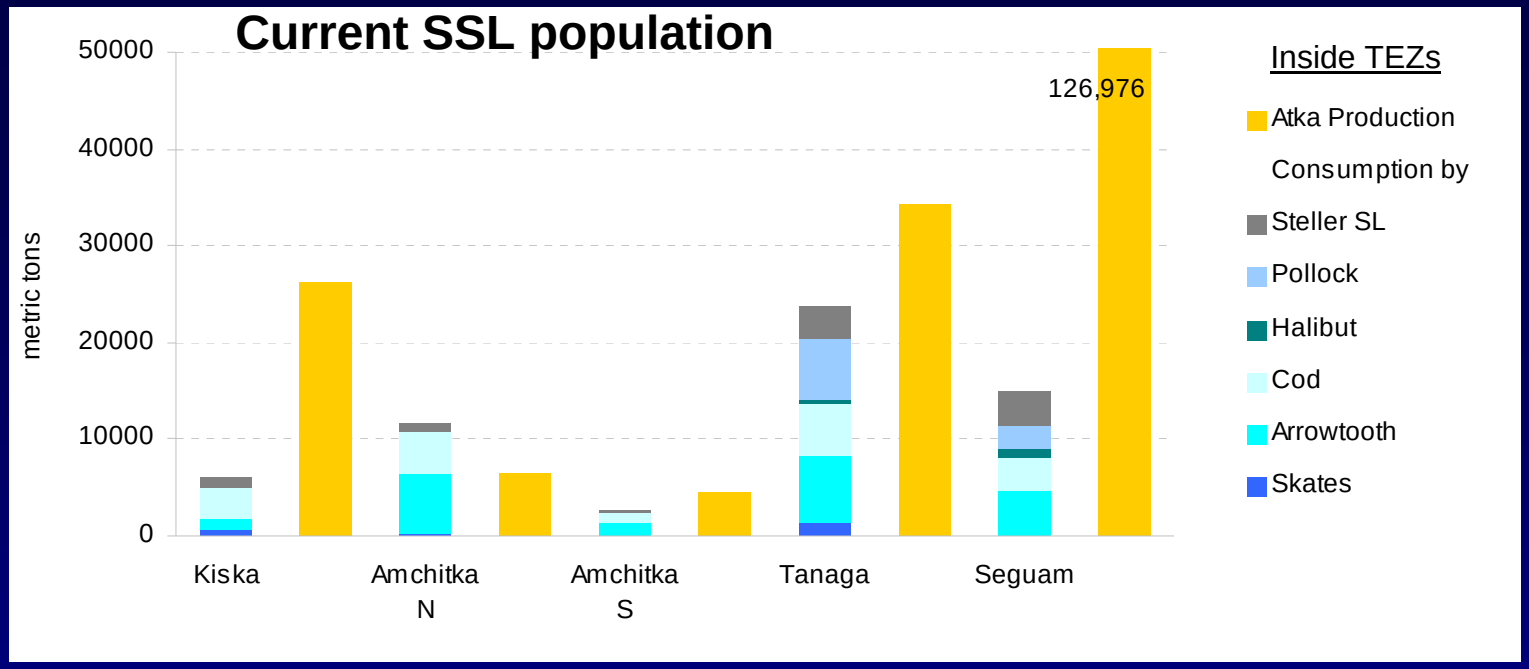

Amchitka Island
Atka Mackerel tag release and recovery locations
Legend
rookery10nm polygon
crithabitat polygon
Release locations
Recovery locations

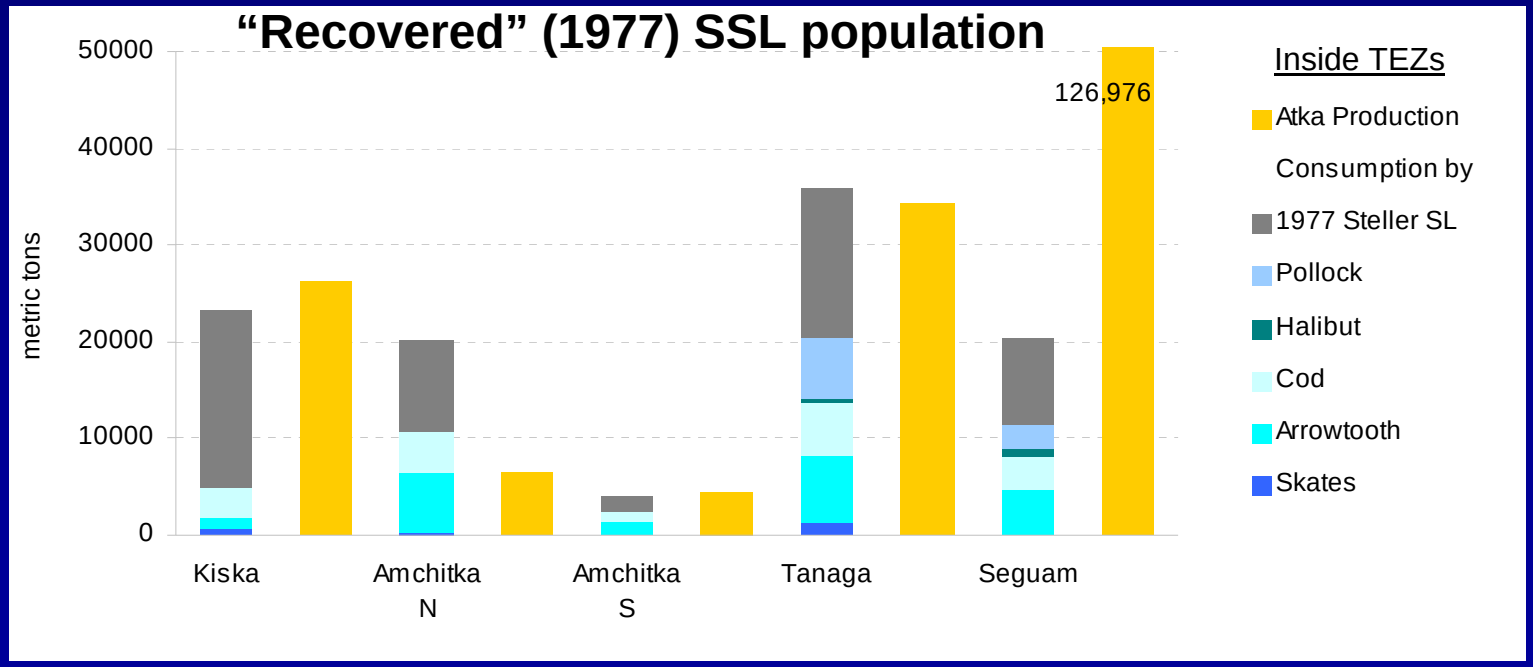

Tanaga Pass
Atka Mackerel tag release and recovery locations
Legend
rookery10nm polygon
crithabitat polygon
Release locations
Recovery locations


176°30'
177°
177°30'
Kiska Island 2006
Tag Release and Recovery Locations
1
2
3
4
52°
Bathymetry in Meters
100 - 200
201 - 500
501 - 1000
Rookery 10nm boundary
Critical Habitat
Tag Release Locations
Tag Recovery Locations

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

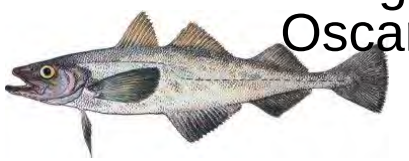
- Special issue *Marine and Coastal Fisheries*
  - S.McDermott
  - Spring 2010
- NPRB proposal for tagging in western Aleutian Islands
  - Pending award
  - Summer 2011
  - Collaborate with North Pacific Fisheries Foundation

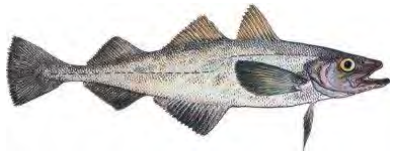
Other FIT research since 2007

- Pollock and SSL survey, Aleutian Islands
- Pacific cod maturity, Bering Sea and Aleutians

2008 Aleutian Islands Cooperative Acoustic Survey Study

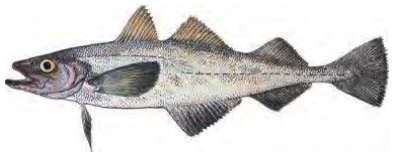
- **S. Barbeaux, L. Fritz, L. Logerwell**
- **Funded by NPRB (Project #730)**
- **Goal:**
  - Whether cooperative biomass assessments and surveys could be an effective way to manage fisheries at the local scales that are important to predators such as Steller sea lions.
- **Methods:**
  - Nighttime acoustic survey 173°-178° W Longitude on board the R/V Oscar Dyson, Feb. 16 – 29, 2008
  - Aerial survey of Steller sea lion rookery and haulouts from 173°-179° W longitude, Mar. 23 - 29
  - SSL scat sampling of haulouts and rookeries from 173°-179° W longitude, Mar. 30 – Apr. 9
  - Nighttime cooperative acoustic survey 174°-178° W Longitude using F/V Muir Milach, Mar. 23-27 , same transects as R/V Oscar Dyson survey

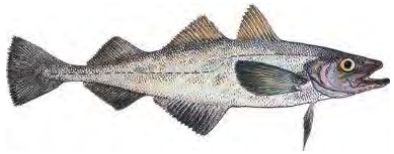




AICASS 2006-2008
F/V Muir Milach

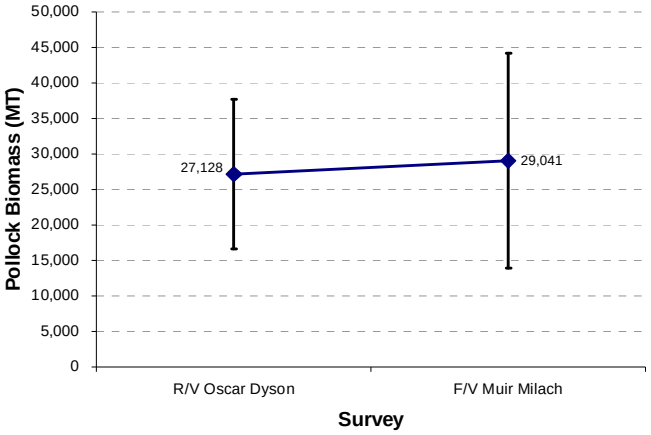
- 32 meter stern trawler
- ES 60 echosounder with a 38kHz transducer

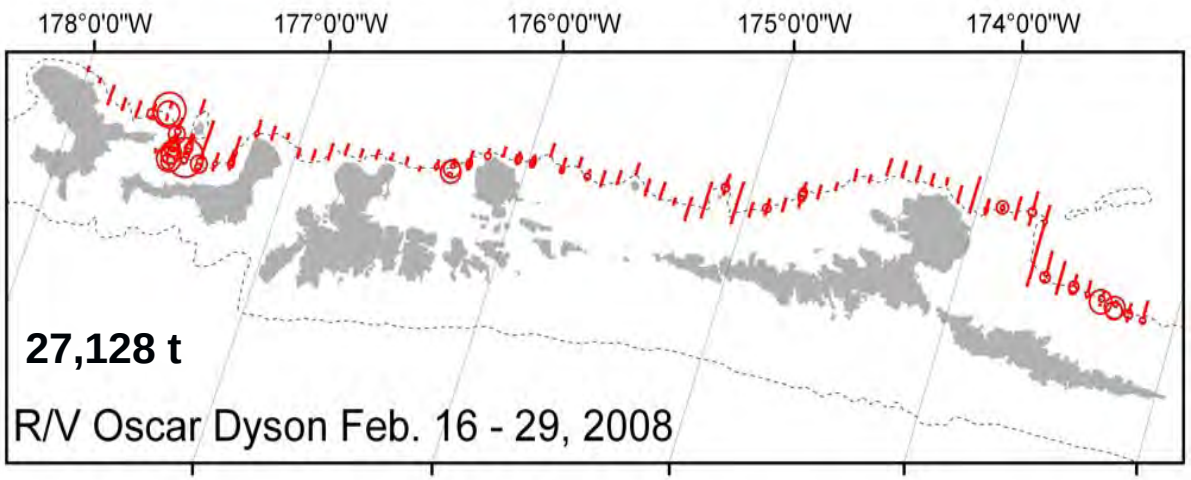


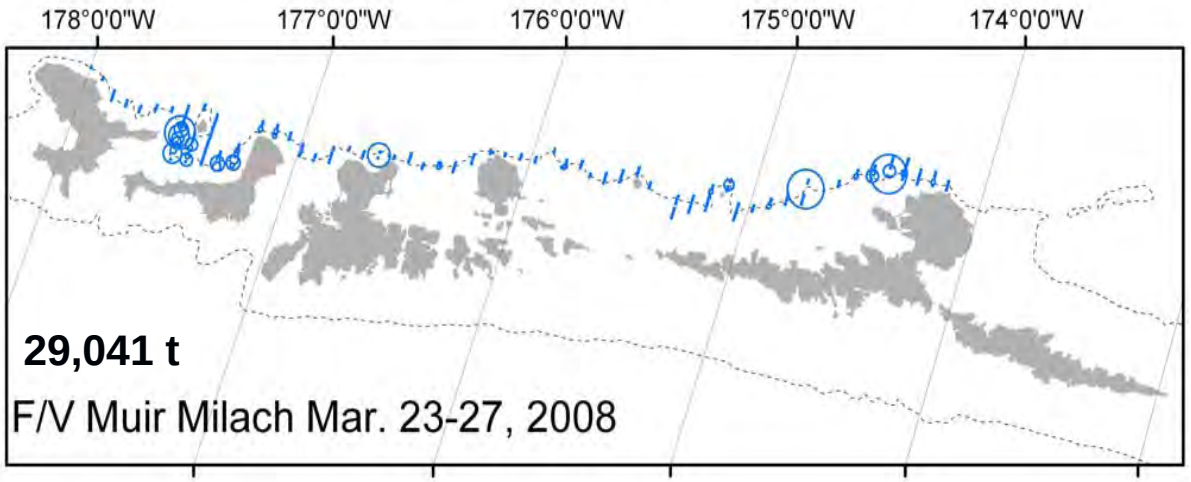


2008 AICASS Results

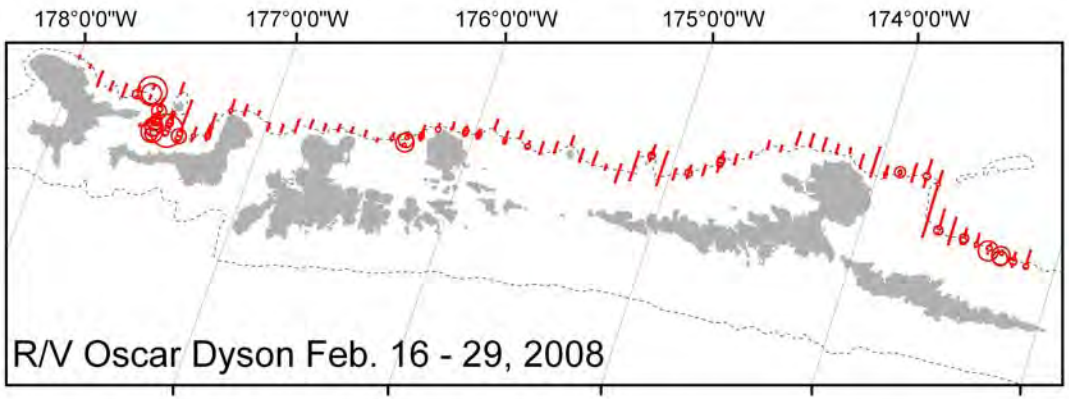
- The distribution, total pollock biomass, and size of pollock

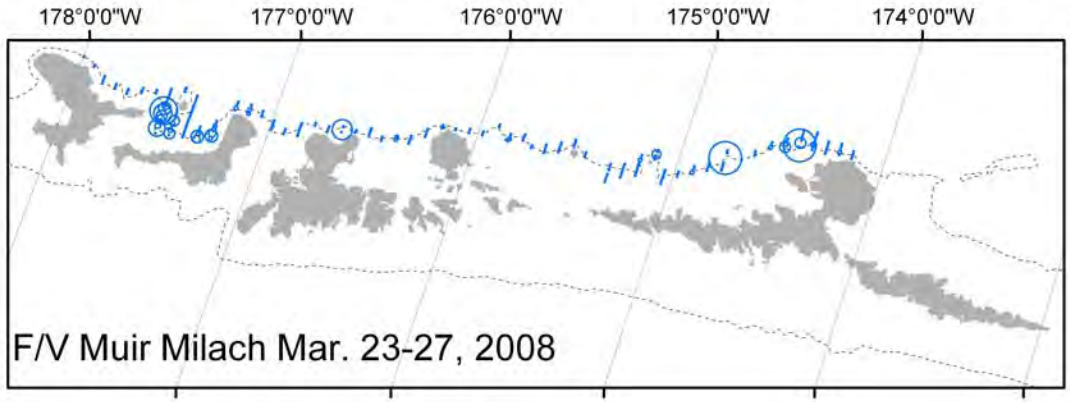


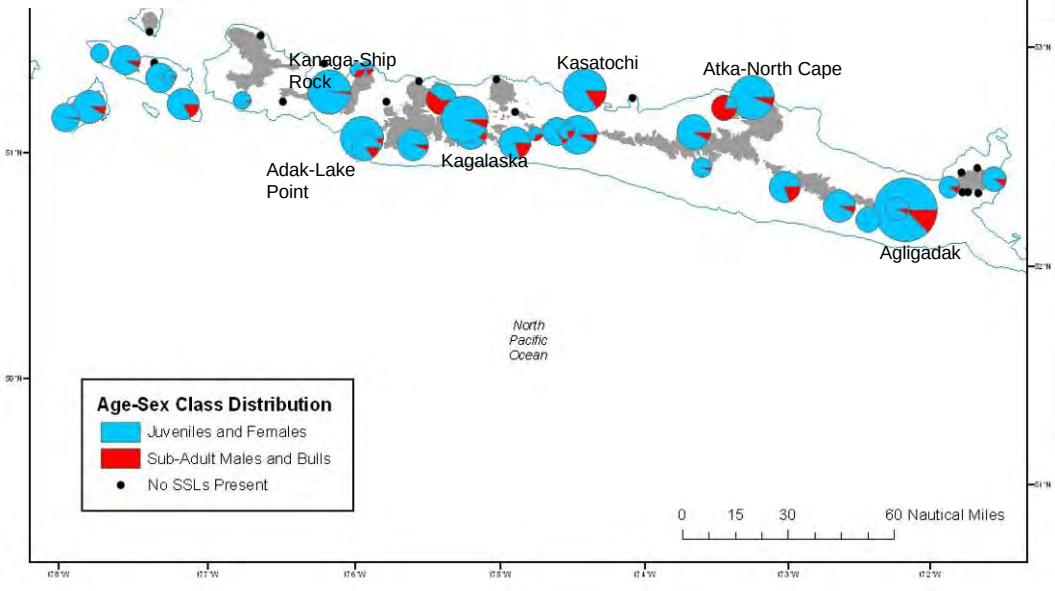




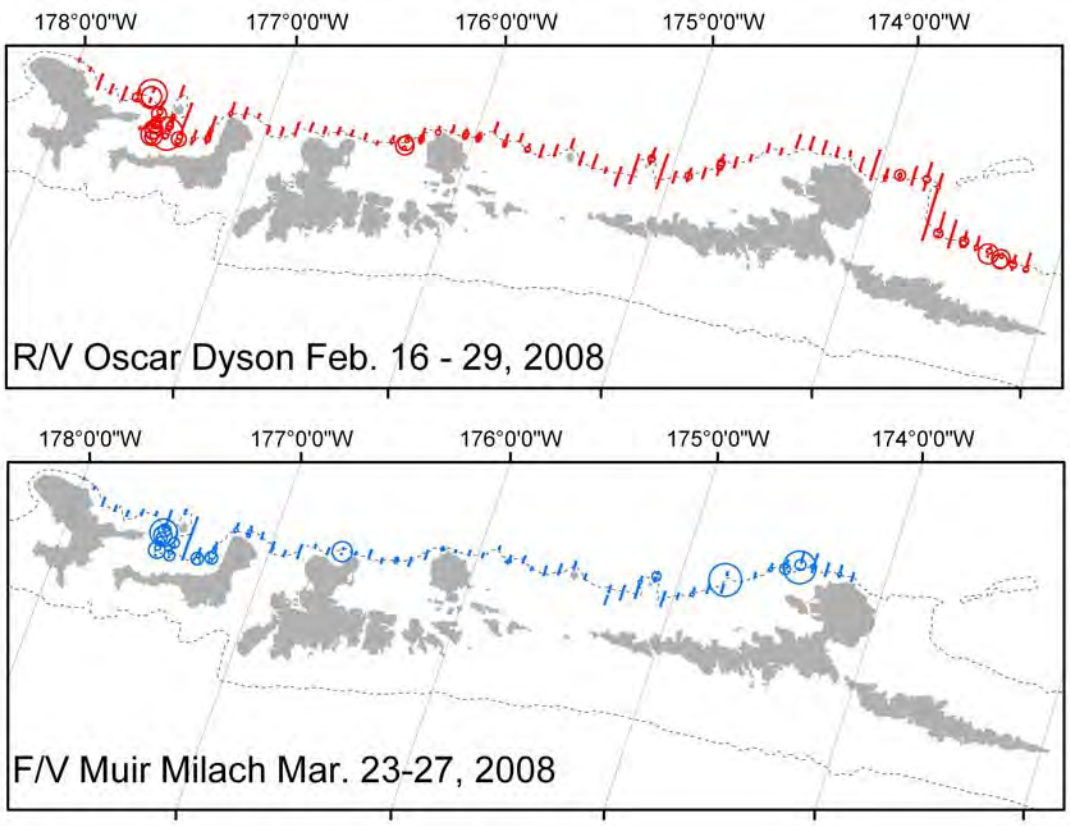
SSL counts

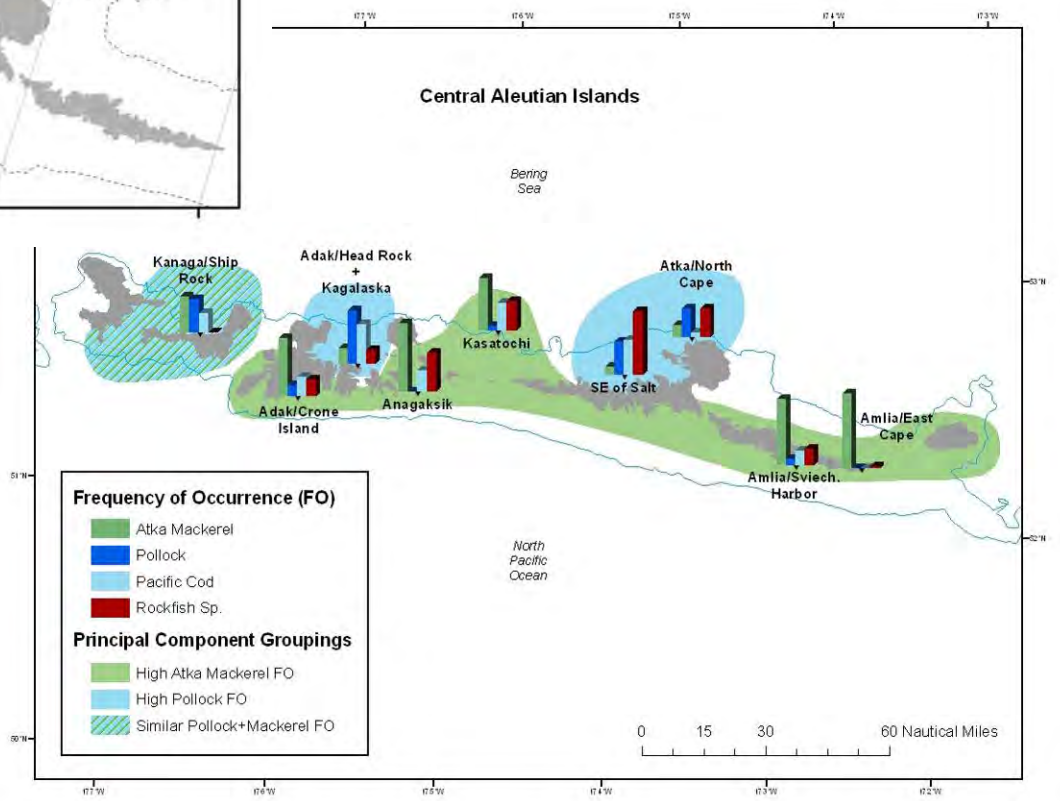

178°0'0"W
177°0'0"W
176°0'0"W
175°0'0"W
174°0'0"W
R/V Oscar Dyson Feb. 16 - 29, 2008


178°0'0"W
177°0'0"W
176°0'0"W
175°0'0"W
174°0'0"W
F/V Muir Milach Mar. 23-27, 2008


Central Aleutian Islands
Bering Sea
Kanaga-Ship Rock
Kasatochi
Atka-North Cape
Adak-Lake Point
Kagalaska
Agligadak
North Pacific Ocean
Age-Sex Class Distribution
Juveniles and Females
Sub-Adult Males and Bulls
No SSLs Present
0
15
30
60 Nautical Miles

SSL diets


178°0'0"W
177°0'0"W
176°0'0"W
175°0'0"W
174°0'0"W
R/V Oscar Dyson Feb. 16 - 29, 2008
F/V Muir Milach Mar. 23-27, 2008


Central Aleutian Islands
Bering Sea
North Pacific Ocean
Kanaga/Ship Rock
Adak/Head Rock + Kagalaska
Adak/Crone Island
Anagaksik
Kasatochi
Atka/North Cape
SE of Salt
Amlia/Sviech. Harbor
Amlia/East Cape
Frequency of Occurrence (FO)
Atka Mackerel
Pollock
Pacific Cod
Rockfish Sp.
Principal Component Groupings
High Atka Mackerel FO
High Pollock FO
Similar Pollock+Mackerel FO
0 15 30 60 Nautical Miles

2008 AICASS Conclusions

- Results from the *F/V Muir Milach*, although more variable, closely match the *R/V Oscar Dyson* survey.
- Pollock abundance in the Central Aleutian Islands remains low.
- The diets of Steller sea lions on haul-outs near areas where high densities of pollock were observed showed high frequency of occurrence of pollock.
- Local pollock aggregations are important for sea lions in the central Aleutians during winter.

Management Implications – The good news

- It is possible to use commercial fishing vessels to survey pollock abundance acoustically in the Aleutian Islands during the winter.
  - Data quality is sufficient.
  - Pollock distribution appears to be consistent among years.
  - Within the wider study area pollock abundance appears seasonally stable.

Management Implications – The bad news

- There is the potential for fishery and SSL interaction.
  - Pollock are a component of the SSL diet in the Aleutian Islands during the winter.
  - SSL feed on pollock in areas where the commercial fishery proposes to operate.
- The abundance of pollock in the Central Aleutian Islands is low.
- The proposed management system is reliant on fishers' willingness to conduct surveys which is reliant on their perceived potential profit from the fishery.

Where to from here?

- Long-term monitoring of AI pollock aggregations using small-scale industry “surveys” during the Pacific cod fishery until stock rebounds.

- If AI pollock resources rebound, possible use of cooperative surveys and small-scale quotas to manage the resource inside critical habitat.

- Cooperative surveys are now being used in the Gulf of Alaska to survey pollock in areas and times not covered in NMFS acoustic survey but fishers believe are important.

Pacific cod maturity

- Sandi Neidetcher, L. Logerwell
- Funding NPRB (Project #618)
- Identify Pacific cod spawning locations in the Bering Sea and Aleutian Islands

Pacific Cod Maturity Codes (female)

Stage Description

1. Immature

Gonads small, close to vertebral column, may be difficult to sex. Ovaries appear as pink or transparent paired sacs, no oocytes are visible to the eye.

* Look for transparent or pinkish coloration. There may be slight silver or dark blotching on the surface, but the ovary should be small and new looking as shown.

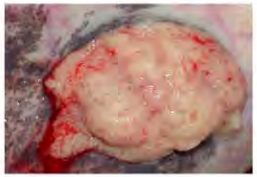
2. Developing

Gonads small, to about ½ the length of body cavity. Ovaries form 2 tapered, distinct lobes having well-developed blood vessels. Transparent and/or opaque orange oocytes are distinct and visible through the ovary wall. Oocytes stick together forming a solid mass.

* The ovary shown is fairly small, as stated above the developing ovary can be up to half of the body cavity

3. Pre-spawning

Ovaries form 2 large distinct lobes. Most eggs appear as mature clear ova, some oocytes remain interspersed throughout the ovary. Ova are less adhesive resembling the consistency of Cream of Wheat (the breakfast cereal).



4. Spawning

Eggs run under slight pressure to the body. Ova are loose in the ovary. (The ovary was cut upon sexing the fish shown at right. The eggs (ova) fill the abdominal cavity and flow freely into the bin.) * To differentiate ovary stages 2 through 4 look at the adhesive quality of the eggs. Stage 2 eggs form a solid mass while stage 3 eggs are looser and stage 4 eggs flow freely.

5. Spent

Gonads are still large, but appear flaccid and watery. Ovaries may contain remnants of disintegrating ova and associated structures.

6. Resting

Ovaries small, firm, may have some black or silver color. No oocytes are visible to the eye.

Pacific Cod Maturity Codes (males)

Stage Description

1. Immature

Gonads small, close to vertebral column, may be difficult to sex. Testes translucent "bumps" on thread-like strands closely associated with, and often indistinguishable from, the gut mesentery.

2. Developing

Gonads small, to about ½ the length of body cavity. Testes appear uniformly ribbon-like, swollen in size, and take on an opaque or increasingly whitish color.

3. Pre-spawning

Testes are large, swollen white and highly convoluted "leaf-lobed" ribbons filling the entire body cavity. Milt is emitted when wall is compromised (pinched).

4. Spawning

Testes milk freely under slight pressure to the body.

5. Spent

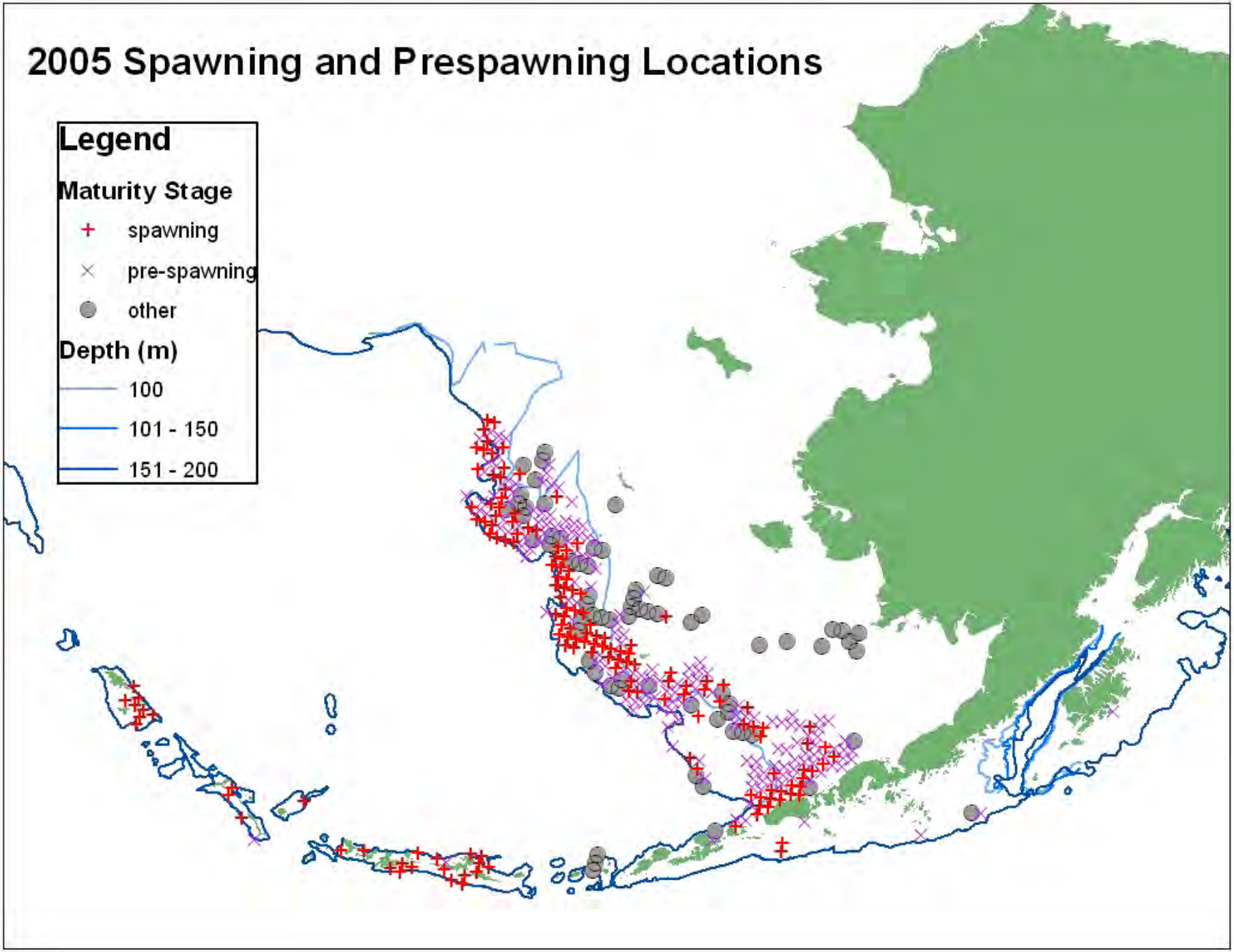
Gonads are still large, but appear flaccid and watery. Testes appear bloodshot. There may be some areas of the testes that still contain milt.

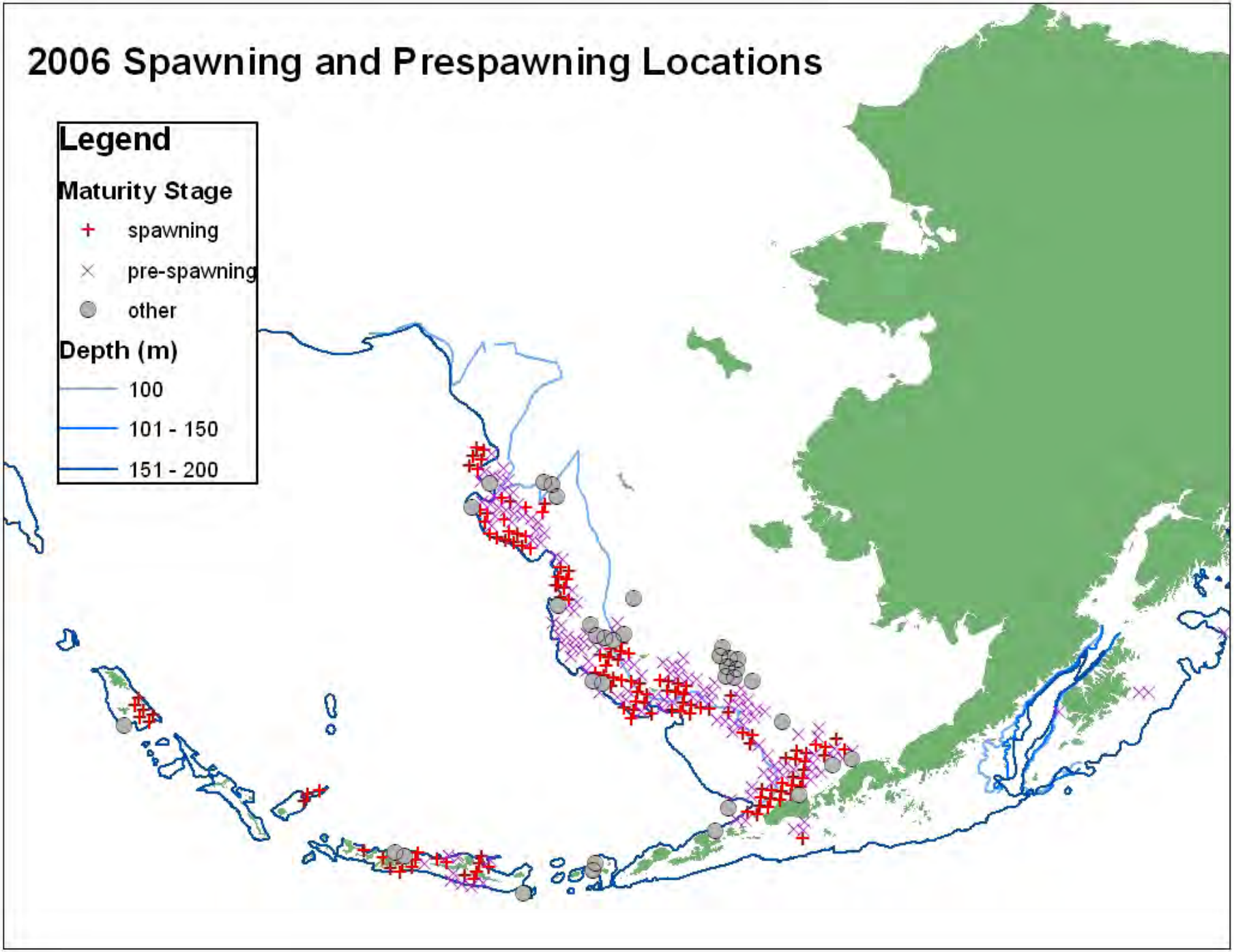
6. Resting

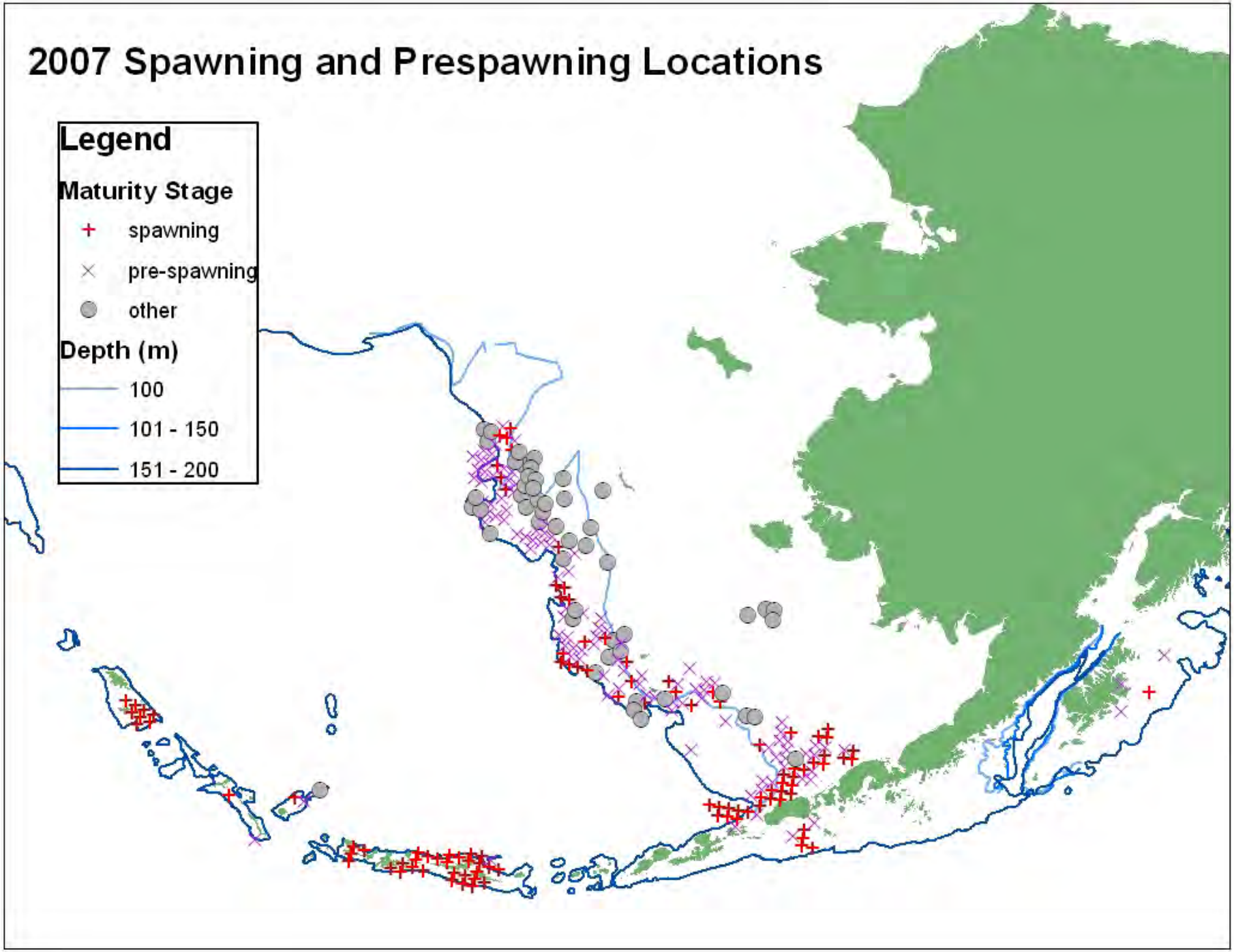
Key developed by Sandi Neidetcher, Alaska Fisheries Science Center,
National Marine Fisheries Service, NOAA.
email: sandi.neidetcher@noaa.gov

Misclassification table

	Immature	Developing	Prespawning	Spawning	Spent	Resting	Total
No yolk, thin wall	90	1	4	1	3		99
Mid-Vitellogenisis		268	152	3	1	2	426
Late-Vitellogenisis		20	86	2	1		109
Hydration		2	17	15	23		57
Post- Ovulatory Follicles	2				9		11
No yolk, thick wall	6				1	1	8
Total	98	291	259	21	38	3	710


2005 Spawning and Prespawning Locations
Legend
Maturity Stage
spawning
pre-spawning
other
Depth (m)
100
101 - 150
151 - 200


2006 Spawning and Prespawning Locations
Legend
Maturity Stage
spawning
pre-spawning
other
Depth (m)
100
101 - 150
151 - 200


2007 Spawning and Prespawning Locations
Legend
Maturity Stage
spawning
pre-spawning
other
Depth (m)
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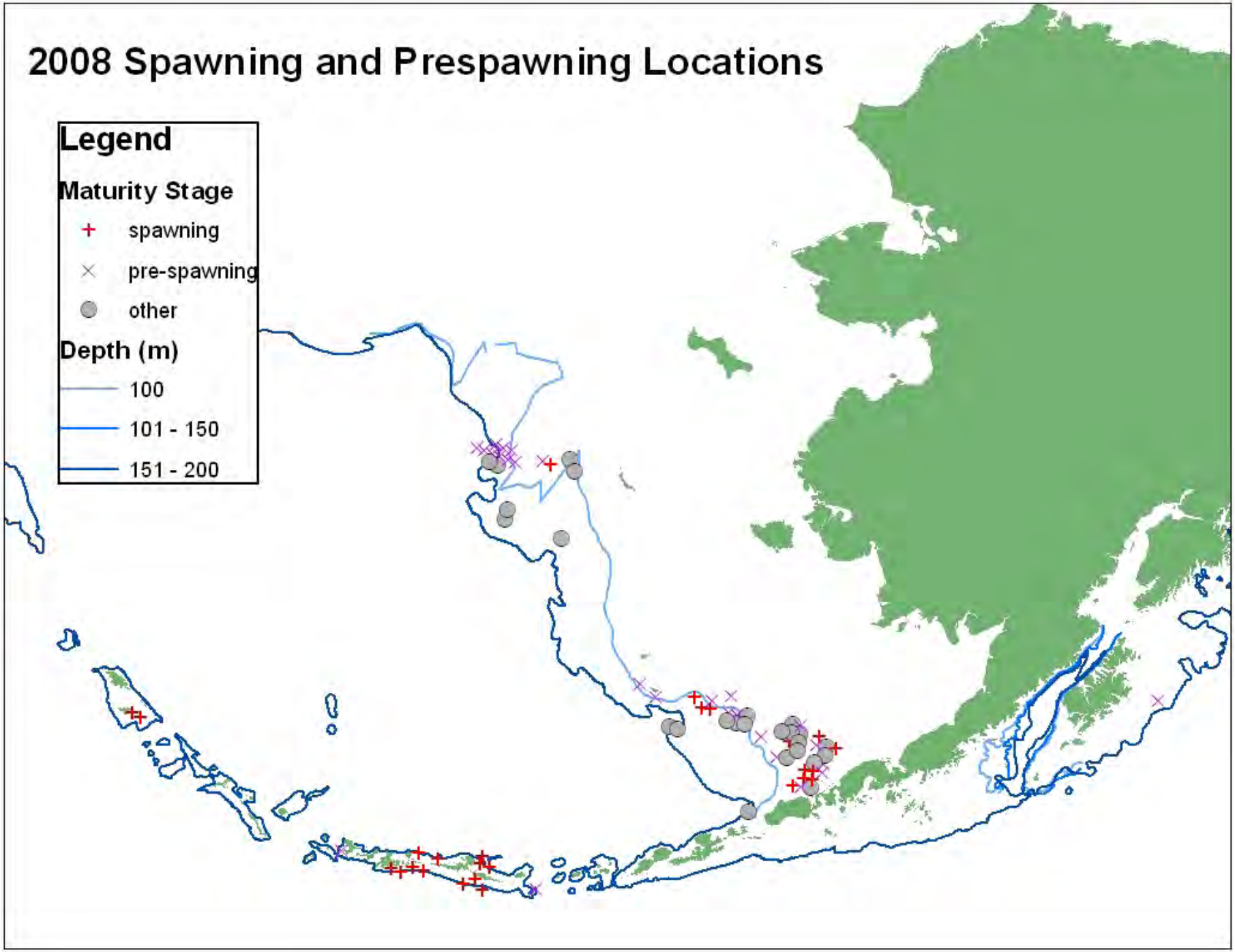
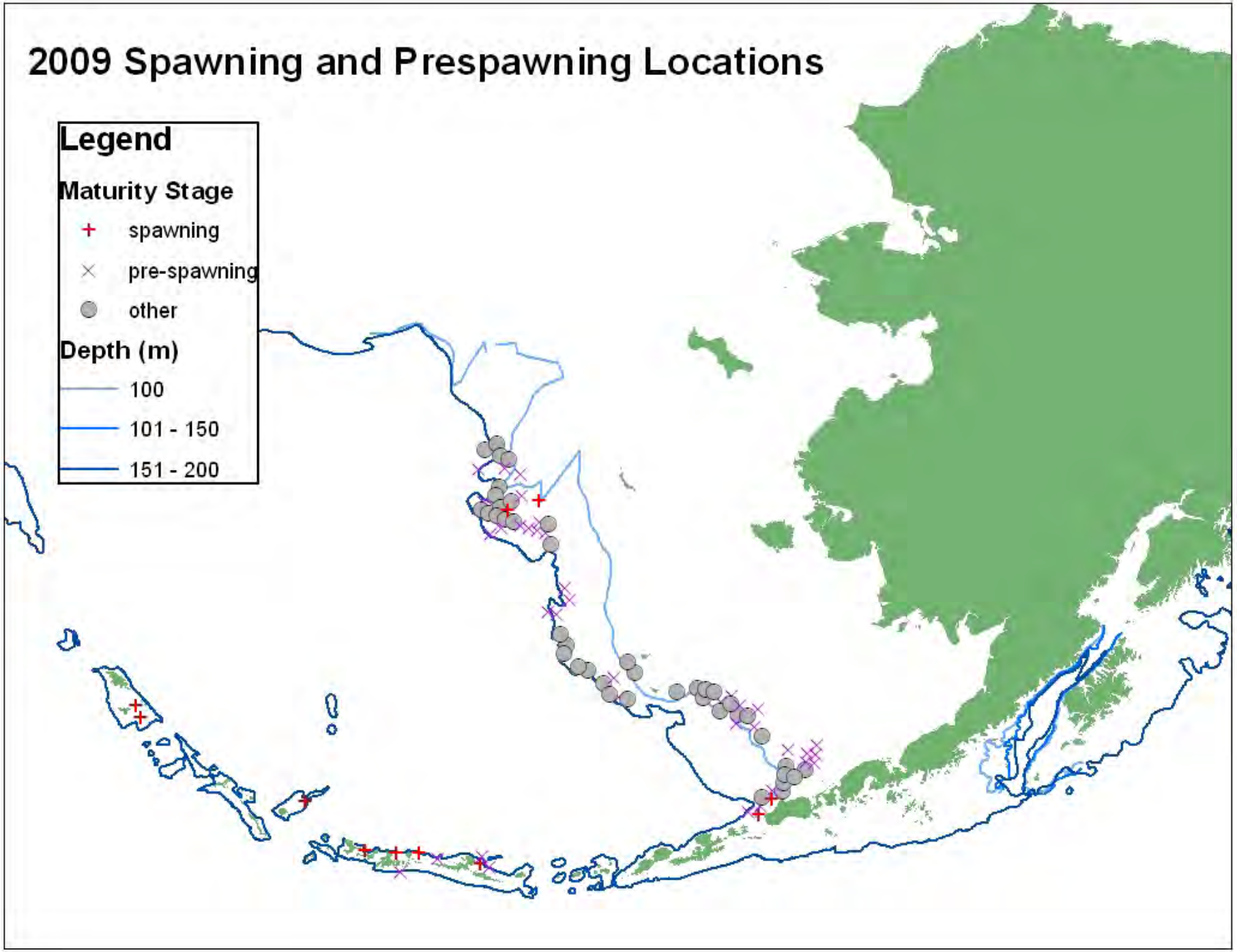
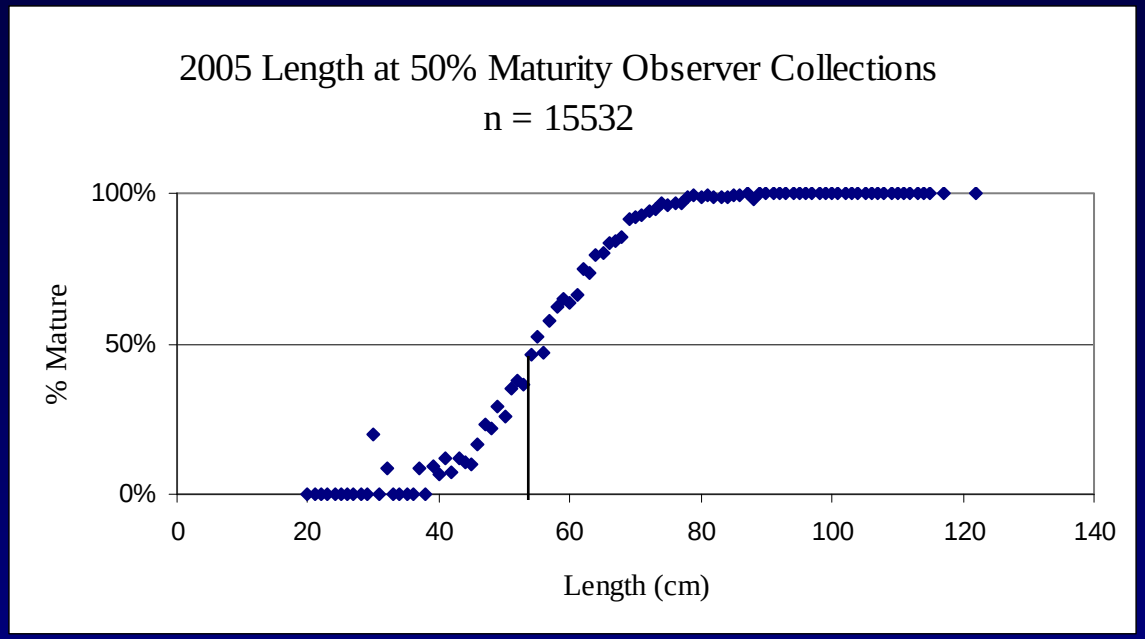
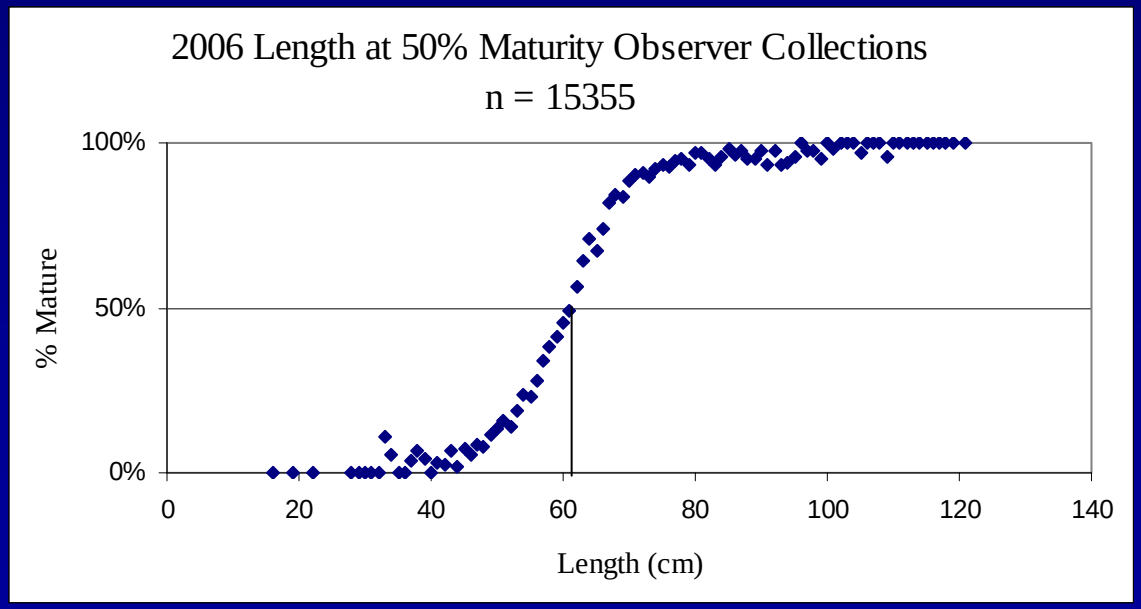
151 - 200


2008 Spawning and Prespawning Locations
Legend
Maturity Stage
spawning
pre-spawning
other
Depth (m)
100
101 - 150
151 - 200


2009 Spawning and Prespawning Locations
Legend
Maturity Stage
spawning
pre-spawning
other
Depth (m)
100
101 - 150
151 - 200


2005 Length at 50% Maturity Observer Collections
n = 15532
100%
50%
0%
% Mature
0
20
40
60
80
100
120
140
Length (cm)


2006 Length at 50% Maturity Observer Collections
n = 15355
100%
50%
0%
% Mature
0
20
40
60
80
100
120
140
Length (cm)

Pacific cod maturity – Conclusions

- Visual maturity key is a useful tool for collecting a lot of data inexpensively
- Spawning locations near Pribilofs, Unimak Pass, Bering Sea outer shelf and Aleutian Islands
- Length at 50% maturity similar to that determined by histology (J. Stark)

Contact information

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

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