

# Seal and sea lion predation on rockfish in Puget Sound



Monique Lance, Steven Jeffries, Wan-Ying Chang, Elizabeth Elliott,  
Jeffrey Bromaghin, Alejandro Acevedo-Gutierrez, and John Kennish

# Rockfish and Hexagrammids

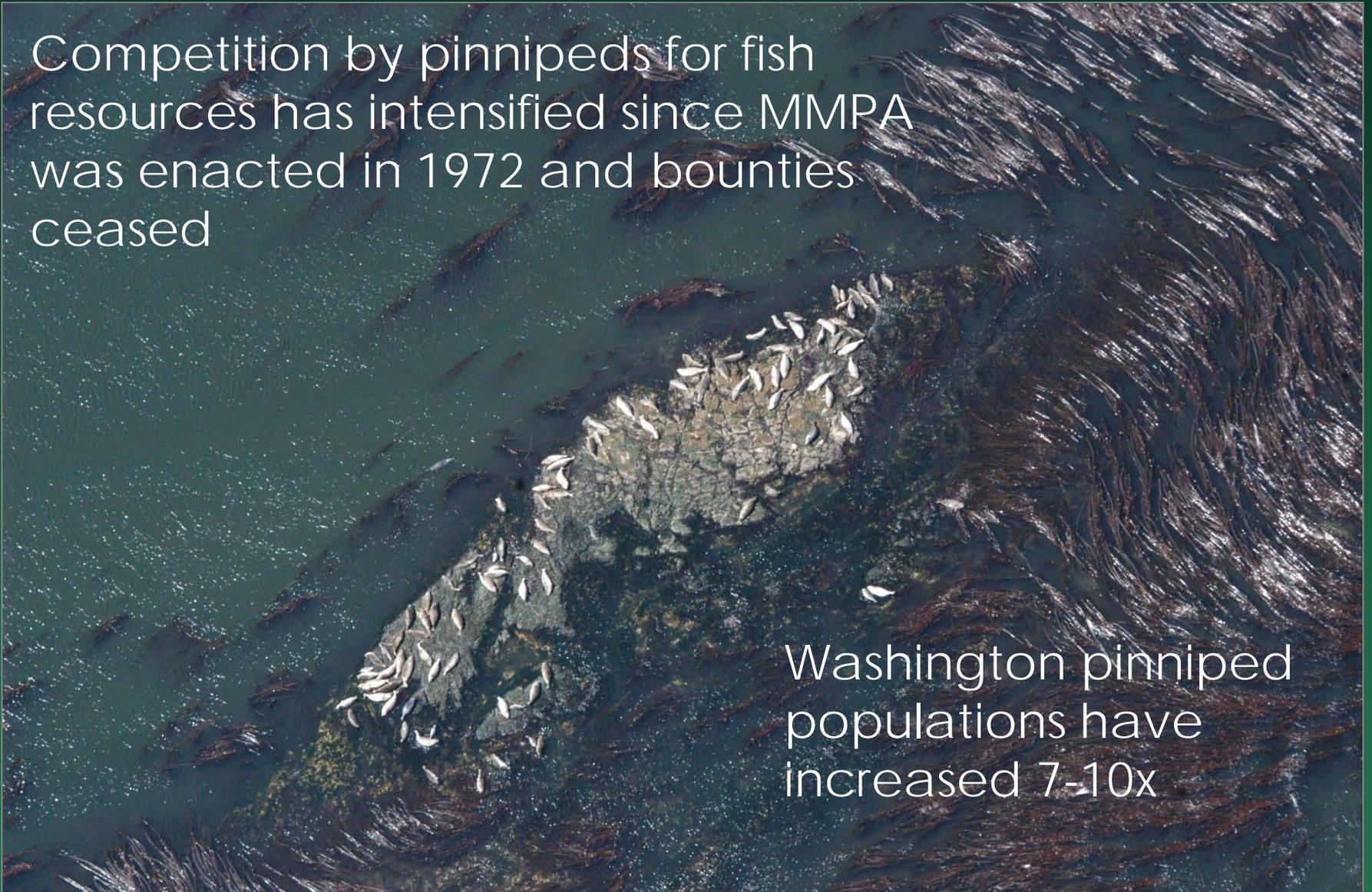


- Intense sport and commercial fisheries in the late 1970s and early 1980s reduced lingcod and rockfish to extremely low abundance by the early 1990s.
- Lingcod are in above average condition in north PS currently due to changes in fishing regulations
- Rockfish populations in many or all areas of Puget Sound including the San Juan Islands are in critical condition
- Puget Sound/Georgia Basin Distinct Population Segments of Yelloweye and Canary Rockfish are listed as threatened, and Bocaccio Rockfish as endangered under the US Endangered Species Act

# Pinnipeds

Competition by pinnipeds for fish resources has intensified since MMPA was enacted in 1972 and bounties ceased

Washington pinniped populations have increased 7-10x



# Pinnipeds in Salish Sea



# Pinniped foraging



- Opportunistic predators - feed on locally abundant prey and commonly switch prey types as prey abundances change annually and seasonally
- Diet typically dominated by a few species ~ adult salmon, herring and gadids

# Pinniped diet studies using scat in Salish Sea

## Harbor seals

- Hood Canal (1998-2004)
- Southern Puget Sound (1995-2004)
- Protection Island (1980s)
- Strait of Georgia (1990s)
- San Juan Islands - ???

## California sea lions

- Everett (late 1980s-early 1990s)

## Steller sea lions

- No data



Small % of diet

# San Juan Islands

- Area of focus for a number of rockfish recovery efforts
- Marine reserves designed to recover rockfish, ling cod and other bottom-fish were established.
- Harbor seal population has grown exponentially in recent years, with an estimated 41,500 – 56,400 harbor seals distributed in the San Juan Islands, Strait of Juan de Fuca and Strait of Georgia
- No diet data



Harbor seals use over 150 haulout locations throughout San Juan Island archipelago

30,000

2,000

2,000

4,000

One of the most dense concentrations of seals in the world!

3,000



# 4 Specific Aims



1. Describe the relative importance of each prey species or family in the diet of seals
2. Determine if there are significant differences in seal diet seasonally and regionally
3. Estimate the size (age) of rockfish (to species if possible) being consumed by seals using otoliths recovered from scat samples
4. Determine whether different methods of investigating diet produce different estimates of rockfish consumed

# 3 ways to examine seal diet

## 1. Scats



## 2. Fatty Acids



## 3. Stable Isotopes



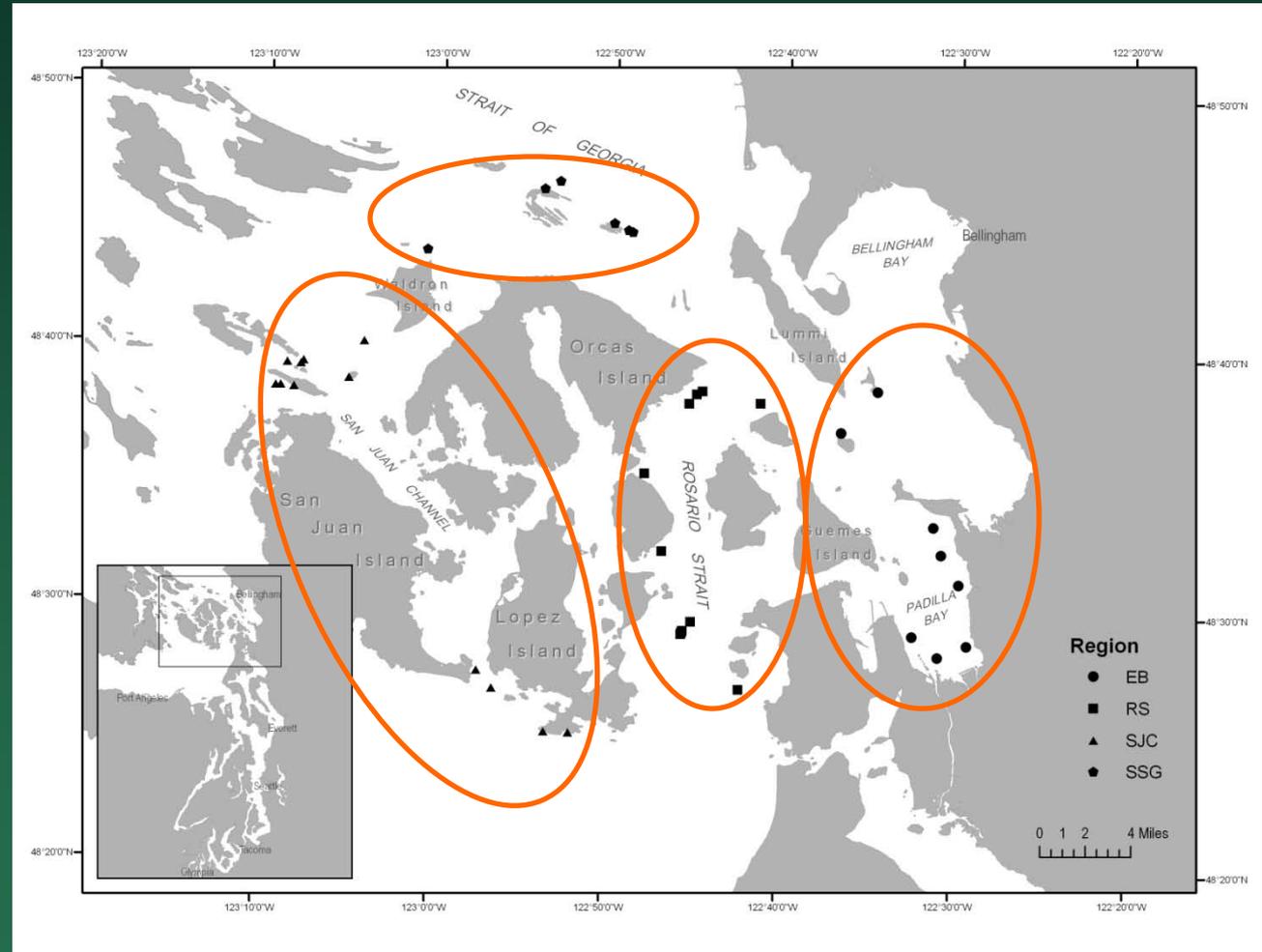
# Scat Sample collection

4 years:

Spring 2005 –  
Winter 2008

- Spring –  
March/April
- Summer/Fall –  
Aug/Sept
- Winter –  
Dec/Jan/Feb

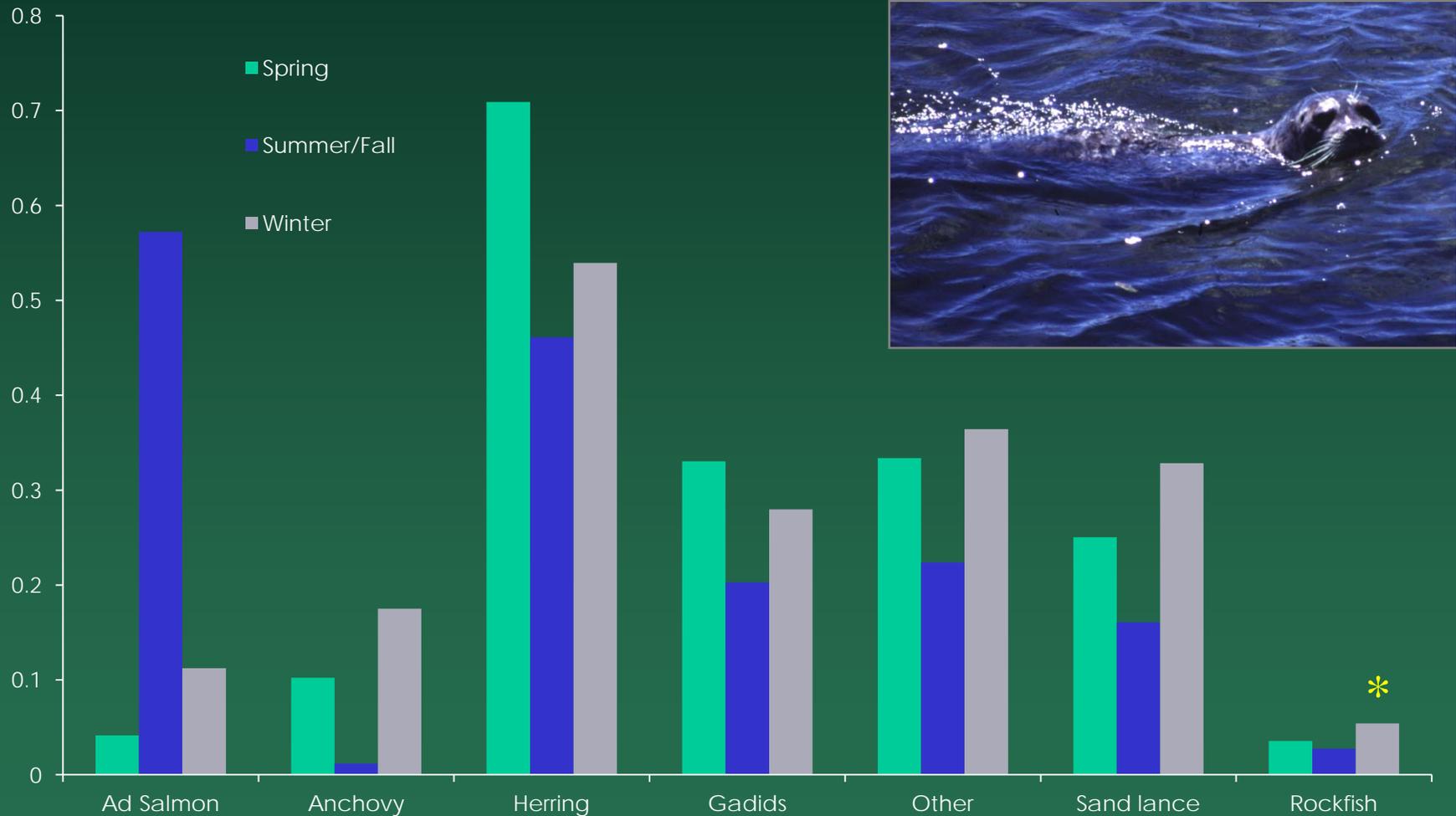
4 Regions



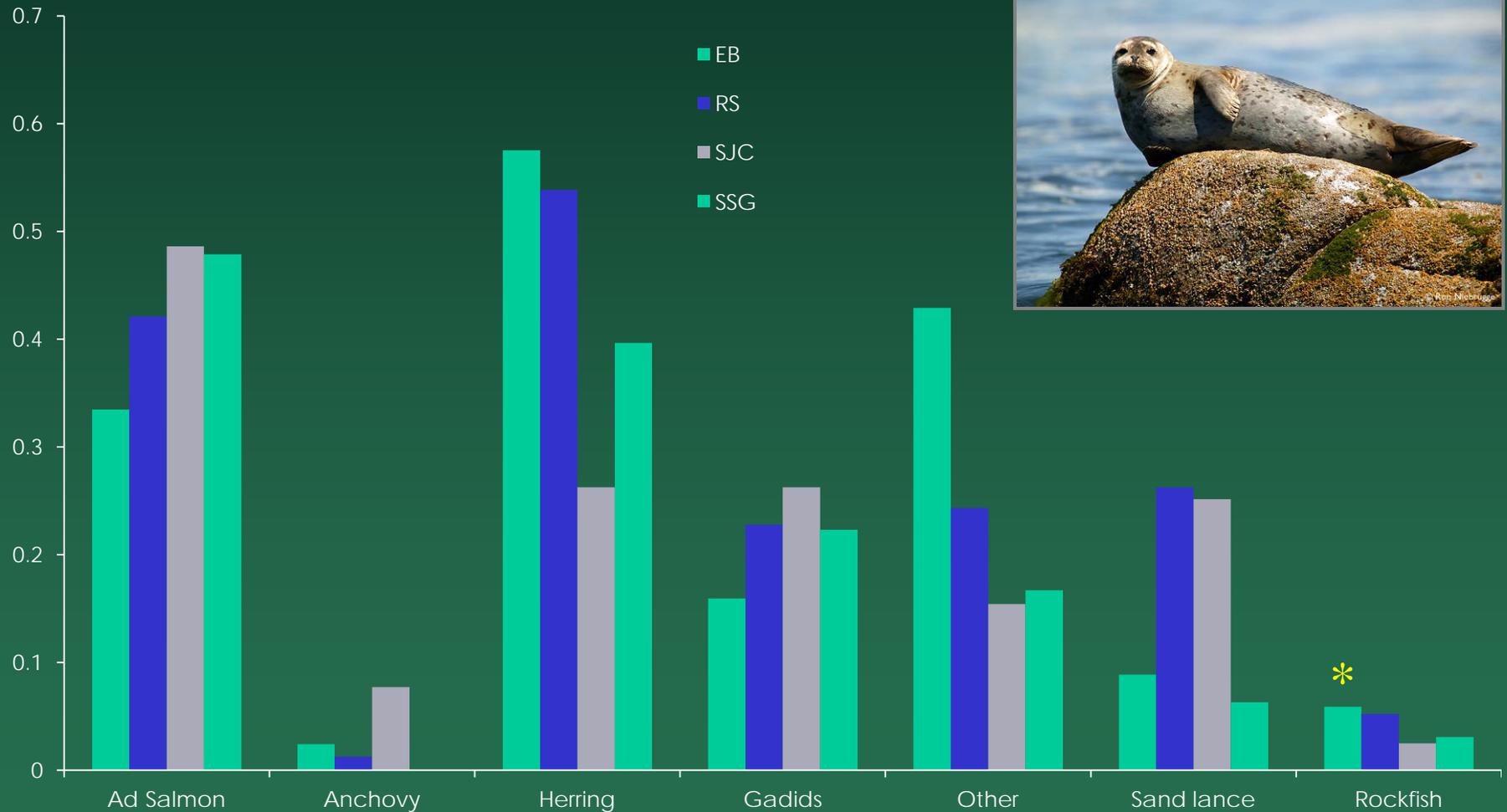
# Scat collection and processing



# Estimated frequency of occurrence of the 6 primary prey species or species groups in harbor seal scat samples (n=1683) for spring, summer/fall and winter seasons, 2005-2008, in the San Juan Islands



# Estimated frequency of occurrence of the 6 primary prey species or species groups in harbor seal scat samples (n=1683) by region all seasons combined, 2005-2008, in the San Juan Islands



# Rockfish species

Few otoliths recovered

All ages:

- juvenile (age 0-2)
- subadult (age 2-4)
- adult (age 6+)

Species:

Yelloweye Rockfish

Black Rockfish

Puget Sound Rockfish +



# Rockfish

- Small amount of predation may be important when harbor seal and rockfish populations are put into context.
- Rockfish may be “buffered” from predation when other prey species are abundant
- Rockfish may be more likely to be consumed during winter when harbor seal diet becomes more diverse



# Fatty Acids

Primary prey species / multiple age classes / n=267



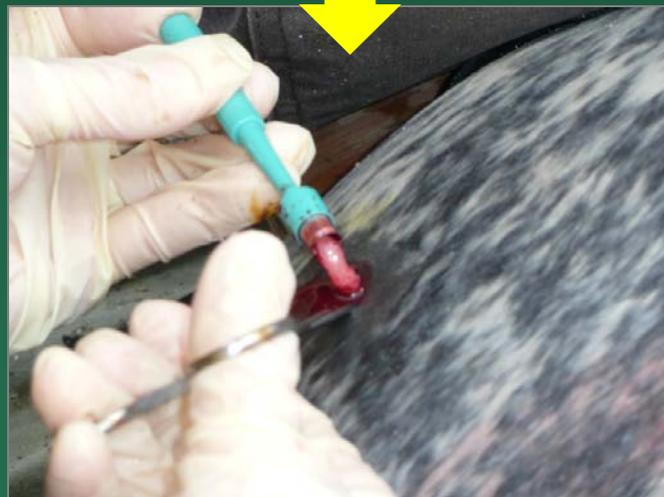
UAA

# Fatty Acids



Captures:  
April 2007-  
March 2008

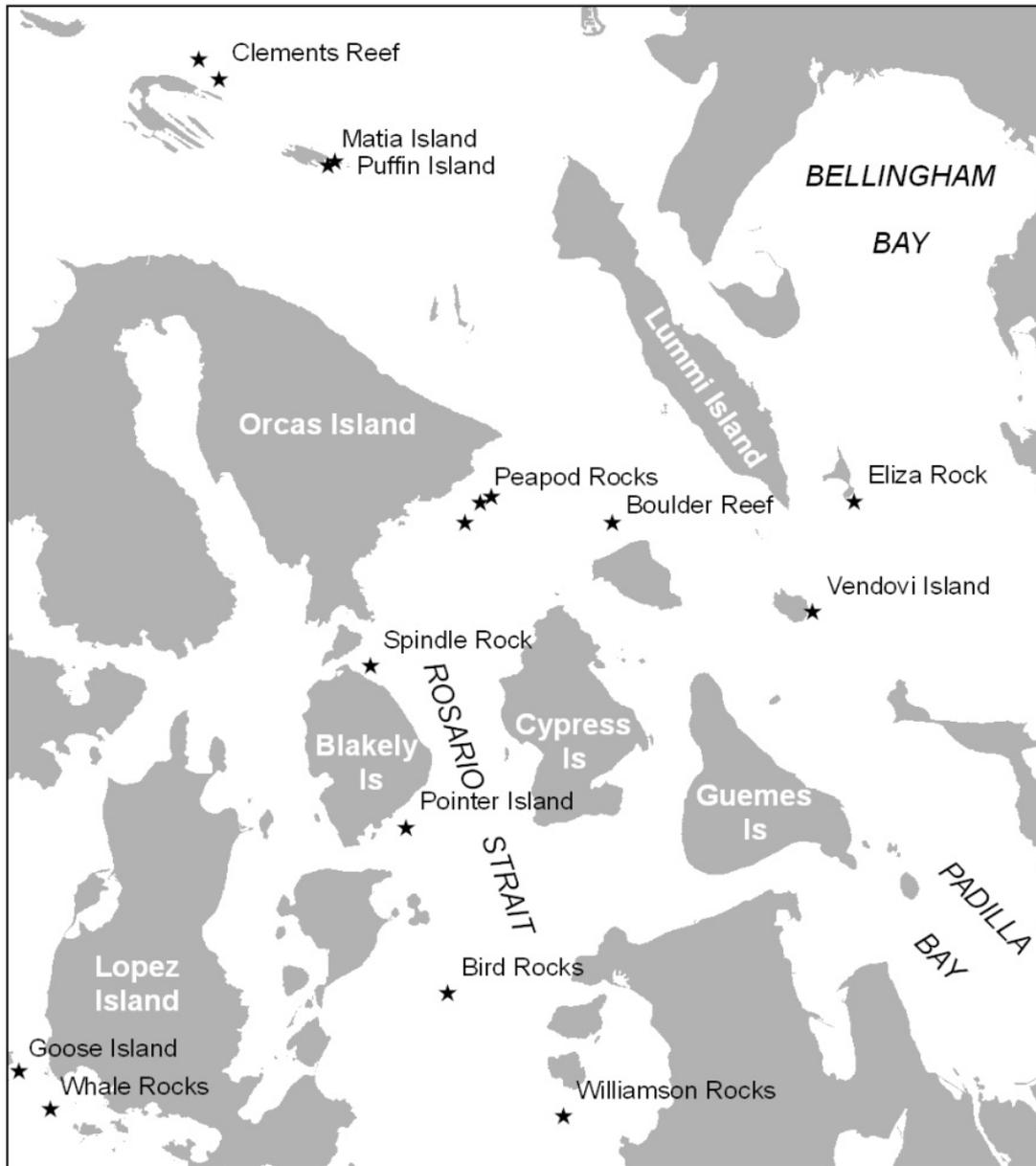
Padilla Bay  
Vendovi Is.  
Bird Rocks \*\*  
Belle Chain



blubber core

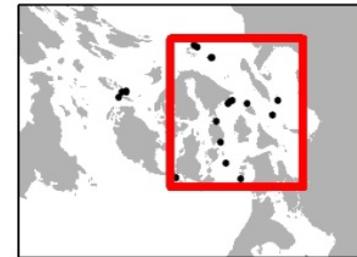


UAA

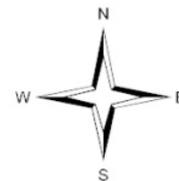


### Map Legend

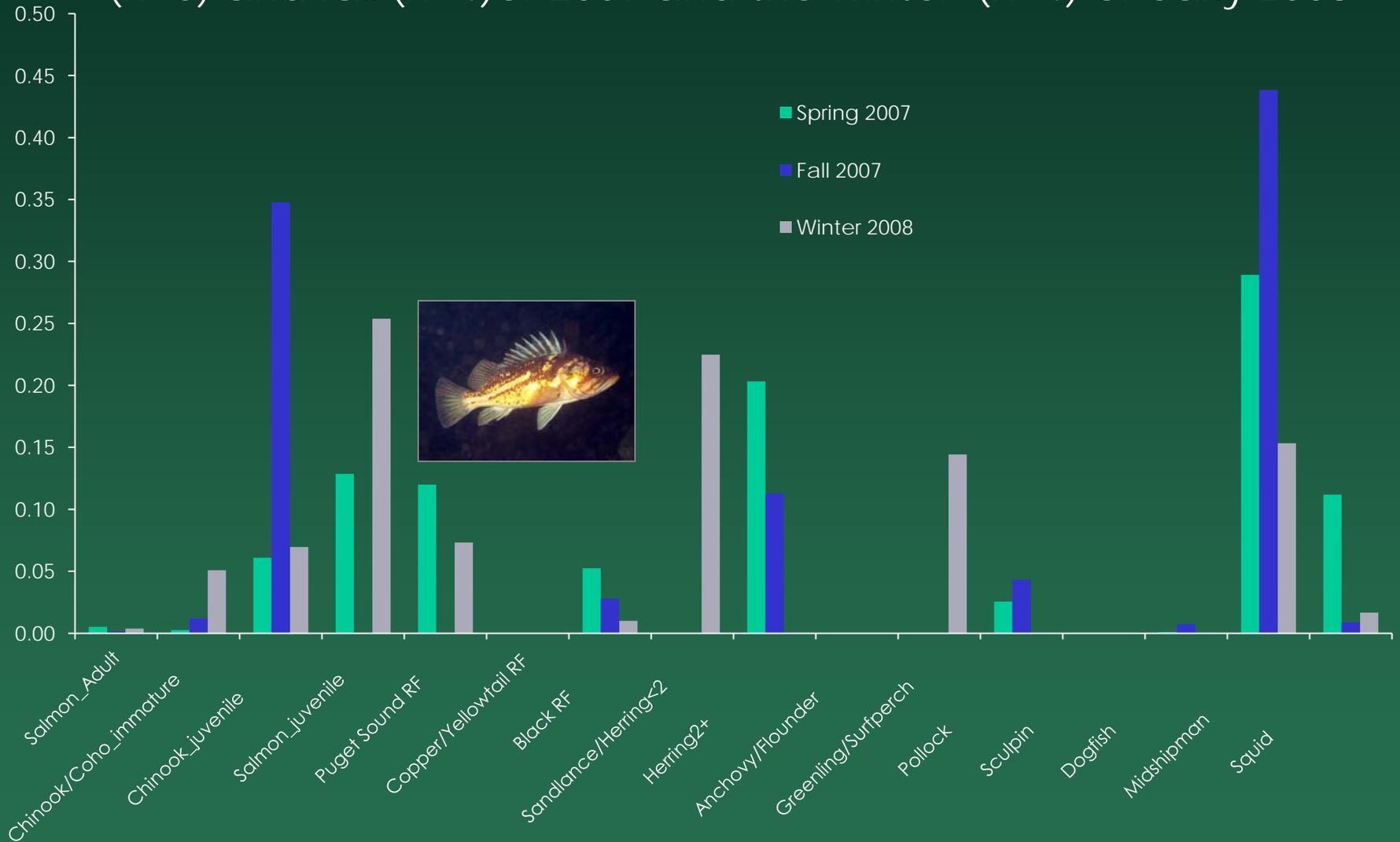
- ★ Haulout Sites
- Emerged Lands
- Water



Reference Scale  
1 : 205 000



**PRELIMINARY:** Average diet composition using fatty acid analysis of harbor seals in the Bird Rocks region in the spring (n=6) and fall (n=4) of 2007 and the winter (n=4) of early 2008



# Comparison of 2 methods for estimating diet



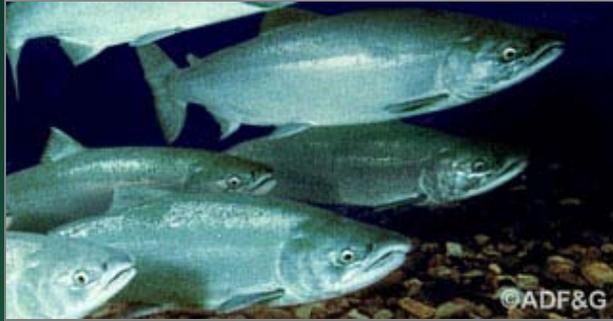
Different estimates!!!

Scat data produce frequency of occurrence statistics  
(sum can be greater than 100%)

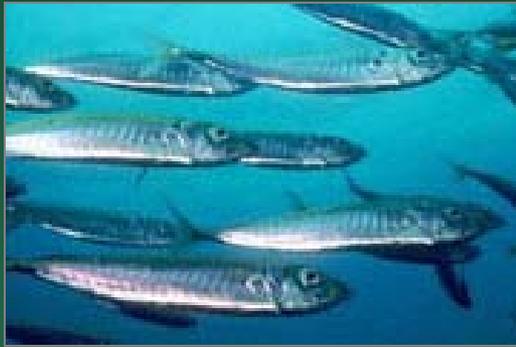
Fatty acid data produce an estimate of true diet  
composition (sum = 100%)

For example, every scat could contain herring remains  
(100% frequency of occurrence), but that does not  
mean that herring are all that is being eaten

# Comparison of 2 methods for estimating diet



Adult Salmon:  
Scat (RS): 16-49%  
FA: 0 - <1%



Herring  
Scat (RS): 16-64%  
FA: 0-22%



Rockfish  
Scat (RS): 4-10% overall  
FA: 0-12%

# Comparison of 2 methods for estimating diet



Large, adult rockfish may be under represented in diet if they are either torn apart at the surface or if they are not ingested and spewed

Not the case for small schooling species – PS RF

# Comparison of 2 methods for estimating diet

Scat samples are composed of what was eaten in previous 24-48 hrs

Fatty acid profiles provide what was consumed during previous weeks



Potentially important difference for seasonally abundant prey species - adult salmon appear to be nearly absent from the diets according to QFASA results, no blubber samples were collected from late May-early October when adult salmon are most abundant

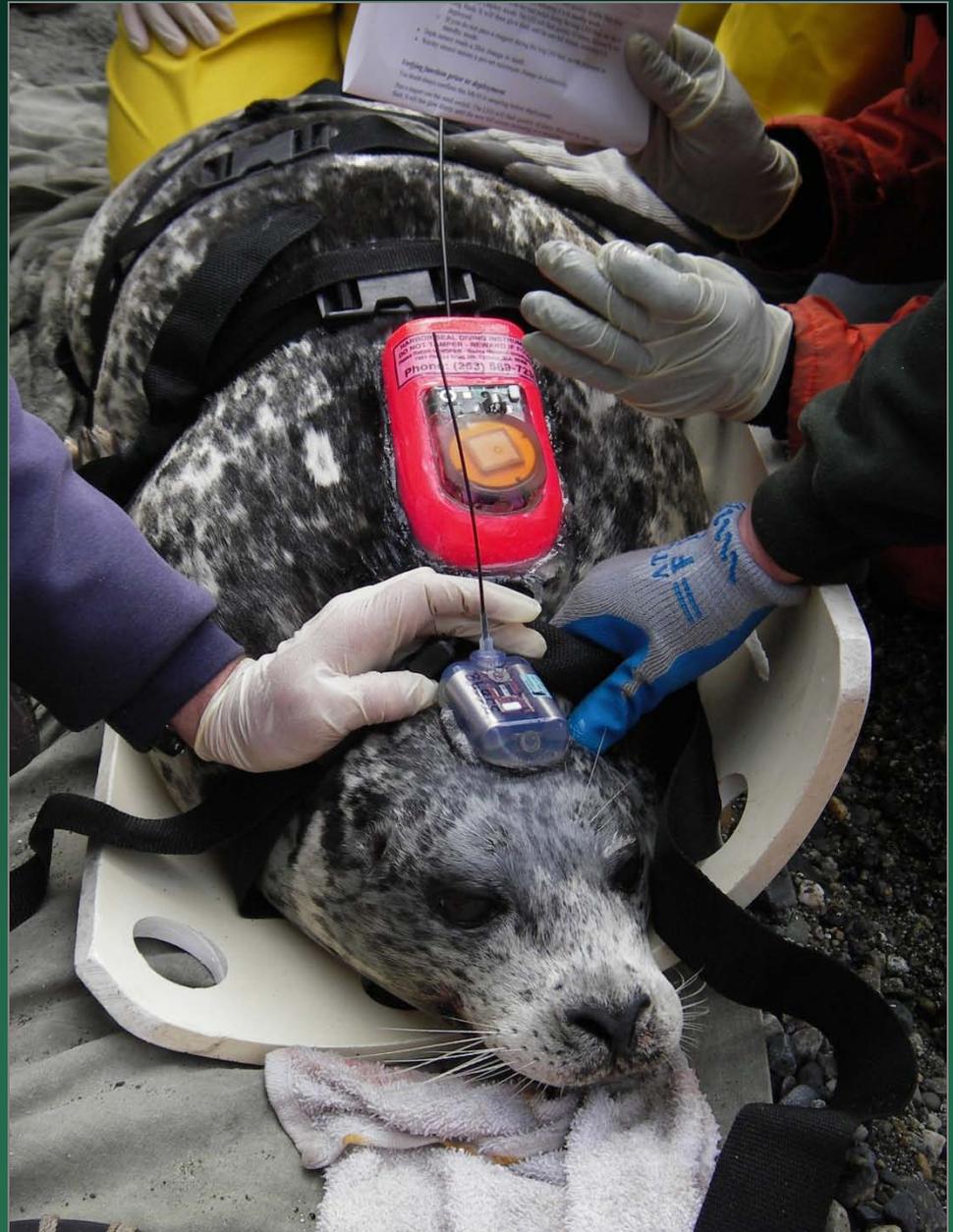
# Foraging Ecology

Satellite tags

TDR

- Mk9
- Mk10F (GPS)

HTR





50

200

Tagged 10.24.07  
Vendovi Island  
PTT 76224  
Sad M

200

VANCOUVER

200

STRAIT OF

VICTORIA

2007/11/02 18:19:14

JUAN-DE-FUCA

1000

48

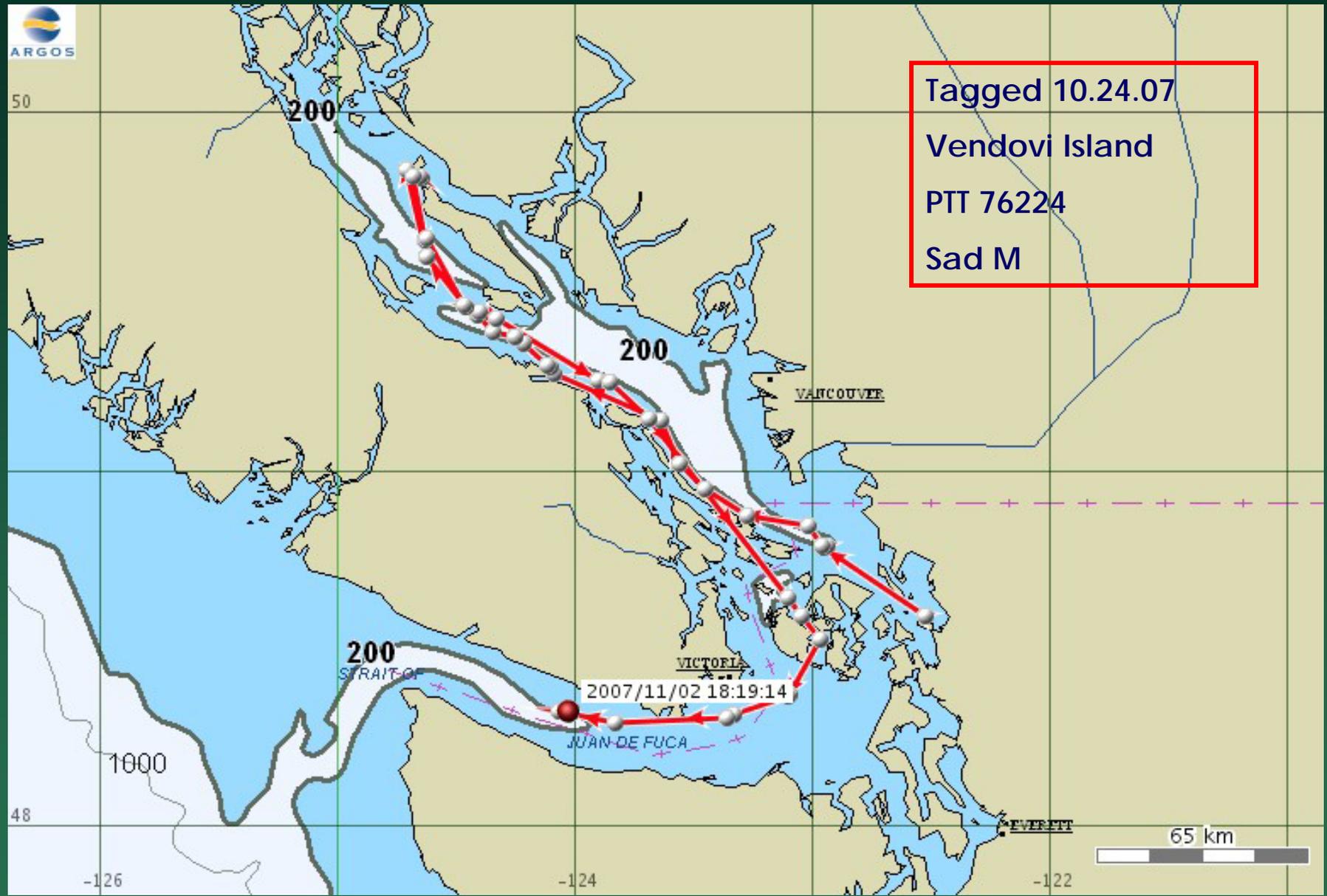
EVERETT



-126

-124

-122



# Comparison of 2 methods for estimating diet



Approach fatty acid results with caution

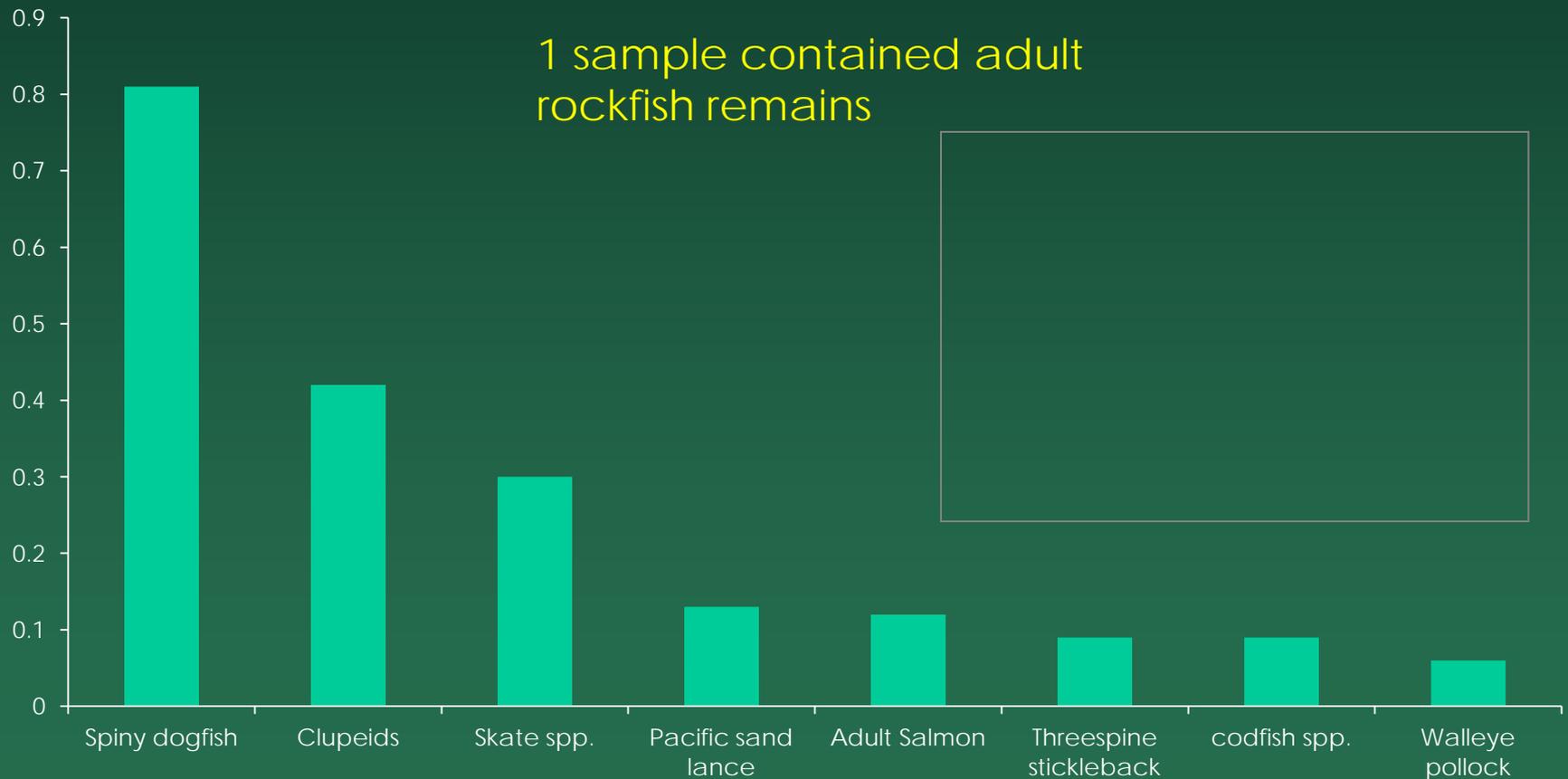
- Analyses are ongoing
- Sample sizes are small
- Prey groups may be adjusted

A photograph of a seal swimming in blue water, holding a large piece of reddish-orange rockfish in its mouth. The seal's head is above water, and its whiskers are visible. The background shows some green foliage in the foreground and background, slightly out of focus. The text is overlaid on the right side of the image.

Rockfish population models should incorporate the low and high estimated pinniped predation rates on rockfish in diet analyses



# Percentage occurrence (FO) of prey species in Steller sea lion scat samples, 2006-2008, in the San Juan Islands (n=67)



# California sea lions



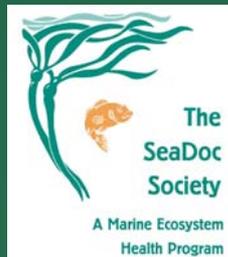
- No diet data have been collected in the San Juan Islands
- Numbers are low
- No predation threat to rockfish at this time

# Acknowledgements

We thank J. Gould for assisting with boat operations and field collection of samples; B. Diehl, K. Luxa, K. Brock, A. Brower, A. Galloway and M. Erkel for assistance with field collection and sample processing; W. Walker for salmon otolith and cephalopod beak species identification; S. Riemer for rare prey species identification; J. Schweigert for the use of herring survey data; W. Palsson for providing recent trawl data and reviews; J. Foisy for creating Figs. 1-2, D. Penttila and K. Stick for providing forage fish information; K. Adicks for providing regional salmon abundance data; J. Gaydos, W. Palsson, D. Penttila, S. Peterson, S. Riemer, K. Stick, A. Thomas, G. Williams, B. Wright for reviews and providing valuable input; J. Topping and S. Rosenfield for identification of rockfish otoliths; and H. Huber and J. Thomason for lab space. Harbor seal research activities were conducted under MMPA Research Permit 782-1702-00. K. Ryan permitted access to intertidal areas at sites within the San Juan Islands Wildlife Refuge and P. Green permitted access to intertidal areas of Goose Island for sample collection.

We thank B. Hagedorn, B. Applegate, R. Tee, and S. Ali for their assistance in the ASET laboratory.

Financial support was provided by WDFW, The SeaDoc Society, a program of the UC Davis Wildlife Health Center, Research Agreement No. K004431-25 and National Science Foundation Award No. 0550443 to A.A.



Questions?

