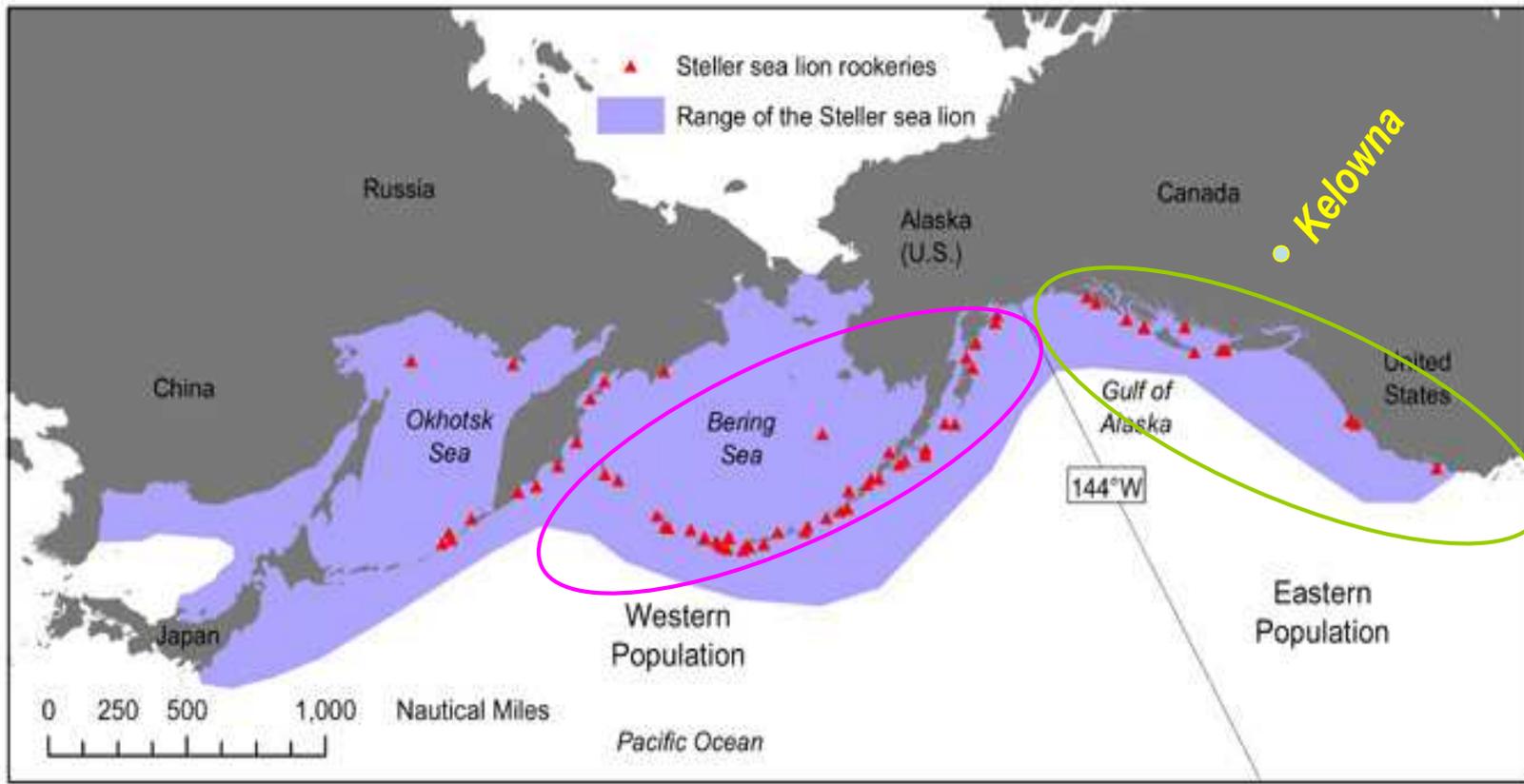


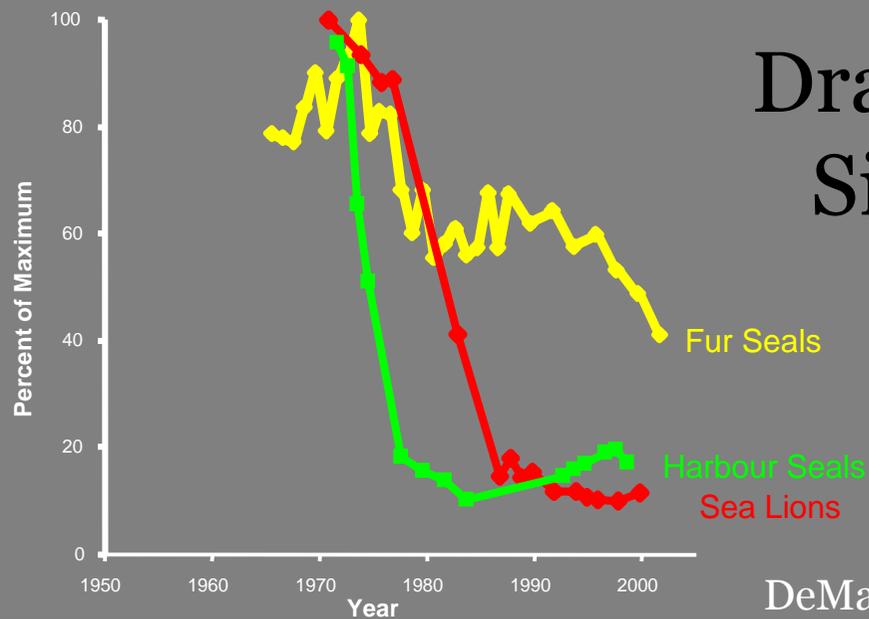
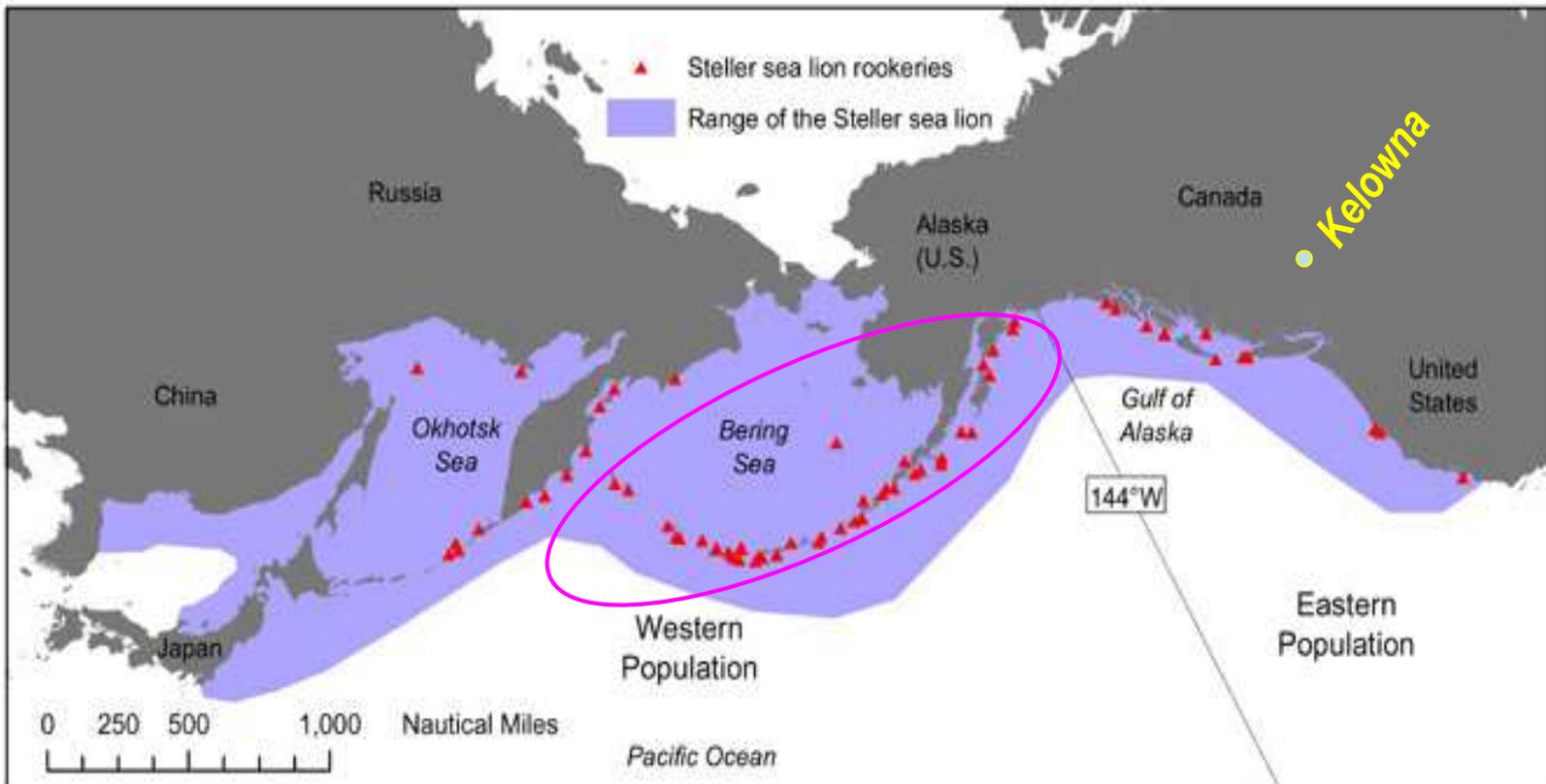
# Decline of the Steller sea lion : Challenges to addressing a dramatic signal in the dynamics of a marine ecosystem.

Ruth Joy

University of British Columbia  
Marine Mammal Research Unit







**Dramatic  
Signal**

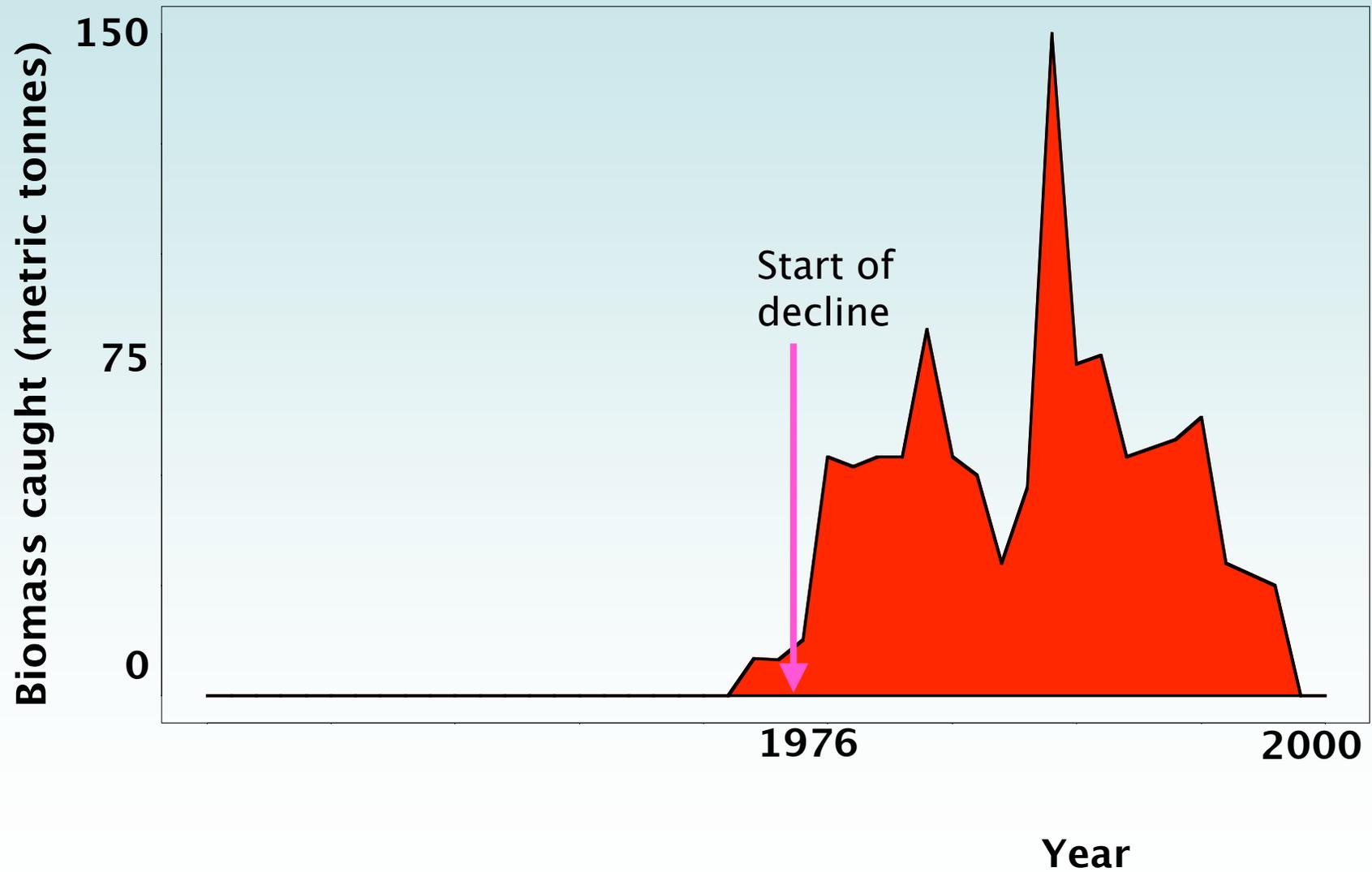
DeMaster et al. 2006

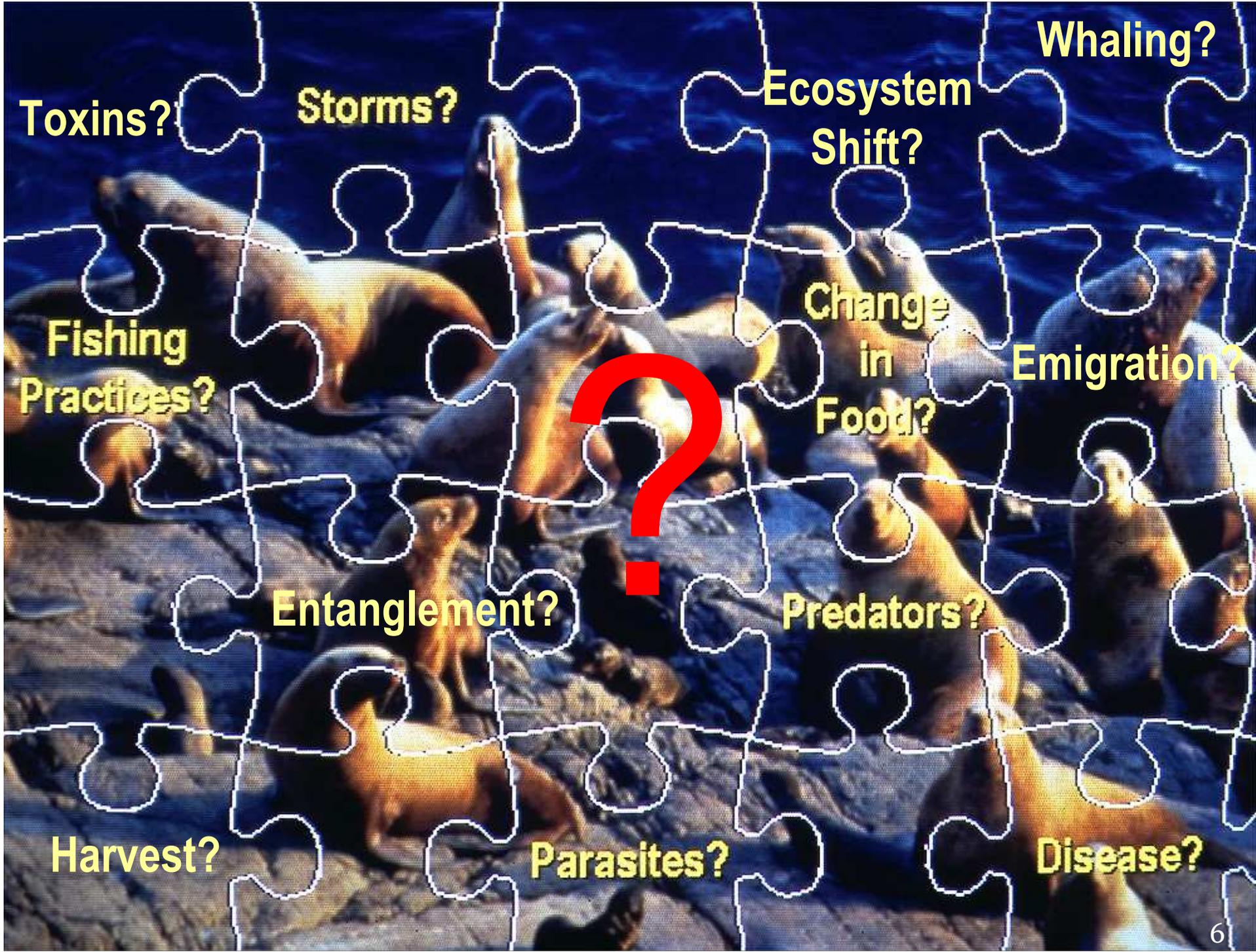


Section 7 of the ESA –  
states that federal agencies must  
ensure that  
“any action authorized, funded, or  
carried out does not jeopardize the  
continued existence of any  
endangered species”.



# Pollock Fisheries Data, Aleutian Islands





Toxins?

Storms?

Ecosystem Shift?

Whaling?

Fishing Practices?

Change in Food?

Emigration?

Entanglement?

Predators?

Harvest?

Parasites?

Disease?



# A change in food availability?

Fisheries reduced stock size so that SSL did not have enough to eat.

Environment change increased stock size so that sea lions eat a less nutritious diet (Junk food Hypothesis)

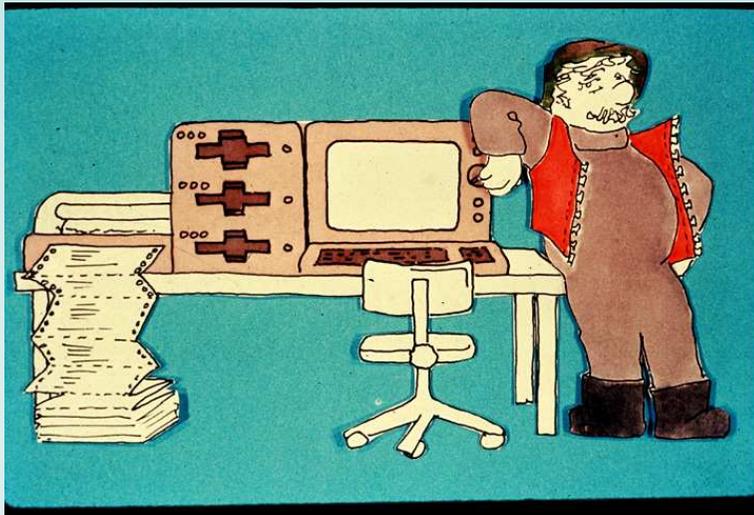
# Available Data and Approaches



Field studies

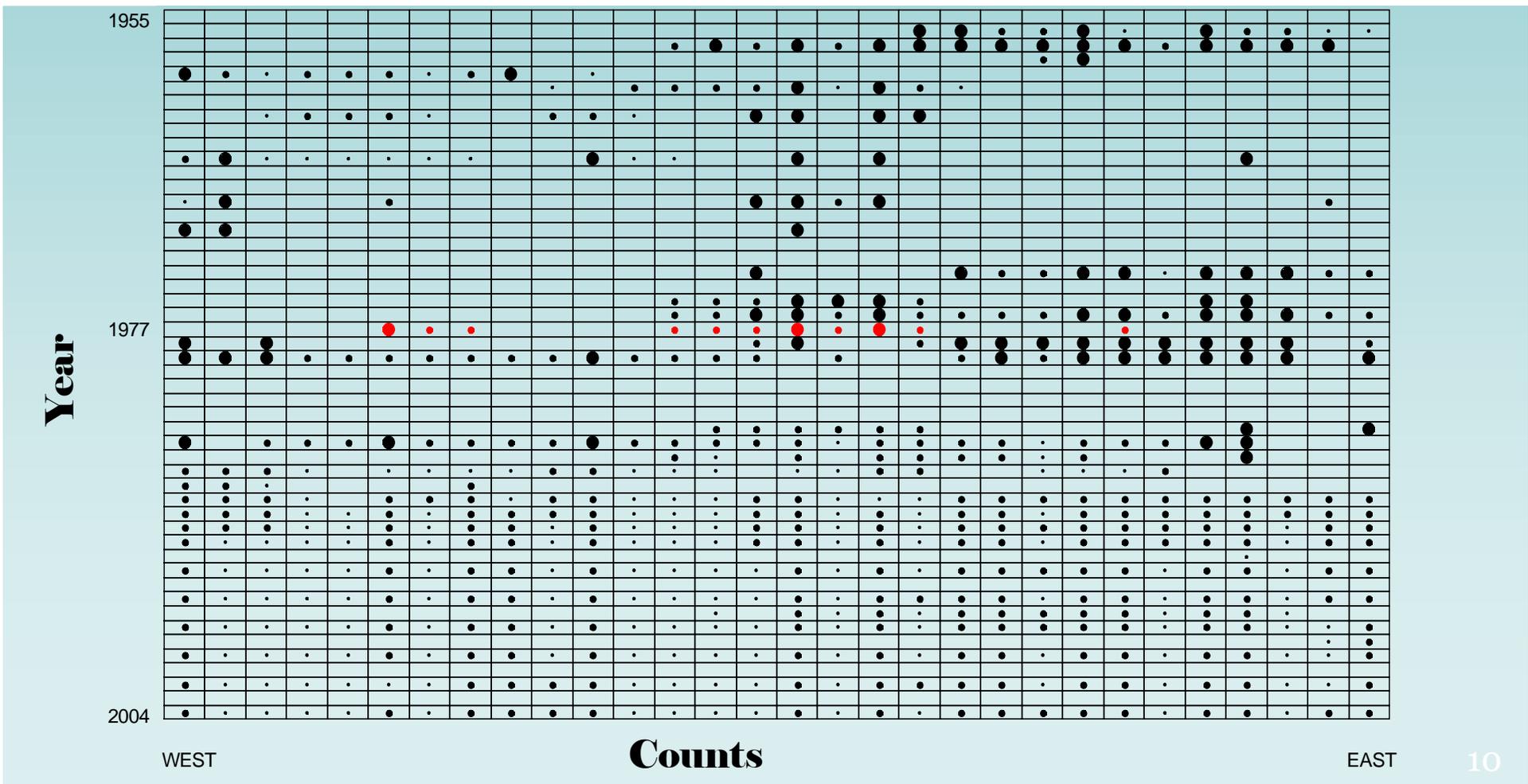


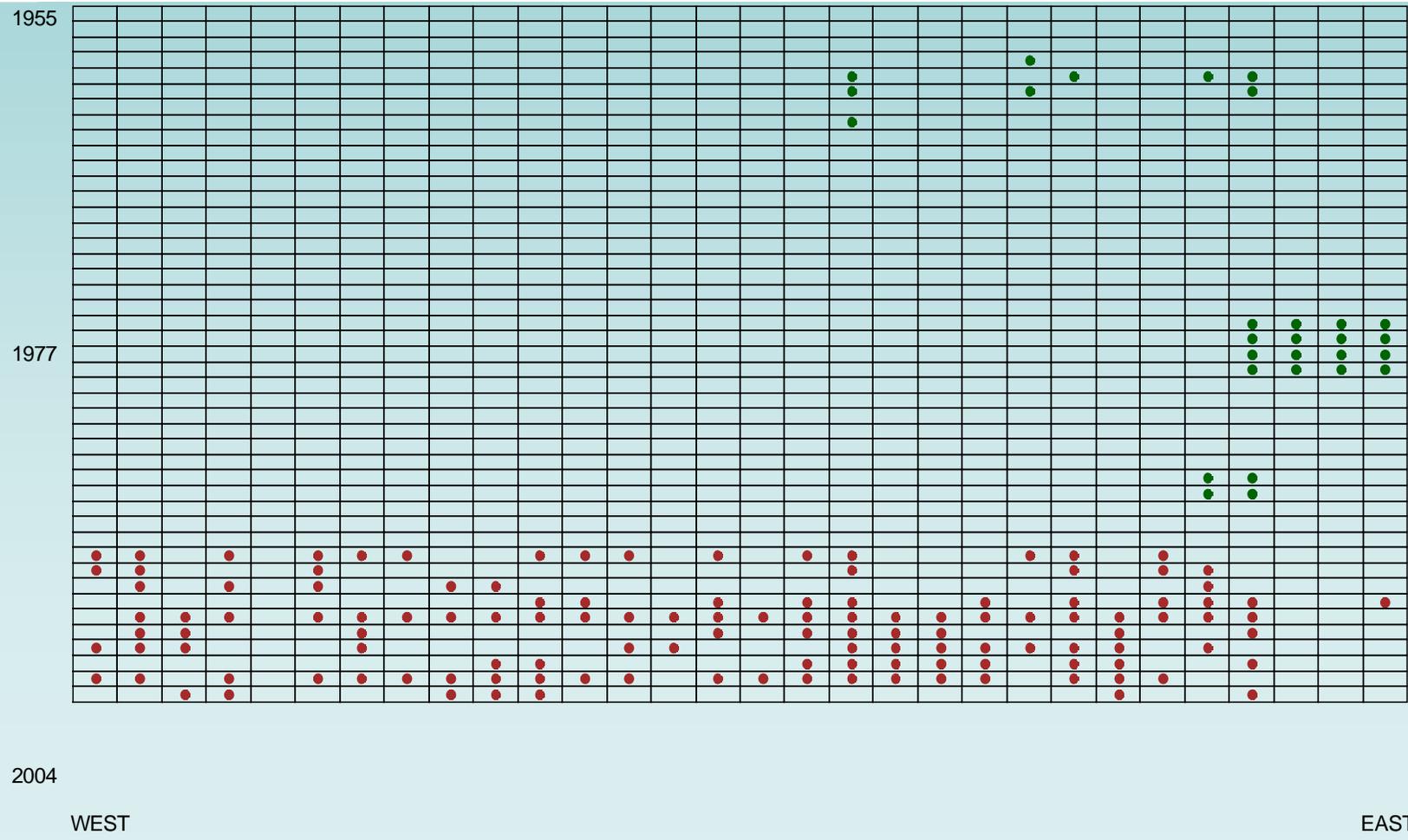
Captive animal studies



Computer and  
animal models







# Nutritional Stress: A problem of proof

- What evidence there is – reduced body size in 1980's over 1970's in the 1 area in which we have data (Calkins and Goodwin 1988).
- No change in blubber depth
- No change in skull size

# Limitations of the field data

- No pre decline data
- No consistency of collection methods
- Opportunistically collected
- Biology is such that you never know what exactly you are collecting

# Captive animal experiments : Physiology



We try to make a link between the captive animals in a controlled environment and the wild population

# NUTRITIONAL STRESS

Two aspects to nutritional stress:

There is the restriction in QUANTITY of food, but there is also the restriction in QUALITY of that diet.

Locomotion

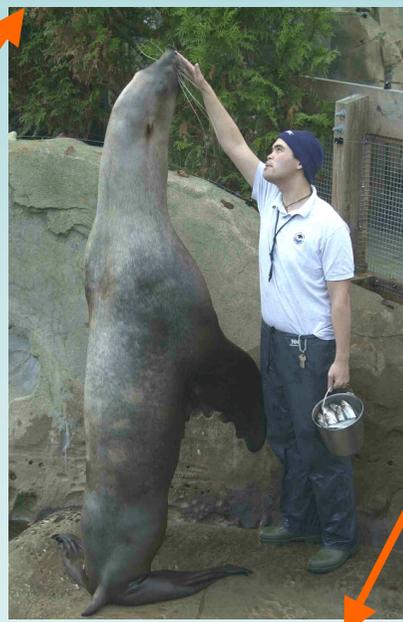
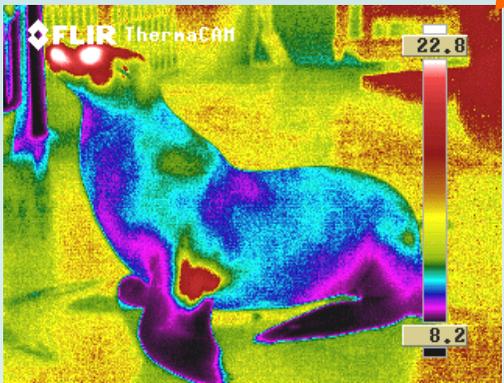
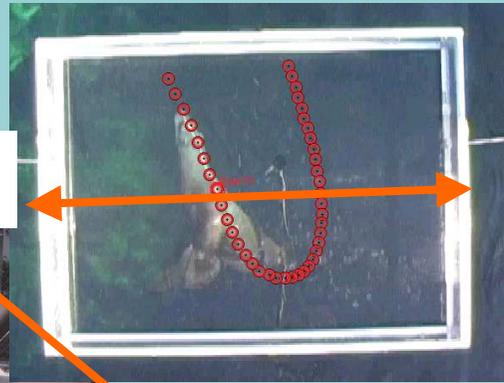
Foraging

Digestion

Metabolism

Thermoregulation

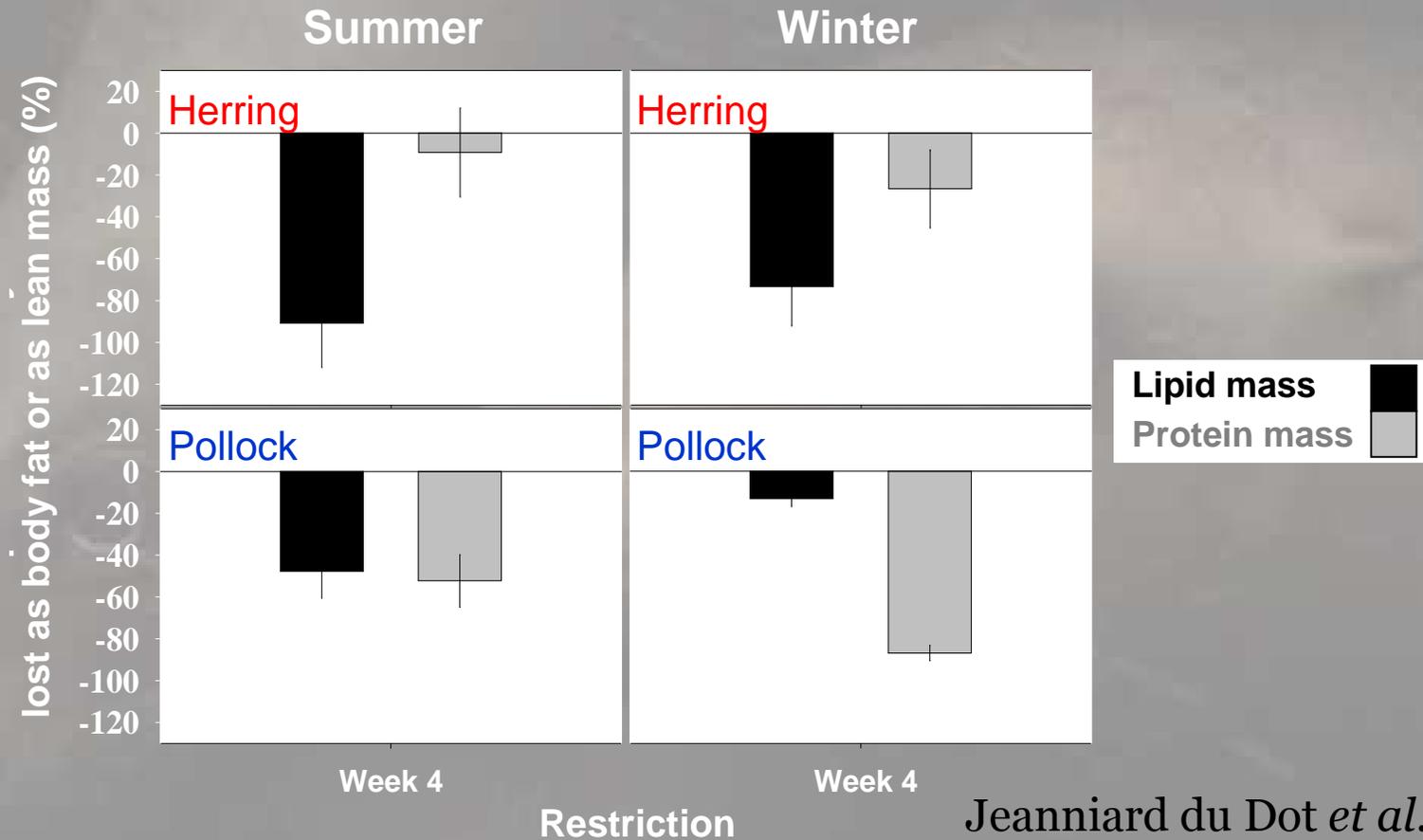
Growth/condition



# Captive Results

- We have shown that young animals cannot buffer the effects of low quality diet. For example, feeding young animals as much as they can eat, they still lose mass on a low energy diet due to restrictions of stomach capacity and digestion efficiency.

# Body composition response to nutritional stress



Jeanniard du Dot *et al.*  
in review

Recall pollock = “junk food”

# “Real World” Implications

An adult male would require **30 kg** of herring per day (C.I.: 22.3, 37.7),

but would require **41 kg** of pollock per day (C.I.: 31.3, 50.7)

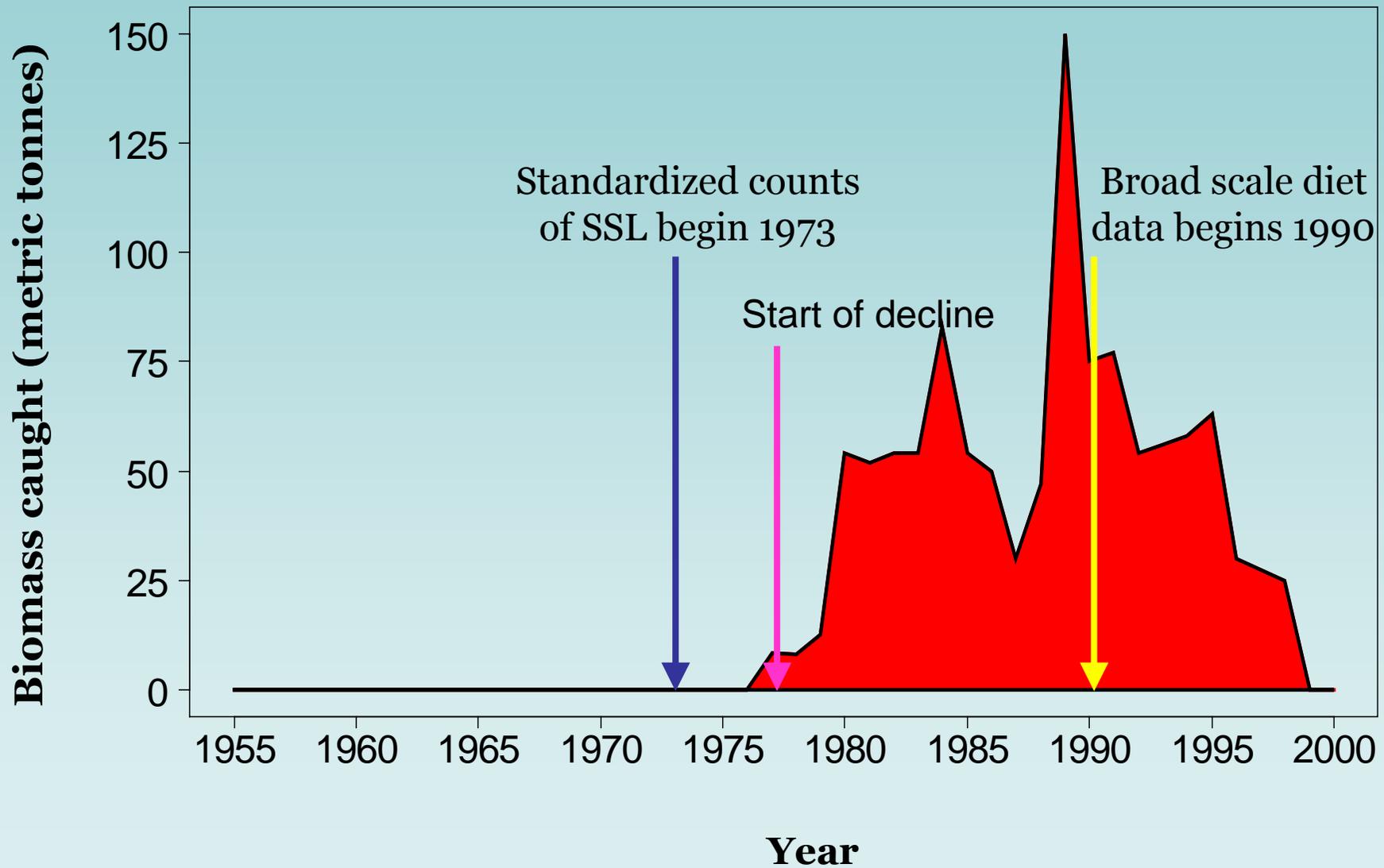
a 37% increase in prey biomass

# Limitations on Captive Experiments

Although we have a “huge” number of marine mammals by captive standards, it’s only 12 animals, and they differ by gender, age, and captive environment.

At the end of the day, the inference for the results is for a captive environment, and the link to the wild is not always obvious.

# Pollock Fisheries Data, Aleutian Islands



# Was it fisheries?

- Classical statistics GEE's attempt to link biomass fished to rates of population change (Dillingham et al. 2006).
- Ecosystem modeling (Guenette et al. 2006)
- Population Dynamic Modeling (Matthiopoulos et al. 2008, Wolf et al. 2006?)

# Modeling limitations

Dependent on assumptions about things we don't know, and modeling this complex system is only as good as our understanding of the system.

# Challenges

There's no reliable PRE DECLINE data

Heterogeneity of the environment and the complexity of sea lion biology make it difficult to separate cause and effect.

No ecosystem level experiments to directly test the question

# \$ 190 million question

Do fisheries jeopardize the survival and recovery of the Steller sea lion?

# Closing comments

As a statistician, it is a challenge to work on such a high profile problem and yet have such limited data.

# Thank you



- [www.marinemammal.org](http://www.marinemammal.org)

