FLIR Data Analysis of the Relationship Between Ice Temperature and Body Temperature of Harbor Seals in John Hopkins Inlet, Alaska

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Table of Contents

Table of Figures

Abstract

This study used a Forward-Looking Infrared Radar (FLIR) data set to analyze temperature data of a population of adult harbor seals at John Hopkins Inlet, Alaska. John Hopkins Inlet is located in the Glacier Bay National Park and has the largest aggregations of harbor seals in the state of Alaska. Little is currently known about these seals or their habitat preferences. With analysis of the FLIR radar, data can be used to better understand these Arctic animals and how to better preserve and protect their habitat. Using the FLIR data, individual images with adult harbor seals on ice were extracted using thermal trend lines. Their thermal temperature with corresponding ice temperature was analyzed for the maximum and minimum temperature variation. These maximum and minimum temperatures were then statistically analyzed to determine if there was a relationship and/or potential thresholds that may be used for later classification between ice and seals in infrared data.

Introduction

John Hopkins Inlet is home to the largest population of harbor seals in Glacier Bay National Park (Figure 1). Harbor seals are situated near the top of the food chain, with few predators other than people and polar bears. As such, they serve as health indicators for a marine ecosystem. Though their ecology and population dynamics are not well known, they are a growing topic of conversation and concern in the study of animal conservation and global warming (Duglas, 2010).

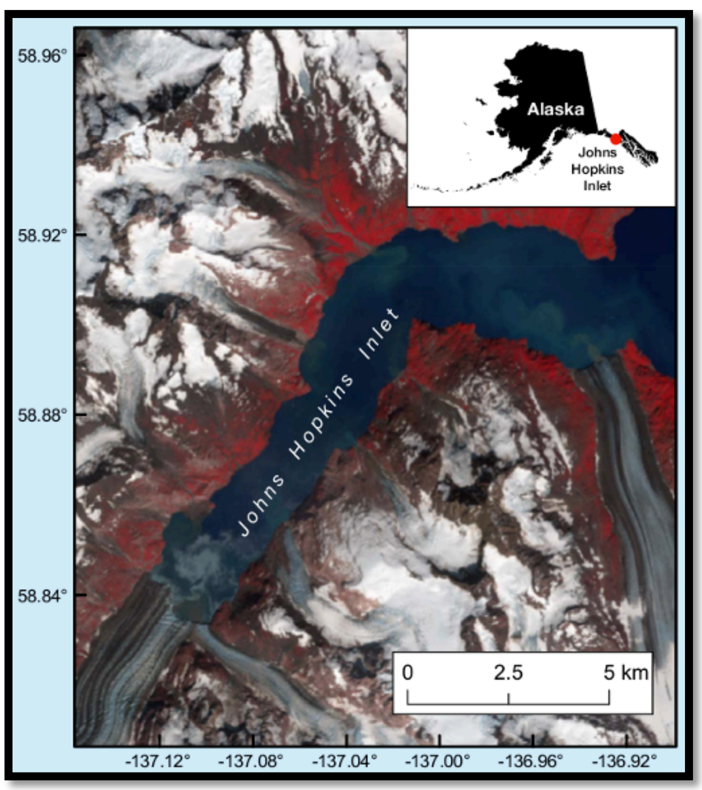

Figure 1: Study area location map of John Hopkins Inlet.
Source: http://harborseals.alaska.edu/

These marine mammals reside in a number of different coastal habitats. Seasonally, however, they inhabit tidewater glacial fjords such as that in the John Hopkins Inlet. Harbor seals haul, or come out of the water, almost daily to rest and be warmed by the sun on icebergs and ice flows. They can not maintain their body temperature if they stay in cold water all the time due to their small size and thin blubber layer ("Harbor Seals"). Thus, the ice flows are a critical part of their habitat: without them the seals would have no place to rest or warm themselves after swimming in Arctic waters. These seals also travel long distances to use the glacial fjord's icebergs to breed, raise pups, and molt, making this ecosystem critical to the life and longevity of harbor seals.

The same data used in this study was previously analyzed to classify harbor seal habitat areas throughout John Hopkins inlet. Therefore, the goal of this study was to look at these same FLIR images of John Hopkins Inlet and answer previously unexplored questions about ice temperature and seal body temperature in a known harbor seal habitat. Using the FLIR data to determine if there is any relationship or potential thresholds that can be used in future reclassification studies between ice and seals in infrared data.

Methods

I processed the FLIR data with ThermaCAM Research Professional 2.9 program. After visually scanning a small portion of the FLIR data I set the temperature bar to fit the absolute max and min of the data set to enhance picture quality. I then picked the Iron color scheme, to allow higher temperatures to stand out as yellow, orange, and reds, while the cooler temperatures were shades of blue, purple, and black. I chose a total of four images from the hours of recorded imagery from the FLIR data (Figures 2-5). In the FLIR data the harbor seals appear as small hotspots and visually stand out against the cooler background temperatures of their habitat. The ThermaCAM program allowed me to isolate these individual images that contained seas and analyze the temperature variations within the image.

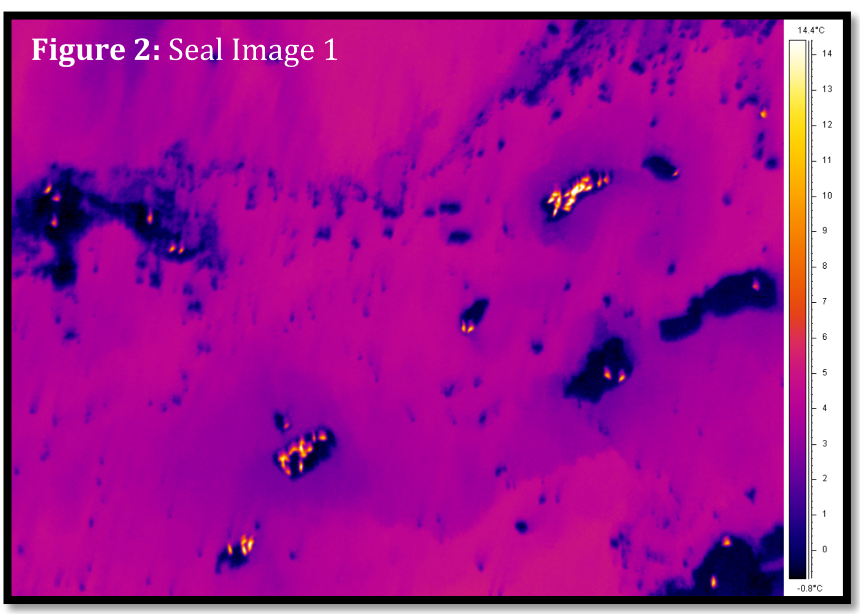

Figure 2: Seal Image 1

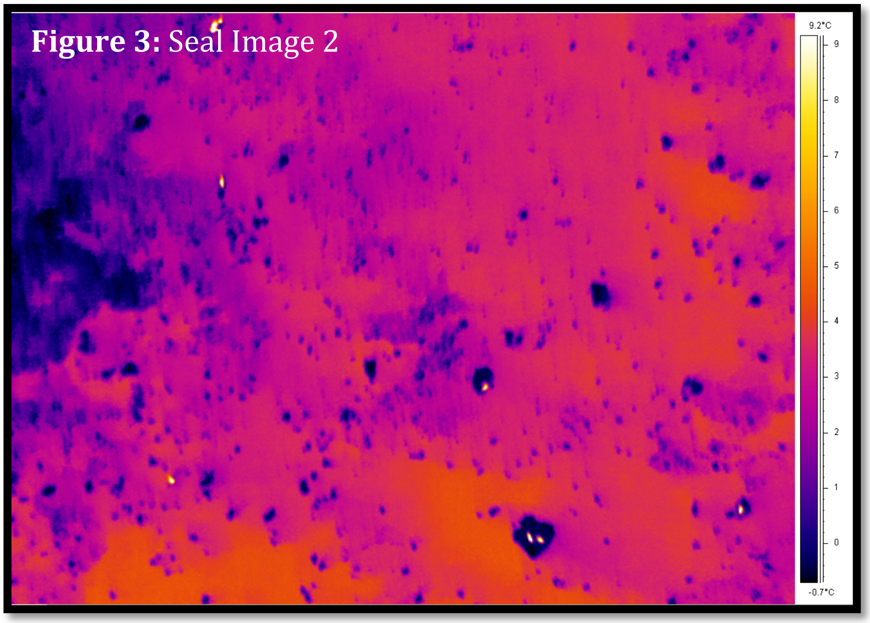

Figure 3: Seal Image 2

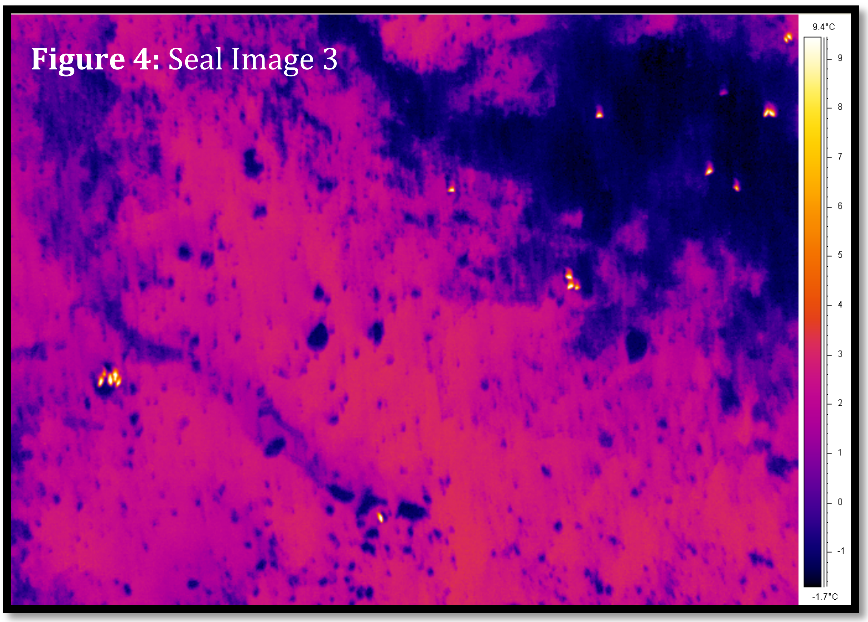

Figure 4: Seal Image 3

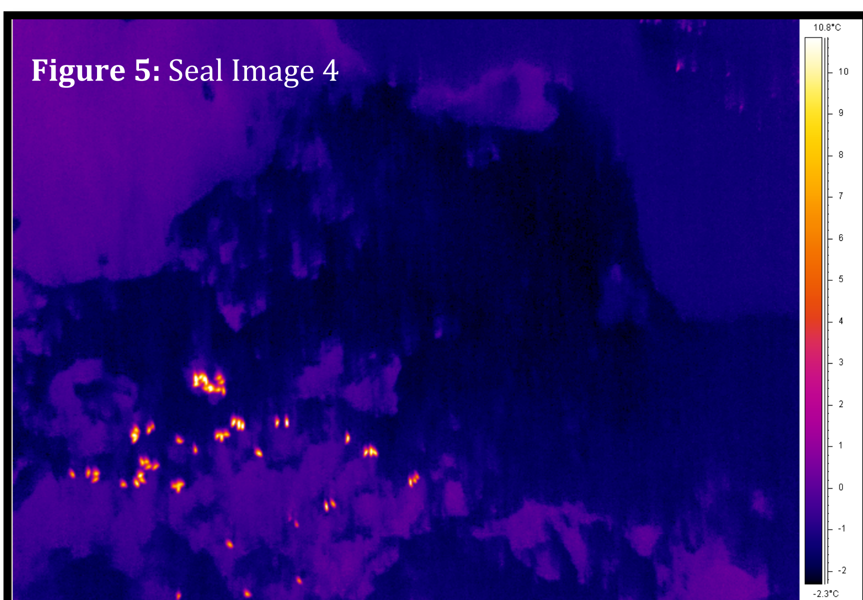

Figure 5: Seal Image 4

After identifying the seals within my four selected images I then began classifying the seals present in the images into categories to determine my specific seals of interest. I initially classified them into two categories: adult seals and pups using visual analysis of the four images. Focusing my attention on only the adult seals, which have much larger bodies and higher temperature profiles than their smaller pups. Then further categorized the image into: adult seals on ice and adult seals in water, using visual analysis (Figure 6)

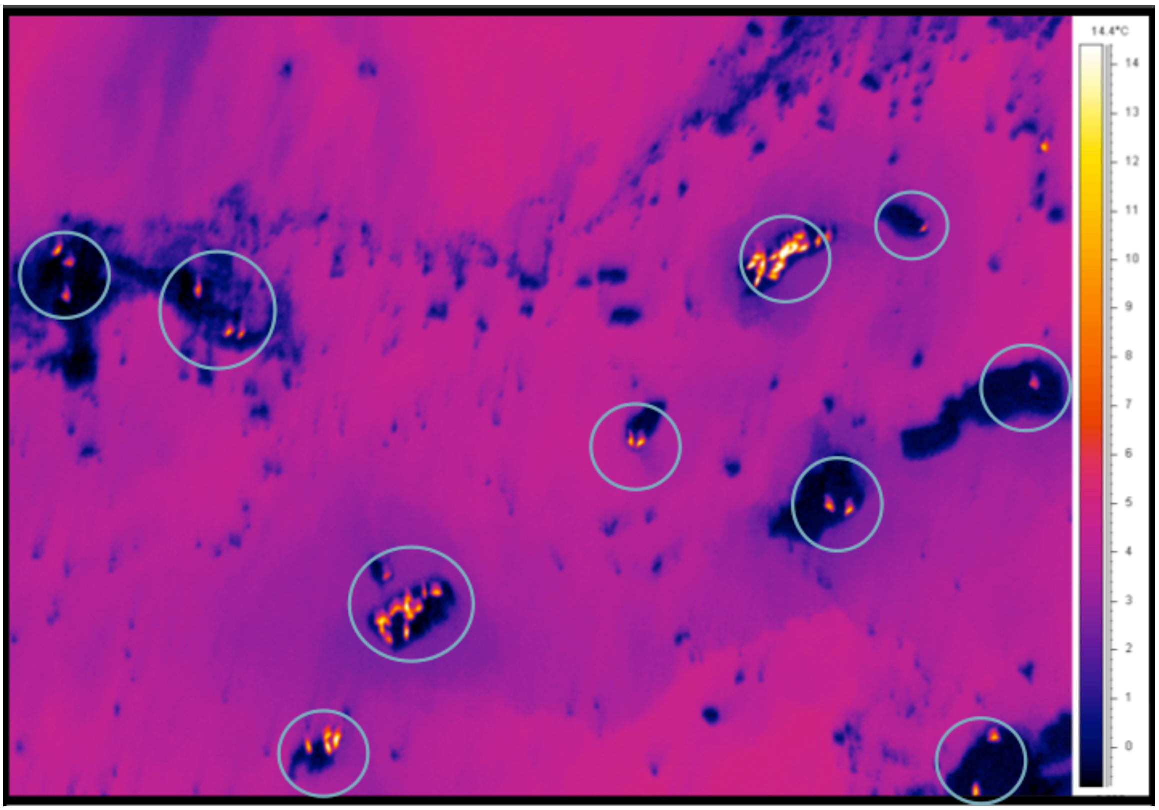

Figure 6: Example of adult seals on ice (circled) from Seal Image 1.

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I then drew thermal sampling lines across only the adult seals on ice (Figure 7). I did this for all four images until I had temperature profiles of over 100 individual seals; I also extended the thermal lines on either side of the seal to include the ice temperature. ThermaCAM Research Professional 2.9 compiled thermal profiles for all of the lines drawn in each individual image (Figure 8). Next, I exported the maximum and minimum temperature for all thermal lines in each of the four images. The maximum temperature displays the highest temperature on the line, the seal body; whereas the minimum temperature present on each data line will show the temperature of the ice body adjacent the seal. These minimum and maximum temperatures were exported and consolidated into Microsoft Excel, where I plotted and statistically analyzed the data for trends within the maximum and minimum temperatures.

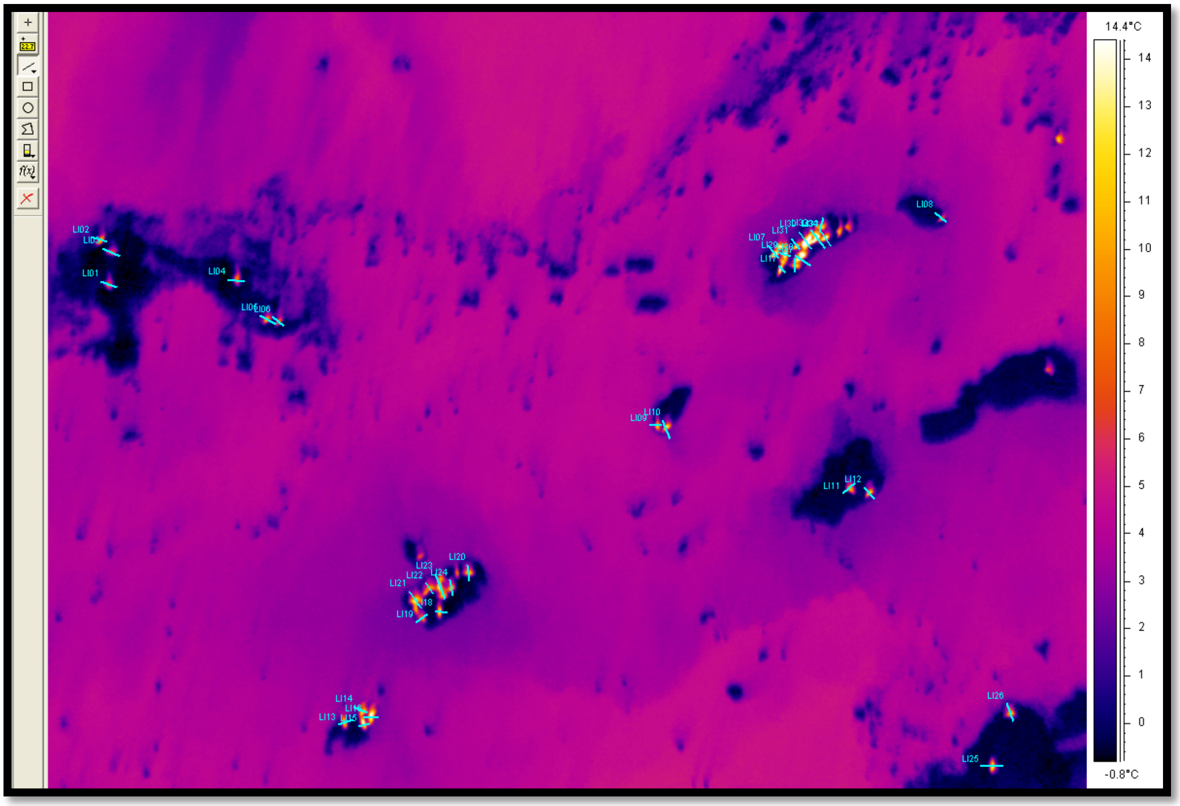

Figure 7: Example of data lines drawn over each individual adult harbor seal on ice with ThermaCAM Research Professional 2.9 using Seal Image 1.

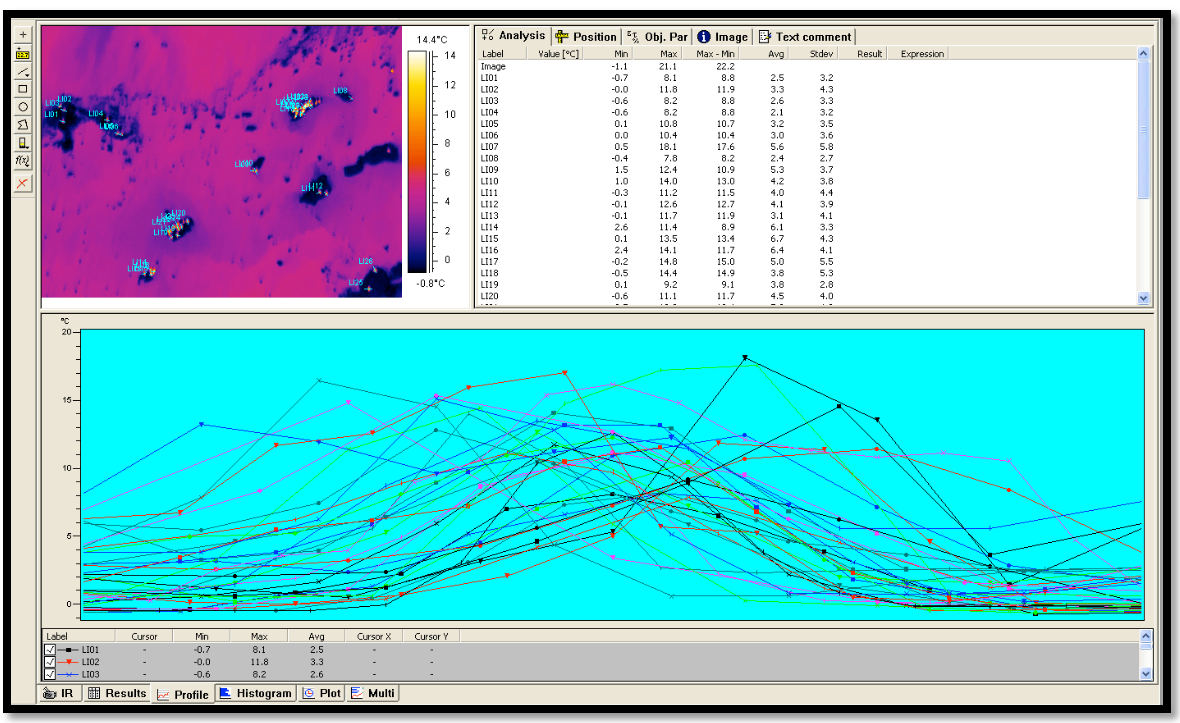

Figure 8: Example of raw numerical data (top right) and compiled thermal profiles of adult seals on ice (bottom) using Seal Image 1.

Results

After compiling the both data sets into a scatter plot graph in Microsoft excel, with the highest temperatures (seal body) in red and minimum temperatures (ice body) in blue, I interpreted the data (Figure 9). It is apparent after looking at the graphed data that there is an easily visible threshold between maximum and minimum temperatures. The Maximum temperatures are contained between 6 and 21 degrees Celsius and the minimum are within -2 and 3 degrees Celsius.

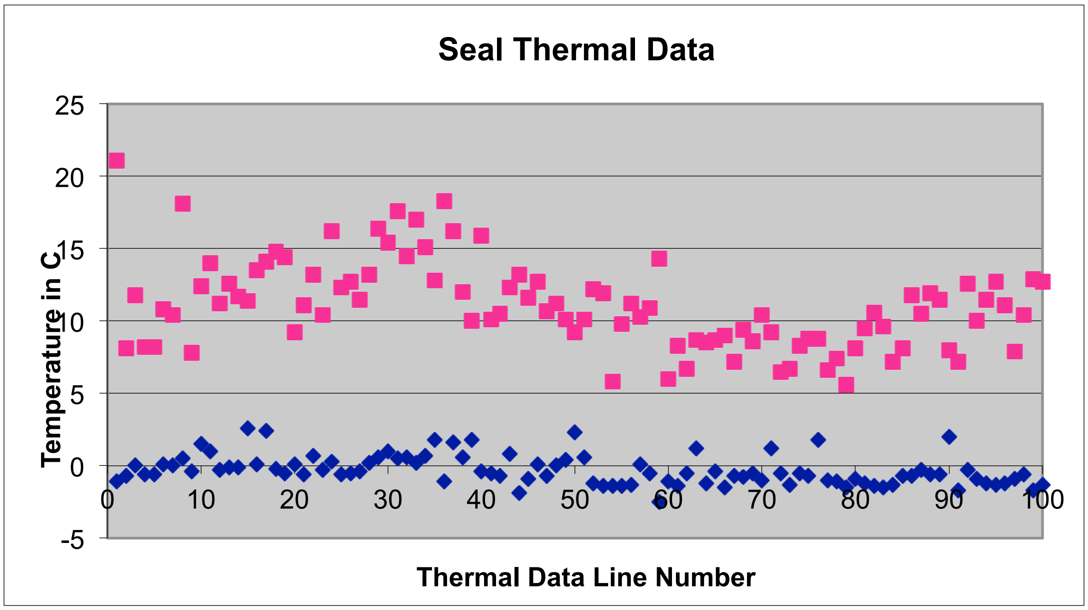

Figure 9: Scatter plot of maximum and minimum temperature of all thermal data lines.

Discussion

The new knowledge that there is a threshold between the seal temperature and their surrounding habitat could be applied in future seal studies using FLIR systems. Rather than visually scanning through hours of recorded FLIR images, one could easily process the data by running a supervised classification via temperature. This would automatically separate images that had seals from those of primarily water, iceberg, or glacier.

In the future I would continue to expand on the data set further by determining if there is a correlation between seal mass and higher thermal temperature. With the presence of sexual dimorphism in seals, where the males of the species are typically larger in size than the females, it might be possible to further categorize the seals into not only pups and adults, but also between male and female seals. The data could also be analyzed for a preference in ice temperatures for seals within their habitat; however, to do this additional data would be needed from outside of their habitat to compare the temperature profiles.

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