

# Western Steller Sea Lions in Alaska



National Marine  
Mammal Laboratory  
AFSC-NMFS

October 2007

## Participants, Contributors & Folks Who Did All the Work:

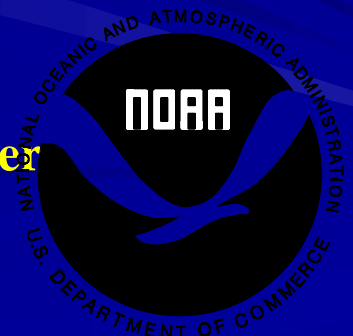
T. Gelatt, E. Kunisch, J. Laake, K. Sweeney & R. Towell, **NMML**

M. Lynn, J. Gilpatrick & W. Perryman, **SW Fisheries Science Center**

M. Nelson & N. Toth, **NOAA Aircraft Operations Center**

E. Holmes, **NW Fisheries Science Center**

G. Pendleton, **Alaska Department of Fish and Game**



# Aerial Survey Methods

## ■ Prior to 2004: 35 mm oblique

- Slides projected onto sheet of paper
- Animals marked and counted



## ■ 2004-06: Medium format (5 inch square) film

- Photos analyzed using dissecting microscope
- Age/sex classes marked with colored dots on acetate
- Manual count



## ■ 2007: MF and Digital

- Digital analyzed using Photoshop, hi-resolution monitors
- Age/sex classes marked with colored dots on screen
- Automatic count

# Comparison of 35mm and Medium Format Non-pup Counts

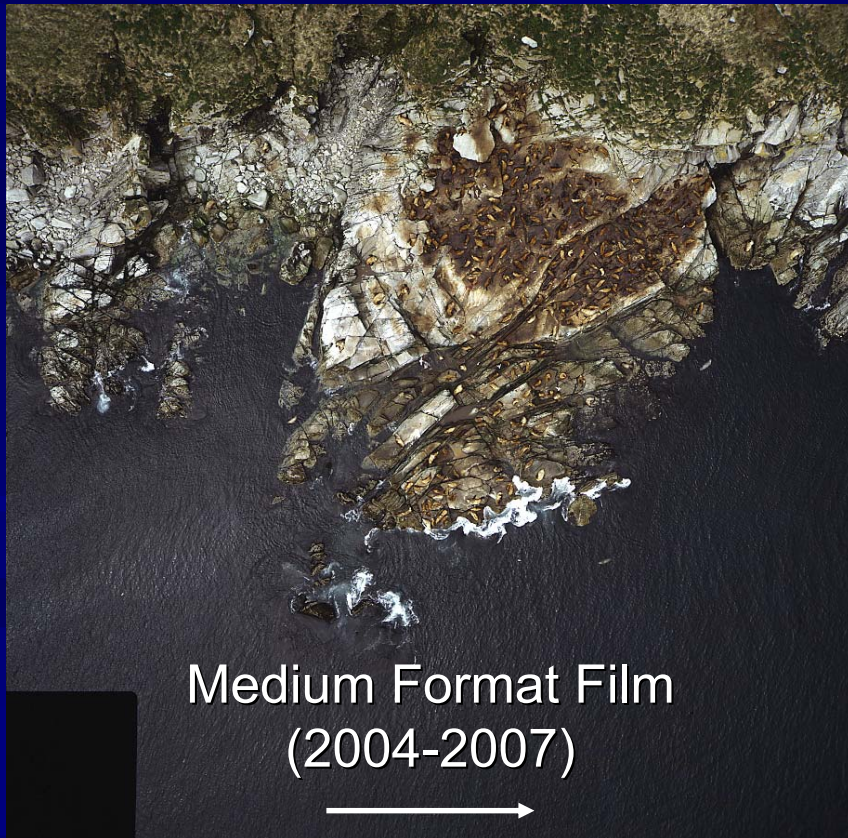
Location	Date	Time	Film Format		% Diff
			35 mm	Medium	
White Sisters	6/24/00	15:10	1,398	1,361	-2.61
SW Brother	6/28/00	18:12	1,499	1,461	-2.50
Jacob Rock	6/24/00	15:52	233	228	-1.94
Sea Lion Rock (Puffin)	6/24/00	16:38	212	213	0.71
Biali Rock	6/24/00	16:10	662	669	1.13
Lowrie I.	6/28/00	15:50	1,213	1,228	1.24
Sugarloaf I.	6/29/00	12:55	746	756	1.34
North Rock	6/28/00	15:35	1,202	1,221	1.58
Marmot I.	6/29/00	13:50	699	720	3.08
Seal Rocks (PWS)	6/24/00	10:30	820	846	3.23
Fish I.	6/24/00	10:10	408	421	3.31
Hazy I.	6/28/00	17:18	1,824	1,885	3.34
East Rock	6/28/00	15:43	193	203	5.45
Cape Ommaney	6/24/00	16:54	289	305	5.72
Cape Addington	6/28/00	16:26	1,116	1,180	5.73
Outer I.	6/29/00	11:37	308	328	6.67
Timbered I.	6/28/00	16:50	267	287	7.69
Sea Lion Rock	6/28/00	15:25	507	557	9.86
Graves Rock	6/24/00	14:25	492	558	13.53
West Rock	6/25/00	11:24	625	732	17.21
<b>Total</b>			<b>14,706</b>	<b>15,159</b>	<b>3.08</b>
<b>Average of site by site % differences</b>					<b>4.19</b>
<b>Average</b>					<b>3.64</b>



# Atkins Rookery Western Gulf of Alaska Alaska



Oblique 35mm  
(1975-2002)



Medium Format Film  
(2004-2007)



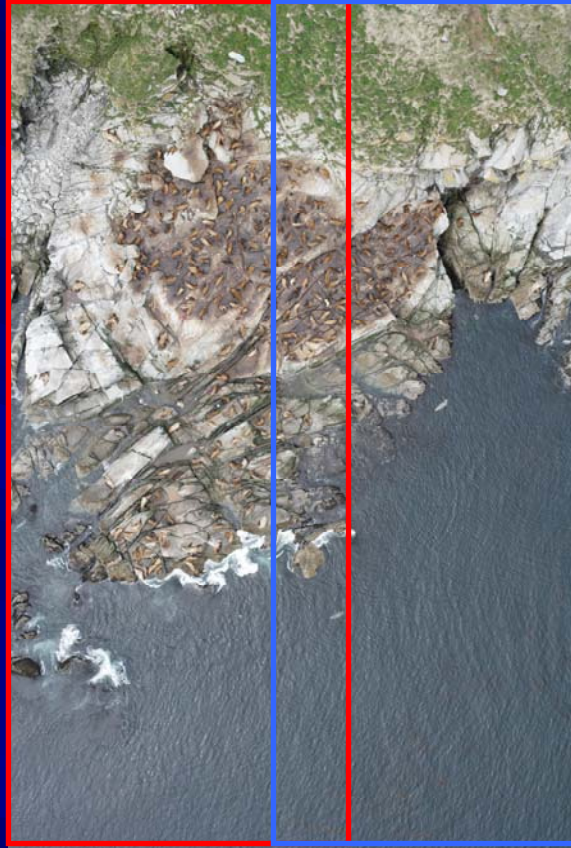
Digital with  
50mm Lens  
(2007)



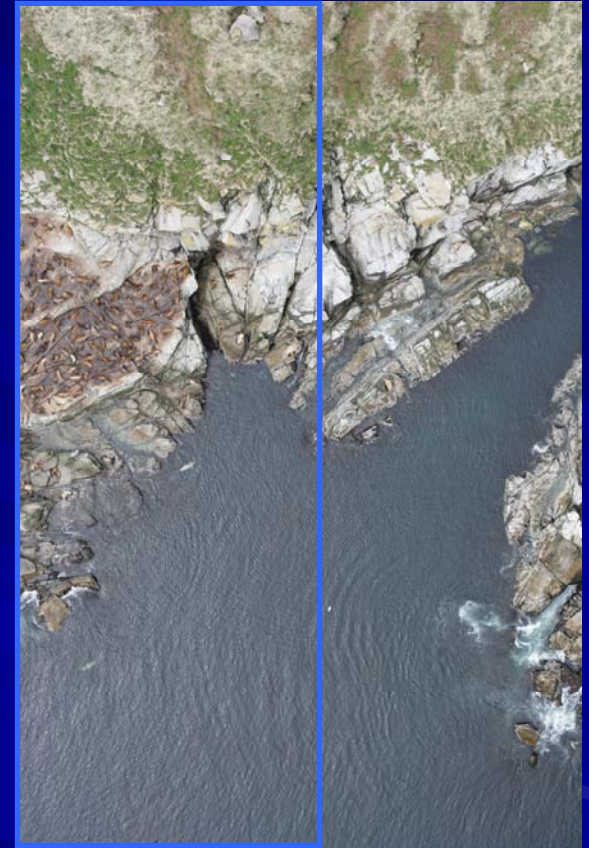
# Digital 50mm Lens 60% Overlap



Frame 6652



Frame 6653



Frame 6654



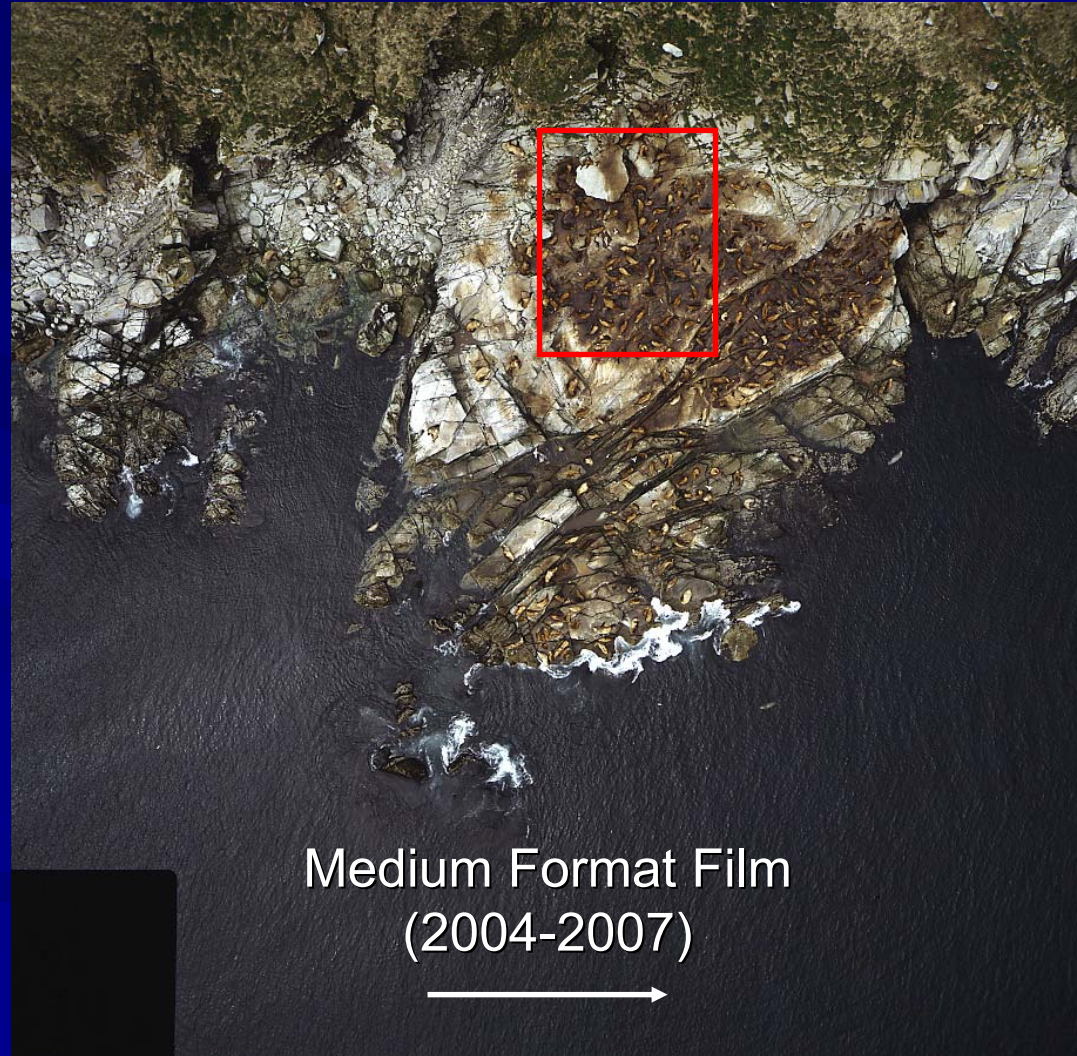
# Identifying Animals



- Bulls
- Sub-Adult Males
- Females
- Juveniles
- Pups



# Counting Atkins

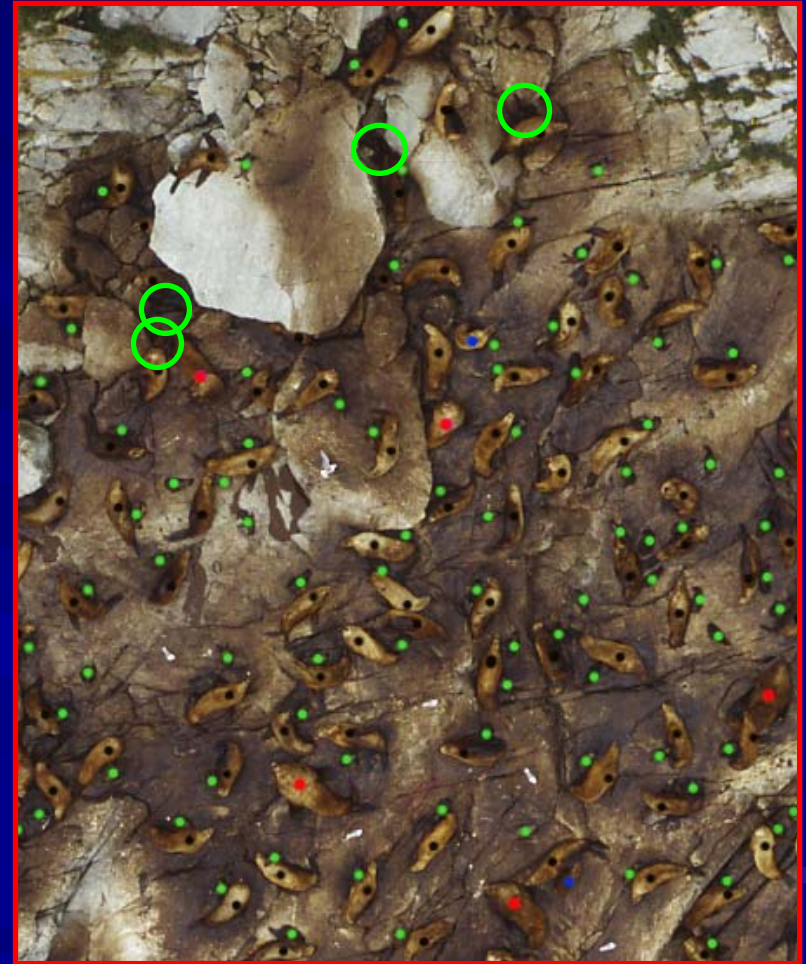




# Counted Images



Digital with 50mm Lens  
(2007)



Medium-Format Film  
(2004-2007)



# The Future of Rookeries



Atkins Rookery (WGOA)  
Digital with 50mm Lens



Yunaska Rookery (CAI)  
Digital with 85mm Lens

# Measuring Sea Lions off Oblique 35mm

(Fraction Juvenile from 1975-2002)





# Example of 2007 Aerial Survey Results

Site Name	Region	Counter One		Counter Two	
		Digital	Film	Digital	Film
Glacier	EGOA	521	529	541	532
Seal Rocks	EGOA		807		798
Sugarloaf	CGOA	660		656	
Sea Otter	CGOA	99	99	100	100
Chernabura	WGOA	1214	1220	1254	1225
Atkins	WGOA	575	588	587	583
Amak+Rocks	EAI	209		207	
Yunaska	CAI		274		275
⋮	⋮	<b>Number of Adults and Juveniles</b>			
⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮

# Statistical Comparisons

Counter	Media	n	t-value	Probability
One	Film & Digital	45	0.16	0.88
Two	Film & Digital	45	0.97	0.35
One & Two	Digital	95	1.50	0.14
One & Two	Film	62	1.61	0.12

Difference between Media Types

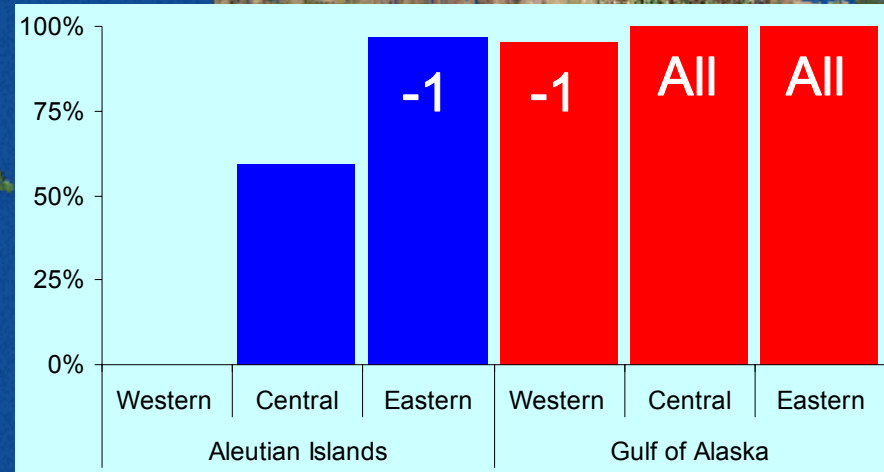
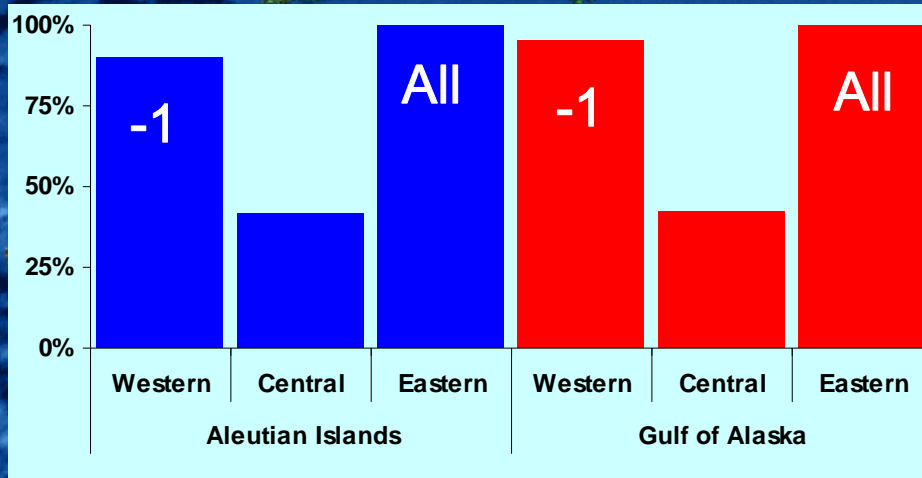
Is Less than Difference between Counters

But None of the Differences are Significant  
(all > 0.1)



# Proportion of Trend Sites Surveyed by Region

2004: 100%



2007

2006

Western Aleutian Islands

Central Aleutian Islands

Eastern Aleutian Islands

Western Gulf of Alaska

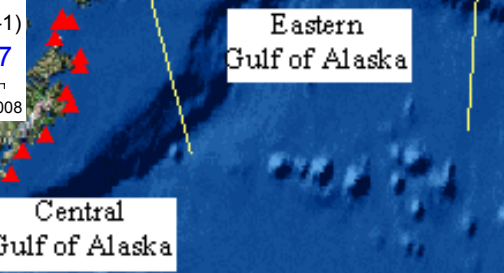
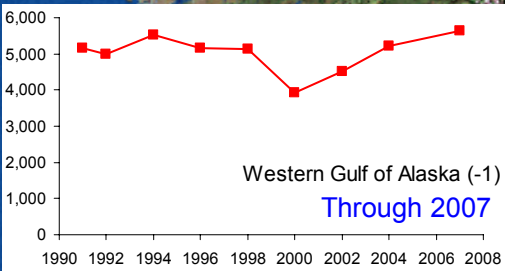
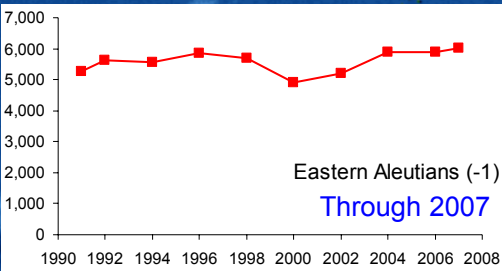
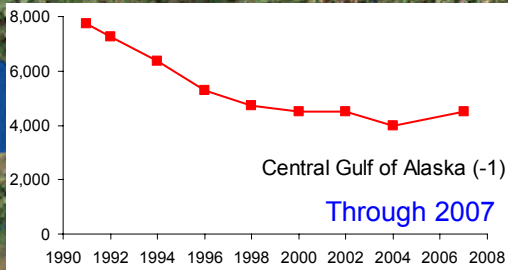
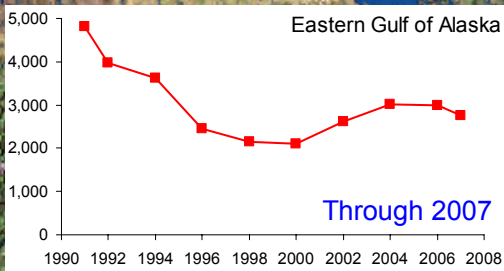
Central Gulf of Alaska

Eastern Gulf of Alaska

1990s Trend Sites N=161

# Western Steller Sea Lions – SubArea Trends

## Number of Adults and Juveniles



Western Aleutian Islands

Central Aleutian Islands

Eastern Aleutian Islands

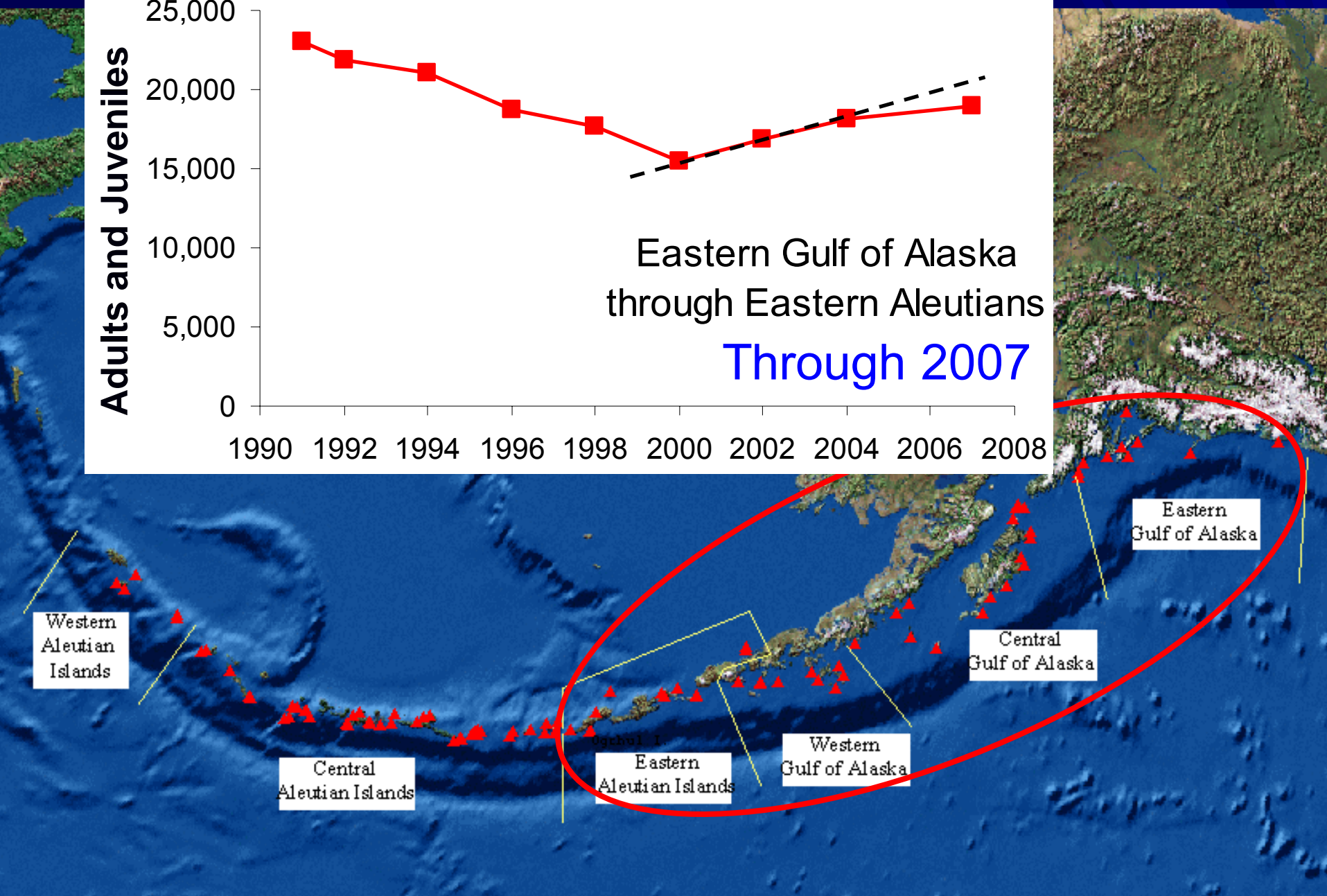
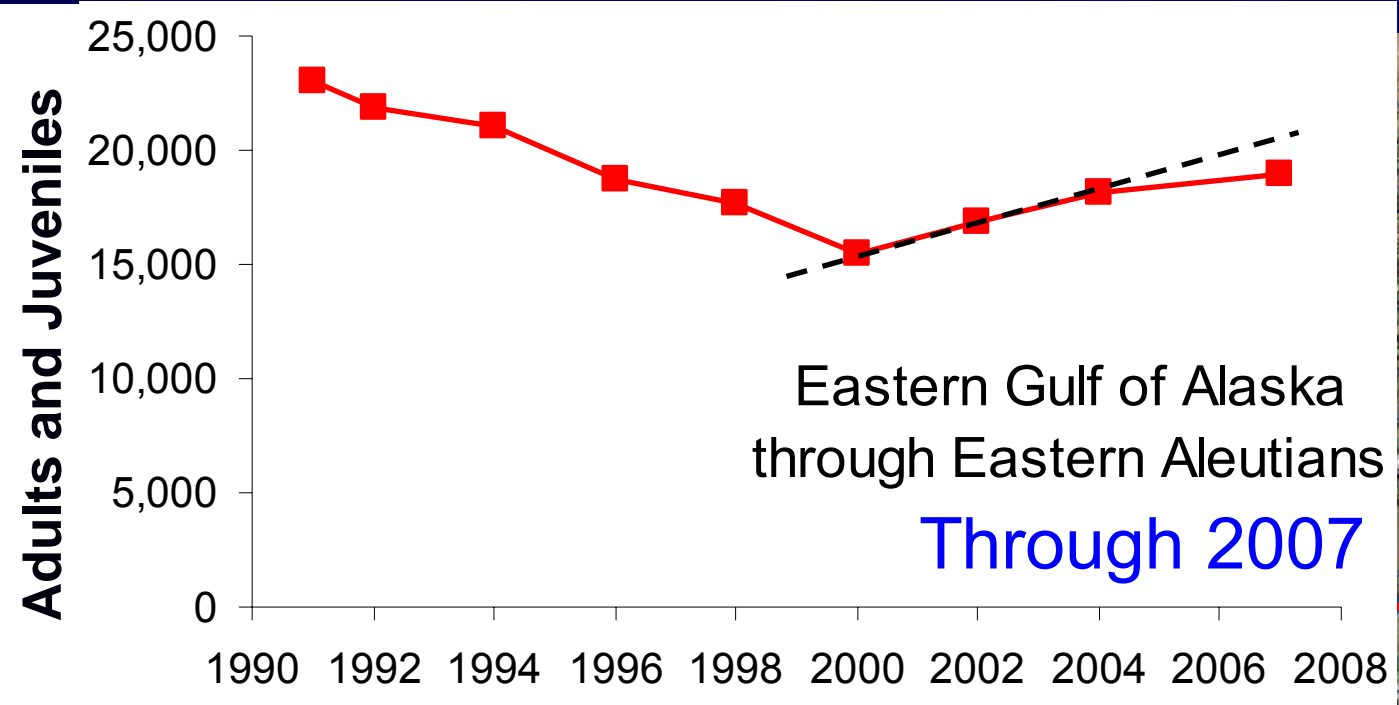
Western Gulf of Alaska

Central Gulf of Alaska

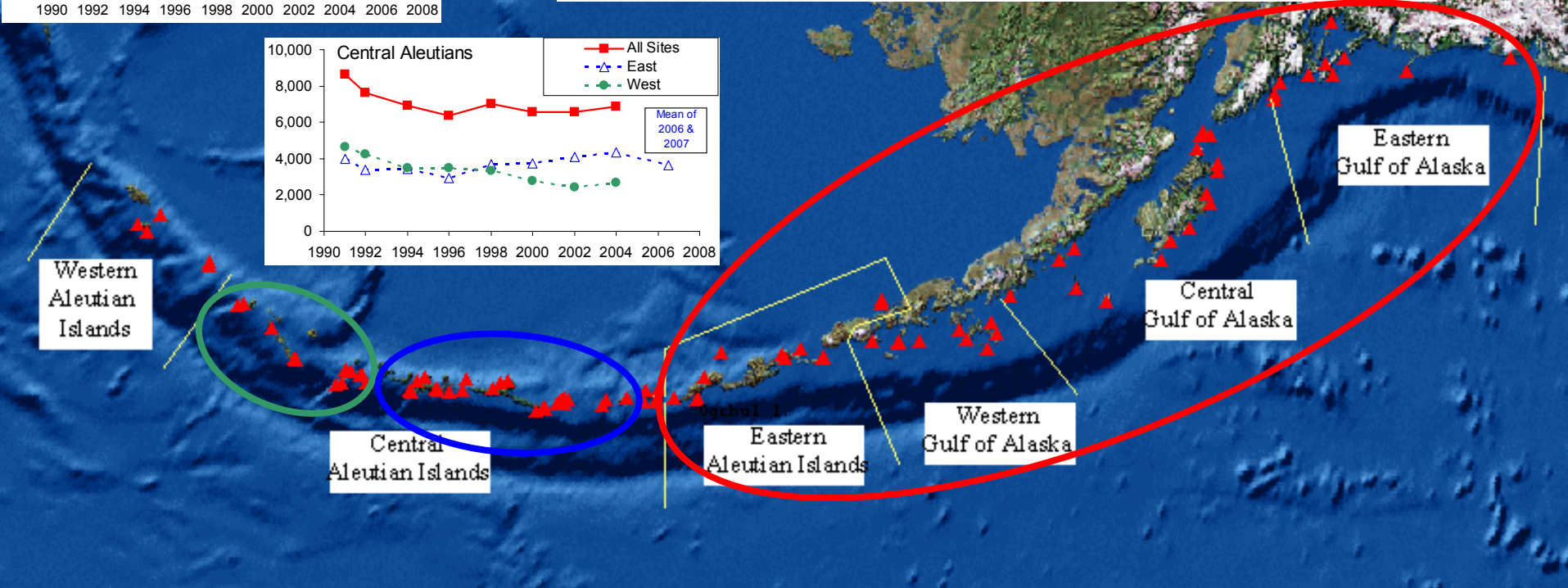
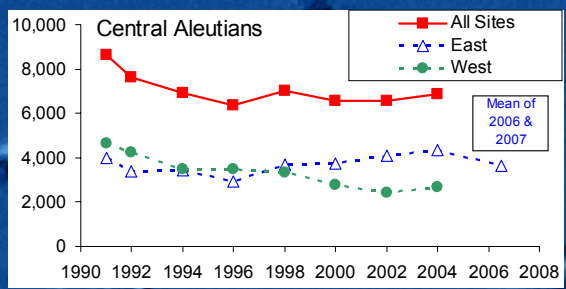
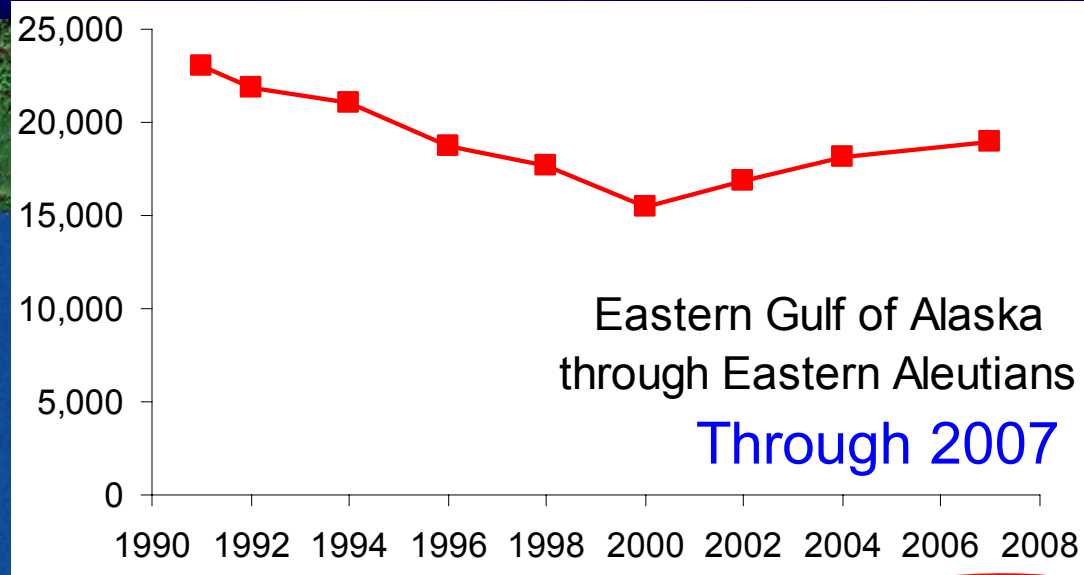
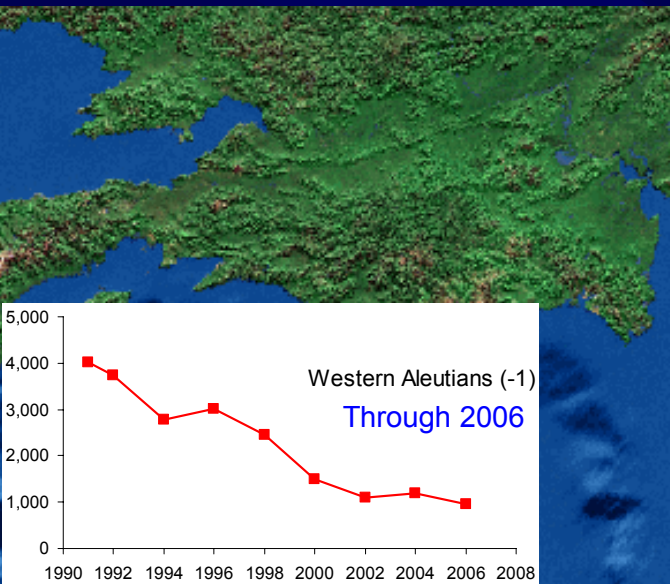
Eastern Gulf of Alaska



# Western Steller Sea Lions – SubArea Trends



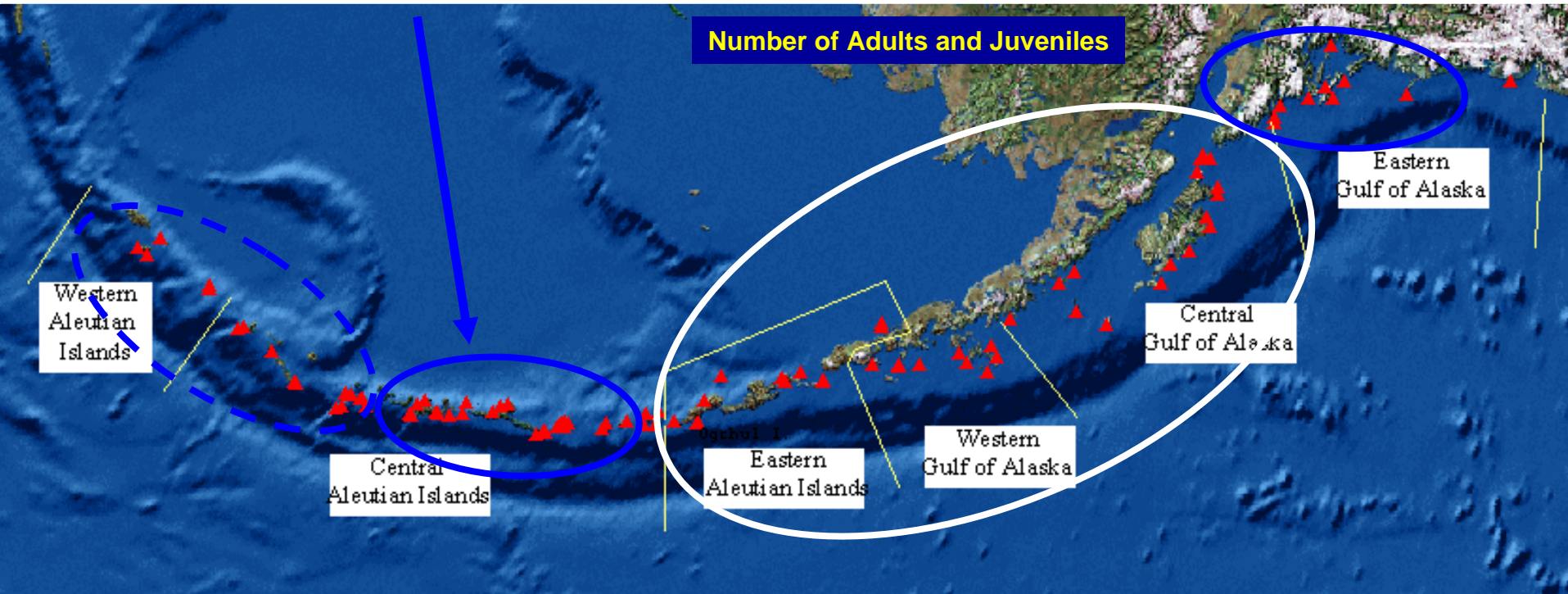
# Western Steller Sea Lions – SubArea Trends





# Western Steller Sea Lions – SubArea Trends

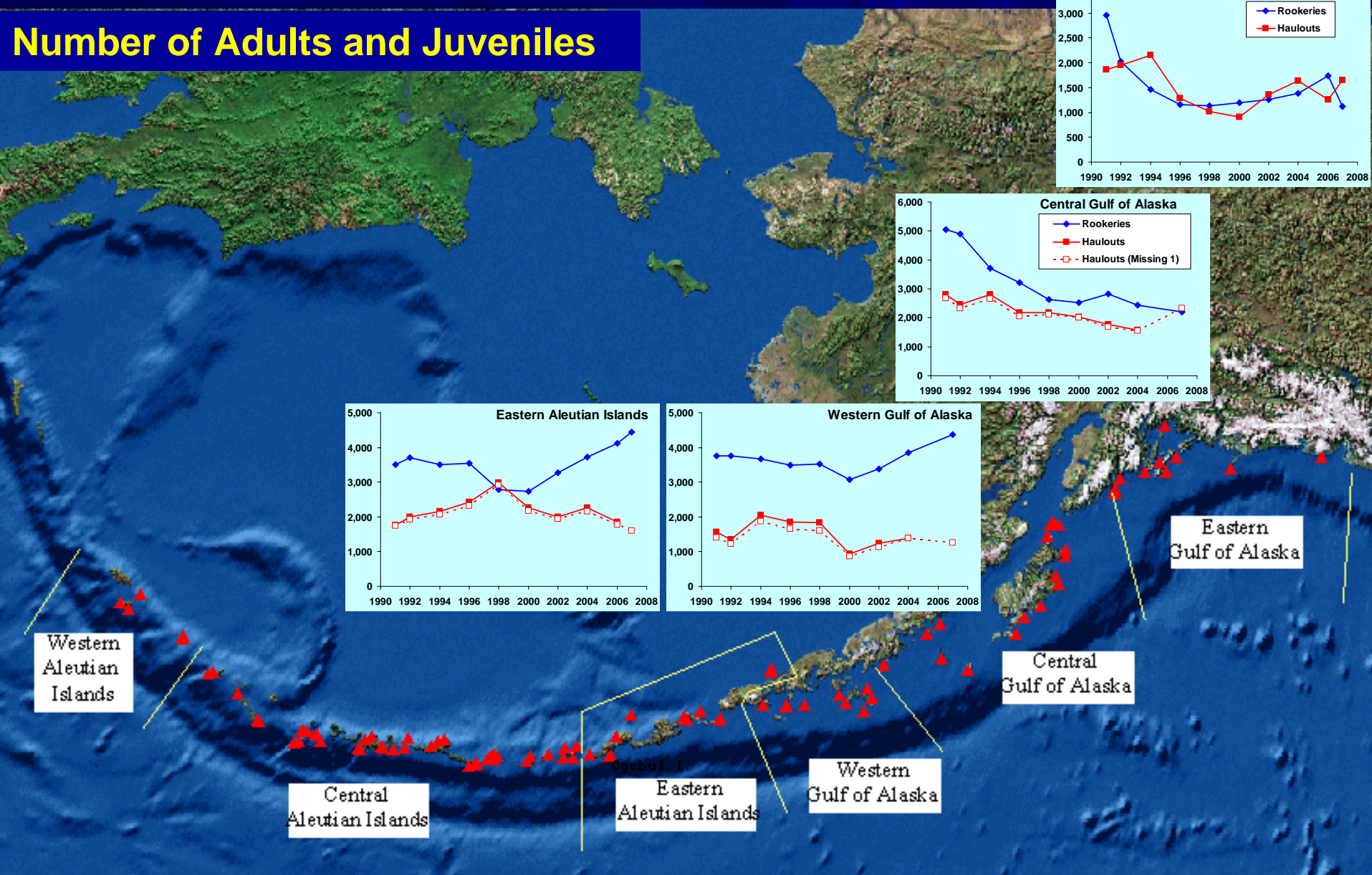
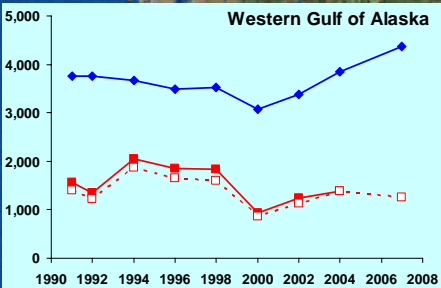
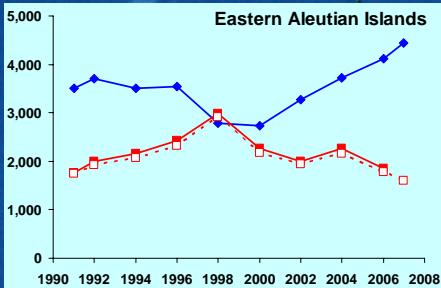
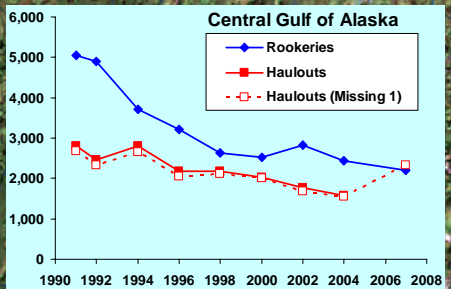
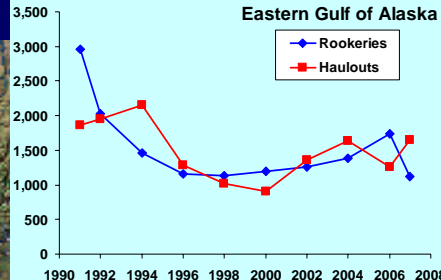
Year	Aleutian Islands			Gulf of Alaska			Total
	Western No Buldir	Central East Only	Eastern No C Aslik	Western No Kak	Central No Long	Eastern All	
2004	1,227	4,318	6,098	5,414	4,148	3,129	23,107
2006	997		6,186			3,218	
2007		3,460	6,261	5,845	4,688	2,865	23,118
Diff		- 858	163	431	540	- 265	11





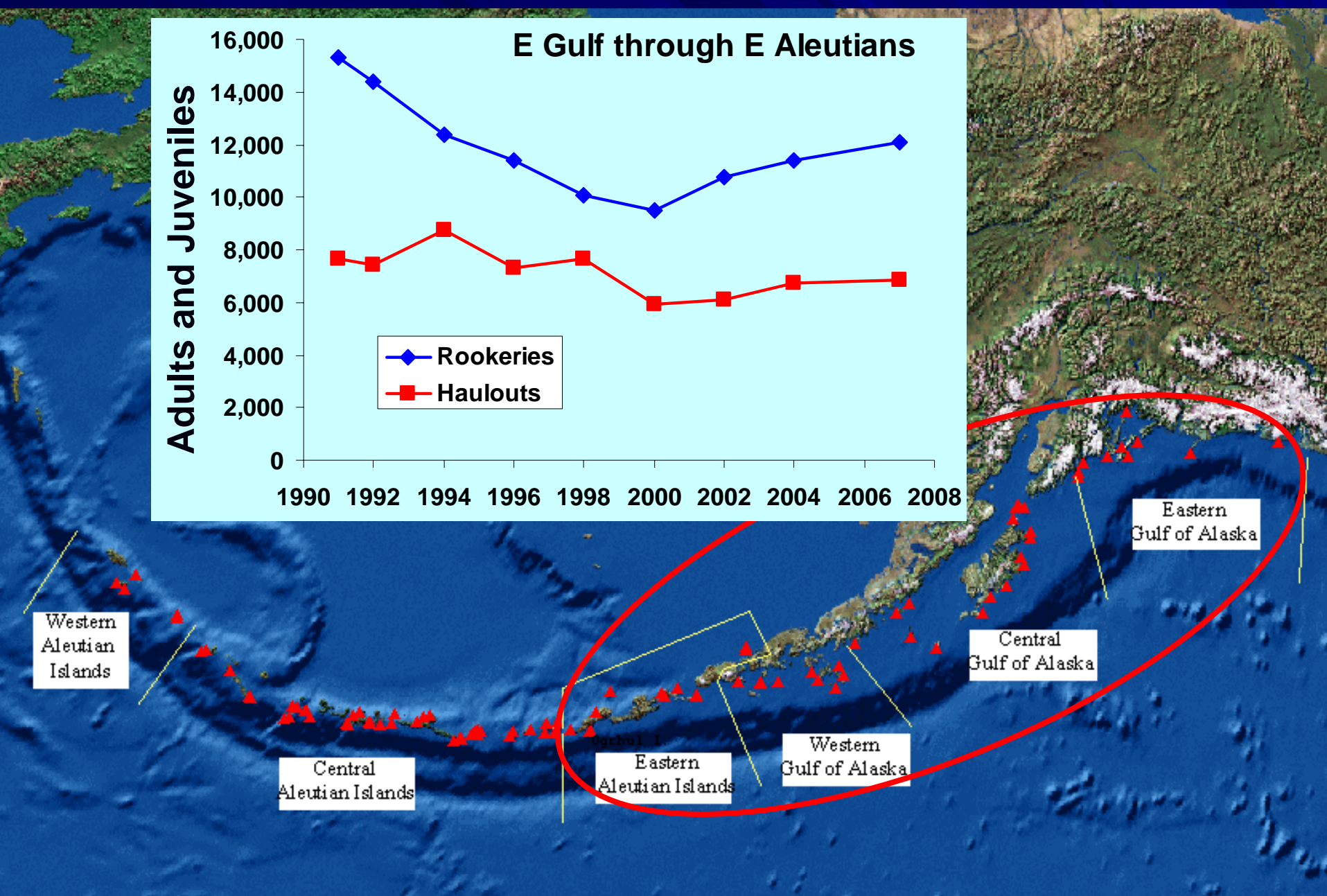
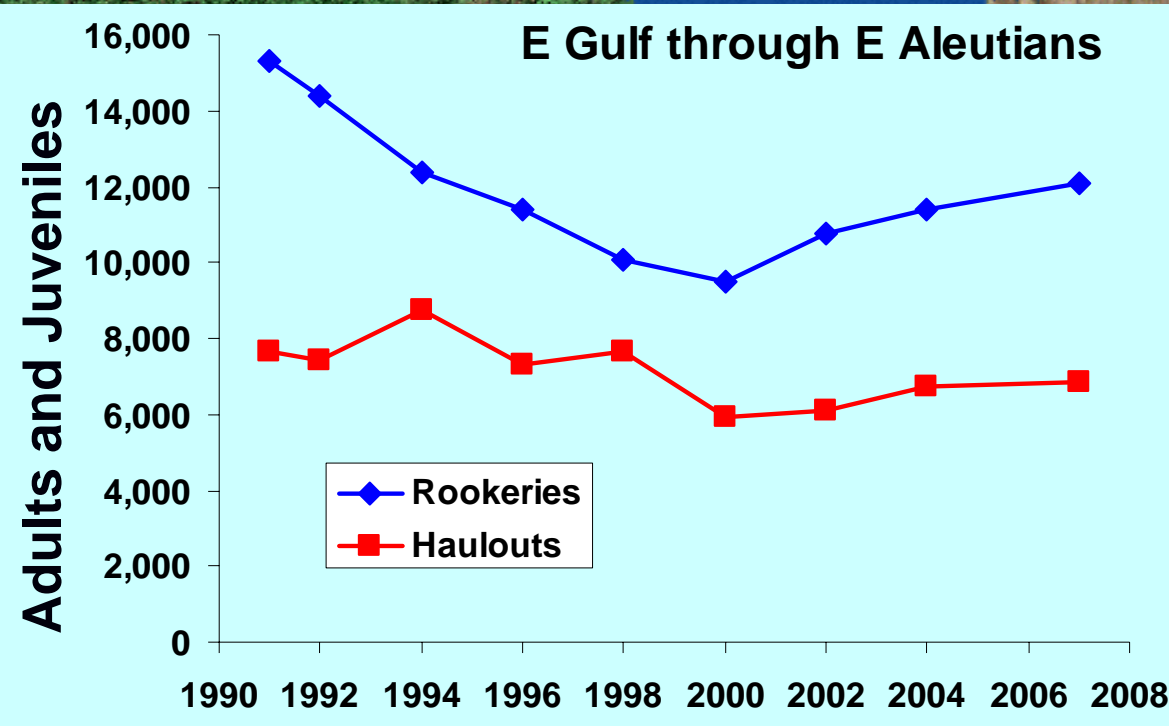
# wSSLs – Rookery vs. Haul-outs Trends

## Number of Adults and Juveniles

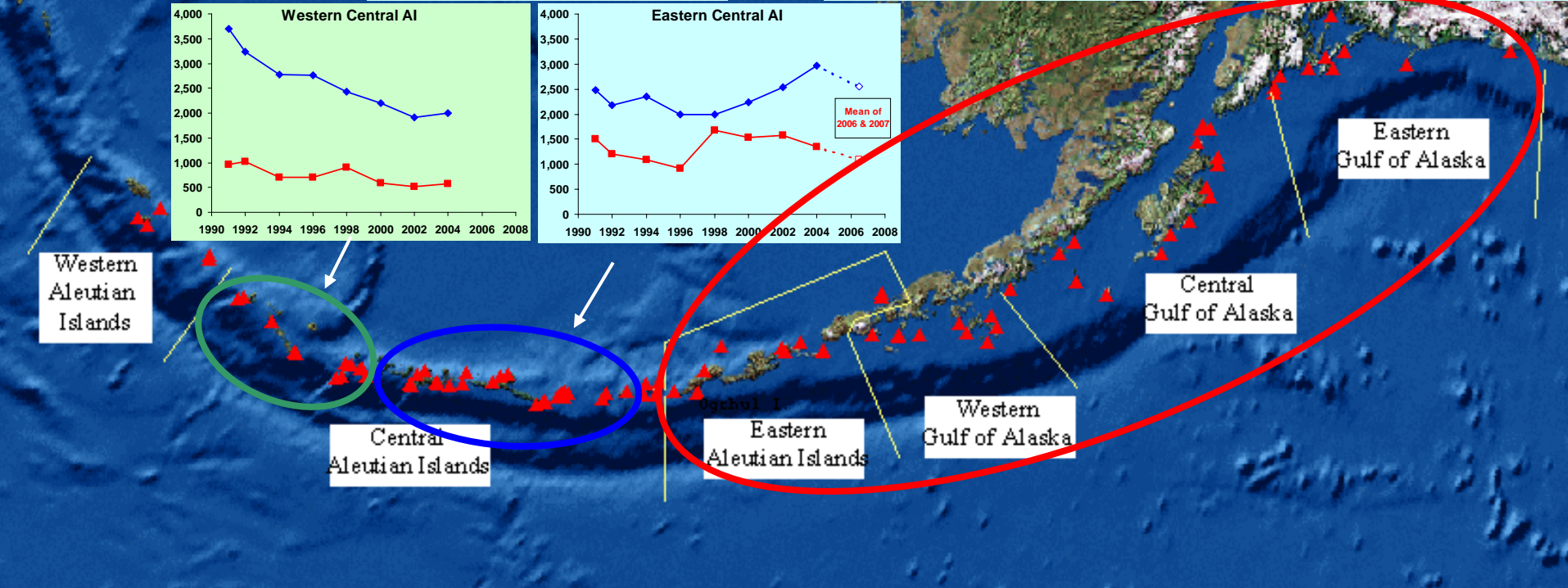
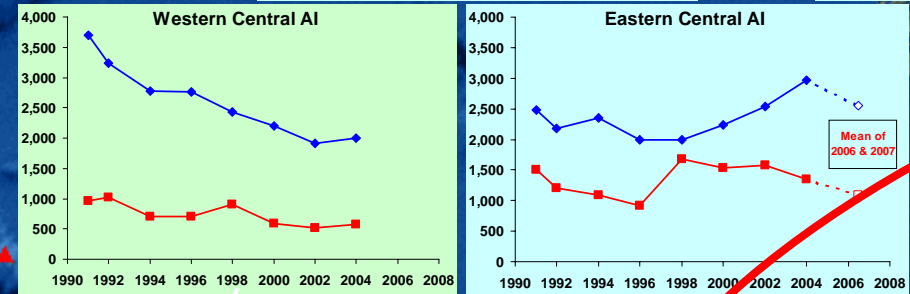
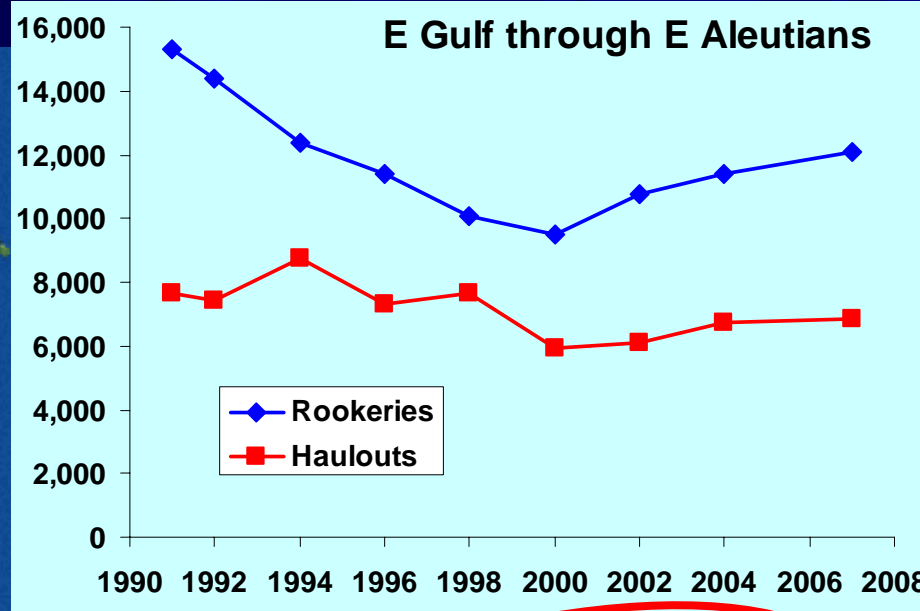
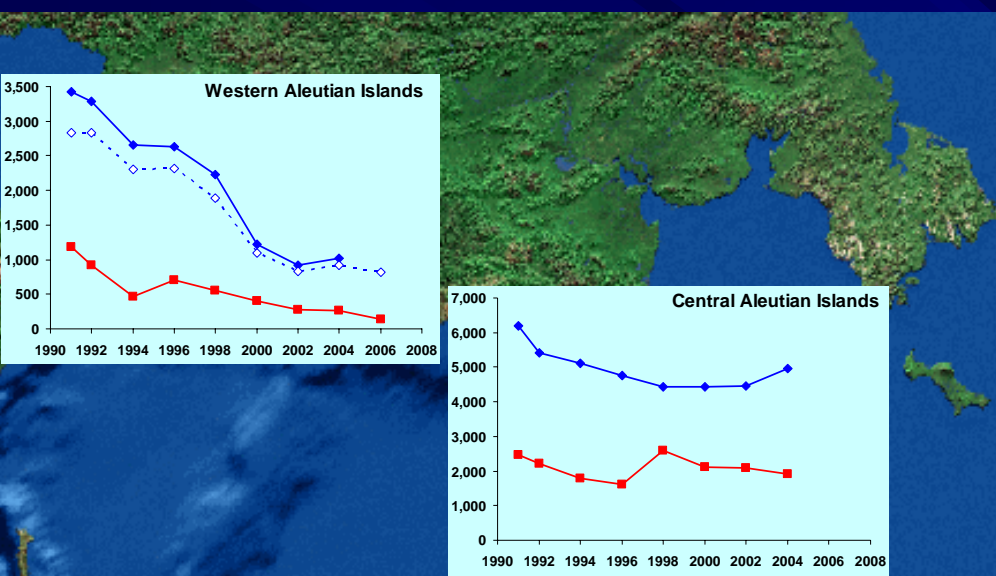




# wSSLs – Rookery vs. Haul-outs Trends



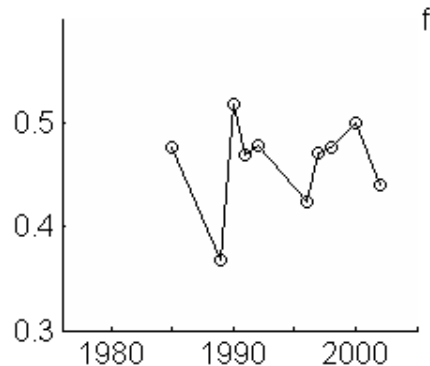
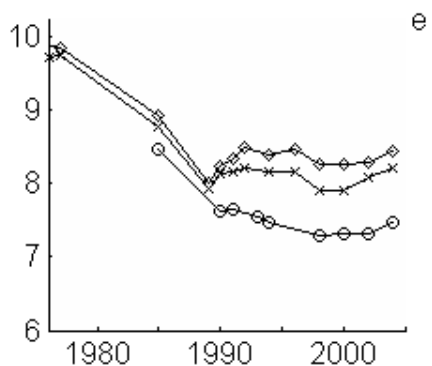
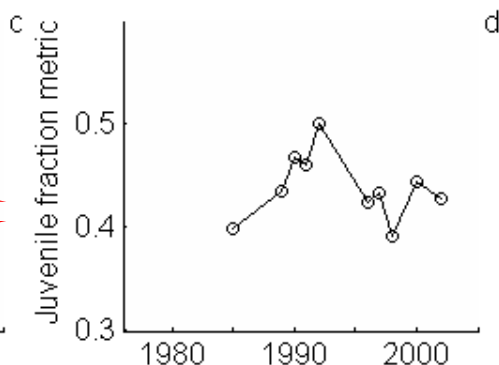
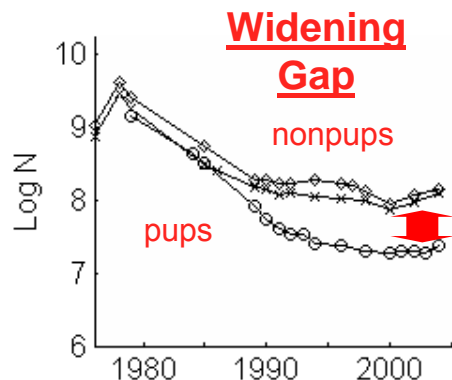
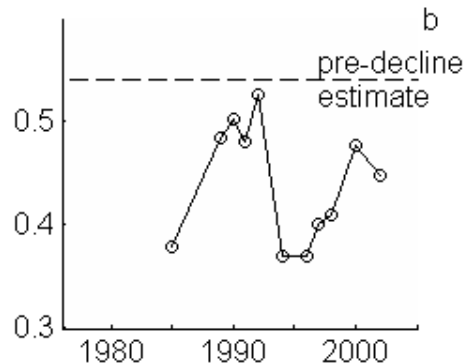
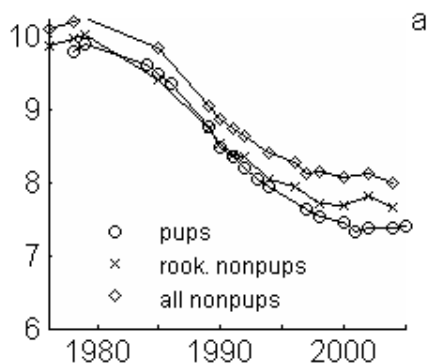
# wSSLs – Rookery vs. Haul-outs Trends





## Pups and NonPups

## Juvenile Fraction



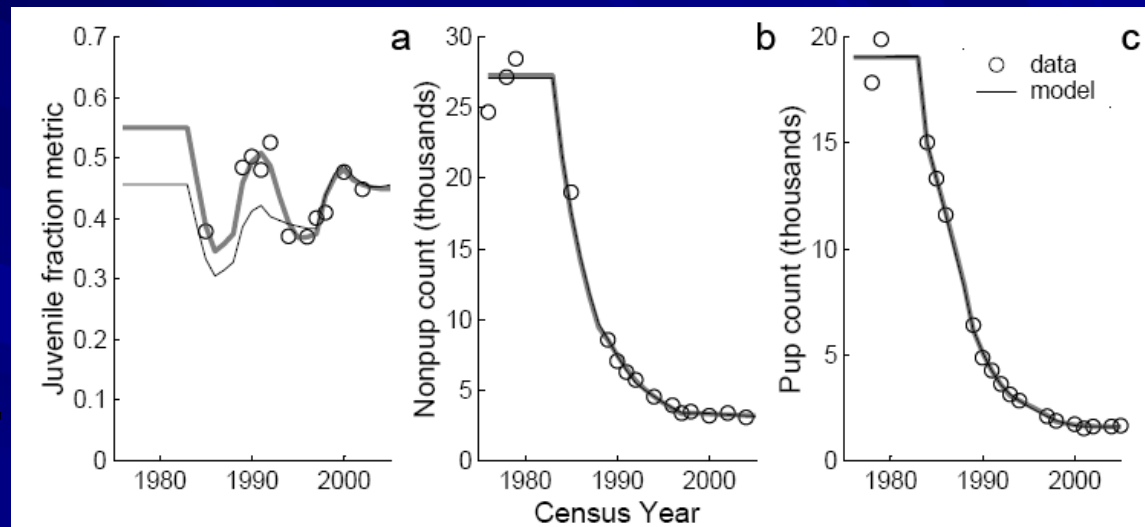
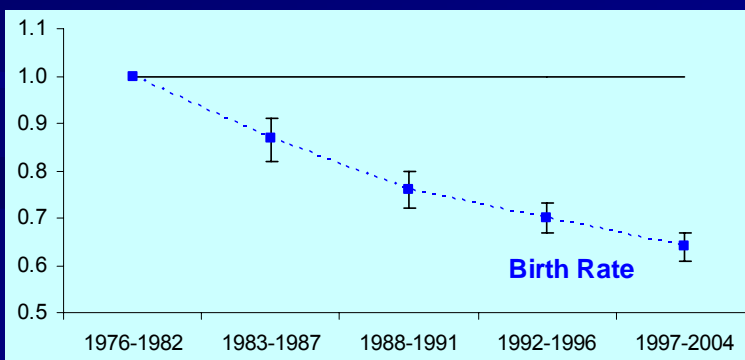
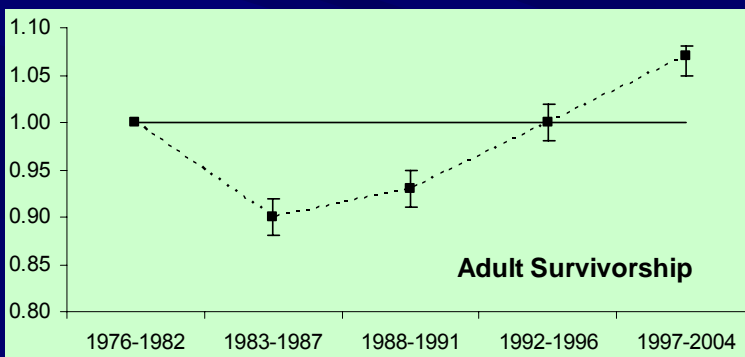
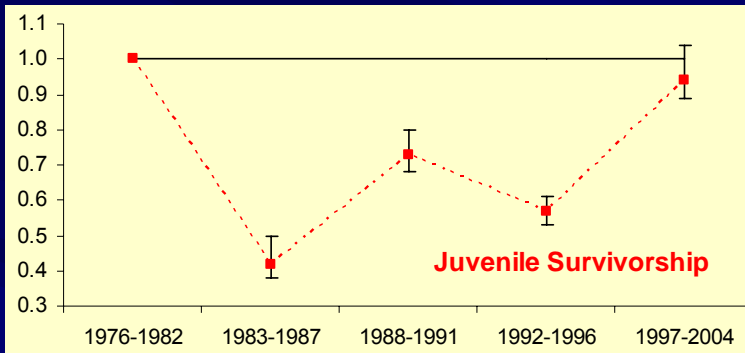
Central Gulf of Alaska

Western Gulf of Alaska

Eastern Aleutians

# Central Gulf of Alaska Survivorship and Natality

- Pup/Non-pup Counts
- Size Distribution on Haulouts



Holmes, Fritz, York, and Sweeney.  
Dec 2007 Ecological Applications



# Vital Rates Estimation

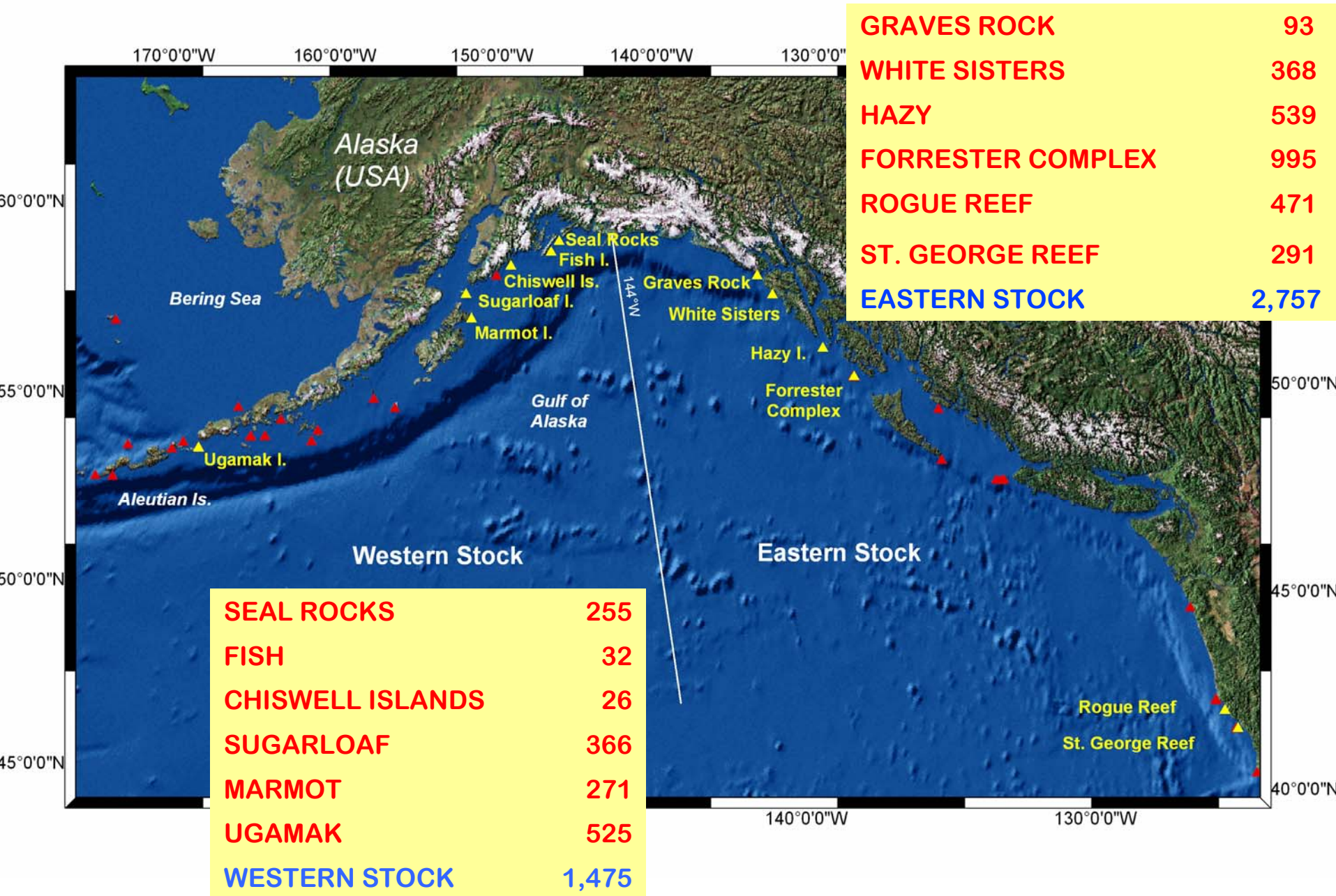
## Pup Branding Program

### ■ Objectives

- Survival and reproductive rates by age and area
- Western Stock
  - Marmot Island 1987-88: 751 pups
- Eastern Stock
  - Forrester Island 1994-95: 799 pups
- Since 2000, almost 6,000 pups have been branded
  - Western ~ 1,500
  - Eastern ~ 2,750
  - Asian ~ 1,700

A179 Resighted 17 May 2004  
At Ugamak, ~ 1 year old





**2000-2005 Pup Branding on Steller Sea Lion Rookeries in the US**



# Distribution of Sightings of Sea Lions Branded as Pups since 2000

## ■ Prince William Sound

- Seal Rocks
- Wooded (Fish) Island

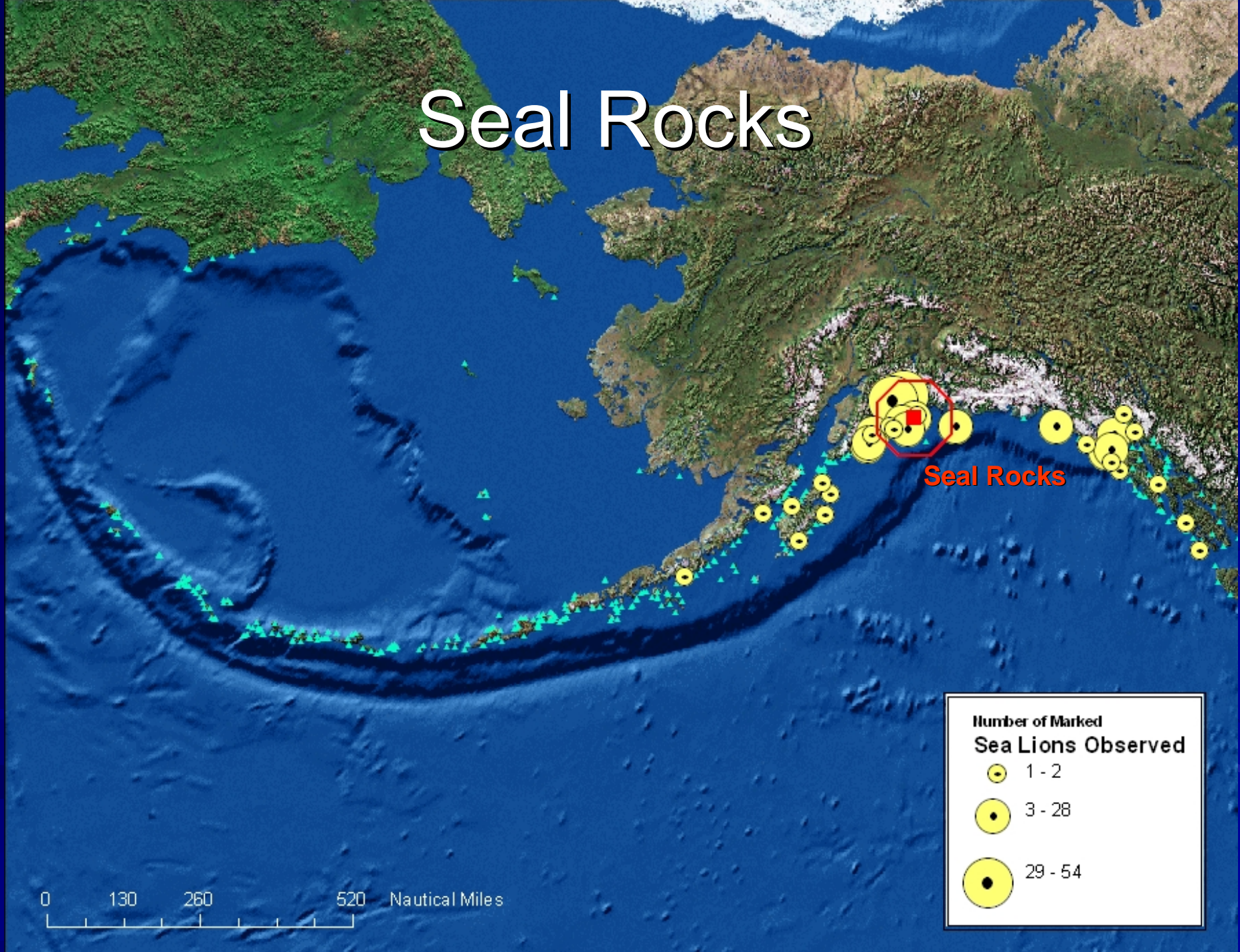
## ■ Kodiak/Barren Islands

- Sugarloaf Island
- Marmot Island

## ■ Eastern Aleutian Island (Unimak Pass)

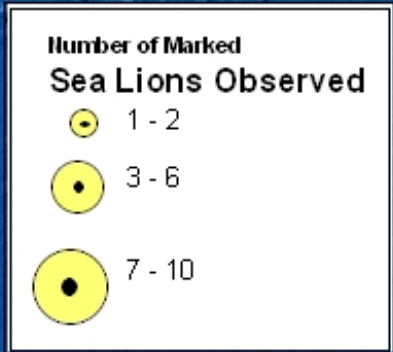
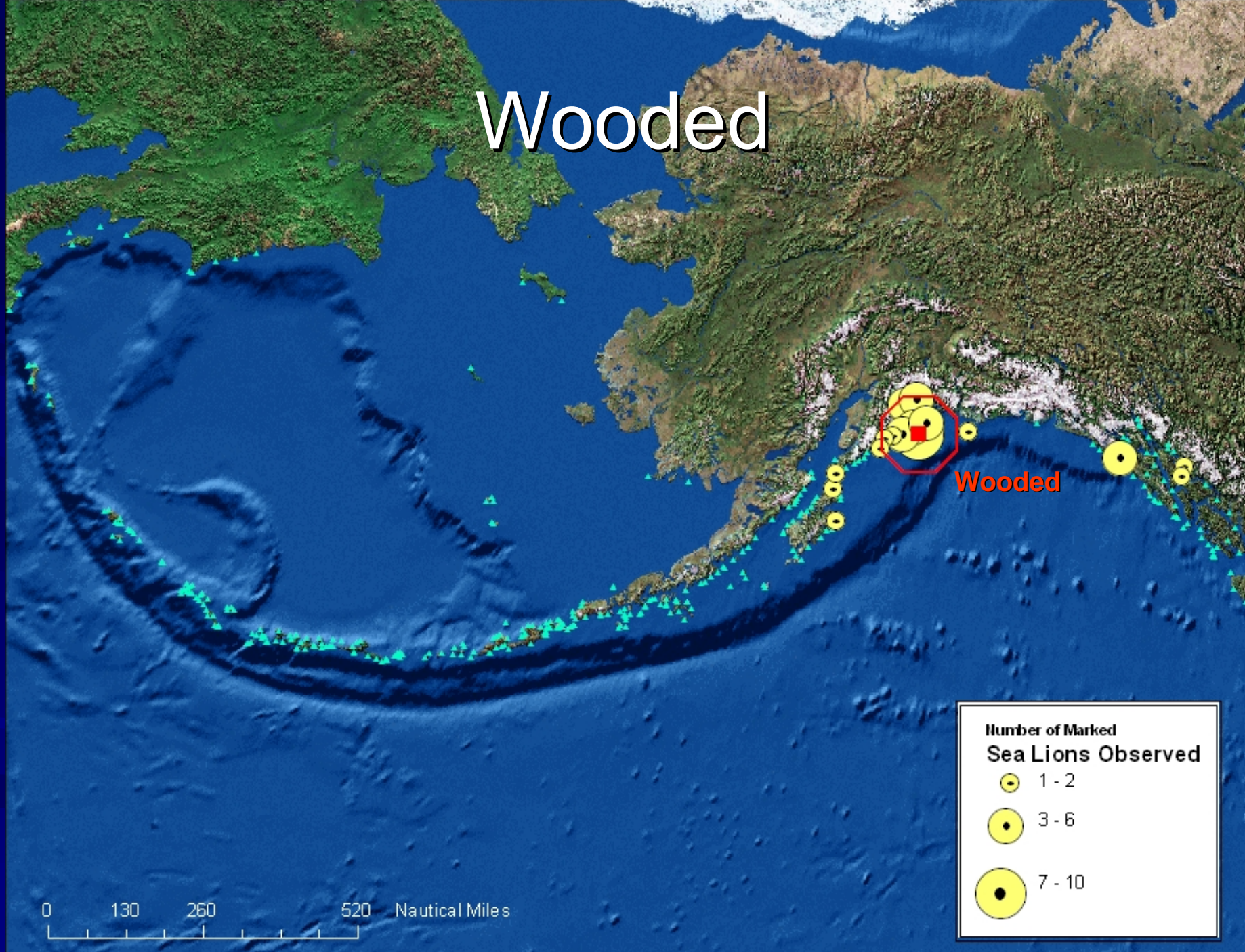
- Ugamak Island

# Seal Rocks



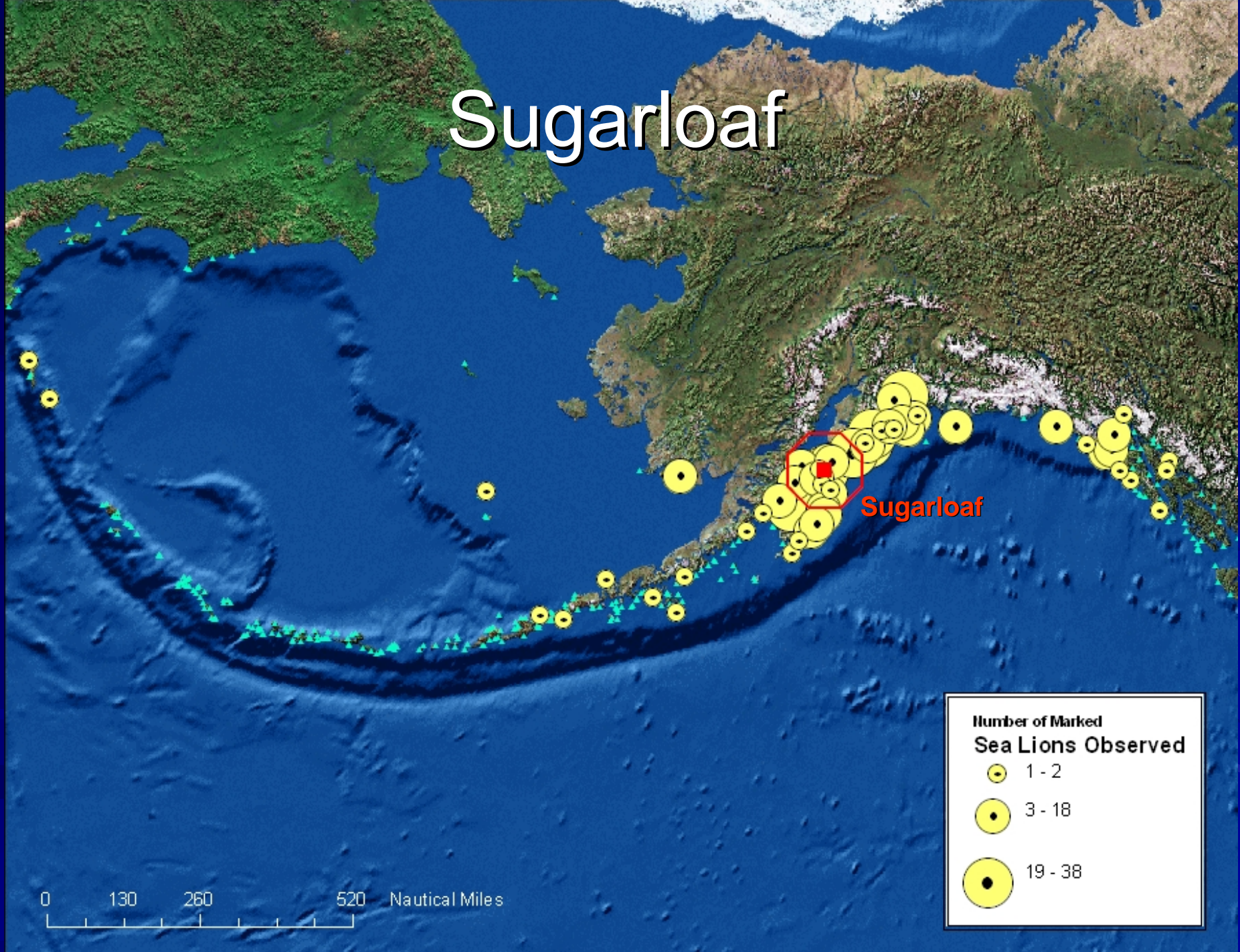


# Wooded



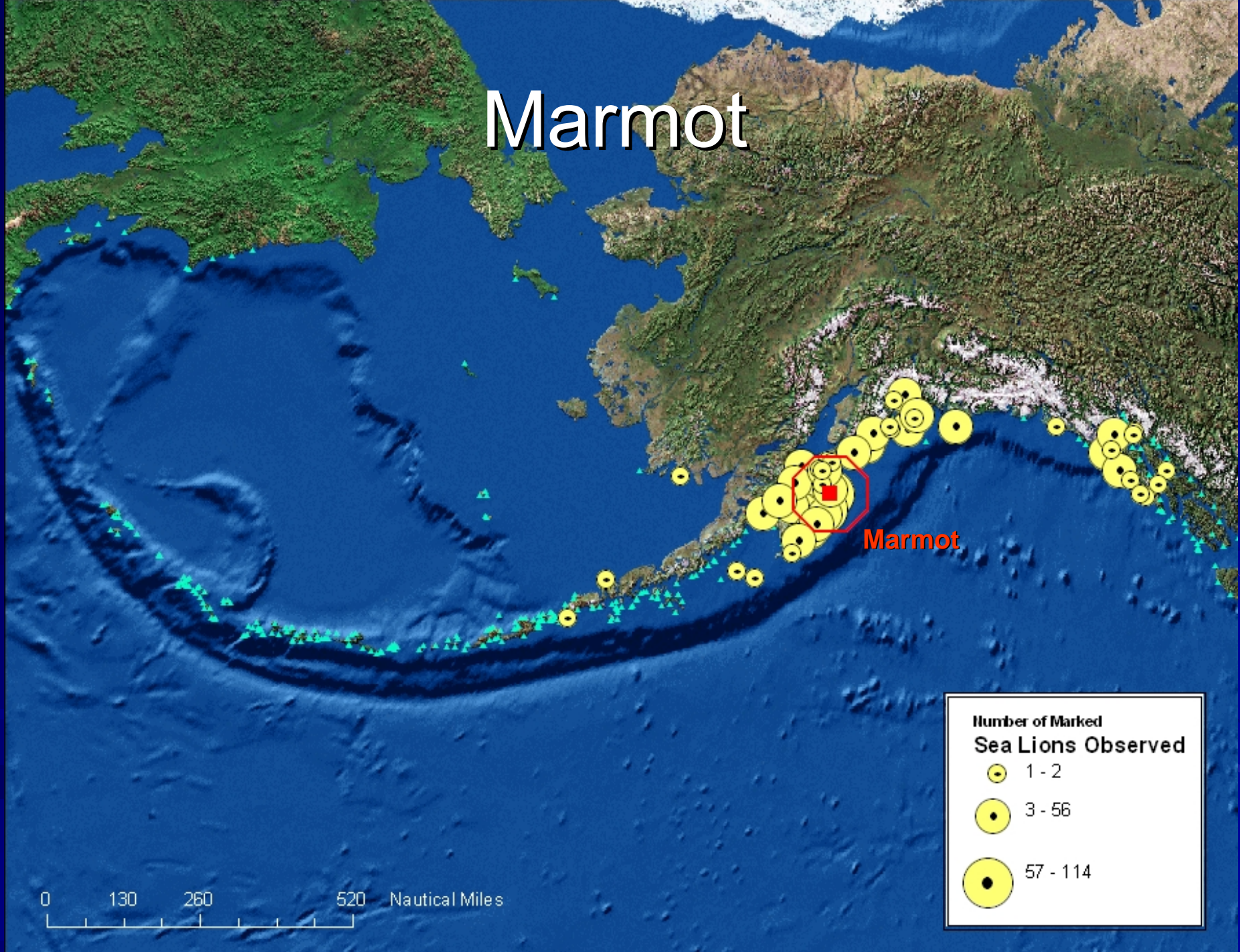


# Sugarloaf



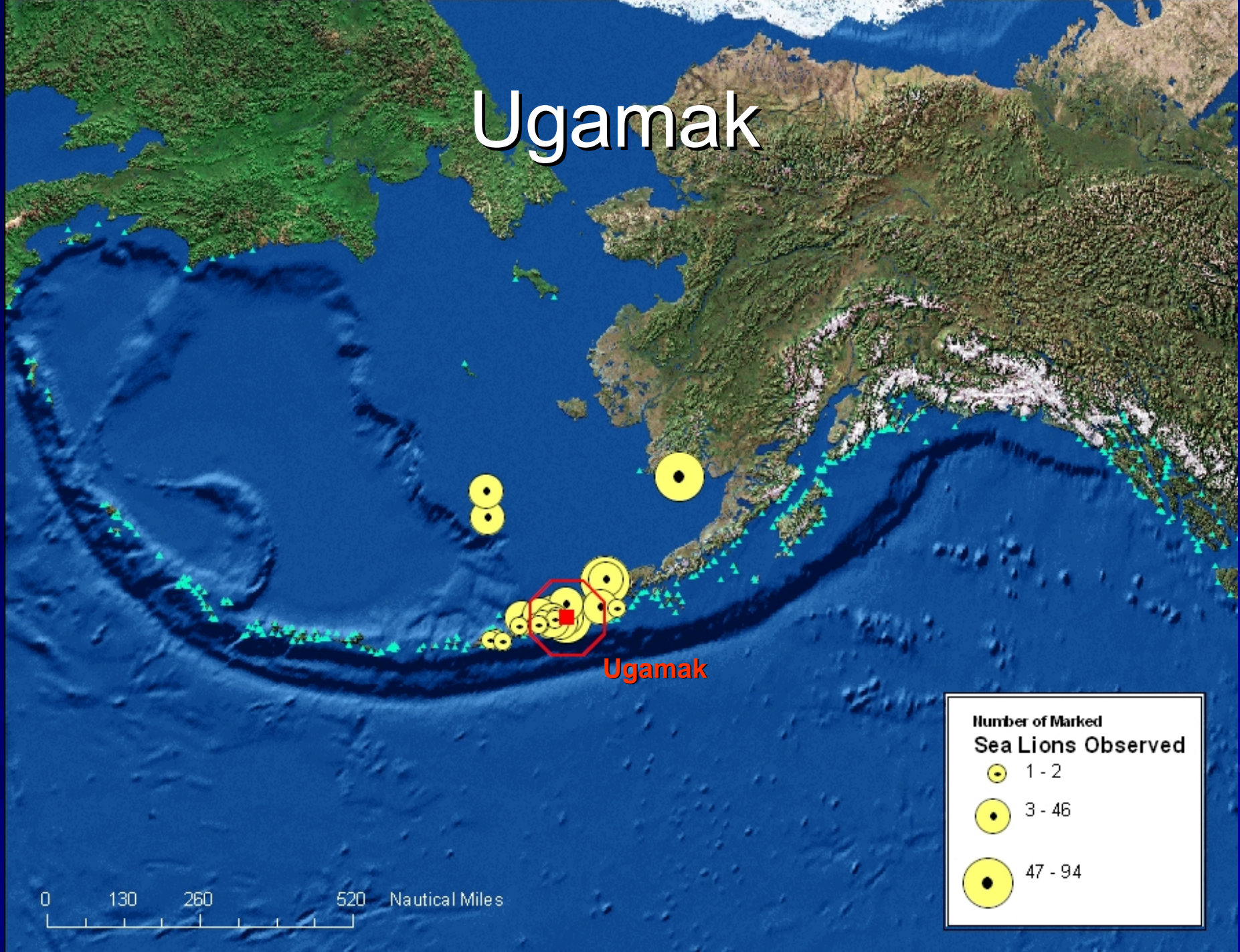


# Marmot





# Ugamak





# Survival Estimation

Release Year	Sighting Year		
	2	3	4
1	$r_{12}$ $p_{12} \quad \varphi_{12}$	$r_{13}$ $p_{13} \quad \varphi_{13}$	$r_{14}$ $p_{14} \quad \varphi_{14}$

Probabilities

$p$  = sighting

$\varphi$  = survival

1100

1101

1110

1111

1010

1011

1110

1111

1001

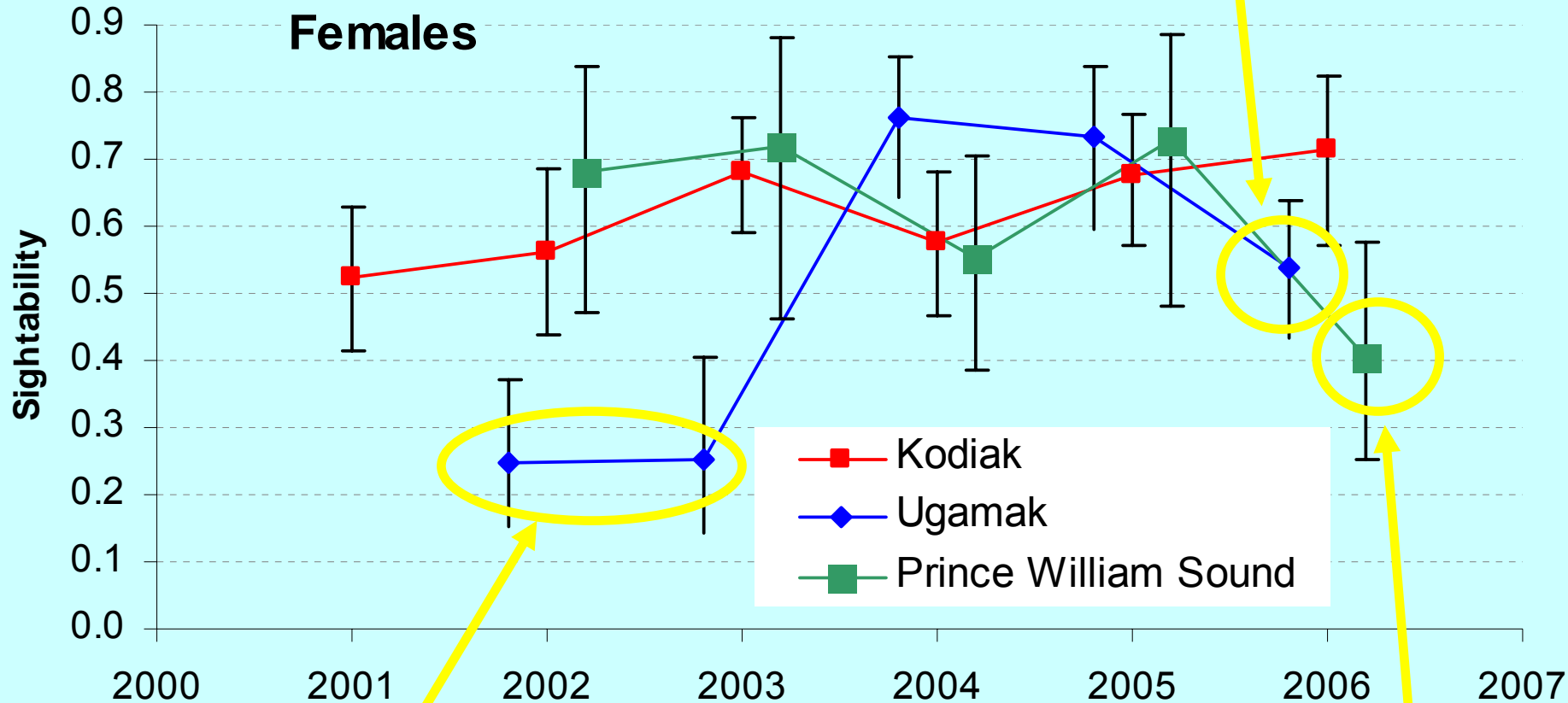
1011

1101

1111

1000

# Sighting Probability



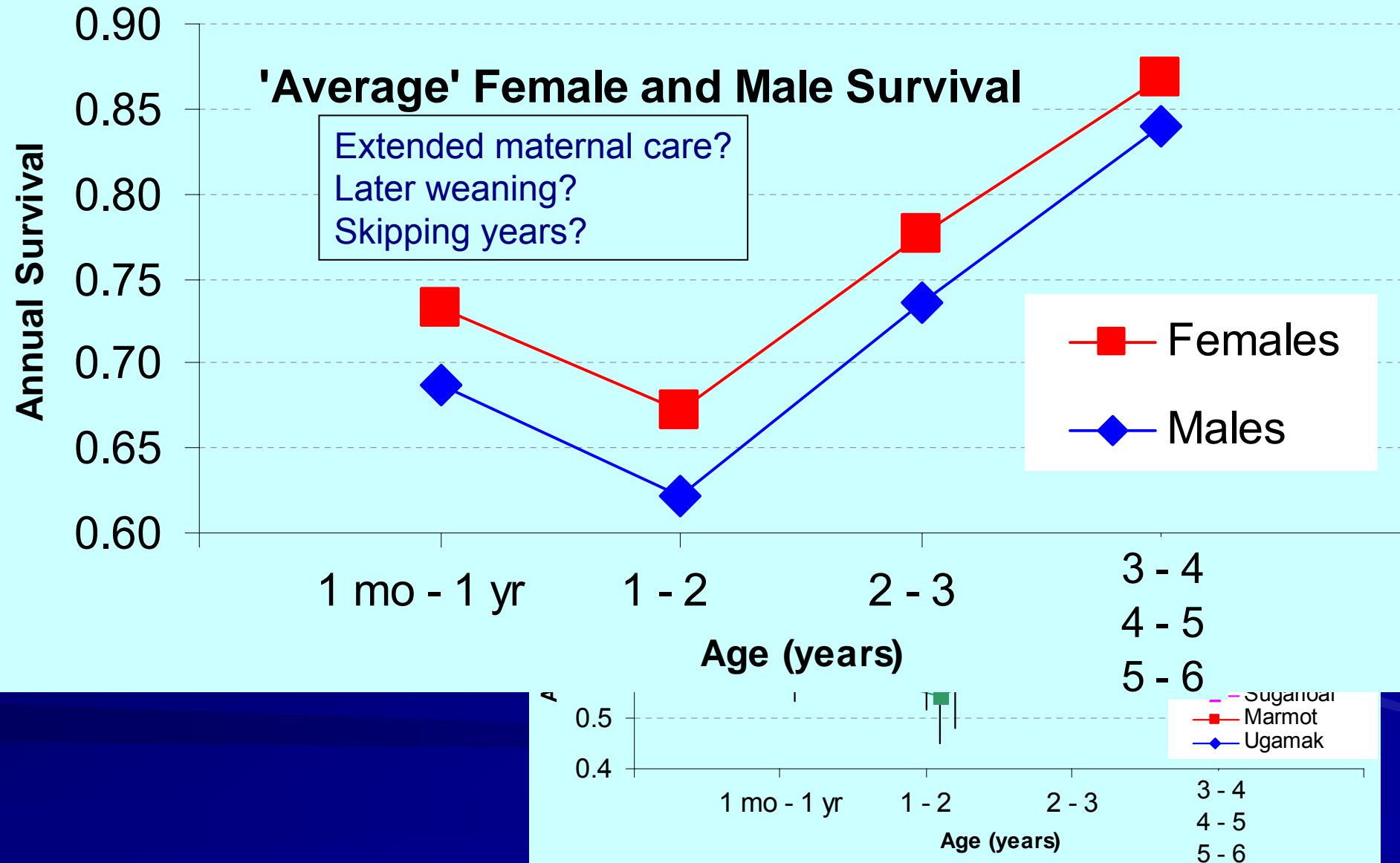
**No Amak  
2002-03**

**No Field Camp  
2006**

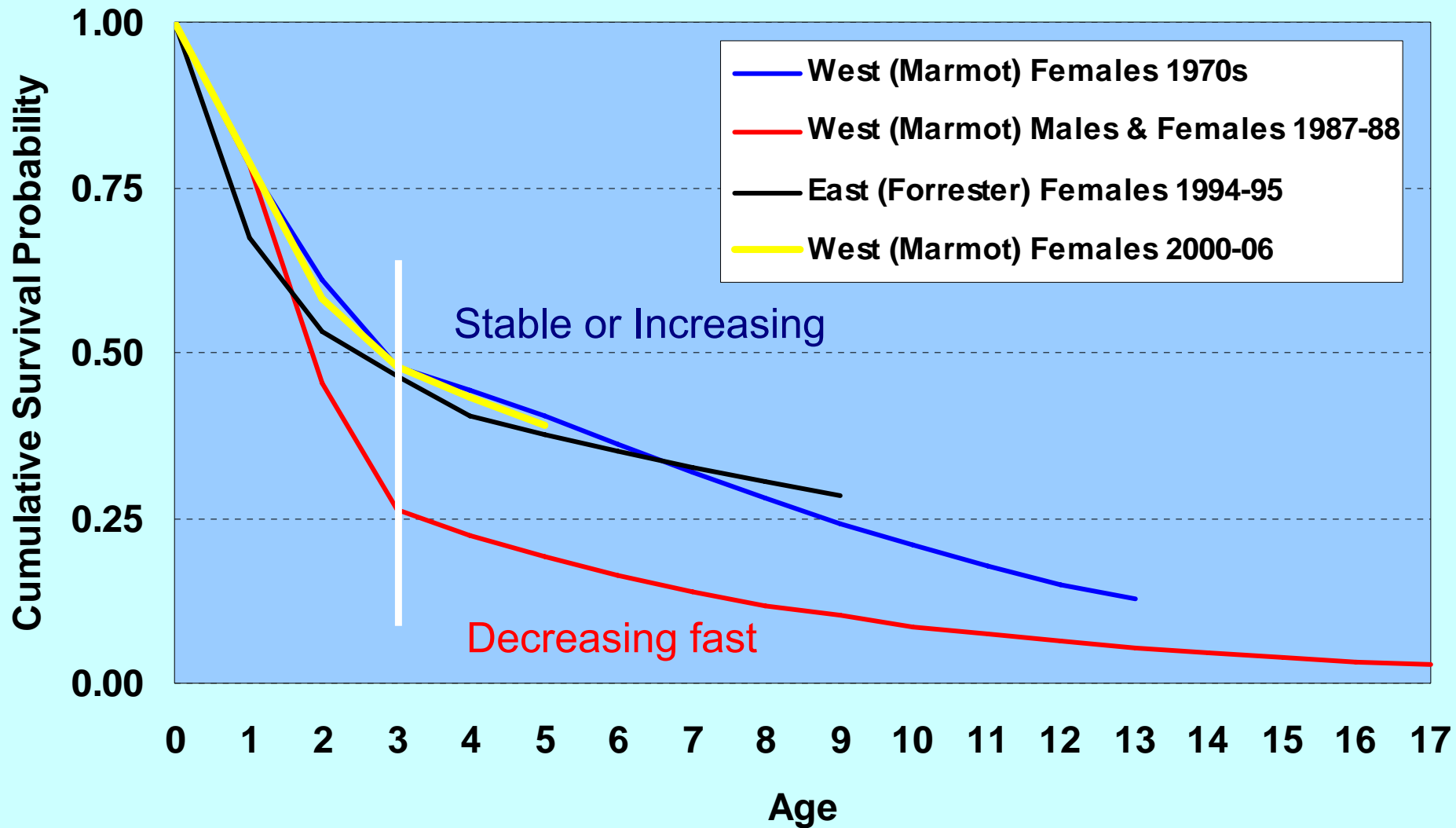
**No Vessel Trip  
2006**



# Preliminary Survival Results



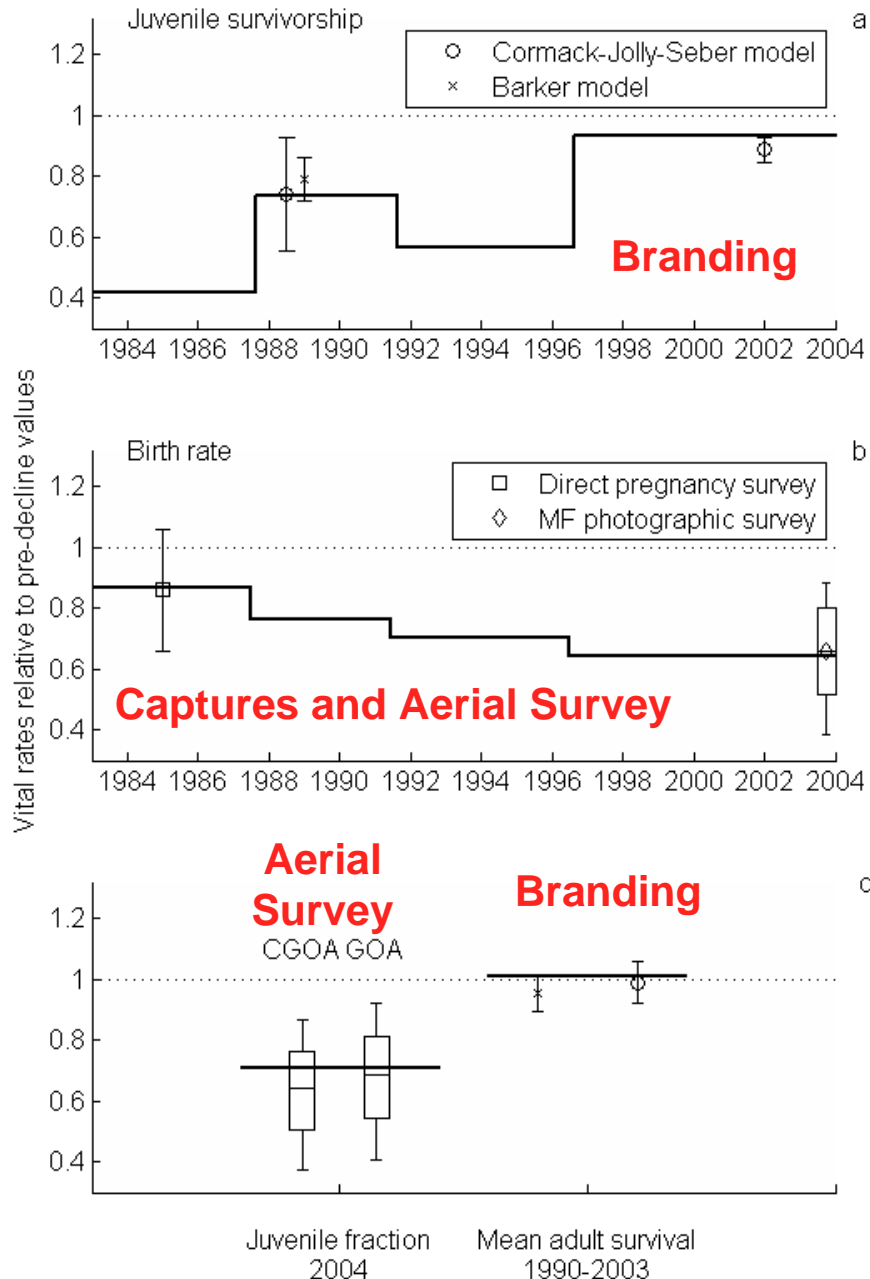
# Comparison Steller Sea Lion Survival: East and West in 1970s-2000s







# Comparison of Model Results with Independent Field Data



- Model results strongly agree with independent field data
- Survival Rates from branding in 1987-88 and 2000-05
- Late-term pregnancy rates from 1985-86 captures on Marmot
- Age structure from 2004 aerial survey



# Cormack-Jolly-Seber Models

$$1 \xrightarrow[\underset{1-p_{12}}{\quad}]{\overset{\varphi_{12}}{\quad}} 0 \xrightarrow[\underset{1-p_{13}}{\quad}]{\overset{\varphi_{13}}{\quad}} 0 \xrightarrow[\underset{1-p_{14}}{\quad}]{\overset{\varphi_{14}}{\quad}} 0$$

$$1 \xrightarrow[\underset{1-p_{12}}{\quad}]{\overset{\varphi_{12}}{\quad}} 0 \xrightarrow[\underset{1-p_{13}}{\quad}]{\overset{\varphi_{13}}{\quad}} 0 \xrightarrow[\quad]{\overset{1-\varphi_{14}}{\quad}} 0$$

$$1 \xrightarrow[\underset{1-p_{12}}{\quad}]{\overset{\varphi_{12}}{\quad}} 0 \xrightarrow[\quad]{\overset{1-\varphi_{13}}{\quad}} 0 \longrightarrow 0$$

$$1 \xrightarrow[\quad]{\overset{1-\varphi_{12}}{\quad}} 0 \longrightarrow 0 \longrightarrow 0$$

