REVIEW OF STELLER SEA LION DIET IN THE EASTERN AND WESTERN NORTH PACIFIC

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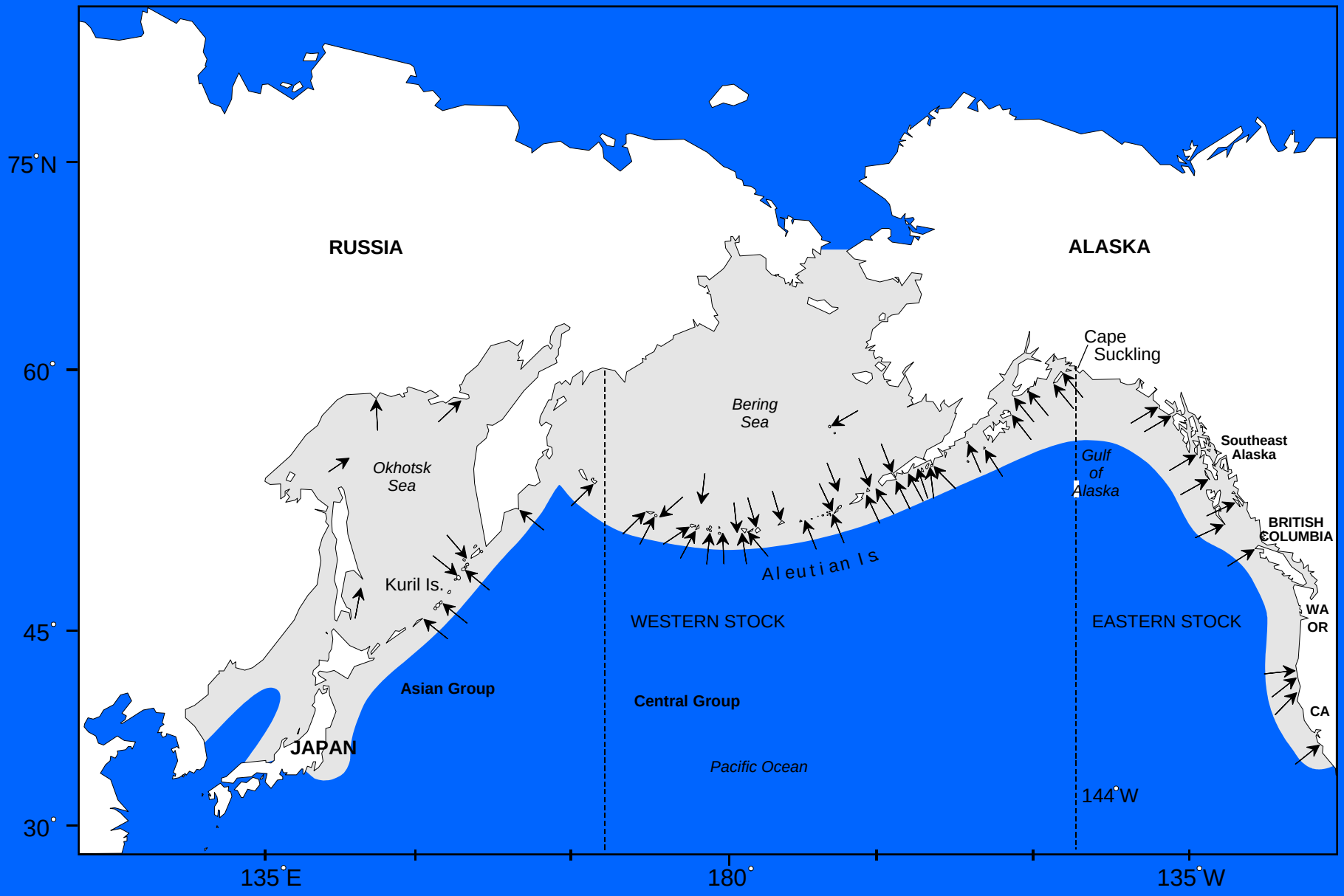
Steller Sea Lion Rookeries and Stock Boundaries



This talk will provide:

Overview of a recent Steller sea lion diet study in the Gulf of Alaska and Aleutian Islands using scat;

Summarize historical published accounts of sea lion diet across the range;

Provide conclusions on sea lion diet by season and year.

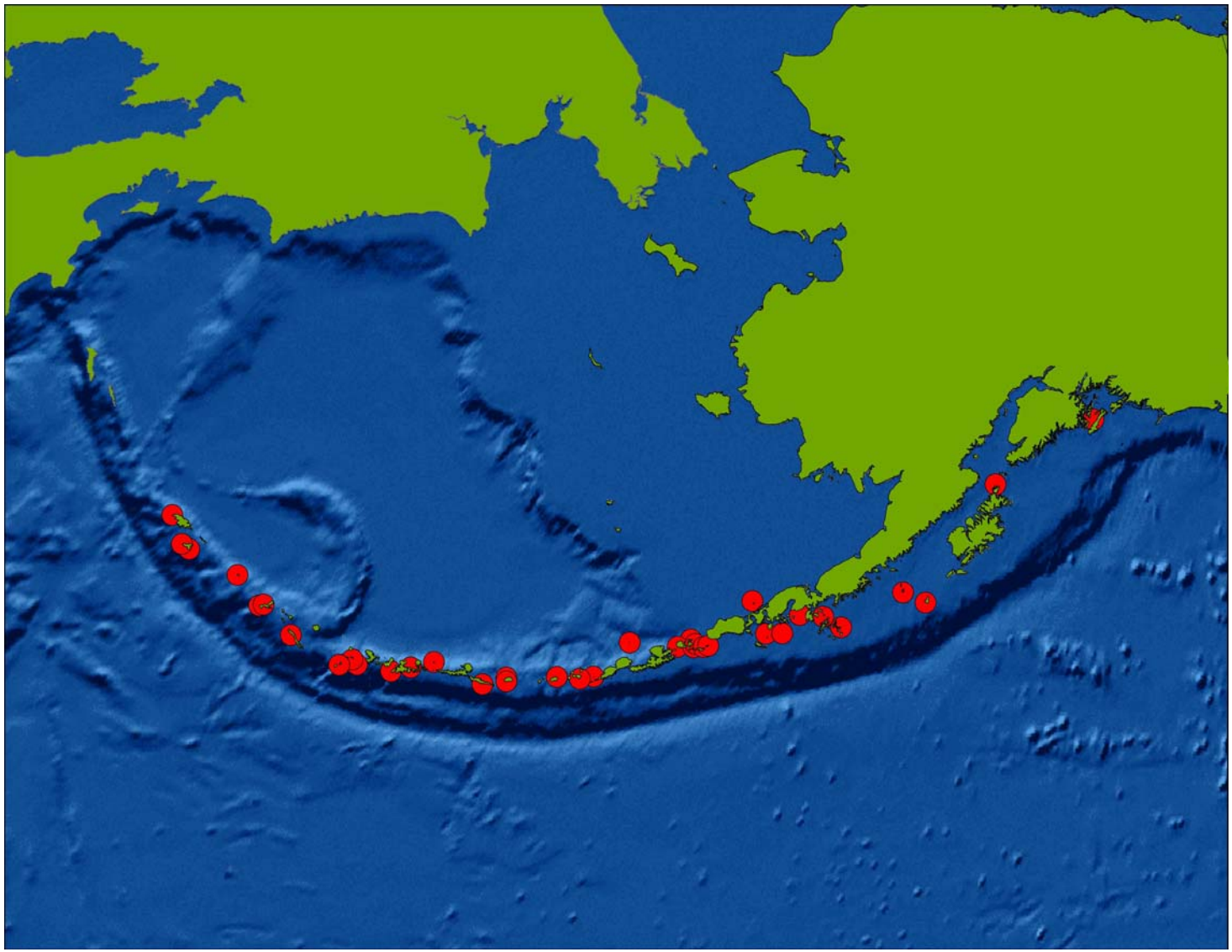
Overview of Sinclair, E.H., and T.K. Zeppelin. 2002. Seasonal and spatial differences in diet in the western stock of Steller sea lions.
J. Mammal. 83(4):973-990.

Study Objectives

- **Describe current trends in diet among the western stock of Steller sea lions relative to historical records**
- **Define regional and seasonal patterns in prey consumption relative to prey movements and distributions**
- **Define regions of diet similarity within the range of the western stock relative to population trends**

(Sinclair and Zeppelin.2002.J.Mammal. 83:973-990.)

Scat Collection Sites (1998-2000)



Frequency of occurrence (FO) to compare sites

$$FO_{jk} = \frac{\sum_{i=1}^{n_k} O_{ijk}}{n_k}$$

where O_{ijk} = 0 if taxon *j* is absent in scat *i* in season *k*

1 if taxon *j* is present in scat *i* in season *k*

n_k = total number of scats containing identifiable prey in season *k*

- summer (May-September), winter (December-April)
- each scat was treated as an independent sample

(Sinclair and Zeppelin.2002.J.Mammal. 83:973-990.)

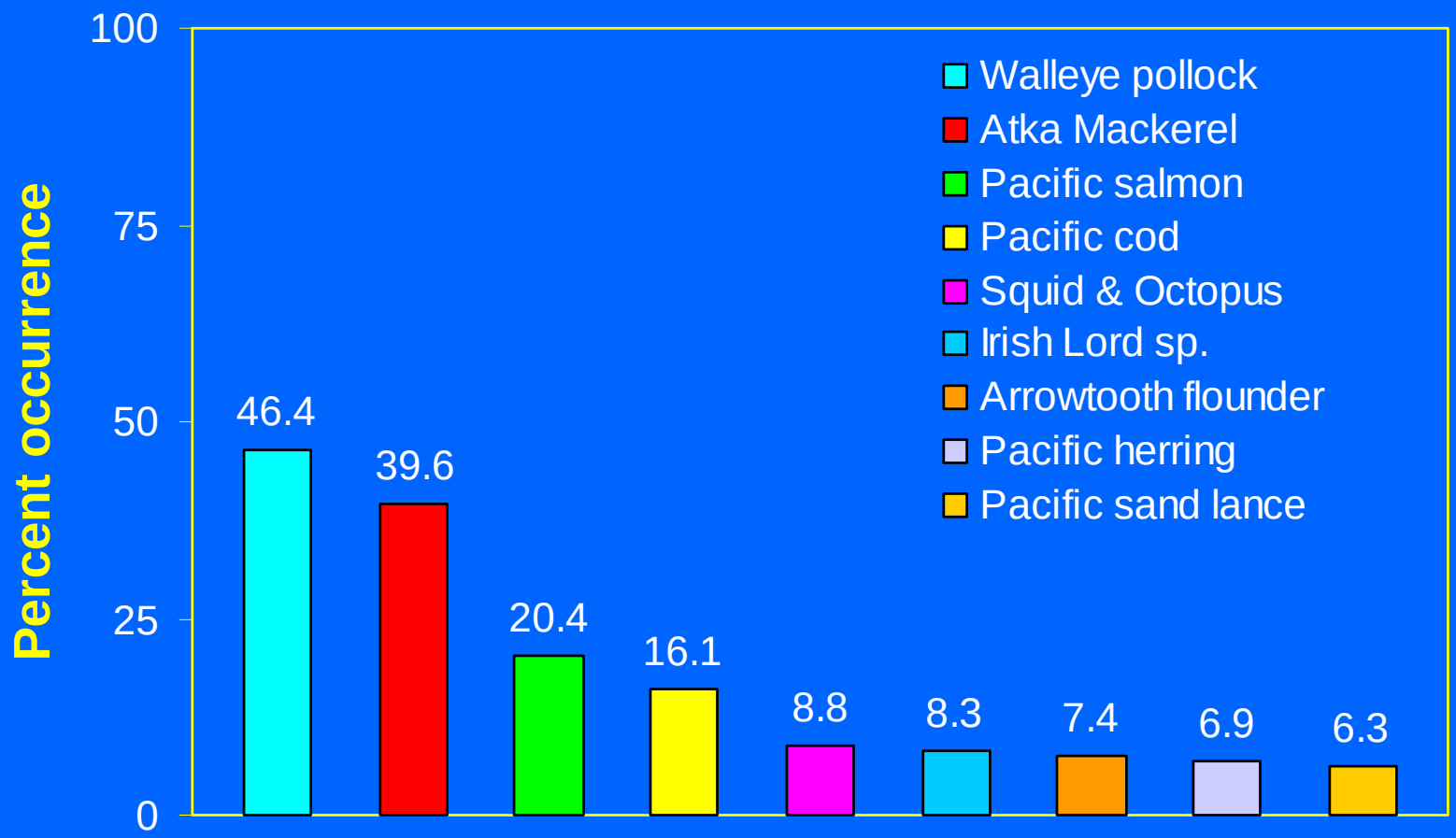
Grouping sites into regions using FO data

- Principle Component Analysis (PCA) - Used to reduce the data into representative factors that accounted for the majority of the variance.

- Cluster Analysis – Conducted on PCA factors using squared Euclidian distance as a measure of similarity between sites and Ward's method to compare cluster distances.

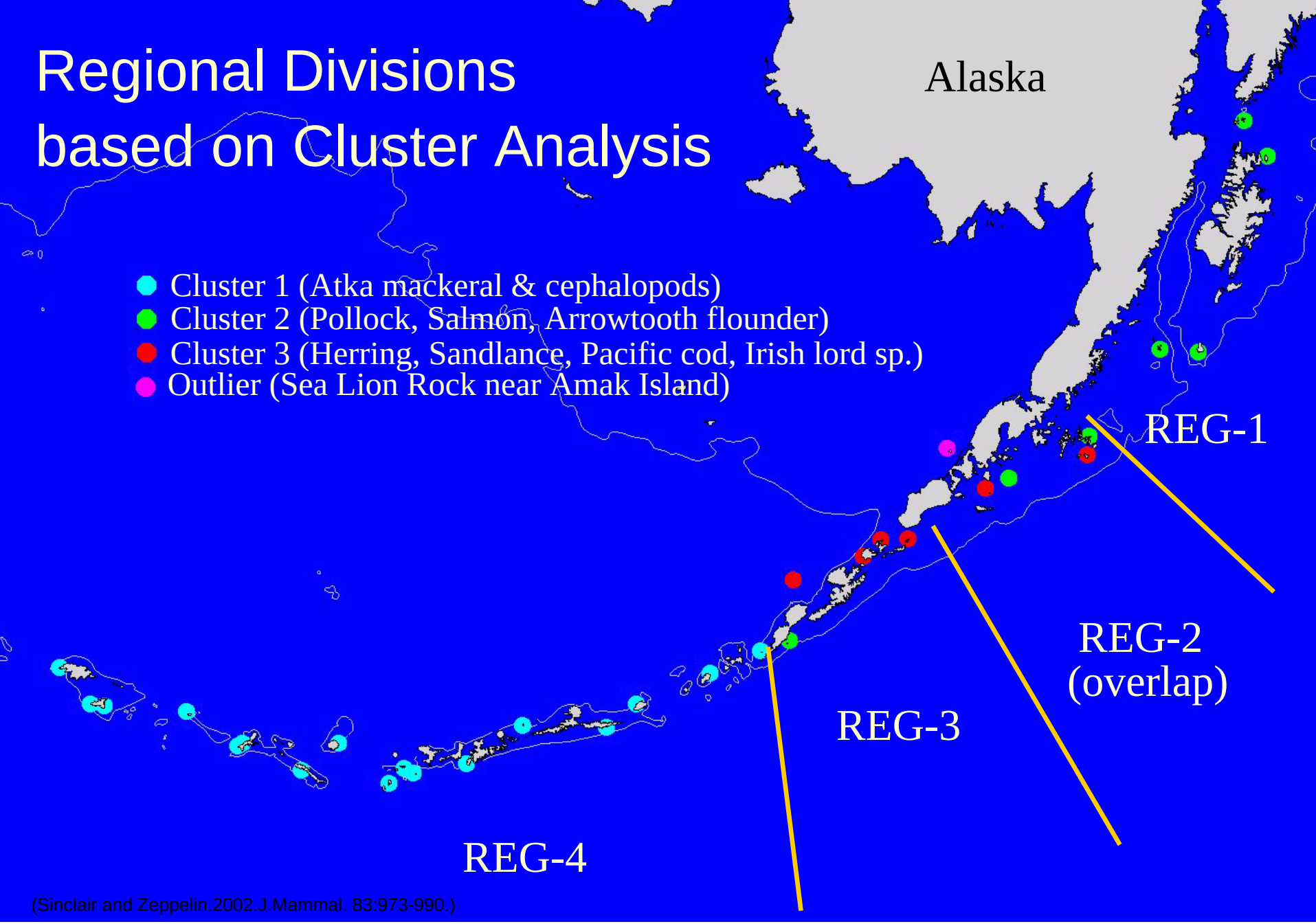
(Sinclair and Zeppelin.2002.J.Mammal. 83:973-990.)

FO across all regions and seasons



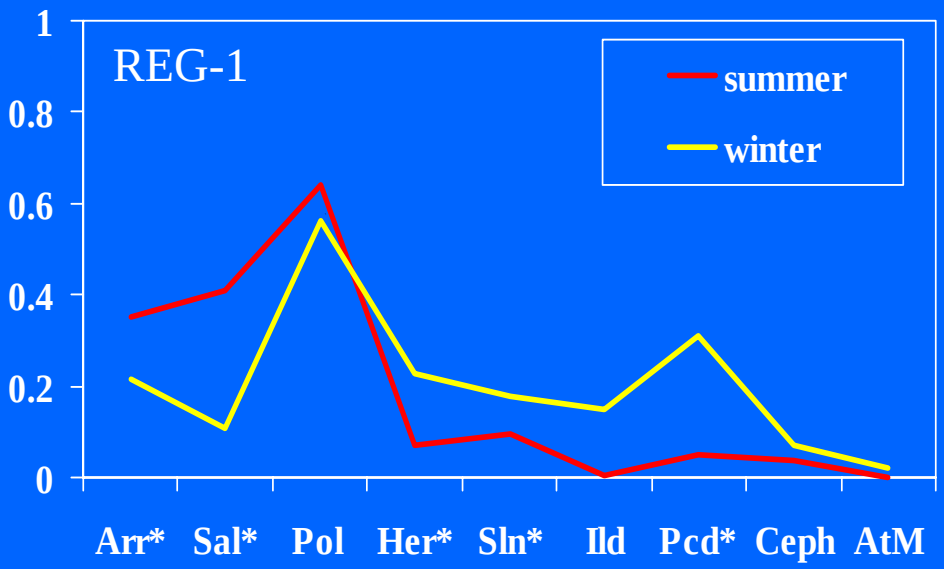
(Sinclair and Zeppelin.2002.J.Mammal. 83:973-990.)

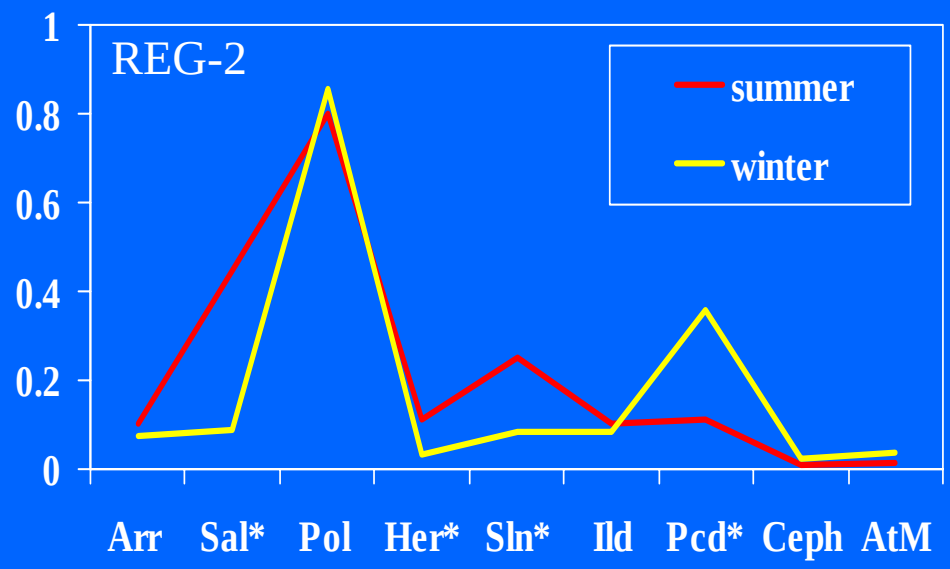
Regional Divisions based on Cluster Analysis

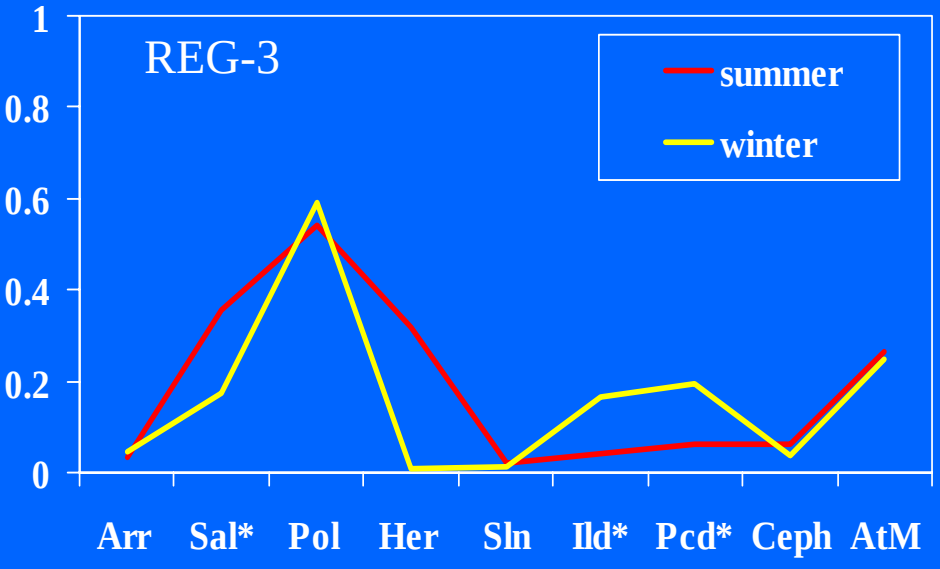


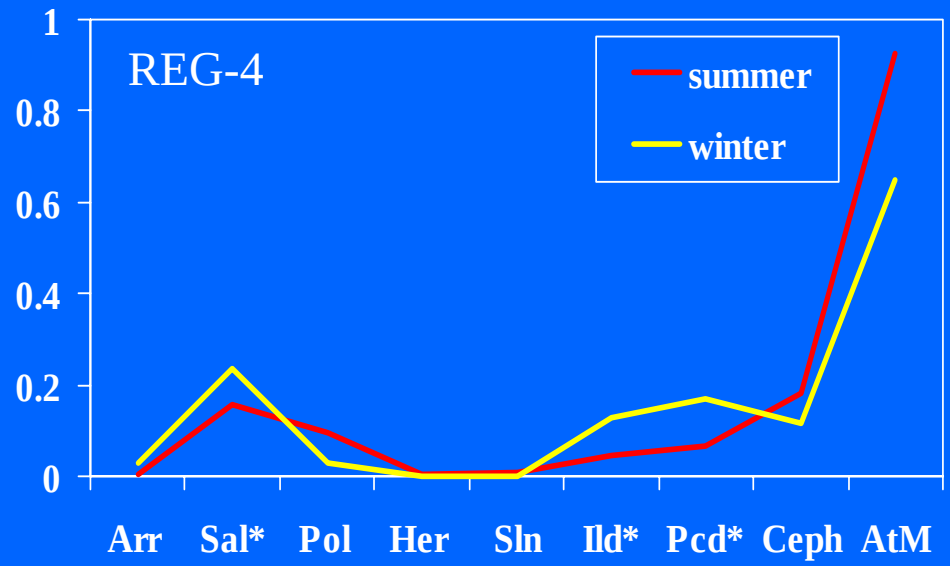
(Sinclair and Zeppelin.2002.J.Mammal. 83:973-990.)

FO by Region and Season

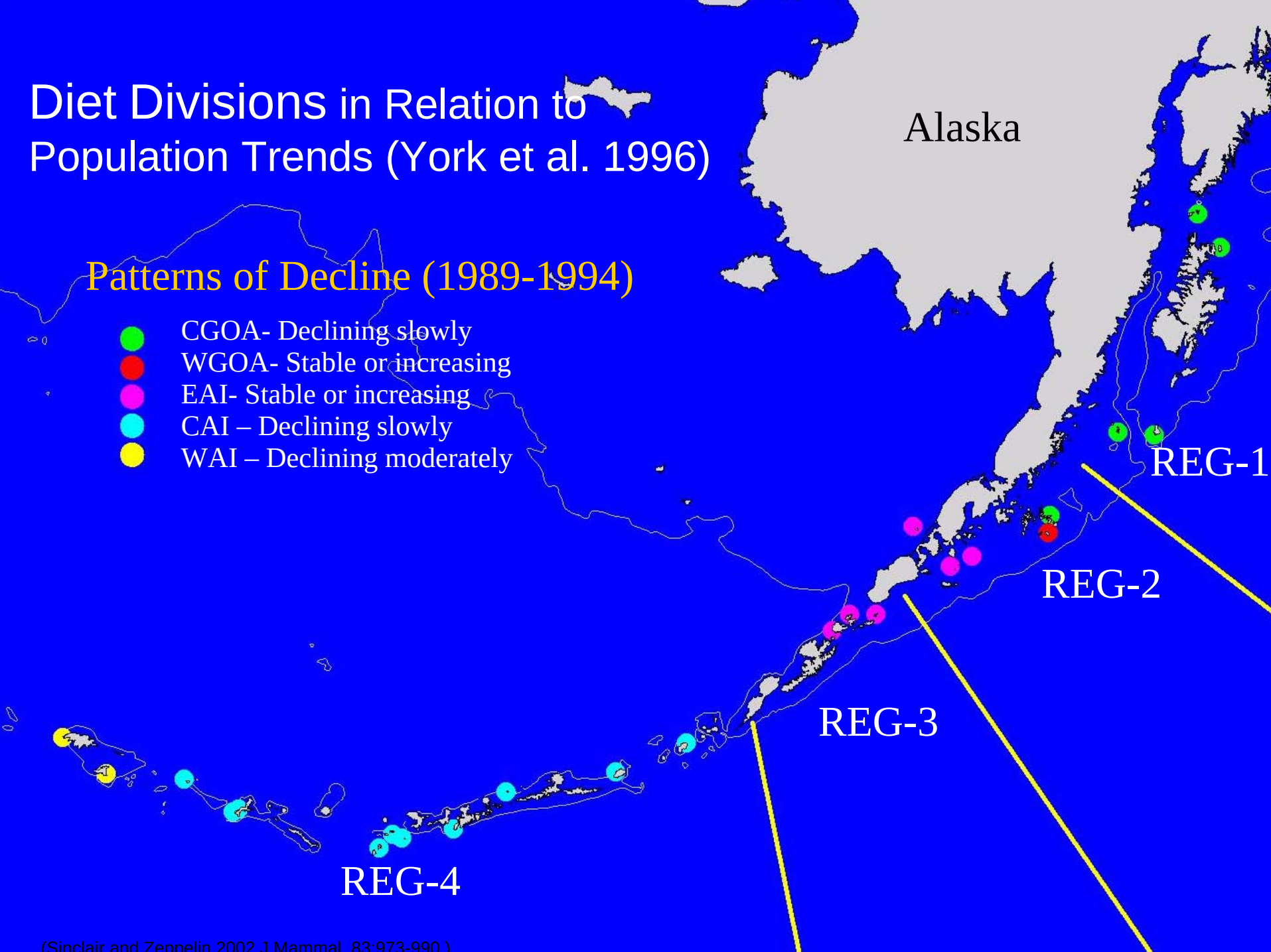








(Sinclair and Zeppelin 2002 J Mammal 83:973-990)


Diet Divisions in Relation to Population Trends (York et al. 1996)
Alaska
Patterns of Decline (1989-1994)
CGOA- Declining slowly
WGOA- Stable or increasing
EAI- Stable or increasing
CAI – Declining slowly
WAI – Declining moderately
REG-1
REG-2
REG-3
REG-4
(Sinclair and Zeppelin 2002 J Mammal. 83:973-990)

Historical published accounts of sea lion diet across the range

Western Population

RANK	1950s-1970s Annual	1980s Annual	1990s Winter	1990s Summer
1	Pollock	Pollock	Pollock	Atka mackerel
2	Cephalopods	Pacific cod	Pacific cod	Pollock
3	Clamshell	Octopus	Atka mackerel	Salmon
4	Capelin	Herring	Salmon	Cephalopods
5	Rockfish Sand lance Unid fish	Squid	Sculpins	Herring

Frequency of Occurrence of Prey in Sample

Sample	Stomach	Stomach	Stomach/Scat		Scat
N	394	177	67	1843	2,340
CGOA	5	3		2	2
WGOA	4			2	2
EAI	3			2	2
CAI	1			2	2
WAI					2
EBS	5	2	Many scat collected since mid 1990s but not analyzed		
Russia	3				
Japan		1 (stomach)			

Type and N

Number of Studies by Area

Fritz, NMFS, unpubl.

Western Population 1990s

Groundfish

"Forage fish"

Winter

RANK	CGOA	WGOA	EAI	CAI
1	Pollock	Pollock	Pollock	Atka mackerel
2	Pacific cod	Pacific cod	Atka mackerel	Rock greenling
3	**Herring**	Salmon	Pacific cod	Pacific cod
4	ATF	ATF	Salmon	Snailfish
5	**Sand lance**	**Sand lance**	**Sand fish**	Cephalopods

ATF=arrowtooth flounder

Summer

RANK	CGOA	WGOA	EAI	CAI	WAI
1	Pollock	Pollock	Pollock	Atka mackerel	Atka mackerel
2	Salmon	Salmon	Salmon	Cephalopods	Cephalopods
3	ATF	**Sand lance**	Atka mackerel	Salmon	Sculpins
4	**Sand lance**	ATF	**Herring**	Pollock	Pacific cod
5	**Herring**	Pacific cod	Rock sole	Pacific cod	Salmon

Fritz, NMFS, unpubl.

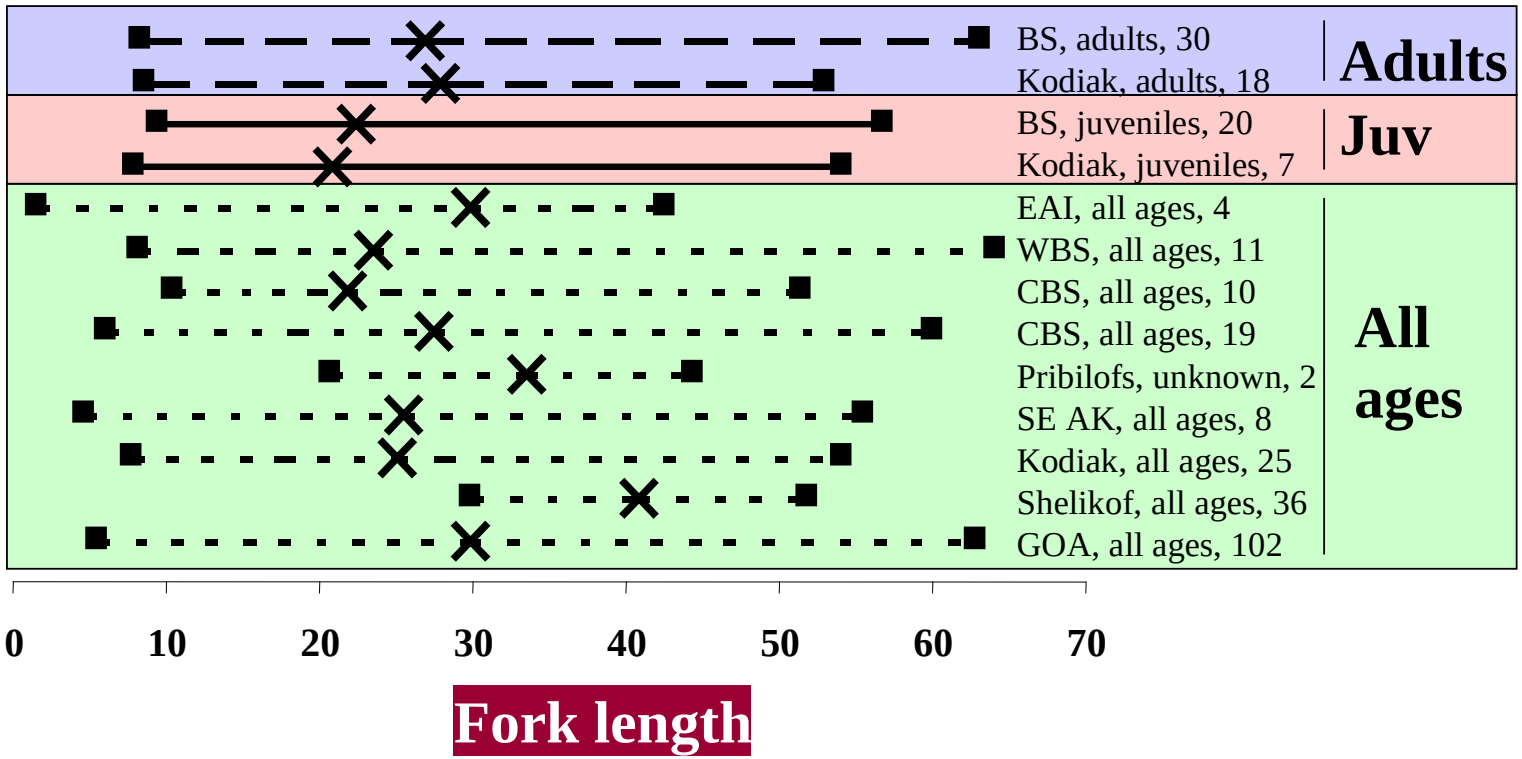
Summary of Principal Prey Groups
(Aleutian Islands and Gulf of Alaska)

Seasonal Prey Species-Groups		Year-Round Prey Species-Groups
Winter-Spring	Herring	Pollock
	Pacific cod	Cephalopods
	Eulachon	Atka mackerel (Aleutian Islands only)
	Capelin	Arrowtooth flounder (Gulf of Alaska only)
Summer-Fall	Salmon	Rock sole
	Irish lords	Sand lance

Fritz, NMFS, unpubl.

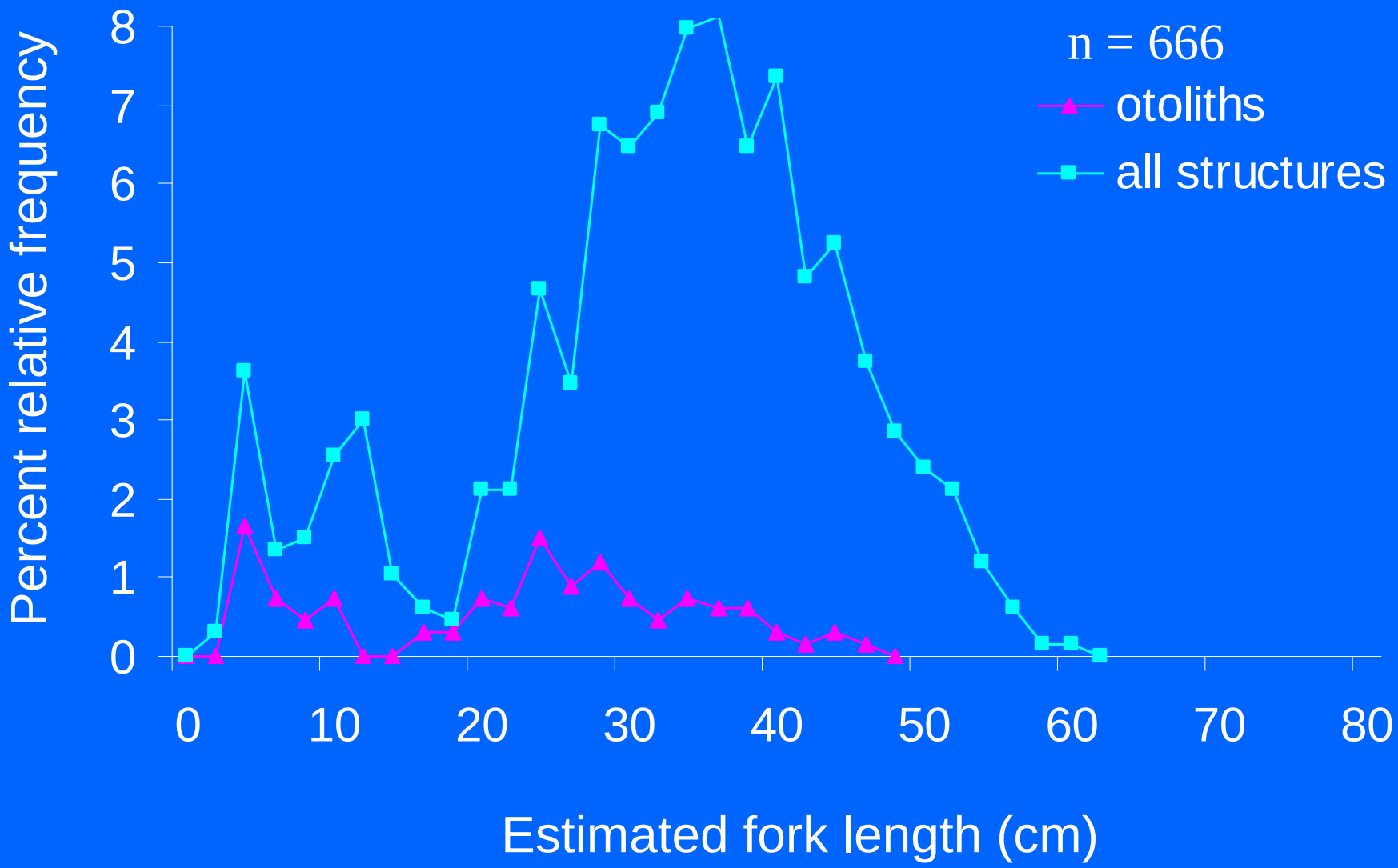
Mean, range of pollock sizes eaten

Sea lion
age classes



Fork length

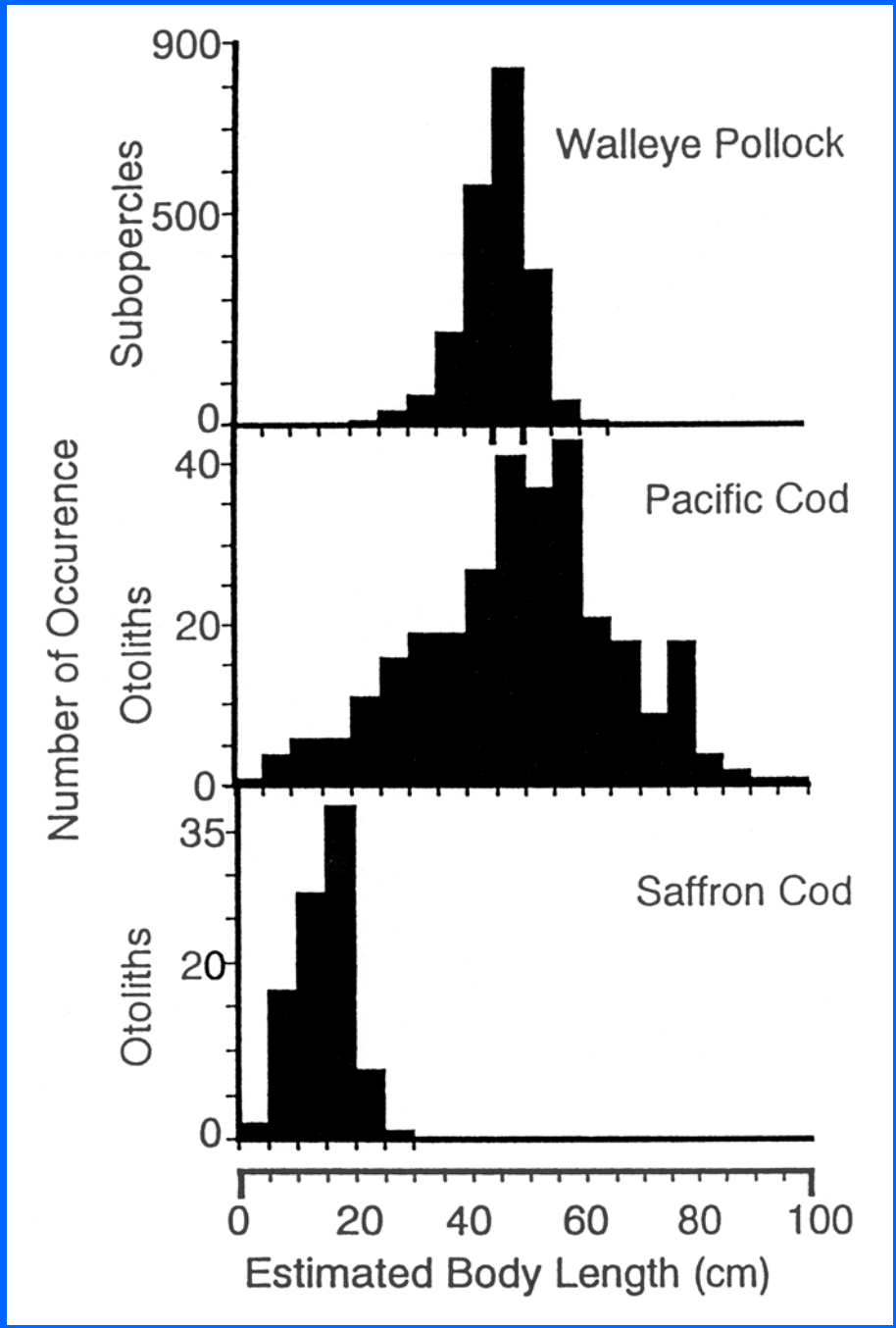
Estimated size of walleye pollock consumed by the western stock of Steller sea lions



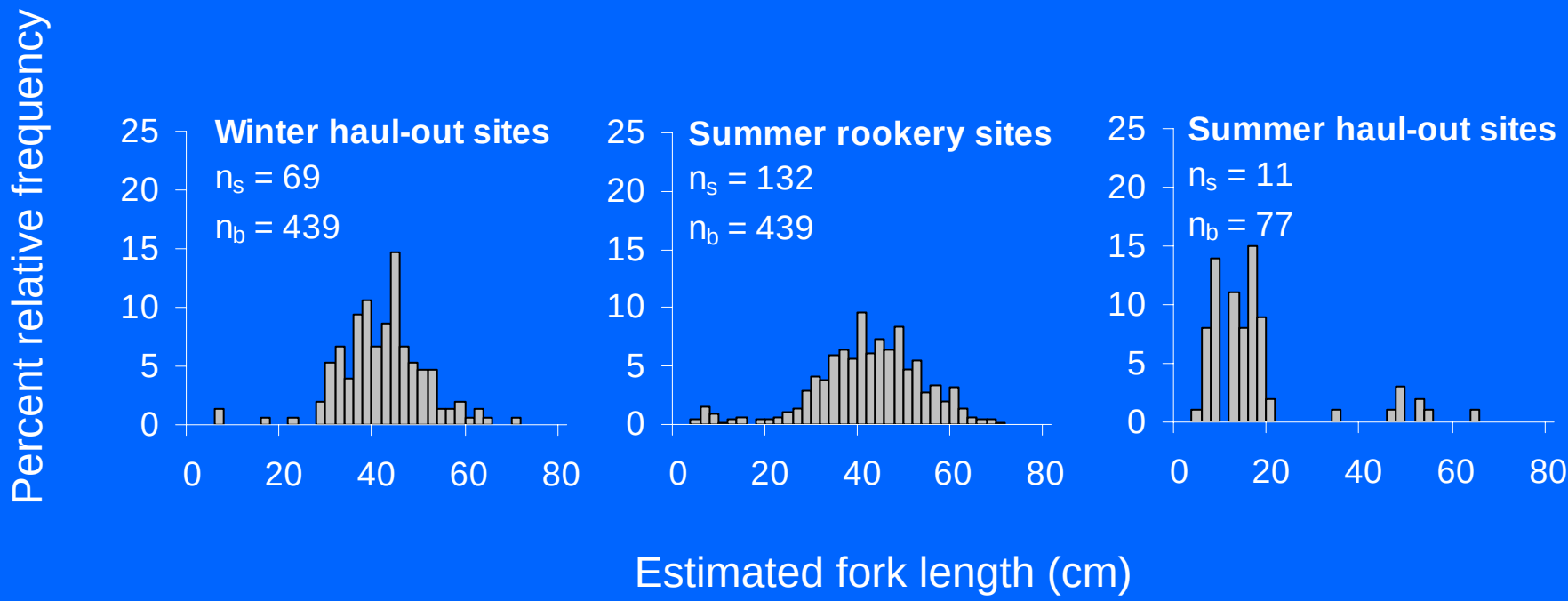
Goto, Y, and K. Shimazaki. 1998. Diet of Steller sea lions off the coast of Rausu, Hokkaido, Japan. Biosphere Conservation 1:141-148

Body lengths of prey estimated from otoliths and subopercles

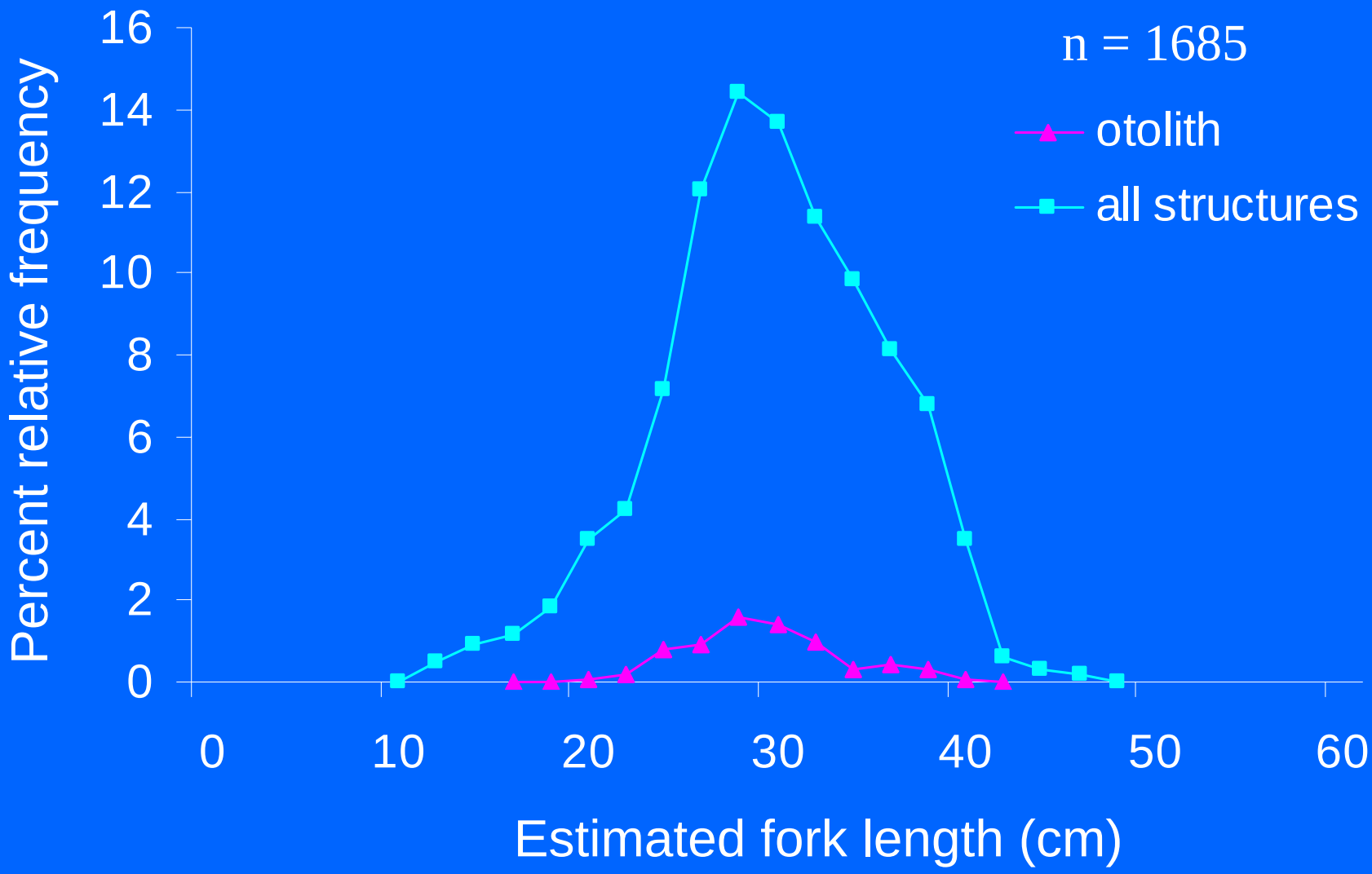
N = 67 stomachs; 1994-96



Walleye pollock length frequency distribution by rookery and haul-out



Estimated size of Atka mackerel consumed by the western stock of Steller sea lions



Eastern Population

RANK	1950s-1970s Annual	1980s Annual
1	Cephalopods	Pollock
2	Rockfish	Flounder
3	**Herring**	Squid **Herring** Unid Fish
4	Pollock	Octopus Pacific cod Salmon
5	Salmon Pacific hake	

Fritz, NMFS, unpubl.

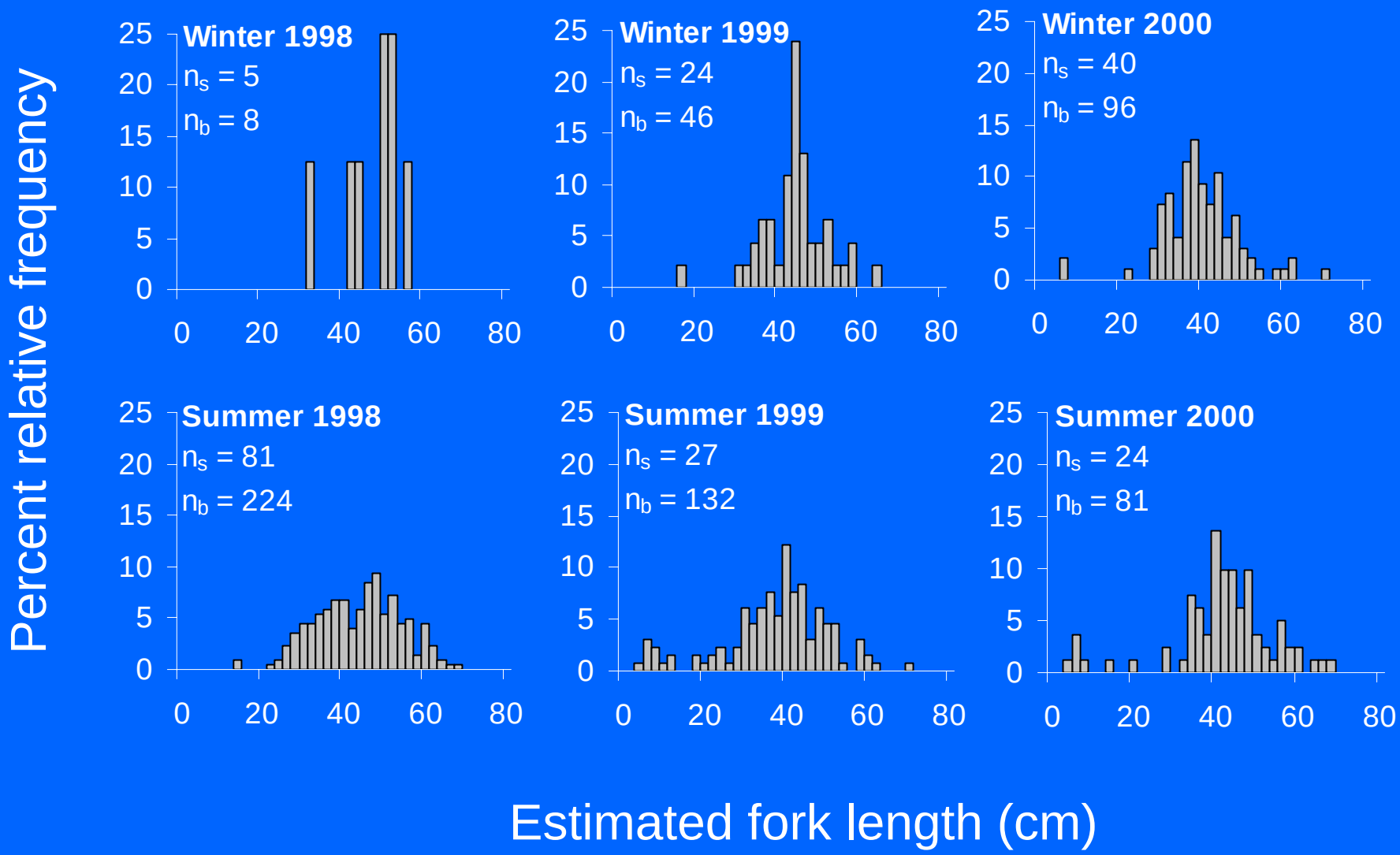
Conclusions

- **SSL consume a wide variety of marine fish and cephalopods, but target prey that are densely schooled in spawning, migratory, or feeding aggregations.**

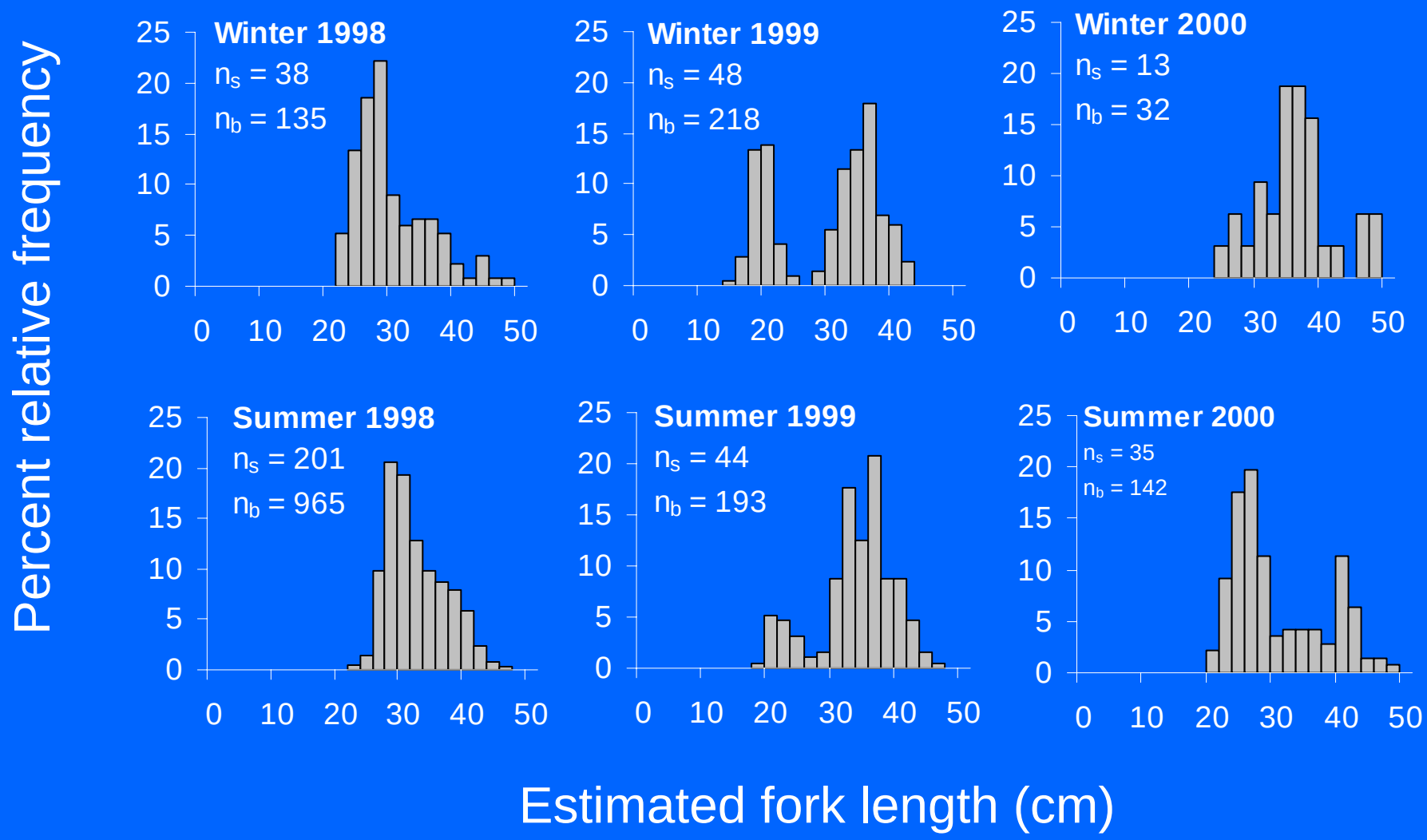
- **Seasonal and regional patterns in prey composition are strongly defined, suggesting SSL foraging site fidelity.**

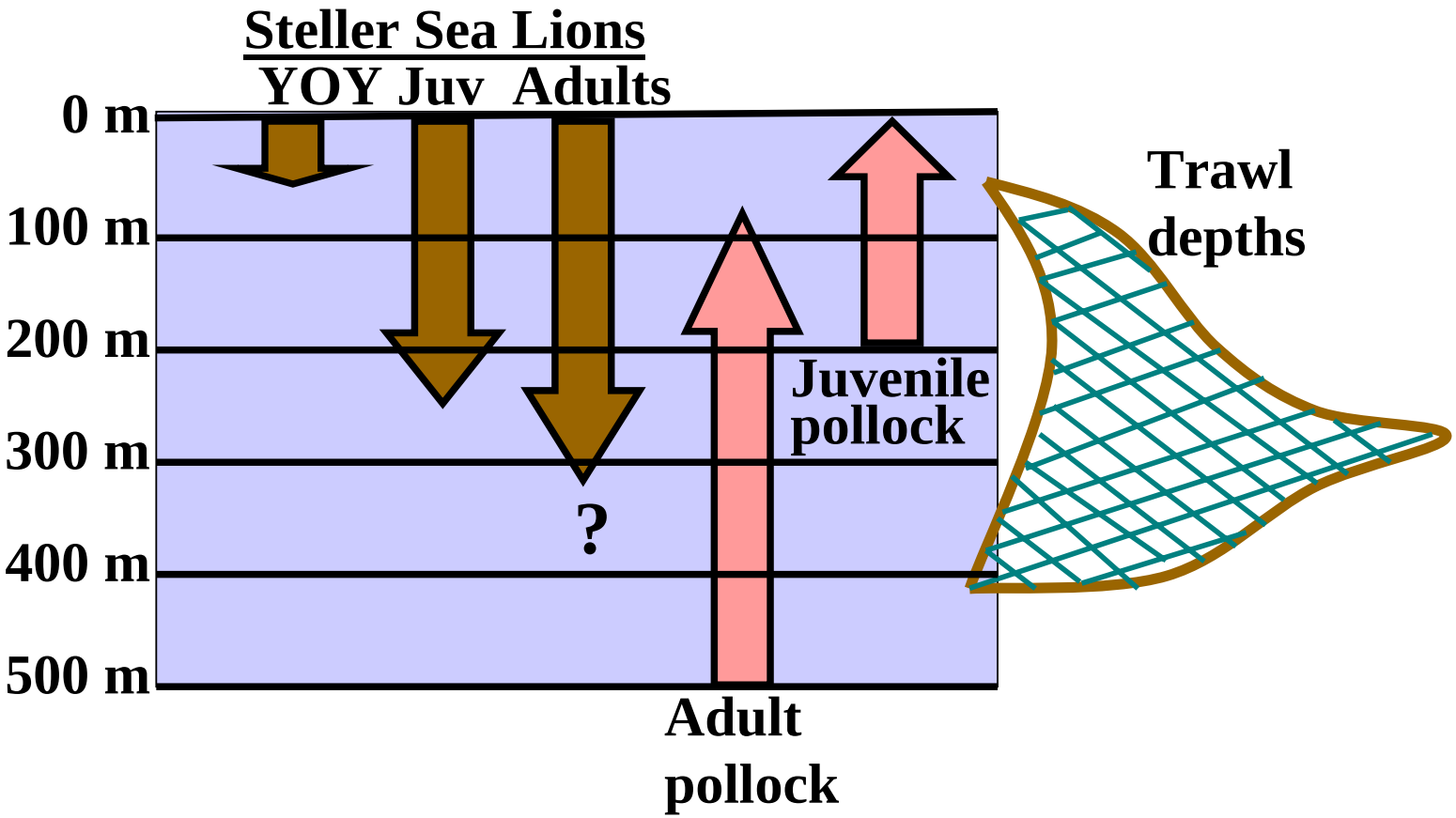
- **Regional diet divisions closely parallel those defined by metapopulation patterns suggesting that diet and population trends are linked.**

Walleye pollock length frequency distribution by year and season



Atka mackerel length frequency distribution by year and season




Steller Sea Lions
YOY Juv Adults
0 m
100 m
200 m
300 m
400 m
500 m
?
Juvenile pollock
Adult pollock
Trawl depths

Frequency of Occurrence by site

Top 3 Prey Items (summer)

Sugarloaf – Sal 58, Arr 55, Smelt 33

Marmot – Pol 69, Sal 39, Arr 36

Chirikof – Pol 69, Sal 43, Arr 19

Chowiet – Pol 79, Arr 43, Sal 33

Chernabura – Pol 78, Sln 28, Sal 16

- **Overall, top prey items were similar at adjoining sites**
- **A few prey items with low FO overall had high FO values at specific sites**

(Sinclair and Zeppelin.2002.J.Mammal. 83:973-990.)