SOAR benthic hotspot workshop

Jackie M. Grebmeier
CBL/UMCES

March 25, 2013
US Arctic Research Commission
Anchorage, Alaska

Outline

- Infaunal abundance biomass, and composition
- Sediment grain size, total organic carbon and nitrogen, chlorophyll a

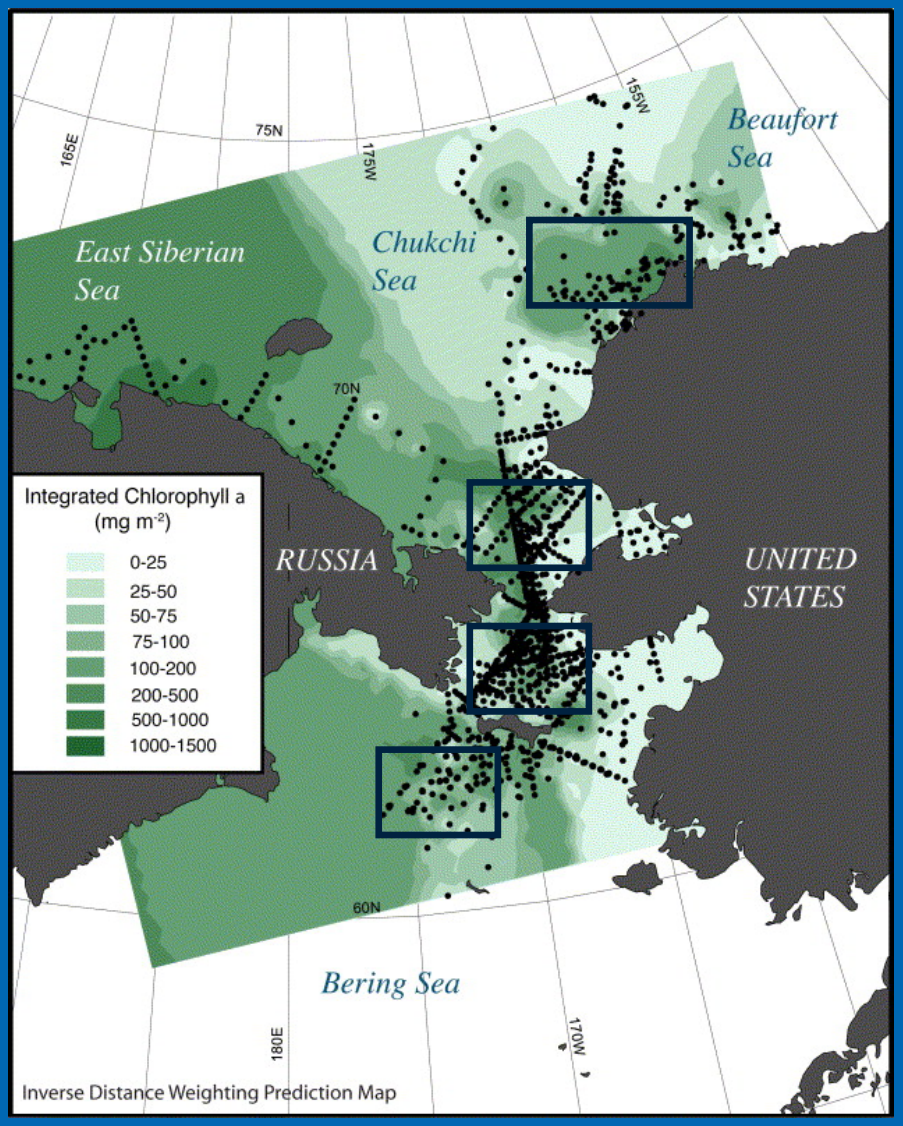
Methods

- Benthos
  - 0.1 van Veen grab
  - Sieve through 1 mm screen
  - Preserved 10% buffered formalin
  - Sorted to family and dominant fauna to species
  - DBO sites sorted to species since 2010 (Kedra)

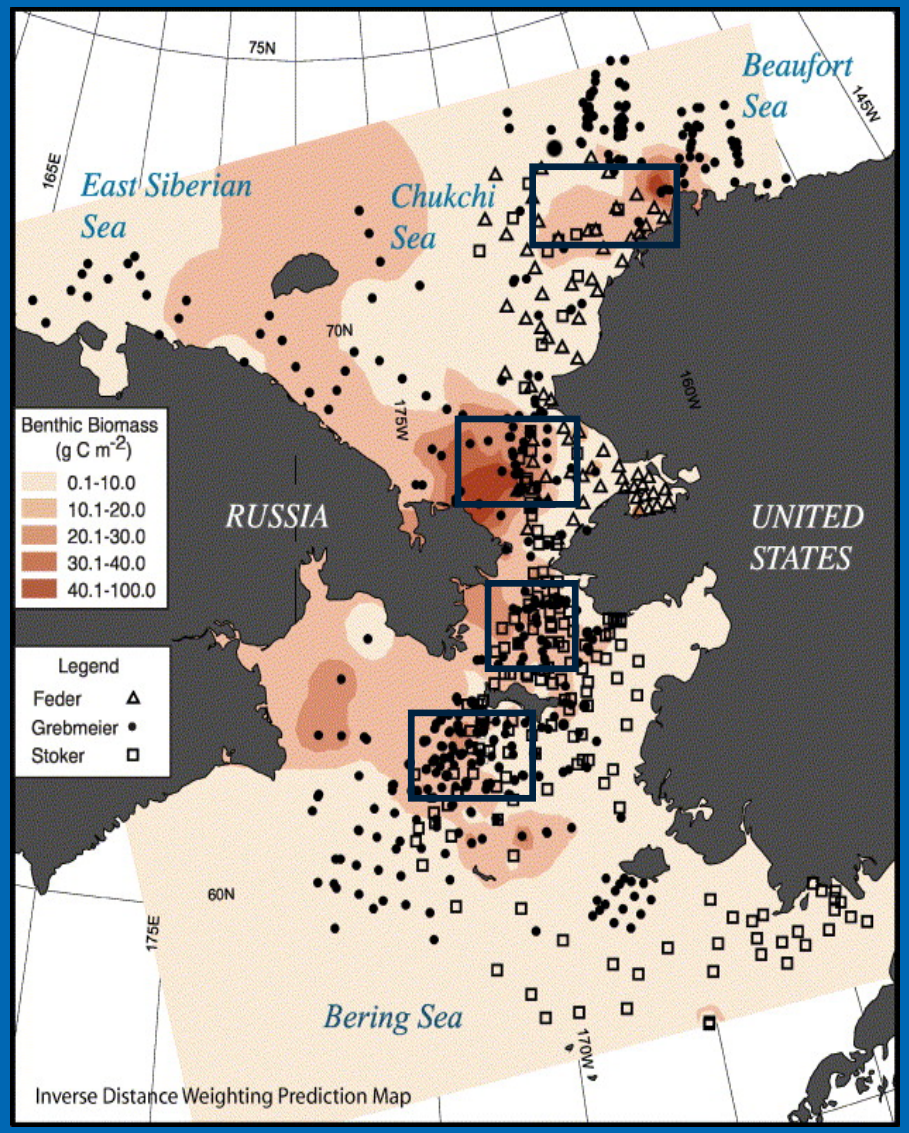
- Sediments
  - Collect surface sediment subsample (top 0-1 cm), frozen, and dried 60°C at land-based lab
  - Subsample for sediment grain size analysis
  - Subsample for total organic carbon and nitrogen analyses
  - Subsample for $\delta^{13}C$ of surface sediments

4 benthic hotspot sites: 1974-2004

Integrated chlorophyll

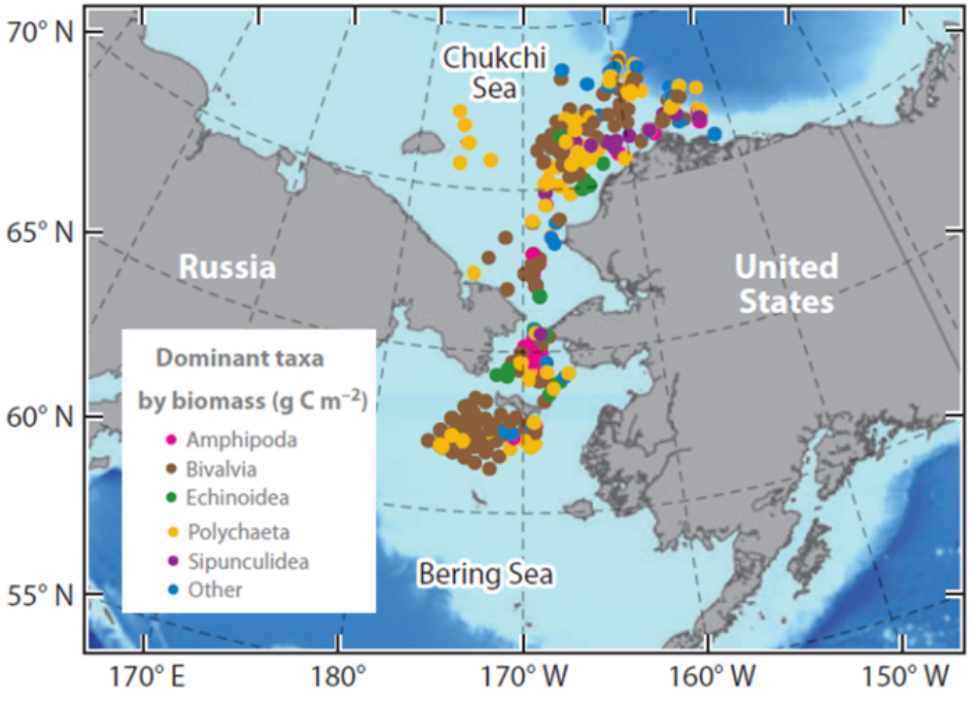


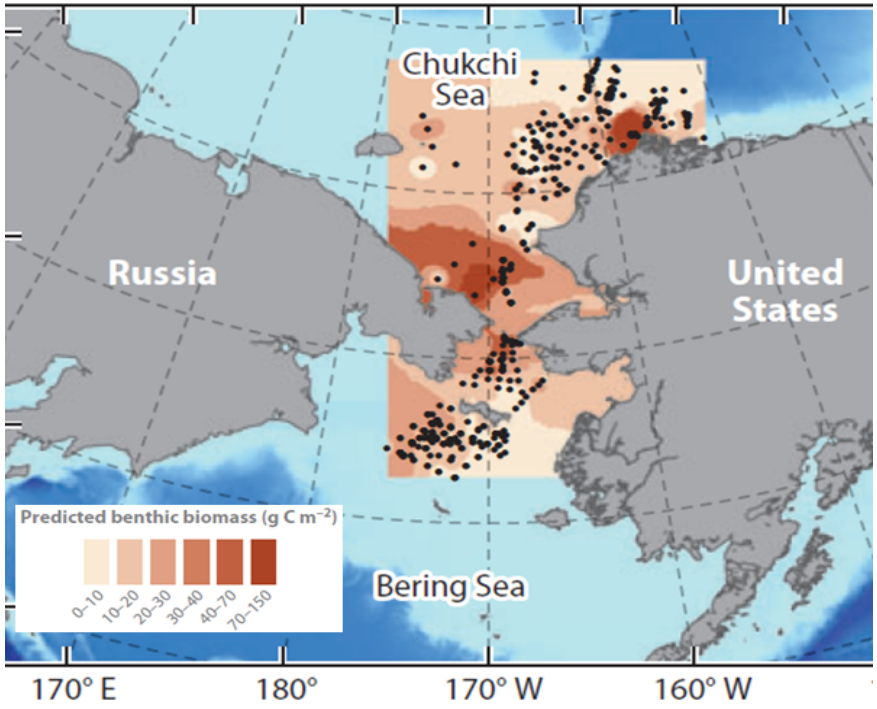
Benthic biomass



From Grebmeier et al. (2006)

Distribution of dominant benthic infauna (by biomass) in the Pacfic Arctic Region, 2000-2010



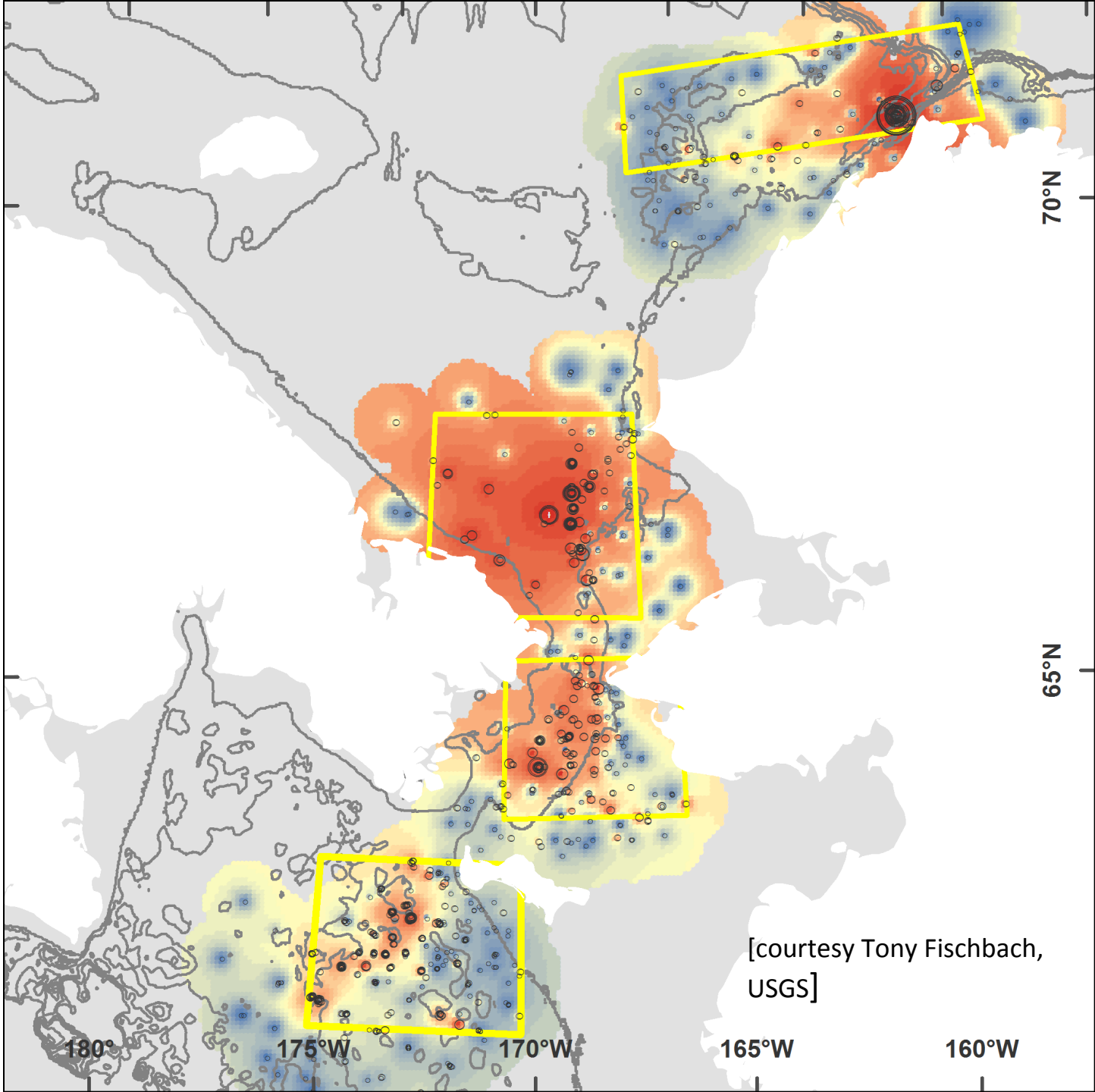


- each dot a station, color coded by dominant taxa
- infaunal benthic biomass, with black dot signifying station location.

[updated from Grebmeier 2012]

Multi-decadal and seasonal distribution of benthic infaunal biomass (gC/m2)

- using inverse distance weighing model (gC ~ 1/ distance to station)
- Plot displays the resulting surface on a log10 scale transformed color ramp (blue = -0.15, yellow = 1.2, red = 1.9 log10 (gC)). Sampling stations are indicated by dark open circles that are scaled by their log10 gC values.



[courtesy Tony Fischbach, USGS]

Benthic hotspot sites in the northern Bering and Chukchi Seas

Monika Kędra

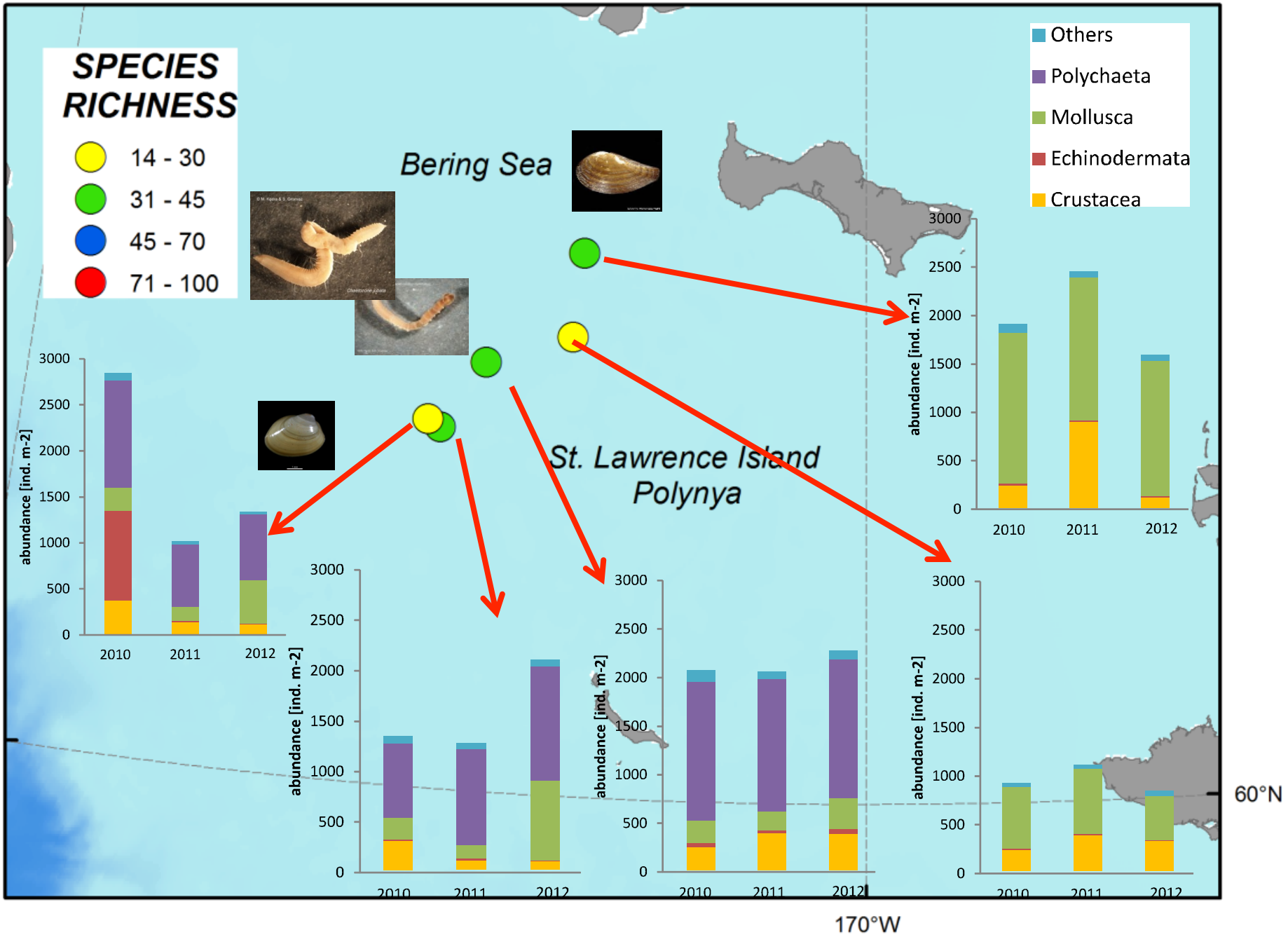
Chesapeake Biological Laboratory
Center for Environmental Science, University of Maryland

Methods: Benthos

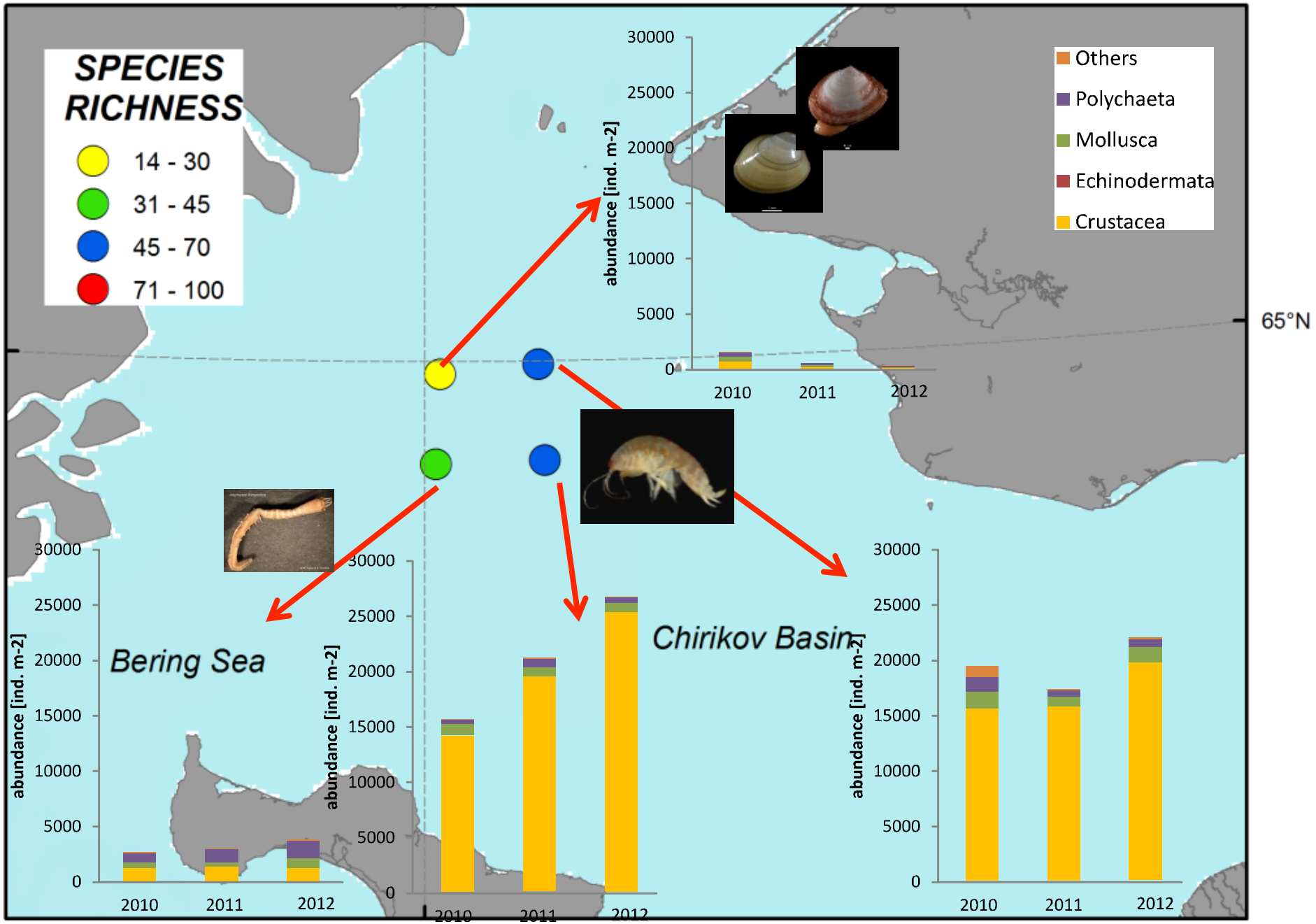
- 0.1 van Veen grab
- Sieve through 1 mm screen
- Preserved 10% buffered formalin
- Sorted to species (Kedra)
- Primer cluster and statistical analyses

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

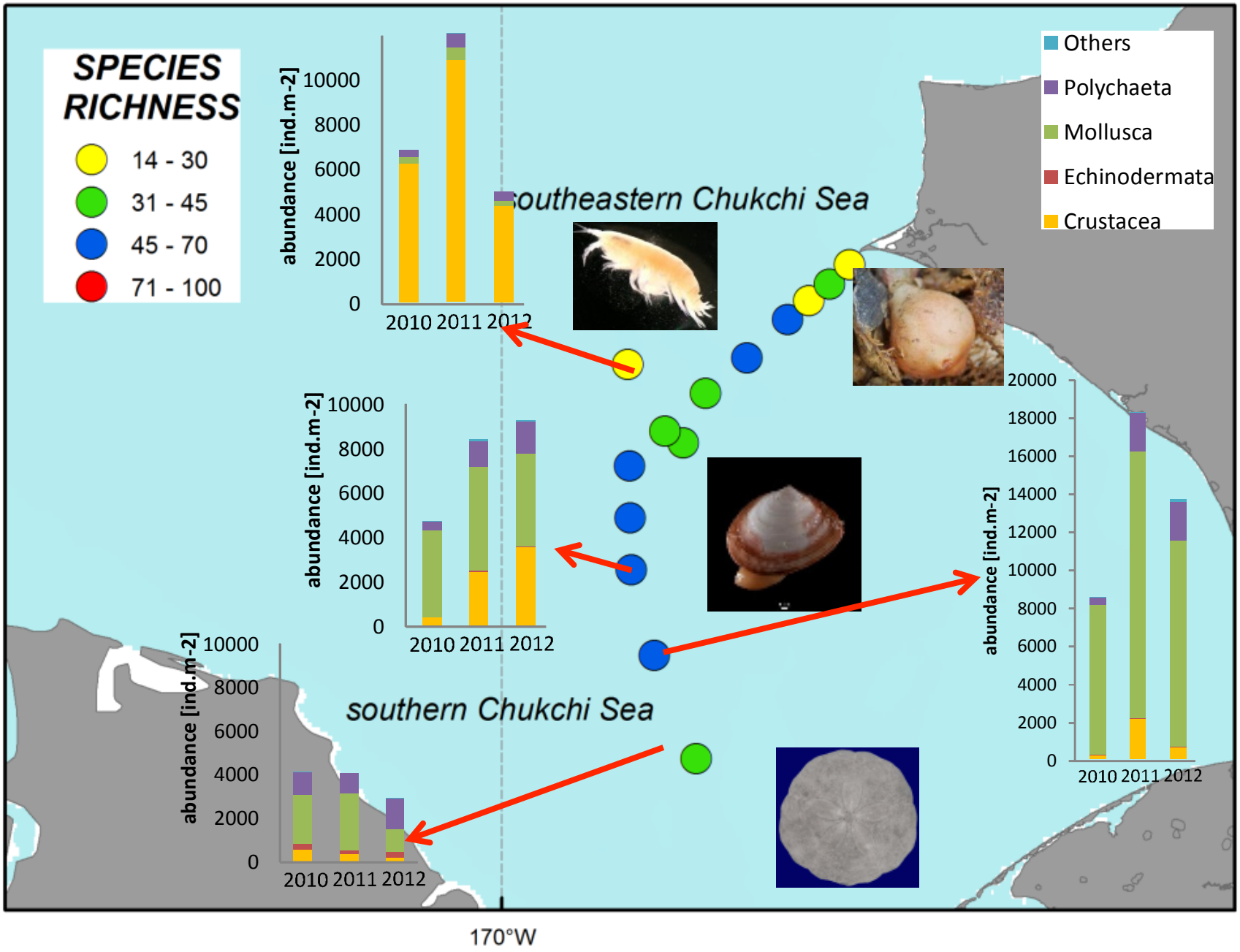
SLIP: south of St. Lawrence Island



Chirikov Basin



Southern Chukchi Sea

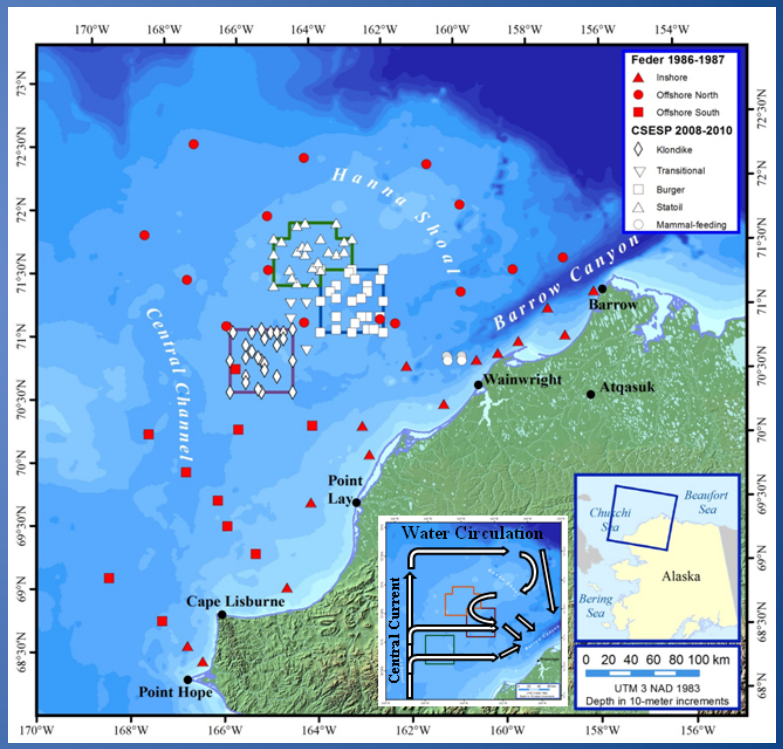


Benthic Data-Arny Blanchard/UAF

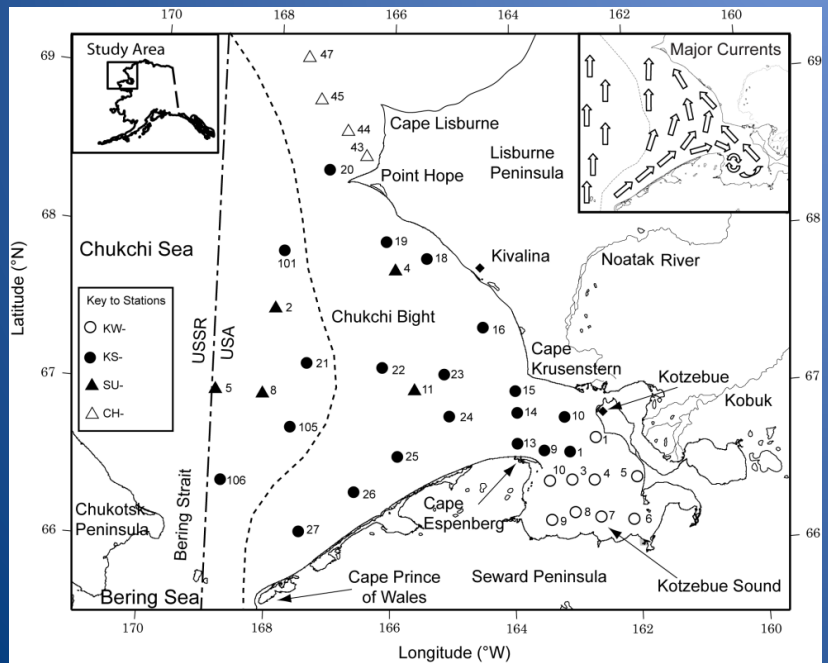
- Macrofaunal data comprised of:
  - Counts and wet biomass of taxa identified to the lowest taxonomic category practical.
  - Macrofauna sampled with 0.1m^2 van Veen grab.
  - Data from 1986 and 1987 (Feder) and 2008-2012 (Chukchi Sea Environmental Studies Program).
- Geographic coordinates recorded:
  - Older coords not best.
  - Recent coords GPS.

The Chukchi macrofaunal data: Feder and CSESP

NE Chukchi



SE Chukchi

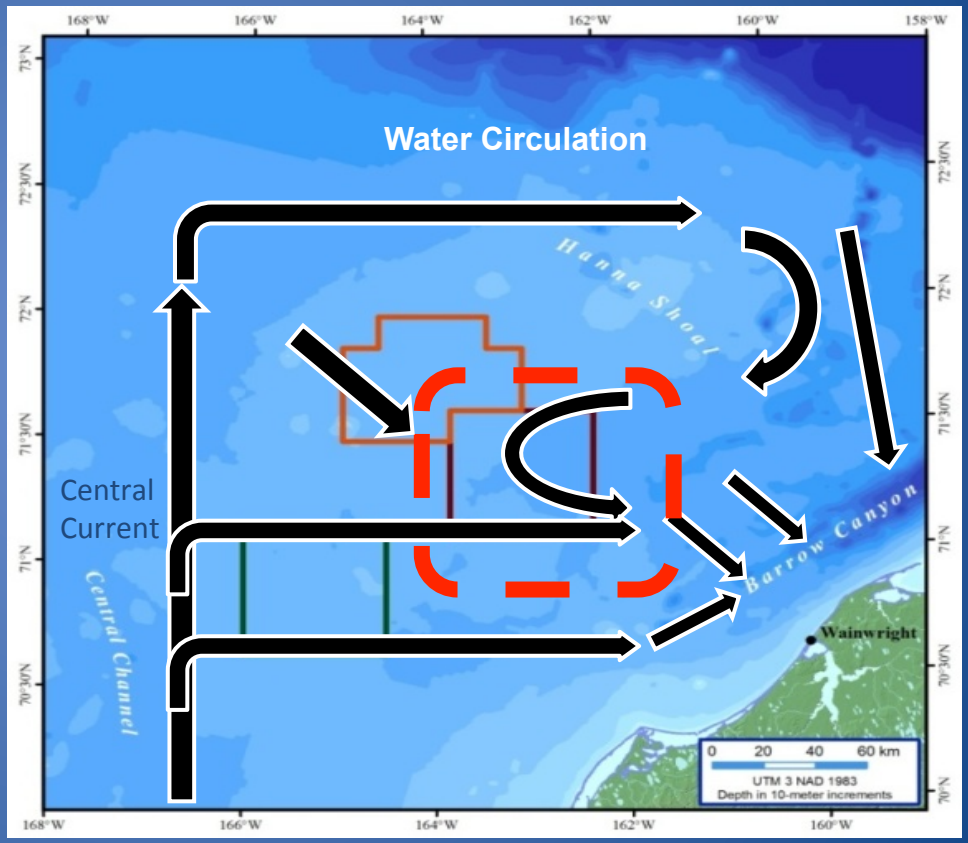


The Influence of Topographic Control

High biomass and densities are found in areas where topographic variations of the submerged shelf alter water flow.

Slower circulation results in greater carbon deposition.

Faster currents leading to and in Barrow Canyon bring more carbon to suspension feeders.



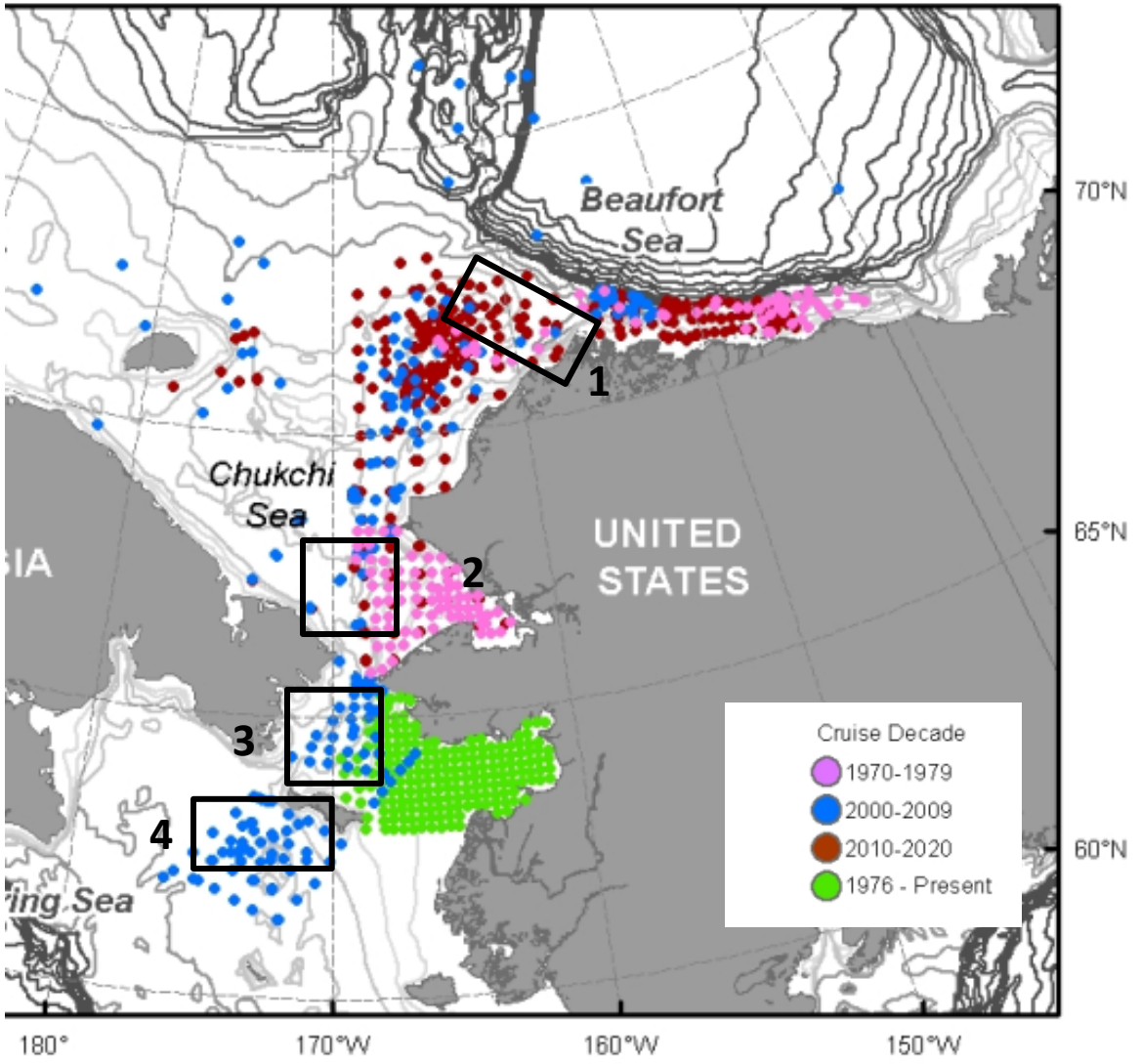
Type of data: Epifauna abundance, biomass, species richness, dominant taxa

In hand:

- 1- NE Chukchi 1990s (Barber cruise)
- 2- Hope Basin: RUSALCA 2004, 2009, 2012 (Bluhm, Iken)
- 2 - Kotzebue Sound 1978 (Feder)

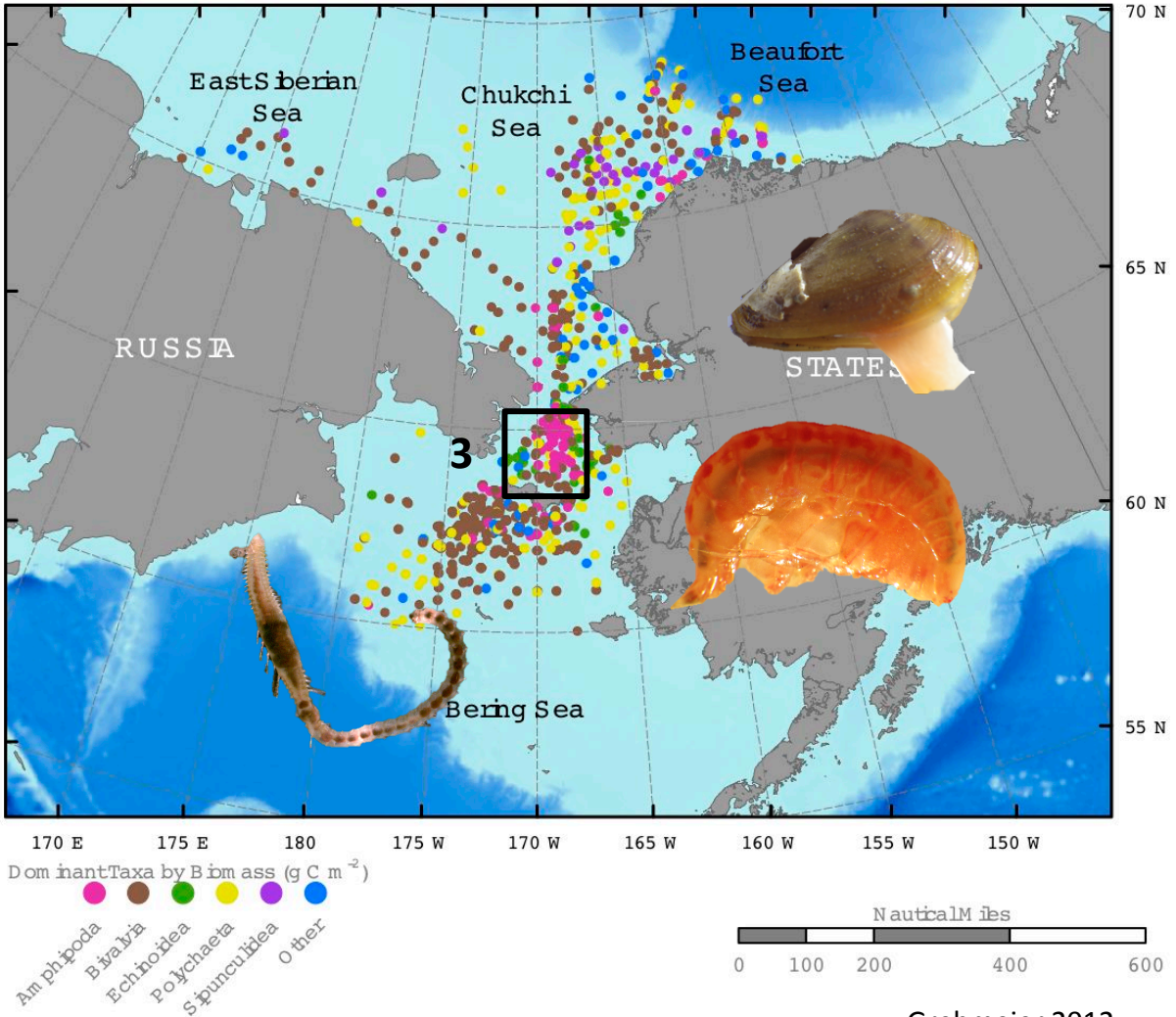
SOAR team:

- 3 - Chirikov, SLIP (Lovvorn)
- 4 - NE Chukchi (Blanchard, Konar)



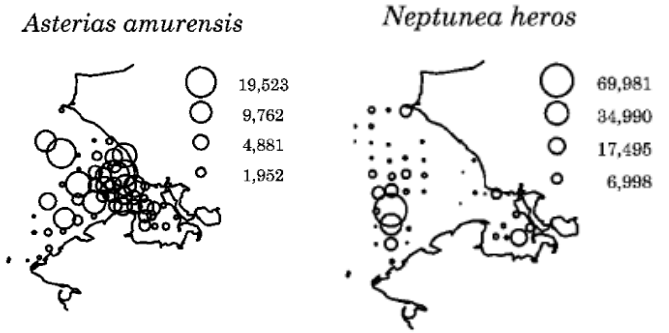
Type of data: Infauna abundance, biomass, taxon richness (family level), dominant taxa

- Wenzel 1986, 2002 et al. (20 stations)



Grebmeier 2012

Some findings



Abundance ind km^{-2} (Feder et al. 2005)

- Crustaceans (snow crab), echinoderms (*O. sarsi*) dominant
- Strong variability related to snow crab pulses?

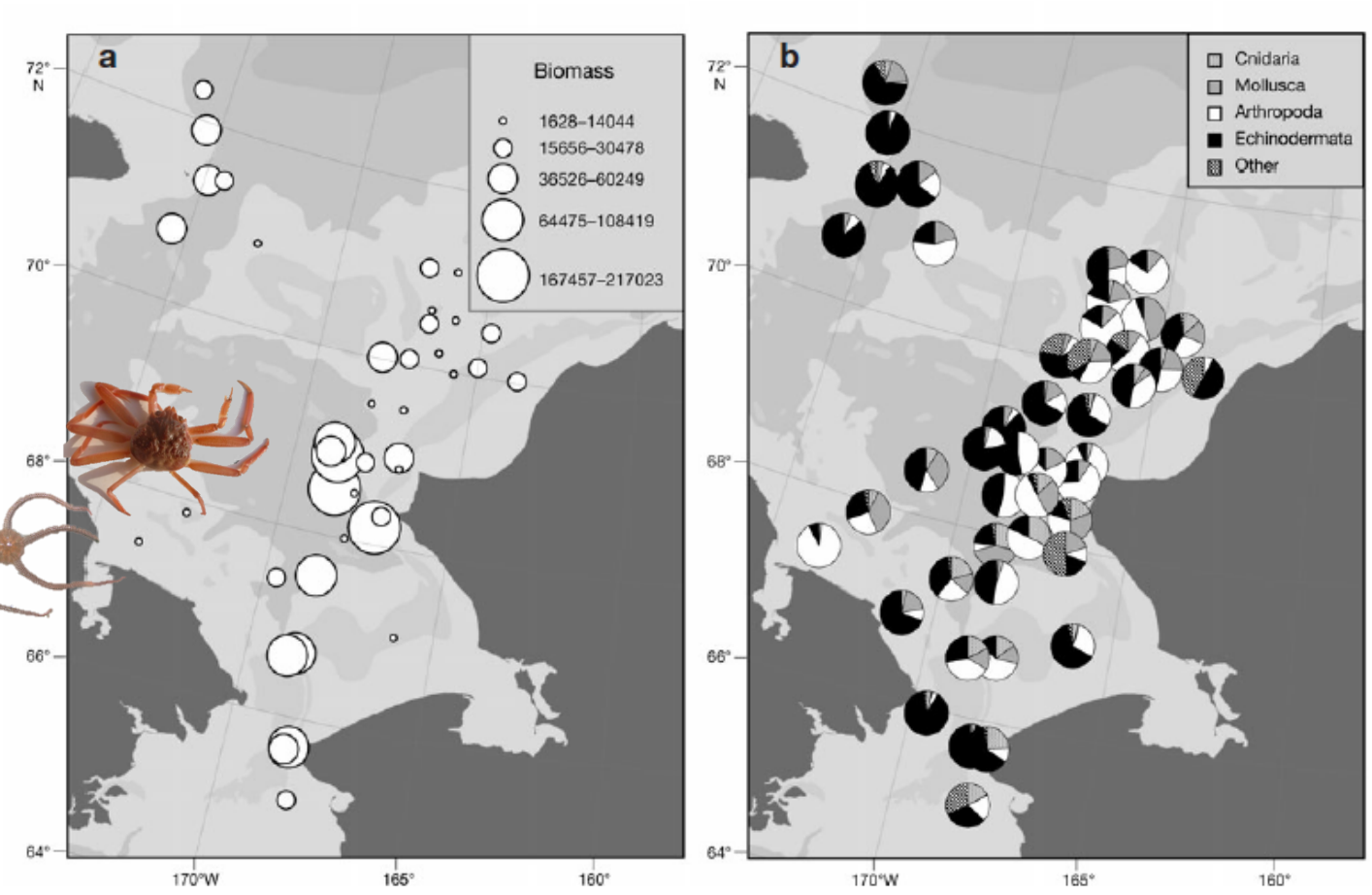


Fig. 3. Epifaunal biomass. (a) Absolute biomass (g wet wt 1000 m^{-2}). Bins delineated according to Jenks' natural breaks criteria (see 'Materials and methods'). (b) Relative composition

To add: 2009, 2012 data

NE Chukchi (Konar)

Primary Data Available:
Epibenthic biomass
Epibenthic dominant taxa
Epibenthic taxon richness

Secondary Data Available:
Epibenthic abundance
Some size frequency data

NE Chukchi (Konar)

-71 stations were sampled in 2009, 2010, and 2012

-Water depths ranged from 28.6 m to 65

-All stations were sampled with an epibenthic 3.05 m plumb-staff beam trawl with a 7 mm mesh and a 4 mm cod-end liner.

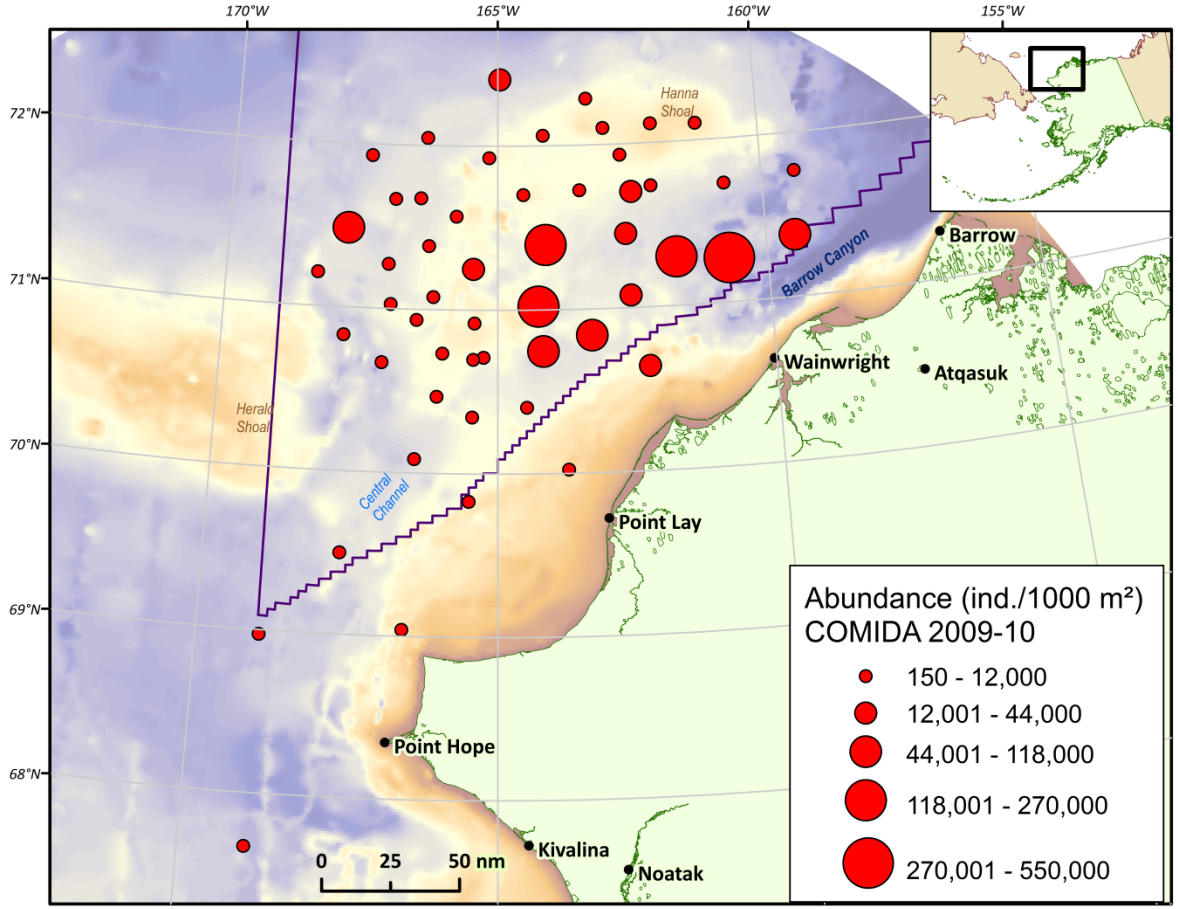
-One haul was carried out at each station for approximately 2.5 minutes at 1.5 knots.

-All trawl catches were sieved through a 4 mm sieve to remove soft sediments.

-Organisms of the full or, in case of very large volumes, a random subset of the trawl catch were then sorted on deck to the lowest practical taxon (typically genus), weighed, and counted.

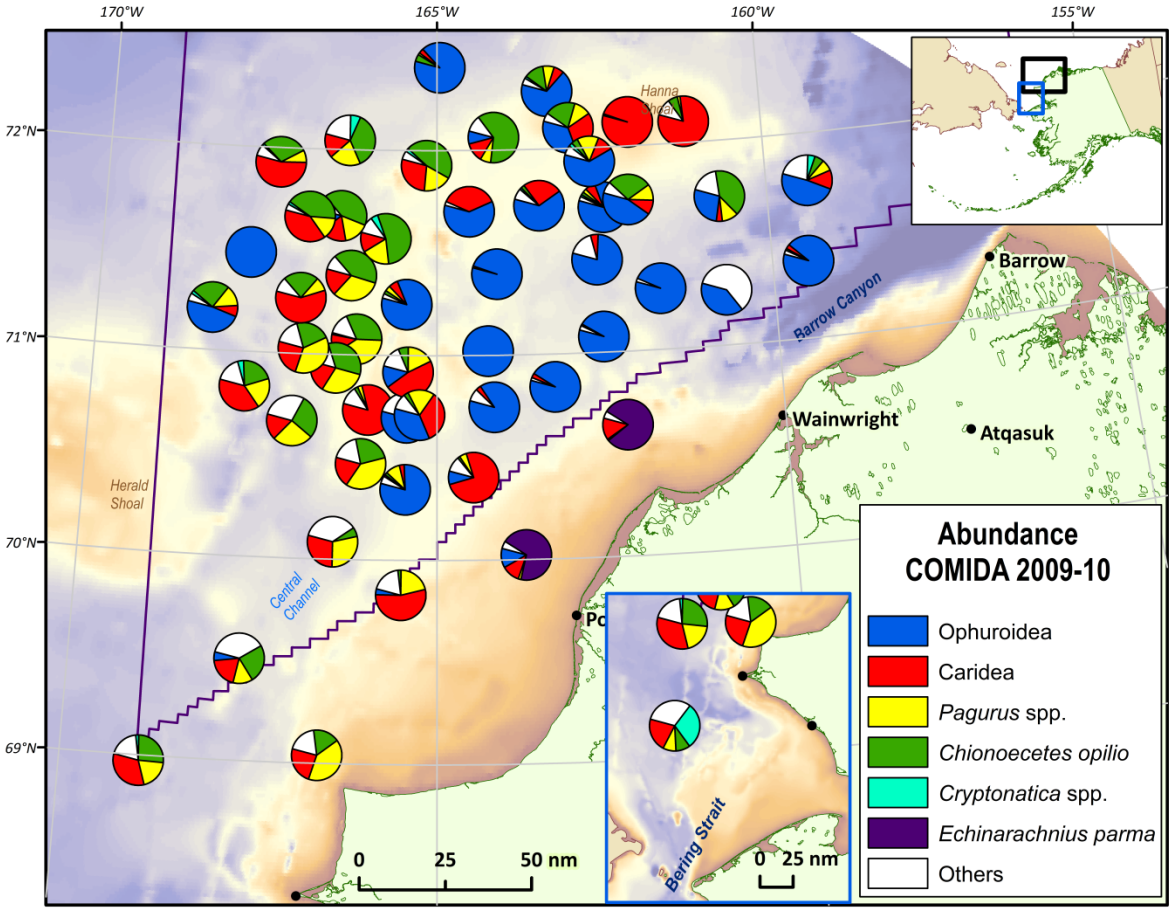
NE Chukchi (Konar)

-Epibenthic abundance is high along the central channel



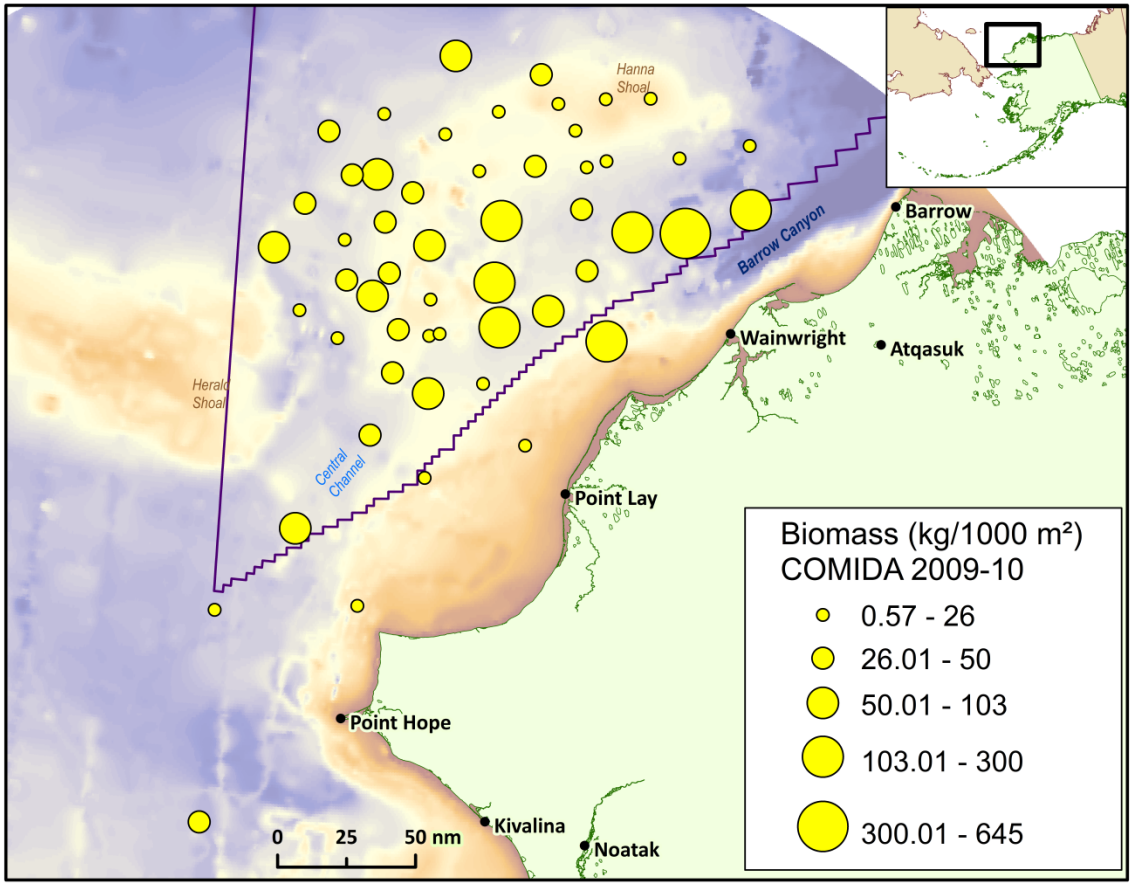
NE Chukchi (Konar)

-The areas that are high in epibenthic abundance are dominated by brittle stars



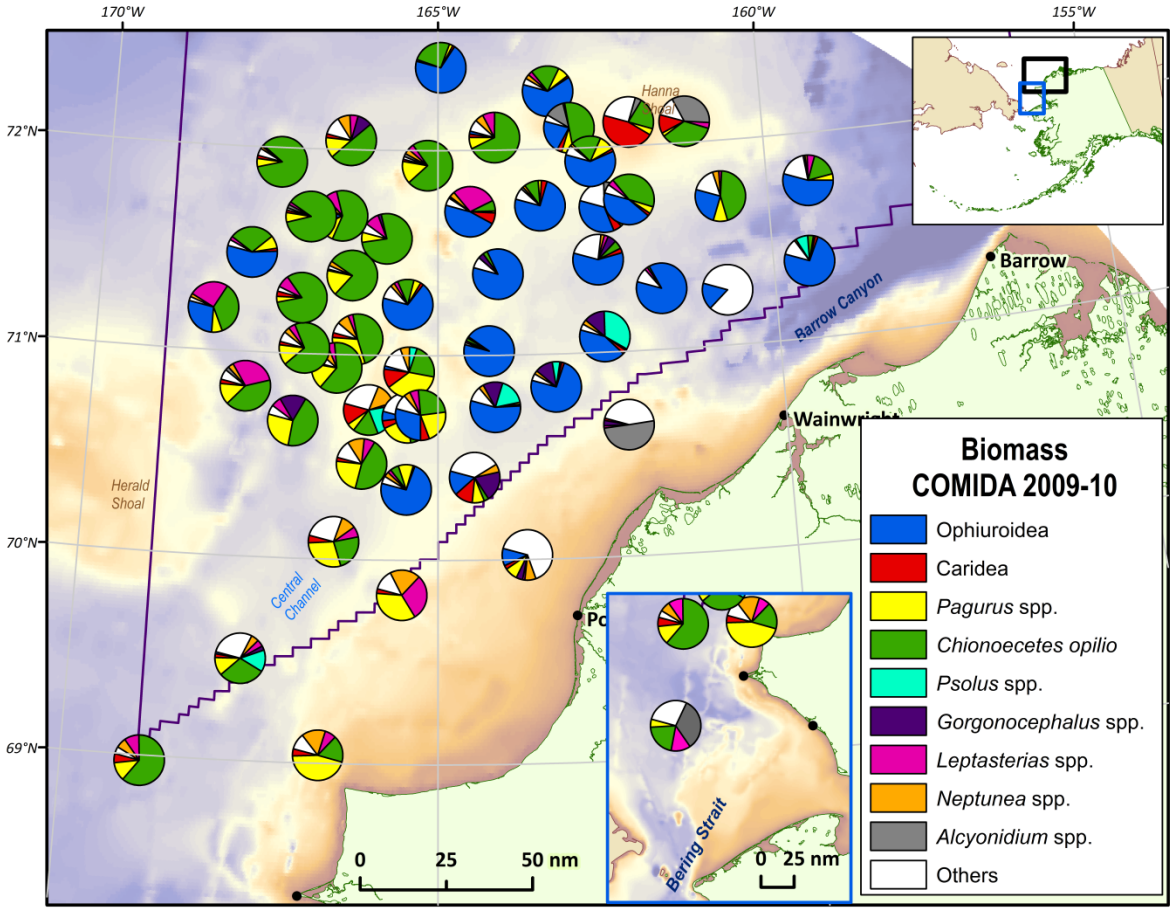
NE Chukchi (Konar)

-Epibenthic biomass is also high along the central channel



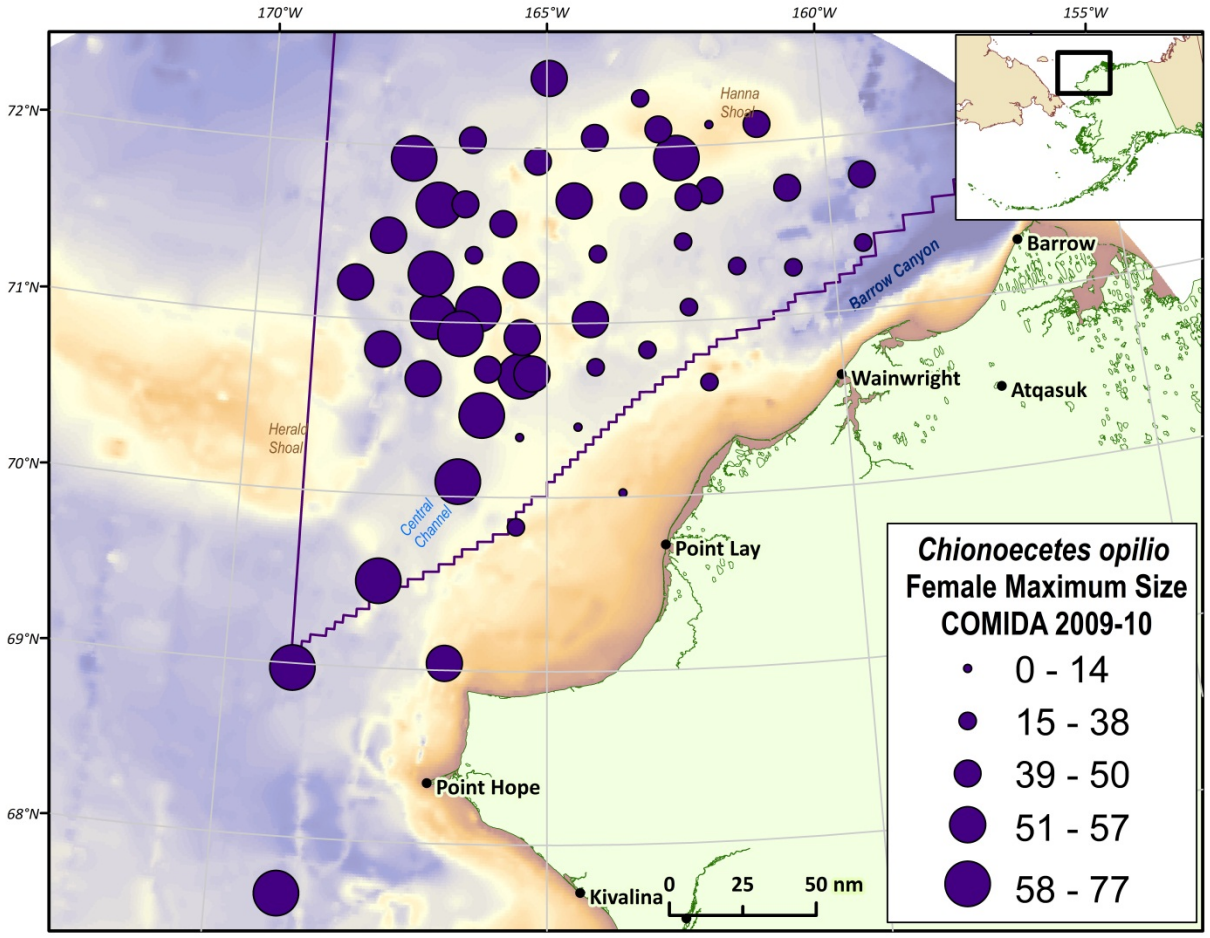
NE Chukchi (Konar)

-The areas that are high in epibenthic biomass are dominated by brittle stars



NE Chukchi (Konar)

-The outer arm of the central channel has large snow crabs



Jim Lovvorn, Southern Illinois University

Epibenthic invertebrates

May and early June, 2006–2007

- SLIP (south of St. Lawrence Island)
  - 33 stations
- Chirikov Basin
  - 18 stations

Jim Lovvorn, Southern Illinois University

Epibenthic invertebrates

9 May – 2 June 2006

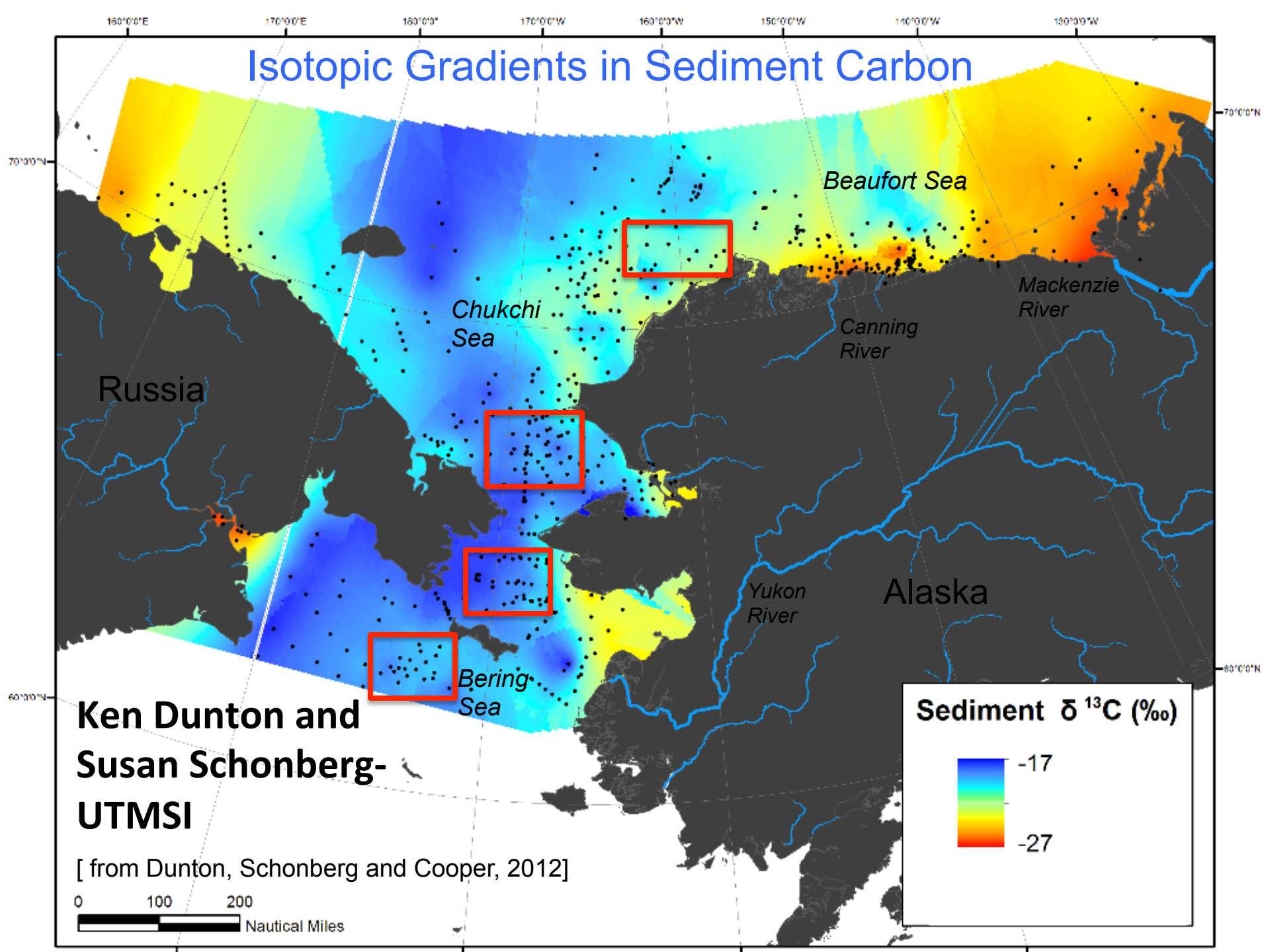
- Otter trawl: 7-m footrope, 3.7-mm (1.5-inch) stretched mesh

18 May - 12 June 2007

- 4-m beam trawl: same mesh

Jim Lovvorn, Southern Illinois University

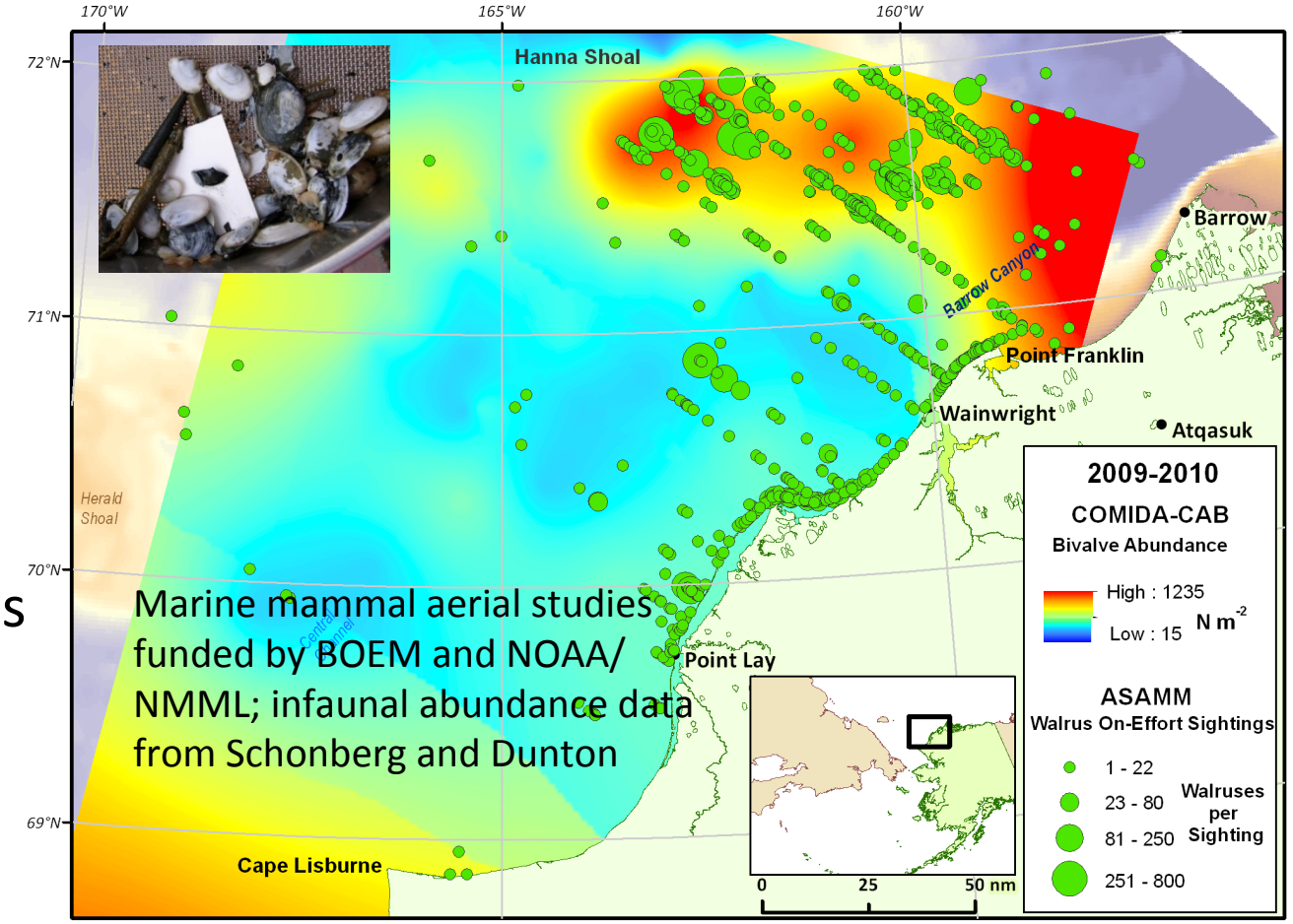
- Snow crabs
  - Very abundant but small, with biennial reproduction
  - Small juveniles very localized in areas with no adults: larvae or post-settlement juveniles are advected into these areas
  - Appears to be ontogenetic dispersal from SLIP toward shelf break, and from Chirikov northward through Bering Strait
  - Diets vary directly with availability of different prey
- Hermit crabs
  - 6 species, only two abundant
  - Distributions do not correspond closely to those of living gastropods of same sizes and species used for shells
- Brittle stars
  - Superabundant in certain areas with high sediment OM
  - Mainly diatoms in guts during spring bloom, but assimilate mainly bacteria on an annual basis


Isotopic Gradients in Sediment Carbon
Beaufort Sea
Chukchi Sea
Mackenzie River
Canning River
Russia
Alaska
Yukon River
Bering Sea
Ken Dunton and Susan Schonberg-UTMSI
[from Dunton, Schonberg and Cooper, 2012]
0 100 200
Nautical Miles
Sediment δ 13C (‰)
-17
-27

Theme 4: Current state of lower trophic prey-base and higher trophic feeding hot spots

Feeding hot spots: Walrus habitat use 2

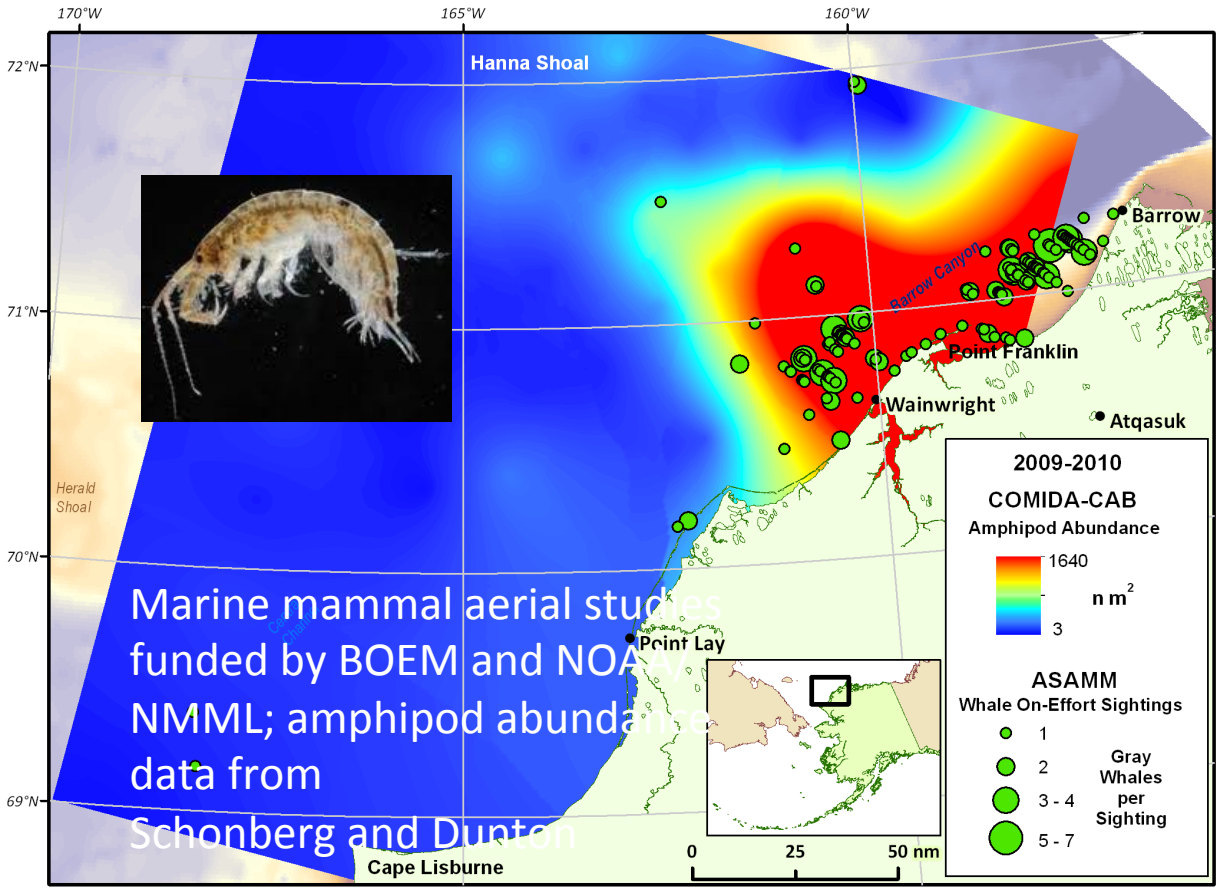
- *Data sources*: NOAA/NMML, Schonberg and Dunton
- Habitat utilization: High density of walrus sightings in area of high bivalve density



Graph by Schonberg and Dunton

Gray whale habitat use

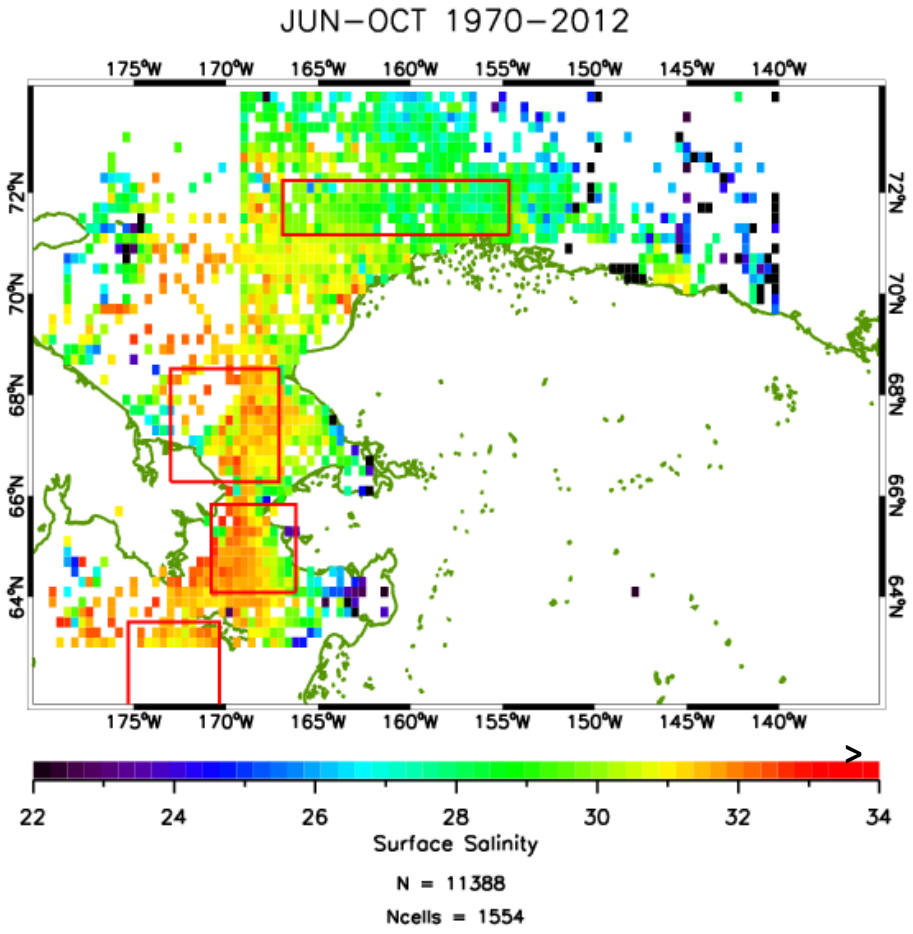
- *Data sources*: NOAA/NMML, Schonberg and Dunton
- Habitat utilization: High density of gray whale sightings in area of high amphipod density

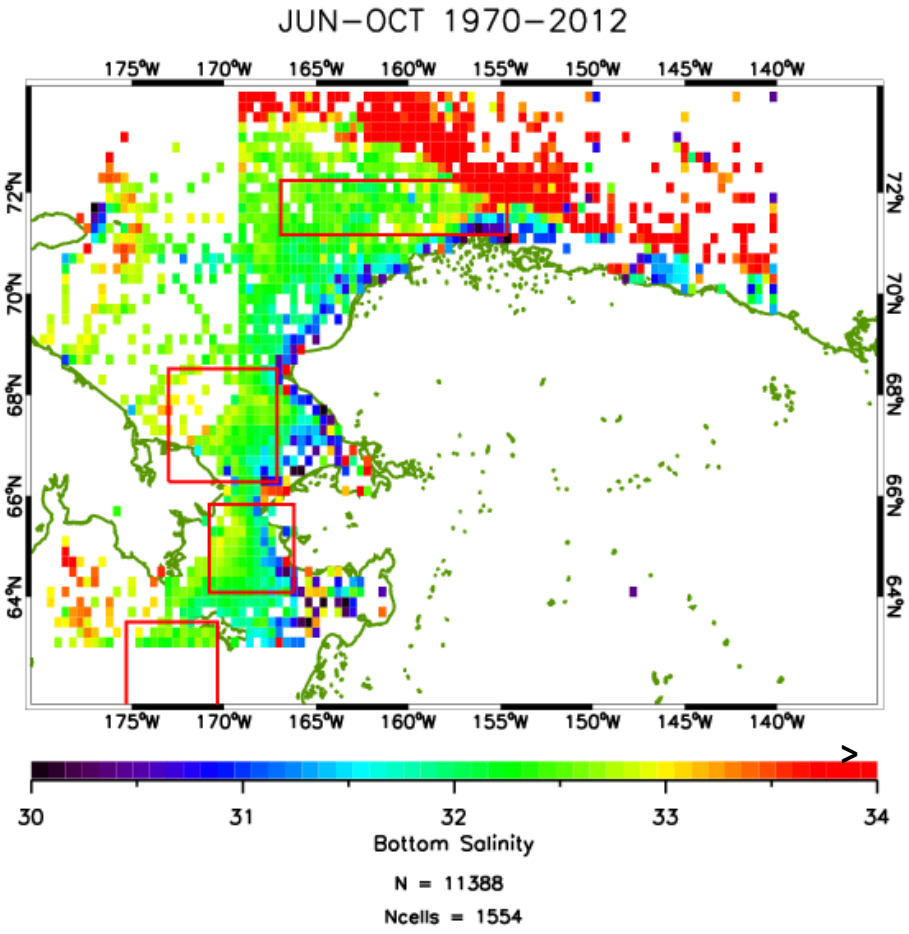


Graph by Schonberg and Dunton

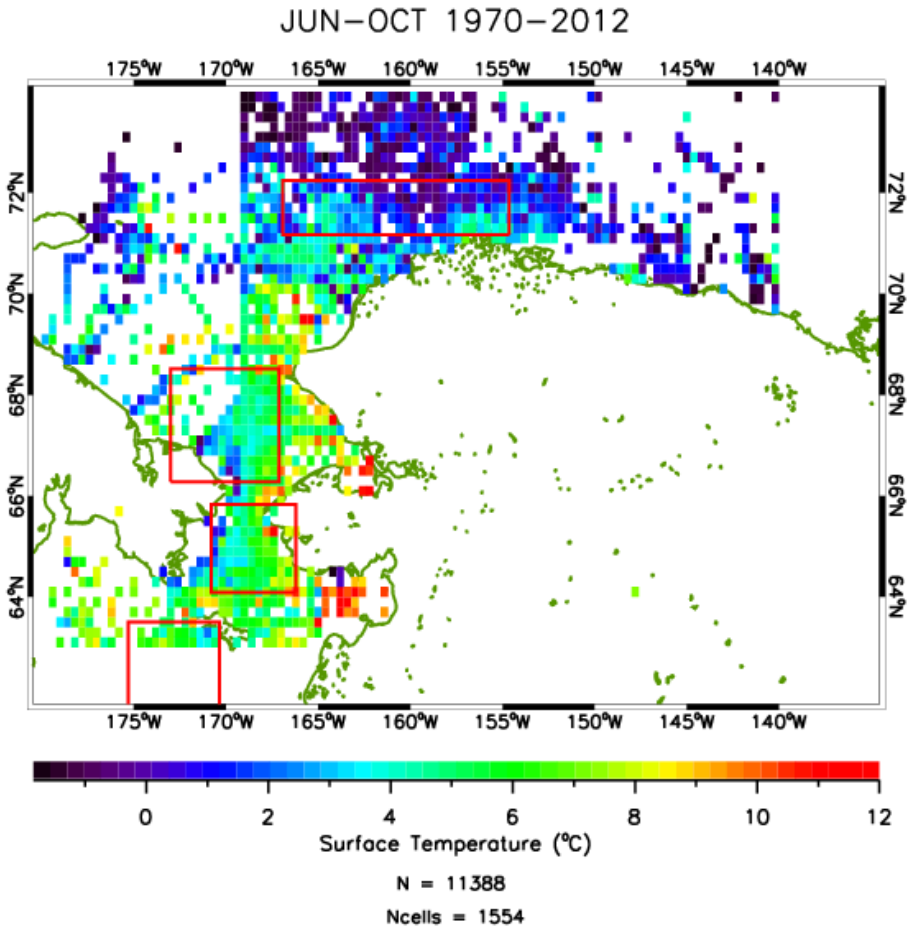
Steve Okkonen-UAF

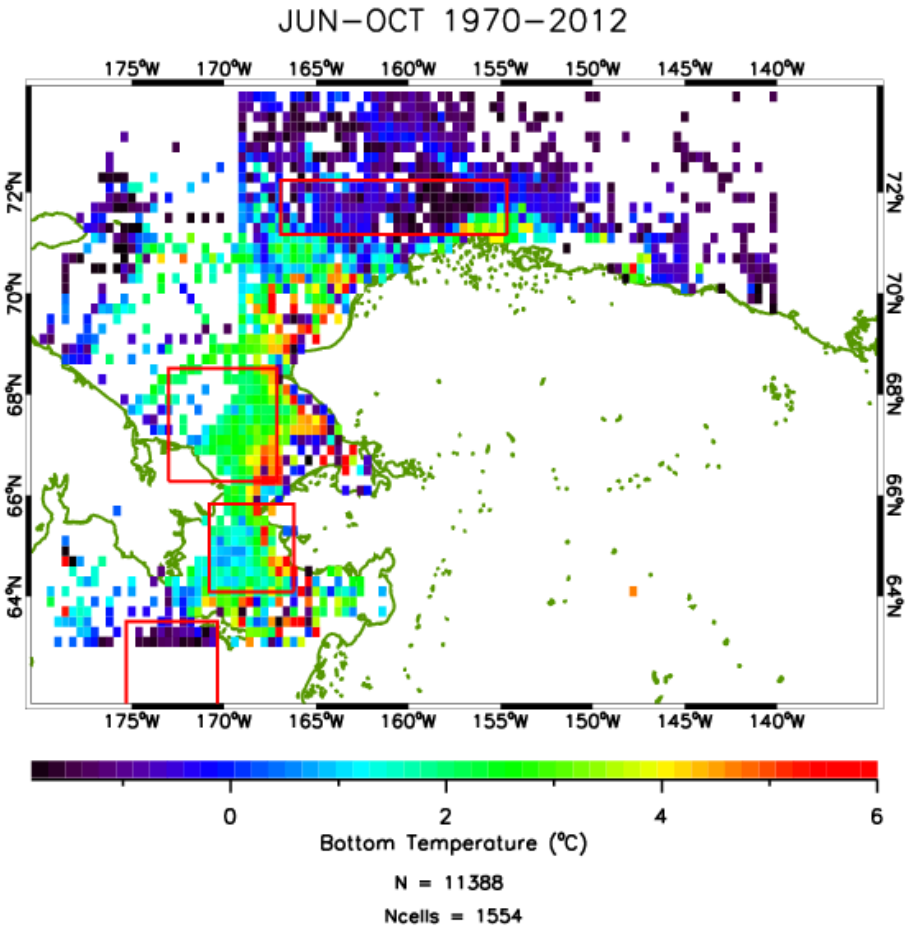
Salinity

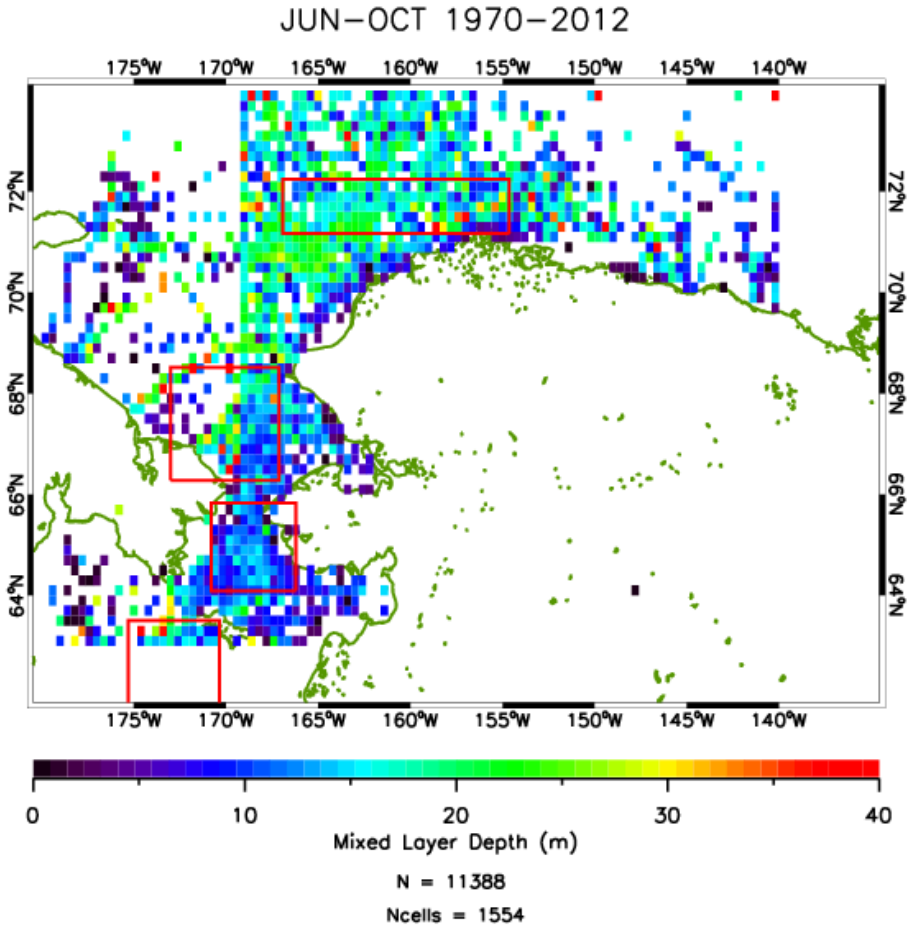




Temperature (°C)






JUN–OCT 1970–2012
175°W
170°W
165°W
160°W
155°W
150°W
145°W
140°W
72°N
70°N
68°N
66°N
64°N
0
10
20
30
40
Mixed Layer Depth (m)
N = 11388
Ncells = 1554

Velocity observations & more

- Current meter moorings:
  - Bering Strait: most years 1990-present (UW/UAF)
  - Chukchi shelf: Early 90s (UAF/UW), 2002-04 (UAF/UW), 2010-present (UAF)
  - St Lawrence Island Polynya experiment: 1998-99 (UAF/UW/UH)
  - BEST central Bering shelf experiment: 2008-10 (UAF/UW)
  - Bering Sea 70 m isobath moorings: late 90's and 2000's (PMEL)
  - Various short deployments from 70's & 80's (UAF/UW/PMEL)
  - Other data may be available if needed (PMEL, JAMSTEC, CSESP, …)
- Surface & near-surface satellite-tracked drifters:
  - 2002 in northern Bering Sea
  - 2011 & 2012 in NE Chukchi Sea
- HF Radar surface currents:
  - 2009-present in NE Chukchi Sea, Aug-Nov, temporal and spatial cover varies

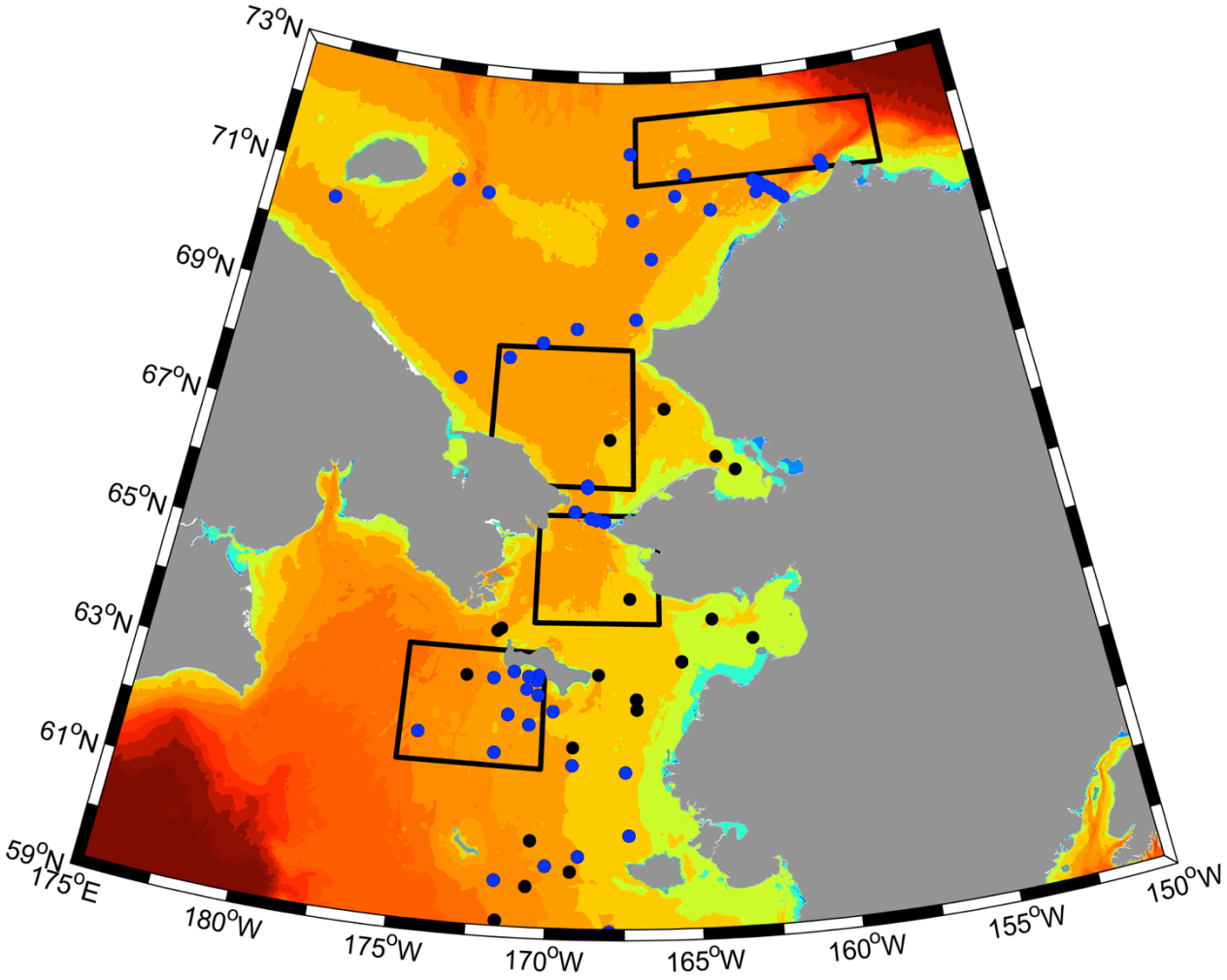
Other:

- ROMS Numerical model hindcasts:
  - NEP domain (all of Bering, southern Chukchi to Pt. Hope), 1970-2005 (NEP5) & 1986-2006 (NEP6)
  - Arctic domain (all of Chukchi & Beaufort seas), 1986-2006
- Atmospheric reanalysis sea level pressure, winds, air temp, insolation, etc.
  - NCEP/NCAR Reanalysis, 1948-present
- Hourly NWS observations
  - Winds, air temp, RH, SLP: 1973-present (Nome), 1941-present (Barrow)

Current meter mooring sites

● >= 1 year

● < 1 year

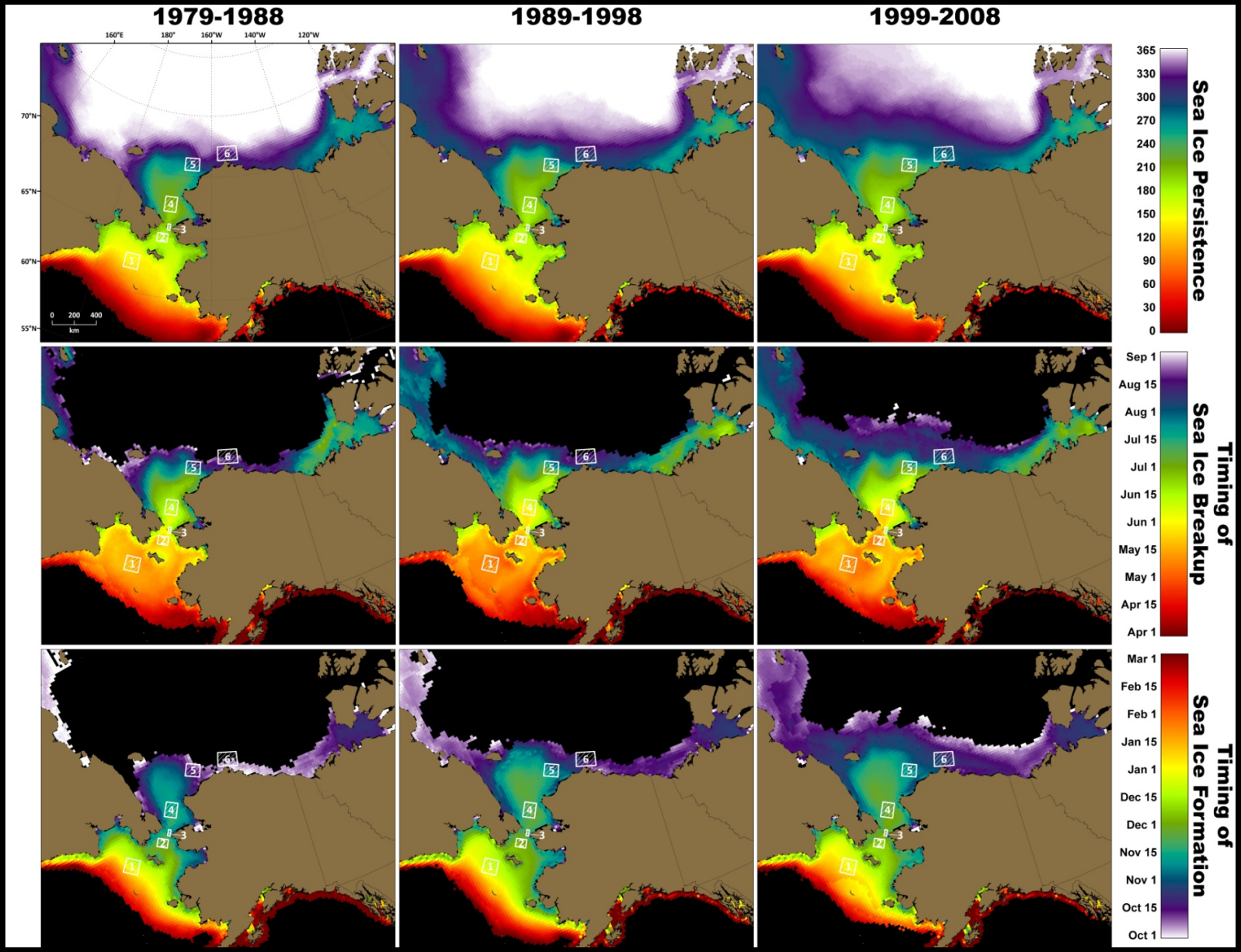


key processes

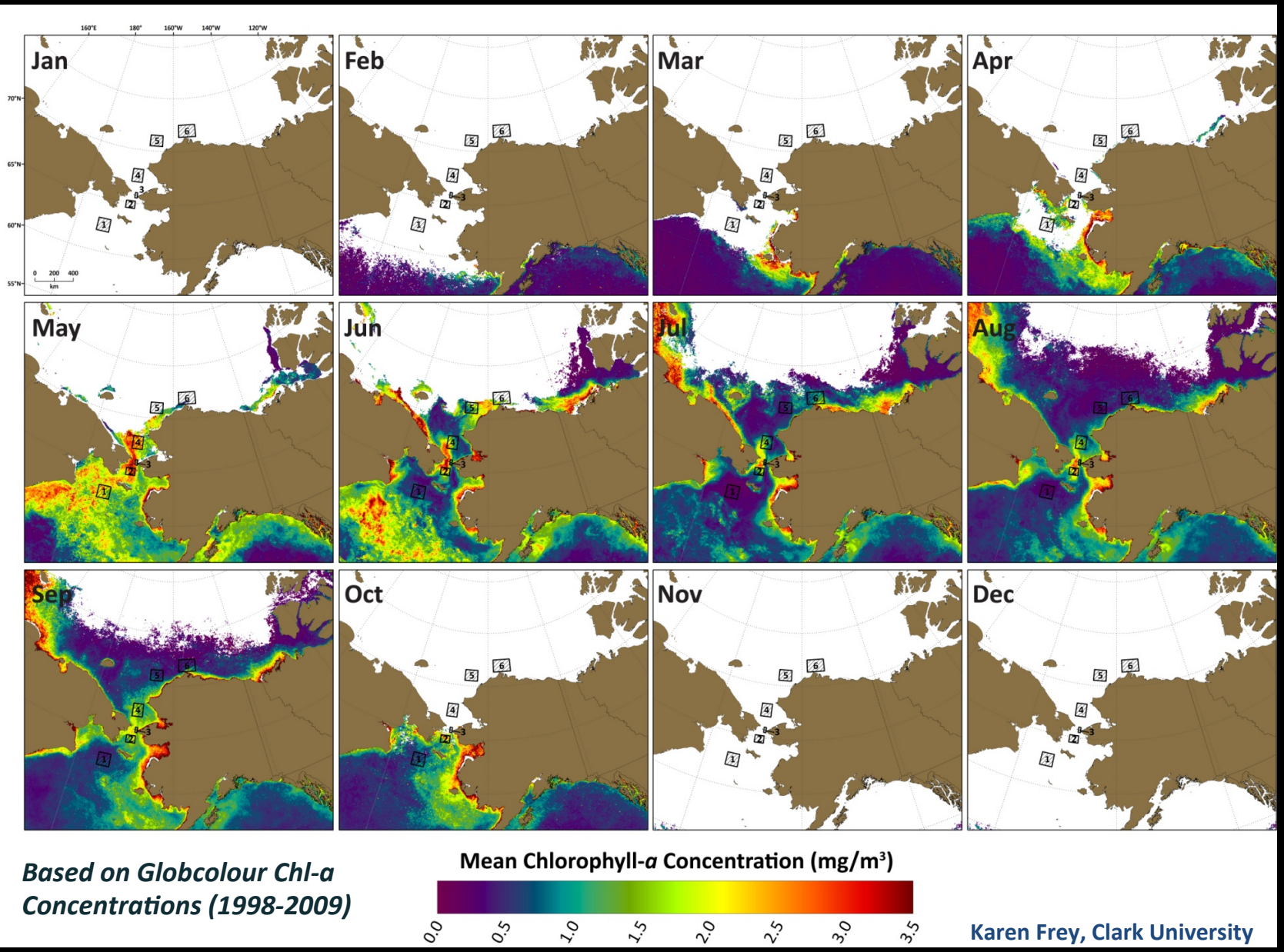
- Pacific-Arctic pressure head sets the mean flow field. Magnitude of the pressure head likely varies with time.
- Winds regularly reverse the mean flow field in winter.
- Summer flow variations are often uncoupled from local winds.
- Mooring sites away from straits are characterized by relatively small mean flow and large flow variance.
- Straits are regions of large means & variances.
- Bathymetrically steered flows are important in setting the mean flow vector orientations but the bathymetric control can be overwhelmed by wind forcing on these relatively flat shelves (especially in winter).
- Baroclinic flows in summer/fall months are mostly important within ~30-50 km of coastlines.
- Constricted flows in straits beget elevated speeds and possibly elevated levels of lateral mixing.
- Tides (and tidal mixing): relatively strong in Bering Sea south of SLI, weak in the Chukchi Sea.

(3) Gridded Satellite Products: (Karen Frey)

Sea Ice Persistence, Breakup, Formation



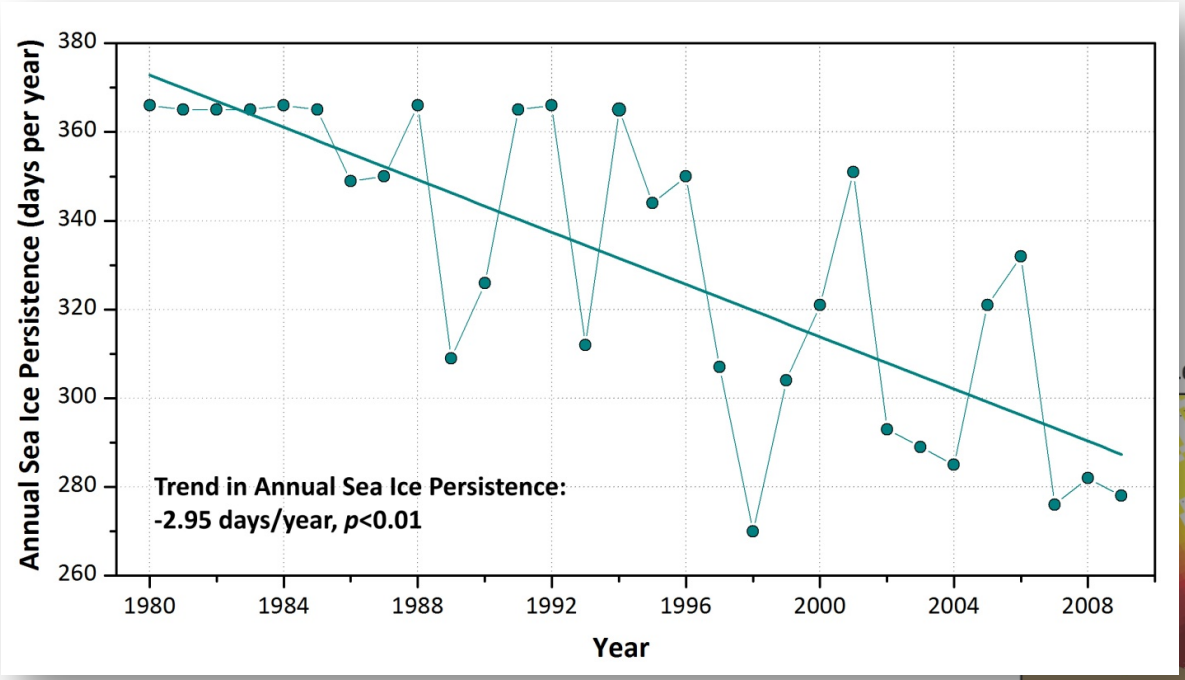
(3) Gridded Satellite Products:
Chlorophyll-*a* Concentrations



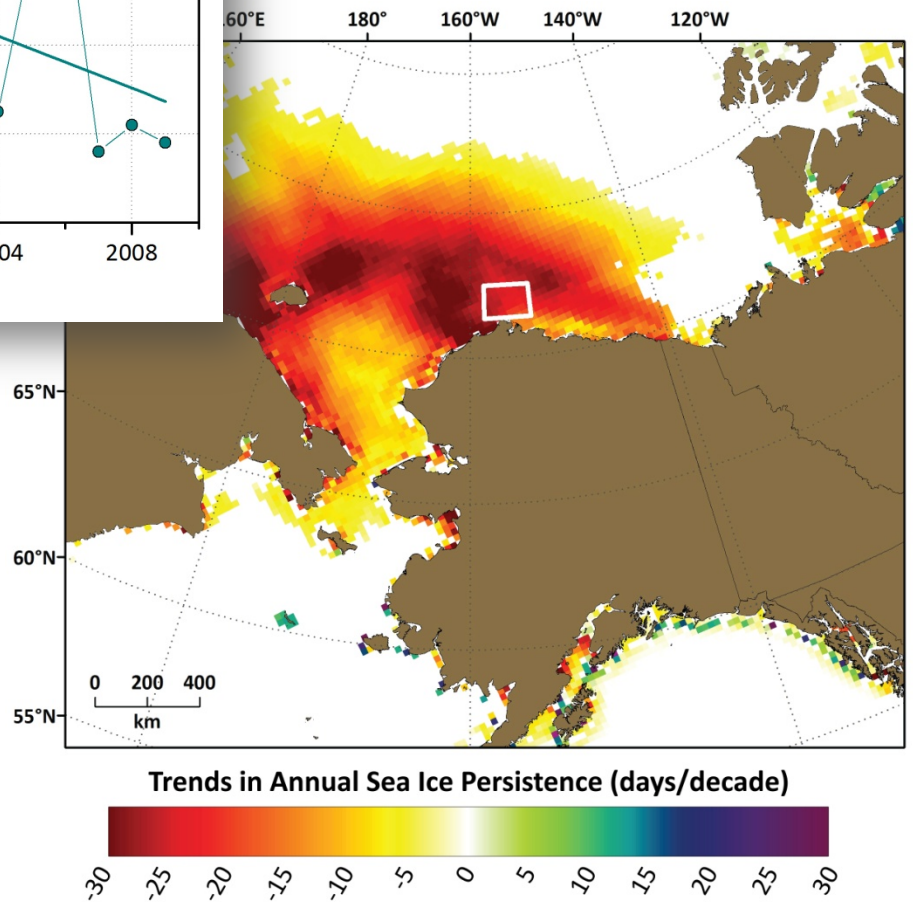
Based on Globcolour Chl-a Concentrations (1998-2009)

Karen Frey, Clark University

Barrow Canyon Sea Ice Variability



Annual sea ice persistence within the Barrow Canyon DBO site from 1980 through 2009, where the trend over this thirty year record shows a loss of sea ice cover of 2.95 days/year (p<0.01). Sea ice persistence data (based on a 15% sea ice concentration threshold) are derived from Scanning Multichannel Microwave Radiometer (SMMR) and Special Sensor Microwave/Imager (SSM/I) passive microwave radiances



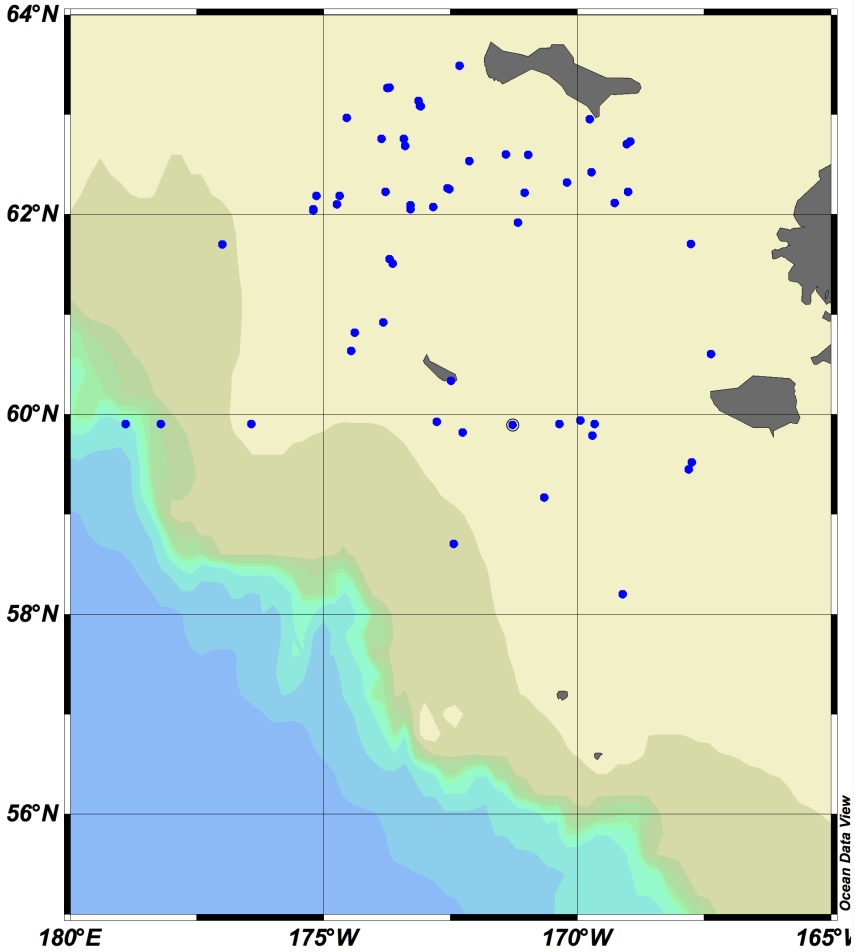
Spatial representation of annual sea ice persistence trends (1979-2008) based on SMMR and SSM/I sea ice concentrations. Only those trends that are statistically significant at 90% are shown. The Barrow Canyon site shown above is denoted with the white box.

Karen Frey, Clark University

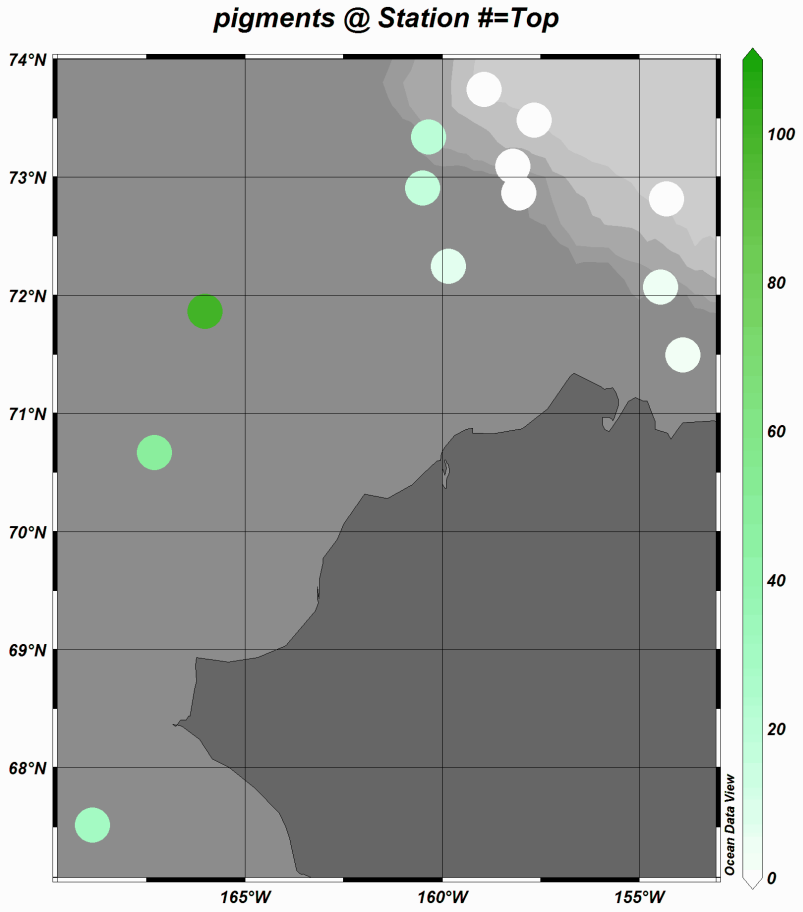
Contributions Gradinger, Bluhm, Iken based on BEST and SBI expeditions

Station map chl; sea ice

Locations BEST 2008-2010

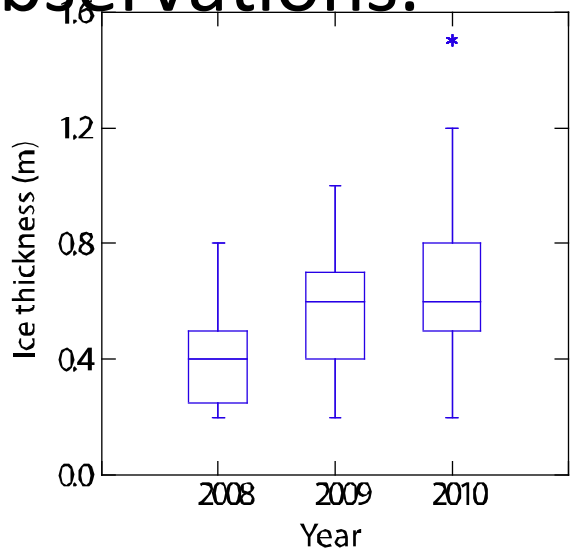


Int chl SBI 2002 (also available for 2004, Same stations)



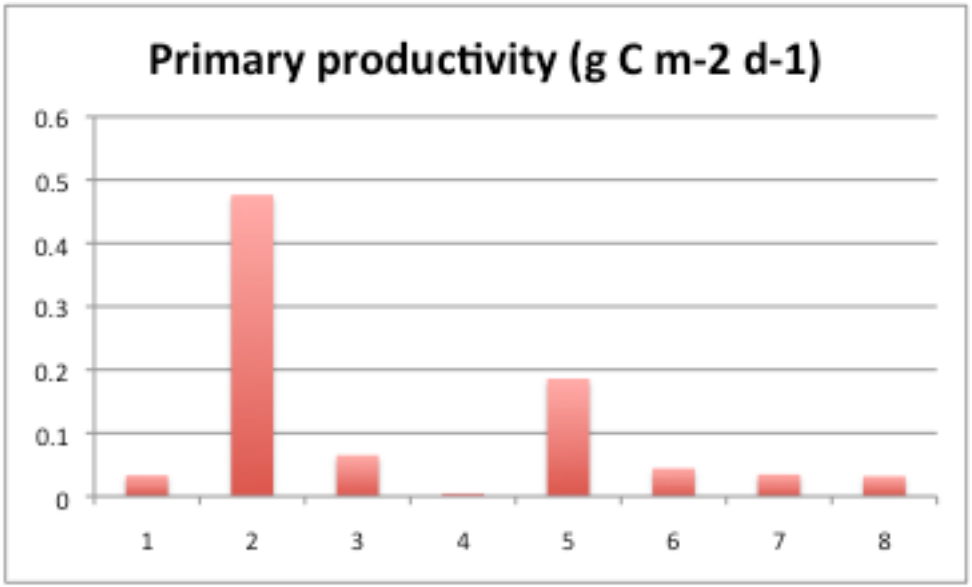
Ice information

- Ice thickness, snow depth, ice coverage (%), ice chl a, POC/PON, for BEST expeditions (2008-2010) and SBI 2002 and 2004 (from ship based ice observations.
- Example:



Primary productivity

- Available subset of stations (about 1/5 of all stations) for BEST and SBI
- Example sea ice algae during BEST 2008:



ICESCAPE-Kevin Arrigo, Stanford University

Types of data collected:

Temperature, salinity
Nitrate, ammonium, silicate, phosphate
Spectral irradiance (upwelling and downwelling)
Chlorophyll a, (fluorometric and HPLC)
Pigments (HPLC)
POC, PON, and POP
DIC, pH, alkalinity
Oxygen, CDOM
^{18}O
Primary production, bacterial abundance and production

ICESCAPE

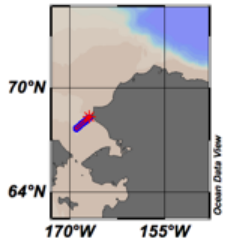
How were data collected?

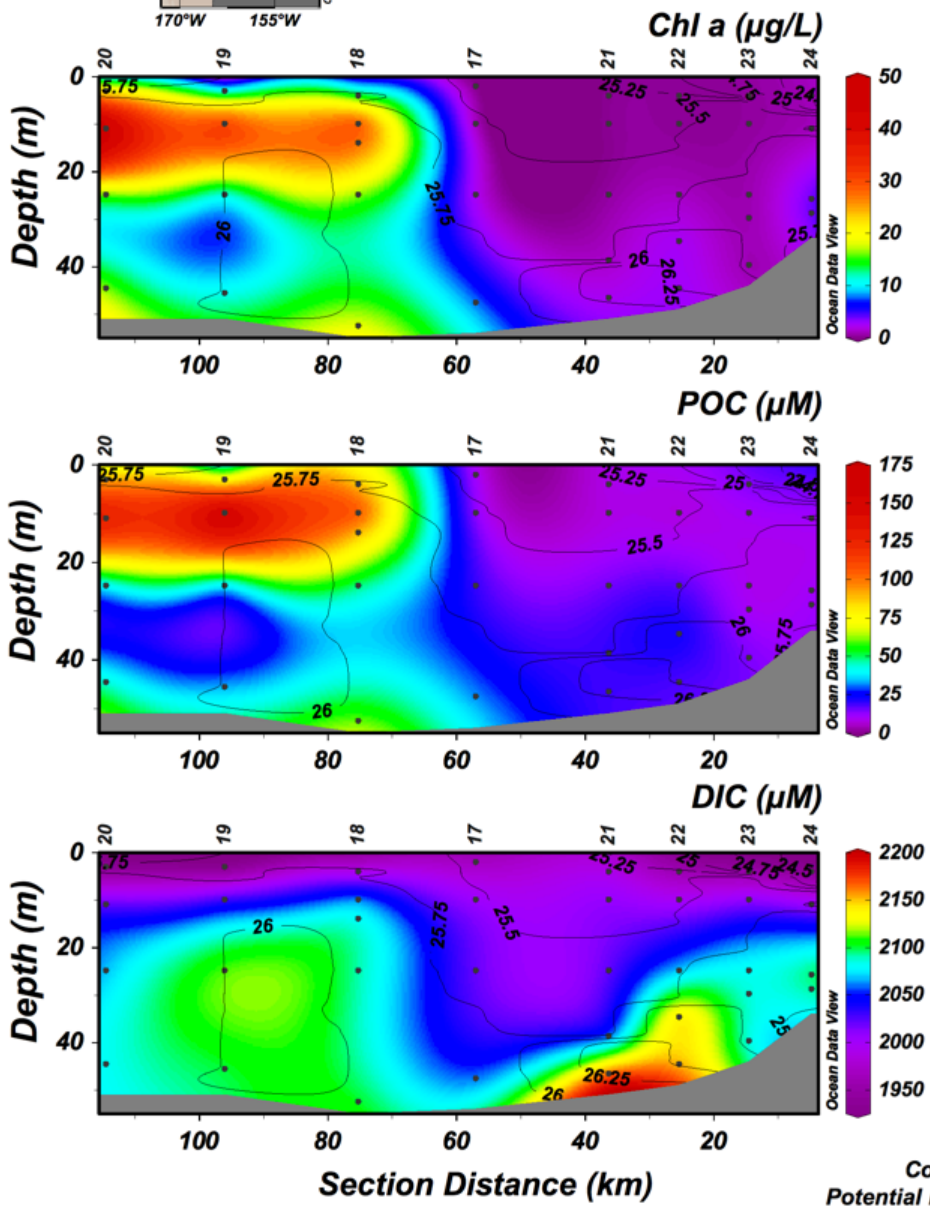
All water samples were collected on a Niskin bottle rosette

Dates
Chukchi Hotspot: 21-22 June, 17 July 2010
Barrow Hotspot: 12-13 July 2010

Chukchi Hotspot: 30 June-1 July 2011
Barrow Hotspot: 22-23 July 2011

ICESCAPE – Chukchi Hotspot



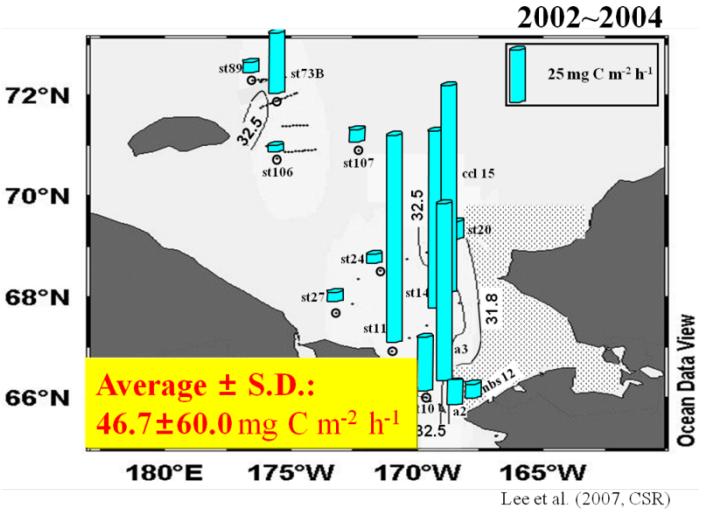


Contours:
Potential Density Anomaly

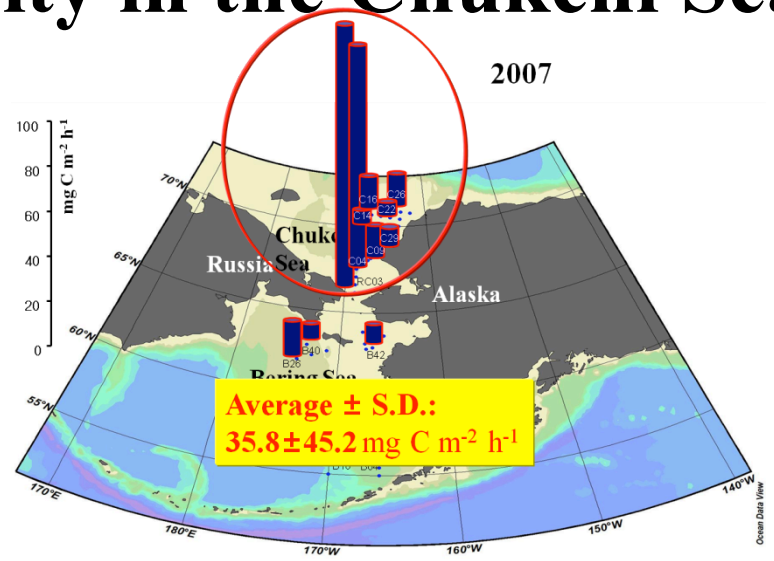
1. **Type of data: Primary Productivity in the Northern Bering/Chukchi seas**
2. **How the data was collected and when: Onboard-measured primary productivity using a C13 stable isotope ratio.**
   In the Chukchi Sea: Aug, 2004, Aug, 2007, Aug, 2008, and Sept, 2009
   in the Northern Bering Sea: mid May-mid June, 2007
3. **What main findings: generally 2-3 times lower primary production in the Northern Bering/Chukchi seas in recent years than those previously reported in decades ago.**

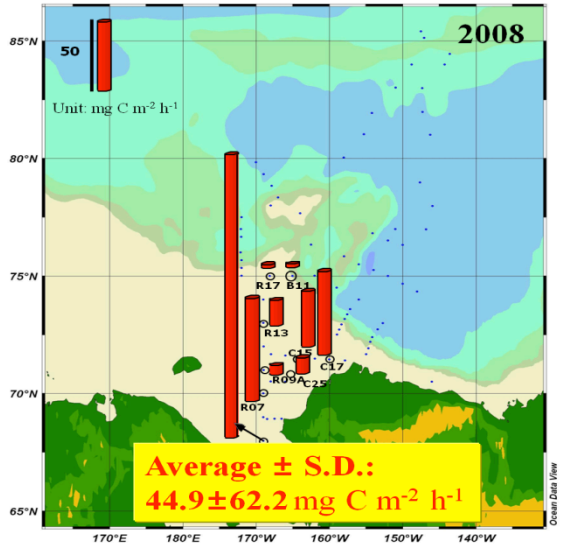
Sang Lee, Pusan National University, S. Korea

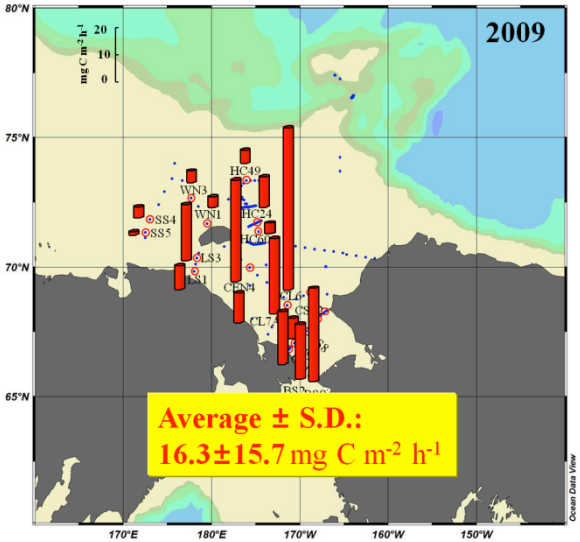
Primary Productivity in the Chukchi Sea



Lee et al. (2007, CSR)

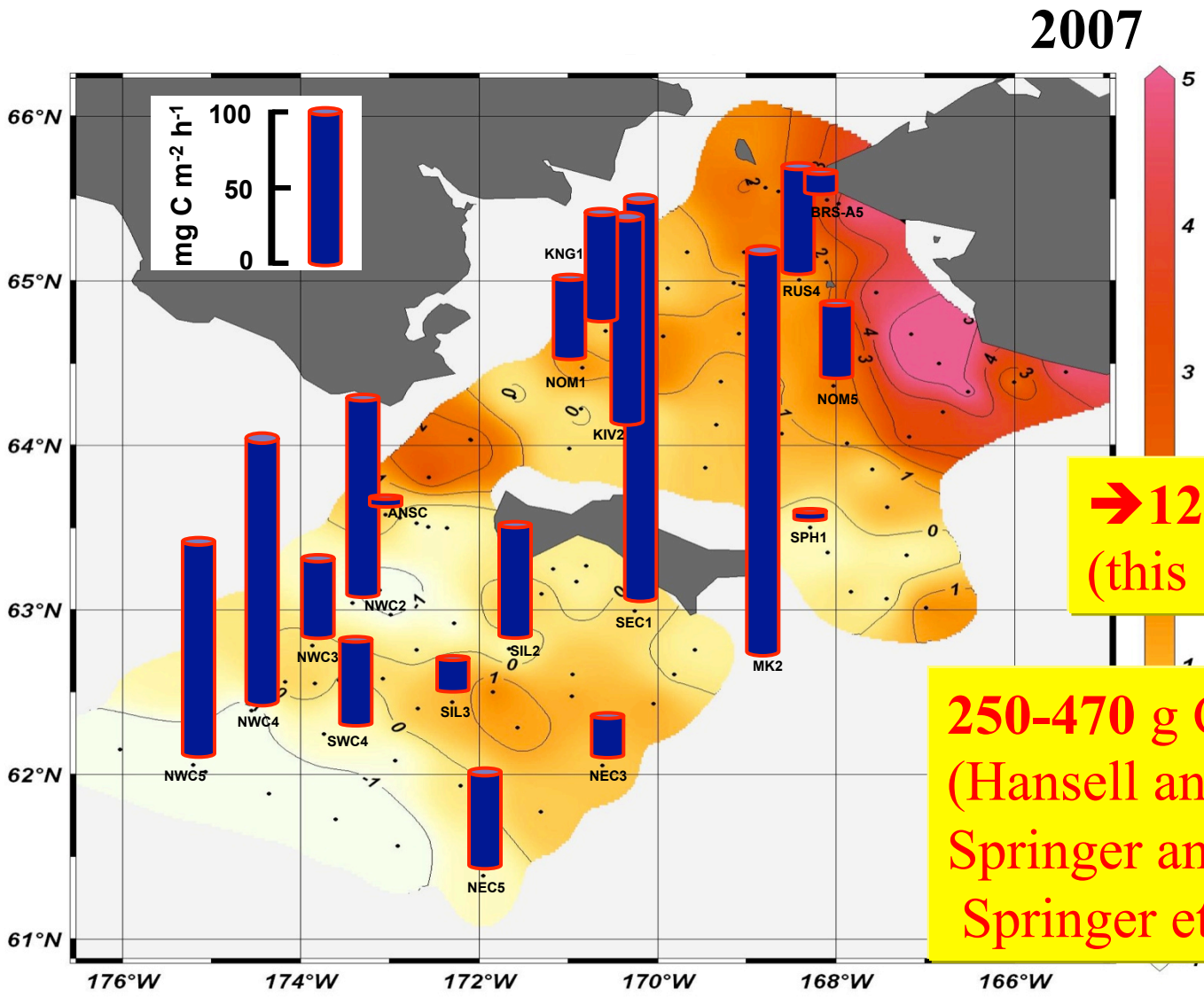






➔ Recent Productivity is ~3 times lower than decade(s) ago in the Chukchi Sea!

Recent PP in the N Bering Sea



➔**120** g C m^{-2} y^{-1}
(this study in 2007)

250-470 g C m^{-2} y^{-1}
(Hansell and Goering 1990;
Springer and McRoy 1993;
Springer et al. 1996)

Lee et al. (2012)

SOAR Hotspot Paper
Hydrography from ICESCAPE and SWL cruises

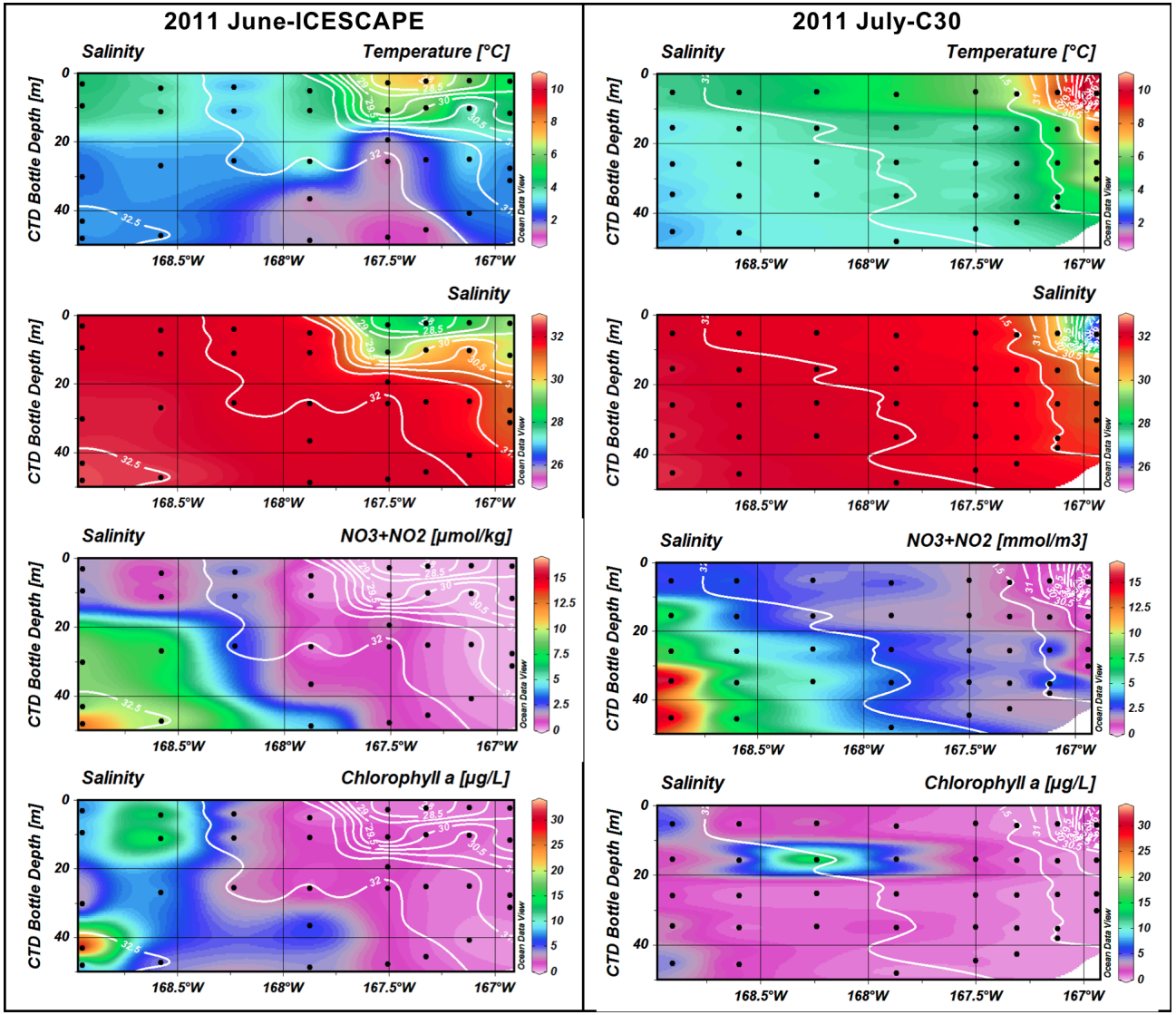
Lee W. Cooper
University of Maryland Center for Environmental Science, Solomons, MD, USA

OUTLINE

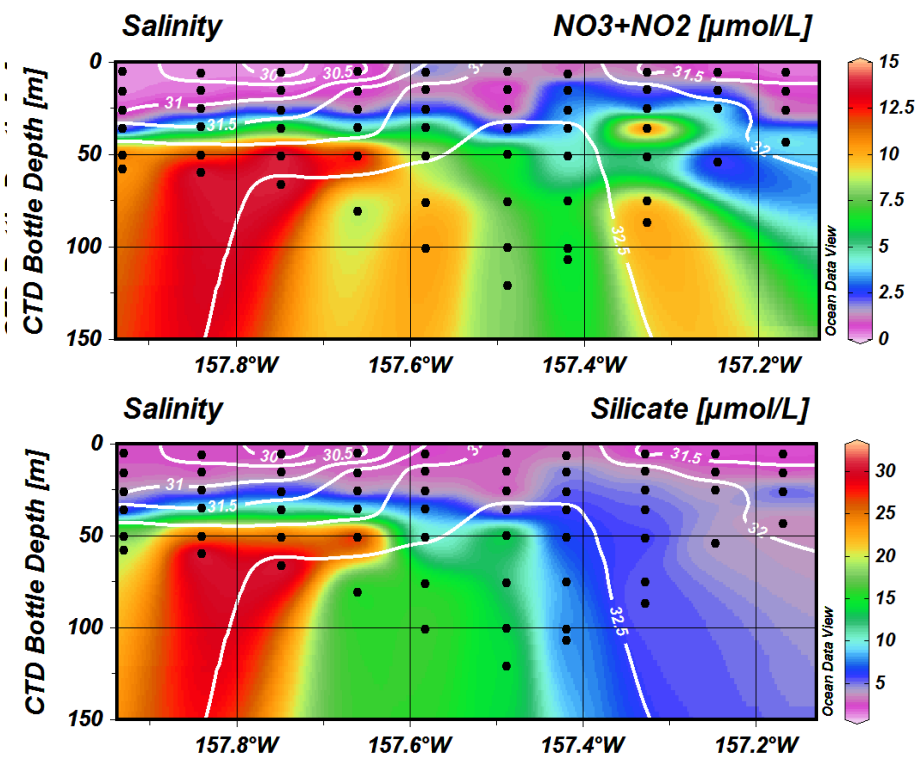
- Nutrients, chlorophyll CCGS Sir Wilfrid Laurier cruises: 2010-2012 (and previous years)
- CTD, nutrients, chlorophyll USCGC Healy, COMIDA Hanna Shoal 2012-2013
- Data from ICESCAPE (nutrients, chlorophyll)-Kevin Arrigo

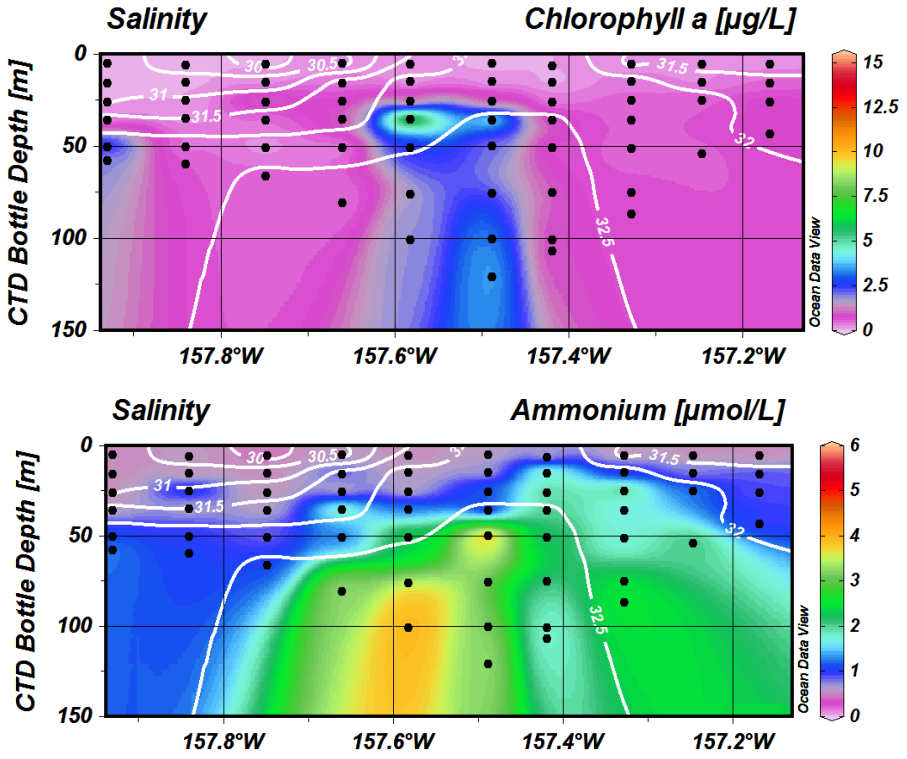
SOAR benthic hotspot workshop
March 25, 2013
US Arctic Research Commission
Anchorage, Alaska, USA

Temperature, salinity, nitrate/nitrite and chlorophyll a profiles overlain on salinity collected in 2011 on the DBO-SCS line by the ICESCAPE program (data courtesy Kevin Arrigo) and the C30 program (data from Grebmeier/Cooper).



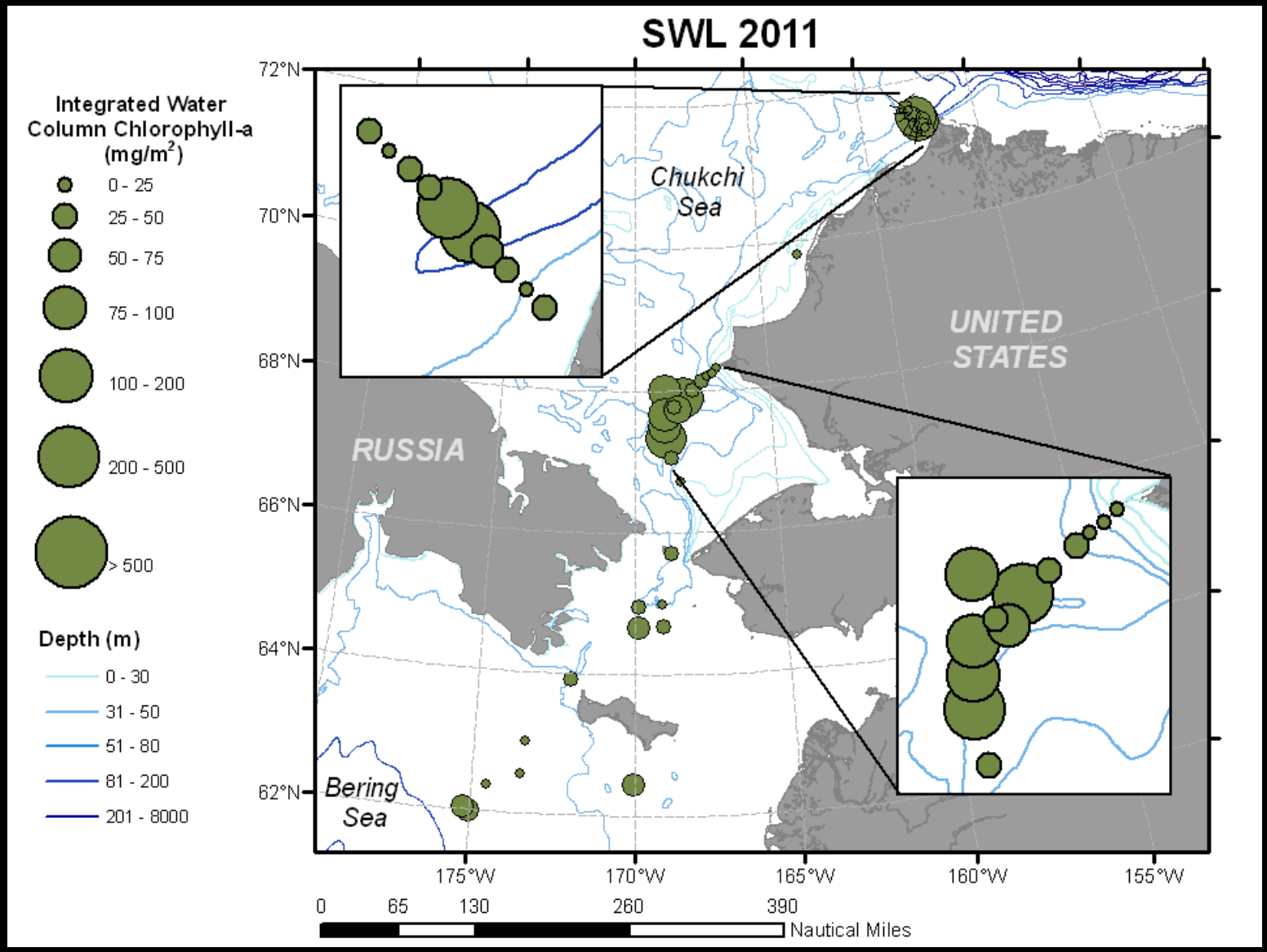
Nutrient data (nitrate, silicate and ammonium) and chlorophyll a (ug/L) overlaid on salinity (white isopleths) in Barrow Canyon during the CCGS Sir Wilfrid Laurier cruise in July 2011.





[Cooper and Grebmeier]

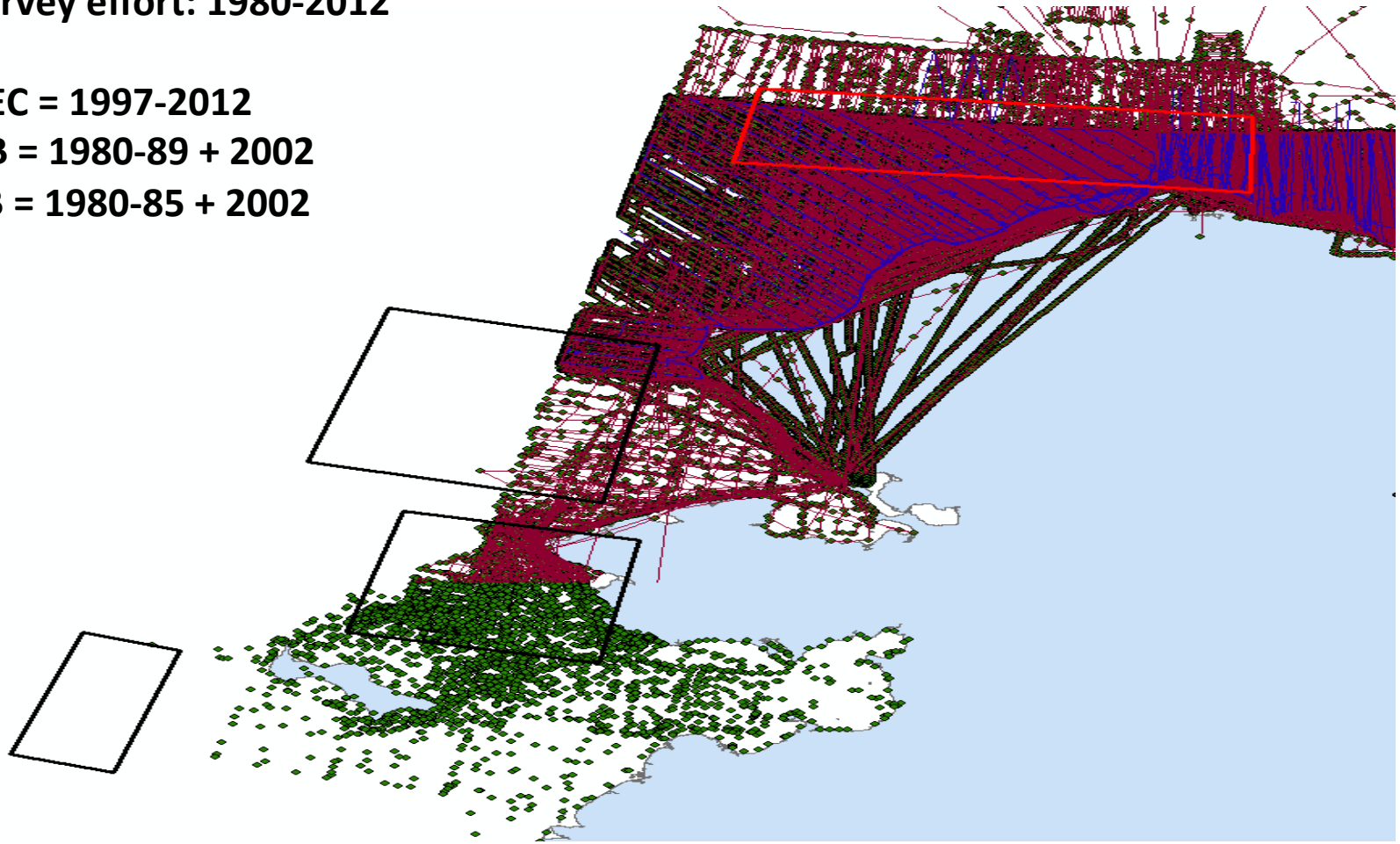
2011 Integrated Chl (mg/m2)

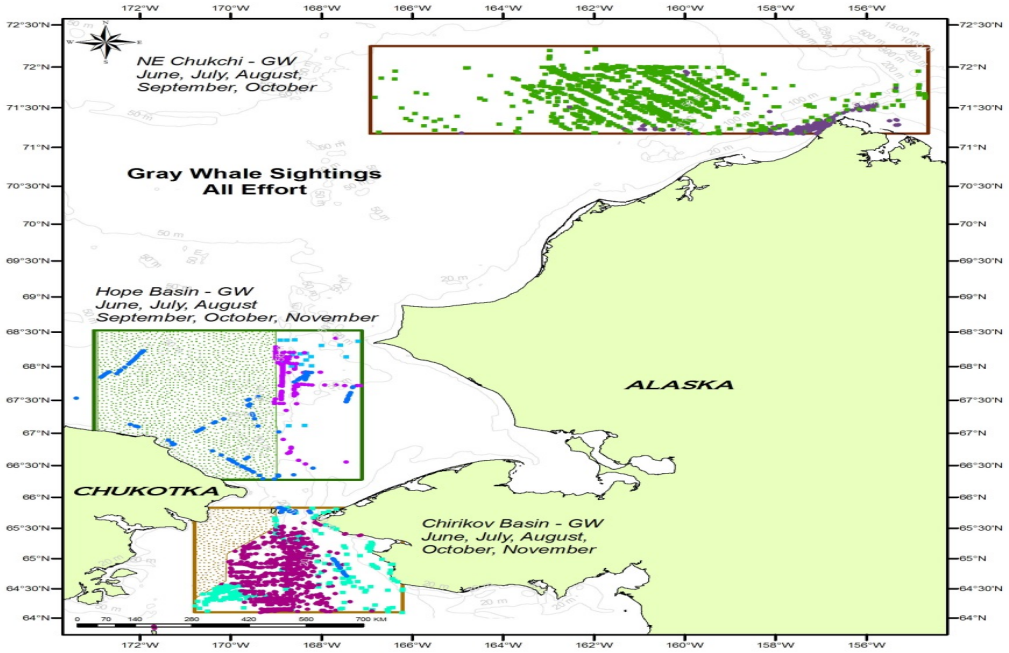


Aerial Surveys of Arctic Marine Mammals (ASAMM)-Sue Moore/NOAA

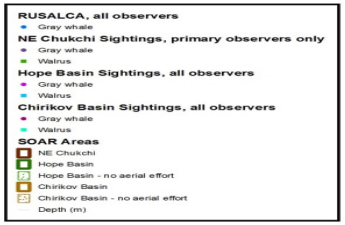
Survey effort: 1980-2012

NEC = 1997-2012
HB = 1980-89 + 2002
CB = 1980-85 + 2002

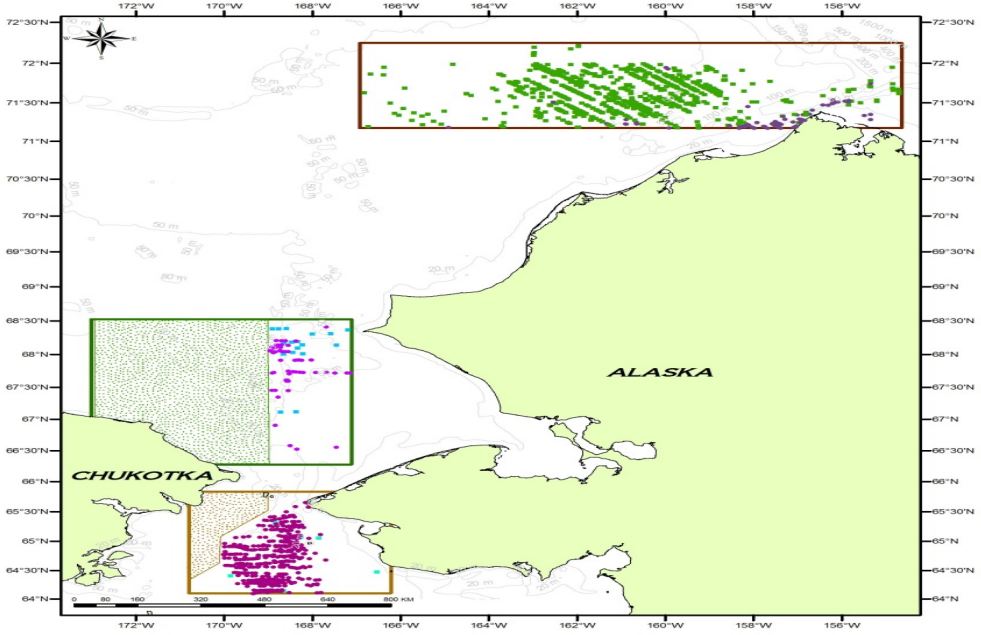




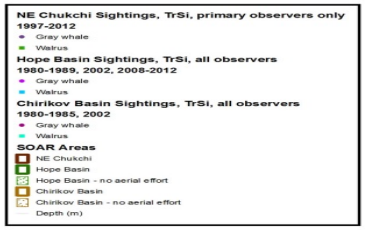
ASAMM and RUSALCA Data – all GW and WS sightings in NE Chukchi, Hope Basin and Chirikov Basin. Note areas of no aerial effort.
[Includes 2002 flights]

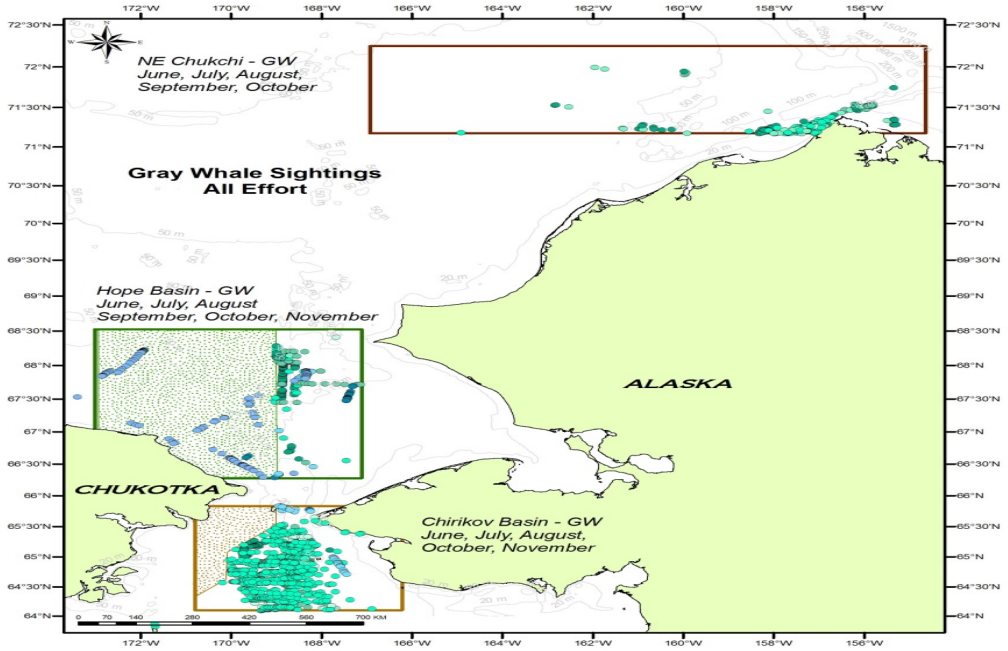


No ASAMM or RUSALCA effort in SLIP.

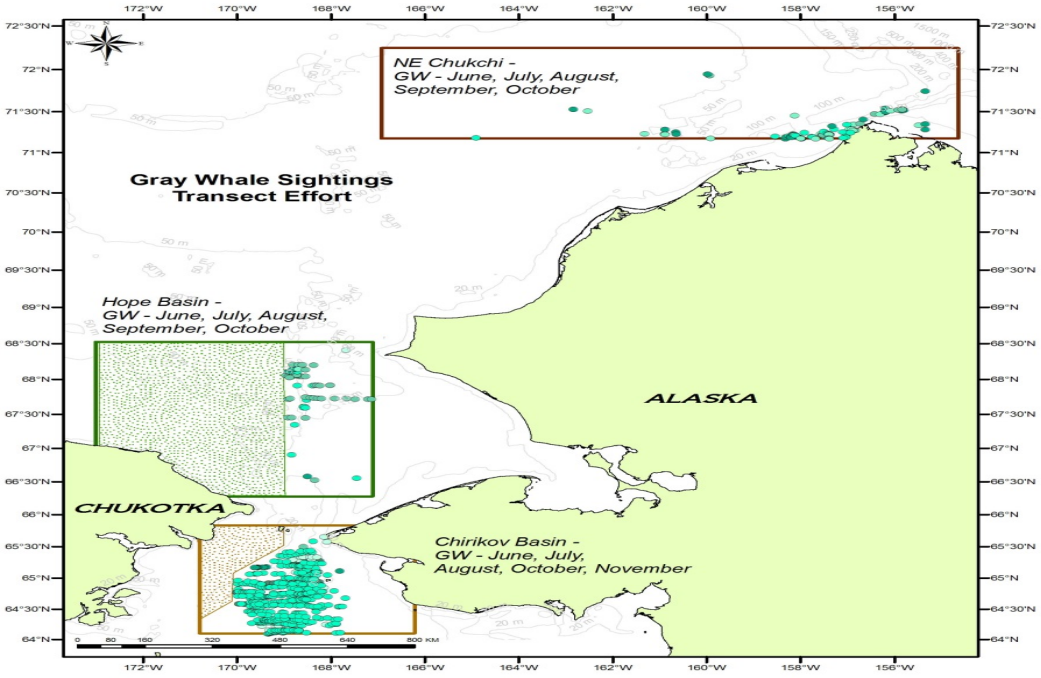


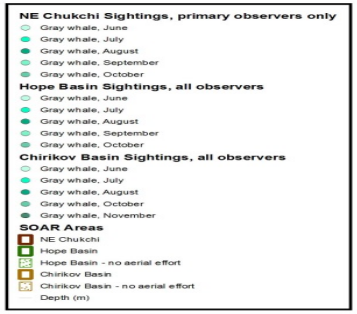
ASAMM Data Only – Transect sightings. Nearly all of the walruses in Chirikov Basin disappear. Curious until we look at monthly breakdown.
[Includes 2002 flights]



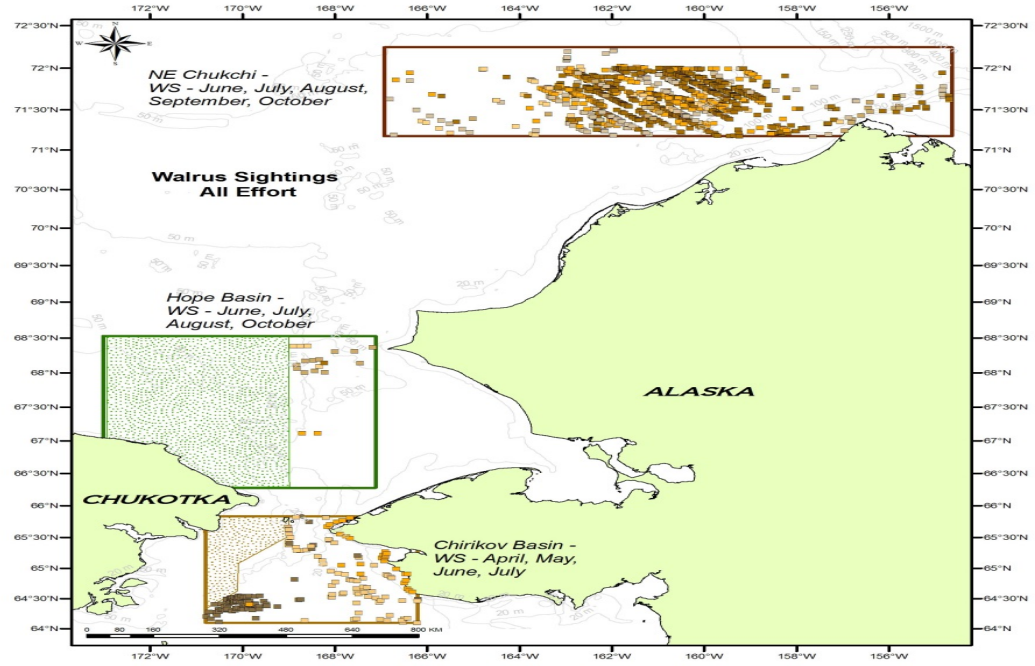


ASAMM and RUSALCA Data – monthly depiction of <u>all</u> GW sightings in NE Chukchi, Hope Basin and Chirikov Basin. Gray whales in almost every month in all three areas. [Includes 2002 flights]

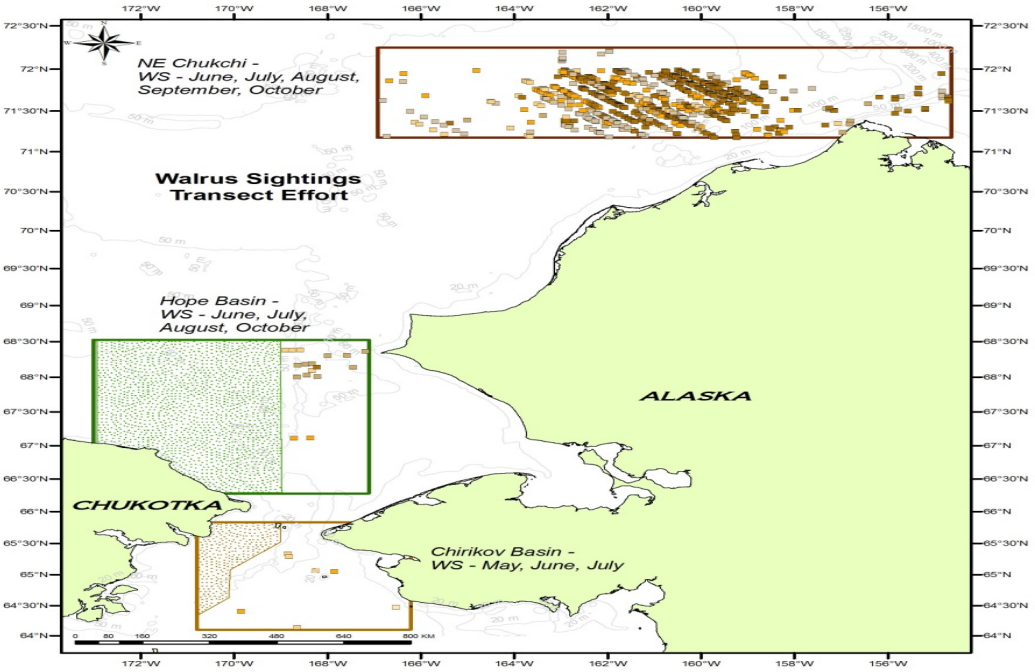




ASAMM Data Only – monthly depiction of <u>transect</u> GW sightings in NE Chukchi, Hope Basin and Chirikov Basin. Gray whales in almost every month in all three areas. [Includes 2002 flights]



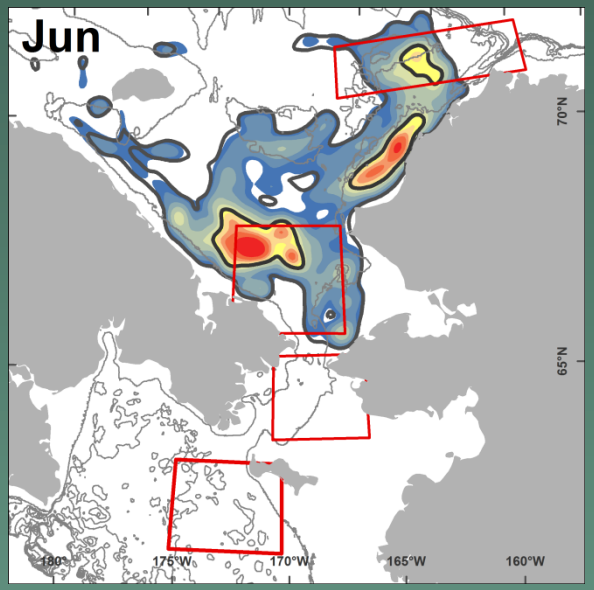
ASAMM Data – monthly depiction of <u>all</u> WS sightings in NE Chukchi, Hope Basin and Chirikov Basin. Walruses in NE Chukchi and Hope Basin in almost every month. Walruses in Chirikov Basin only in April ,May, June, July; only 7 sightings of 118 walruses on transect; most transect flights during this time were south of Bering Strait.

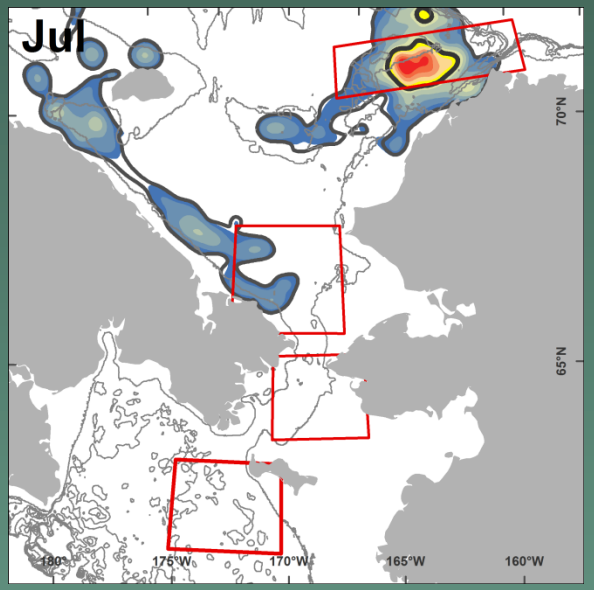


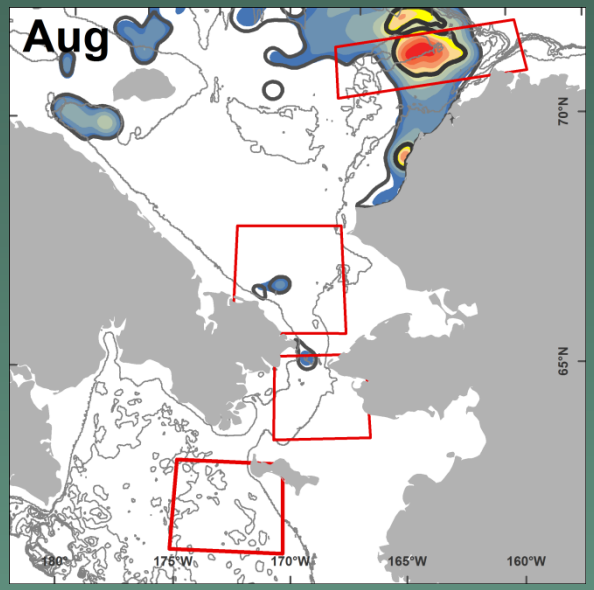
ASAMM Data – monthly depiction of <u>transect</u> WS sightings in NE Chukchi, Hope Basin and Chirikov Basin. Walruses in NE Chukchi and Hope Basin in almost every month. Walruses in Chirikov Basin only in May, June, July; only 7 sightings of 118 walruses on transect; most transect flights during this time were south of Bering Strait.

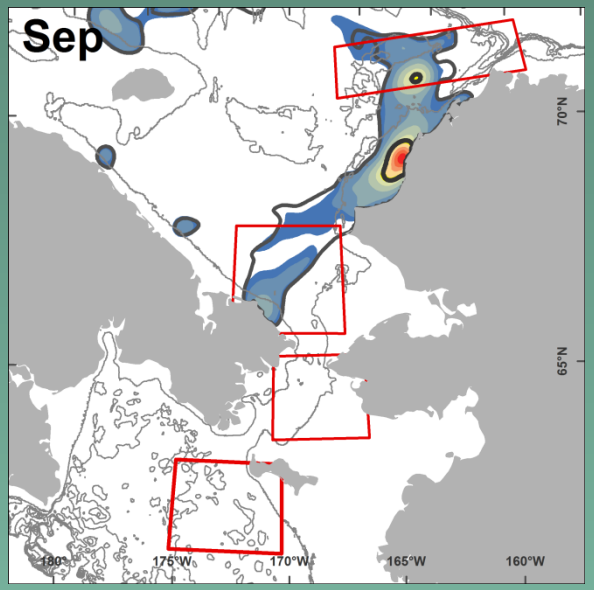
Chad Jay, USGS

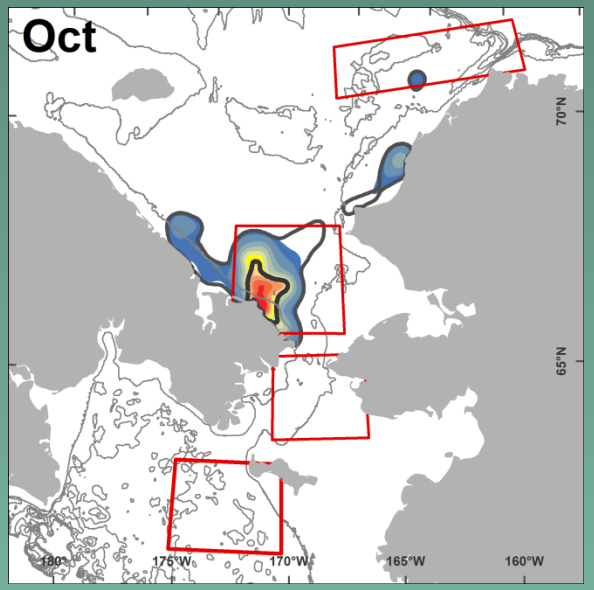
Walrus foraging areas, Chukchi Sea, 2008-2011

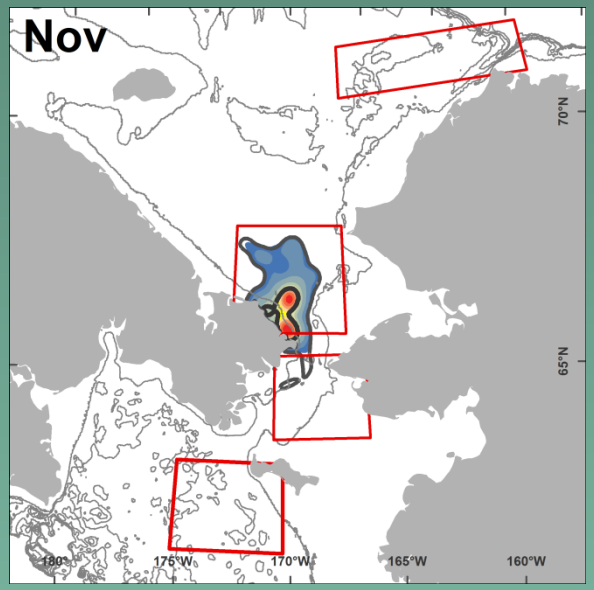












Walrus foraging areas, Chukchi Sea, 2008-2011

- Utilization distribution (UD) estimates of walrus foraging (red to blue color ramp contours, 10 to 95% UDs) and occupancy (solid line contours, 50 and 95% UDs) in the Chukchi Sea, 2008 to 2011 (Jay et al. 2012 MEPS)
- Estimates based on foraging locations from radio-tracked walruses

- For Bering Sea: may be able to provide information on walrus selection of sea ice and infauna; or possibly provide UDs of occupancy??

USGS

Walrus foraging areas, Chukchi Sea, 2008-2011

- Current distribution related to recent sparse sea ice cover, particularly September
- Earlier and more extensive sea ice retreat in June to September, and delayed freeze-up of sea ice in October to November, created conditions for walruses to arrive earlier and stay later in the Chukchi Sea than in the past
- Lack of sea ice over the continental shelf from September to October caused walruses to forage in nearshore areas instead of offshore areas as in the past
- Areas of concentrated foraging generally corresponded to regions of high benthic biomass, such as in the northeastern (Hanna Shoal) and southwestern Chukchi Sea
- A notable exception was the occurrence of concentrated foraging in a nearshore area of northwestern Alaska that is apparently depauperate in walrus prey

USGS

At-sea surveys -Bering, Chukchi, Beaufort

Ships of opportunity

Single observer on bridge, 300m strip

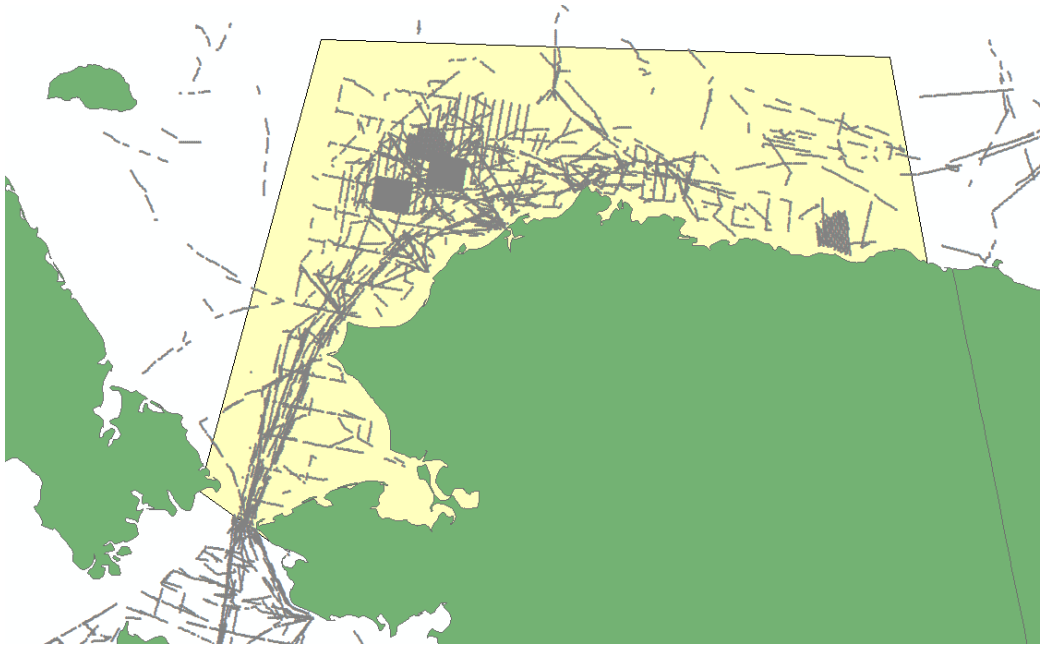
GPS-integrated data recording

2006-2012: > 158,000 km surveyed

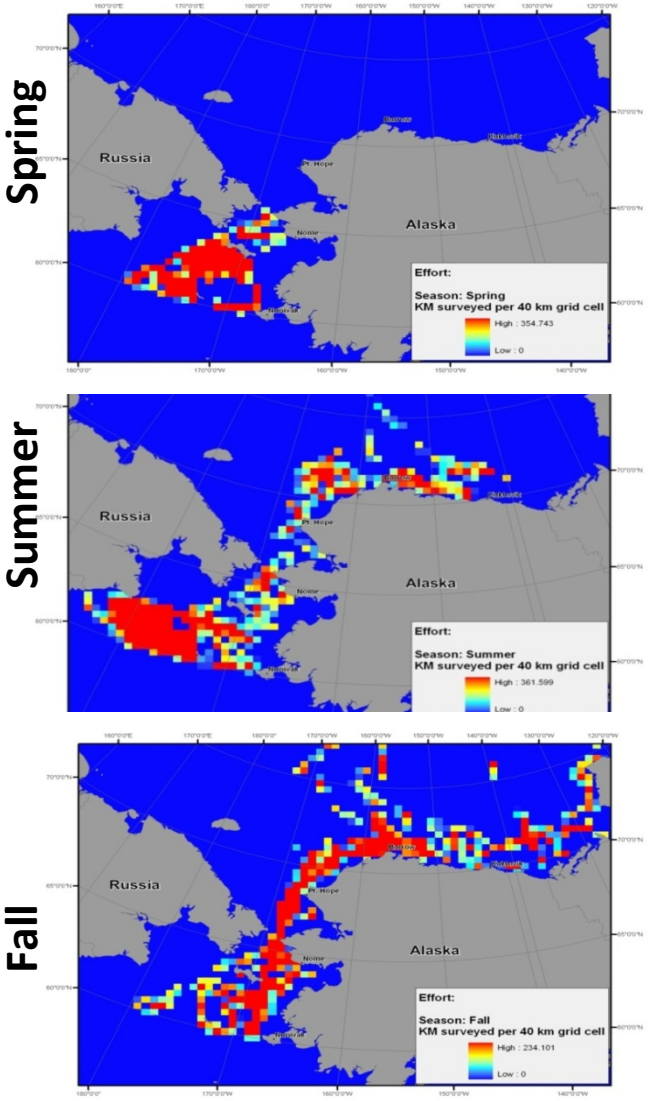
(~ 35,000 km in N. Bering & Arctic)

Kathy Kuletz, U.S. Fish & Wildlife Service

SOAR survey effort (maps by Brendan Hurley)



Revised SOAR/bird & mammal hotspot study area
Marine bird transects shown in grey



Seabird surveys

Focus on Arctic in 2010-2014 / BOEM & USFWS

Synthesis efforts involved with this data:

- **SOAR/ benthic hotspots** (*Grebmeier et al*.)
- PacMARS (*Grebmeier & Cooper et al*.)
- SOAR/ Barrow Canyon (*Pickart et al*.)
- SOAR/bird & mammal hotspots *(Kuletz et al.)*

Brief on SOAR/Birds & Mammal Hotspot project:

Seasonal changes in marine bird & mammal distributions
Identify 'hotspots' (abundance, spp richness, diversity)
Will analyze selected species separately & overlap all
Birds: 18 spp & 4 forage groups x 2 seasons (summer & fall)
Changes:
Dropped spring & N. Bering (no mammal data)
Added ABR (Industry) bird data & co-authors

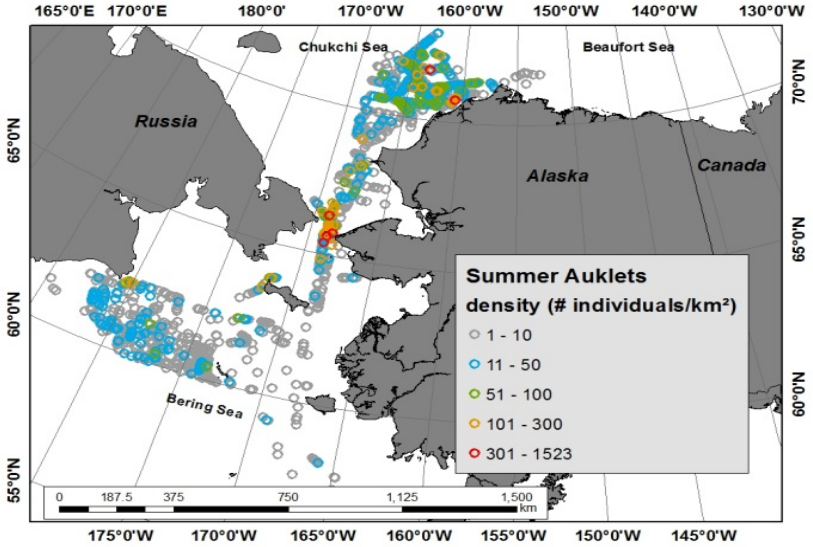
SOAR project
(Sea*bird & mammal hotspots)*

Example:
***Aethia* auklets** *(3 spp; planktivores)*

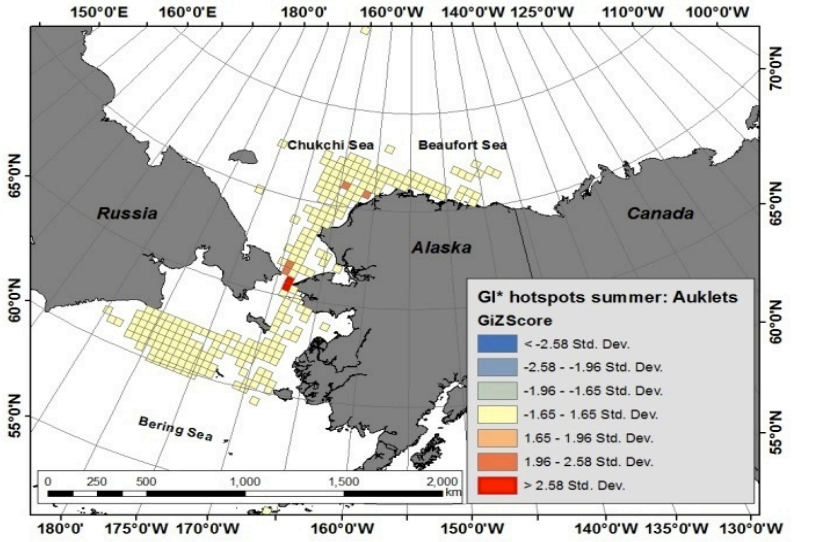
40 km grid to overlap seabird vessel-based & mammal aerial surveys.

Min. cell coverage for hotspot analysis:
20km within season- birds
40 km within season - mammals
(combine years 2007-2012)

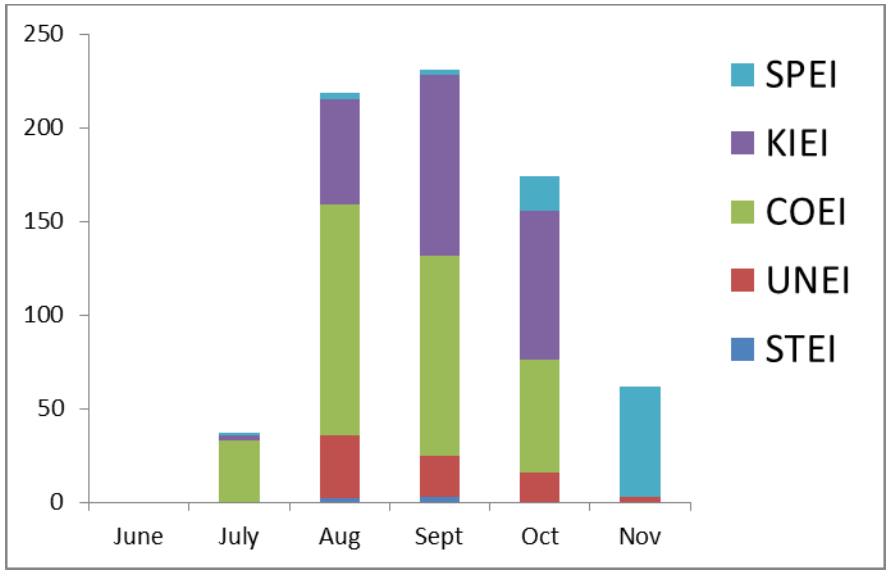
Preliminary results
Bering Straight and Barrow Canyon (west of Pt. Barrow) are statistically significant hotspots.
(**will be run with colony areas removed**)



Densities/40km cell - summer

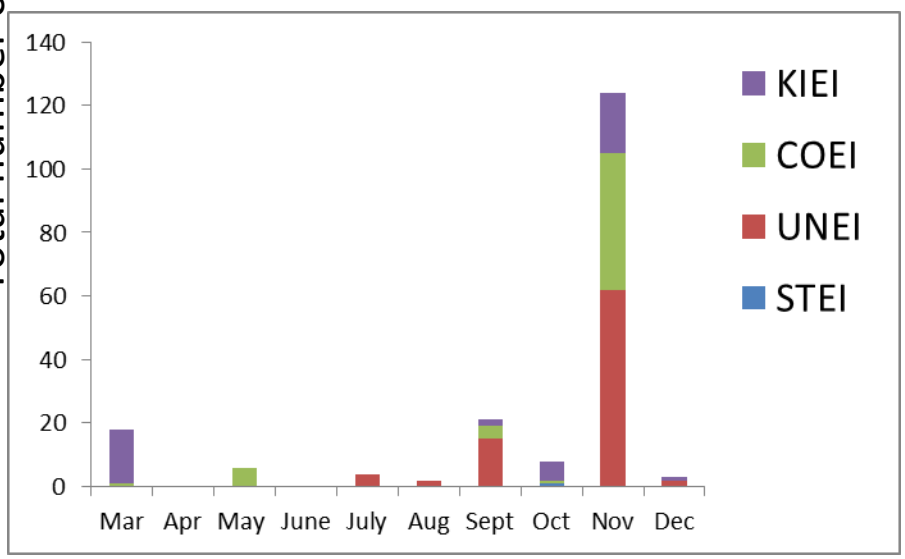


Hotspots - Summer



Chukchi/Beaufort surveys – Eider records

Total number of birds in study area



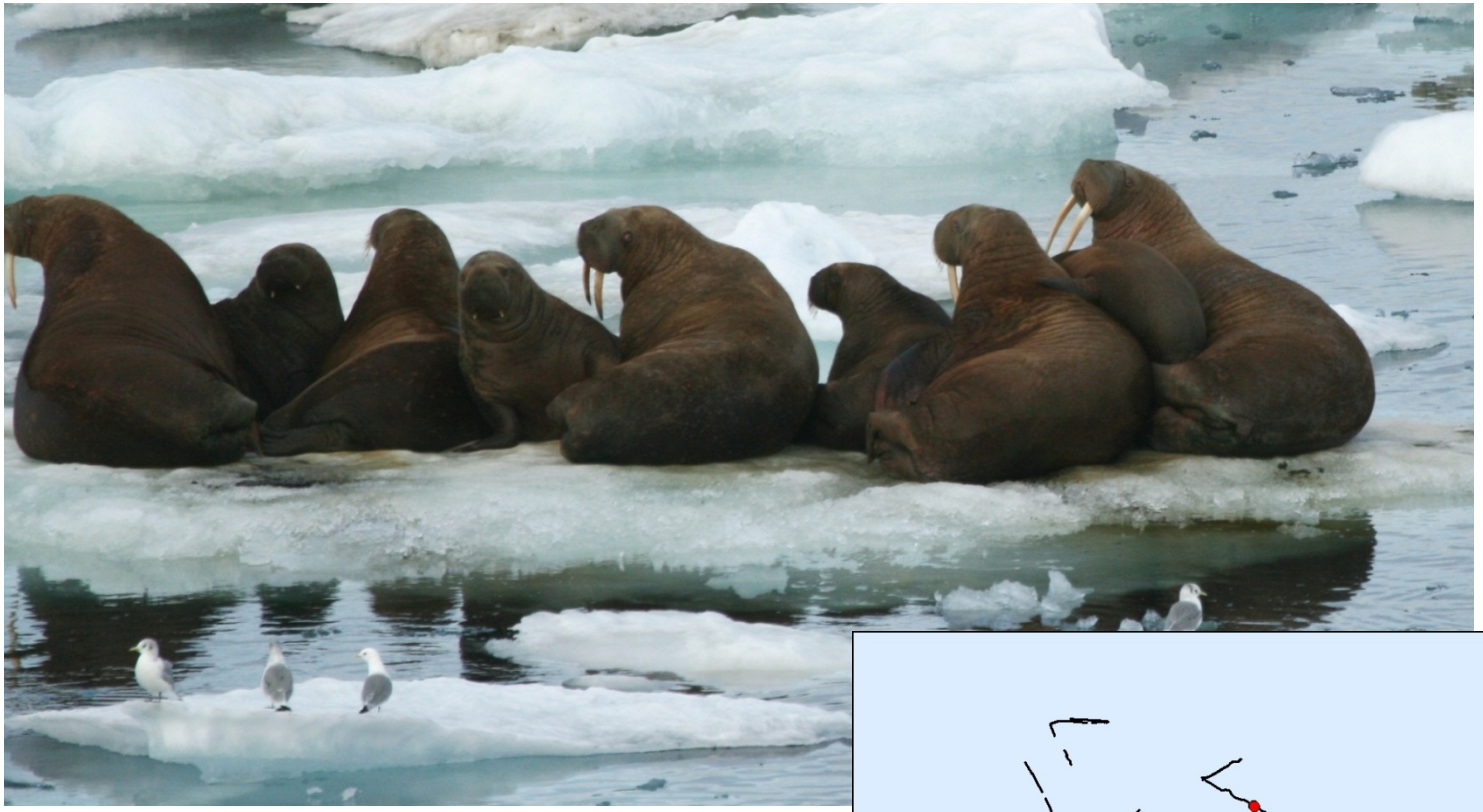
N. Bering Sea – NO Spectacled Eiders included

<u>Preliminary/Rough</u>
examples of eiders
(benthic foragers)
by month

Did not include
Spectacled Eiders/spring/
N. Bering Sea
(off the charts)

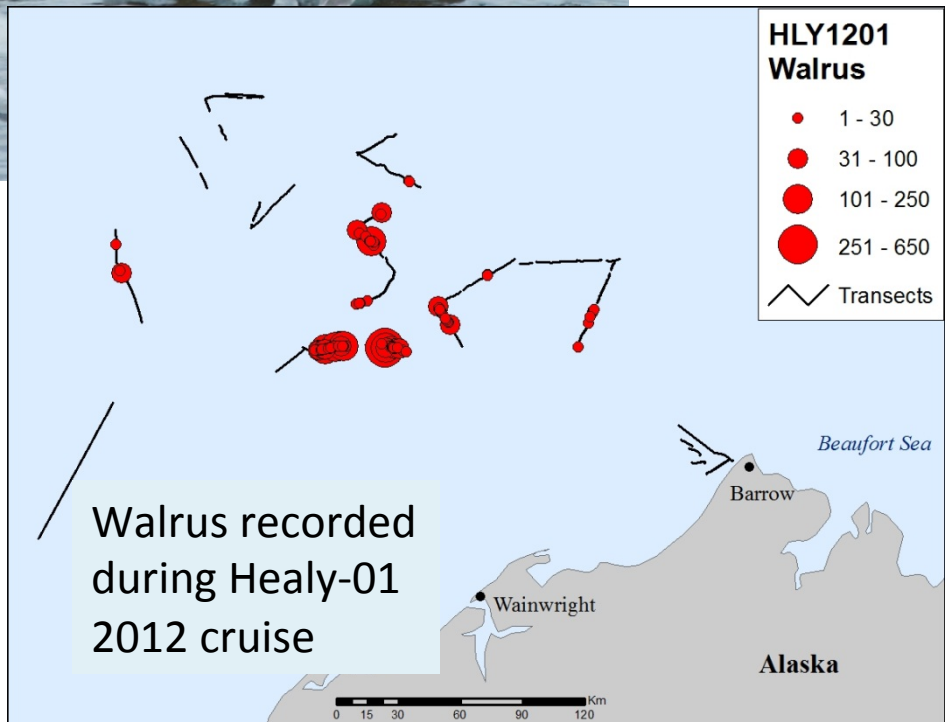
Strong seasonal component

Eiders & other benthic foragers were very small portion of total birds



During our USFWS seabird surveys, marine mammals are recorded, but using seabird protocols.

Most mammal records are ‘off transect’ (recorded as >300m from ship); but there is known time & linear effort and lat/long for each record.

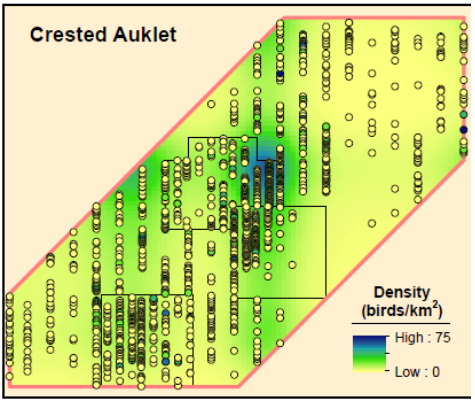


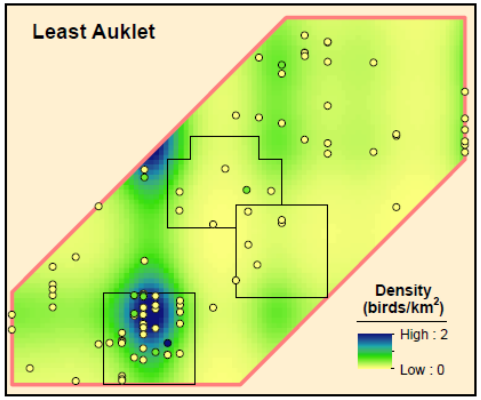
Walrus recorded during Healy-01 2012 cruise

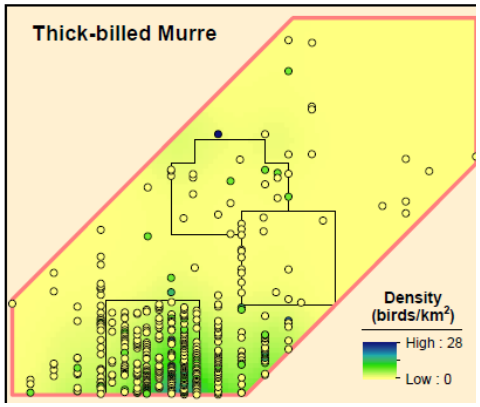
BIRDS AND THE NORTHEASTERN CHUKCHI HOTSPOT-Bob Day/ABR, Inc.

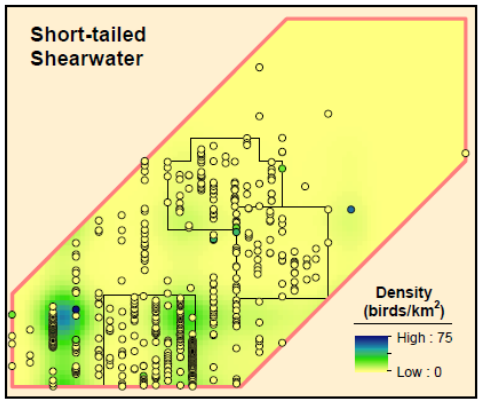
- Data are not crunched yet BUT…
- Benthic-feeding seaducks are rare in the offshore part of the Chukchi—calculated mean densities will be very low (<<1 bird/km^2)
- Those seaducks that have been seen in the offshore area (primarily Long-tailed Ducks and eiders) only have been seen flying toward the SW —toward Russia; therefore, none are foraging in this area, even though water depths (~35–45 m) are shallow enough for foraging by seaducks

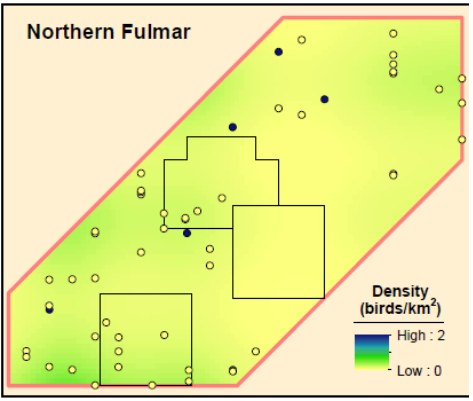
SEABIRDS (2011)

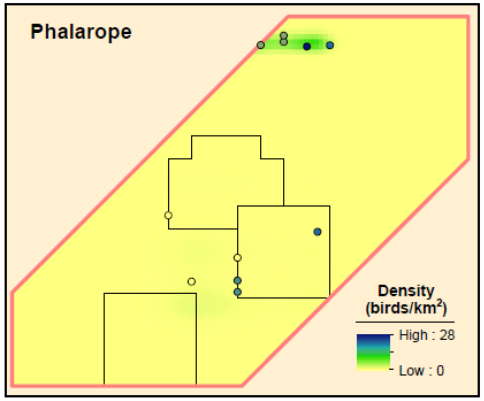


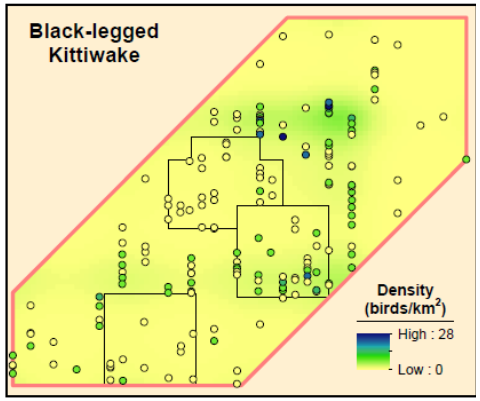


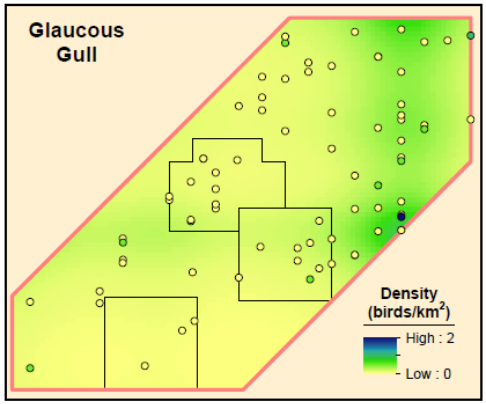






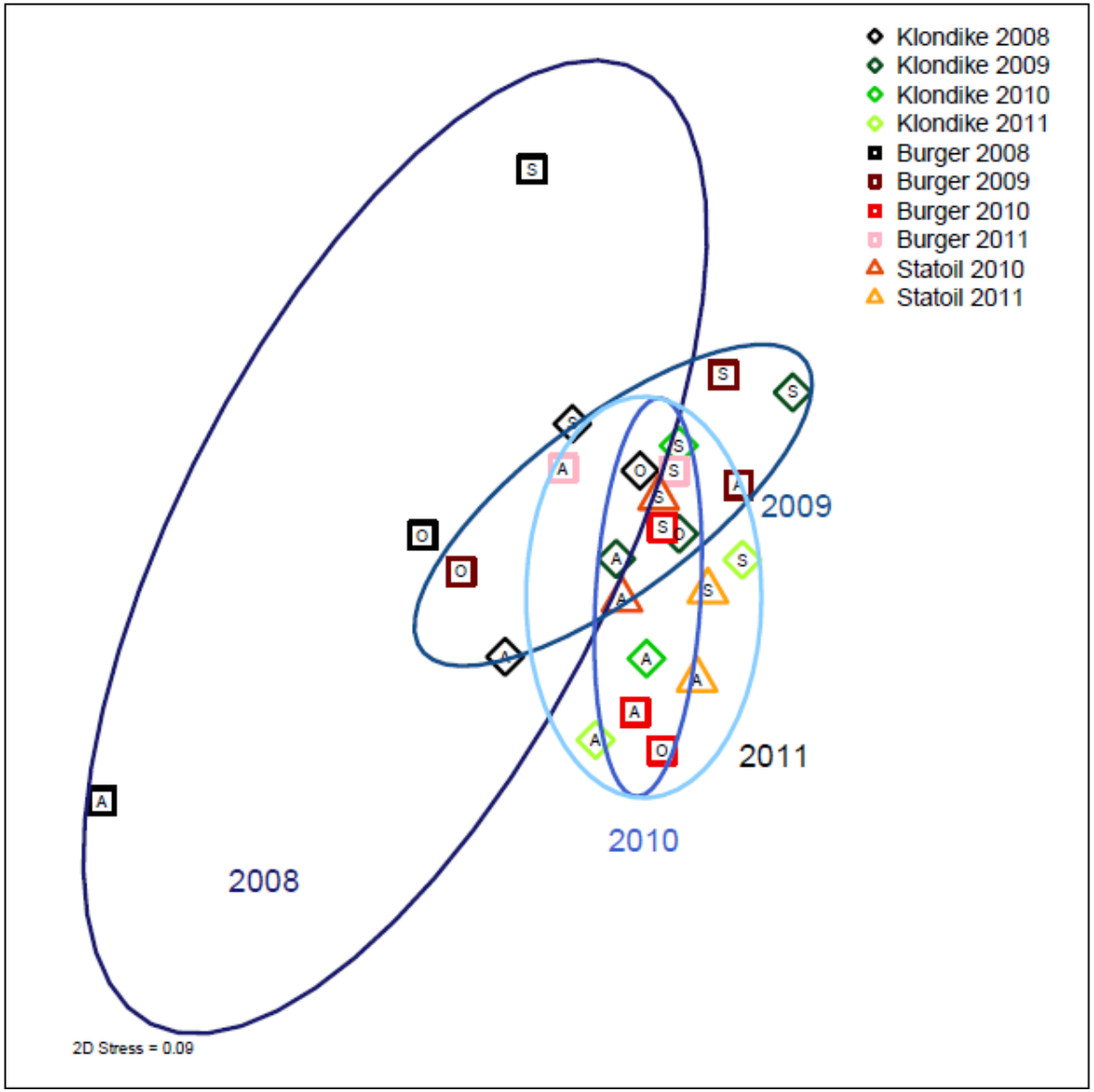






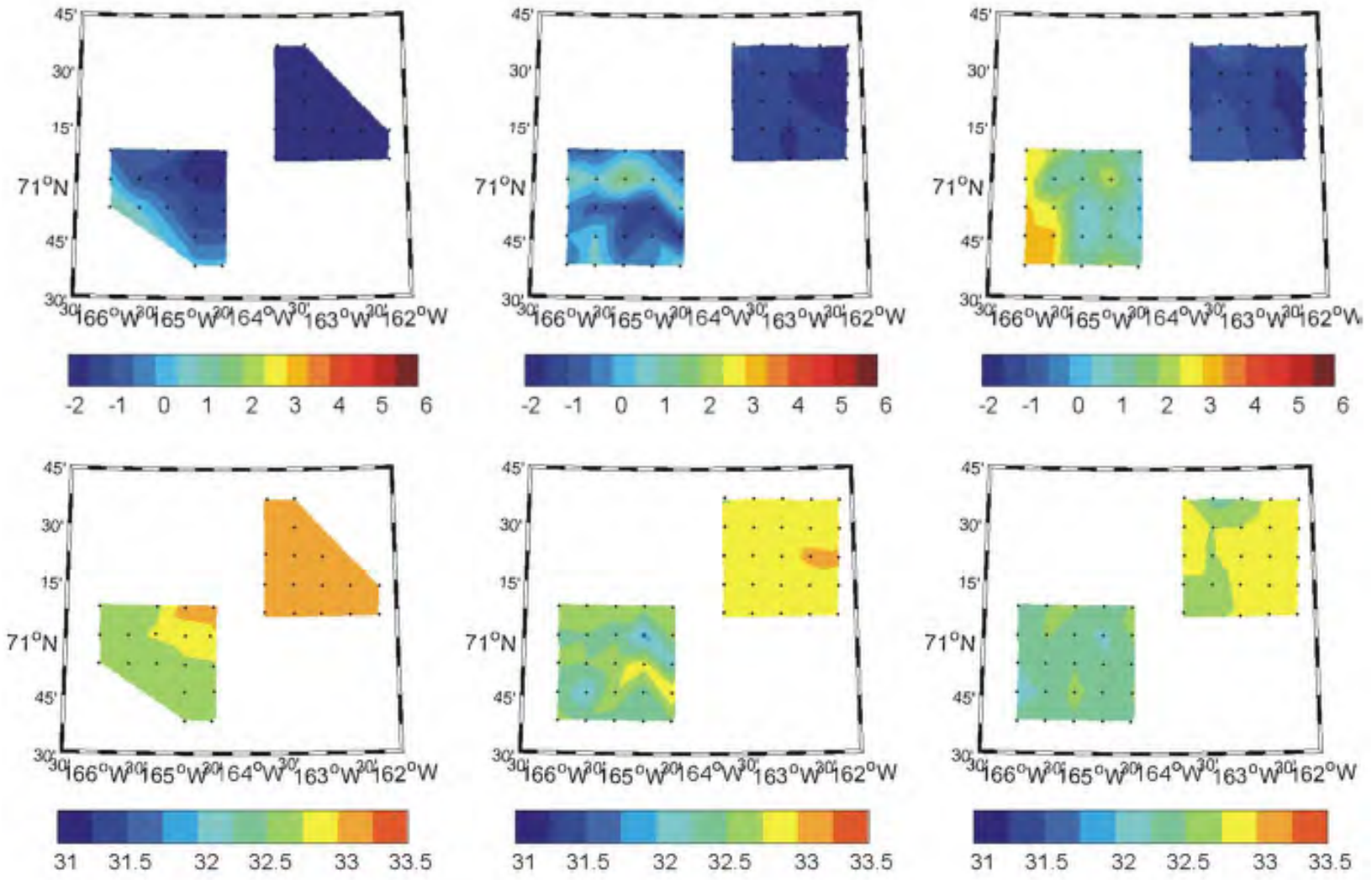
GALL AND DAY (2012)

SEABIRD COMMUNITY (2008–2011)



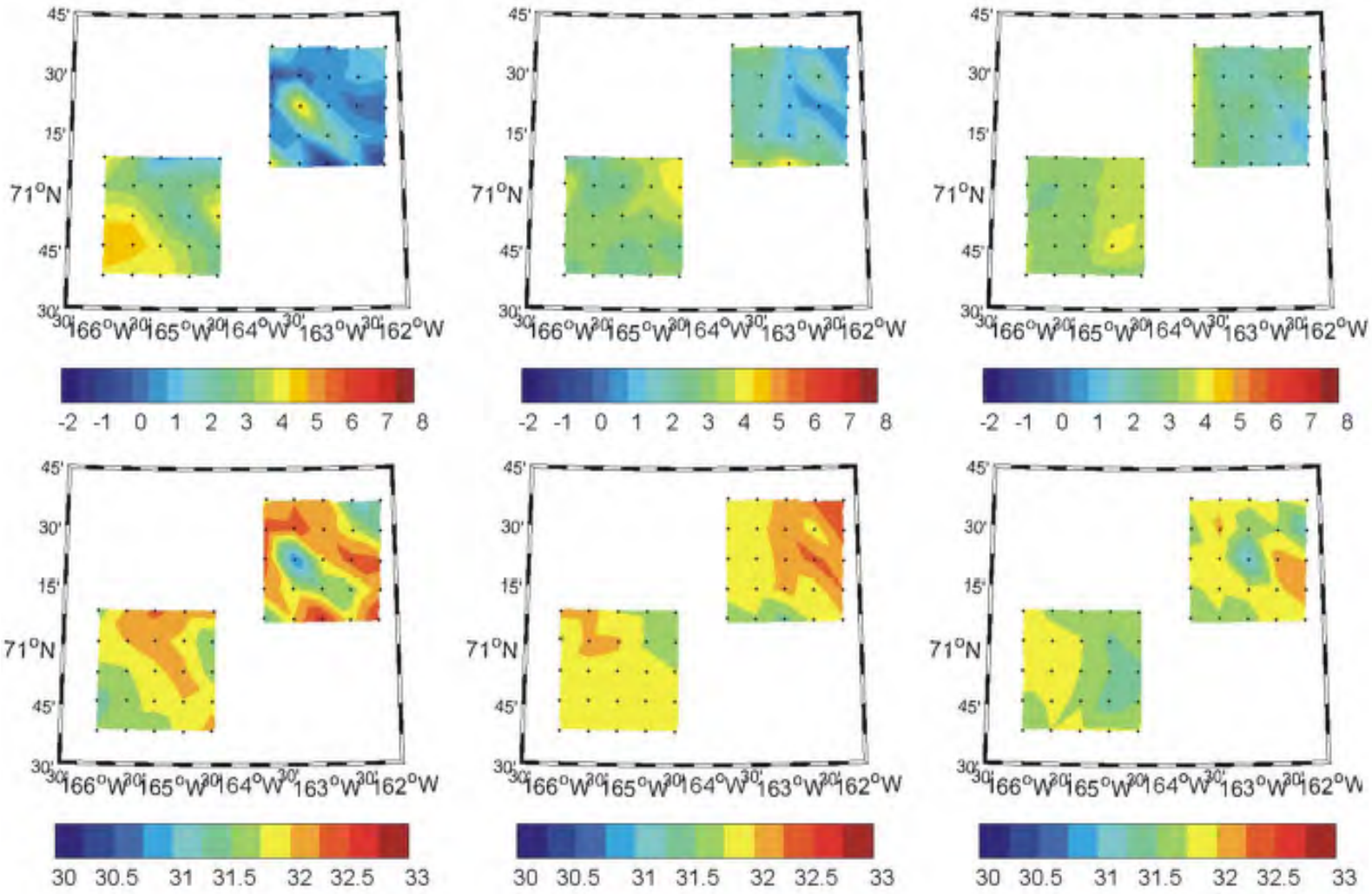
GALL AND DAY (2012)

MEASUREMENTS BELOW MIXED LAYER (2008)



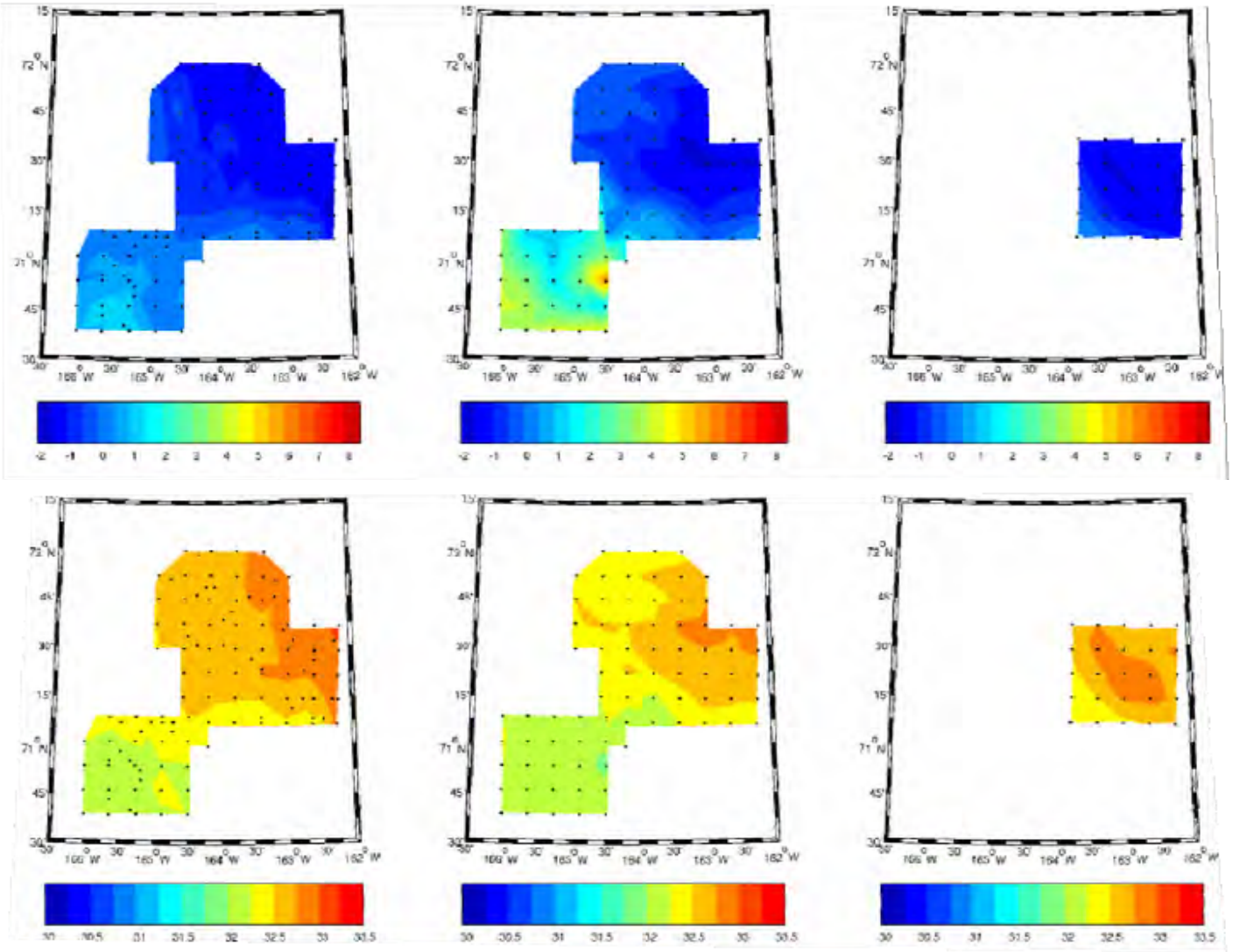
WEINGARTNER ET AL. (2011)

MEASUREMENTS BELOW MIXED LAYER (2009)



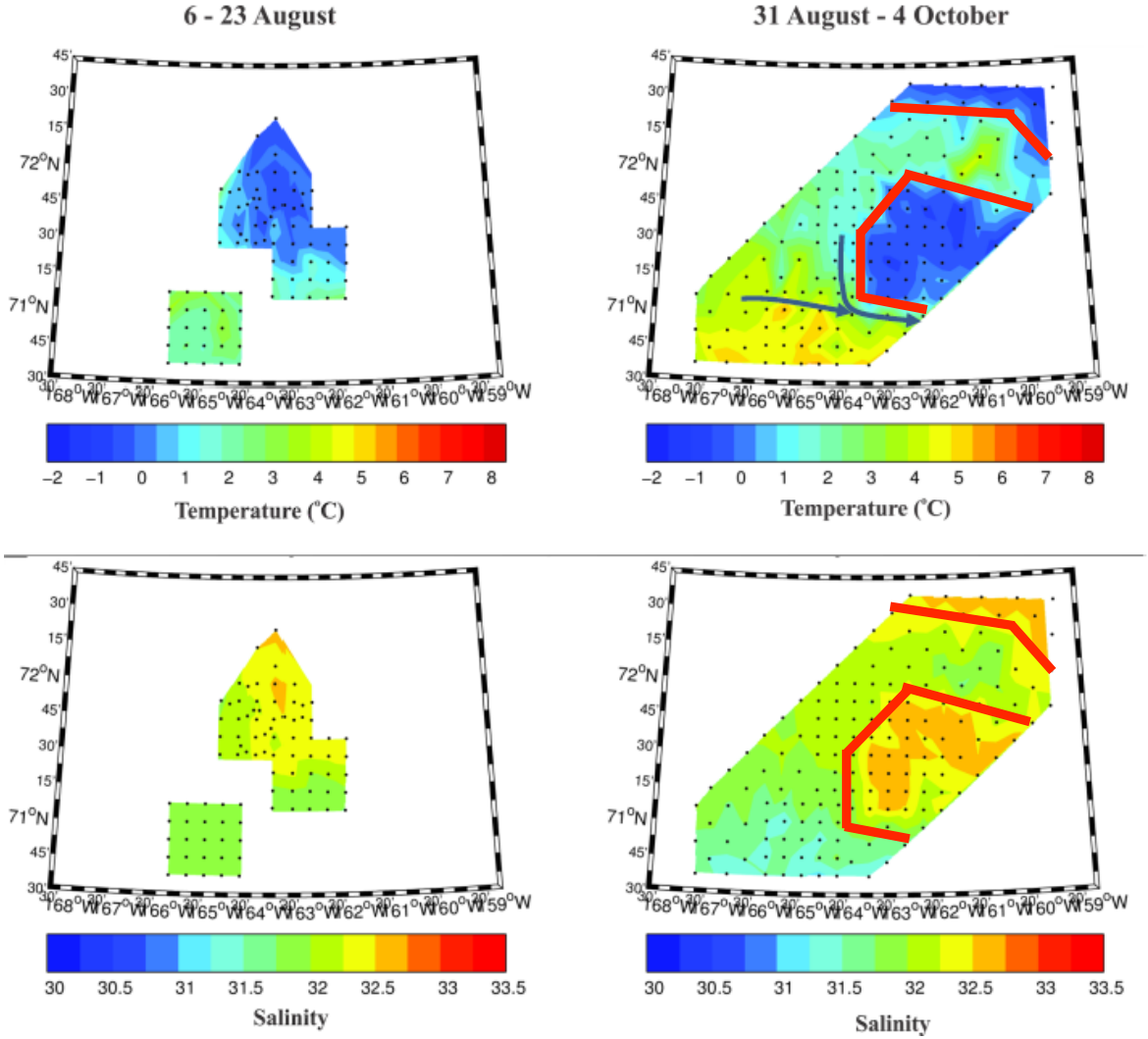
WEINGARTNER ET AL. (2011)

MEASUREMENTS BELOW MIXED LAYER (2010)



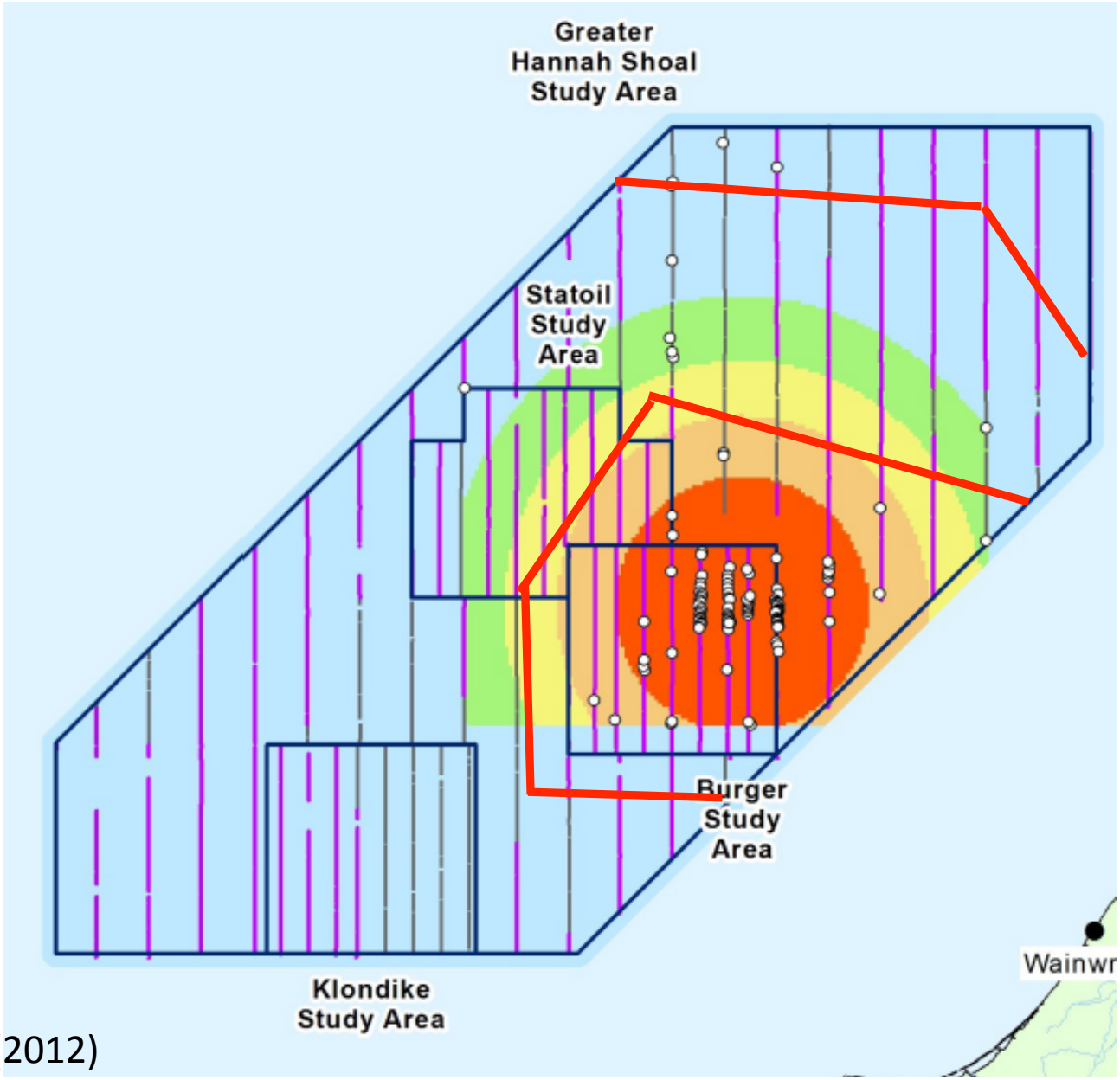
WEINGARTNER ET AL. (2011)

MEASUREMENTS BELOW MIXED LAYER (2011)



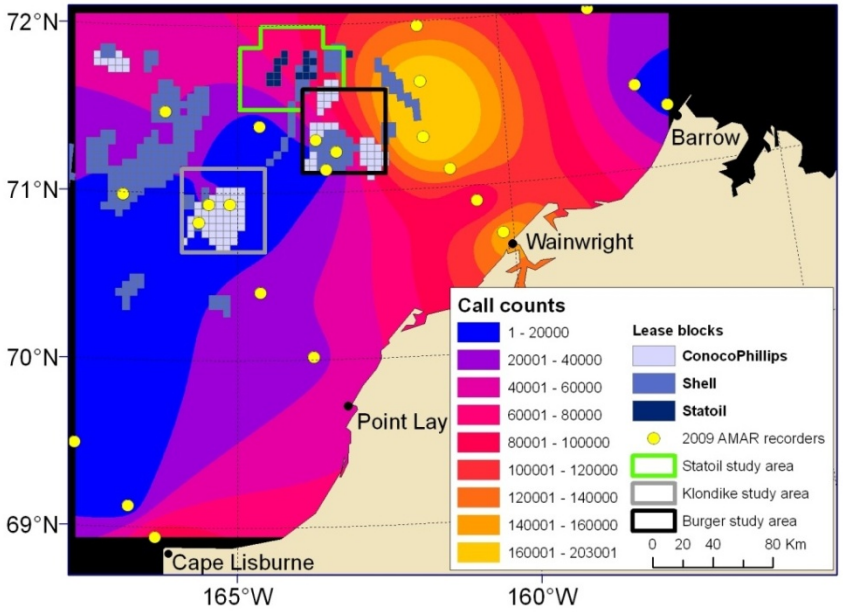
WEINGARTNER ET AL. (2012)

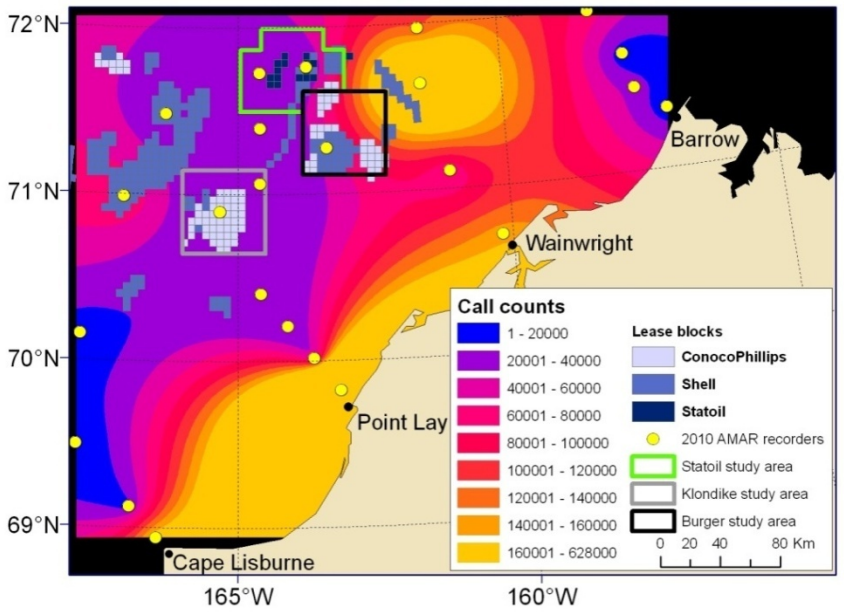
WALRUSES AT SEA (2011)

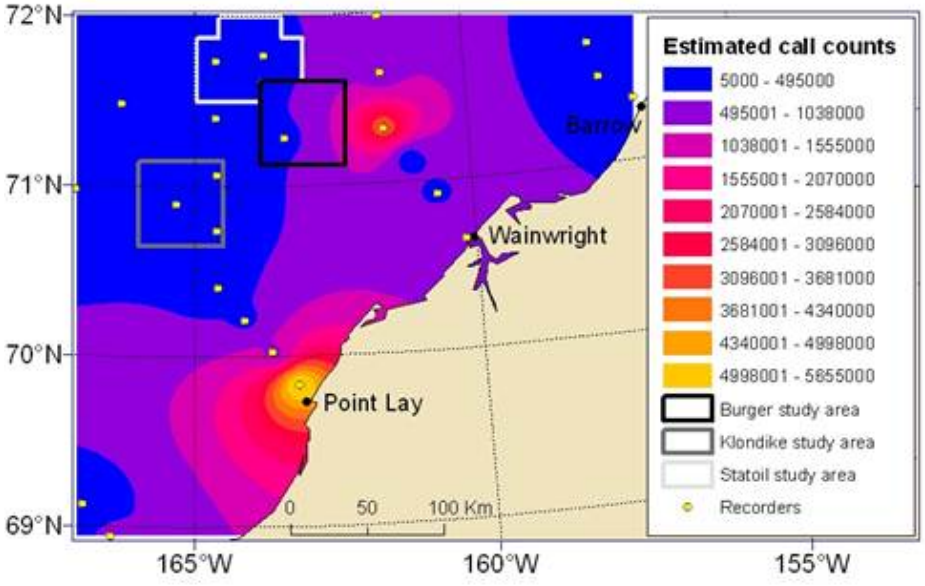


AERTS ET AL. (2012)

WALRUS ACOUSTICS(2009–2011)

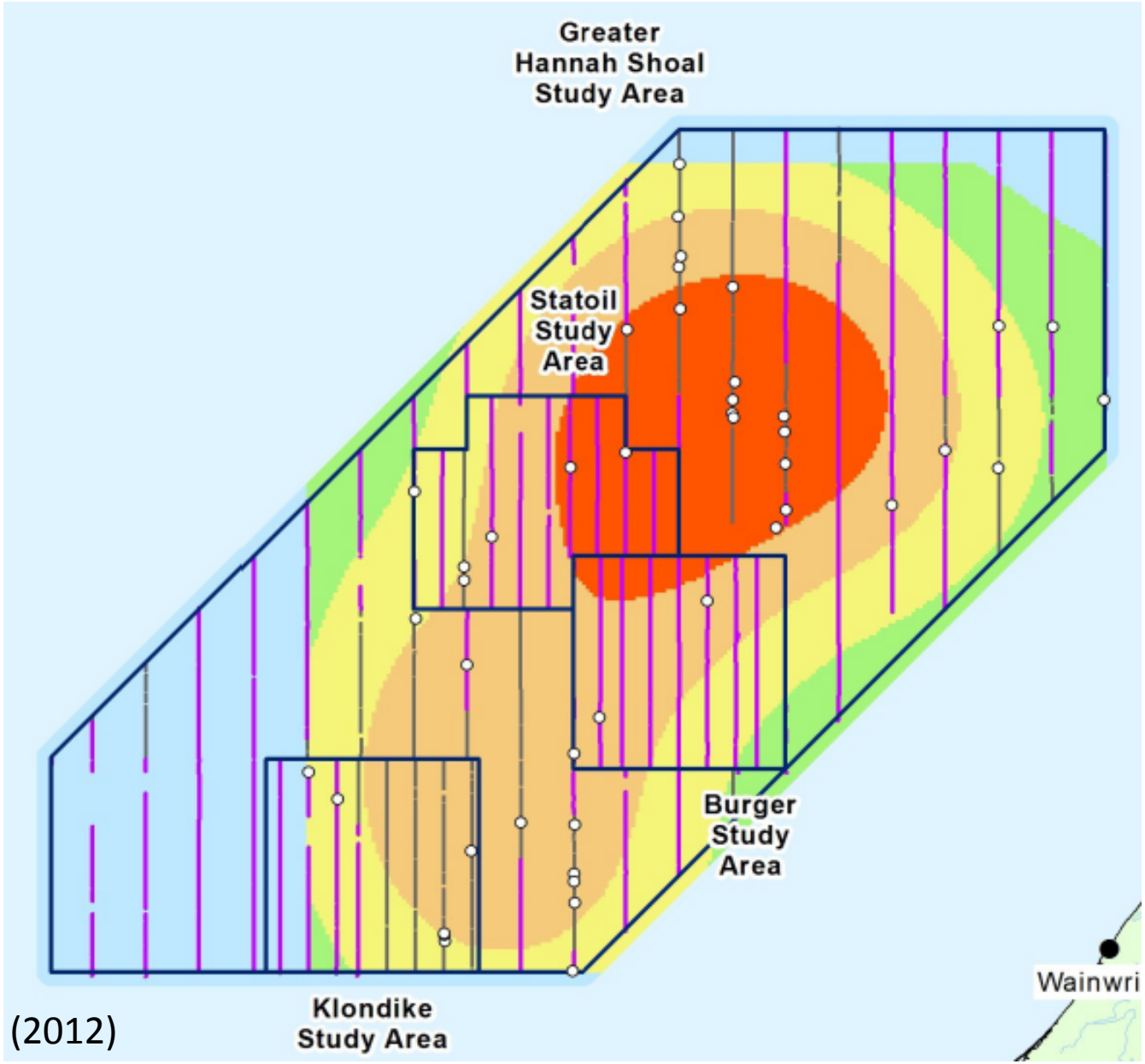






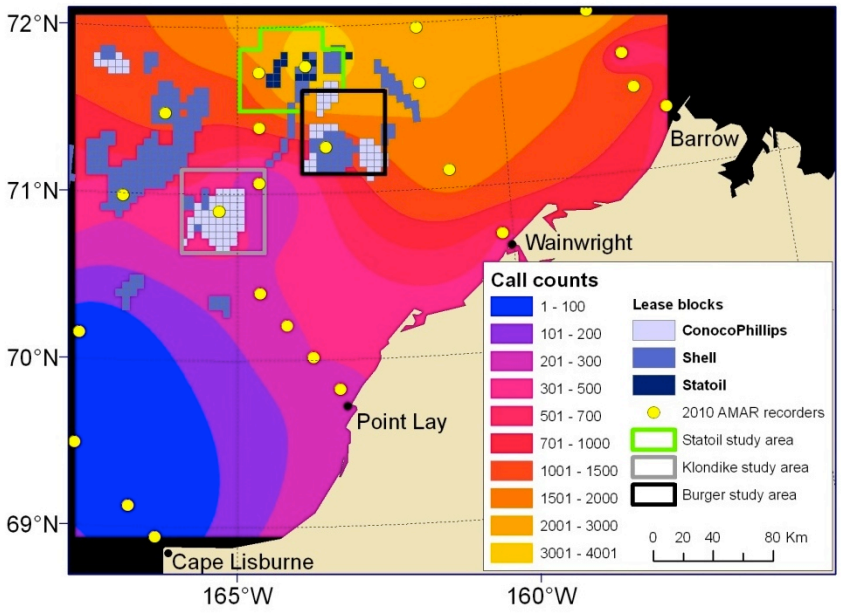
AERTS ET AL. (2012)

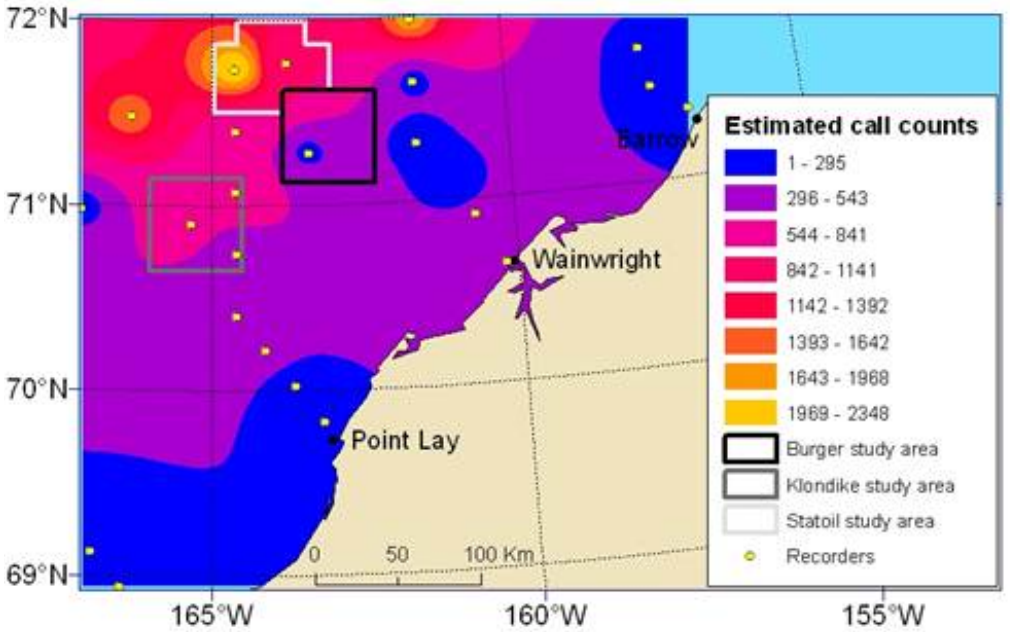
BEARDED SEALS AT SEA (2011)



AERTS ET AL. (2012)

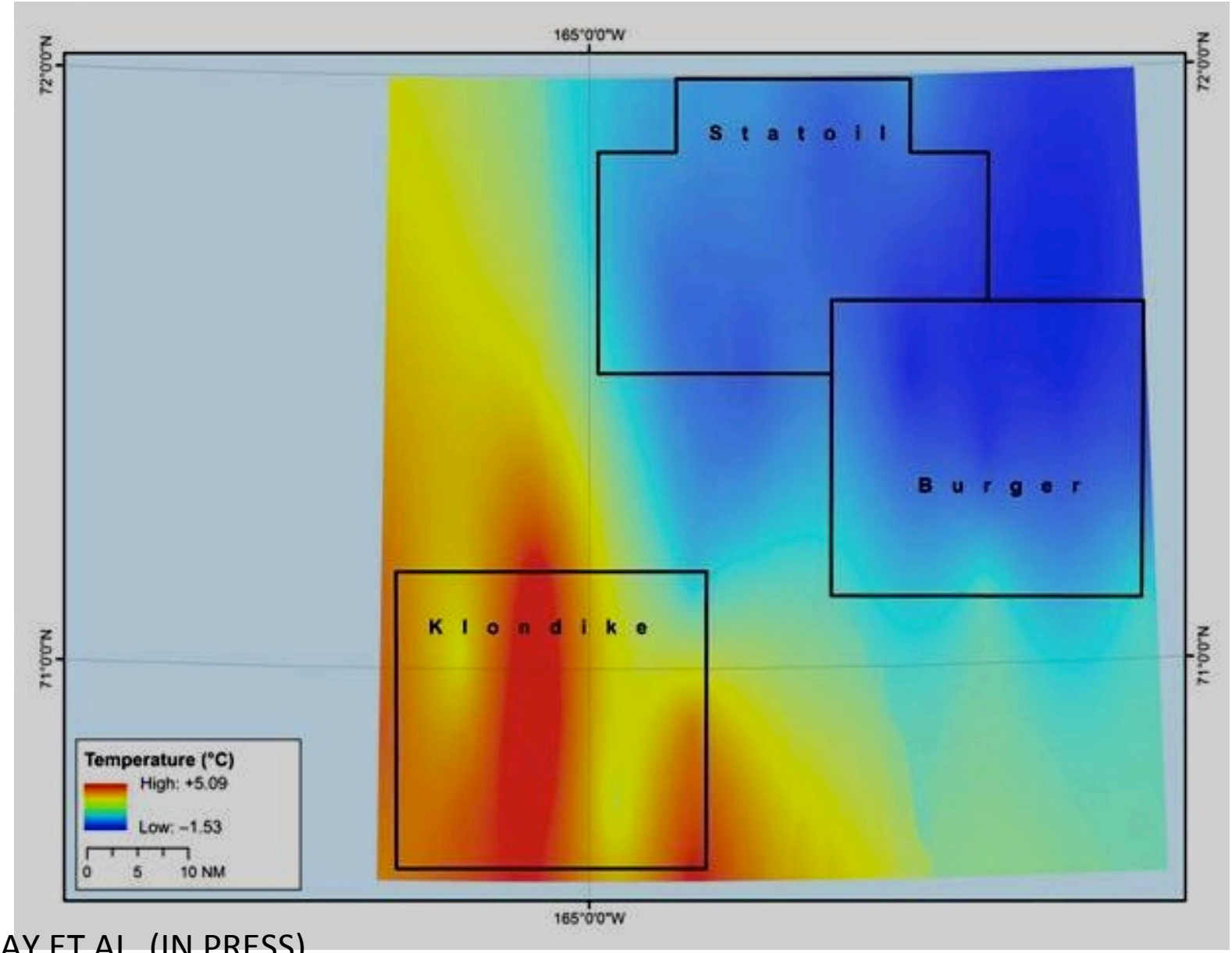
BEARDED SEAL ACOUSTICS (2010–2011)





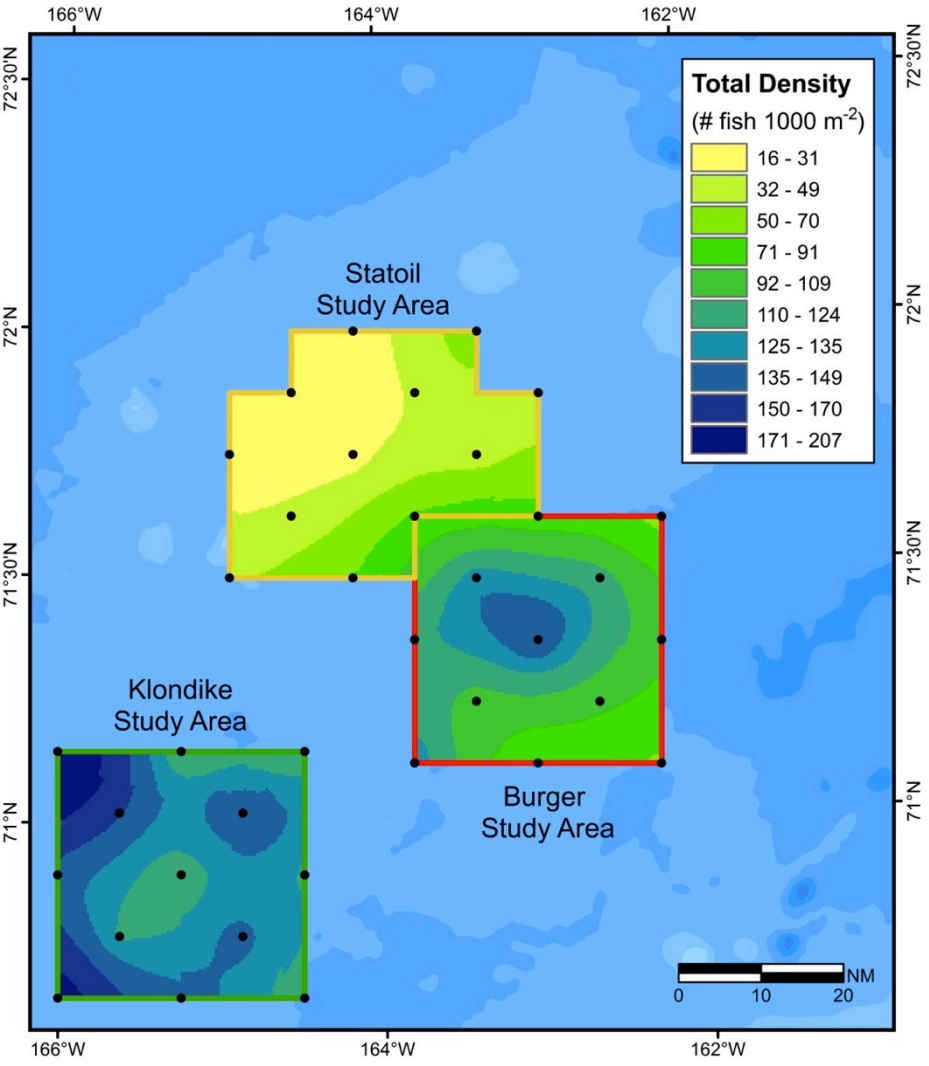
HANNAY ET AL. (2012)

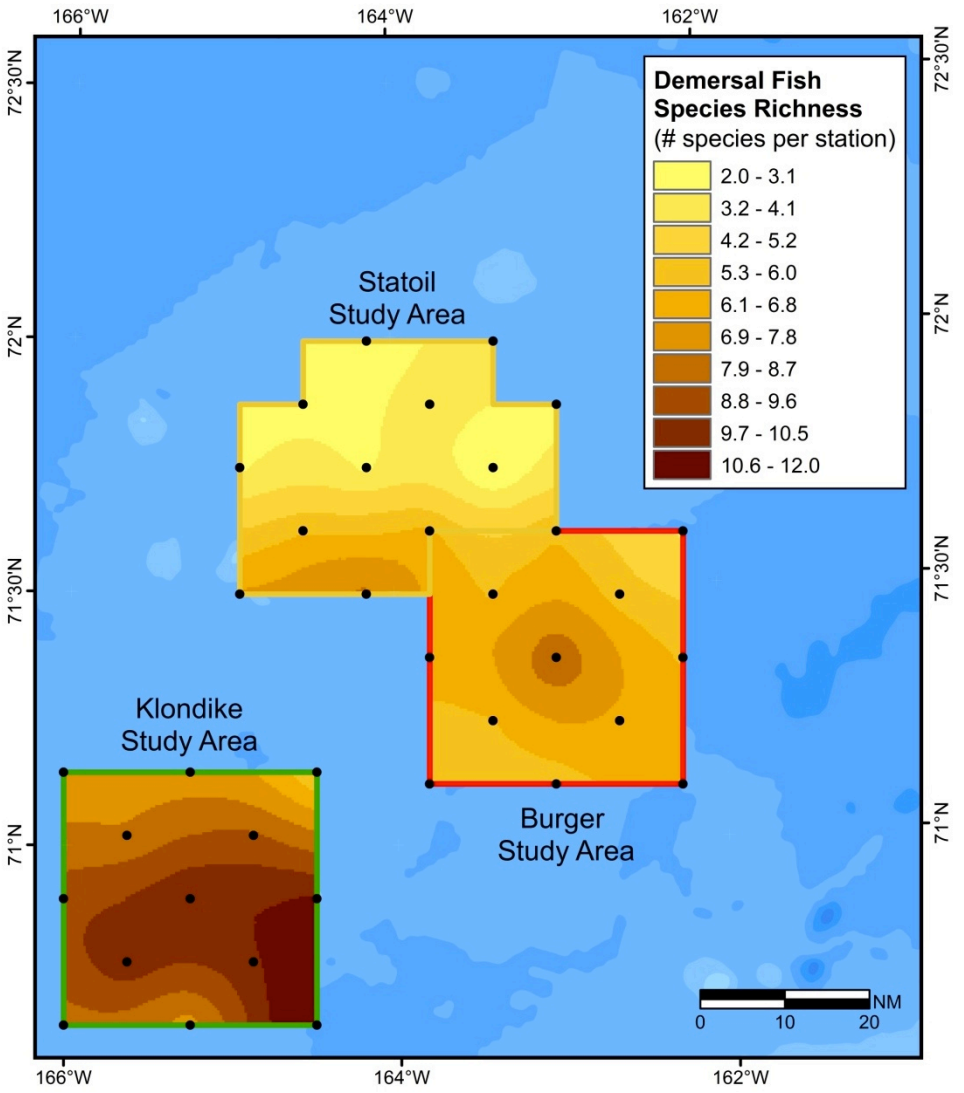
BOTTOM TEMPS (SEP 2010)



DAY ET AL. (IN PRESS)

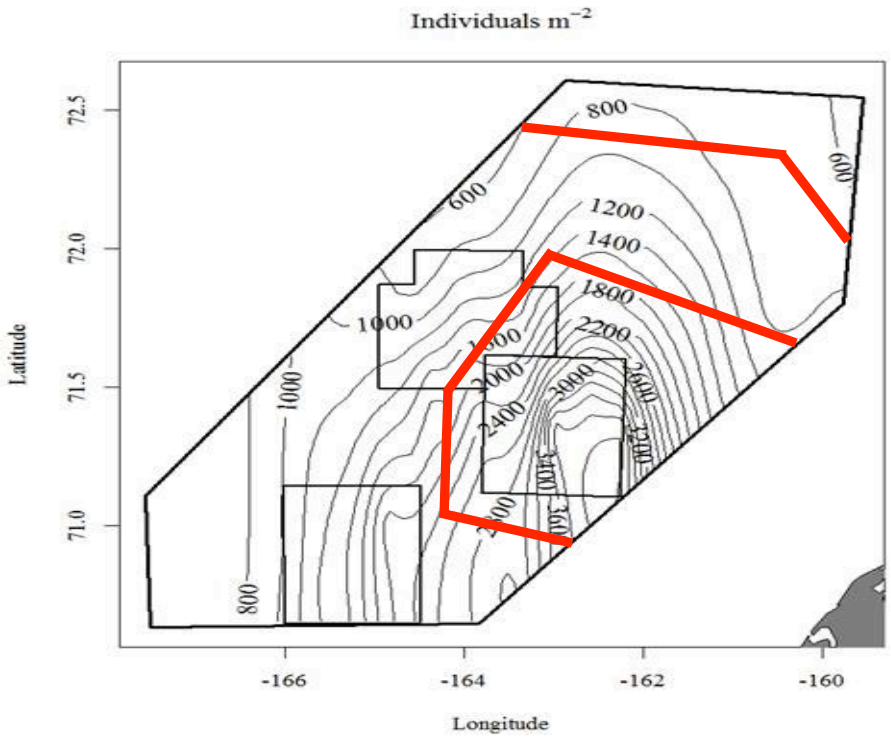
BENTHIC FISHES (2009–2010)

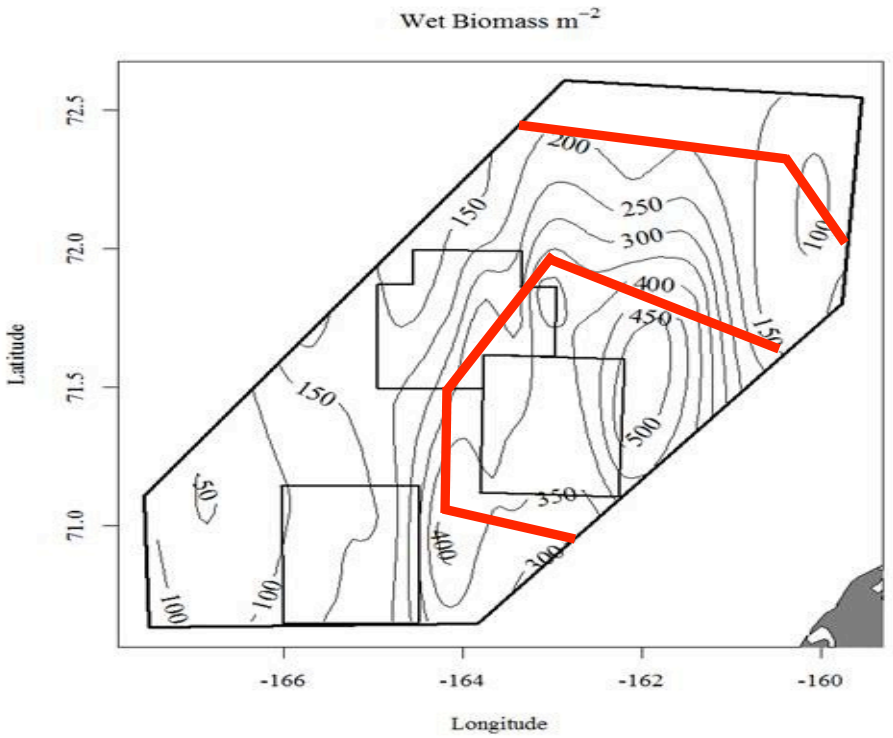




NORCROSS ET AL. (IN PRESS)

MACROFAUNA (2011)

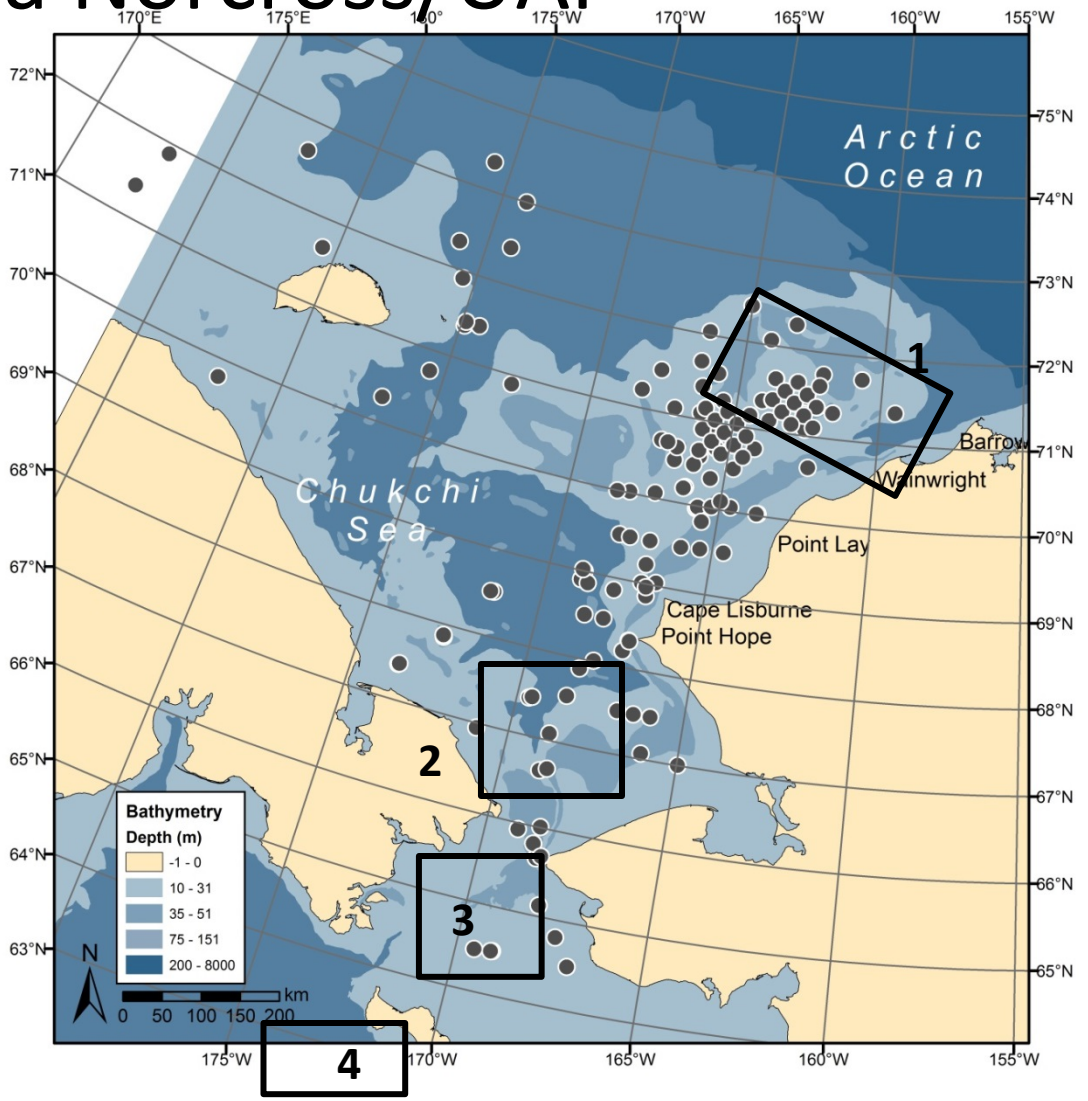




BLANCHARD ET AL. (2012)

Type of data: Fish abundance, biomass, species richness, dominant taxa-Brenda Brenda Norcross/UAF

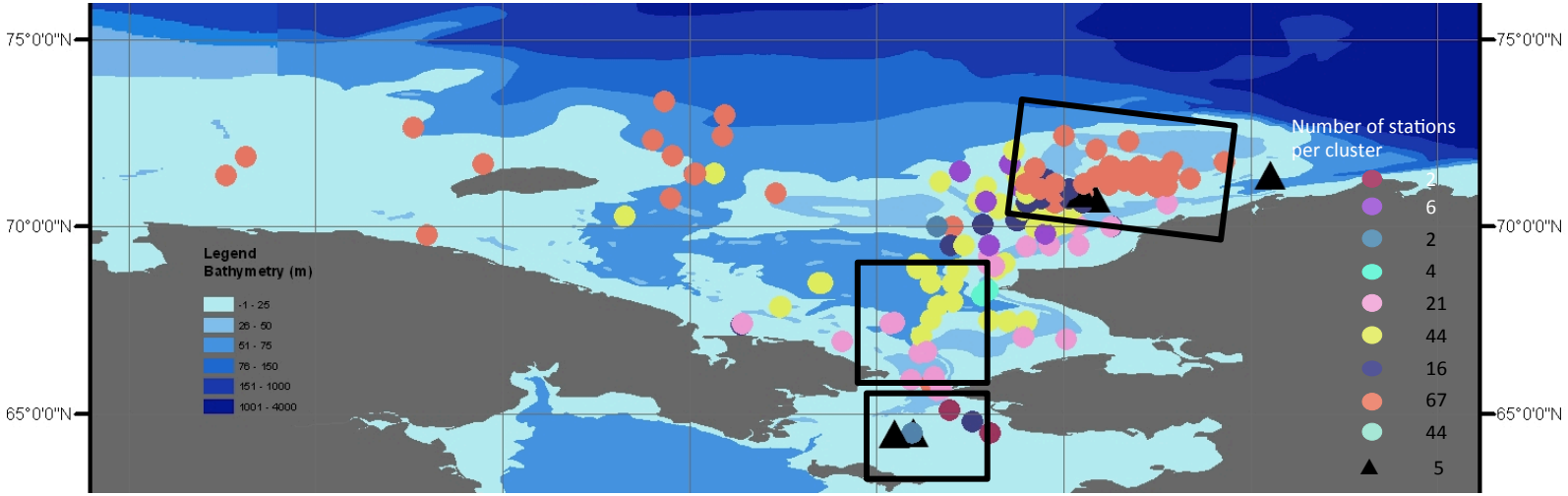
- 1- Barber 1990s, COMIDA 2009, CSESP 2009
- 2- RUSALCA 2004, 2009, 2012, Oshoru Maru 2007, 2008
- 3 – Oscar Dyson 2007
- 4 - none



How

- Plumb-staff beam trawl
- 2.26 m effective opening
- 1-5 min single haul per station
- Typically process entire haul
- For selected species: sizes, diets

Some findings



Norcross, Bluhm e tal in prep. Fish clusters (based on biomass, square root transformed)

- 1 - Northern fishes Arctic cod, stout eelblenny, polar eelpout
- 2 – Nearshore fishes shorthorn, Arctic staghorn sculpins, slender eelblenny; central fishes Bering flounder, Arctic staghorn sculpin, eelblennies

Distribution of demersal fish south and north of St. Lawrencie Island, Alaska

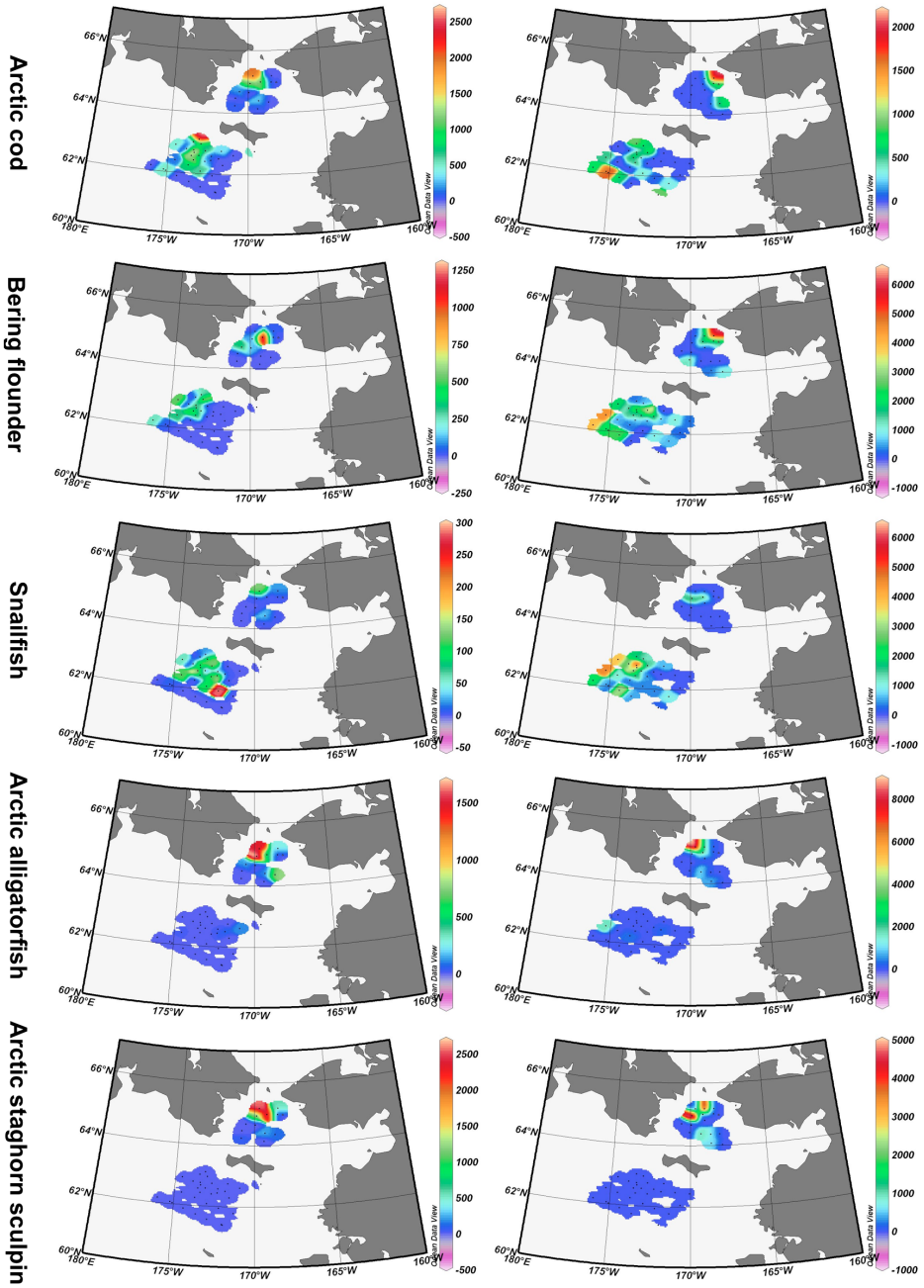


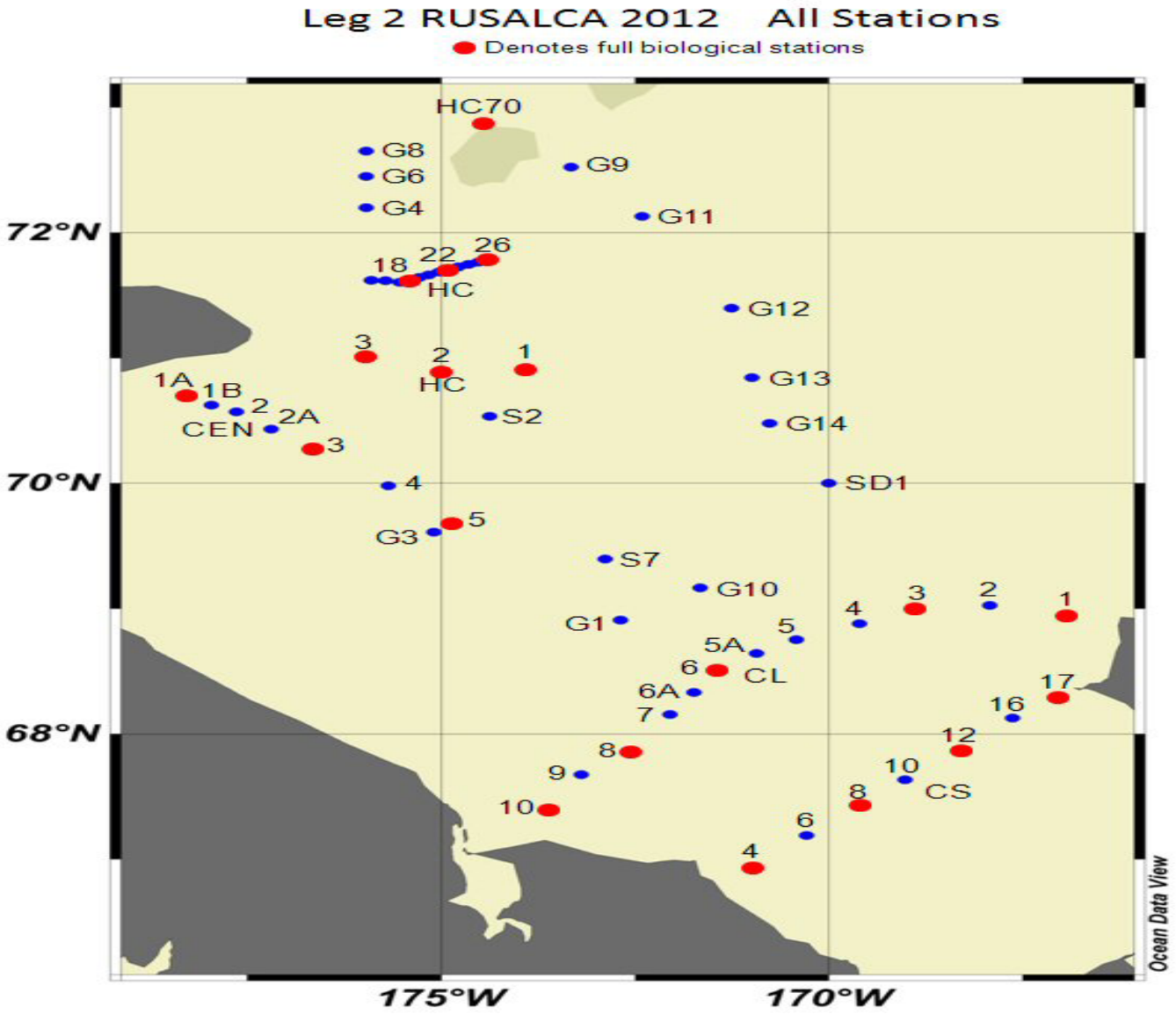
Fig. 7. Spatial patterns of dominant demersal fish abundance in 2006 (left) and 2007 (right). Cold color (blue) represents fish abundance is zero or close to zero, warm color (red) is the highest abundance. Scales on right are number of fish km^{-2}.

[Cui. X., J.M. Grebmeier. L.W. Cooper et al. 2009, MEPS 393:147-160]

Russian-American Long-Term Census of the Arctic (RUSALCA) 2004-2012

Biological cruises – 2004, 2009 & 2012; also BERPAC 1984, 1988, 1993

Terry Whitledge, UAF



Measurements collected in Aug-Sept 2012; also similar data for 2004 and 2009

- CTD – T, Sal, Fluor, DO, ADCP, DOC, Video Plankton profiles
- Water samples – Nuts, Chl, Phaeo, Frac Chl, DIC, DOC, O-18 (~5m intervals
- Phytoplankton – Species, C/N nat abundance, PN, N & C prim, prod
- Zooplankton – Vertical tow, live animal tow
- Sediment – Hap's core, VanVeen grabs (12)
- Benthic epifauna – bottom trawl
- Fish – ecology (juvenile), diversity (adult)
- Mammals
- Birds

Data has just been freed from embargo after cleared by Russian officials

PI meeting is tentatively for May 2013 when data will start to be distributed

Rusalca 2004