

02/21/13

Overview:

Sea Otter

Science

<TARGET><BILL></BILL><SUBJECT>02-21-13 Overview Sea Otter  
Science</SUBJECT><COMM>HFSH28</COMM></TARGET>

# Sea otters in southeast Alaska; their current population status & causes of mortality

Verena Gill



# Outline of presentation



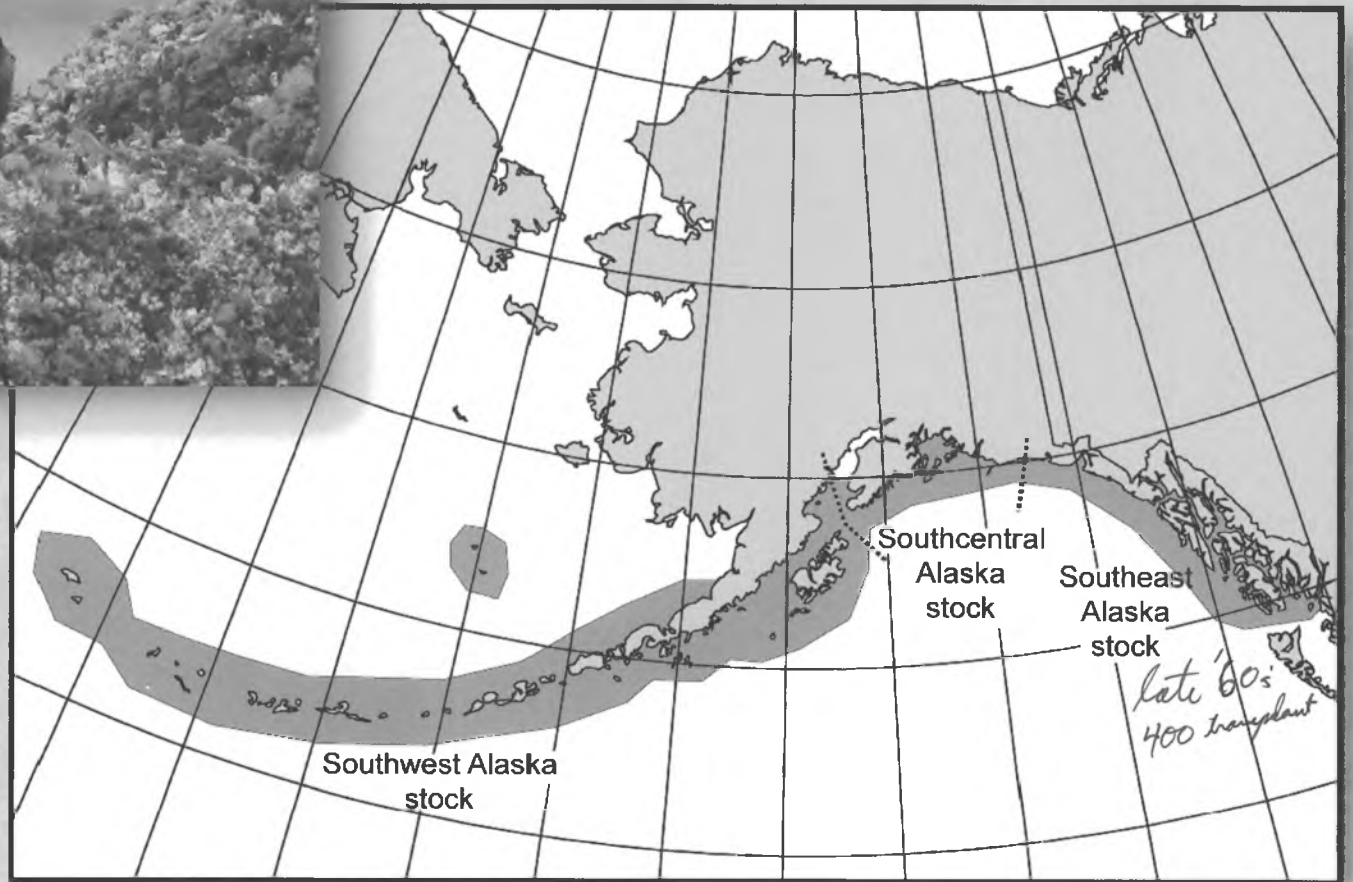
- Population trend & abundance of sea otters in SE Alaska
- Sources of mortality in SE AK



# Population trend of sea otters in SE Alaska



# There are 3 population stocks of northern sea otters in Alaska



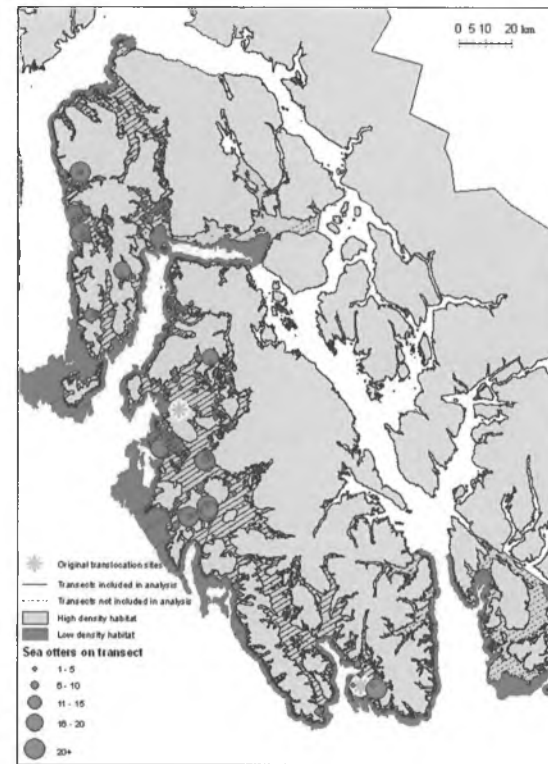
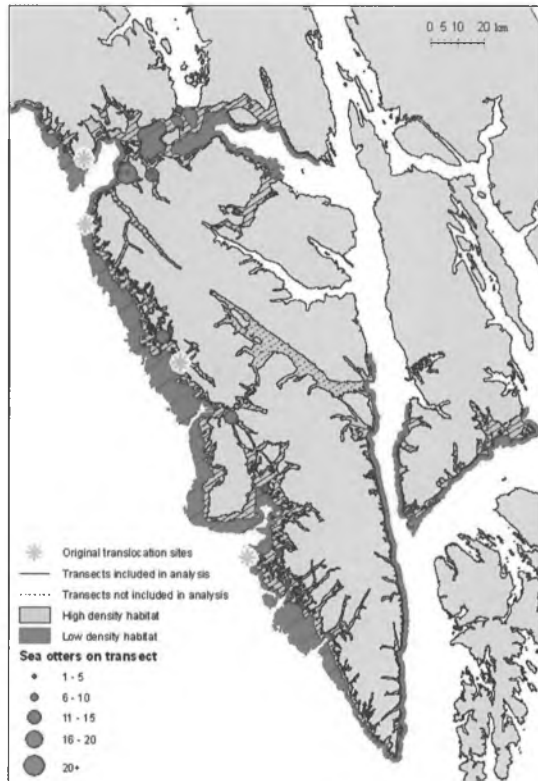
# 2010-2012 aerial survey in SE AK



**USGS**  
science for a changing world



Current annual growth rates;  
12-14% yr<sup>-1</sup> increase across stock; but  
Glacier Bay driving the increase in north



2003 = 10,563  
2012 = 25,712

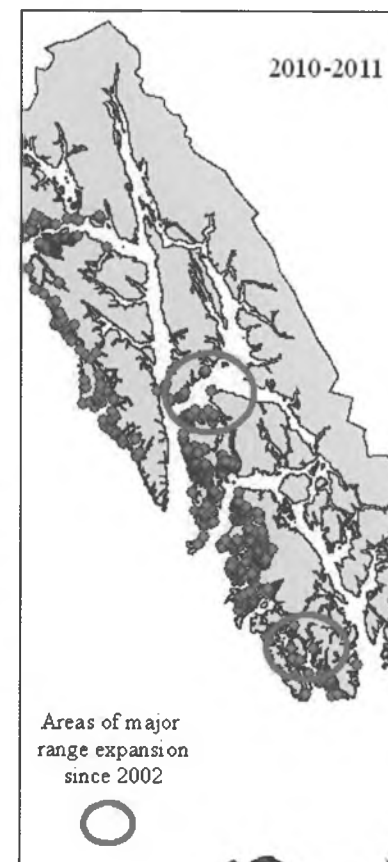


# Latest SE stock assessment (2013)

Survey Area	Year	Adjusted Estimate	CV	N <sub>MIN</sub>	Reference
North Gulf of Alaska	2000	32	0.38	24	USGS unpublished data
Glacier Bay NP	2012	8,508	0.20	7,201	Esslinger, Bodkin, & Weitzman (2013)
Northern Southeast Alaska (NSE)	2011	2,717	0.22	2,270	Gill and Burn unpublished data
Southern Southeast Alaska (SSE)	2010	12,873	0.18	11,099	Gill and Burn unpublished data
Yakutat Bay	2005	1,582	0.33	1,203	Gill and Burn (2007)
<b>Current Total</b>		<b>25,712</b>		<b>21,798</b>	
<b>2008 SAR Total</b>		<b>10,563</b>		<b>9,136</b>	



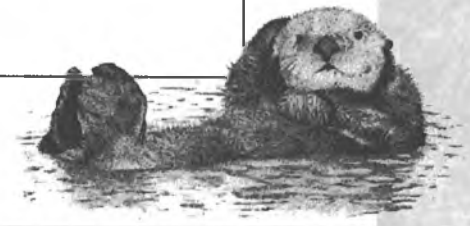
# Range expansion 1987-2011



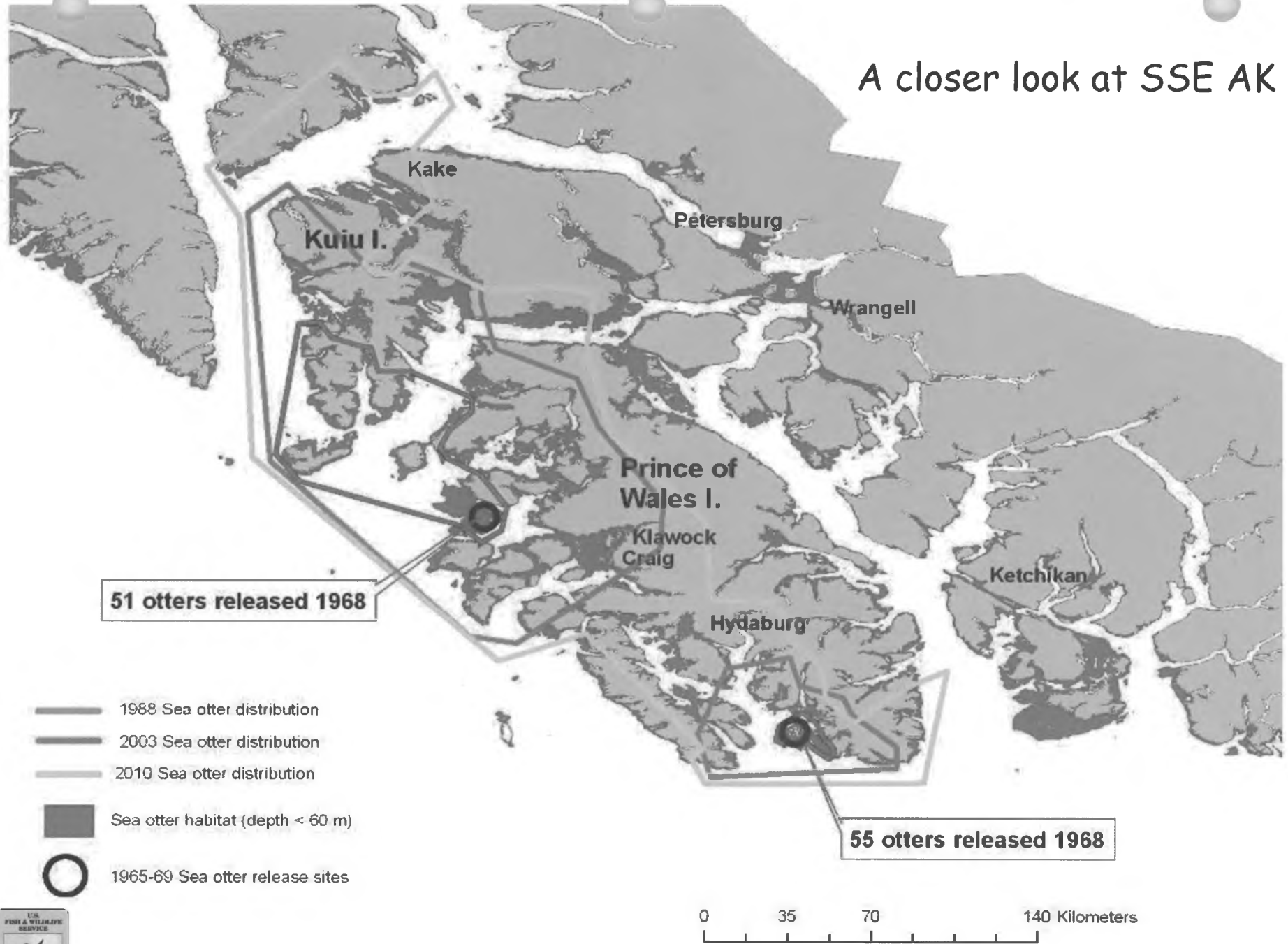
**USGS**  
science for a changing world



*4% expansion of  
Glacier Bay left out*



# A closer look at SSE AK



# Potential Biological Removal (PBR) of sea otters from SE AK stock is 2,180

*PBR = the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimal sustainable population.*

PBR is the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor:  $PBR = N_{MIN} \times 0.5 R_{MAX} \times F_R$ . The recovery factor ( $F_R$ ) for this stock is 1.0 as population levels have been stable or increasing with a known human take. For the SE AK stock of sea otters,  $PBR = 2,180$  animals ( $21,798 \times 0.5(0.2) \times 1.0$ ).

*(- 8,500 for Glacier Bay)*

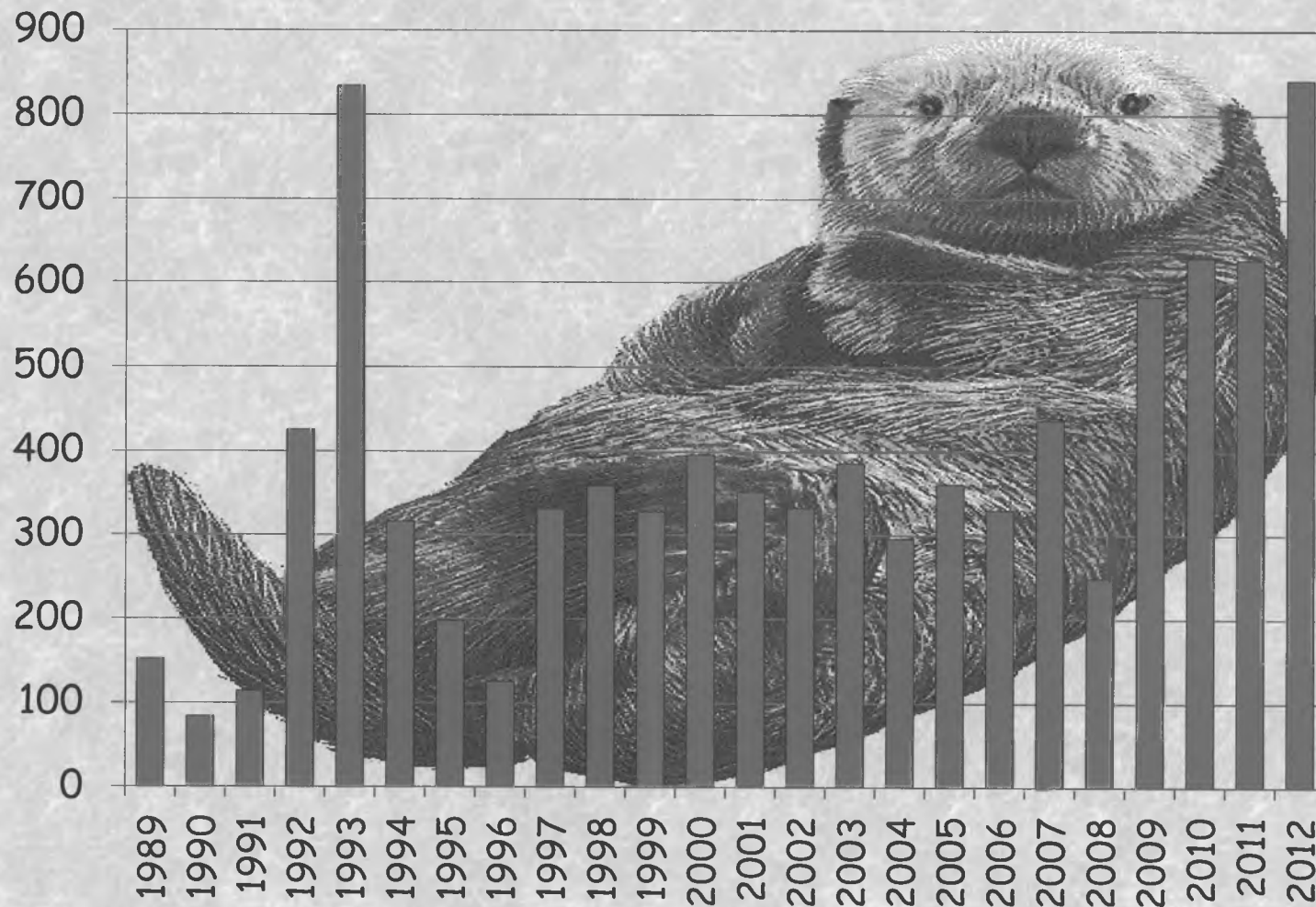


\*no hunting allowed in Glacier Bay but large pop in GB contributing to PBR

# Sources of mortality



# Reported subsistence harvest of sea otters from SE AK, 1989-2012.



Do these harvest  
represent population  
density or simply  
human availability

# Locations of reported subsistence harvest of sea otters from SE AK, last 5 yrs.

Village	2008	2009	2010	2011	2012	total
Coffman Cove	0	0	0	21	0	21
Craig (4)	15	44	136	98	63	356
Hoonah (5)	30	27	53	28	127	265
Hydaburg	0	0	0	20	14	34
Juneau	31	33	35	3	7	109
Kake	7	2	17	21	94	141
Ketchikan	9	0	11	14	0	34
Klawock (3)	7	199	58	49	58	371
Naukati Bay	0	0	0	3	64	67
Pelican	10	3	4	21	2	40
Sitka (1)	126	141	218	201	285	971
Wrangell	6	18	9	0	11	44
Yakutat (2)	8	117	89	149	117	480
	249	584	630	628	842	2933



Even if PBR not reached, local depletion can be a problem

# Health and disease program

- When possible, recover all sea otter carcasses reported across Alaska
- Necropsy all depending decomposition status
- Full work up on fresh dead animals
- All live-captured animals are also screened
- Samples to various collaborators for testing and variety of studies



# Sample sizes for screening

- Average of 80 dead otters sampled annually across AK; av. 7/yr in SE AK
- Live captures sporadic; 31 otters in SE AK 2011



# Testing and studies for sea otter disease surveillance



## Testing

- microbiology, virology, protozoal, fungal, biotoxins, histopathology

## Specific studies

- Protozoal encephalitis surveillance
- Bacterial flora surveillance
- Morbillivirus surveillance, focusing on PDV
- Avian influenza surveillance
- Herpes virus surveillance
- *Bartonella* spp. surveillance
- Contaminants (PBDE, PFC)
- Biotoxin surveillance (Domoic acid & PSP)
- *Coxiella* (Q fever) surveillance
- Clinical pathology (serum chemistry & complete hematologic analyses) of live sea otters

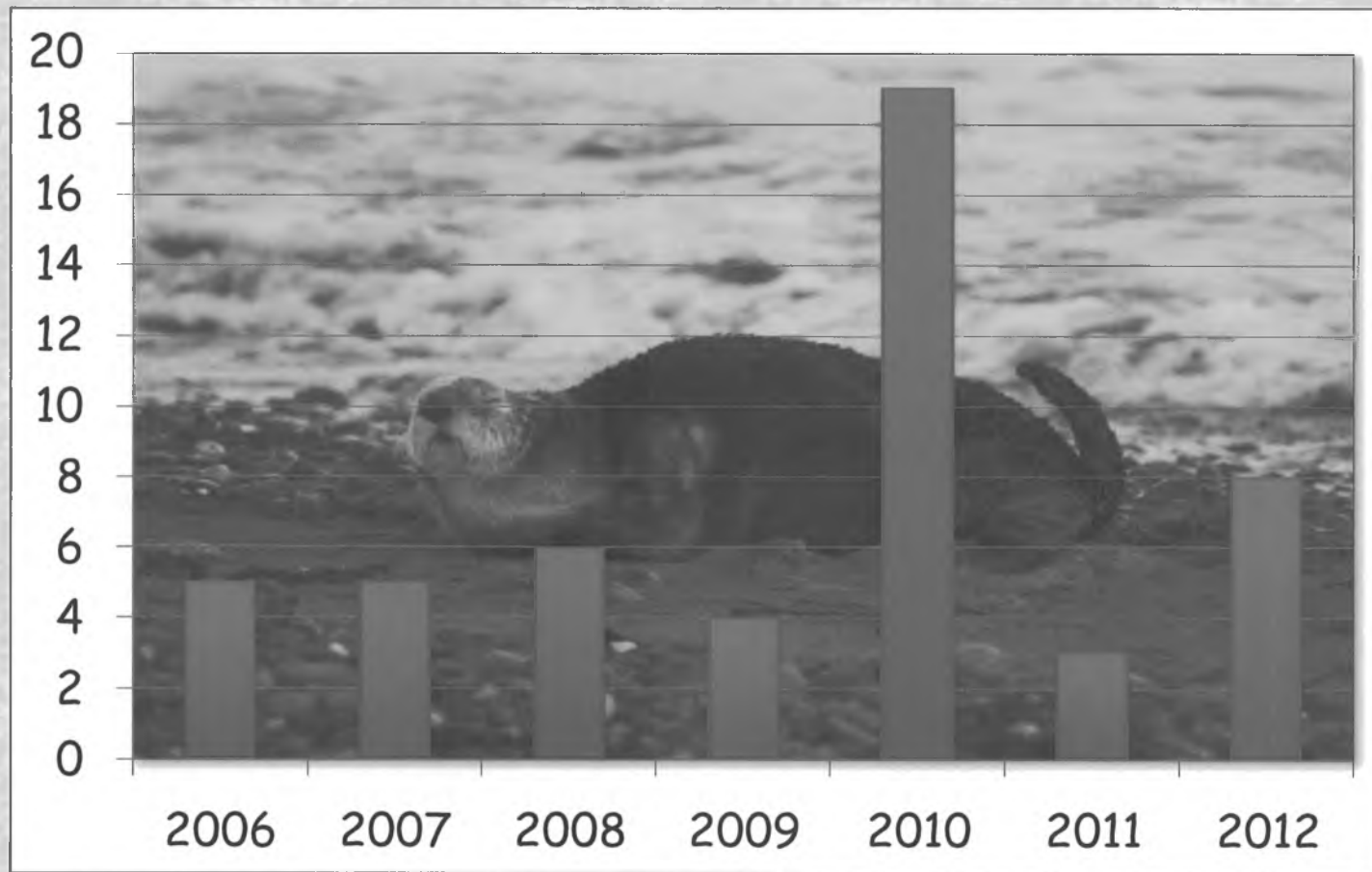


# Biotoxin surveillance project

- Project with NOAA
- Urine, pericardial fluid, stomach contents
- 137 sea otters tested for DA and Saxitoxin (PSP) that died 2005-2010 from various causes 39 (28%) had DA detected (Glacier Bay to Kodiak)
- 12 (9%) had PSP detected (Juneau to Kodiak)
- Had otter deaths related to PSP (Kodiak)
- All age classes, all sexes, all years, across range
- 30/31 live captured otters had PSP detected in May 2011 in SE AK



# Number of sea otter carcasses recovered in SE AK



*most from Glacier Bay*

# Location of carcasses recovered in SE AK

2006-2012

Location	Number
Glacier Bay	32
Sitka	13
Yakutat	2
Craig	1
Juneau	1
Kake	1
<b>TOTAL</b>	<b>50</b>

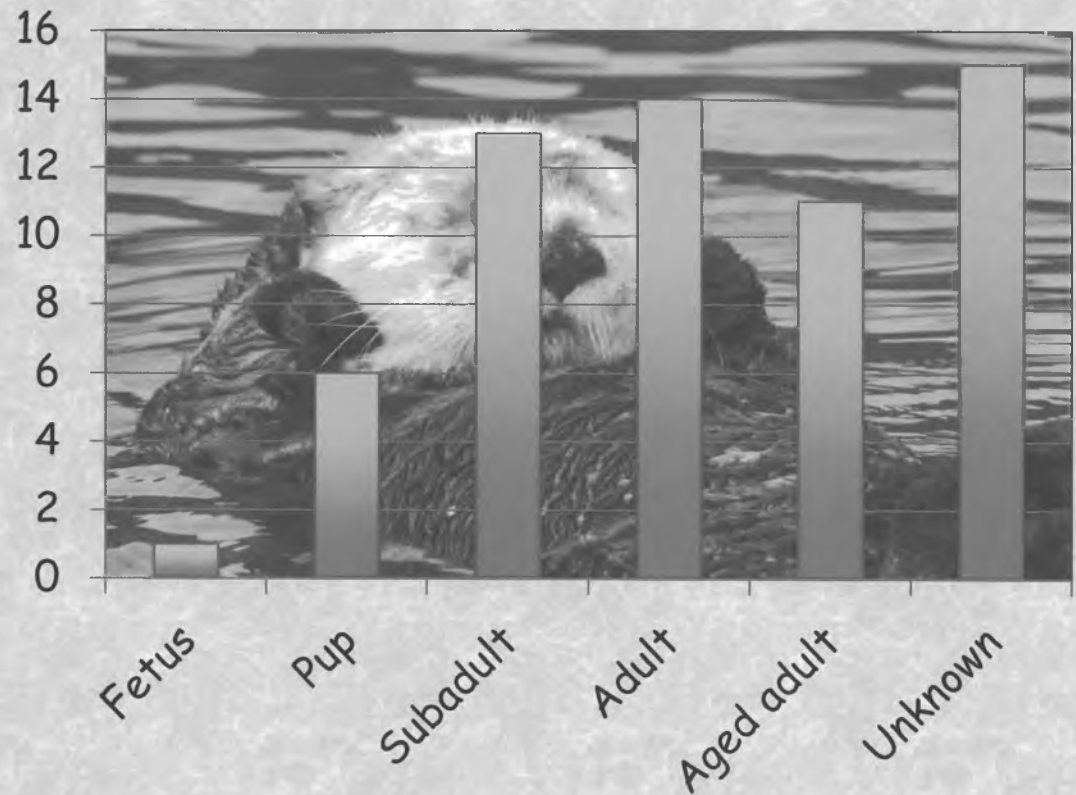


*Tauna moose*

# Age & sex composition of carcasses found in SE AK 2006-2012; profile is adult male



- Male
- Female
- Unknown



# Of documented CODs 2006-2012, trauma is #1 in SE AK

Cause of death	Number
Undetermined	23
Gunshot (not reported hunting)	6
General Trauma	6
Valvular endocarditis	4
Starvation	4
Torsion	2
Pup abandonment	1
Aortic aneurysm	1
Drowning	1
Heart failure	1
Sepsis	1
<b>TOTAL</b>	<b>50</b>

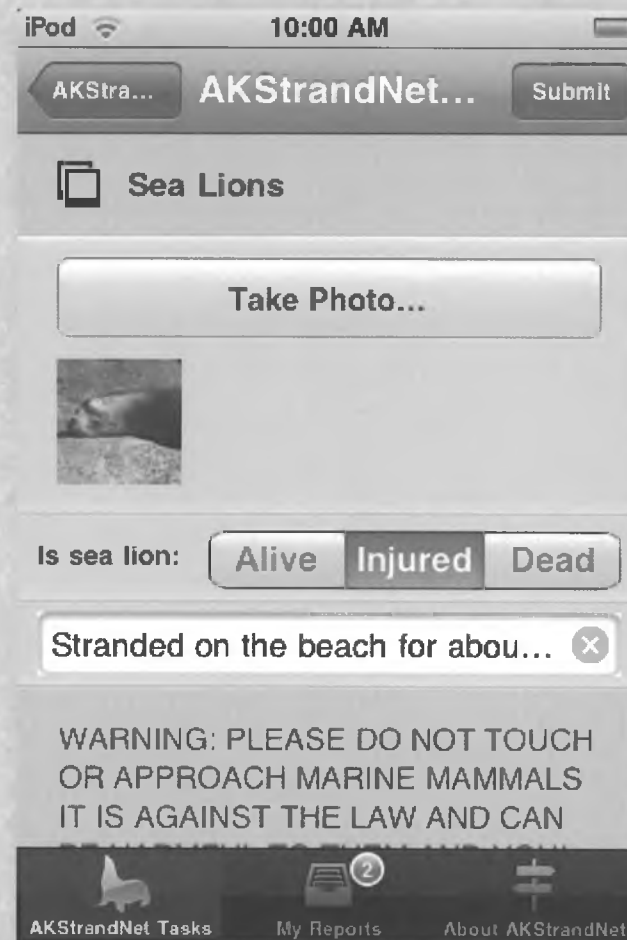


# SE AK sea otters are healthy

- Survey of live captures and stranded animals show that otters in SE have good body condition, healthy, and relatively disease free compared with other AK stocks.
- Only major current finding is presence of Saxitoxin (PSP).



# Ways to increase samples; AKStrandNet on iTunes (free)



# Sea otters and kelp forests

+



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James A. Estes  
University of California  
Santa Cruz



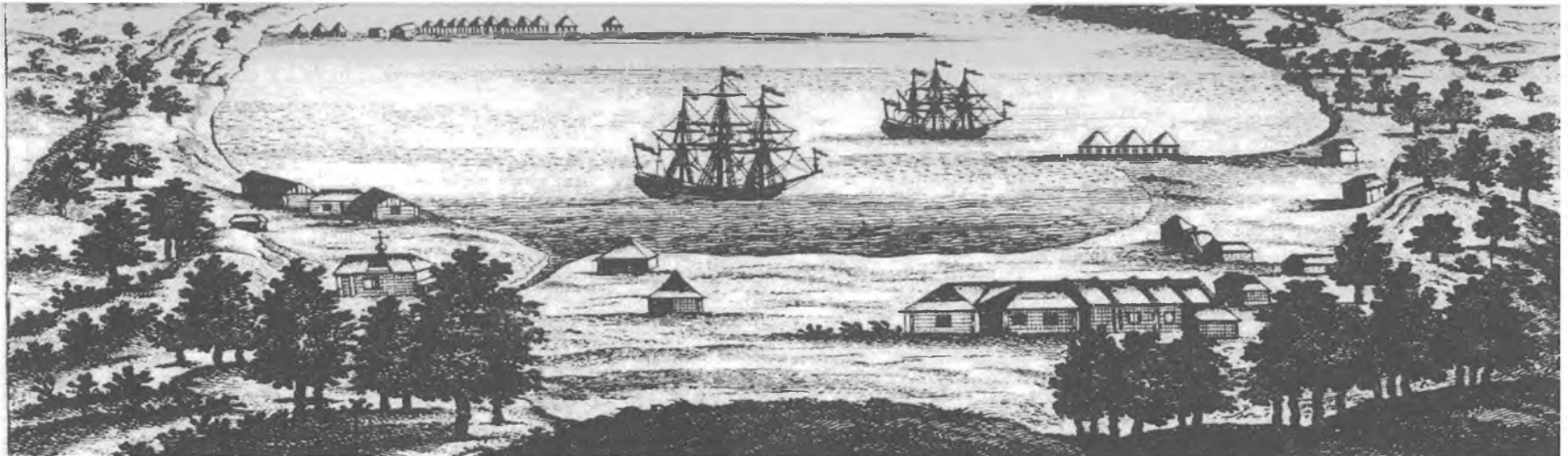
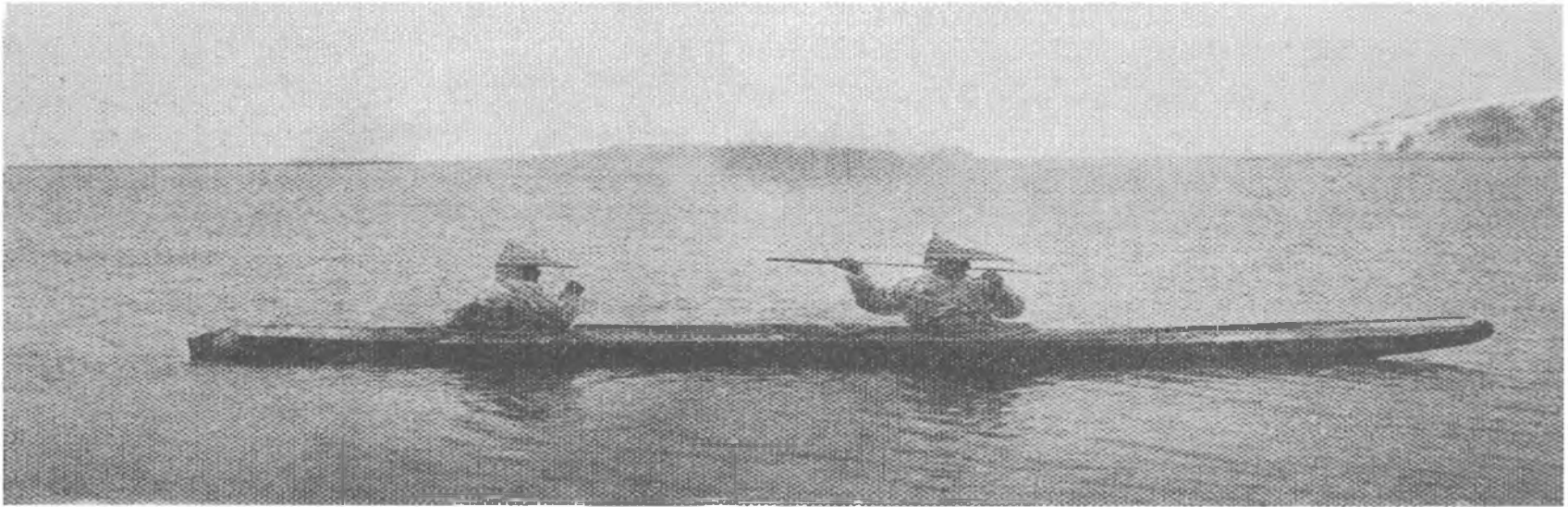
# Question?

What are the effects of sea otters on  
kelp forest ecosystems?

# Approaches

## History

*depletion fur trade  
repopulation change  
in ecology*



# Players



Sea otters



Coastal fishes



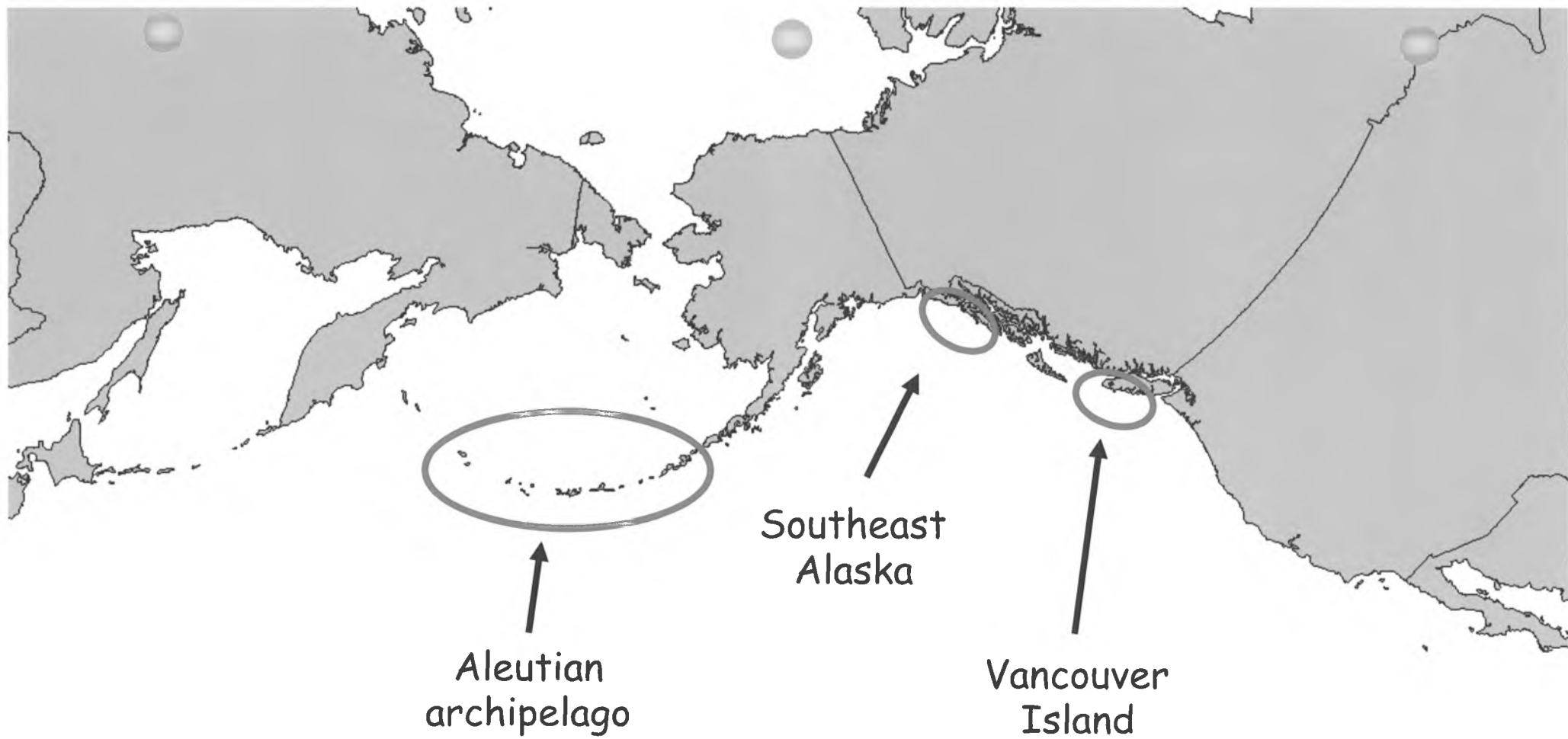
Sea urchins



Kelp



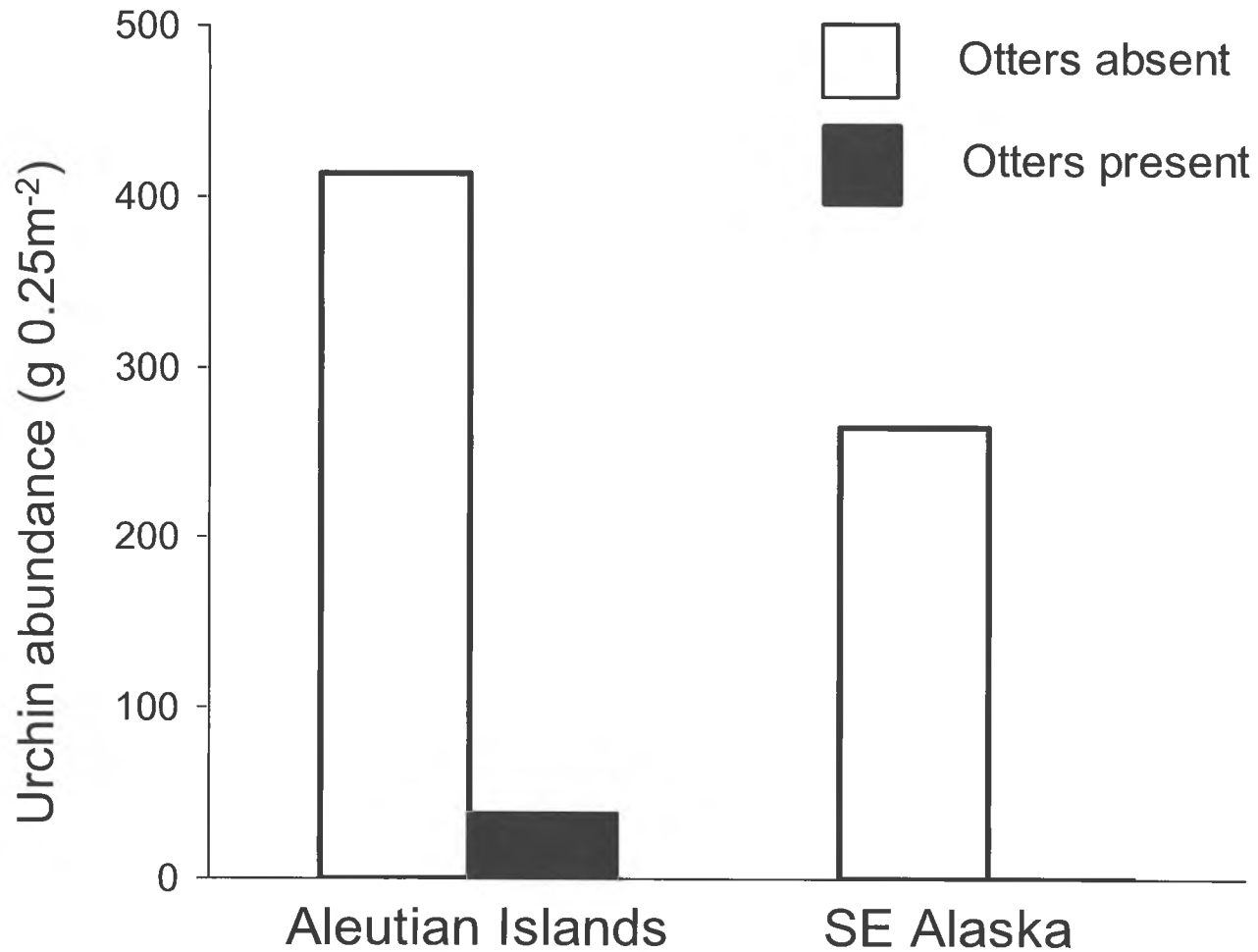
Carbon dioxide



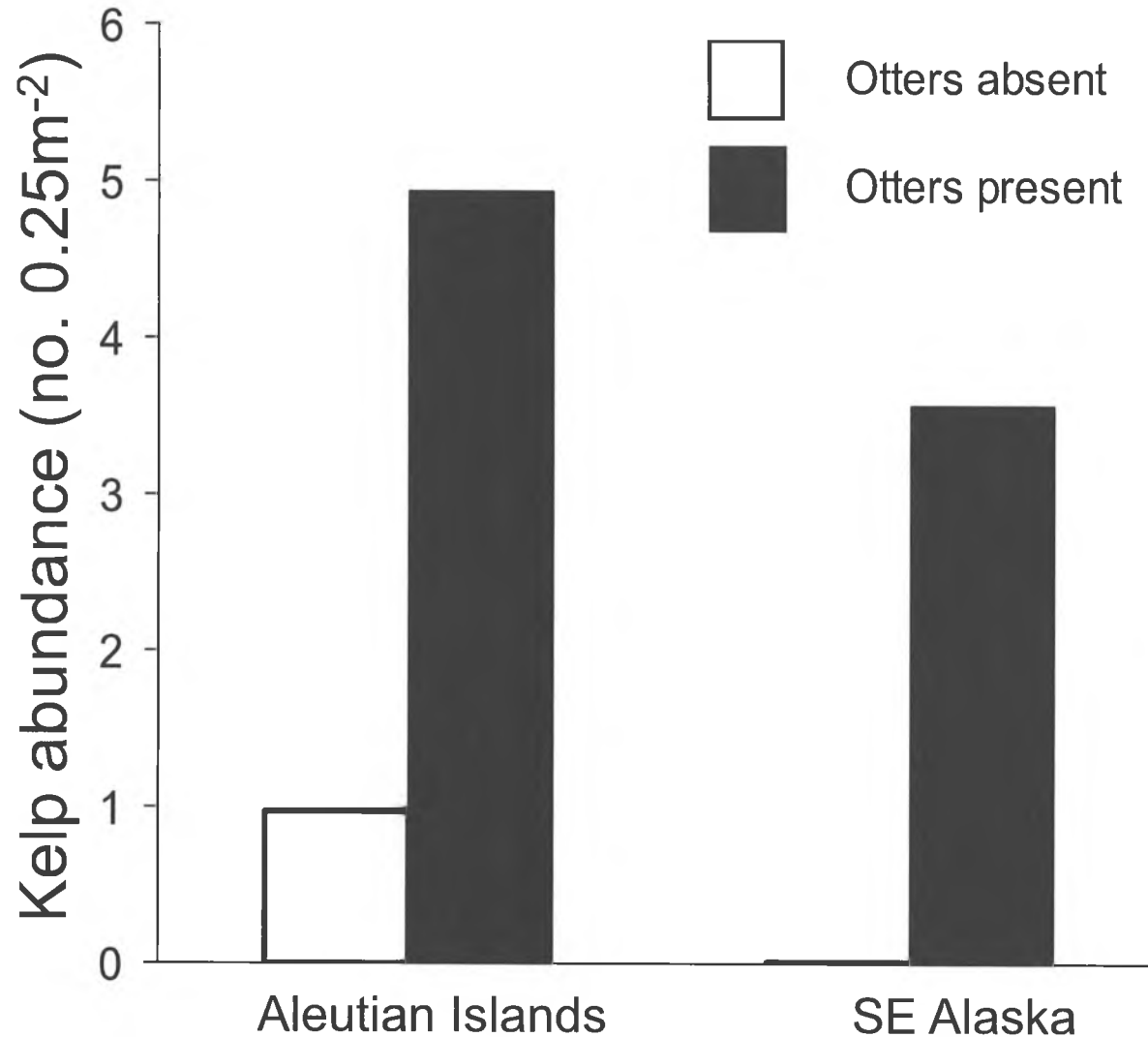
Approach:

- With vs. without otters
- Before vs. after otters

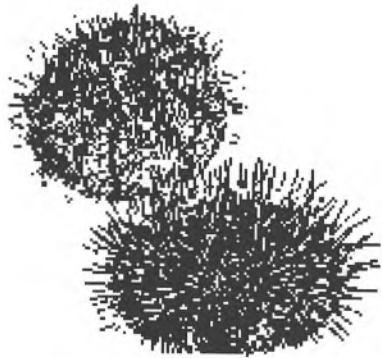
# Direct effect--sea otters on sea urchins

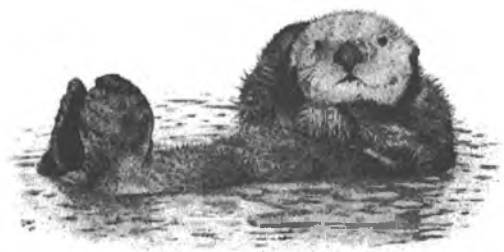


# Indirect effect—sea otters on kelp

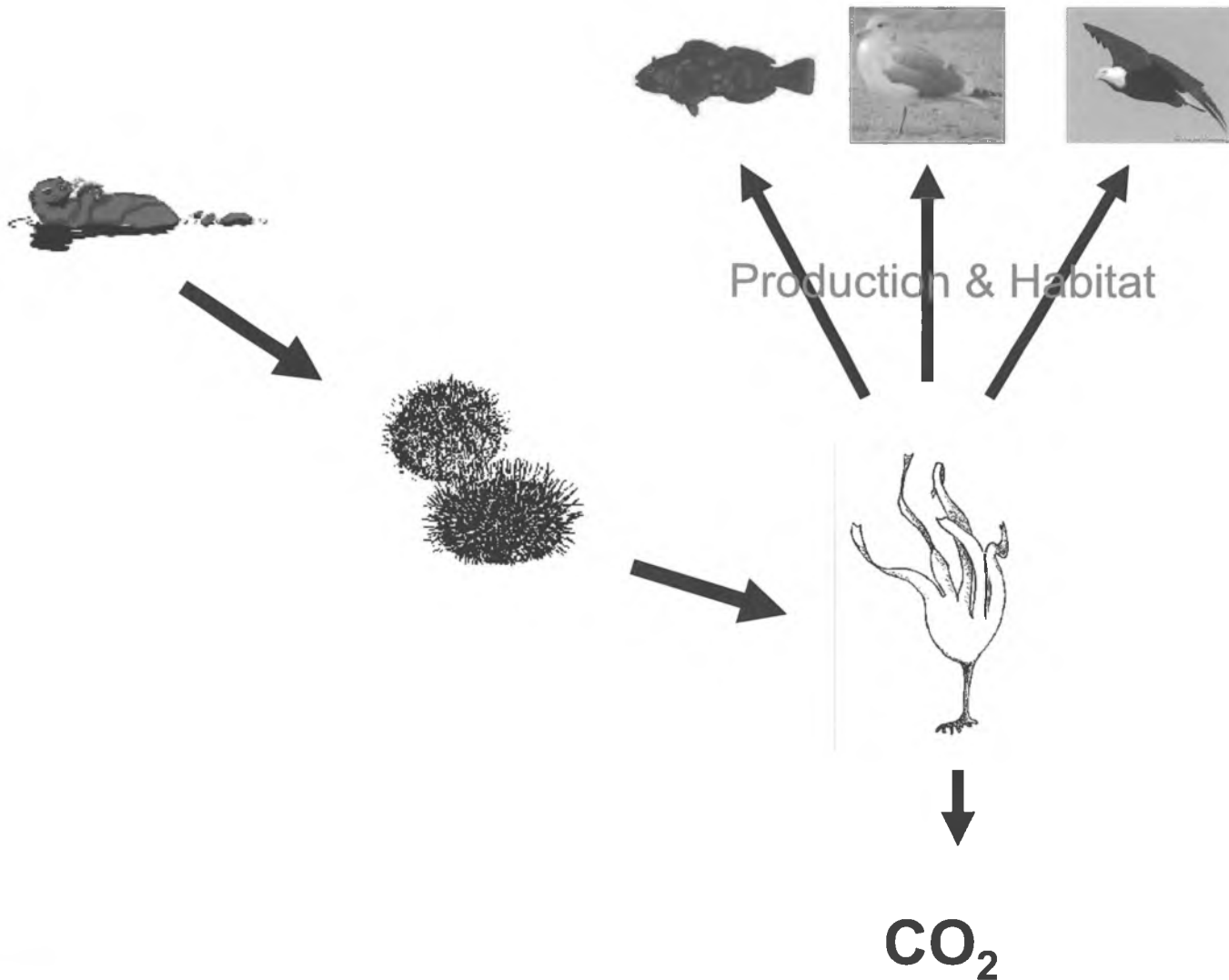


# A "trophic cascade"



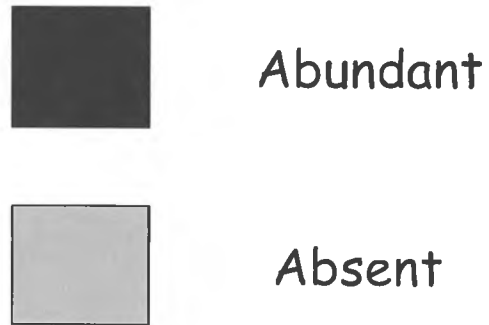


# Influences of sea otter-kelp forest trophic cascade on other species and ecosystem processes?

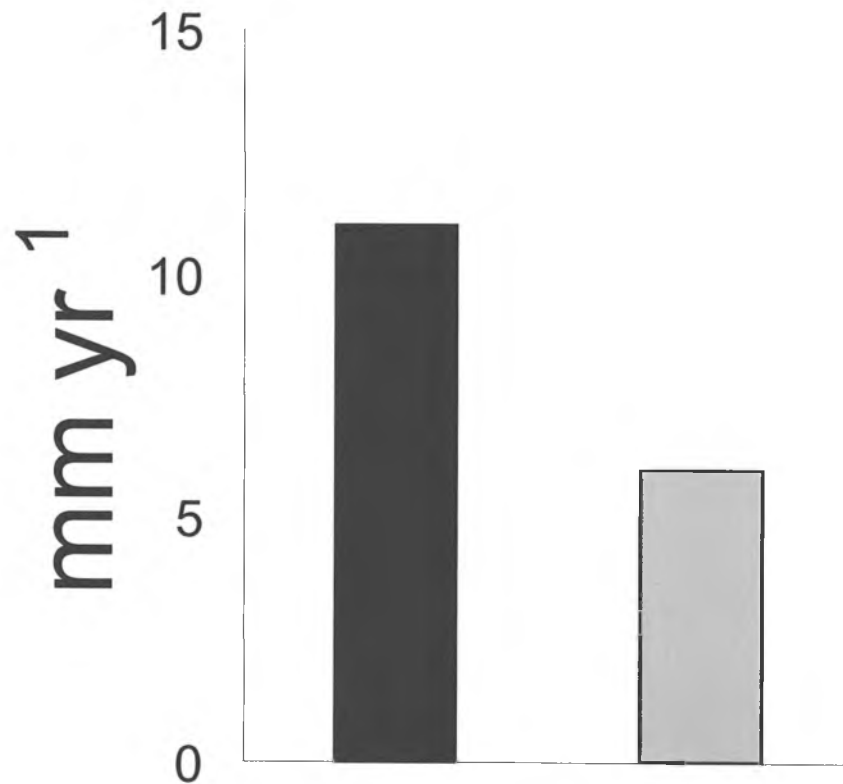


# Production

## Sea otters



## Mussel growth *rate*



# Kelp forest fish abundance

## Sea otters



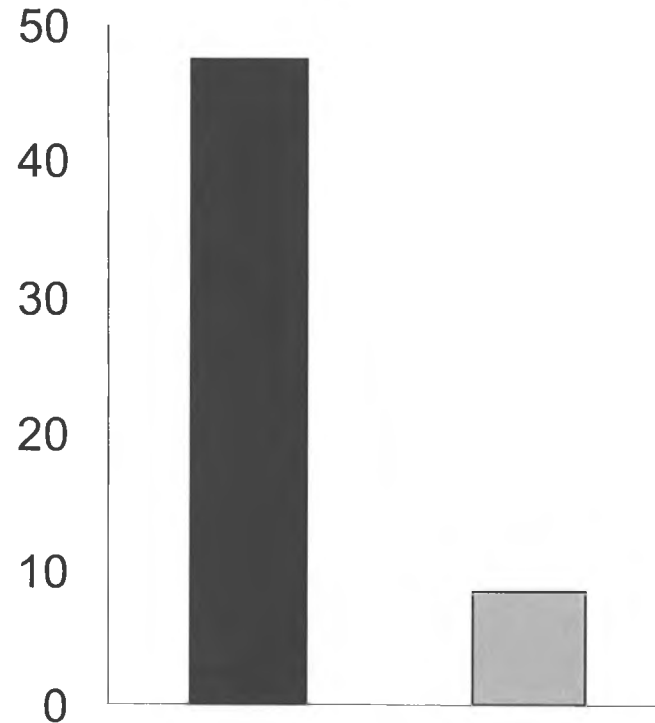
Abundant



Absent

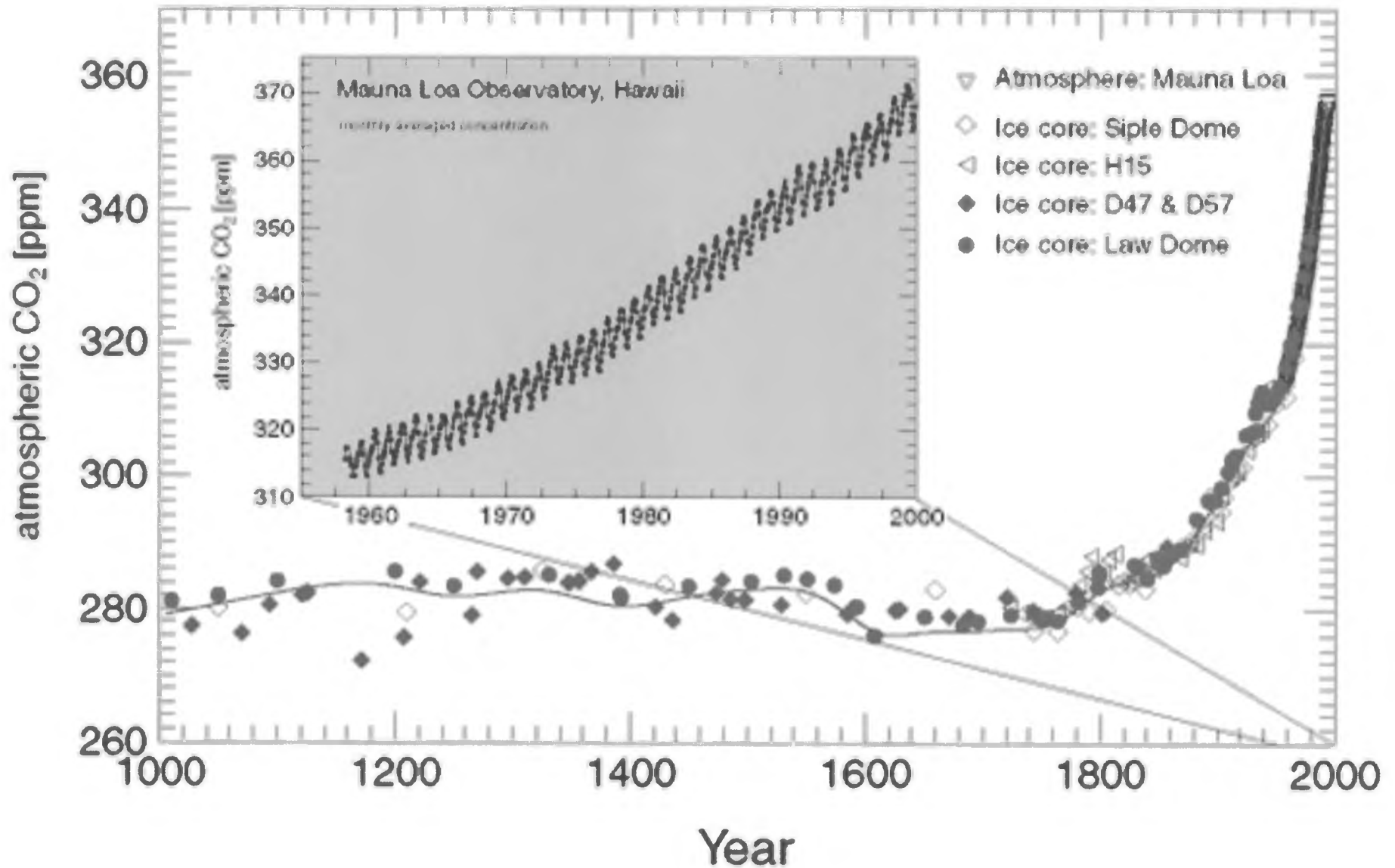
*Trammel net,  
C.P.U.*

Catch effort

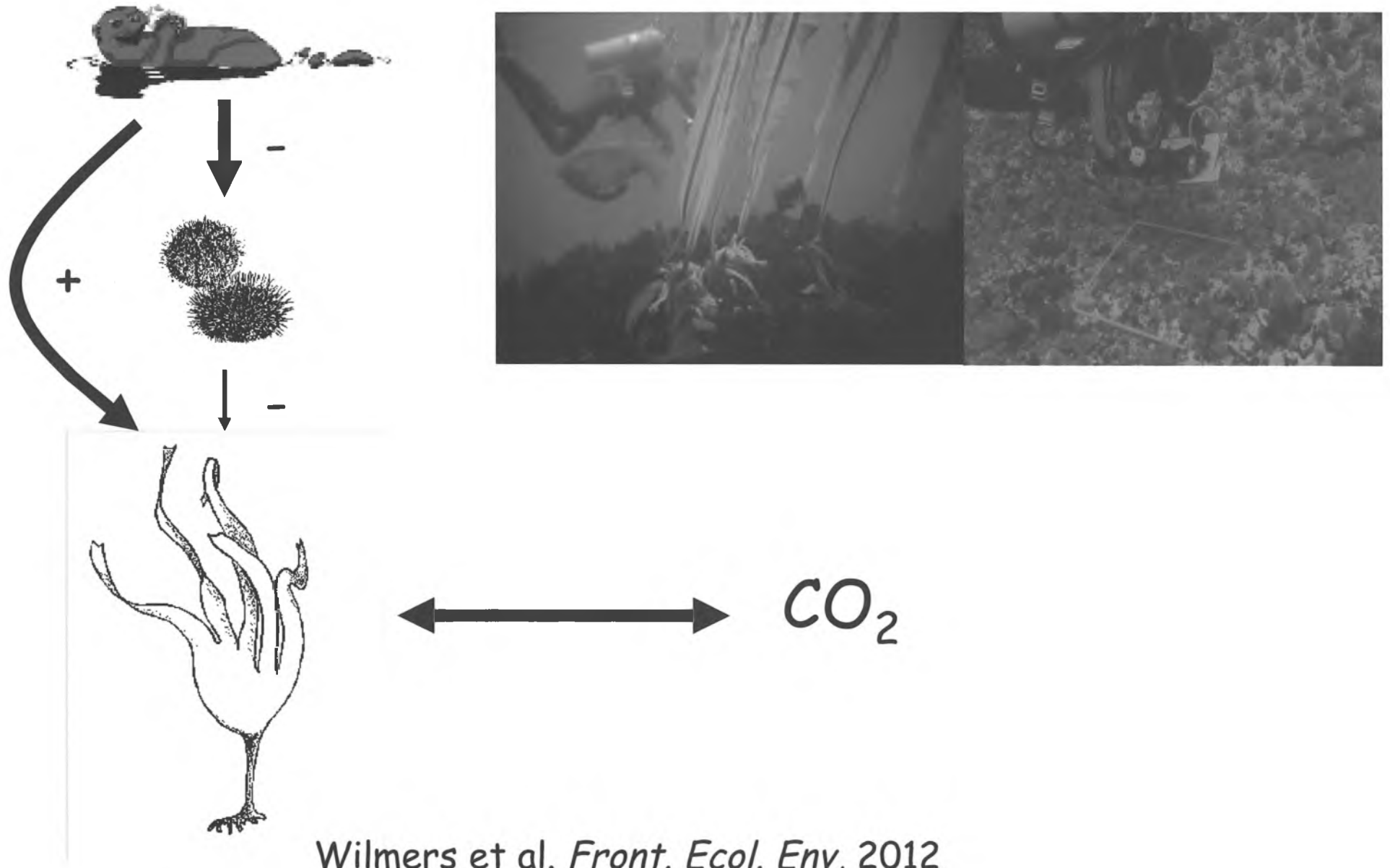


# Sea otters and carbon

## ATMOSPHERIC CO<sub>2</sub> VARIATIONS SINCE 1000AD



# Mitigation by sea otters?



Wilmers et al. *Front. Ecol. Env.*, 2012

**Comparison of kelp carbon dynamics between scenarios with and without sea otters at ecologically effective densities.**

	Sea otters absent	Sea otters present
Kelp biomass (wet weight)	75-133 gm <sup>-2</sup>	911-1618 gm <sup>-2</sup>
Kelp carbon	8-14 gCm <sup>-2</sup>	101-180 gCm <sup>-2</sup>
NPP	25-70 gCm <sup>-2</sup> yr <sup>-1</sup>	313-900 gCm <sup>-2</sup> yr <sup>-1</sup>
Difference in scenarios with and without otters in Alaska and British Columbia		
Kelp carbon	4.4 to 8.7 TgC	
Atmospheric carbon pool	5.6 to 11 %	
Atmospheric carbon pool since pre-industrial times	21 to 42 %	
Value of kelp carbon standing stock	\$304 to \$603 million	
	<i>if European Carbon Trading value</i>	

**Table 2.** Potential yearly value of sea otter impact on atmospheric carbon sequestration by kelp. Scenarios represent the percentage of yearly kelp NPP that is transported to the deep ocean where it may persist for long periods of time. We present an order of magnitude variation in scenarios as much uncertainty remains on total carbon transport to the deep ocean.

Sequestration scenarios*	Carbon sequestration tCyr <sup>-1</sup>	Yearly value*
1%	$(1.3 - 4.5) \times 10^5$	\$9-31 million
5%	$(0.6 - 2.3) \times 10^6$	\$44-157 million
10%	$(1.3 - 4.5) \times 10^6$	\$87-314 million
50%	$(0.6 - 2.3) \times 10^7$	\$436-1,570 million

\* Yearly value is based on Dec 10, 2010 Futures on the European Carbon Exchange.

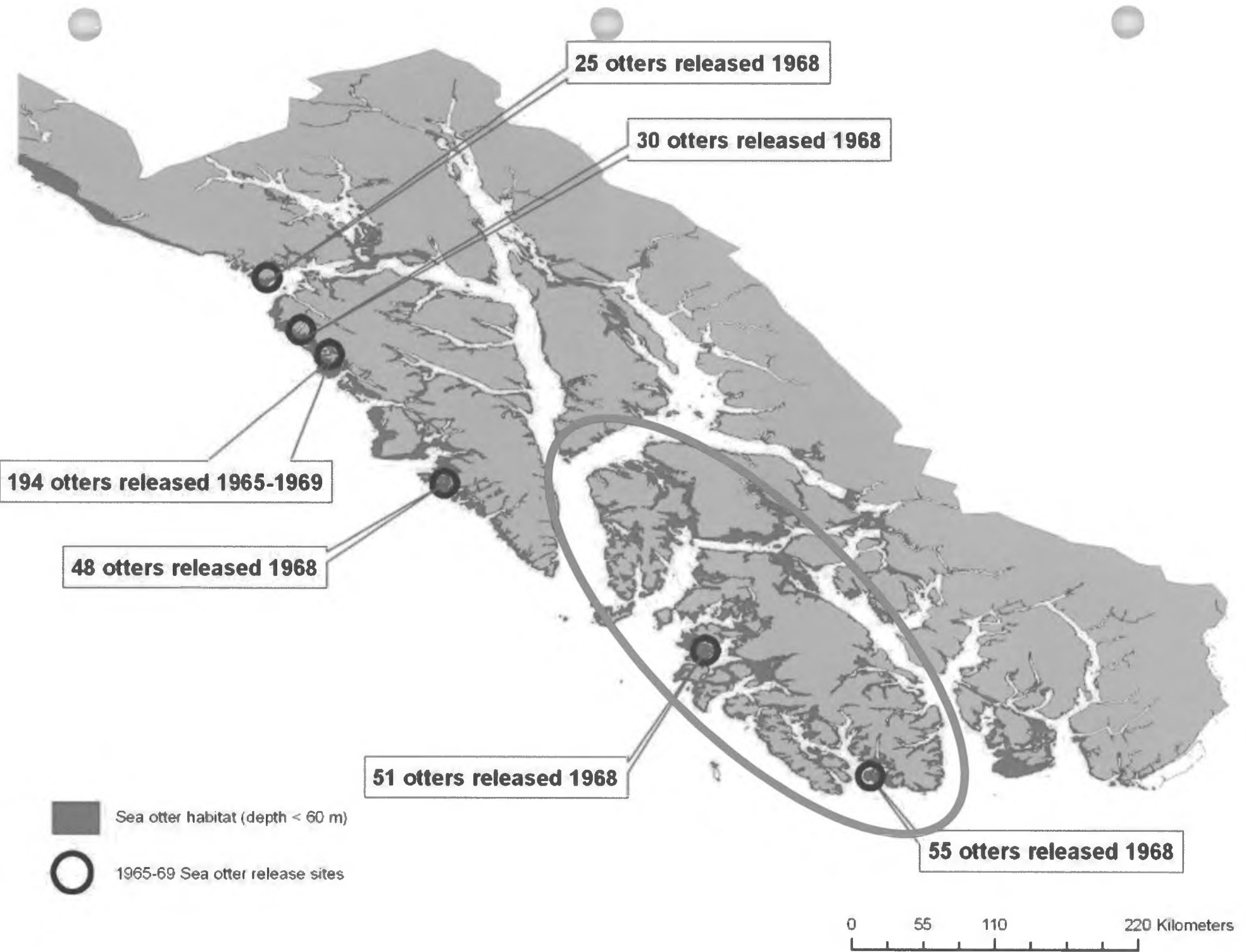
# Concluding Points

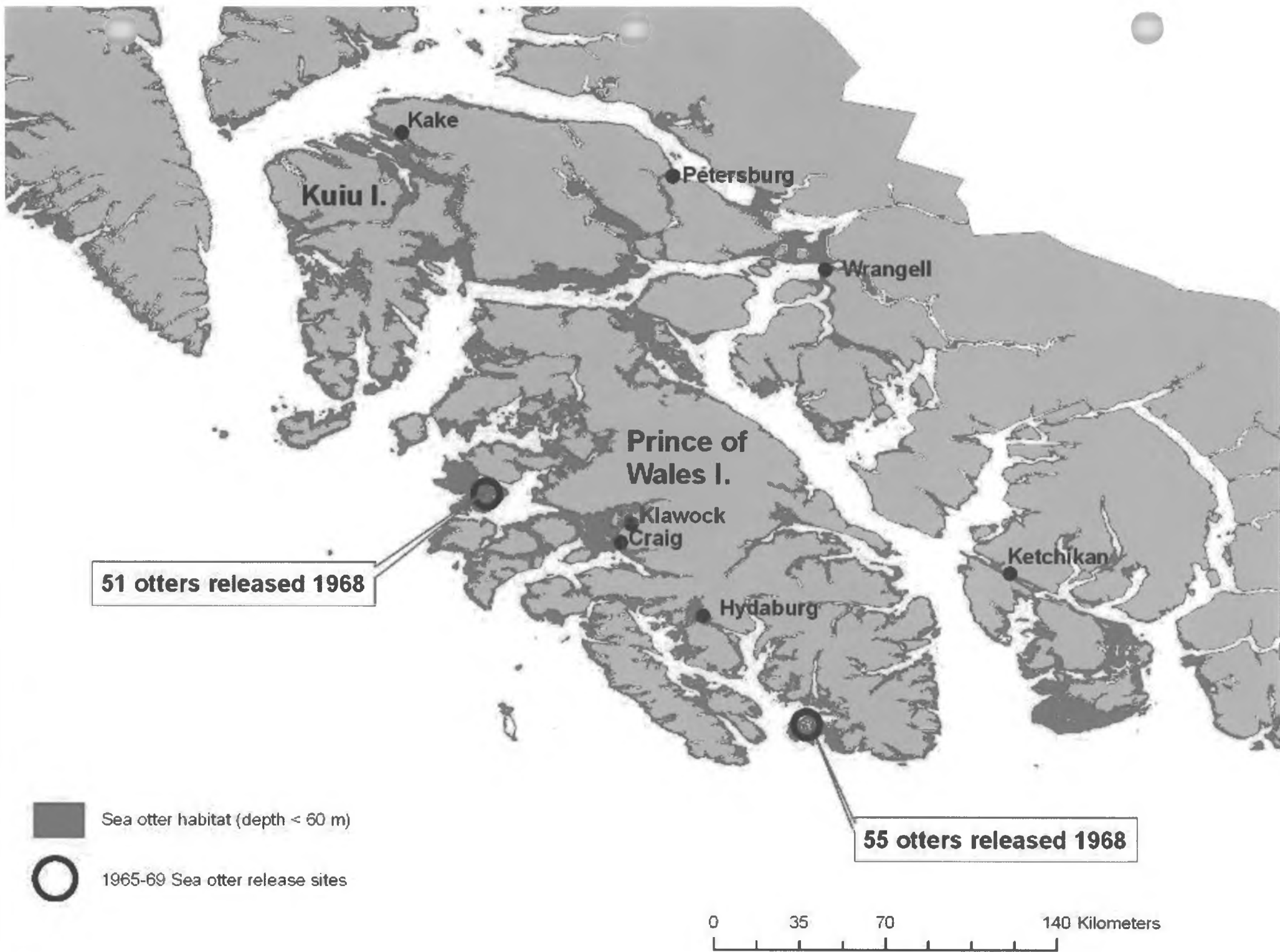
- I. Sea otters have a strong *direct negative effect* on kelp forest invertebrates (shellfish)
- II. This direct negative effect on invertebrates results in a strong *indirect positive effect* on kelp abundance and distribution
- III. Kelp forests have myriad effects of other species and ecological processes
- IV. Sea otter management should weigh the costs and benefits of all these effects

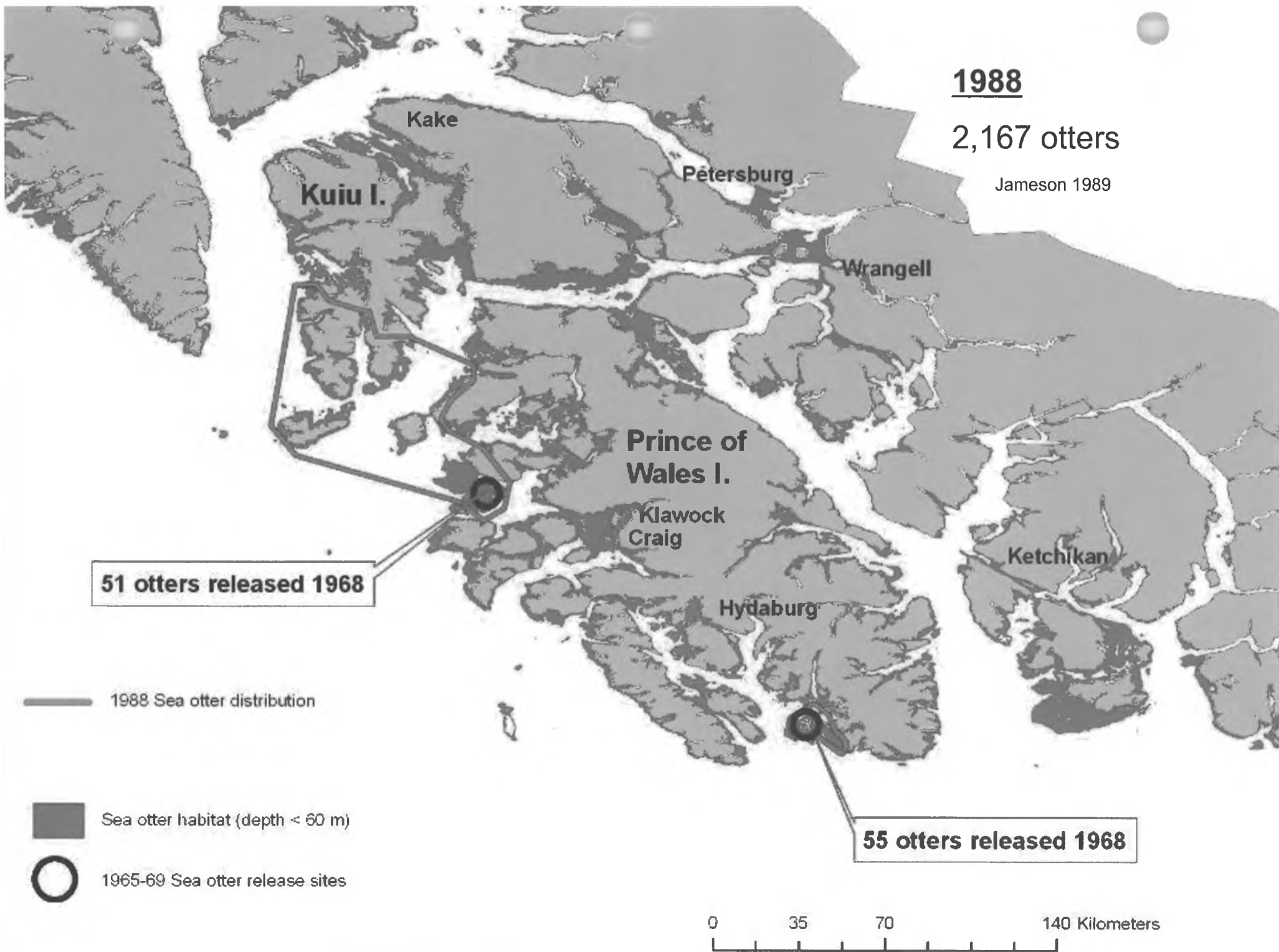
# Recovery of the sea otter population and conflicts with shellfish users in Southeast Alaska



Ginny Eckert<sup>1</sup>, Zac Hoyt<sup>1</sup>, Sean Larson<sup>1</sup>, Verena Gill<sup>2</sup>, Sunny Rice<sup>1</sup>  
<sup>1</sup>School of Fisheries & Ocean Sciences, UAF & <sup>2</sup>USFWS



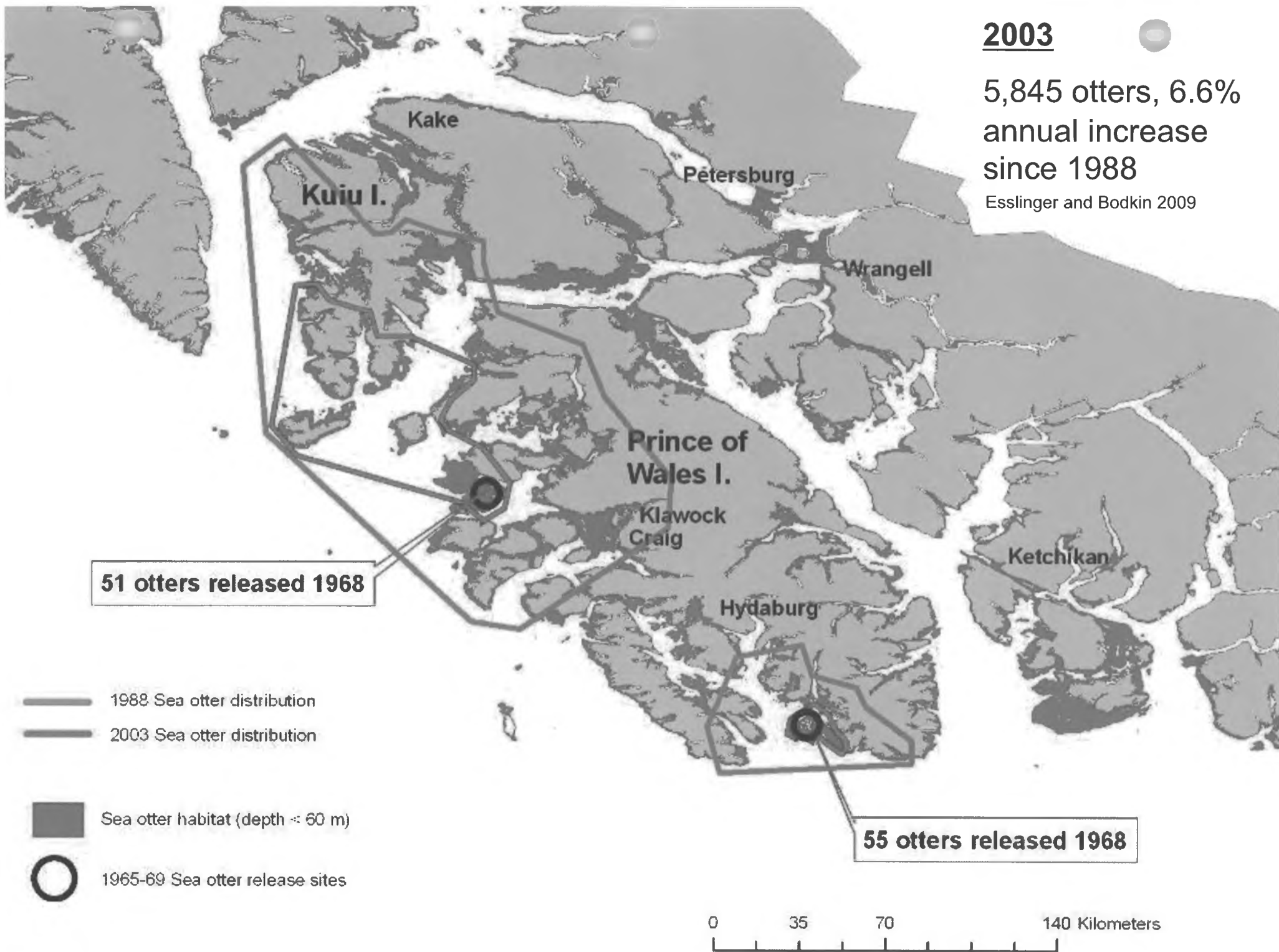




**2003**

5,845 otters, 6.6%  
annual increase  
since 1988

Esslinger and Bodkin 2009



51 otters released 1968

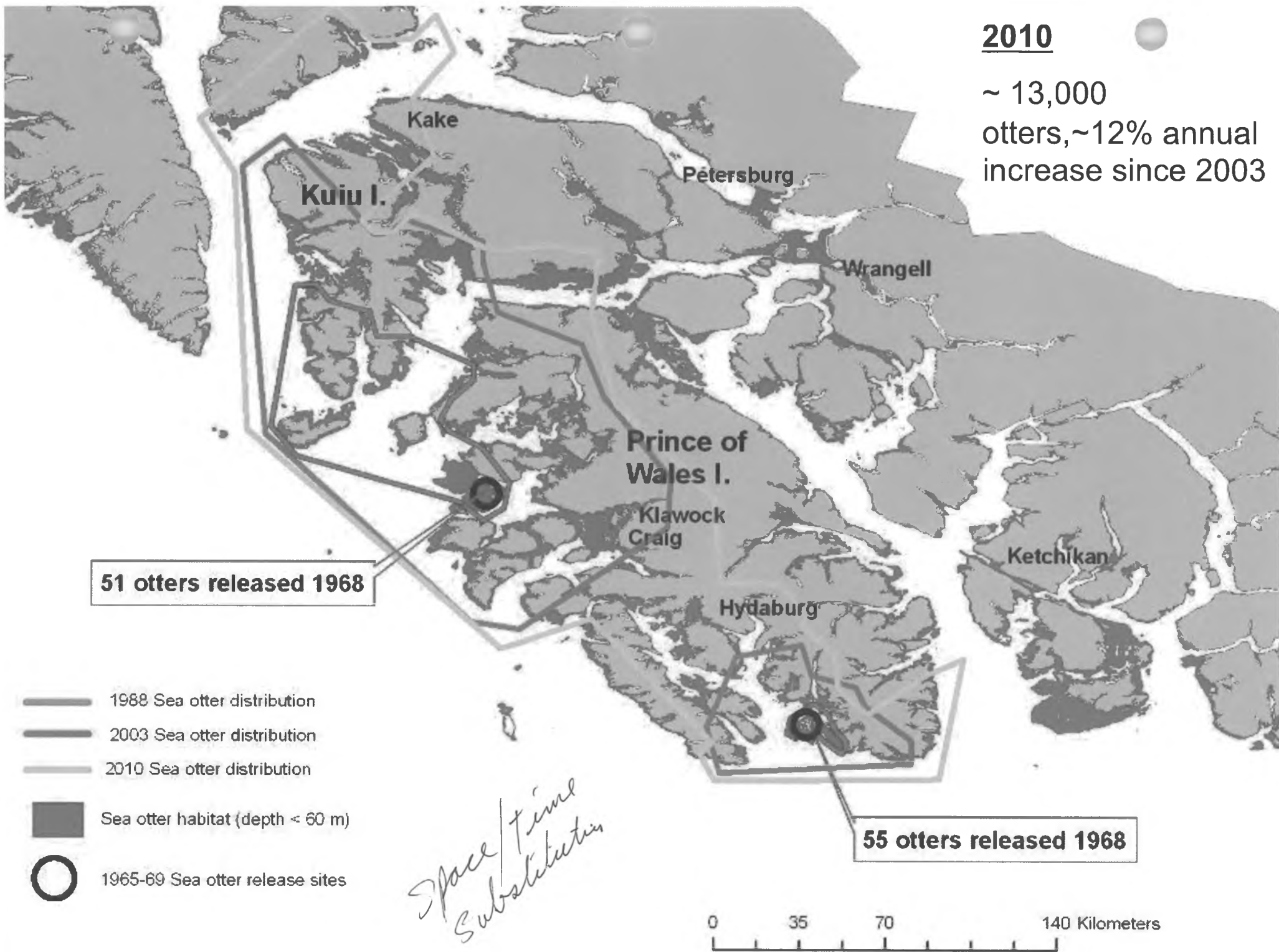
55 otters released 1968

- 1988 Sea otter distribution
- 2003 Sea otter distribution
- Sea otter habitat (depth < 60 m)
- 1965-69 Sea otter release sites

0 35 70 140 Kilometers

**2010**

~ 13,000  
otters, ~12% annual  
increase since 2003



## Fisheries affected in southern SE AK



Dungeness crab, *Cancer magister*

*no dungeness surveys*



Red sea urchin, *Strongylocentrotus franciscanus*






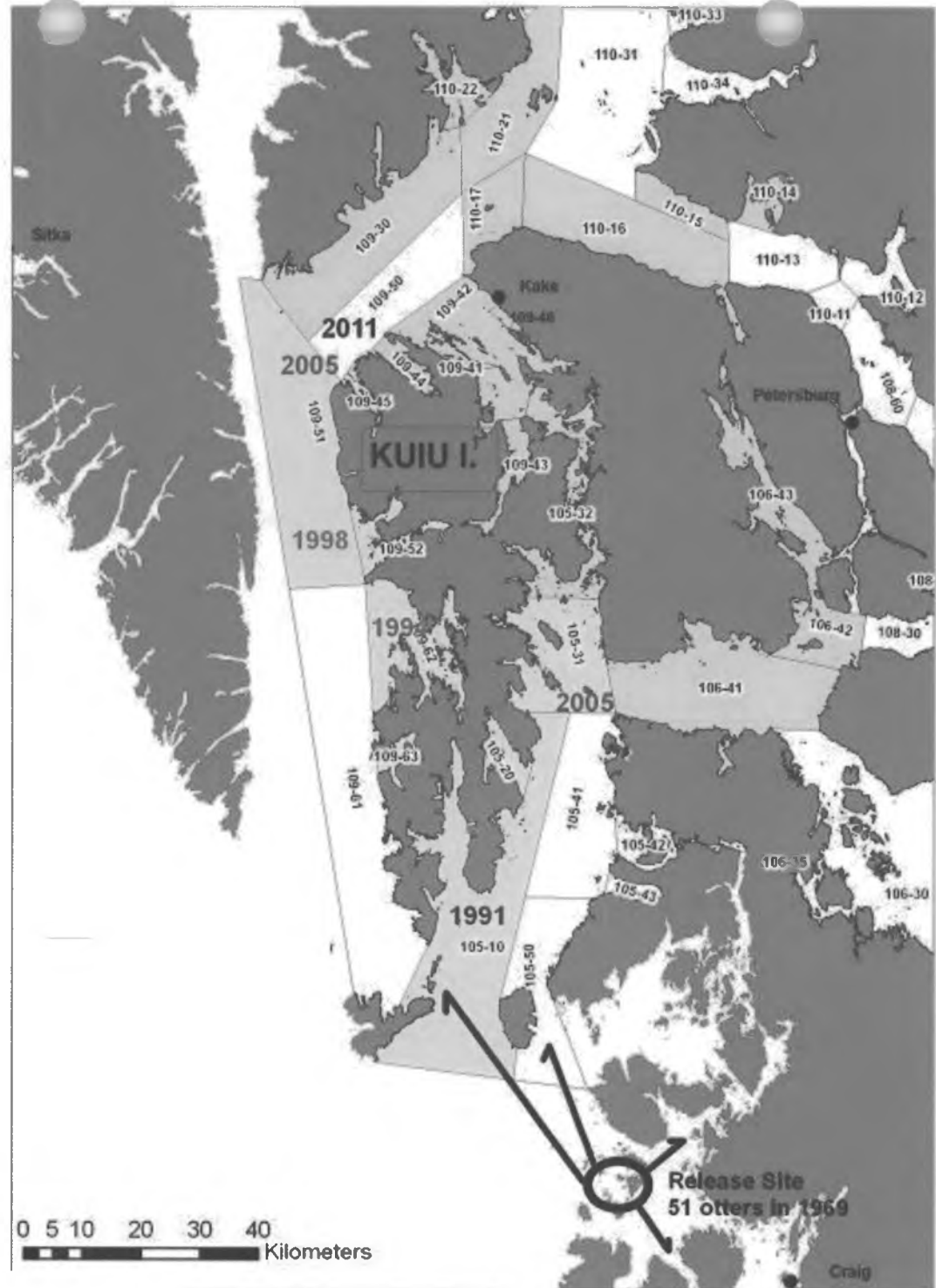
California sea cucumber,  
*Parastichopus californicus*



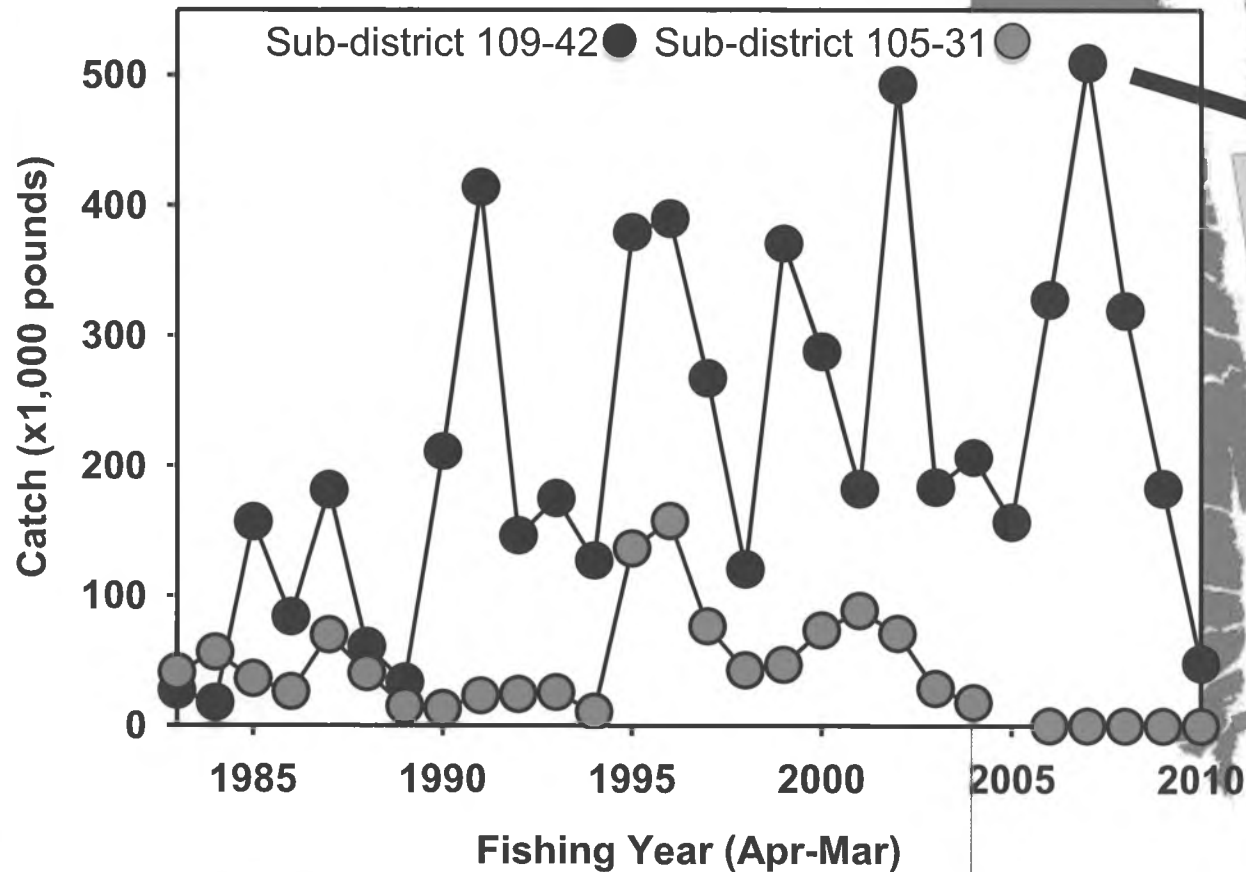
Geoduck clam, *Panopea abrupta*

# Dungeness crab impacts

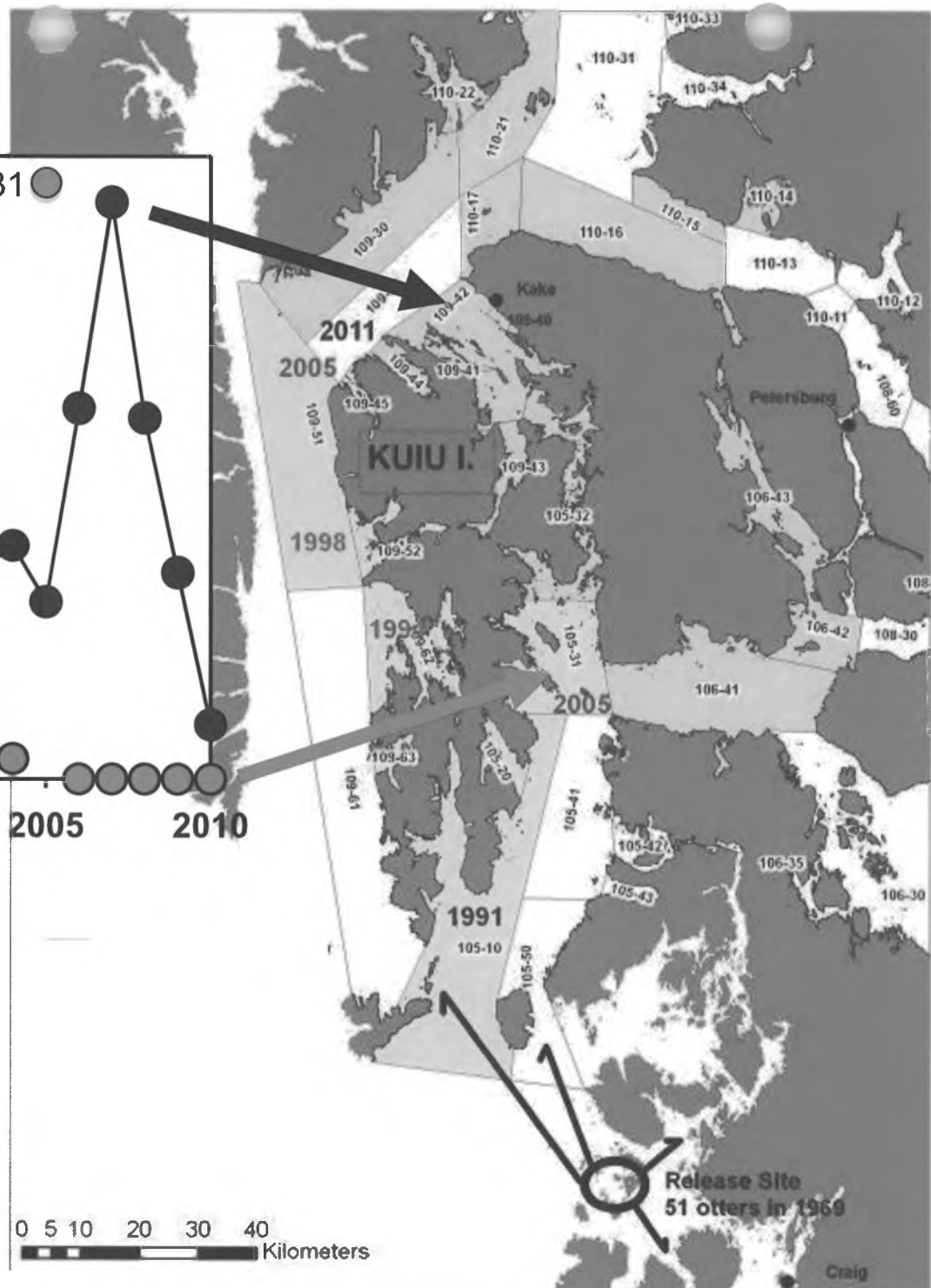
-  ADF&G subdistricts no longer commercially viable
-  ADF&G subdistricts still commercially viable
-  ADF&G subdistricts with little fishing effort or currently unaffected by sea otters



# Dungeness crab impacts

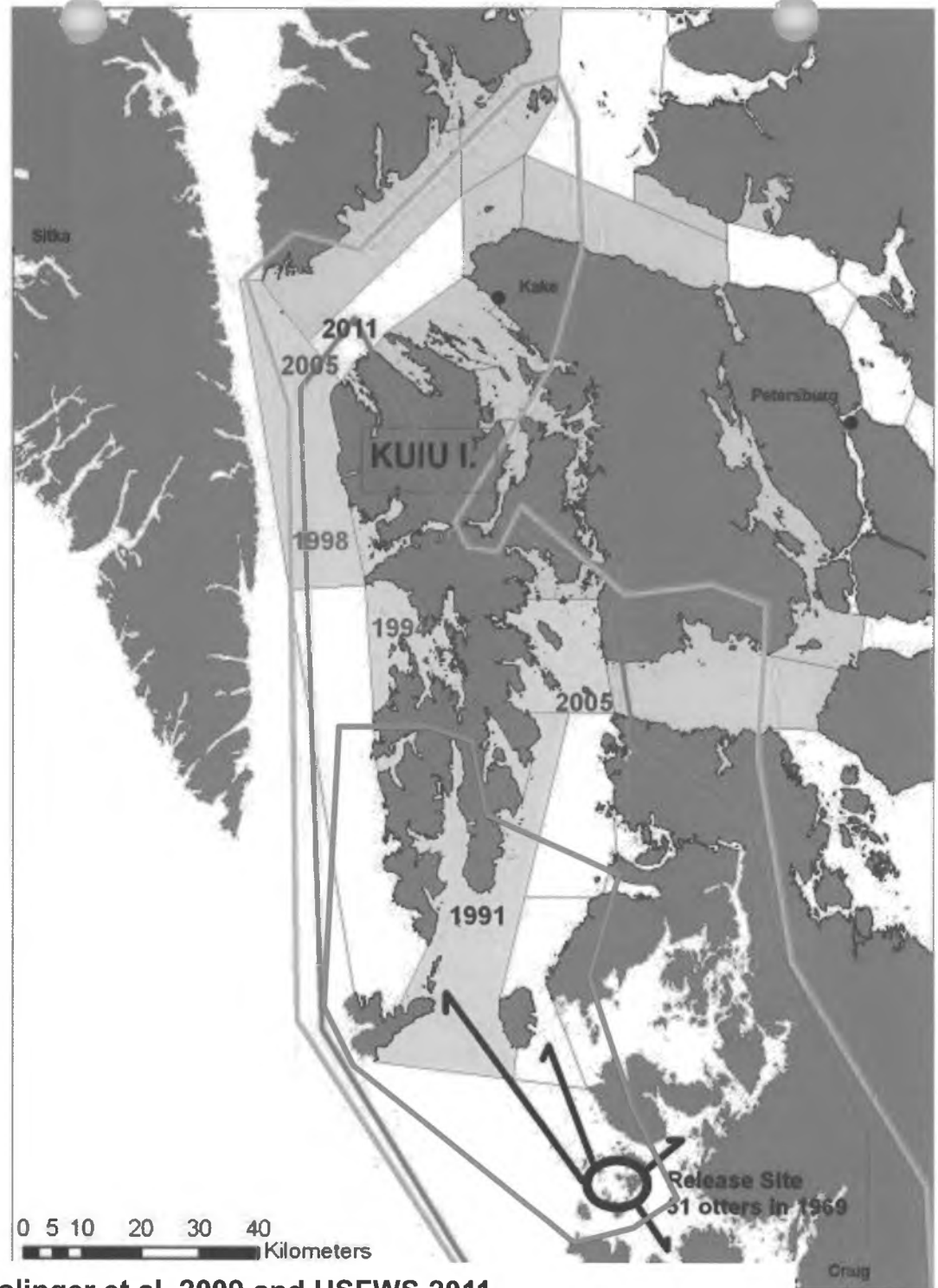


- ADF&G subdistricts no longer commercially viable
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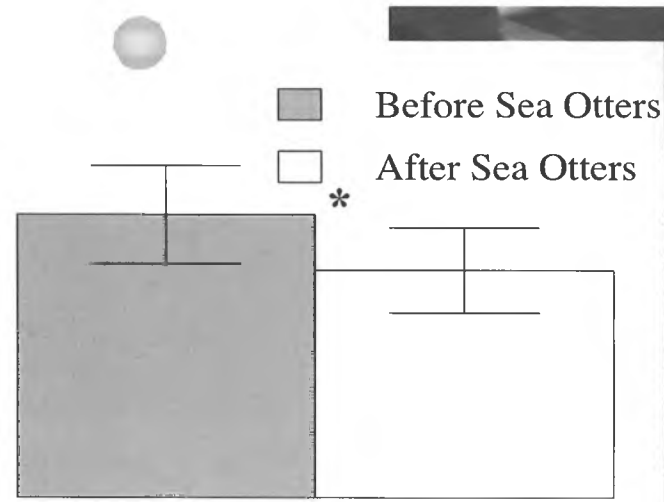
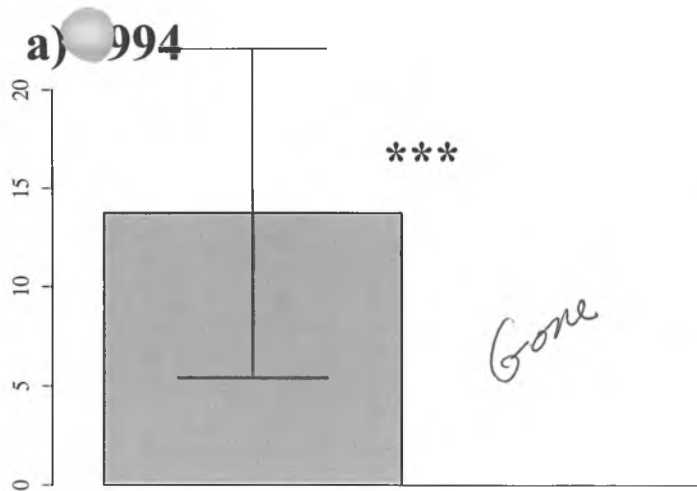


# Sea otter persistence and viability of the commercial Dungeness crab fishery appear spatially correlated

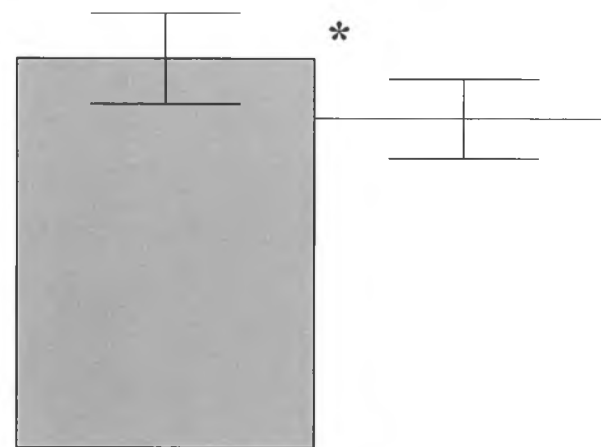
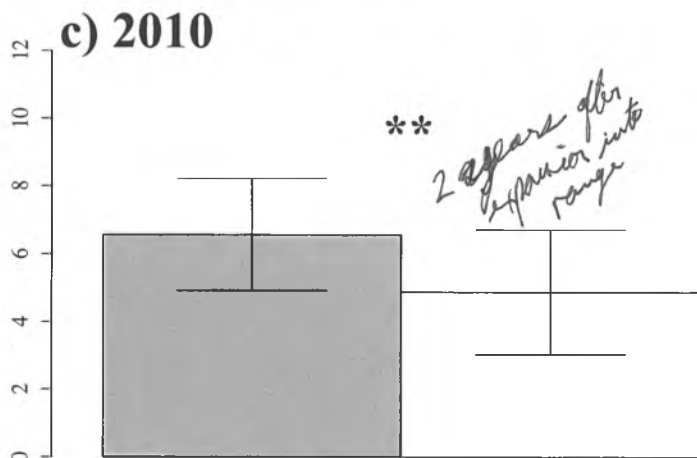
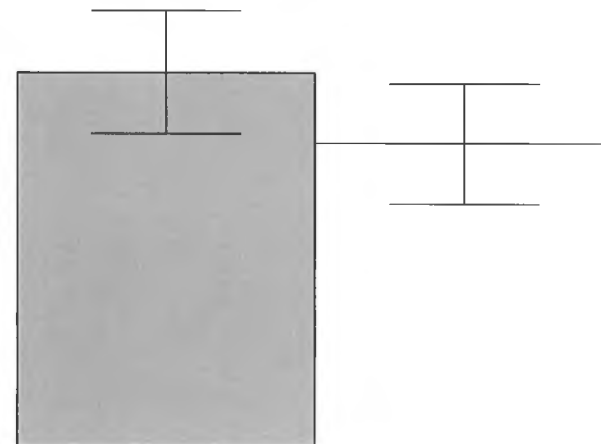
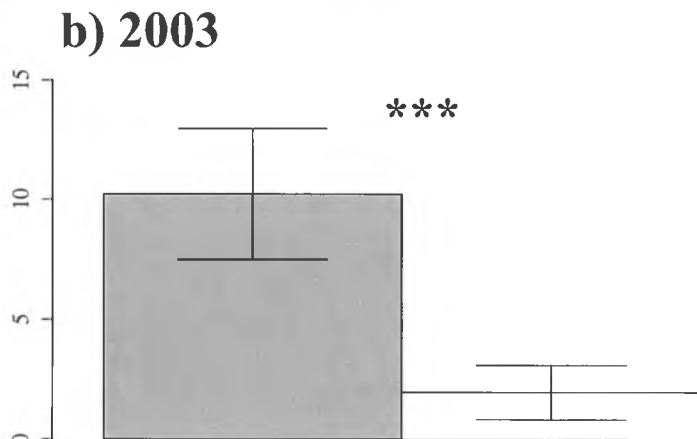
- 1988 sea otter distribution
- 2003 sea otter distribution
- 2010 sea otter distribution
- ADF&G subdistricts no longer commercially viable
- ADF&G subdistricts still commercially viable
- ADF&G subdistricts with little fishing effort or currently unaffected by sea otters



Mean +/- 95% CI Sea Cucumbers per m Shoreline



Sea cucumber impacts

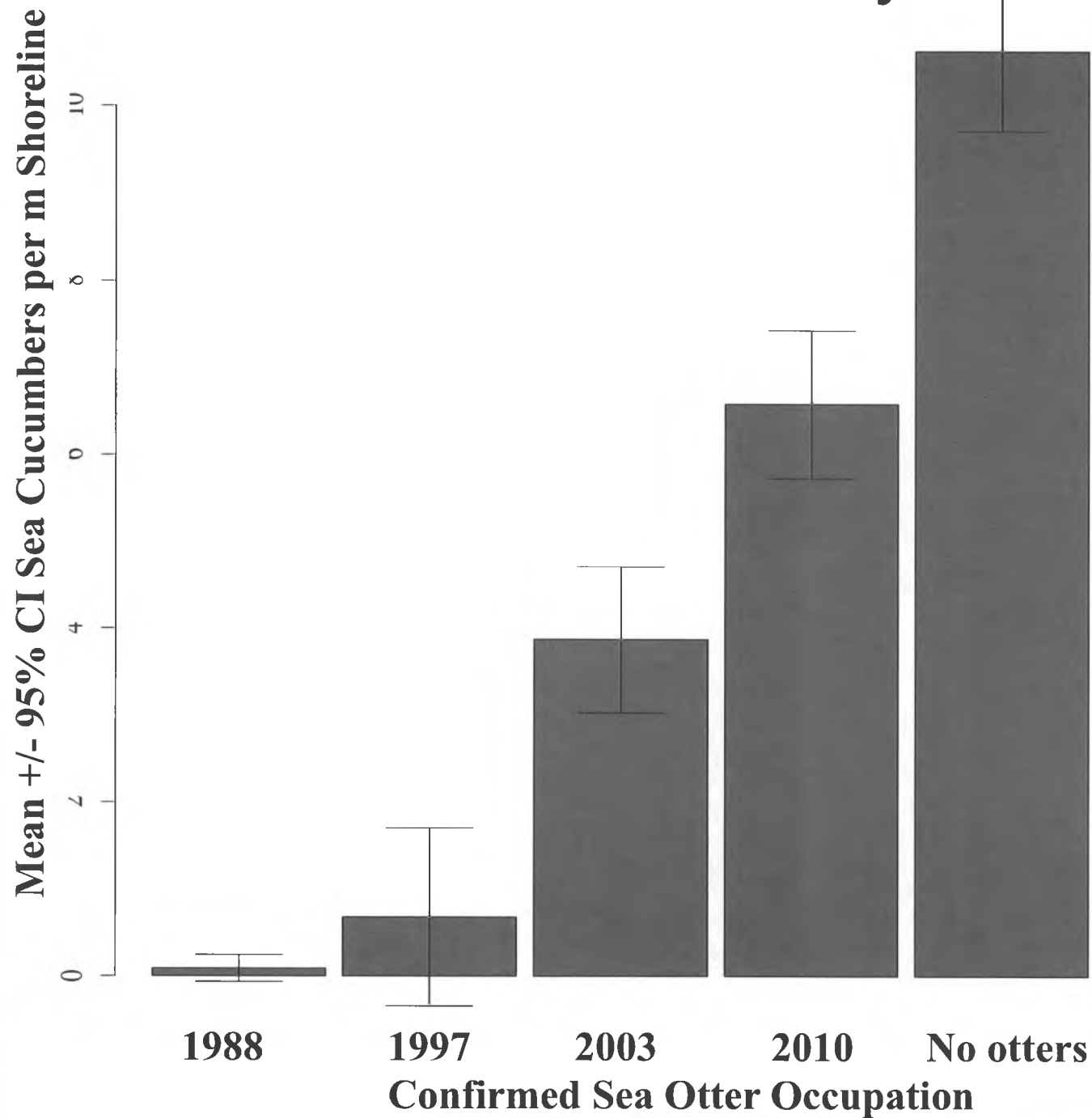


With Sea Otters

Without Sea Otters

Larson 2012 MS Thesis,  
Larson et al. in review

# Sea cucumber density



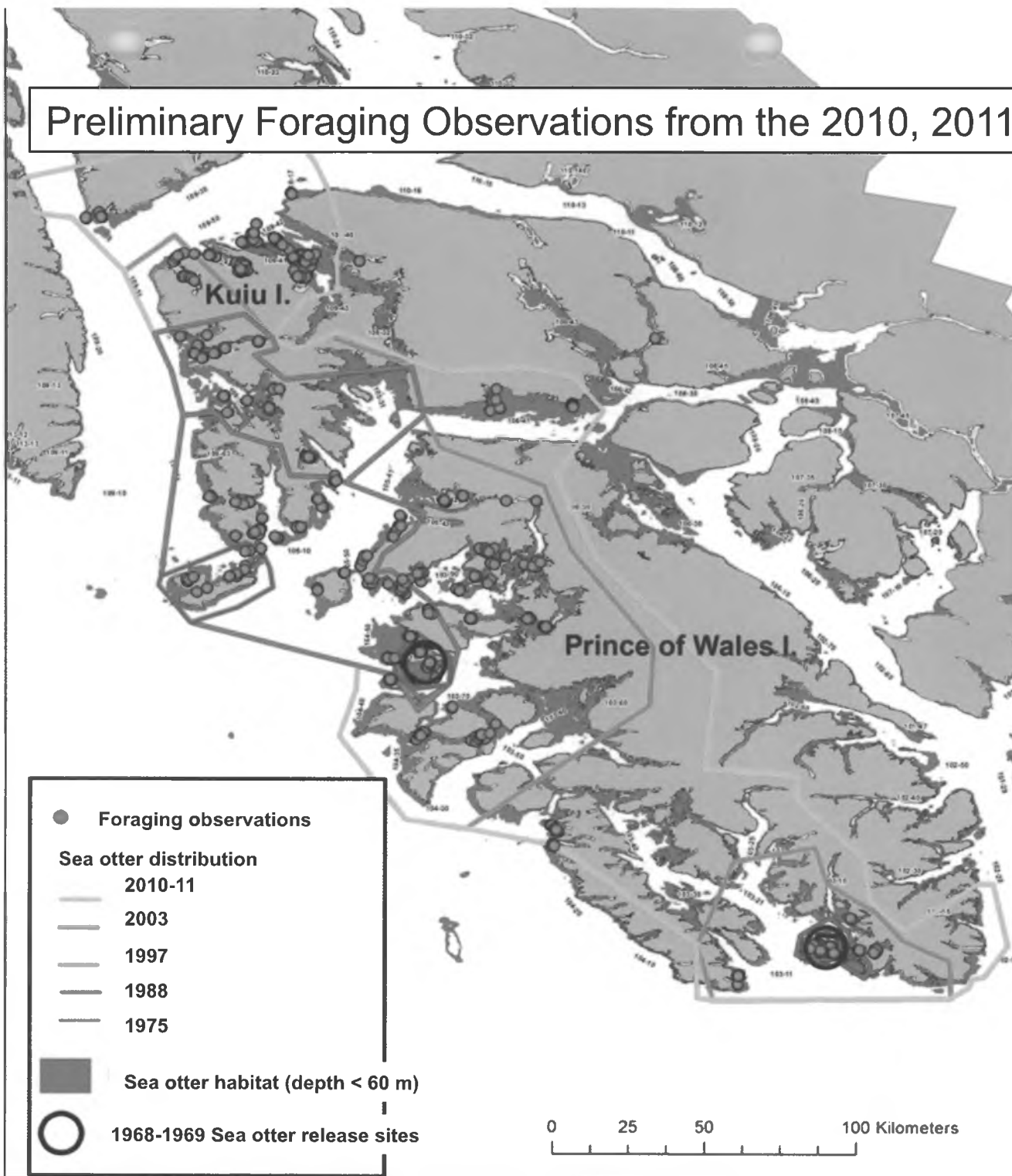
Larson 2012 MS Thesis,  
Larson et al. in review

# Foraging

data collection



# Preliminary Foraging Observations from the 2010, 2011, and 2012 field seasons

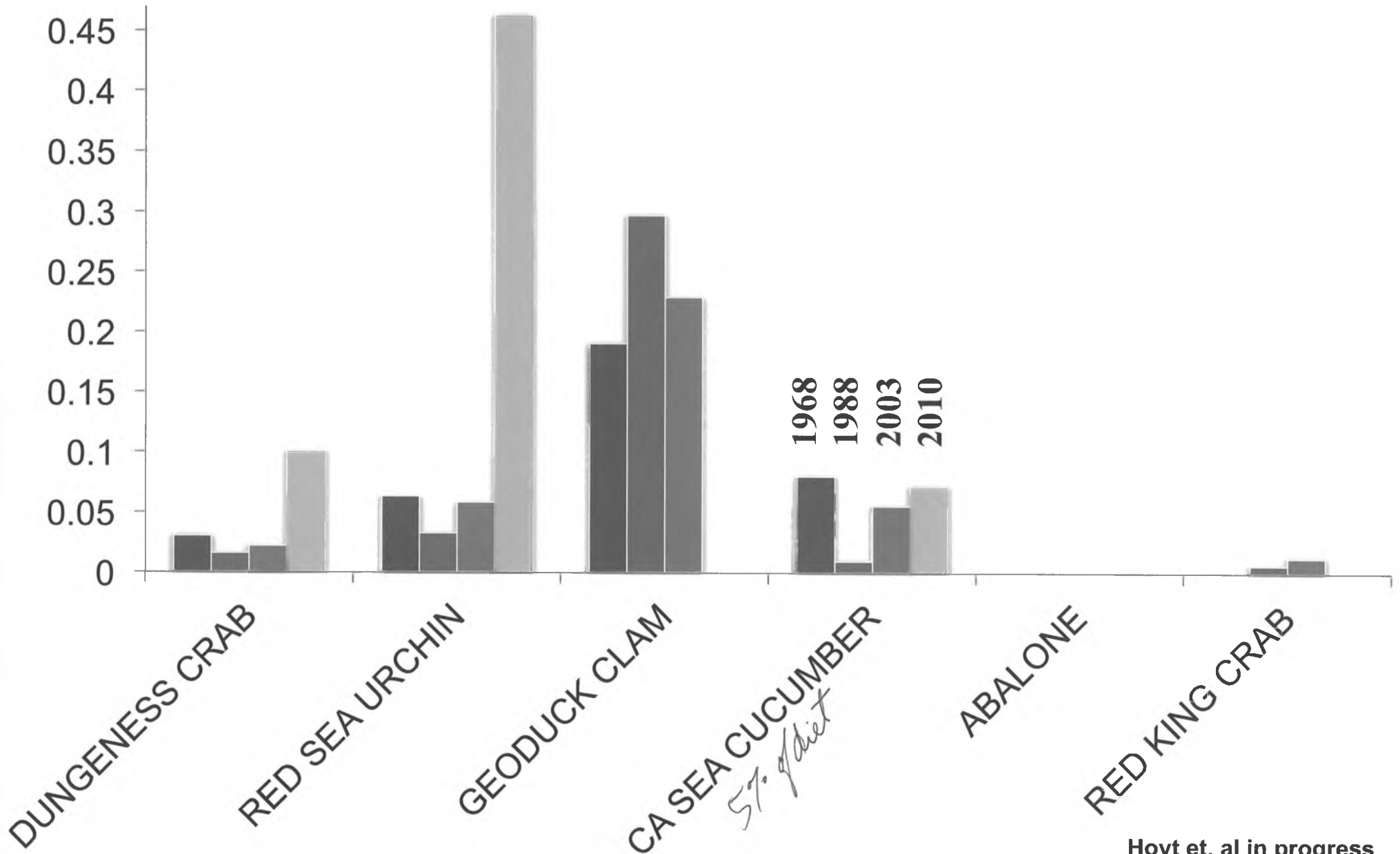


**6117** foraging dives  
**9** sampling areas  
**699** foraging bouts

Hoyt et. al in progress

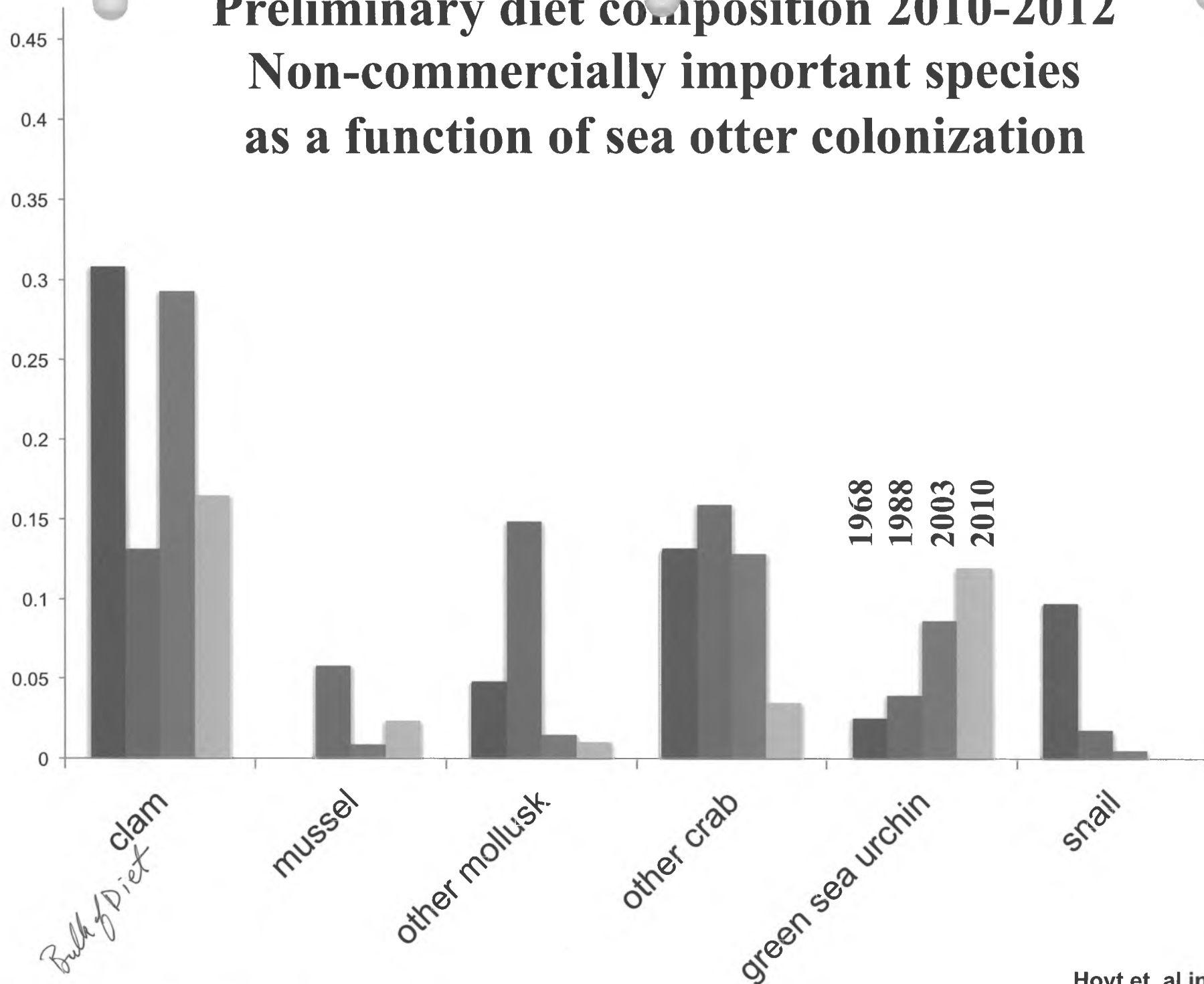
# Preliminary diet composition 2010-2012

## Commercially important species as a function of sea otter colonization



# Preliminary diet composition 2010-2012

## Non-commercially important species as a function of sea otter colonization



## Much information still needed...

1. Other roles of sea otters
  - a. role in kelp forest ecosystem
  - b. positive fishery impacts (ex. herring, rockfish, salmon)
  - c. tourism
2. Are areas without otters suitable otter habitat? Where are they likely to expand?
3. Standing stock biomass of Dungeness crab in the region
4. Changes in fisheries  
e.g. compression of Dungeness fleet
5. Otter distribution and abundance pre-fur trade & shellfish distribution and abundance at that time

# Thank you!



PETERSBURG MARINE MAMMAL CENTER



Southeast Alaska Regional Diver Fisheries Association  
Ketchikan, Alaska (USA)

