

Science, Service, Stewardship



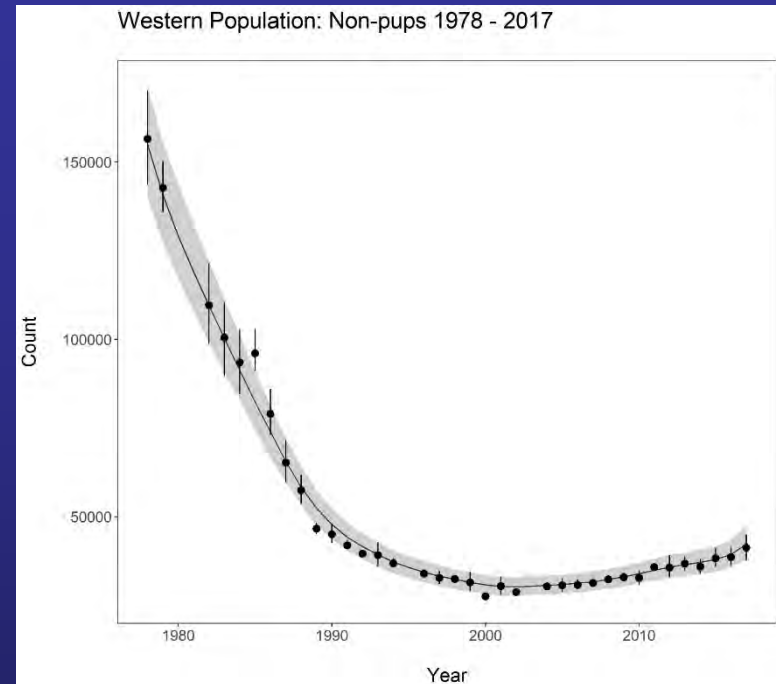
Seasonal Distribution and Relative Abundance of Steller Sea Lion Prey in the Aleutians

Libby Logerwell, Susanne McDermott,
Kimberly Rand, Mike Levine, James
Ianelli,

Alaska Fisheries Science Center, Seattle, WA
North Pacific Fisheries Foundation
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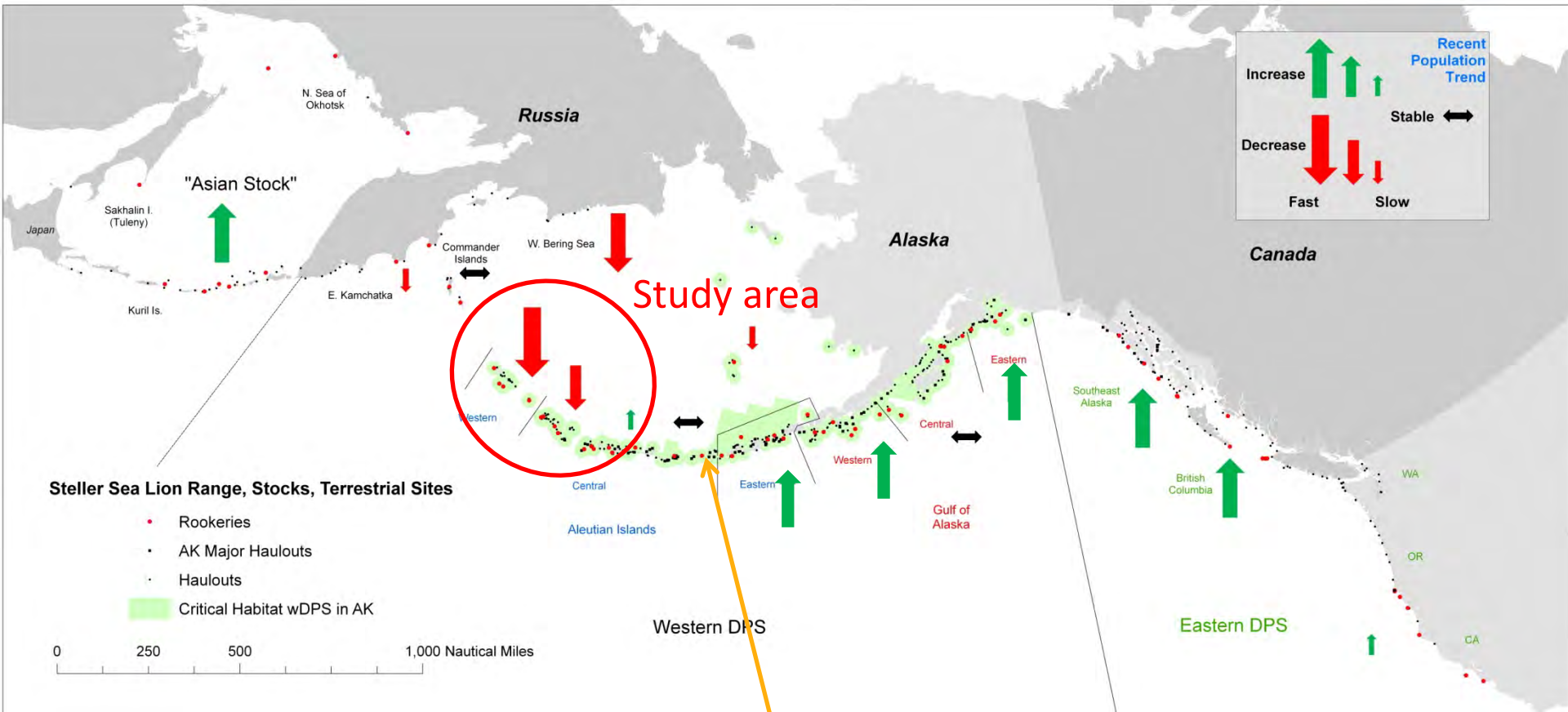
**NOAA
FISHERIES
SERVICE**

Steller sea lion and Fisheries



- 1997: Western stock of Steller Sea lion was declared endangered
- 2000, 2010 and 2014 Endangered Species Act - Biological Opinions on effects of groundfish fishery on Sea lion populations:
 - Mitigation measures
 - Complex temporal and spatial closures
 - Trawl exclusion zones, Critical habitat, seasonal allocations

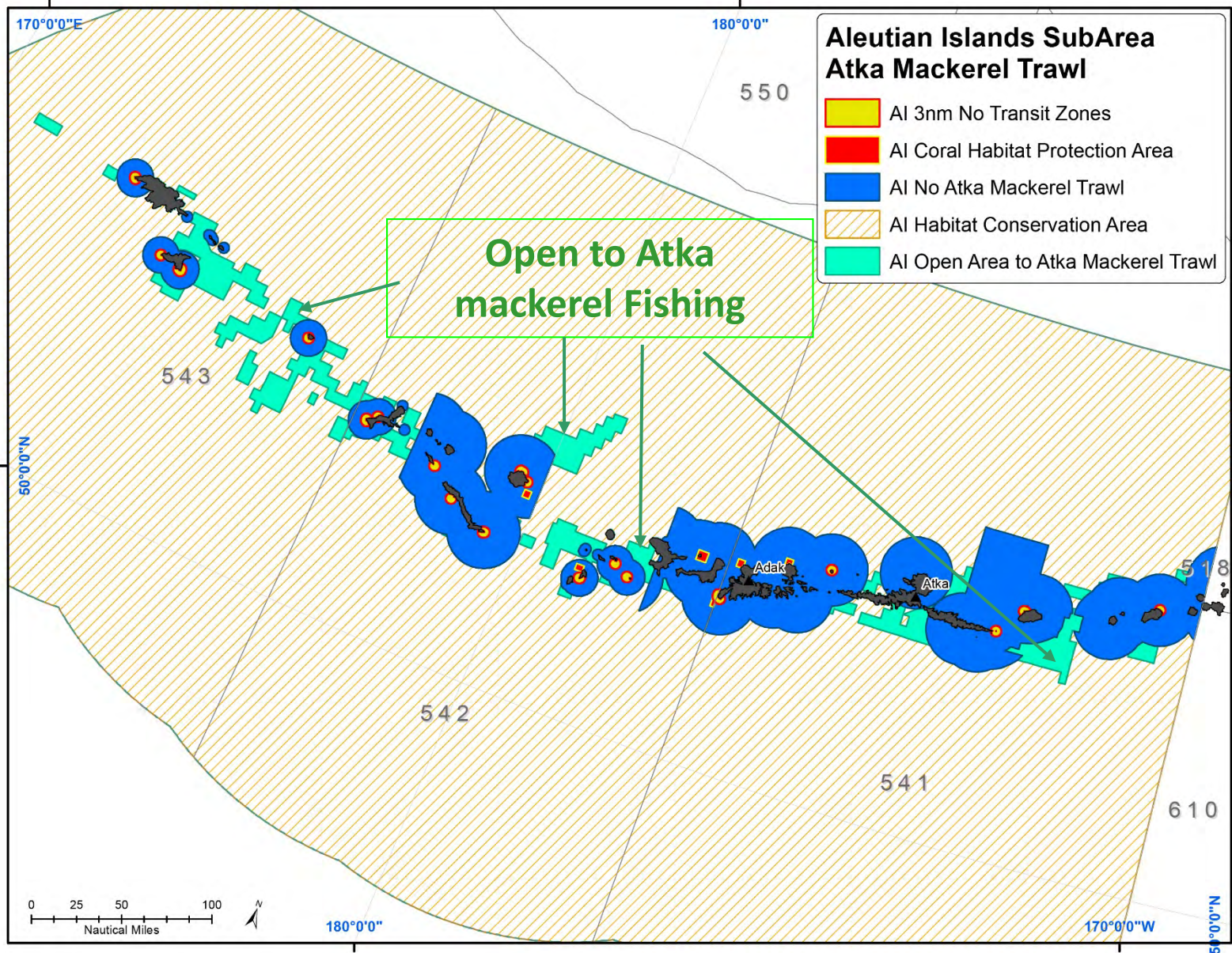
SSL Range-wide Non-pup Trends since 2000



Samalga Pass

Courtesy Lowell Fritz

2015-2018 Atka mackerel Fisheries closures



Reasons for Mitigation measures

- Concern for competition between fisheries and Steller sea lion for prey
- Minimize interactions between fishing vessels and Steller sea lions
- Acknowledgement of limited knowledge on impacts of fishing on Steller sea lion prey field

Sea lion prey species with potential fishery impact



- Atka mackerel
 - (> 70% occurrence in diet in summer)



- Pacific Cod
 - (13% occurrence in diet in winter)



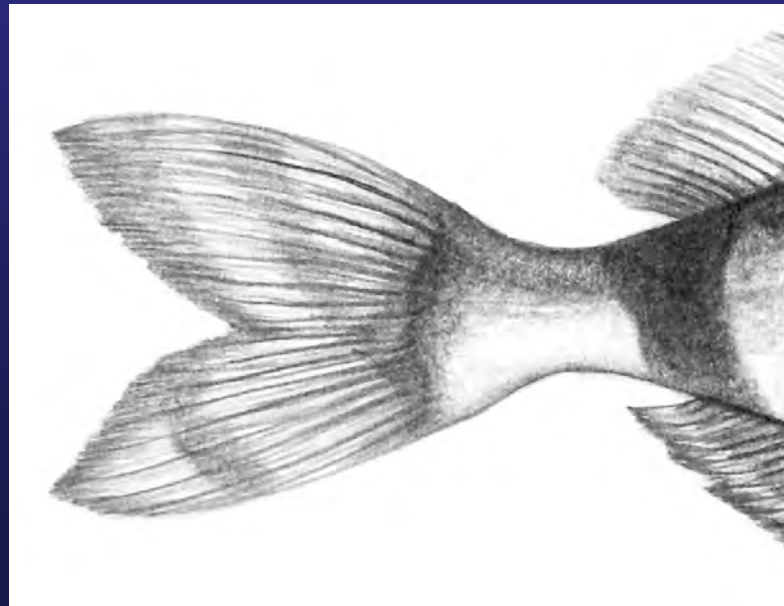
- Rockfish
 - (10% occurrence in diet in winter)



- Pollock
 - (8% occurrence in diet in winter)

Assessing Steller sea lion Prey distribution

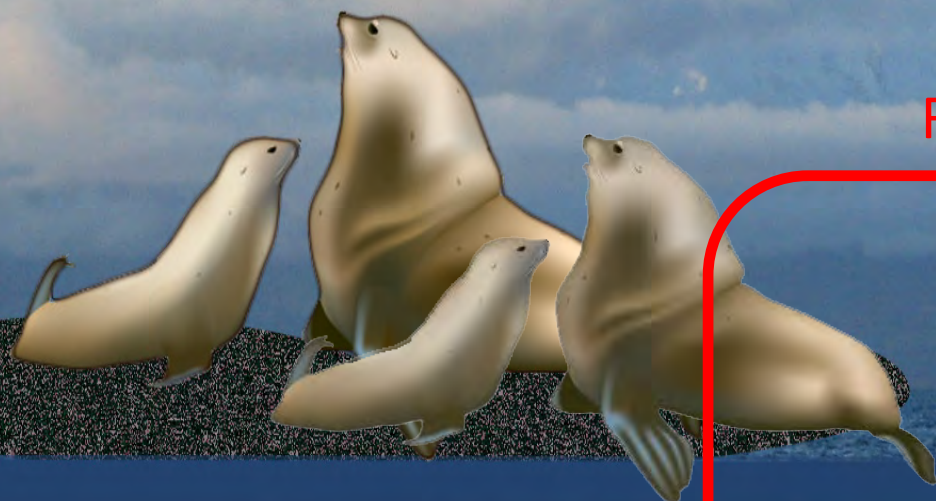
A Tale of Scale



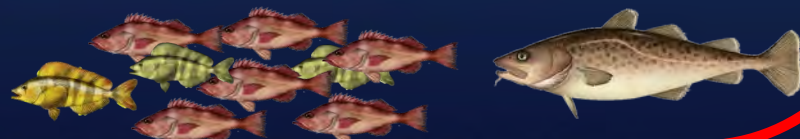
The Steller sea lion puzzle

Ecosystem Scale

Fishery Interaction Scale



Sea Lion Foraging Scale



A Tale of Scale



1. Fisheries Interaction Scale

- A. Estimate local abundance and exploitation rate of Atka mackerel with tagging (McDermott et al.)
- B. Estimate fish density inside and outside of Trawl Exclusion Zones using survey trawl catch-per-unit-effort CPUE (Rand et al.)

2. Ecosystem Scale

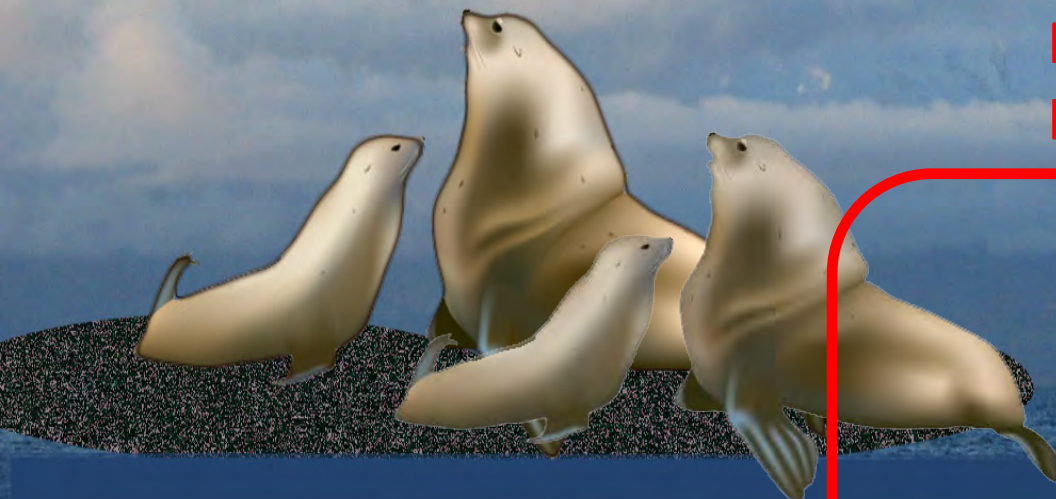
- A. Assess species composition, relative abundance and its correlation with environmental variables (Rand et al.)

3. Steller Sea Lion Foraging Scale

- A. Distance of prey aggregations to rookeries
- B. Localized prey body size
- C. Diurnal migration patterns

The Steller sea lion puzzle

Fisheries Interactions –
Localized depletion?

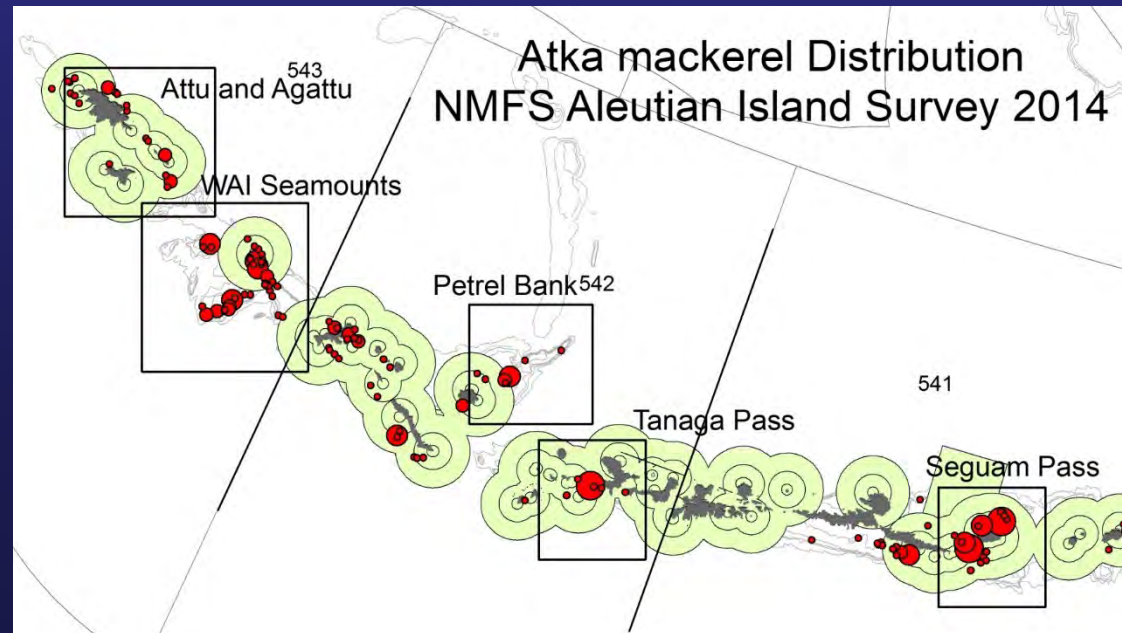


Atka mackerel tagging study 2002-2015



- One of the most abundant groundfish in the Aleutian Islands

- 2019 Biomass of age 1+ ~ 498,320 mt,
- 2019 Total Allowable Catch ~58,900 mt
- Patchy Distribution
- High current areas
- High site fidelity (> 97% of tagged fish recovered at same site)



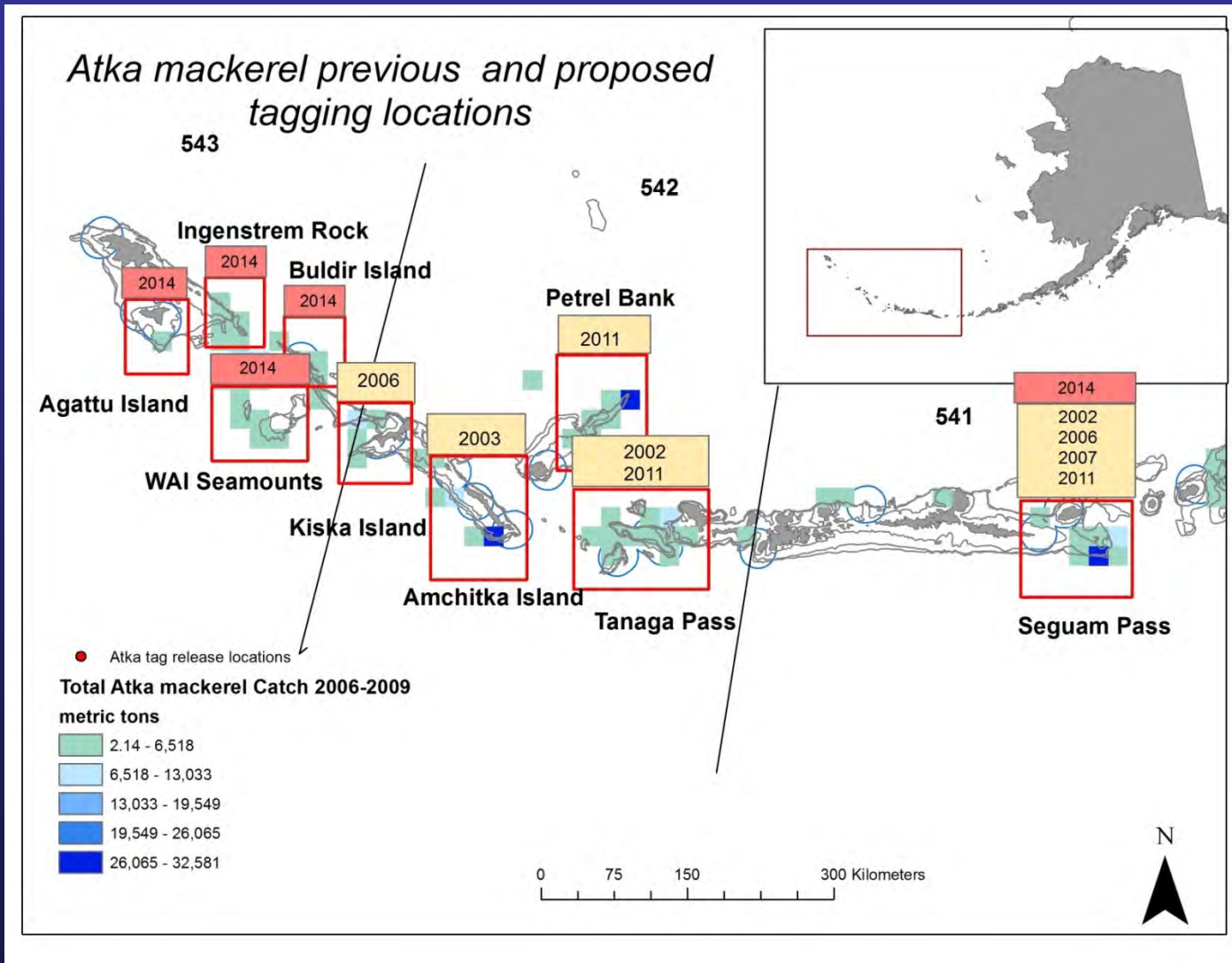
Atka Mackerel Fishery



- Fleet of Factory trawlers (Amendment 80 fleet)
- Individual quotas per vessel
- Complicated temporal and spatial allocations due to Steller sea lion mitigation measures

Project history

Released over 100,000 tags to date



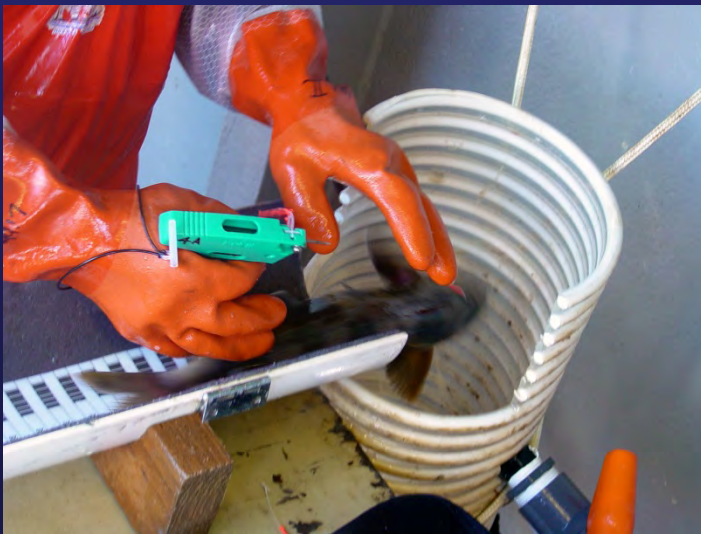
Catch



Tag



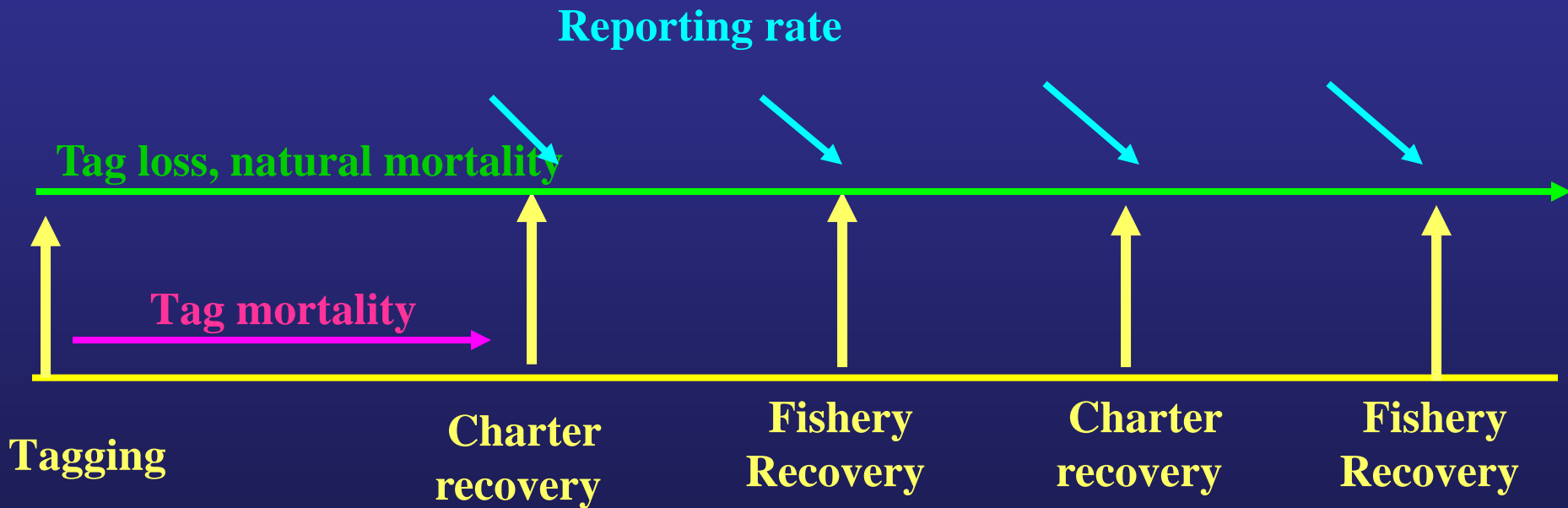
Release



Recapture



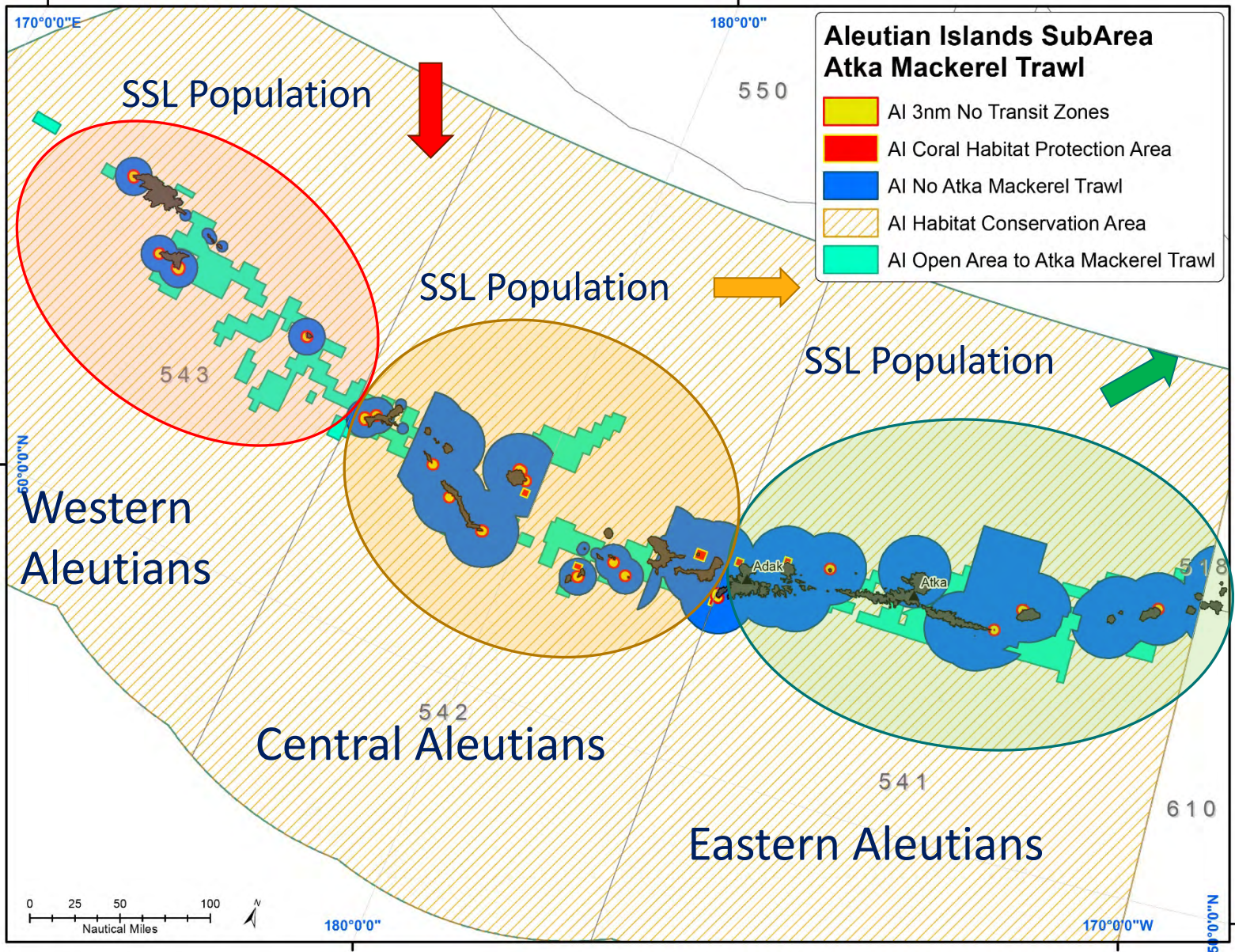
Integrated likelihood model

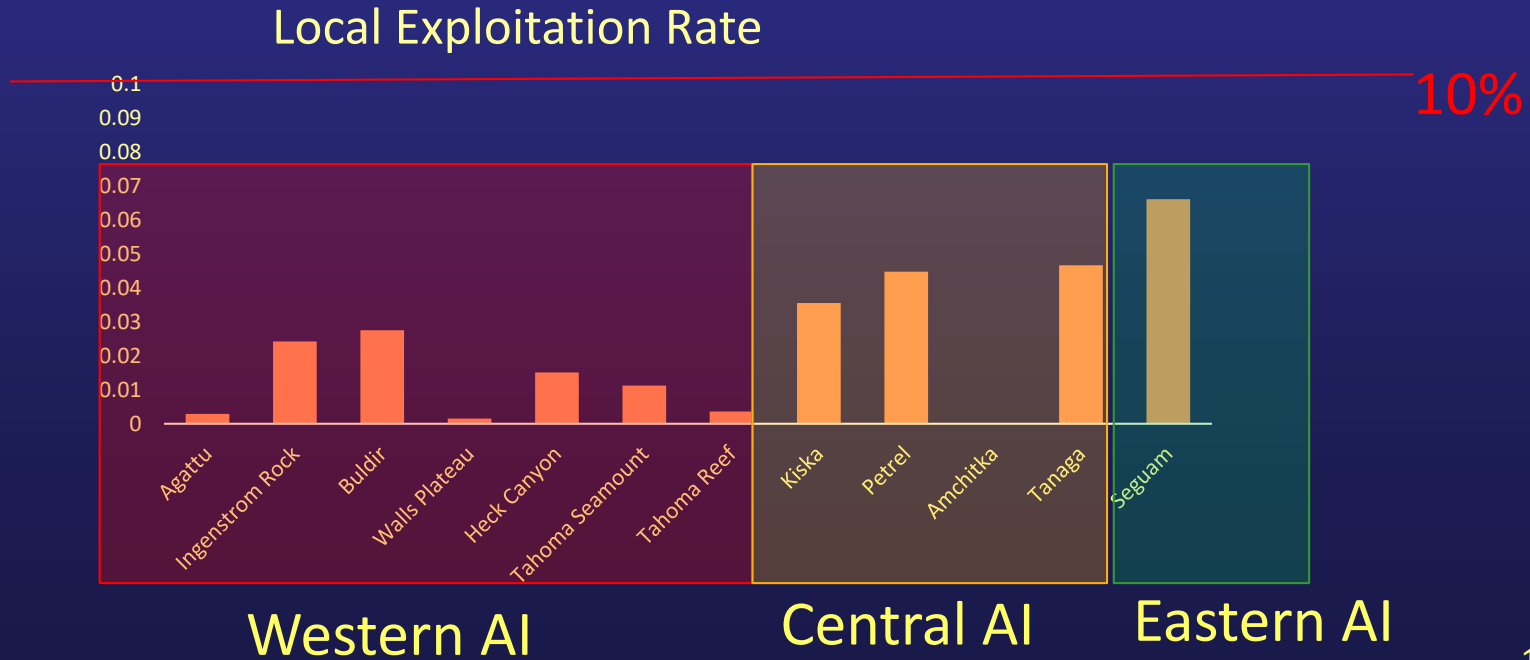
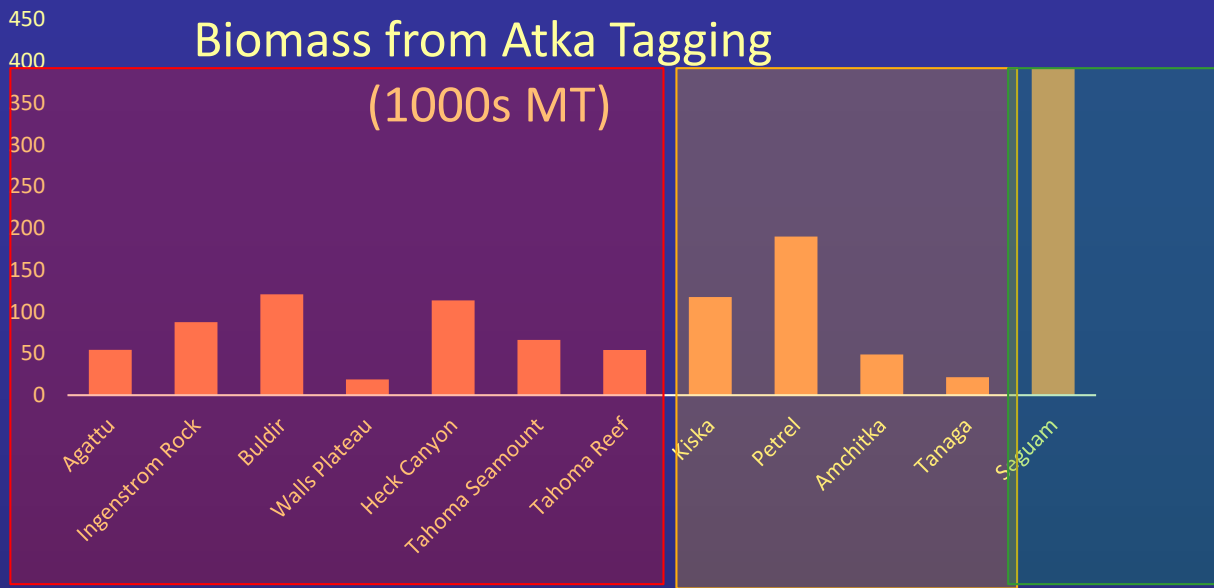


Results



Fisheries Scale



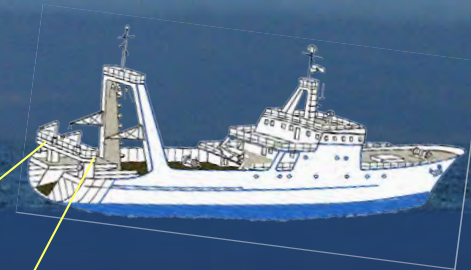
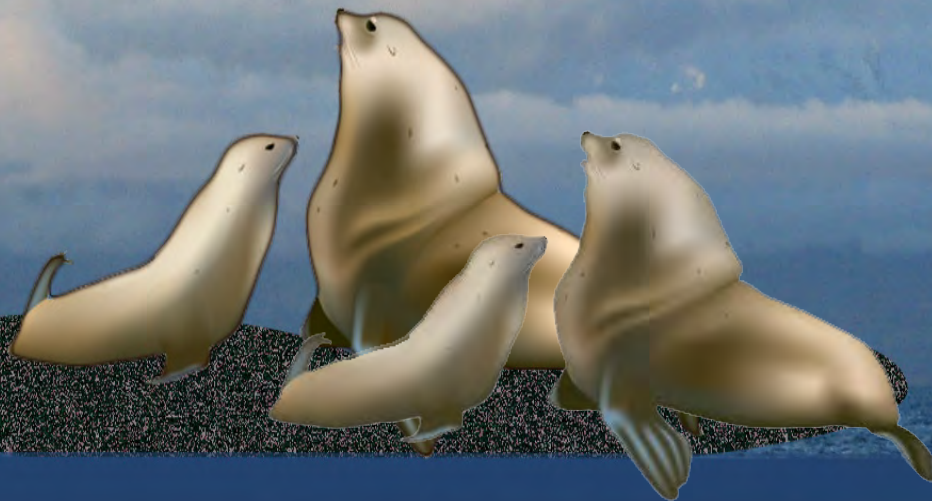


Summary Fishery Interaction

- No “smoking gun”
- Current exploitation rate below 10%
 - Even lower in the Western Aleutians where Sea lions are doing poorly
 - Mitigation measures seem to be working

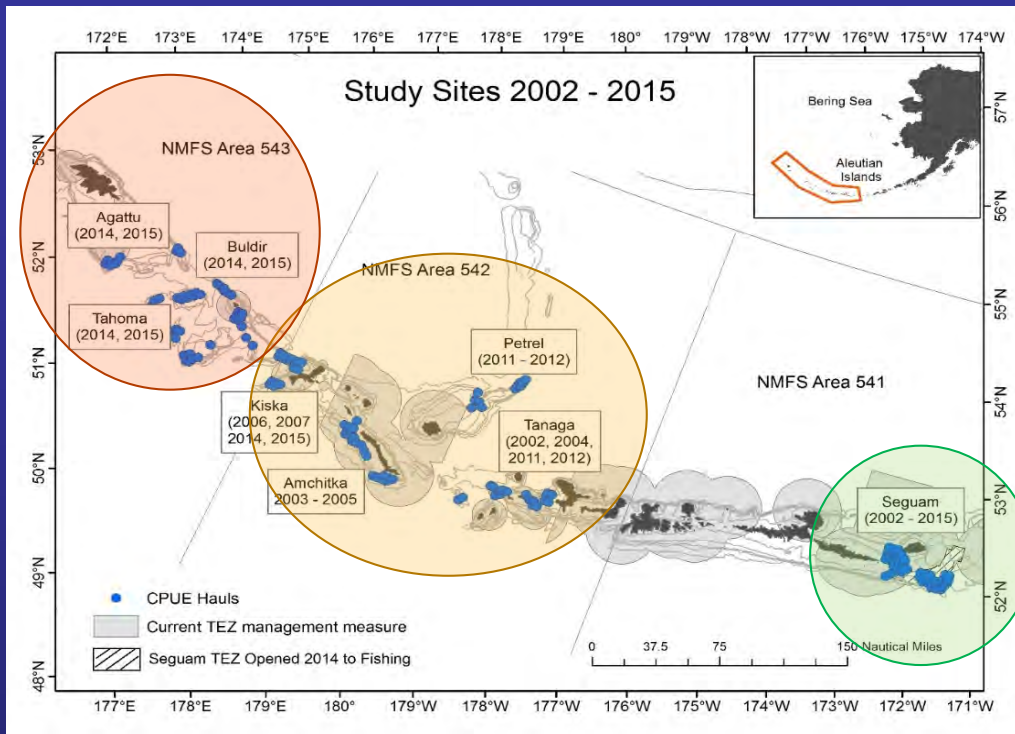
The Steller sea lion puzzle

Ecosystem Scale



2. Ecosystem Scale

- Relative abundance of all 5 prey species
- Environmental drivers of patterns in density of Atka mackerel and northern rockfish



1400

1200

Species density (catch-per-unit-effort) Atka mackerel Tag recovery cruises 2002-2015

1000

800

600

400

200

0

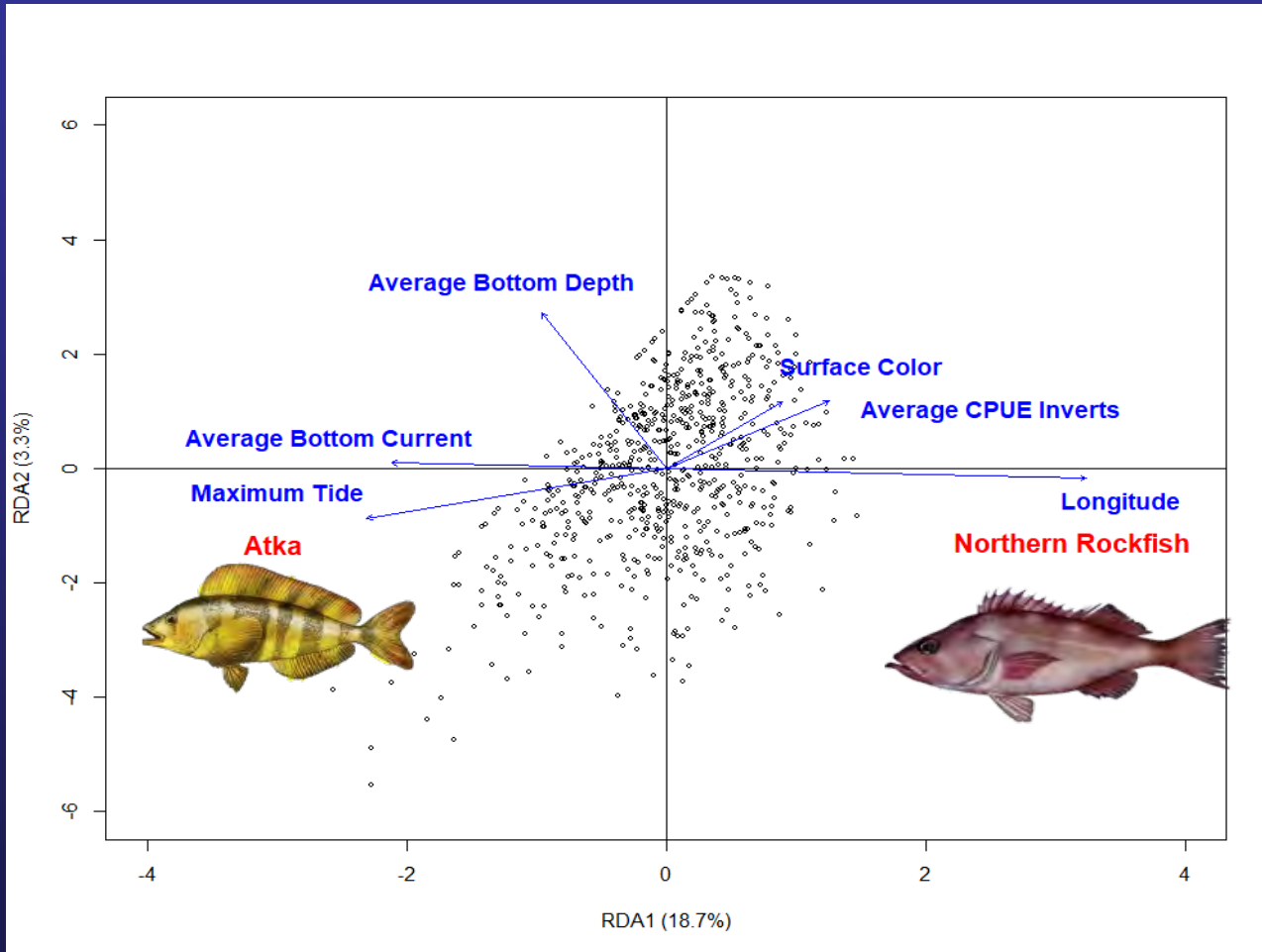
■ Atka mackerel ■ northern rockfish ■ Pacific cod
■ Pacific ocean perch ■ walleye pollock



Fish density and Environment

- Multivariate analysis for Atka and northern rockfish
- Variables correlated with density
 - Tidal and bottom current
 - Bottom depth
 - Invertebrate density
 - Longitude
 - Sattelite-derived ocean color (productivity)

Ecosystem Scale – Atka mackerel and Northern Rockfish Density



Atka mackerel

- decreases east to west
- Increases with high bottom current
- Increases with high tidal current.

Northern rockfish density

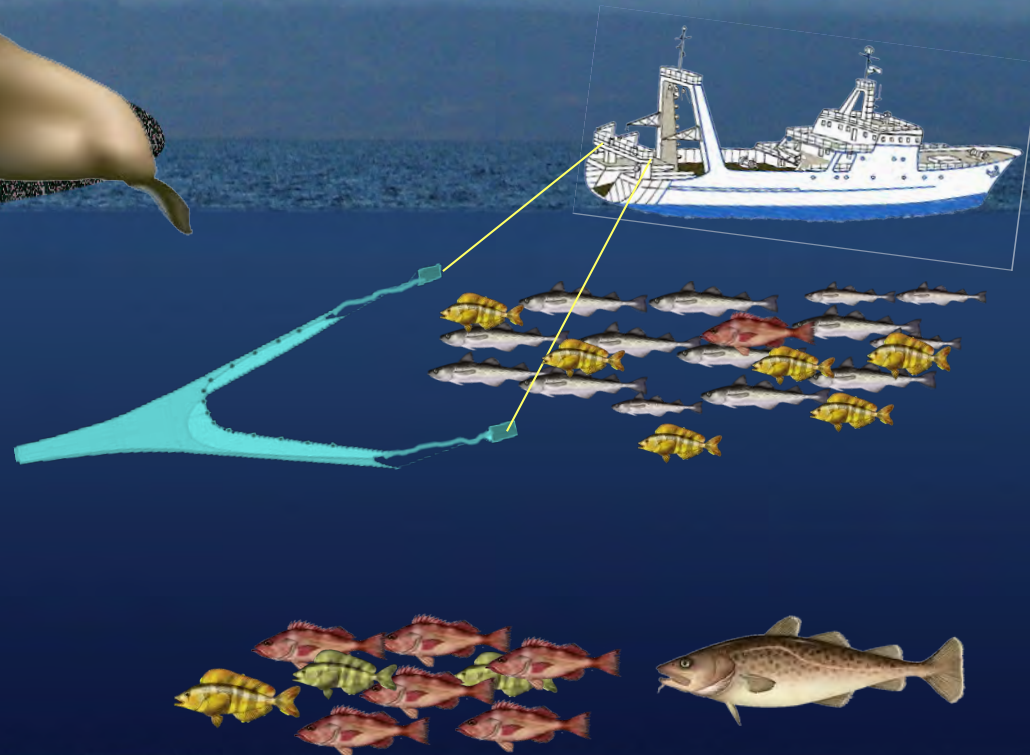
- Increases east to west.

Summary Ecosystem Scale

- Species composition changes from east to West (less Atka mackerel, more diverse West)
- Atka mackerel density decreases from East to West
- Northern rockfish density increases from East to West
- Atka mackerel and northern rockfish have different environmental variables influencing densities - different ecological niches
- Atka mackerel densities strongly related to current (current intensity decreases east to western passes)

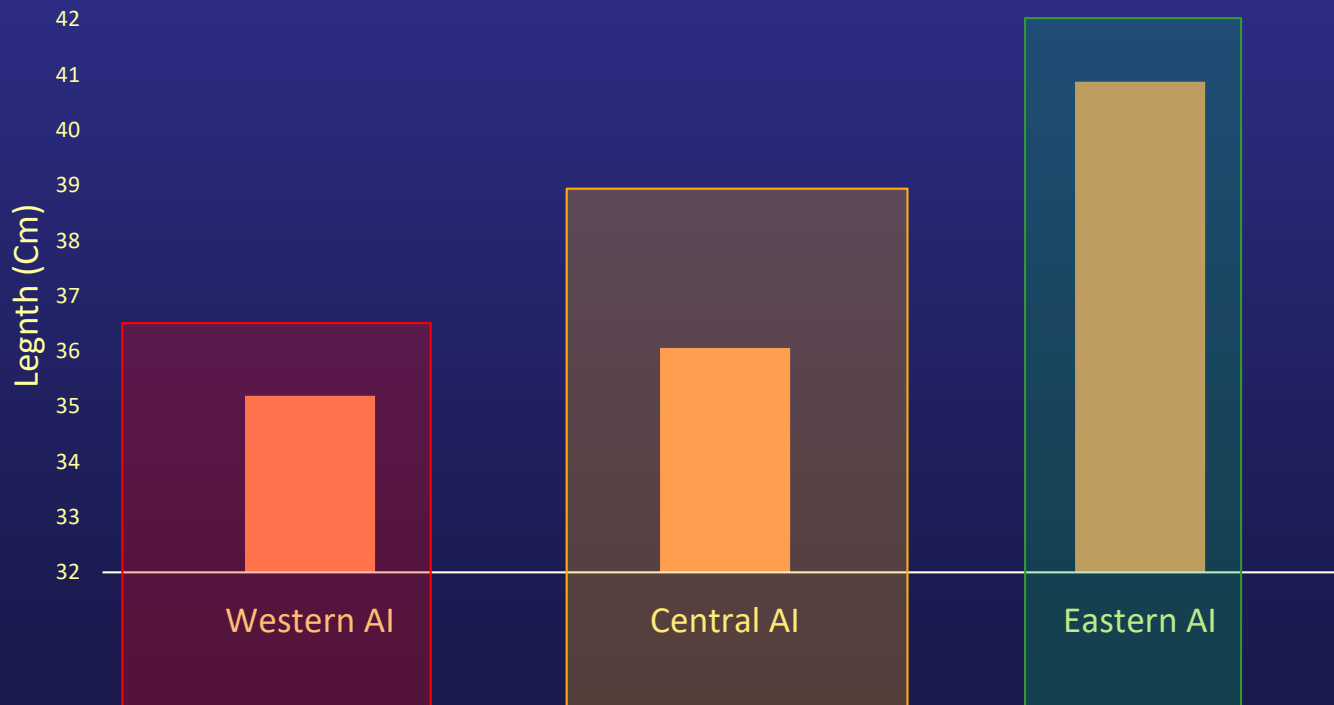
The Steller sea lion puzzle

Sea Lion Foraging Scale

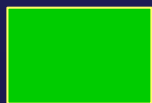
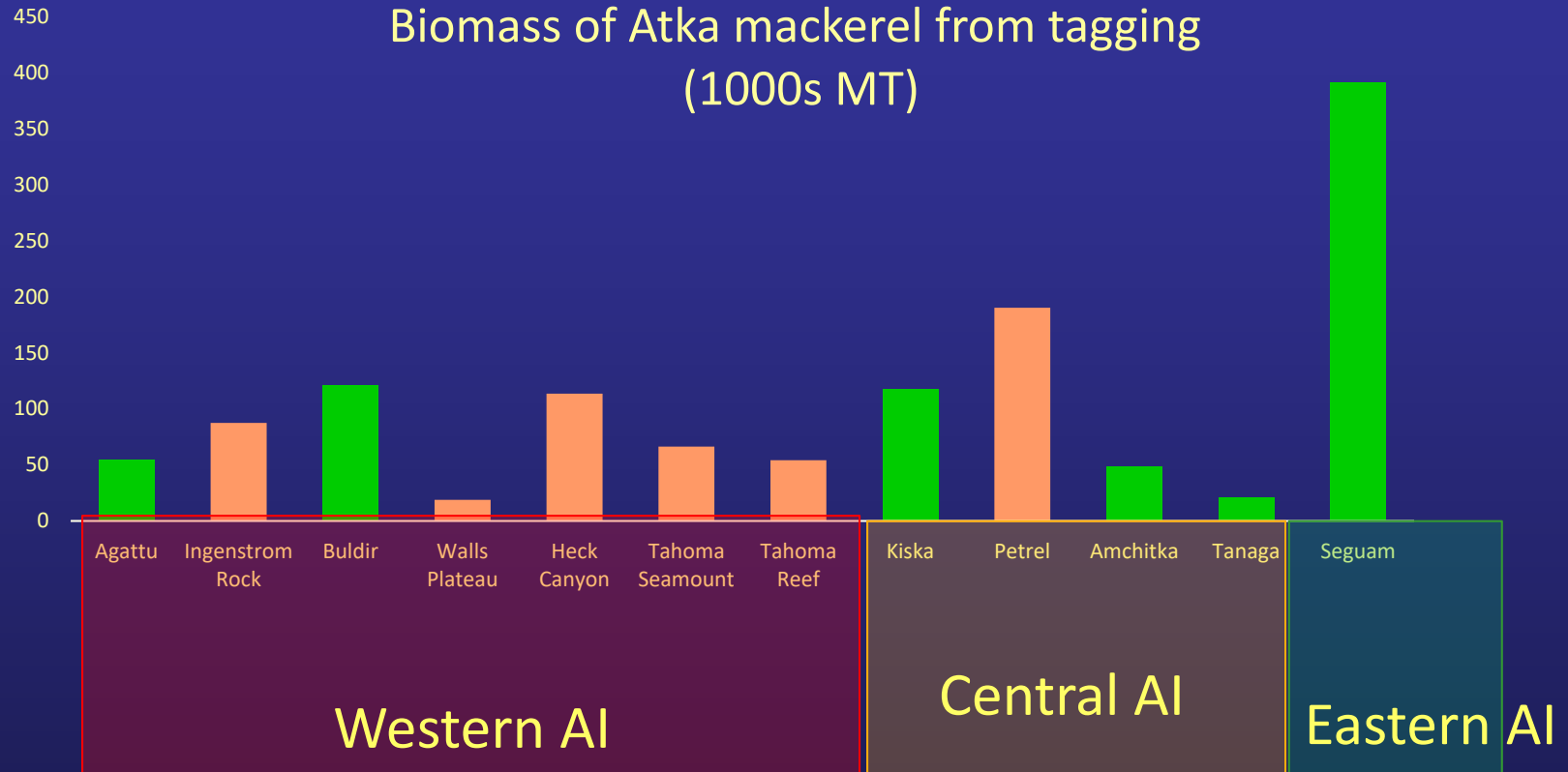


Atka mackerel Growth

Average Atka mackerel Length



Distance From Rookeries

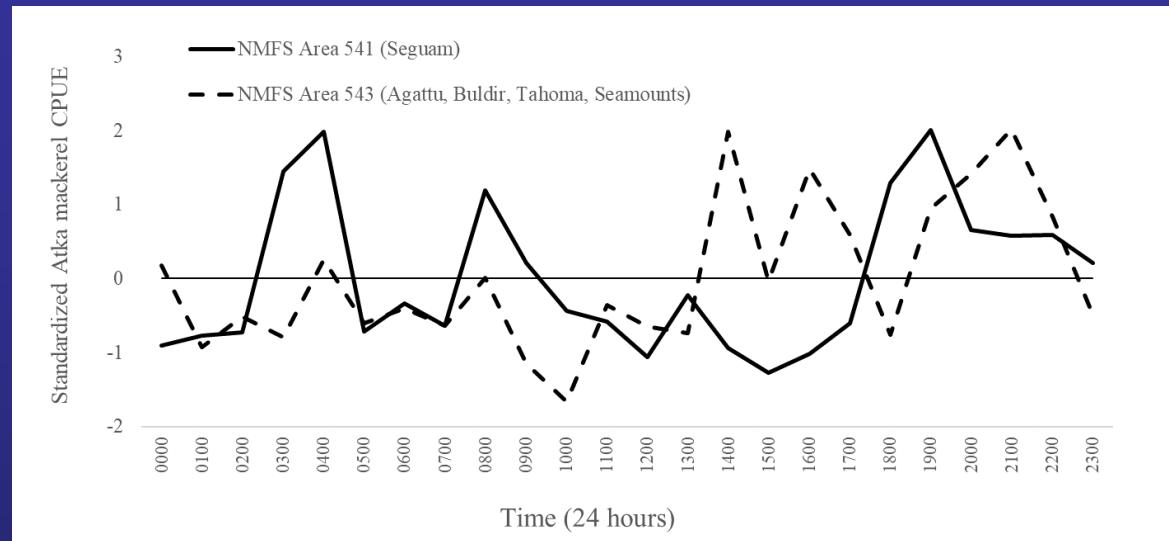


< 20 miles from rookeries



> 20 miles from rookeries

Atka mackerel diurnal Migration patterns



- High catch-per-unit-effort (CPUE)= Fish are aggregated on bottom
- Eastern Aleutians: High CPUE at night
- Western Aleutians: High CPUE during the day
- Sea lions forage mostly at night

Summary Sea lion foraging Scale

East



West

Large Atka mackerel size

Small Atka mackerel size

Aggregations close to rookeries

Far from rookeries















Atka mackerel on bottom at night

Atka mackerel on bottom during
the day

So What?



The Big Picture

	Eastern Aleutians	Western Aleutians
Atka mackerel abundance	~ similar to West 	~ similar to East 
Atka mackerel exploitation rate	7% 	4% 
Species Composition	90% Atka mackerel, 10% Rockfish 	40% Atka mackerel 45% Rockfish 
Relative species density	Atka mackerel high 	Atka mackerel low 
Atka mackerel size	Large 	Small 
Atka mackerel distance to rookeries	Close 	Far 
Atka mackerel diurnal patterns	Aggregated at night 	Aggregated during day 

The Big Picture



- Eastern Aleutians might be a more favorable place for Steller sea lions to forage
- Mitigation measures seem to work to limit exploitation rates
- Cautionary principle:
 - Fisheries interactions might have greater impact in Western Aleutians where foraging is more difficult

Thank You!



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