Chukchi Sea Environmental Studies Program Overview

Robert H. Day, ABR, Inc.—Environmental Research & Services

Caryn L. Rea, ConocoPhillips Alaska, Inc.

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Acknowledgments

- Michael Macrander (SEPCO)
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- Max Akpik and Herbert Tagarook
- Captains/crews of *Bluefin* and *Westward Wind*

Chukchi Environmental Studies Program

ConocoPhillips Alaska

OBJECTIVE: Collect Information to Understand the Chukchi Environment to Support Exploration Permitting

- Building on the historical scientific data collected in the Chukchi Sea
- Ecosystem approach to baseline data acquisition
- Data can be used to assess potential adverse impacts from oil and gas activities

Ecosystem Approach to Data Acquisition

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- Marine Mammals
- Seabirds
- Fisheries
- Biological Oceanography
  - Benthic invertebrates
  - Plankton ecology
- Physical Oceanography
  - Currents, sea temperature, conductivity
- Hydroacoustics:
  - Acoustic Recordings of Vocalizing Marine Mammals
  - Prospect Specific & Regional Scale
- Two sets of Upward Looking Sonar Buoys/ADCP
- Metocean Buoys
- Metals & Hydrocarbons in Sediment & Biota
- Ambient Air Monitoring

A standard 61-cm bongo net fitted with 0.333-mm mesh used in plankton sampling.

This Talk

- Observations on ecosystem and potential prey

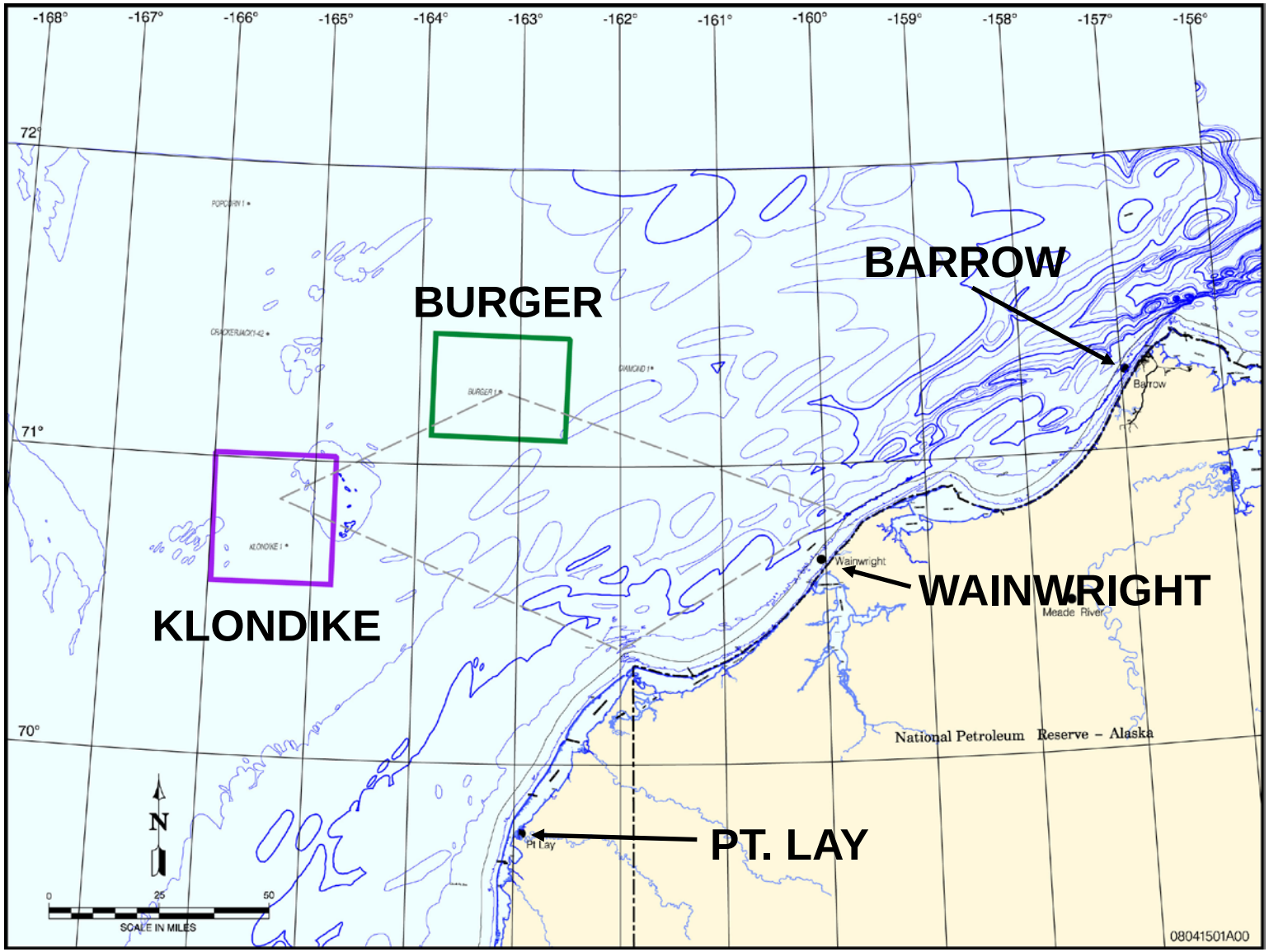
  Physical Oceanography

  Zooplankton Ecology

  Benthic Ecology

- Marine Mammals

Study Areas


BURGER
BARROW
KLONDIKE
WAINWRIGHT
PT. LAY
National Petroleum Reserve – Alaska
Barrow
Wainwright
Meade River
Pt Lay
SCALE IN MILES
08041501A00

Cruise Schedule (2008–2009)

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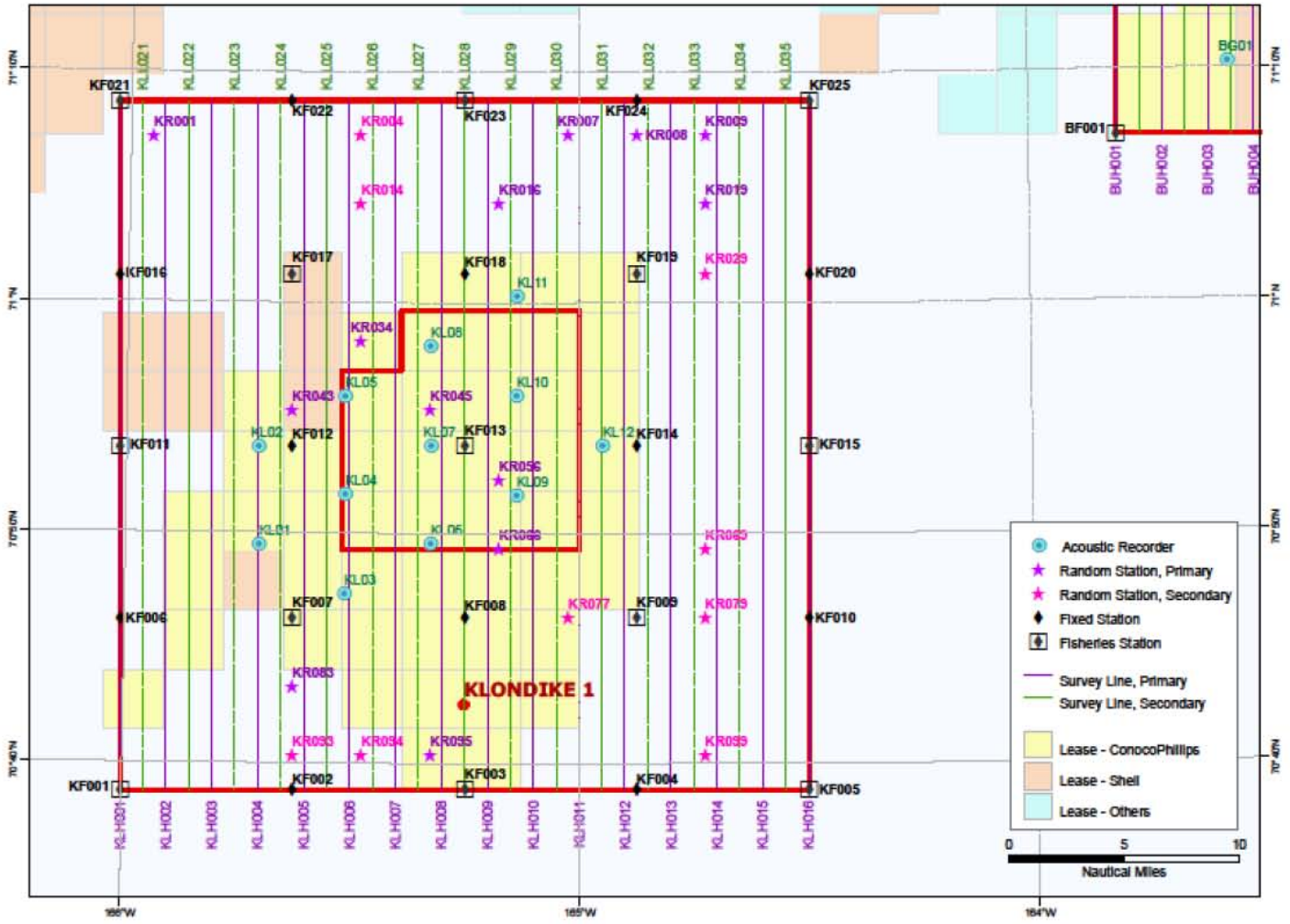
- Three main cruises/year (~20–30 days each)

	2008			2009		
Discipline	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
Physical Oceanography	X	X	X	X	X	X
Nutrients/PP/Zooplankton	X	X	X	X	X	X
Benthic Ecology		X			X	
Baseline Chemistry		X			X*	X
Fisheries				X		X
Seabirds	X	X	X	X	X	X
Marine Mammals	X	X	X	X	X	X

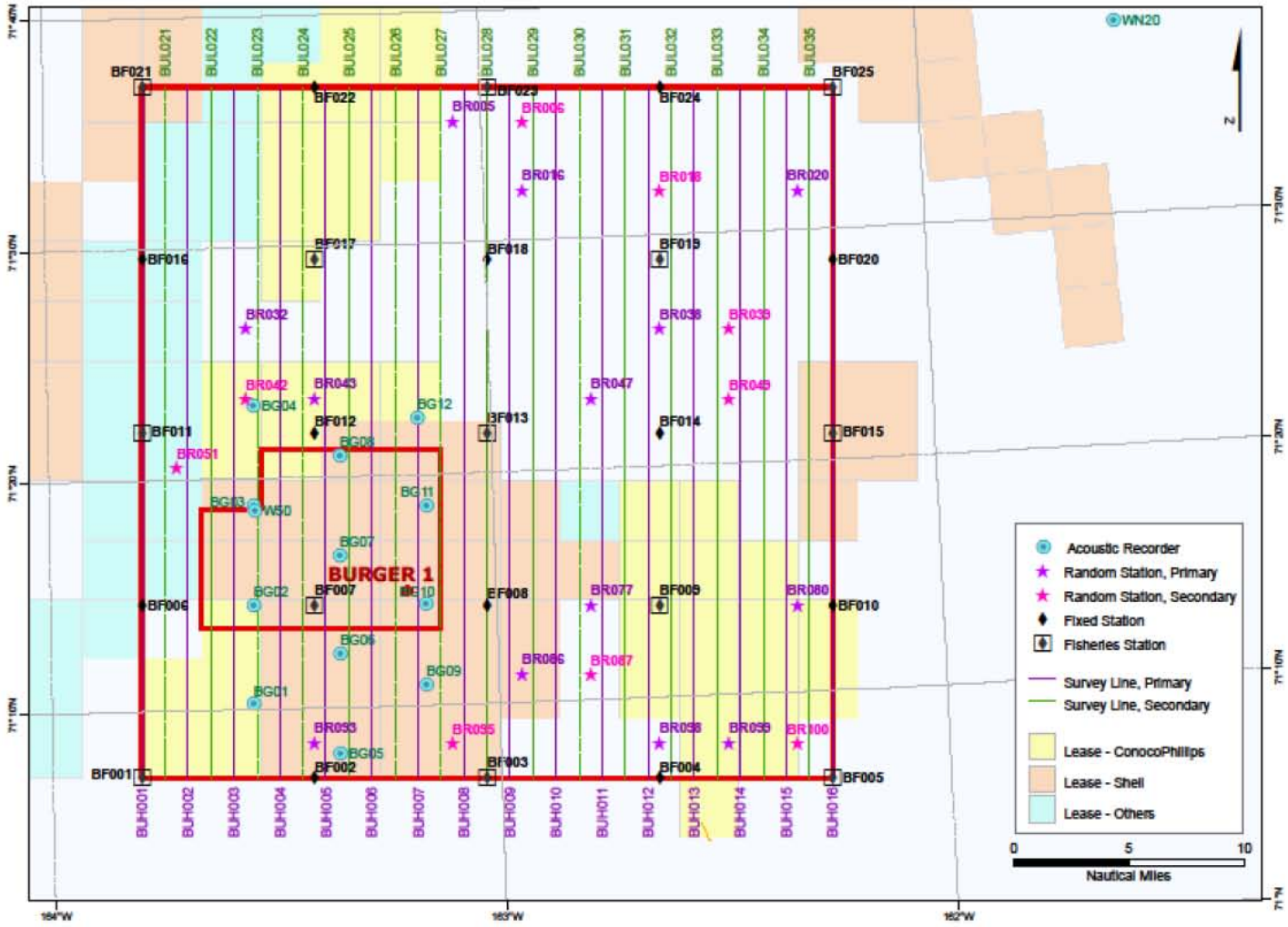
- Acoustic mooring deployment/retrieval
  - Late July–August
  - Mid-October

* Around historic well locations; conducted by COMIDA CAB Scientists

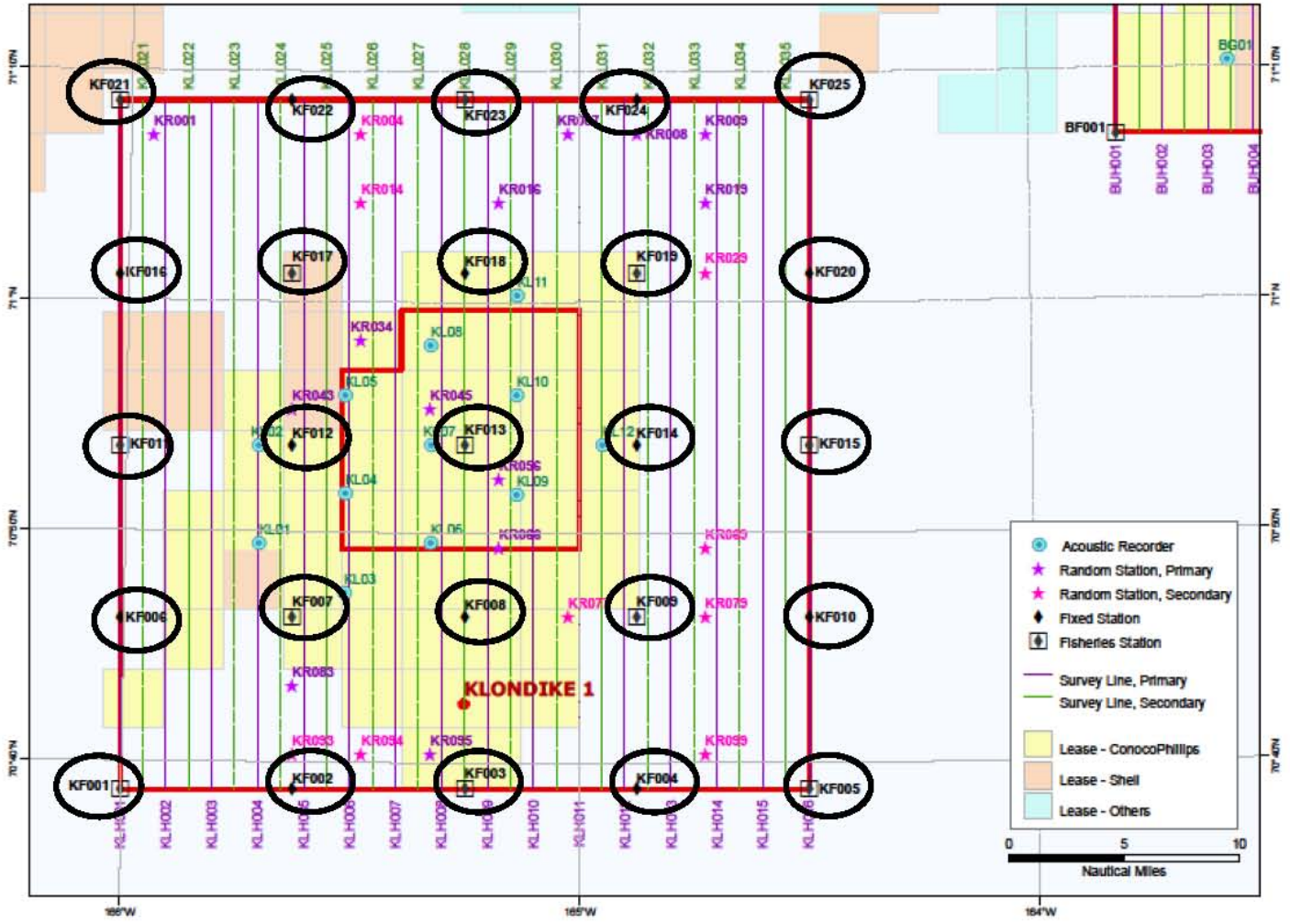
Klondike Study Area



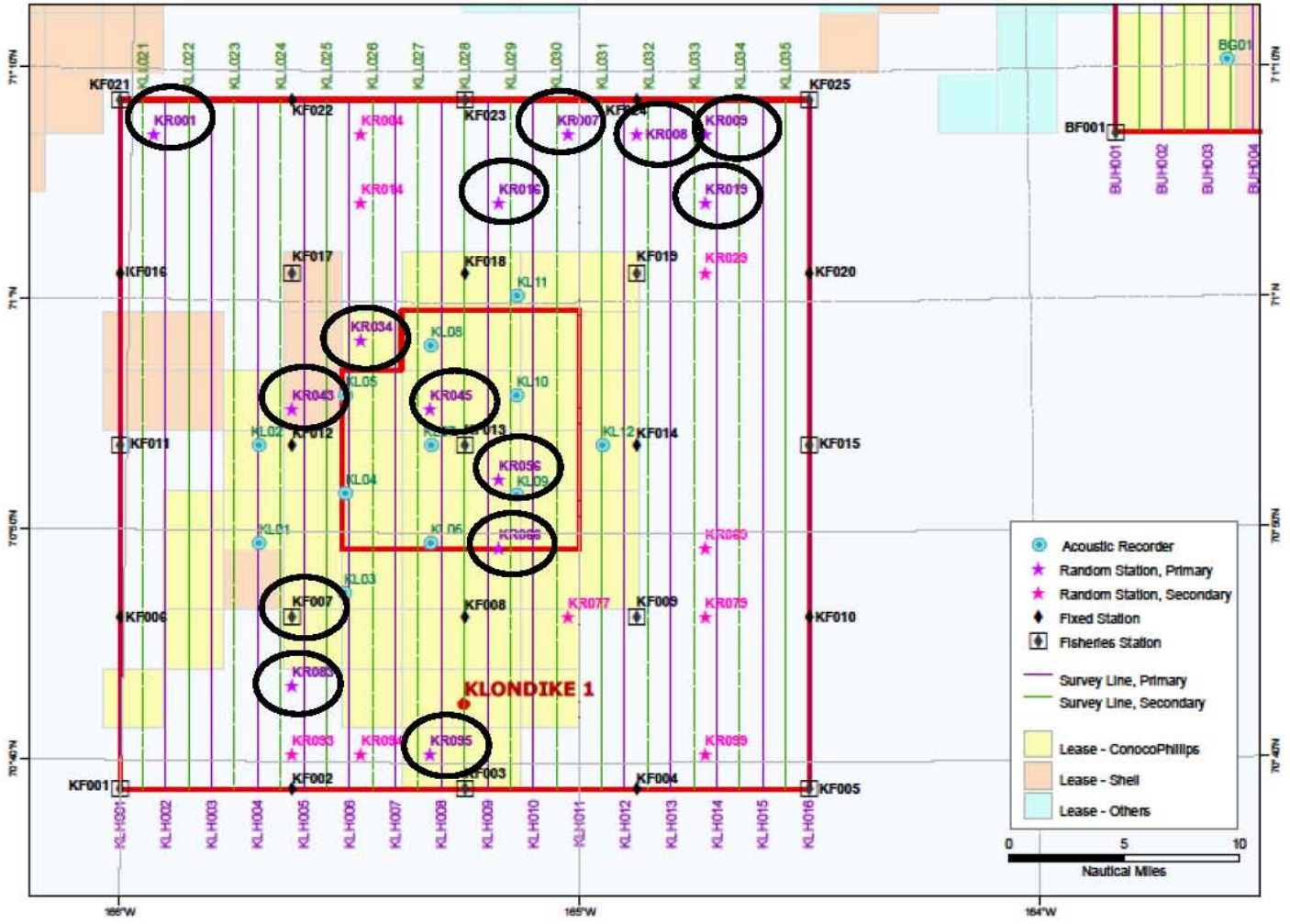
Burger Study Area



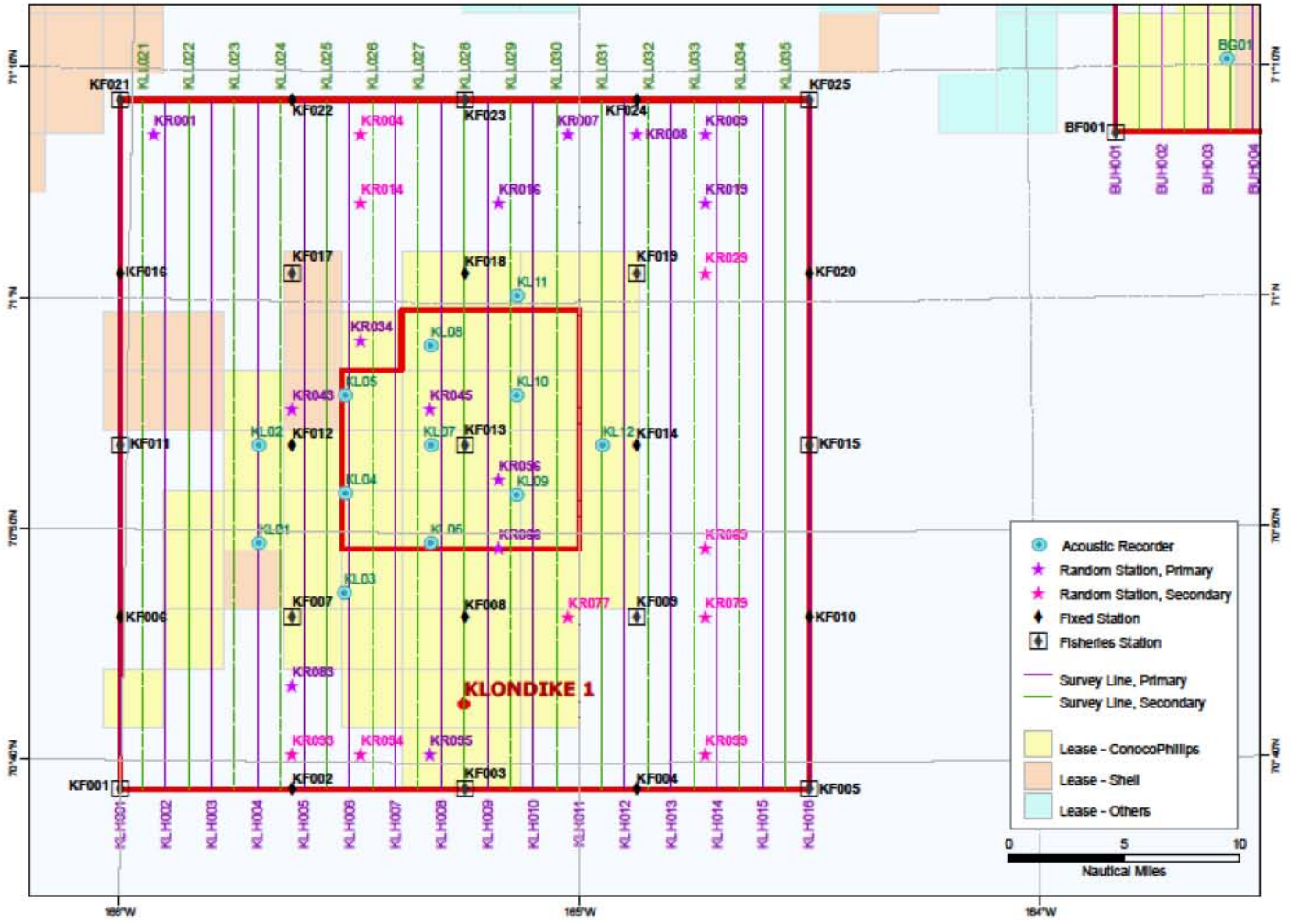
Oceanographic Stations (Fixed)



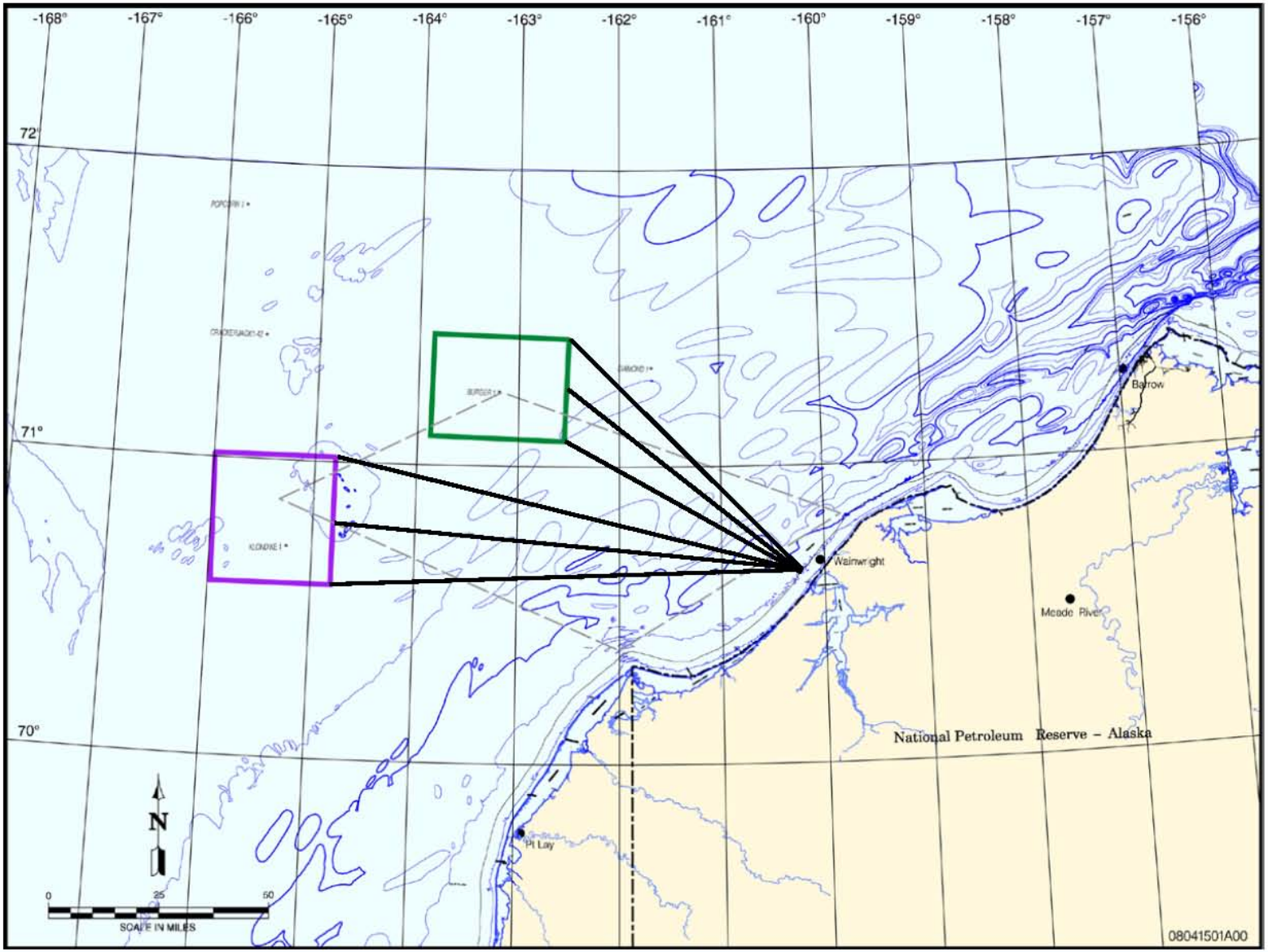
Oceanographic Stations (Random)



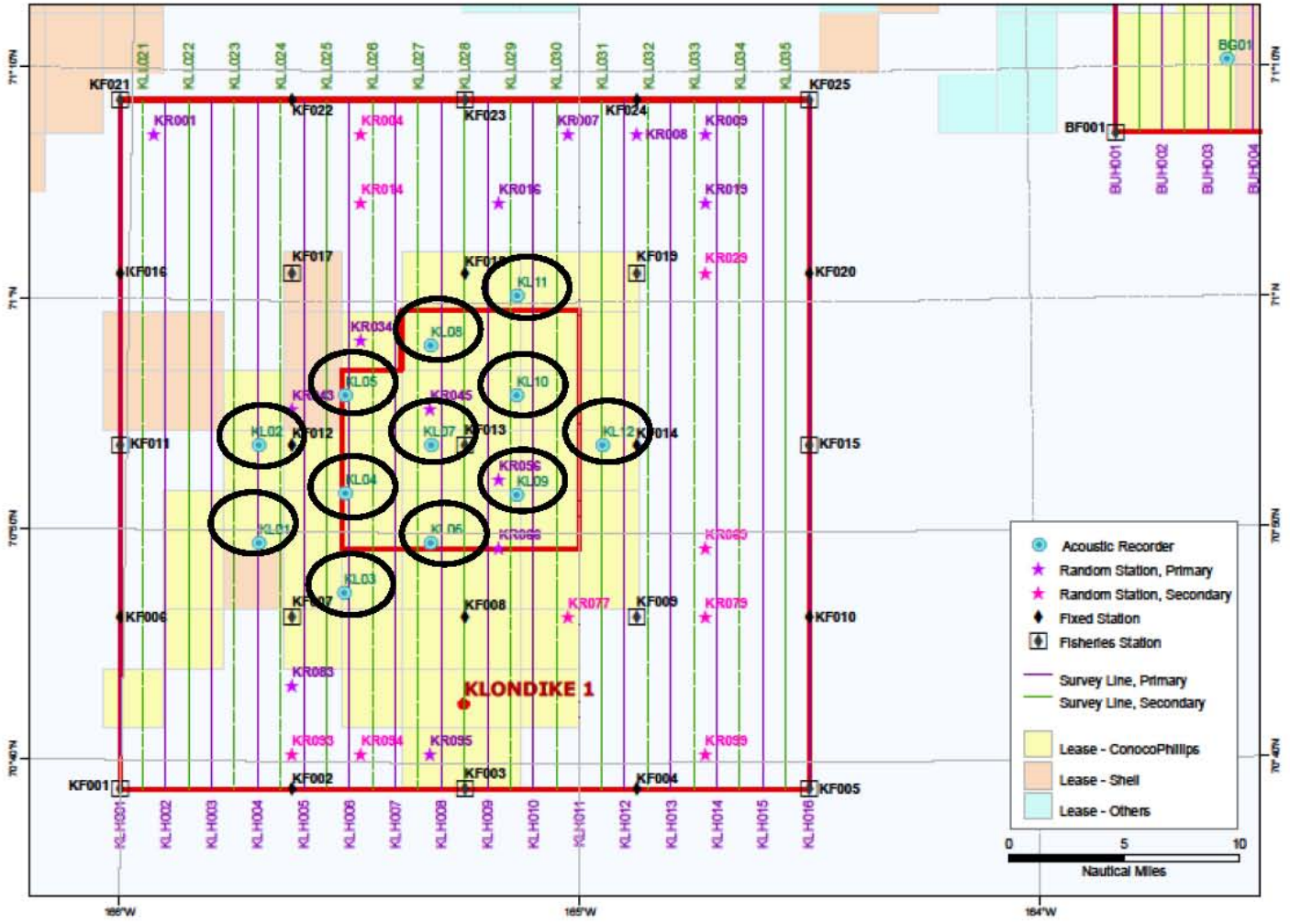
Bird/Mammal Survey Lines



Transit Survey Lines



Acoustic Moorings



WHAT WE KNOW AND WHAT WE THINK WE KNOW

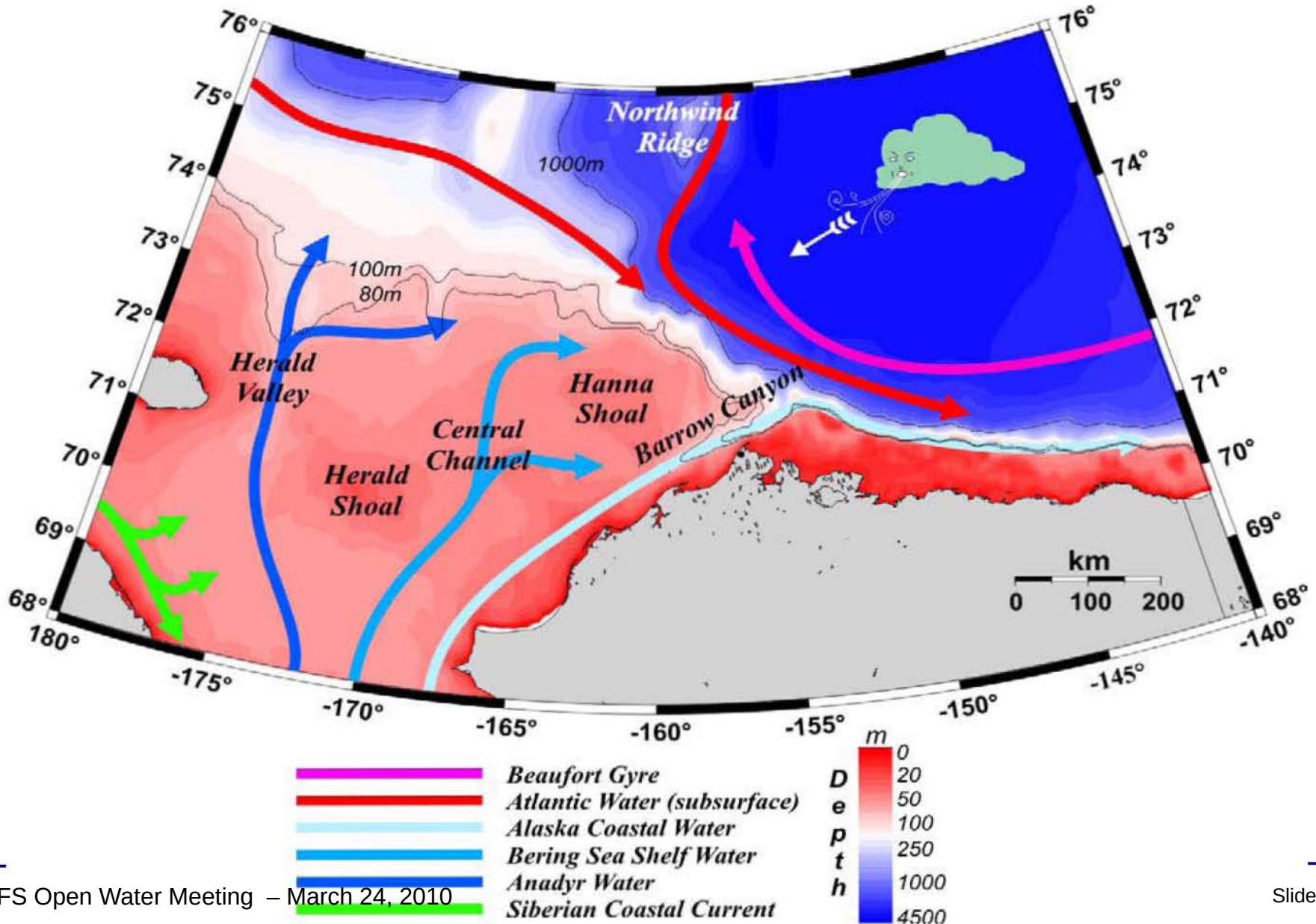
Physical Oceanography

Thomas Weingartner, Seth Danielson
Institute of Marine Sciences
University of Alaska—Fairbanks

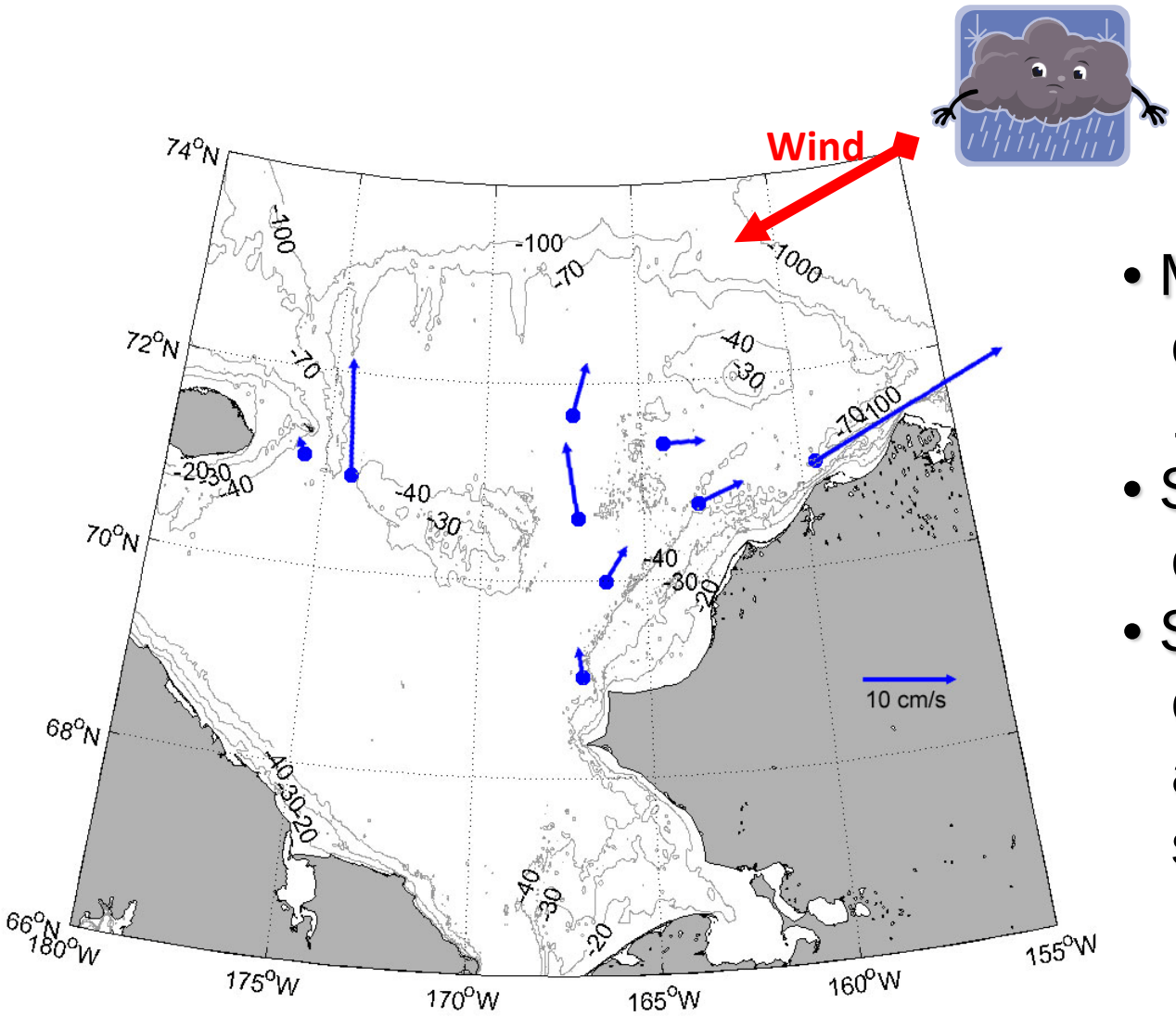
BACKGROUND: Physics Rule! (the system)

- Primarily northward-flowing currents
- Transport heat, carbon, nutrients from Bering Sea—strongly affect production in the Chukchi and Arctic Ocean
- Create water-masses with different characteristics (physics, productivity, species-composition)

Main Currents

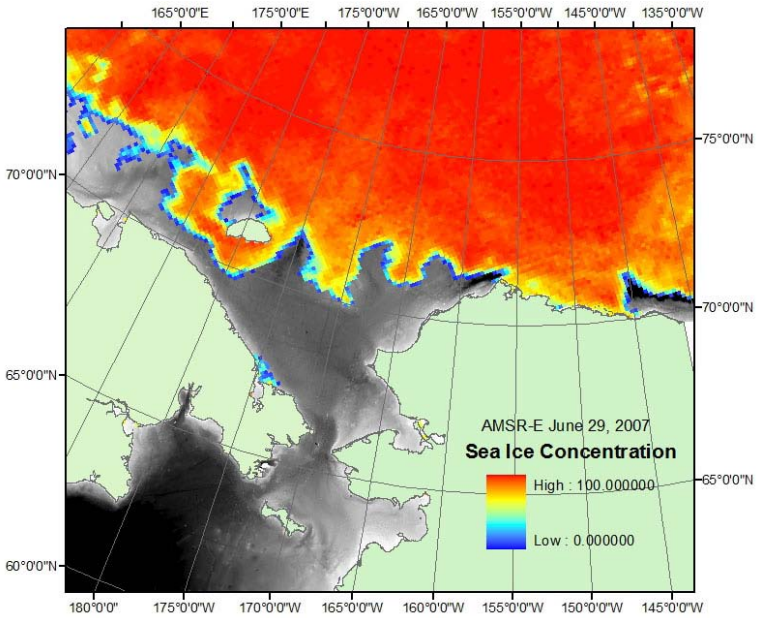


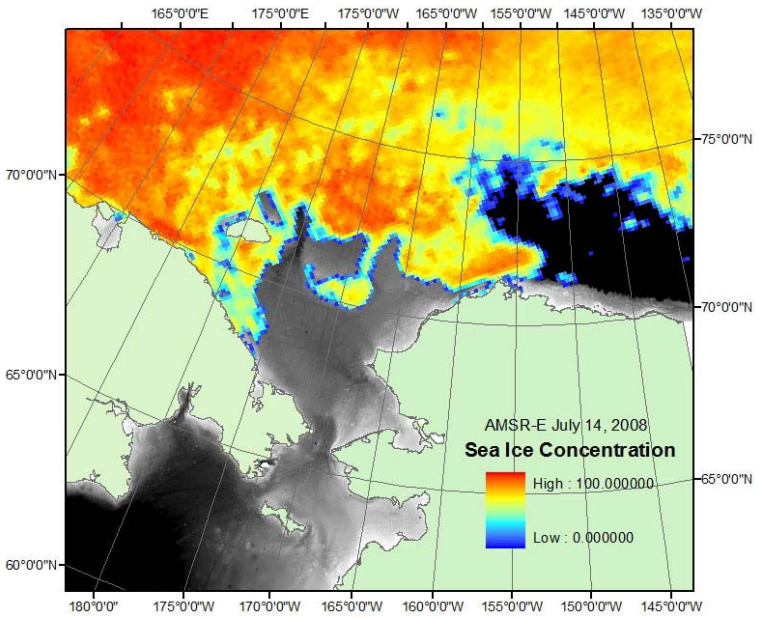
Surface vs. Subsurface



- Mooring data collected from 1990 to 1995
- Subsurface currents oppose mean winds
- Swiftest in canyons/channels and weakest in shallow regions

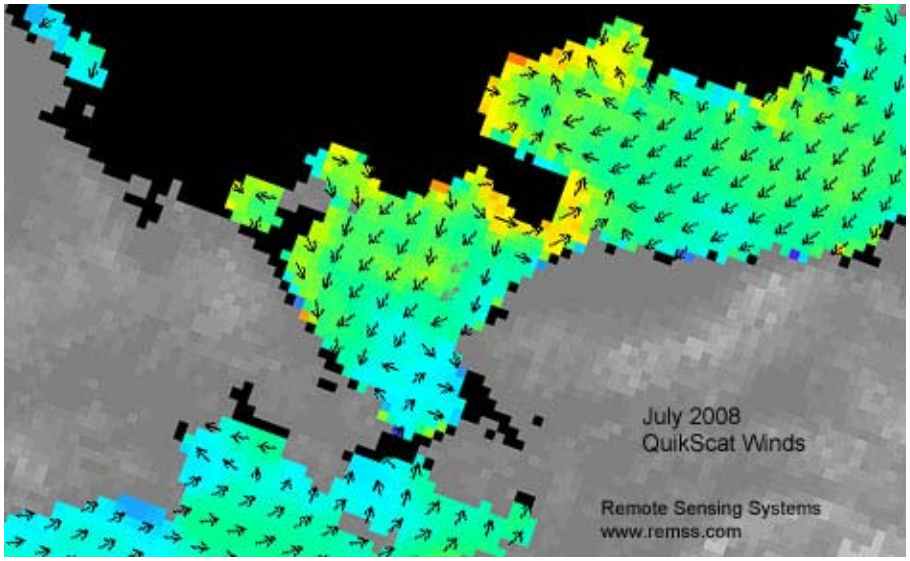
Currents Affect Ice Retreat

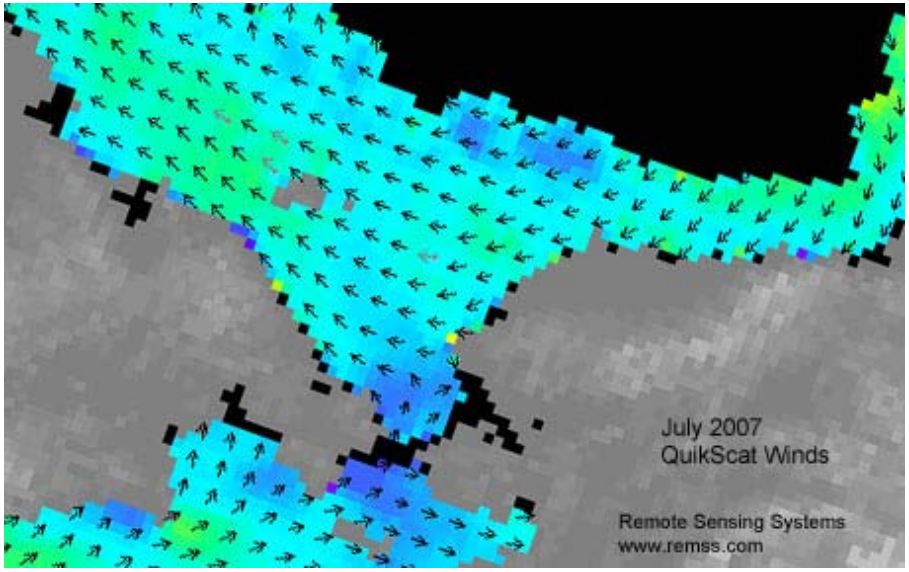




- Currents transport heat, advect water
- Ice retreats earliest in channels and latest over shoals—implications for marine mammals
- Much variability among years

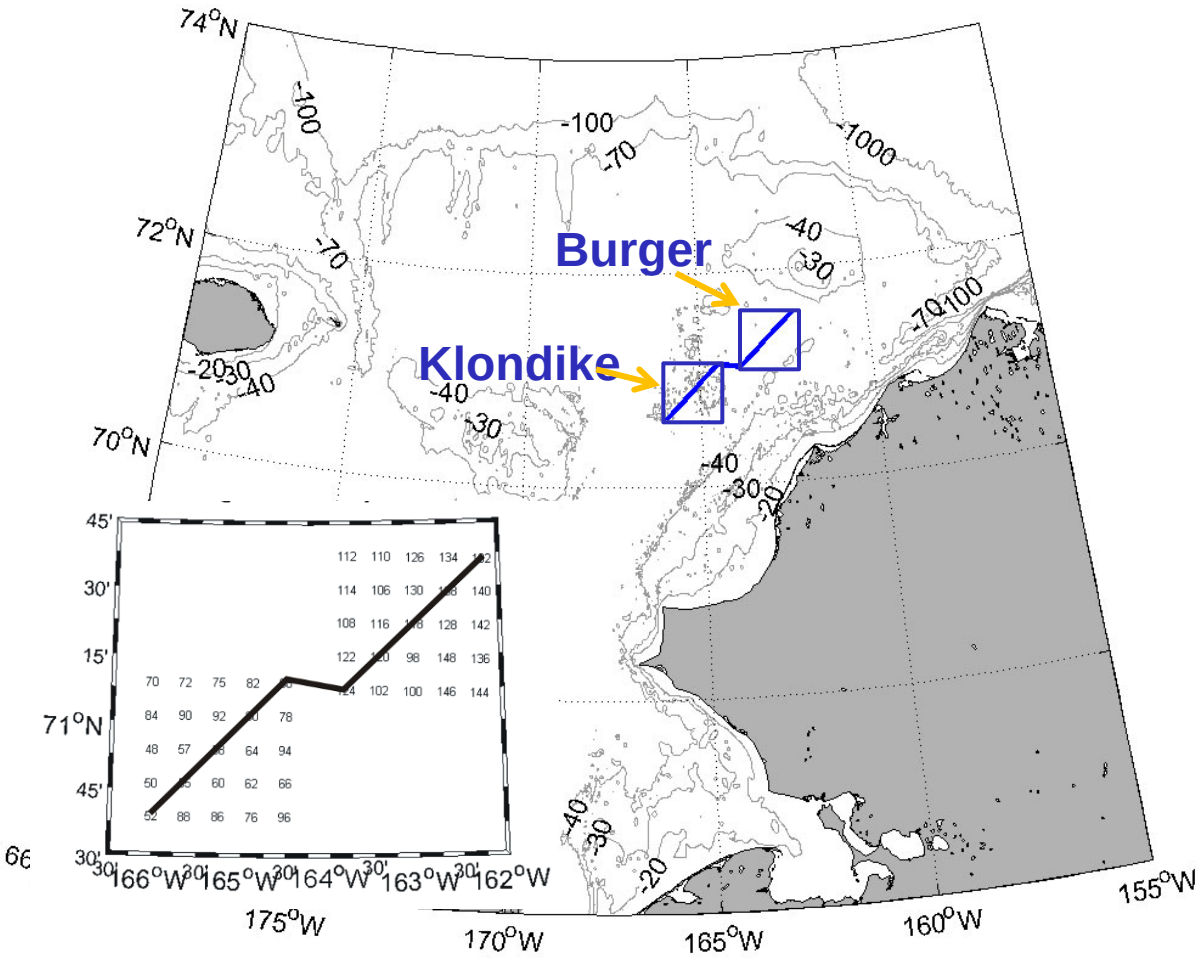
Wind Direction & Magnitude Affects Ice





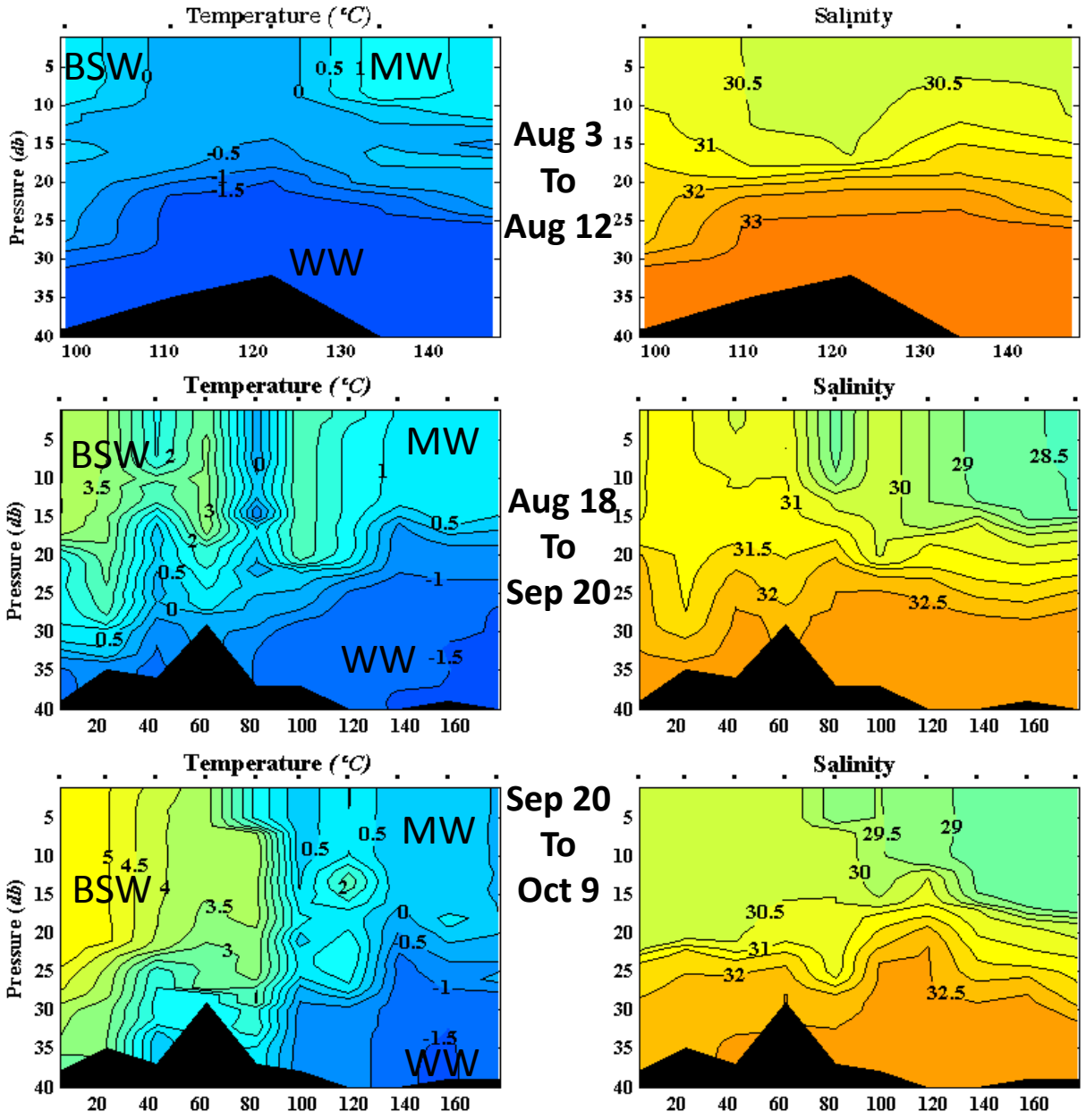
- Wind direction in July 2008 different from that in 2007 and 2009
- July 2008 winds blowing southward (against current direction)
- July 2007 and 2009 winds blowing westward

Transect Of 2008 CTD Stations



- July 25 to August 12
- August 18 to September 20
- September 20 to October 9

Vertical Sections (2008)



- Water is getting warmer through time
- WW is gradually displaced northeastward through time
- MW is always at the surface
- BSW penetrates northeastward with time (flow increases)

Interannual Variability

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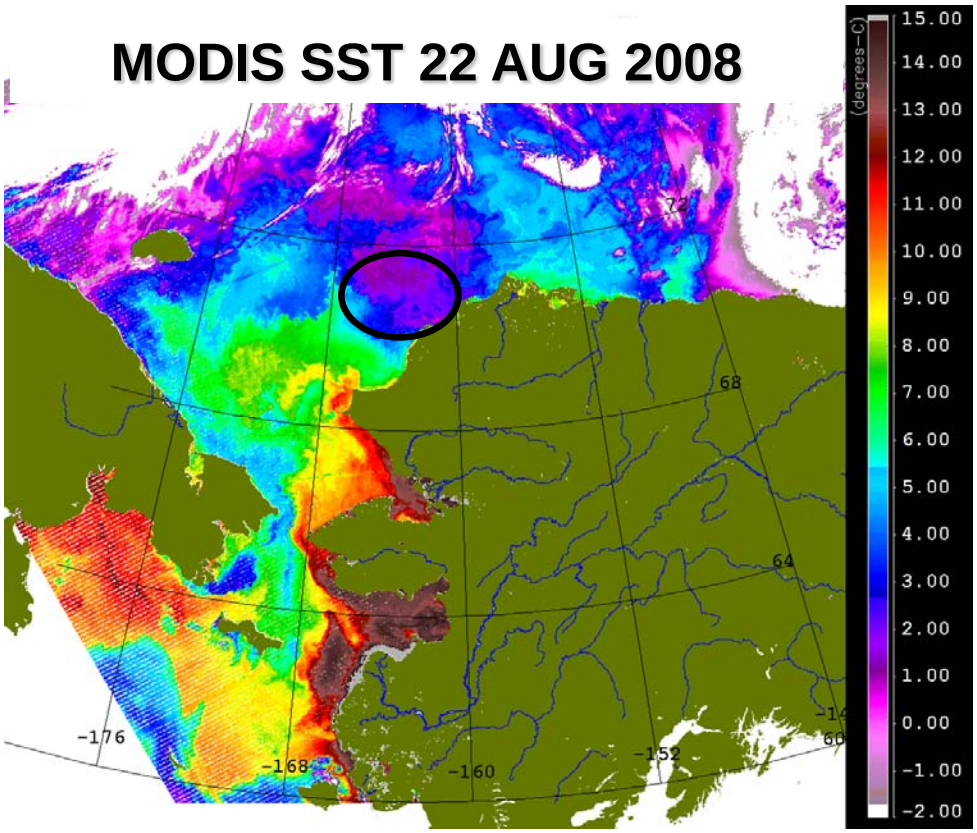
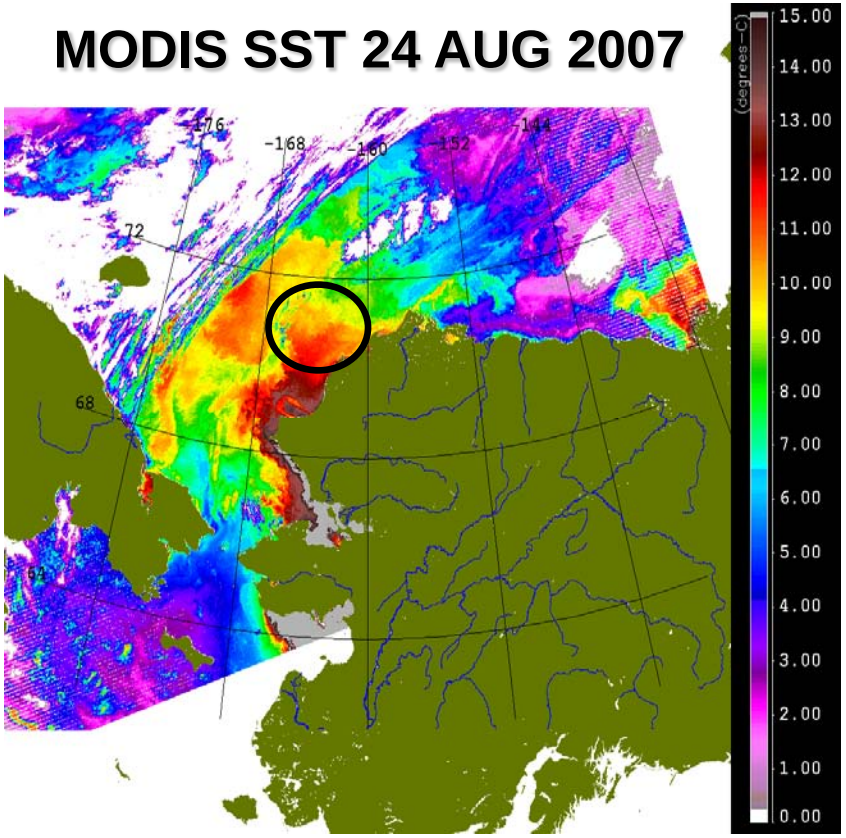
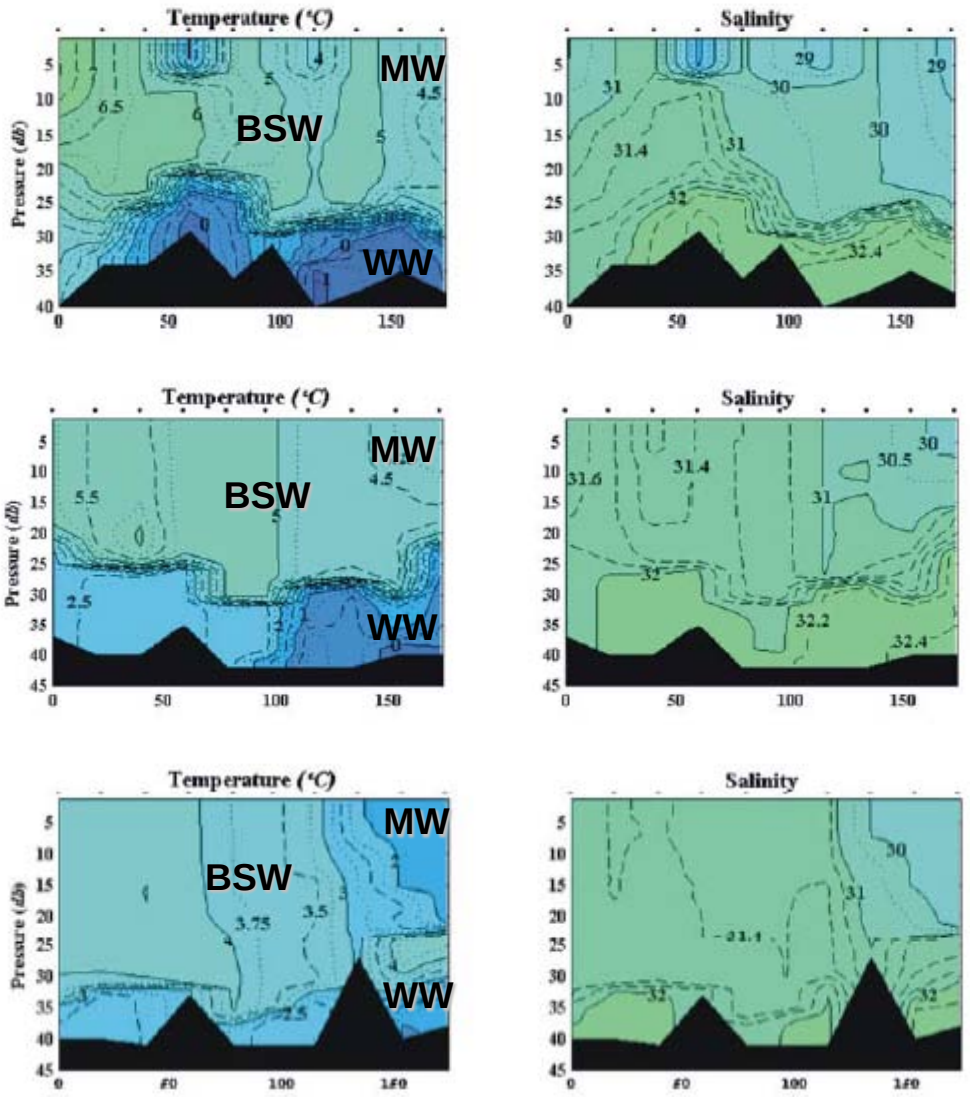
MODIS SST 22 AUG 2008



MODIS SST 24 AUG 2007



Vertical Sections (2009; Preliminary)



- Dramatic difference between years
- WW and MW barely occur in NE corner Burger
- Area flooded by BSW

Zooplankton Ecology

Russ Hopcroft, Jennifer Questel, Cheryl Clarke
Institute of Marine Sciences
University of Alaska—Fairbanks

Planktonic Communities

- Nutrients (N, P, Si)
- Chlorophyll (phytoplankton)
- Zooplankton (meso- and macro-)

Zoops (2008)

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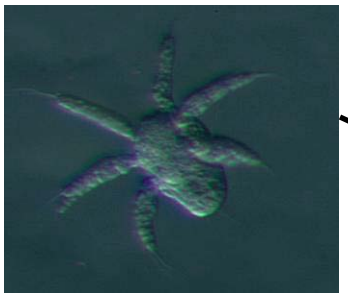
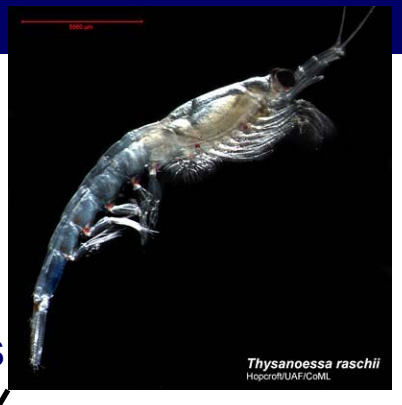
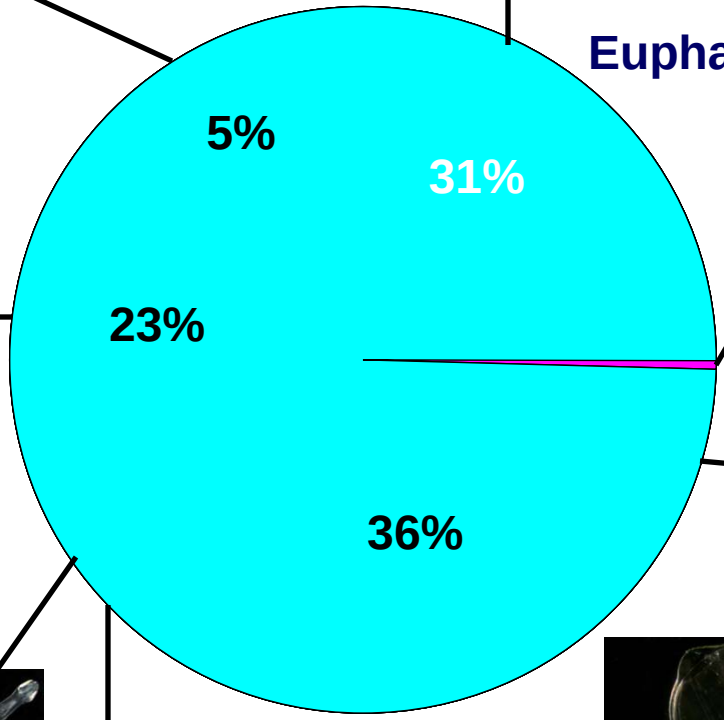
Copepod nauplii



Copepods

Euphausiids





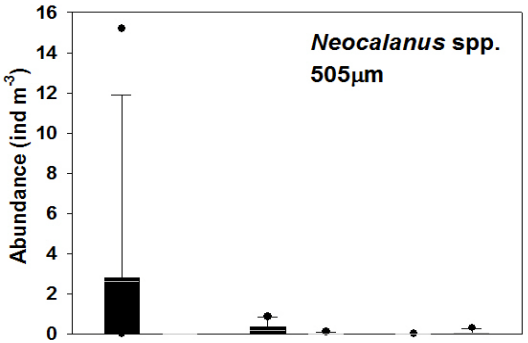
Larvaceans

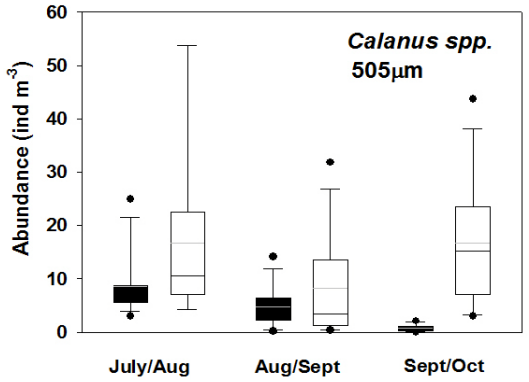
Meroplankton

Chaetognaths

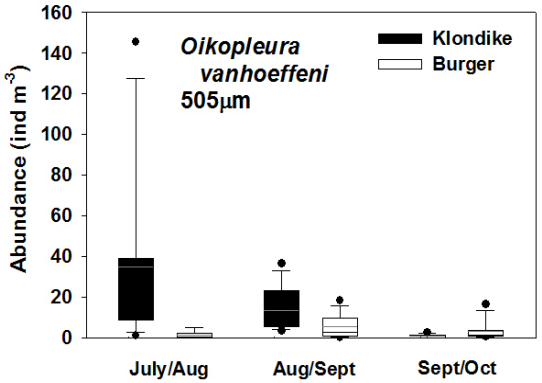
Jellies

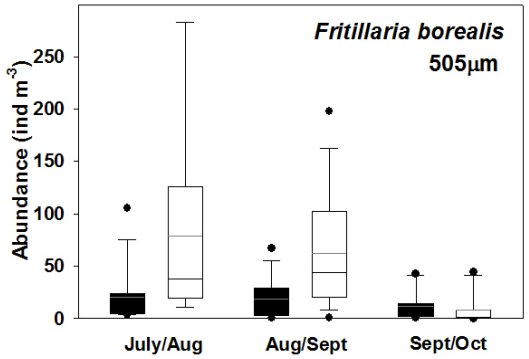
Area Differences (2008)



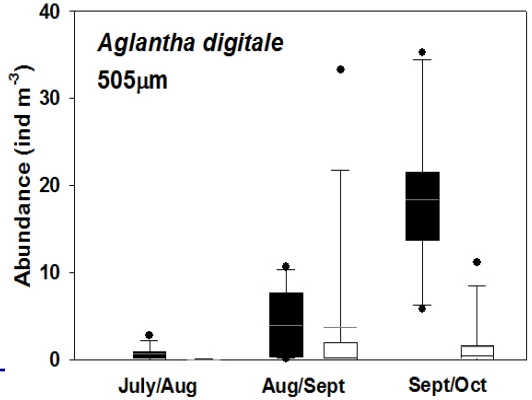


LARGE COPEPODS

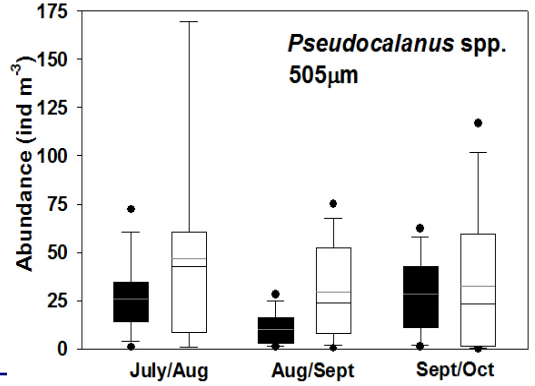




APPENDICULARIANS

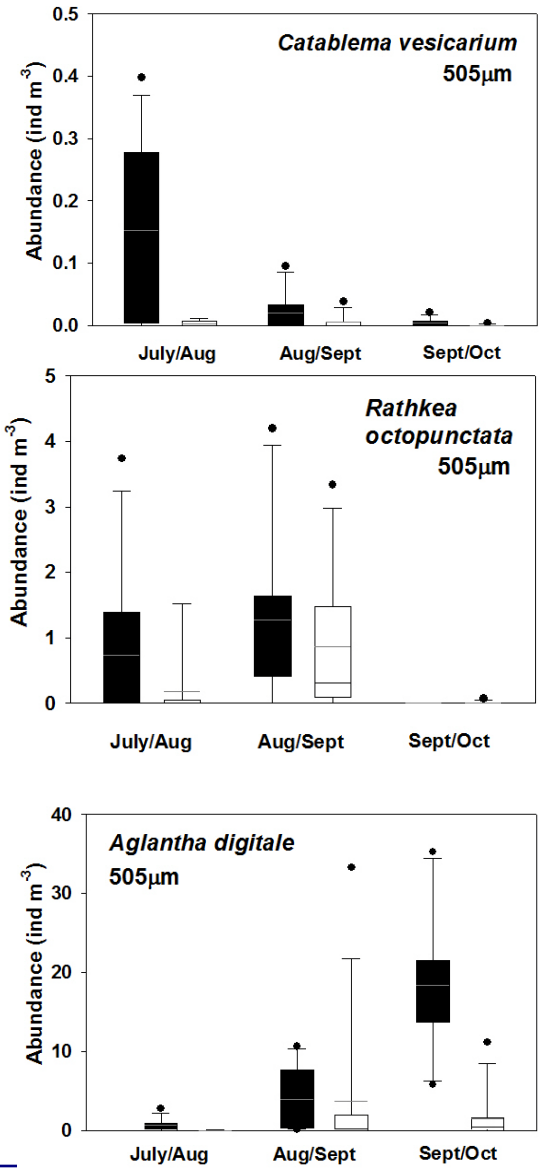


MEDUSAE



SMALL COPEPODS

Temporal Variation (2008)



- Medusae (jellies)
- In primarily oceanic water
- Communities changing constantly—seasonal succession
- Makes characterizing plankton communities difficult

How Are Stations & Cruises Related?

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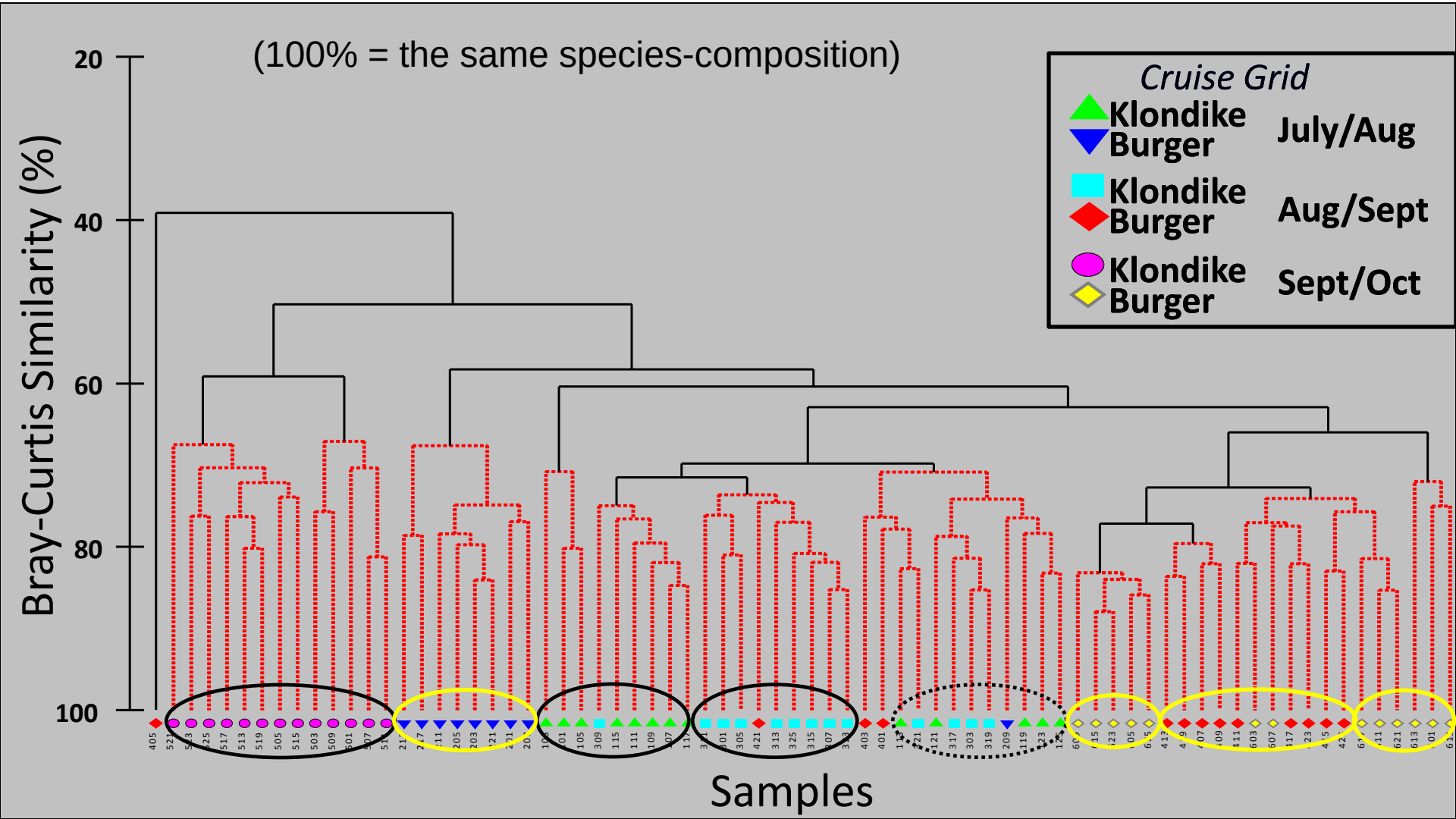
- Bray-Curtis Similarity Index
- Look for patterns among samples/seasons



Interannual Variability

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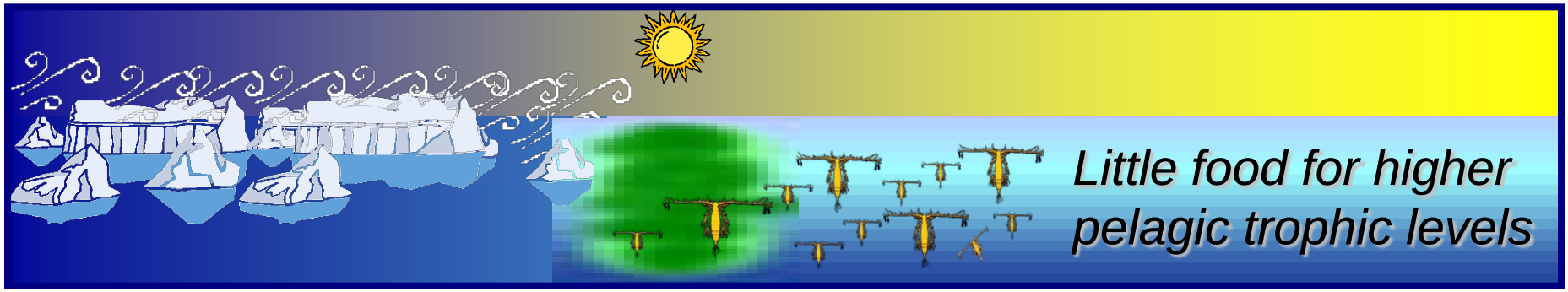
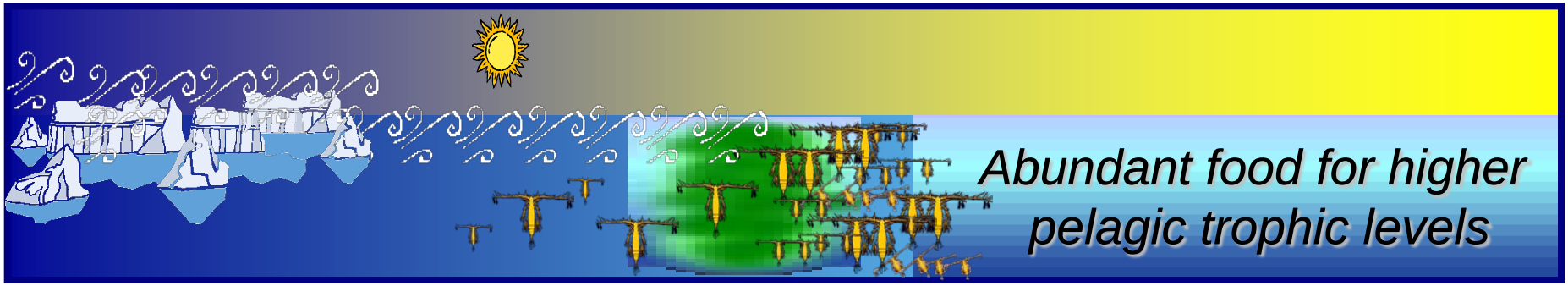
2008: Late ice retreat and low SST



2009: Early ice retreat and high SST



Hunt's BEST program

Benthic Ecology

Arny Blanchard, Hilary Nichols, Carrie Parris
Institute of Marine Sciences
University of Alaska—Fairbanks

BACKGROUND: Plants On The Ground!

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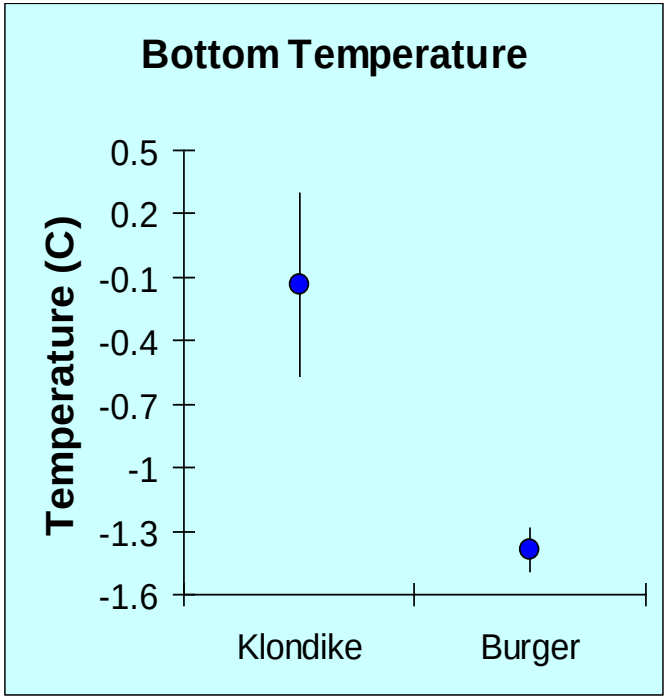
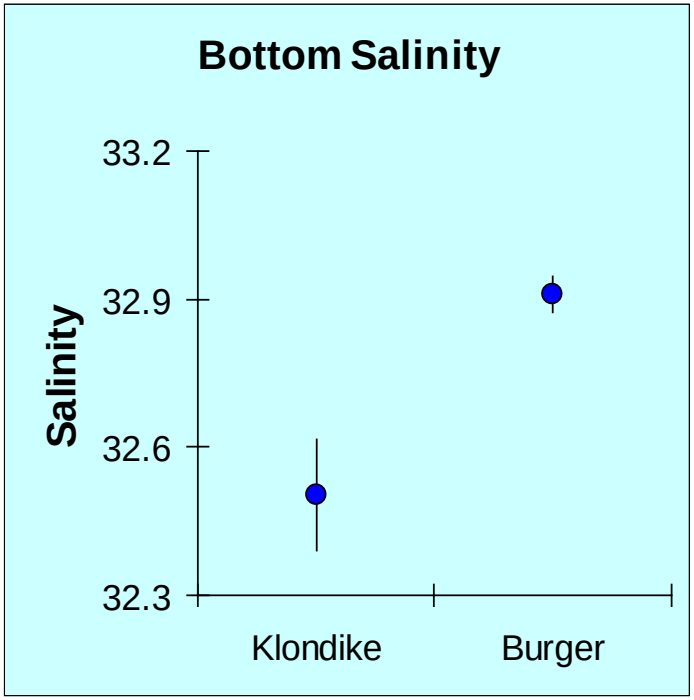
- Advection of nutrient-rich water from the Bering Sea is critical to the ecology of the Chukchi Sea
- The tight coupling of pelagic production and the benthos results in rich benthic communities
- Benthic communities are rich, directly supporting upper trophic levels

Bottom-water Characteristics

- Klondike was warmer and less saline than Burger in 2008; these differences probably resulted from differences in circulation
- More mud at Burger





Data from Tom Weingartner and Seth Danielson, IMS, UAF

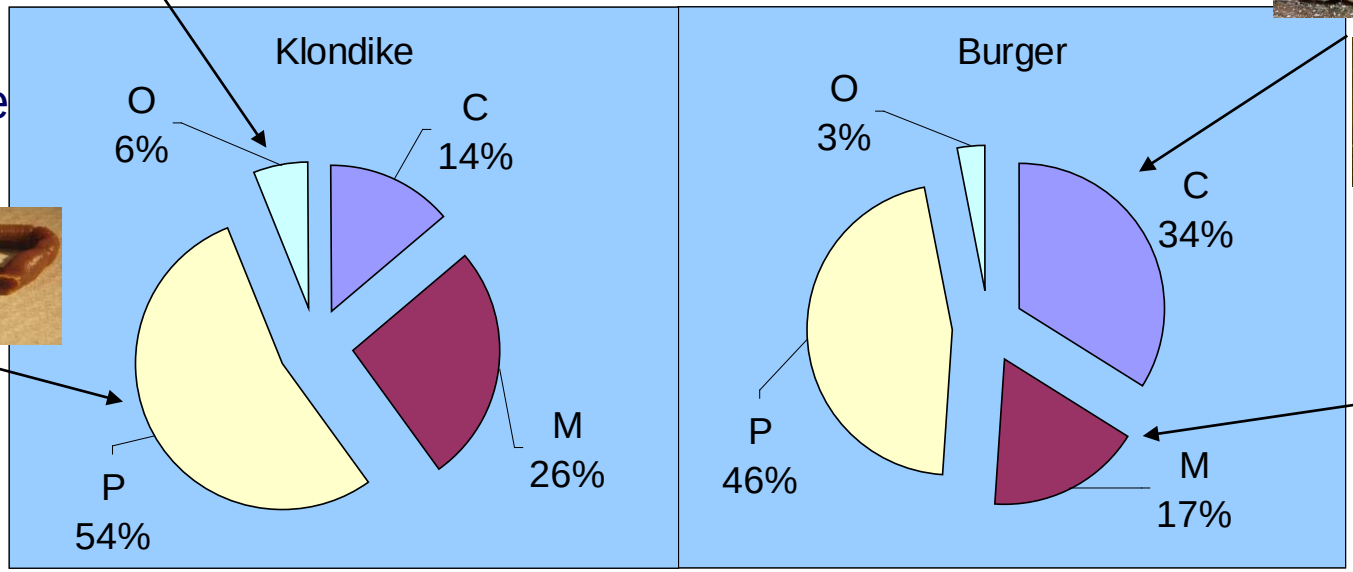
Infauna (2008)

Infaunal communities differed between areas in composition of major groups

Others

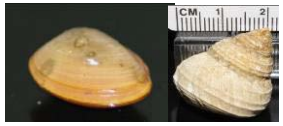
Crustaceans

Percent abundance (individuals/m^2)



Polychaete worms

Mollusks



Infaunal Comparison (2008)

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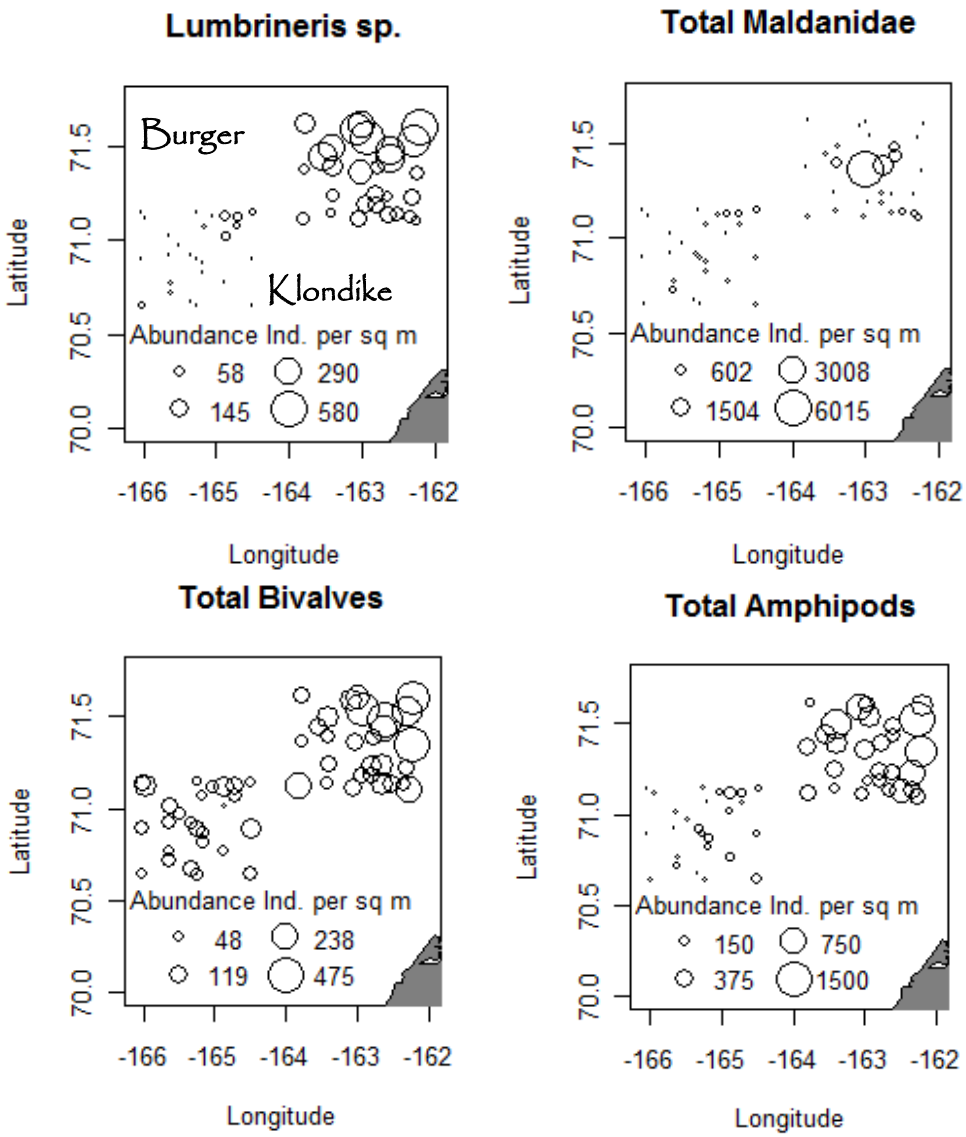
Same species found in both areas

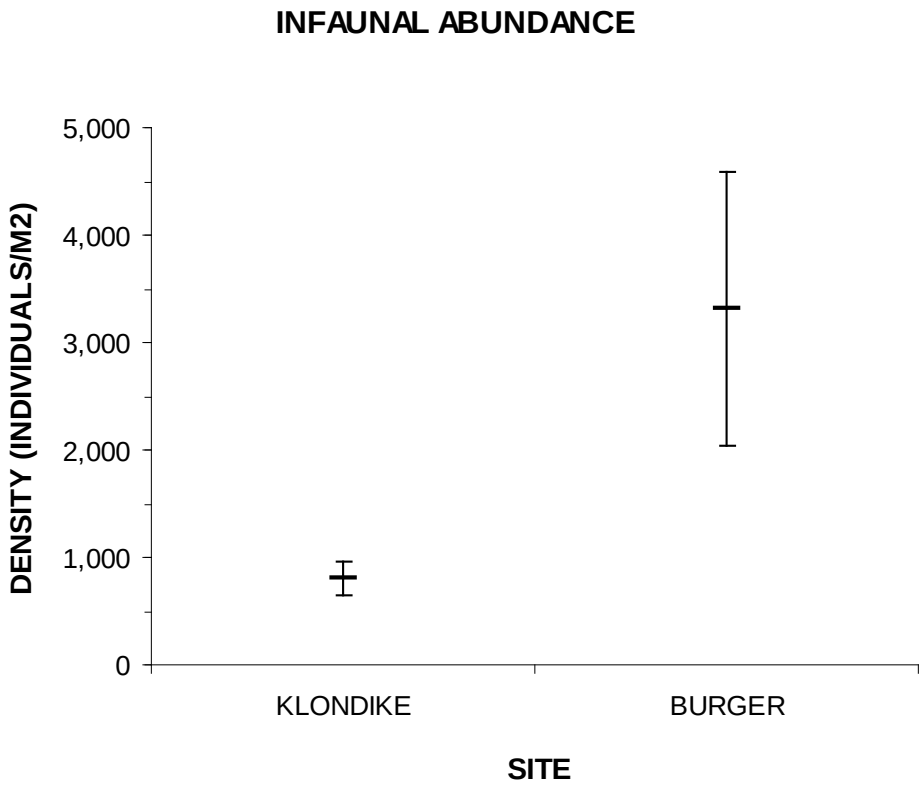
Across all taxa, infauna were more abundant at Burger

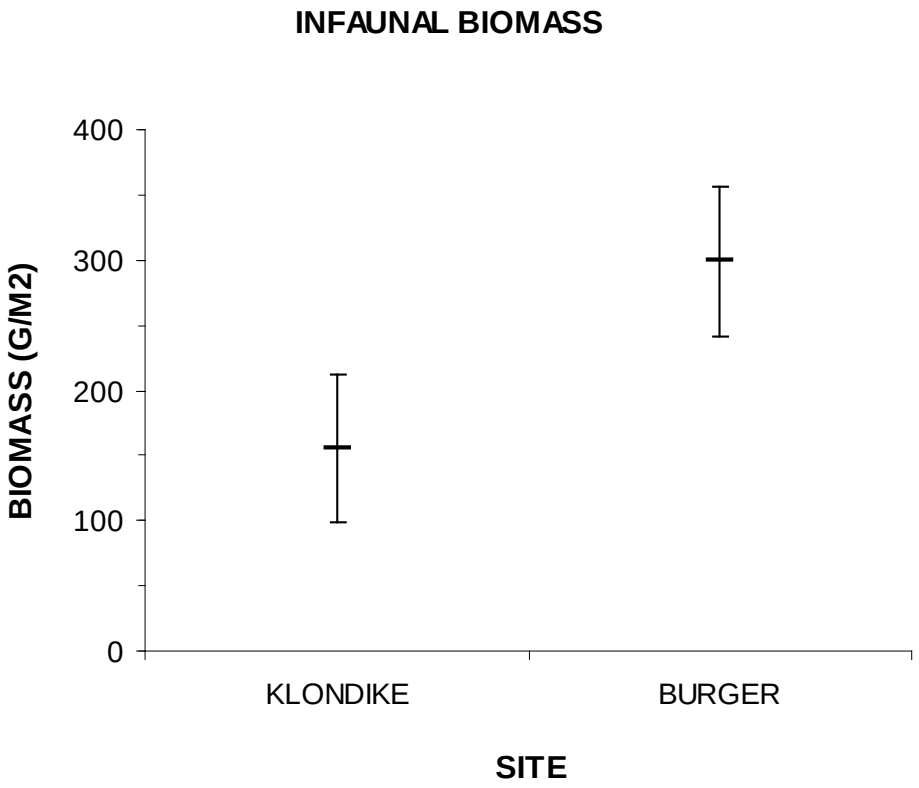
Diversity was similar between areas

The differences reflected environmental gradients (depth and sediment grain-size)



Infaunal Differences (2008)



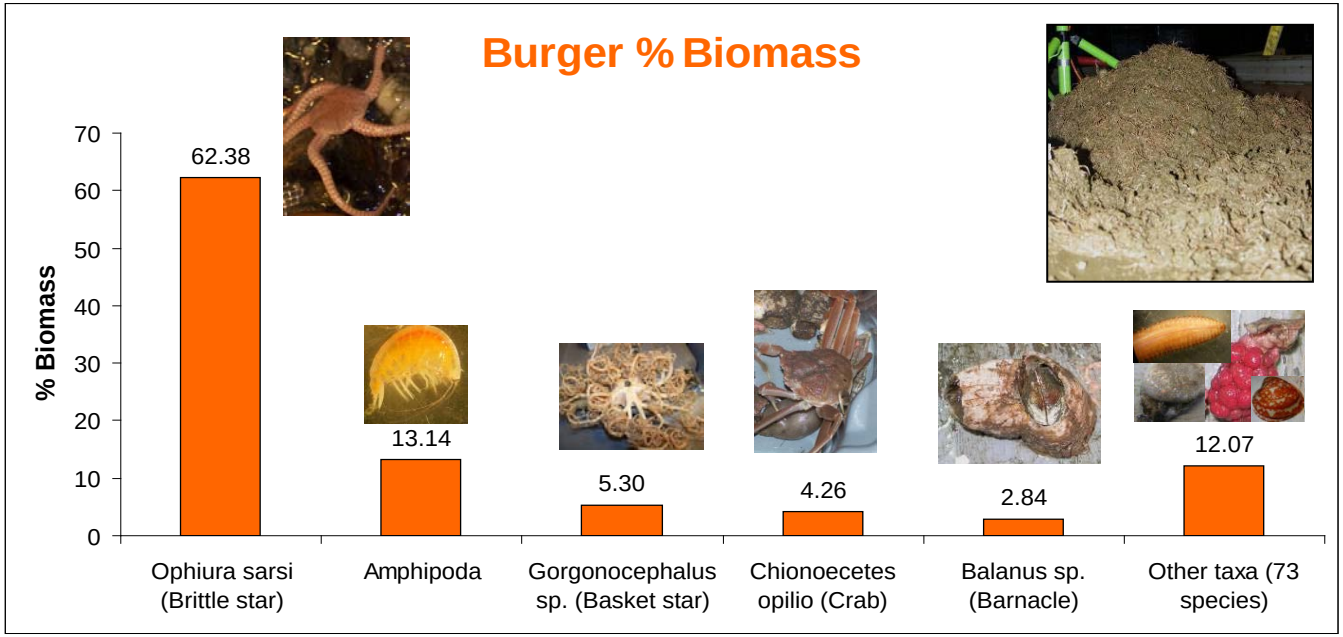


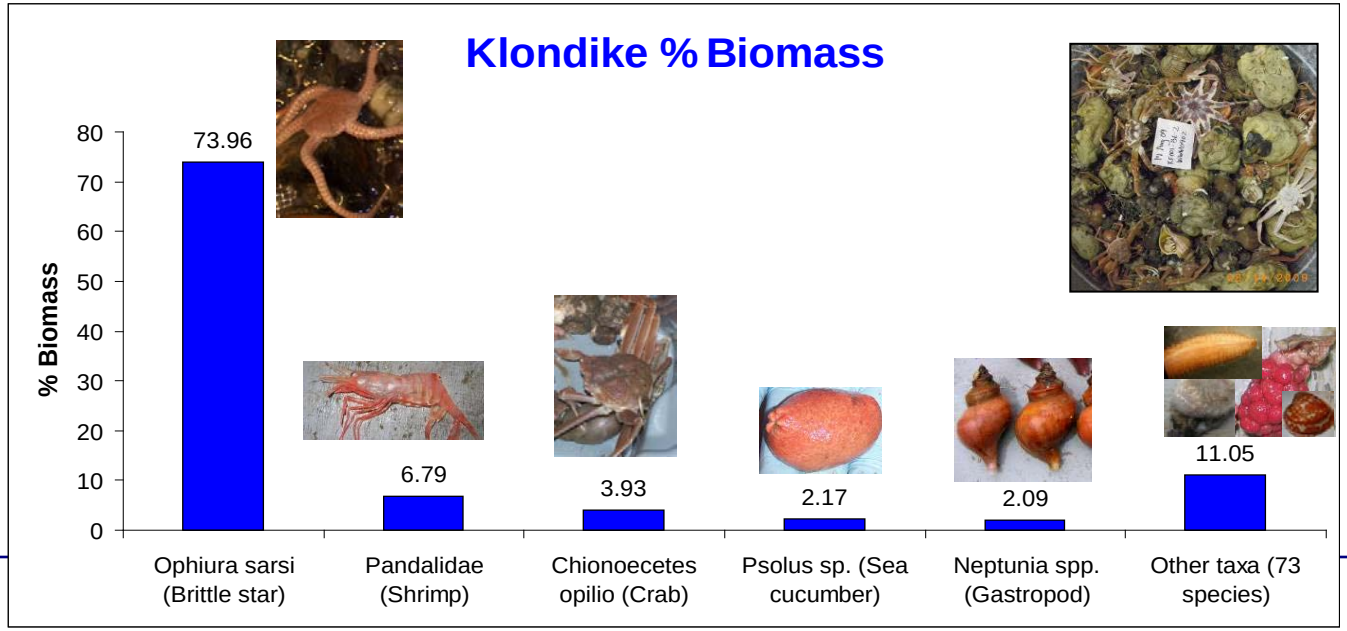
MEAN ABUNDANCE IN BURGER 4X THAT IN KLONDIKE

MEAN BIOMASS IN BURGER 2X THAT IN KLONDIKE

Epibenthos (2009; Preliminary)

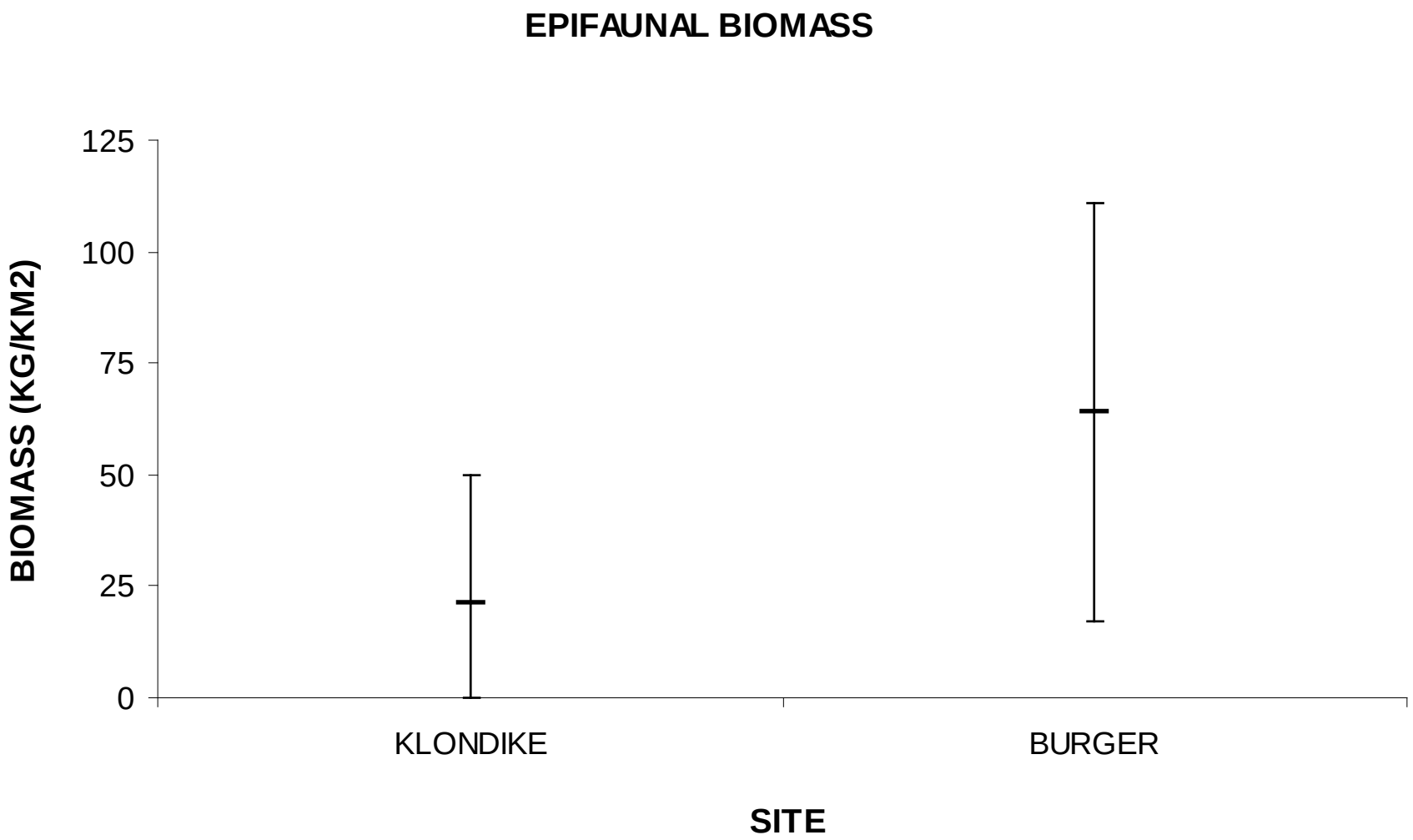
The brittle star *Ophiura sarsi* is the dominant epifaunal species





Composition of major taxon categories similar between sites but Burger has greater biomass.

Epifaunal Differences (2009; Preliminary)



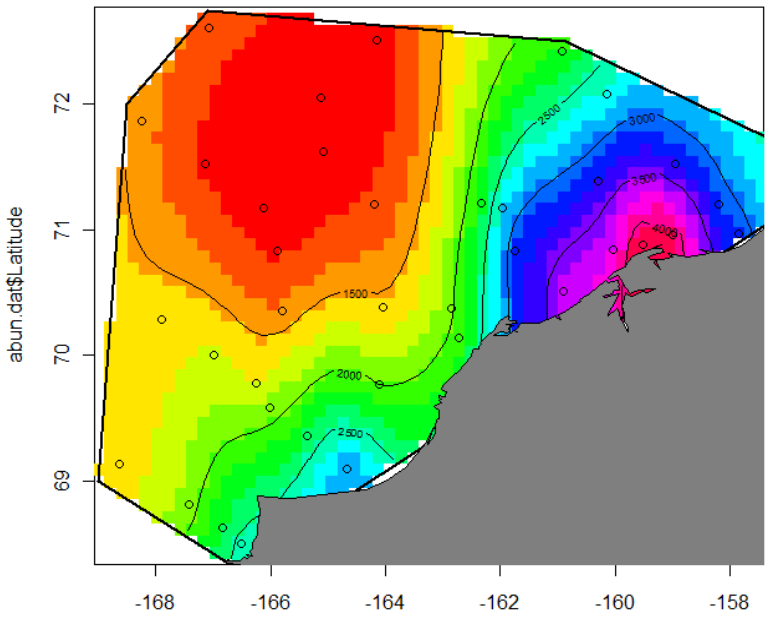
MEAN BIOMASS IN BURGER 3X THAT IN KLONDIKE

Howard Feder's "Benthic Hot Spot"

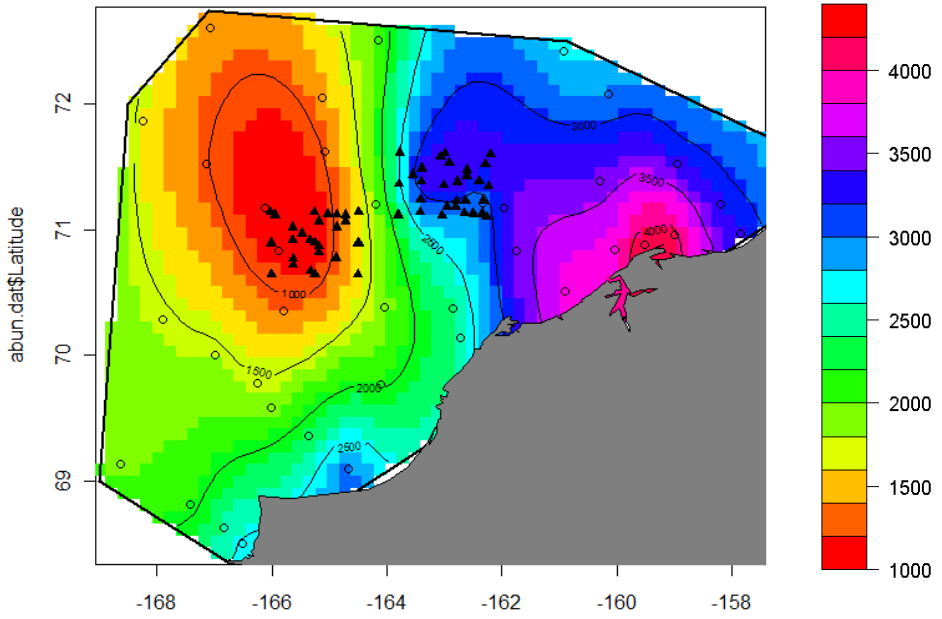
In contrast to Feder's 1986 study, fauna from Burger and Klondike were of similar composition

The geostatistical model updated with the 2008 data highlights his benthic (infaunal) "hot spot" in the NE Chukchi Sea

Abundance (ind. m^{-2}) 1986 Only



Abundance 1986, 2008 Combined



Marine-Mammal Ecology

ConocoPhillips Alaska

Jay Brueggeman
Canyon Creek Consulting
Seattle

Data-collection Procedures

- Two marine mammalogists alternating 4-hr watches all daylight hours
- Observe from bridge with binoculars
- Line-transect sampling

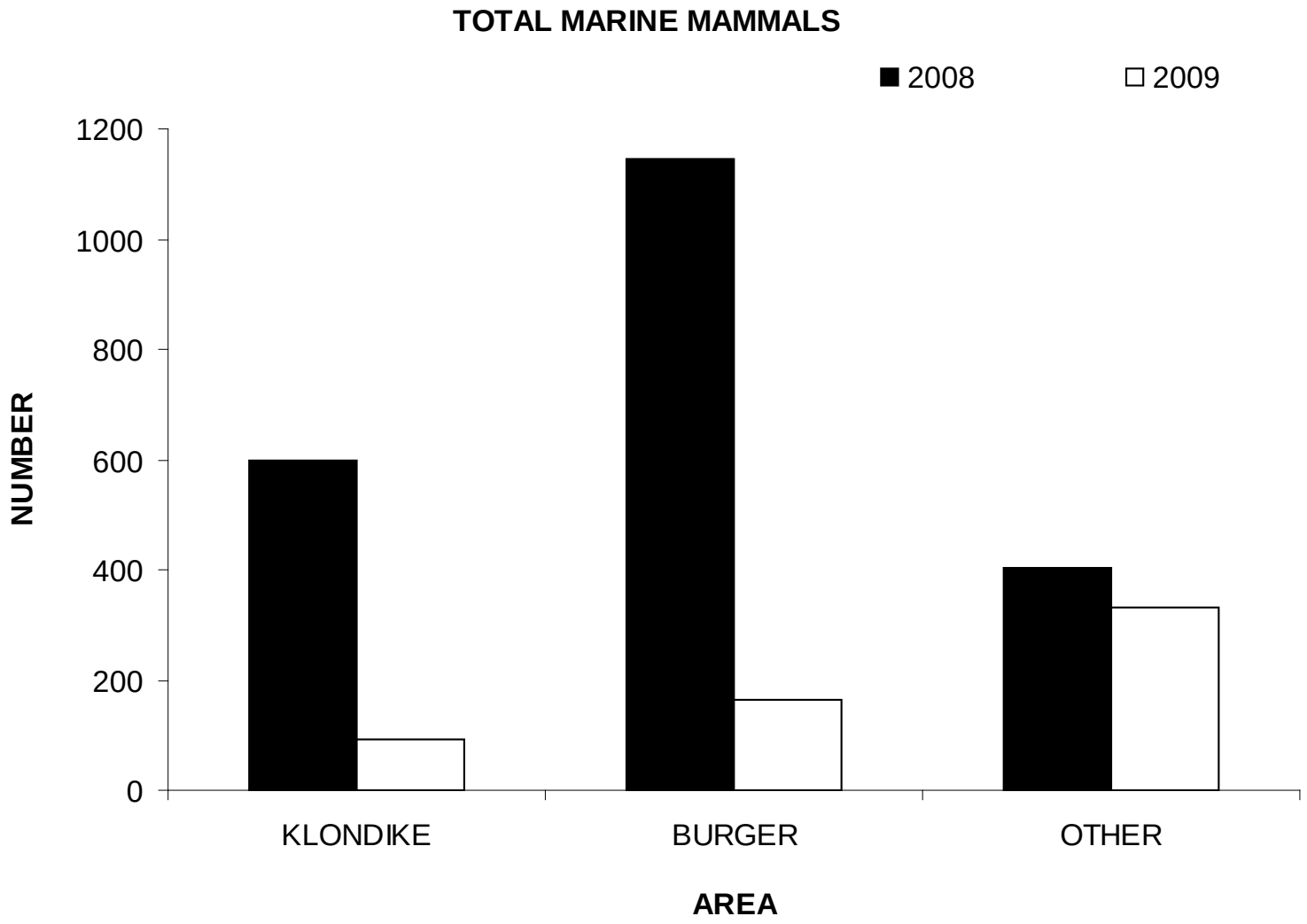
Species List

- PINNIPEDS
  - Ringed Seal
  - Spotted Seal
  - Ribbon Seal
  - Bearded Seal
  - Walrus

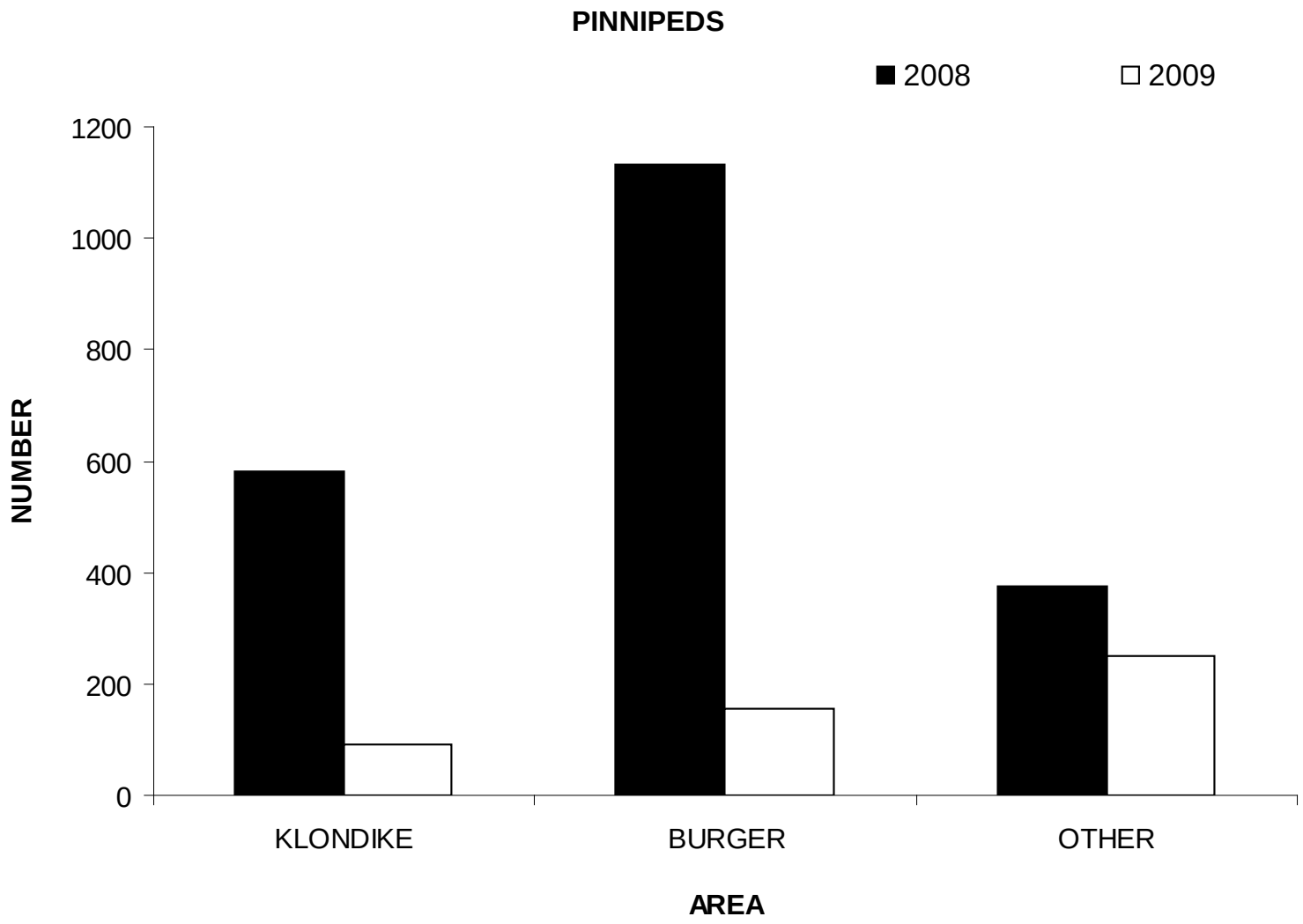
- CETACEANS
  - Bowhead Whale
  - Minke Whale
  - Gray Whale
  - Killer Whale
  - Harbor Porpoise

  - Polar Bear

Marine Mammals Sighted (2008–2009)



Pinnipeds Sighted (2008–2009)



Pinnipeds (2008)

Species/Group	Klondike	Burger	Other
Seals	549	173	368
Walrus	24	940	1
Unidentified pinnipeds	7	19	6

Pinnipeds (2009)

Species/Group	Klondike	Burger	Other
Seals	78	90	11
Walrus	8	62	239
Unidentified pinnipeds	5	5	0

Seals (2008)

Species	Klondike	Burger	Other
Ringed/Spotted	112	31	38
Ringed Seal	67	13	37
Spotted Seal	20	16	24
Bearded Seal	37	62	20
Ribbon Seal	4	2	0
Unidentified seal	309	49	249

Seals (2009)

Species	Klondike	Burger	Other
Ringed/Spotted	36	31	2
Ringed Seal	6	11	1
Spotted Seal	7	5	3
Bearded Seal	7	22	1
Unidentified seal	22	21	1

Cetaceans (2008)

ConocoPhillips Alaska

Species	Klondike	Burger	Other
Gray Whale	3	1	18
Bowhead Whale	0	2	0
Minke Whale	0	1	0
Killer Whale	9	0	0
Harbor Porpoise	7	0	0
Unidentified whale	1	2	8

Cetaceans (2009)

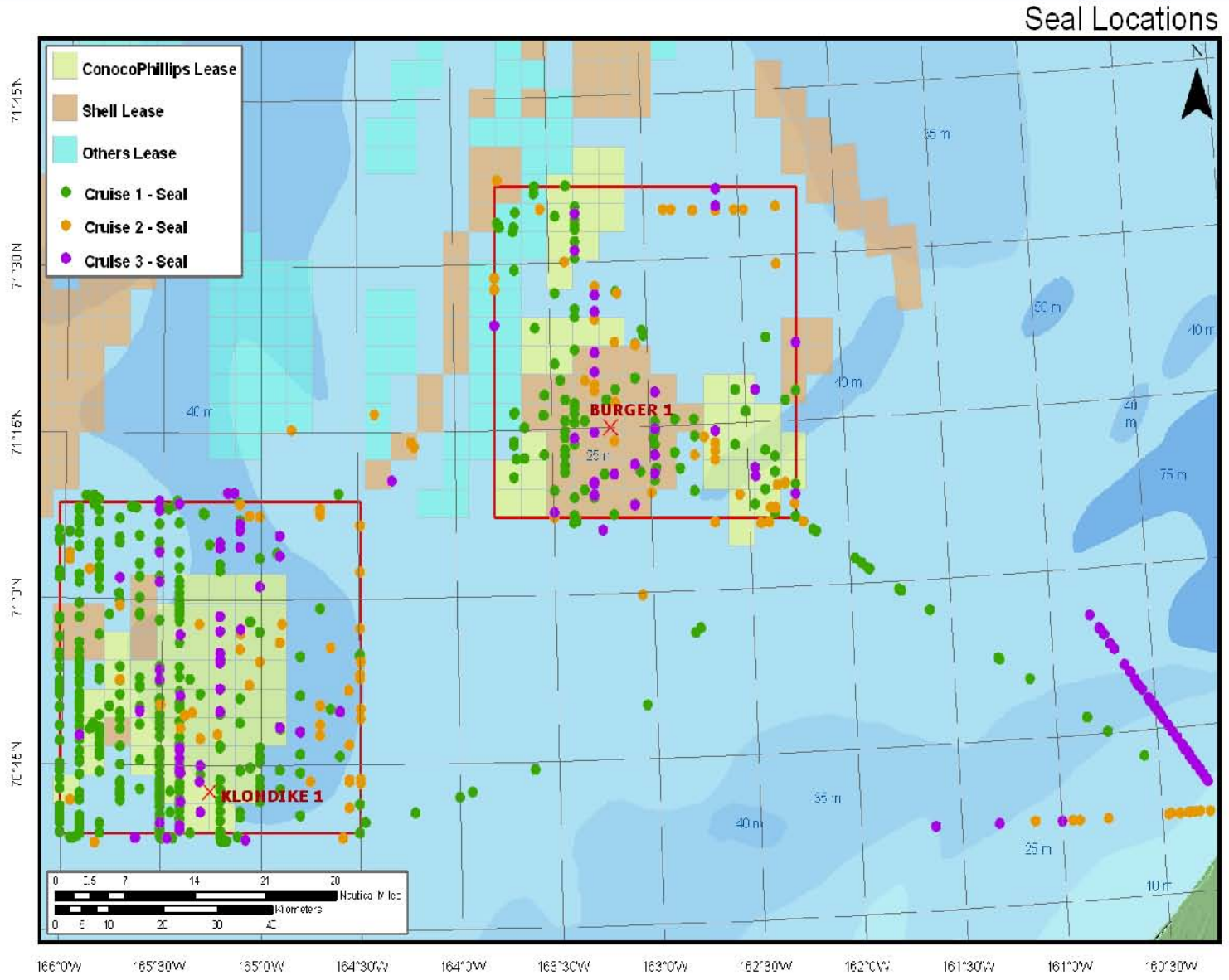
ConocoPhillips Alaska

Species	Klondike	Burger	Other
Gray Whale	1	1	75
Bowhead Whale	0	3	0
Minke Whale	1	0	1
Harbor Porpoise	0	0	3
Unidentified whale	0	1	0

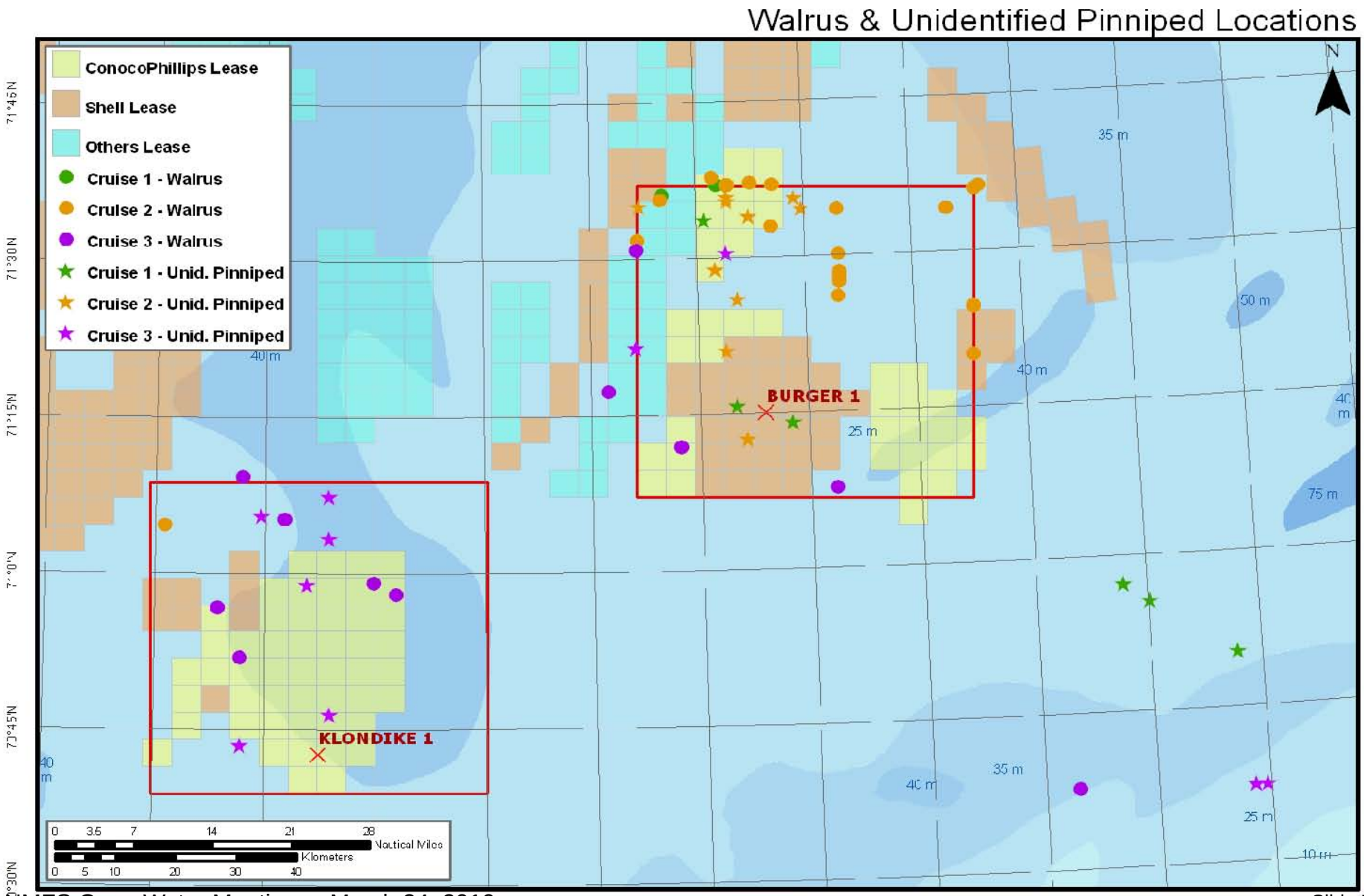
Polar Bears (2008–2009)

Year	Klondike	Burger	Other
2008	0	9	0
2009	0	0	4

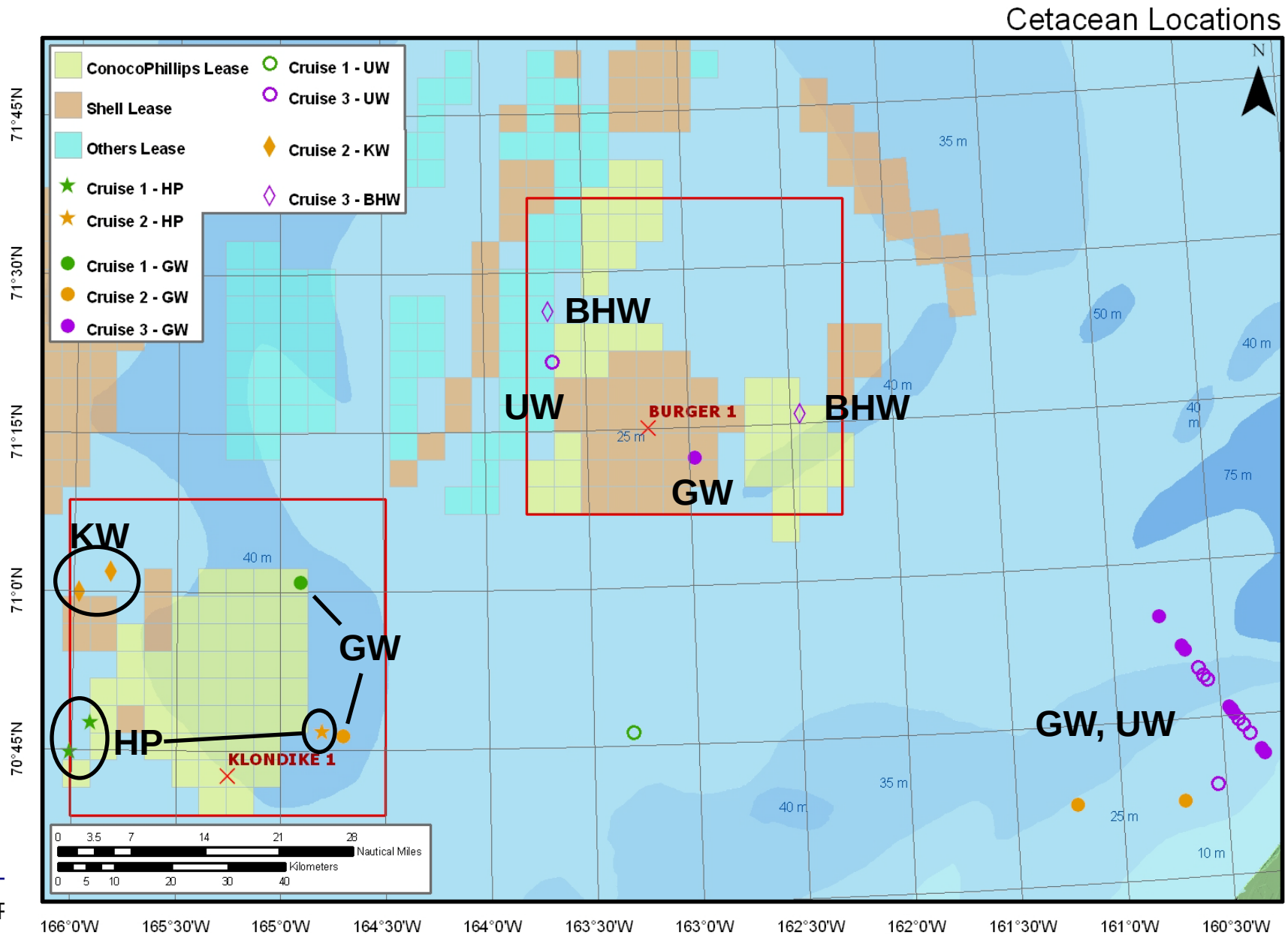
Seal Distribution (2008)



Walrus Distribution (2008)



Cetacean Distribution (2008)



HYPOTHESES ABOUT MARINE MAMMALS AND OCEANOGRAPHY IN THE NORTHEASTERN CHUKCHI SEA DURING THE OPEN-WATER SEASON

Pelagic Comparison (2008–2009)

- In 2008, Klondike was pelagic-dominated system and Burger was benthic-dominated system
- In 2009, both areas were pelagic-dominated system
- Prediction: Pelagically-feeding seals will differ in relative abundance between study areas in 2008 but not 2009

Benthic Comparison (2008/2009)

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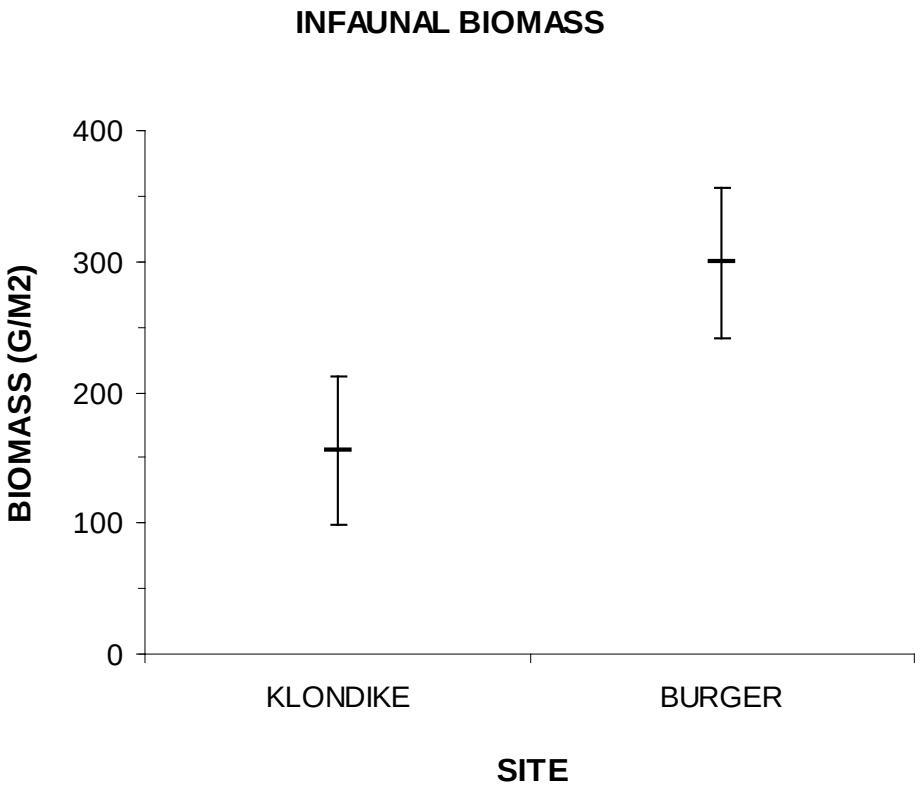
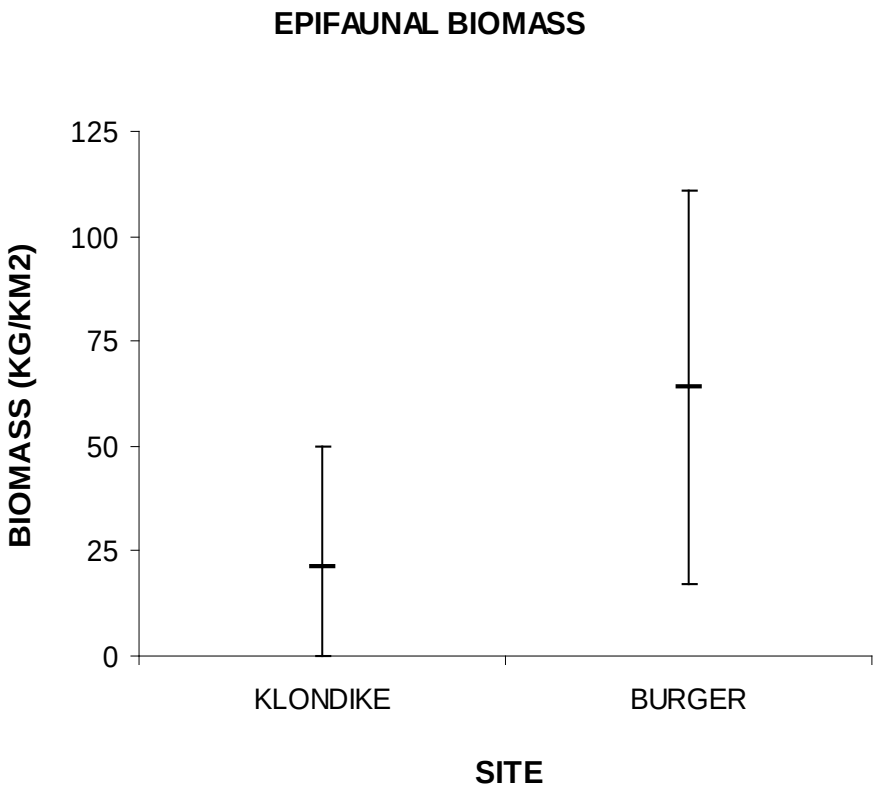
Prediction: Benthically feeding seals & Walruses will differ in abundance between study areas in both years



MEAN BIOMASS IN BURGER 2X THAT IN KLONDIKE

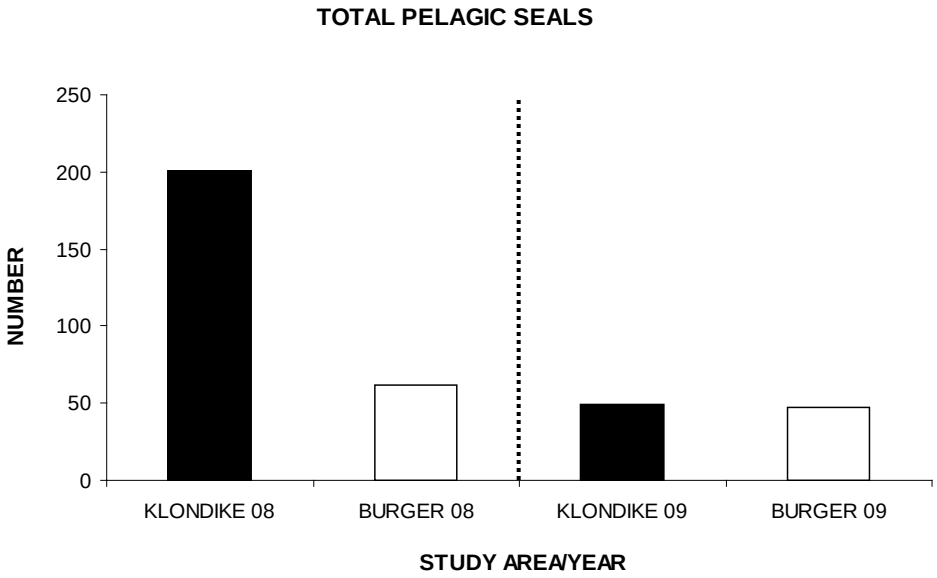


MEAN BIOMASS IN BURGER 3X THAT IN KLONDIKE

Pelagic vs. Benthic Pinnipeds

IDENTIFIED ANIMALS ONLY

ConocoPhillips Alaska



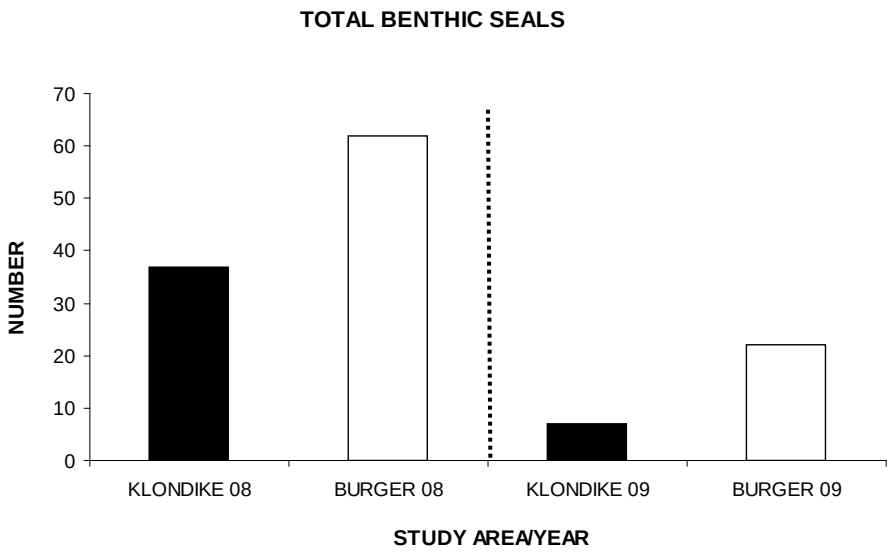
BEARDED

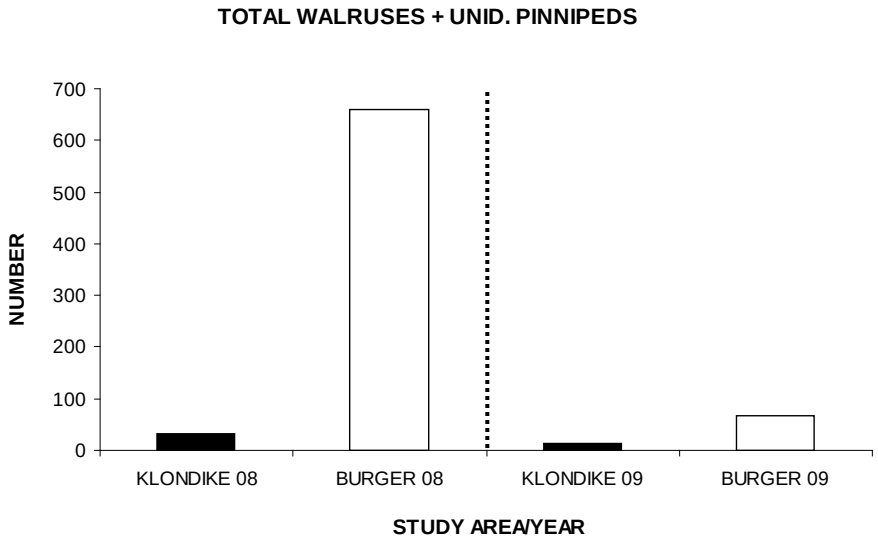
RINGED

SPOTTED

RINGED/SPOTTED

RIBBON





Conclusions (2008–2009)

- Study areas were not spatially uniform
- Differences in water-masses
- Differences in zooplankton communities
- Differences in benthic communities
- BUT some interannual differences

Conclusions (MM 2008–2009)

ConocoPhillips Alaska

- Most marine mammal species found in the Chukchi Sea also occurred in one or both study areas in various numbers
- Remnant sea ice affected numbers of seals, Walruses, and Polar Bears
- Seals were significantly more abundant in both study areas during Cruise 1, with lower and similar numbers during Cruises 2 and 3 (2008)
- Most Gray Whales were east of the Klondike and Burger survey areas, primarily near the coast

Conclusions (MM 2008–2009)

- Small numbers of other cetacean species occurred sporadically in survey areas, including two Bowhead Whales observed at Burger in October (but no surveys in Klondike in October)
- Some Bowhead Whales migrate through or near both study areas
- Hypothesis of greater numbers of benthically-feeding Walruses and Bearded Seals at Burger and greater numbers of pelagically-feeding seals in Klondike* during open-water period, reflecting environmental differences
- Interannual variability is high