Can Northern Fur Seals Tell Us About the Location of and Seasonal Changes in the Bering Sea Cold Pool?

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Background

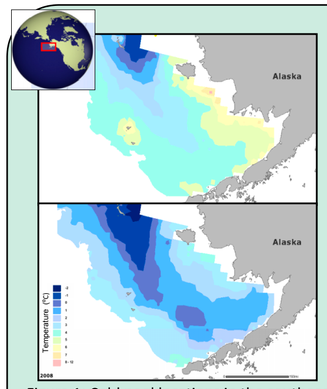


Figure 1: Cold pool locations in the southeast Bering Sea in 2005 (top) and 2008 (bottom) determined from oceanographic surveys.

- In the south eastern Bering Sea, winter sea-ice forms a subsurface pool of cold water (< 2° C) that is maintained into the summer
- The size and location of this cold pool varies annually and it can act as a boundary between arctic and subarctic communities (Fig. 1)
- Each year through oceanographic sampling the location and size of the cold pool is determined, but these studies are limited spatially and temporally

Objective: Test whether northern fur seals can provide information about the location of and seasonal changes in the Bering Sea cold pool

Methods

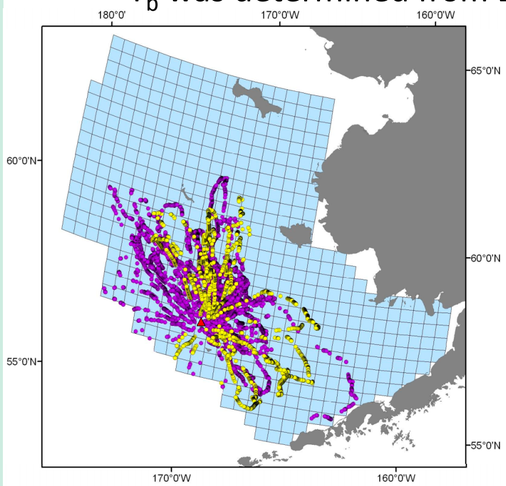
- To test northern fur seals as ocean sensors 34 females were tracked from St. Paul Island in 2007 (Sept.) and 2008 (Aug.-Oct.)
- Each female was equipped with a GPS tracking instrument and dive recorder that measured ambient water temperature (MK10-AF, Wildlife Computers, Fig. 2)
- A dive was selected for analysis if:
  - maximum dive depth was ≥ 75% of the bottom depth, *or*
  - the dive exceeded 50m, *or*
  - the measured bottom temp (T_b) was <2°C
- The NOAA Eastern Bearing Sea survey grid was used to divide the area into 20 x 20 nm sections

Figure 2: A female northern fur seal equipped with tracking instruments.

- For each grid cell, T_b was determined based on the minimum and mean T_b for all dives and then compared to the T_b acquired from oceanographic surveys (RACE: June-July 2007 and 2008, BASIS: Aug.-Oct. 2007 and Sept. 2008, Fig. 3)
- Comparisons were made for all dives within a year and between months with overlapping dive and survey data (BASIS 2007 Sept., BASIS 2008 Oct.)
- Each grid cell was also classified as cold pool present (< 2°C) or absent (≥ 2°C) to compare the size, location, and seasonal changes in the cold pool determined by fur seals and oceanographic surveys

Results

T_b was determined from 17,071 dives



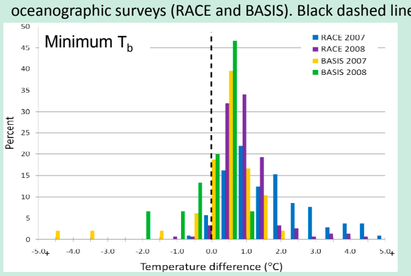
Number of surveyed grids where diving occurred:

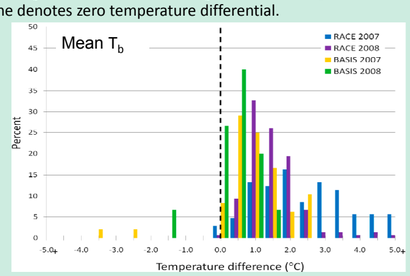
	RACE	BASIS
2007	105	48
2008	150	15

Figure 3: Location of dives used to determine T_b (2007: yellow, 2008: purple) overlaid on the Eastern Bering Sea survey grid. St. Paul is denoted by red triangle in the center.

Minimum T_b from all dives within a cell provided a better fit to oceanographic data than mean T_b

Figure 4: Difference between the min (left) and mean (right) T_b recorded by seals and T_b recorded during oceanographic surveys (RACE and BASIS). Black dashed line denotes zero temperature differential.





- Range: -4.7° C to 6.0° C
- Mean difference: 0.87° C

- Range: -3.7° C to 5.5° C
- Mean difference: 1.44° C

- For BASIS data, 59% of grid cells were within ± 0.5 °C
- Largest differences occurred for RACE data due to temporal differences in sampling (June-July vs. Aug.-Oct., only 30% within ±0.5 °C)

Comparing T_b measured within a month results in reduced differences

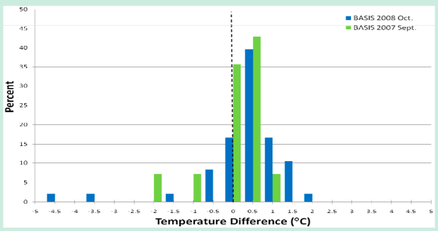
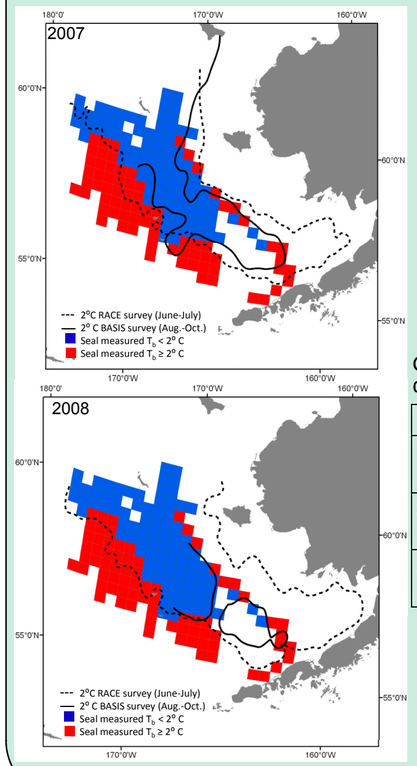


Figure 5: Difference between T_b derived from seals and oceanographic survey T_b during overlapping months. Black dashed line denotes zero temperature differential.

- Range: -4.7°C to 1.8°C
- Mean difference: 0.02°C
- 71.6% of grid cells within in ± 0.5 °C

Results

Cold Pool Location and Seasonal Changes



- All T_b changes occurred along the outside edge of the cold pool
- Trend for increased T_b shows the seasonal reduction in the cold pool between June (RACE survey) and Oct. (seal data)

Grid cell differences between seal derived T_b and survey data:

		RACE	N	BASIS	N
No difference	2007	64%	67	83%	40
	2008	84%	126	80%	13
Seal > Survey	2007	36%	38	13%	6
	2008	15%	22	13%	2
Seal < Survey	2007	0%	0	4%	2
	2008	1%	2	7%	1

Figure 6: Comparisons of cold location between RACE (black dashed line), BASIS (solid line), and seal derived data (colored squares).

Conclusions

- Temperature data collected from fur seals successfully identified the location of the Bering Sea cold pool
- If sufficient sampling occurs, using marine species as ocean samplers can provide insight into environmental conditions in the Bering Sea
- This tool can also be used to define other water column properties in fur seal foraging areas (e.g. thermocline depth, salinity, etc.), which can only add to our understanding of the complex Bering Sea environment

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