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# Monitoring Body Condition of Seals in Alaska: Phase III - Test Data Collection

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# Monitoring Body Condition of Seals in Alaska: Phase III - Test Data Collection

## 2023 Uncrewed Aerial Surveys at University of California Santa Cruz

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## INTRODUCTION

Environmental conditions in the subarctic and Arctic have been changing rapidly during recent decades, with warming temperatures and declining sea ice. Ice-associated seals depend on sea ice for critical life history events, including pupping, breeding, and molting (Boveng et al. 2009, 2013; Cameron et al. 2010). The need to develop additional methods to survey and monitor body condition of ice-associated seals is becoming more urgent as warming in the subarctic and Arctic has been occurring faster than in other parts of the world (Rantanen et al. 2022). Ecological changes due to warming conditions will propagate throughout the Arctic food web resulting in potentially substantial changes affecting Arctic marine mammals (Mueter et al. 2021). Body condition is a key indicator of population health and productivity, but traditional methods of capturing and measuring individuals to assess body condition are challenging and expensive. Recent studies have indicated that body condition of ribbon and spotted seal pups sampled in the Bering Sea in spring declined during 2007-2018 (Boveng et al. 2020). The ability to monitor body condition of ice-associated seals using traditional methods is limited and environmental conditions are changing rapidly; thus, developing new methods to expand the numbers of animals being monitored is increasingly important.

In 2020, the Polar Ecosystems Program began a project to develop non-invasive, low-disturbance methods for monitoring body condition of Arctic seals using photogrammetry with small, uncrewed aircraft systems (sUAS) to collect imagery of seals in the wild and greatly increase the numbers of seals that can be assessed for body condition. A key component of this work was to develop a model that can be used to estimate body mass to use in an index for body condition (i.e., mass/length). To develop this model, we used an sUAS to collect imagery of captive bearded (*Erignathus barbatus*), ringed (*Phoca hispida*), and spotted (*P. largha*) seals, which were weighed and measured regularly at the captive facilities. Measurements of the captive seals have been taken from the UAS imagery to build the model, and known measurements of the captive seals will be used to validate the model. We completed the first two phases of this project in 2020-2022, during which we researched sUAS, purchased an sUAS, and collected images of captive seals and seals in the wild.

In 2021 and 2022, we used an sUAS to collect imagery of captive spotted, ringed, and bearded seals at the Alaska SeaLife Center (ASLC) and Long Marine Laboratory at the University of California Santa Cruz (UCSC). We obtained UAS images of the seals in seven different body positions at different altitudes from which we extracted measurements to use in a model to estimate body condition. Due to equipment issues during the initial site visit, much of the data collected at UCSC were compromised and we are unable to use them in our analyses. These data included imagery of the only captive bearded seals available for our study, which are critical to the ability to build a model to estimate body mass for this species. We returned to UCSC in July 2023 to re-collect imagery of the seals to complete the dataset of UAS images and measurements. In this report, we describe the activities that we conducted in July 2023 at UCSC to collect the remaining captive seal imagery needed to complete model development to estimate body condition of Arctic seals.

## METHODS

### Fieldwork Objectives

The primary objective of this work at UCSC was to collect images of female ringed seal (Nayak) and male bearded seal (Noatak) in seven body positions using the same DJI Mavic 2 Enterprise Advanced (M2EA) and the Lightware SF20/C LiDAR rangefinder (LRF) that were used to obtain images of seals and range (altitude) data at the ASLC in 2022. Secondary objectives were to collect images of the seals using a new sUAS, the DJI Matrice 30T (M30T) and to conduct acoustic tests with the M2EA and M30T to measure noise levels associated with each sUAS.

## UAS Flights

The primary objective at UCSC was to collect images of the seals using the same sUAS, LRF, and protocol that we used for the earlier flights at ASLC to obtain comparable images from both locations that can be used to develop a model to estimate body condition. To achieve this objective, we used the M2EA and the LRF that were used at ASLC to take images of Nayak and Noatak at the seven altitudes (50, 75, 100, 125, 150, 175, 200 ft) and in the seven body positions chosen for this project (down, down-c, roll (half), roll (half)-c, relaxed, alert, roll (full)) (Fig. 1). We used the same LRF that was used at ASLC to measure the altitude of the sUAS above the seals; the LRF measurements enabled us to calculate a more accurate ground sampling distance than if we used the GPS altitude provided by the M2EA.

In 2022, we purchased the M30T, and a secondary objective of the fieldwork at UCSC was to take images of the captive seals with the M30T to test the new system, learn how it operates, and collect imagery and data to evaluate how it could be used for future projects. The M30T has capabilities that are not available with the M2EA, including an integrated LRF and optical zoom levels, so we used a slightly different protocol to collect images with the M30T. We took images of the seals using the same seven positions, but we took photos from eight altitudes (100, 125, 150, 175, 200, 250, 300, 400 ft), three of which were different from those used with the M2EA. We also took images to test different optical zoom levels. At each altitude, we took images using 2×, 5×, and 20× zoom.

Another secondary objective was to conduct calibrated acoustic measurements with the M2EA and the M30T to assess noise levels of the sUASs and potential disturbance to seals. Acoustic recordings and measurements were made with the drone directly overhead at a range of altitudes (50-400 ft) using a calibrated Brüel and Kjær 2270 sound level meter/recorder. The sound level meter was positioned at 0 degrees (on-axis) with the microphone 53 cm off the ground (seal height). The substrate was compacted earth/gravel and the weather was clear with light wind. A custom black-and-white scale bar was positioned next to the microphone setup to ensure known elevation of the sUAS during acoustic measurements.

## Personnel

NOAA, AFSC: Gavin Brady, Stacie Koslovsky, Heather Ziel

UCSC: Colleen Reichmuth, Maddie Meranda, Brandi Ruscher

## Summary of Field Activities

Details about daily survey operations and notes about protocols, data, equipment, and issues encountered each day are summarized below.

Monday, July 10, 2023

- Travel from Seattle to UC Santa Cruz.
- While preparing to start afternoon surveys, we realized that the LRFs had been left in Seattle. Rather than flying surveys immediately with the M30T drone, we opted to focus on getting the LRFs to Santa Cruz ASAP. Gavin and Heather identified a solution of having the LRFs sent to San Jose airport using a time-sensitive express delivery service so it could be picked up the morning of July 11th.

Tuesday, July 11, 2023

- Weather summary:
  - Morning fog impacted our ability to operate above 250-300 ft.
  - After the fog burned off, it became breezy. We waited for the seals to be ready and for the winds to die down a bit before conducting afternoon flights.

- Conducted 8 flights using M30T; completed all positions and altitudes for Noatak and completed down and down-C at all altitudes for Nayak.
  - fl01.
    - Test flight to evaluate altitudes at which seals responded to the noise of the drone.
    - Based on the seal's response, we opted to only conduct M30T flights over seals at 100 ft and above.
  - fl02 - Noatak (down).
    - Unable to fly above 250 ft due to fog.
    - Ended flight early due to issues with sea gull attacking the drone.
    - Although the data look okay, it is likely that the LRF was not engaged on this flight, so we should not use these data.
  - fl03 - Noatak (down-C and down).
    - Started operations at 300 ft due to fog; able to fly to 400 ft by end of session due to fog clearing.
    - The LRF was not engaged on this flight, and there are some erroneous range values in the EXIF data.
  - fl04 - Nayak (down).
    - LRF was engaged halfway through the flight; the data collected after look as expected.
    - Strong wind warnings at the end of the flight.
  - fl05 - Noatak (half roll and half roll-C).
    - Took 10× zoom (instead of 20× zoom) photos at 100 ft because Noatak was not completely in the frame.

        - The LRF *was* engaged on this flight, but there are some erroneous range values in the EXIF data.
    - fl06 - Noatak (relaxed and alert).
        - Took 10× zoom (instead of 20× zoom) photos at 100 ft because Noatak was not completely in the frame.
        - LRF was engaged, and LRF values look as expected.
    - fl07 - Noatak (full roll and down).
        - Took 10× zoom (instead of 20× zoom) photos at 100 ft because Noatak was not completely in the frame.
        - LRF was engaged, and LRF values look as expected.
    - fl08 - Nayak (down-C).
        - LRF was engaged, and LRF values look as expected.
- LRF was picked up at San Jose airport by some of Colleen's students (Noah and Carson) and brought back to Santa Cruz.
- After morning flights (fl02-fl05) over seals, we reviewed data and identified some potential issues:
    - Data management will be different for M30T data for several reasons:
        - There are three images taken simultaneously. The EXIF data for each are slightly different. Images taken together have the same number and are distinguished based on the _W(Wide)/T(Thermal)/Z(Zoom) at the end of the file name.
        - Each image has a different focal length. So where we were able to apply one correction to the focal length in tbl_aircraft in the DB for the M2EA images, we will need to apply the focal length and any potential correction factor to each of the three M30T images separately.

        - Need to consider how we want to manage/store data for the two different drones separately. How will images be named (consecutive numbering throughout the data or by drone). How will data be stored in the DB for each (two different tables?).
    - Need to decide what zoom level is optimal for each altitude.
    - Need to decide what images we want to collect (wide, zoom, and thermal).
    - If the LRF is not "engaged", LRF values are still being written to the EXIF metadata.
        - Need to further explore if there is a way to know the LRF was not engaged for those images.
        - Need to identify ways to QA/QC LRF data, since we do not have a continuous stream of information like we do with the M2EA setup.
        - Perhaps add a checkbox to the datasheet (and in turn the DB) to confirm LRF was engaged -- as an extra check and for data quality control, and add a note to engage the LRF to the preflight checklist.
- Despite potential issues in the data, we opted to complete image collection for Nayak and Noatak in all the positions using the M30T. We decided what we collected using the M30T drone that day would be the entirety of what we'd collect. We were hesitant to hold off on further data collection since we were there, the seals were ready to work, and we could only fly the M30T at that time. But we decided that since we were unable to evaluate the data in the field -- and since we had found some items in the data that needed more investigation -- we would not continue collecting data using this drone once we started surveying with the M2EA and LRF, since collecting data with the M2EA was the primary objective of the trip.

- Other M30T notes.
    - In order to collect 48MP images, have to set the camera to collect images in 8K in the camera settings in Pilot 2; we did not do this for some flights so images from those flights were collected as 12MP.
    - The zoom level (e.g., 5x, 10x) is not recorded in the EXIF data; focal length is recorded, from which zoom level can be calculated.
    - Each battery provided 20-25 minute flights.
    - Spare lithium-ion batteries for the M30T can be taken in carry-on on Alaska Airlines, but are limited to 2 per person.
- Flight notes with the M30T.
    - Taking 3 images at 3 different zoom levels took longer than taking 3 images with the M2EA; mean duration of M2EA flights (n = 9) was 13:27; mean duration of M30T flights (n = 7) was 18:48.
    - Flying the M30 and moving it to the correct altitude was smooth and easy.
    - Not always easy to hear a sound or see the image change on the controller to indicate when a picture is being taken.

<u>Wednesday, July 12, 2023</u>

- Weather summary.
    - Morning fog did not impact our operations because we only flew the M2EA up to 200 ft (as opposed to ideally up to 400 ft for the M30T).
    - After the fog burned off, it became breezy. We waited for the seals to be ready and for the winds to die down a bit before conducting afternoon flights.

- Conducted 7 flights using M2EA and LRF; completed all positions and altitudes for Noatak and Nayak.
  - fl01 - Noatak (down and down-C)
    - Drone was set to GMT+1 in order for times to be recorded in actual GMT (this was the case for all subsequent flights, as well).
  - fl02 - Noatak (half roll and half roll-C).
  - fl03 - Nayak (down and half roll).
  - fl04 - Noatak (relaxed, alert and full roll).
  - fl05 - Nayak (down-C).
    - Drone looked much lower than expected when approaching the 75 ft altitude.
    - Unable to survey at 50 ft because the drone would have been too low.
    - Pilot reported the drone was reading 27 ft at landing.
  - fl06 - Nayak (relaxed and alert).
    - High wind messages during flight.
  - fl07 - Nayak (half roll-C and full roll).
- Data issues
  - Confusing setting re: drone to GMT – need to look into this further!
  - More issues with the drone drifting off the altitude target, like we experienced in Seward, AK, last summer.

<u>Thursday, July 13, 2023</u>

- Weather summary.
  - Very foggy morning, but it burned off quickly; we had a slight delay to our start as a result of this, but we able to complete all our objectives for the day.

- We evaluated field reports of data, decided we wanted to re-do data collection (as detailed below) due to issues with the altitude:
    - Noatak: down and down-C.
    - Nayak: down-C.
- Conducted two flights using M2EA and LRF -- the drone looked to be at the appropriate altitude when at 50 ft, so we assumed all data collection was good for these flights!
    - fl01 - Noatak (down and down-C).
    - fl02 - Nayak (down-C).
- Completed acoustic test flights for the M2EA and M30T before calling it a wrap!
    - fl03 - M2EA.
    - fl04 - M30T.
- Transit home to Seattle.

## RESULTS AND DISCUSSION

Details about the daily activities and results of each flight conducted are described above in the Summary of Field Activities. We completed all flights with the M2EA to obtain images for both Noatak and Nayak in all positions and at all altitudes on July 12-13. On July 12, we conducted seven flights and completed flights for all positions and altitudes for both seals. However, after reviewing the data collected, we found that a couple flights had problems with the altitudes, so we decided to redo flights for two positions for Noatak and one position for Nayak. We completed those flights on July 13, and the altitude data looked reasonable. We collected all the imagery and data we needed to complete the dataset to develop a model to estimate body condition in two days and with nine flights with the M2EA.

On July 11, we conducted flights and collected imagery of the seals with the M30T. The objective with the M30T was to test the system and collect imagery and data to determine how it could be used in future projects. After we conducted five flights and collected imagery using the modified protocol for the M30T, we identified several issues with data collection and data management that are different from the M2EA. These issues are described in detail in the July 11, 2023 daily summary. We determined that the data from the M30T differed enough from what is collected with the M2EA that we needed to decide how to manage data from the two systems separately, instead of integrating the M30T data into the database with the M2EA data. We flew three more flights that day with the M30T to further test the system and collect more data to help with evaluating how it can be used for future projects. We flew it once more at UCSC for the acoustic testing. The imagery that we collected with the M30T will not be used for the body condition project.

We completed the acoustic testing for noise levels of the two sUASs on July 13. The drones were flown directly over the recording instruments and paused at intervals between 50-400 ft and 50-300 ft for the M30T and M2EA, respectively, to collect noise level profiles. The calibrated measurements of noise associated with ambient outdoor conditions at Long Marine Laboratory and with the M30T (Fig. 2) and the M2EA (Fig. 3) indicate that noise from both of the sUASs overlaps with the range of best hearing for Arctic seals. Although the M30T is substantially louder than the M2EA, both systems make noise that is discernible above background ambient noise at distances up to 300-400 ft. Conditions during these acoustic tests were as controlled as possible and are likely different from ambient noise levels in the field; however, these tests demonstrate that these sUASs make noise within the range of hearing for Arctic seals and above ambient sound levels. Thus, noise disturbance from sUASs should be recognized and considered when planning UAS surveys with Arctic seals.

We successfully collected the data at UCSC that we need to complete the development of a model to estimate body condition of Arctic seals, which is the final objective of the project. Validation data describing directly measured body condition for each seal was provided by the UCSC team.

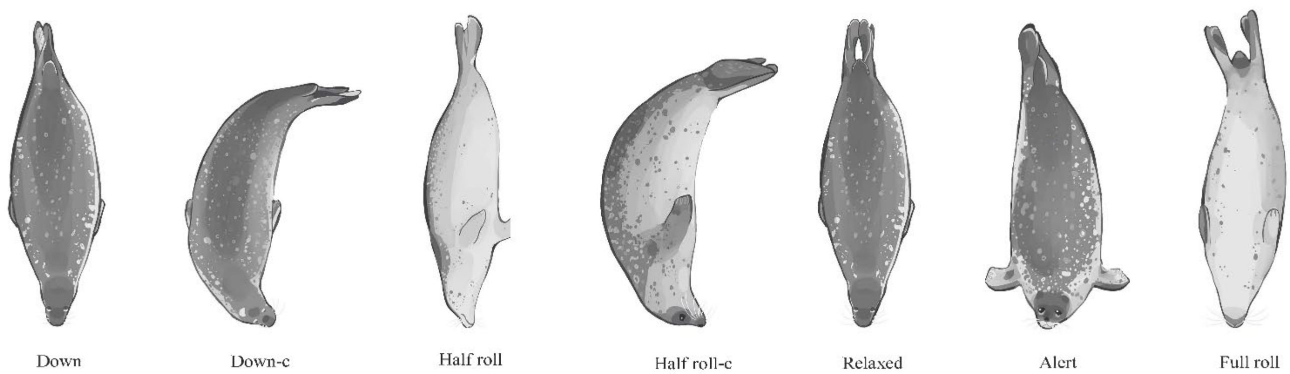


Figure 1. -- Seal body positions in images taken with UAS

Figure 1. -- Seal body positions.

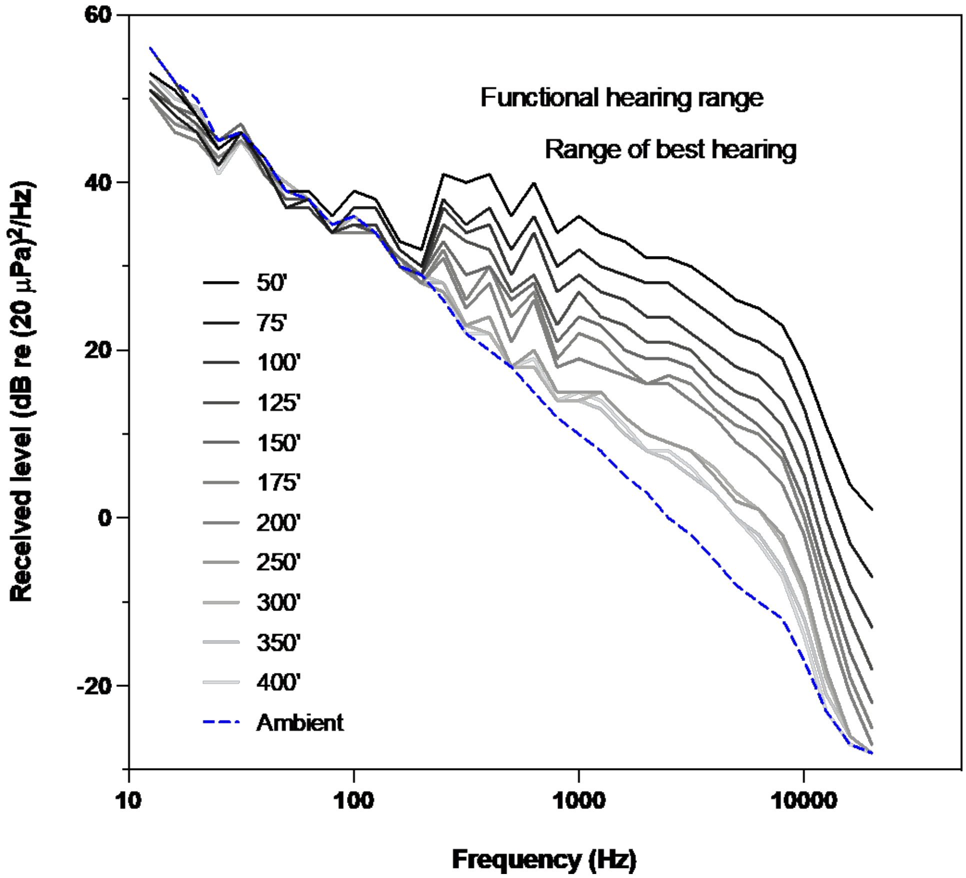


Figure 2. -- Calibrated measurements of noise associated with ambient outdoor conditions at Long Marine Laboratory and the DJI Matrice 30T drone, holding at fixed positions ranging from 50 ft to 400 ft above the sound recorder.

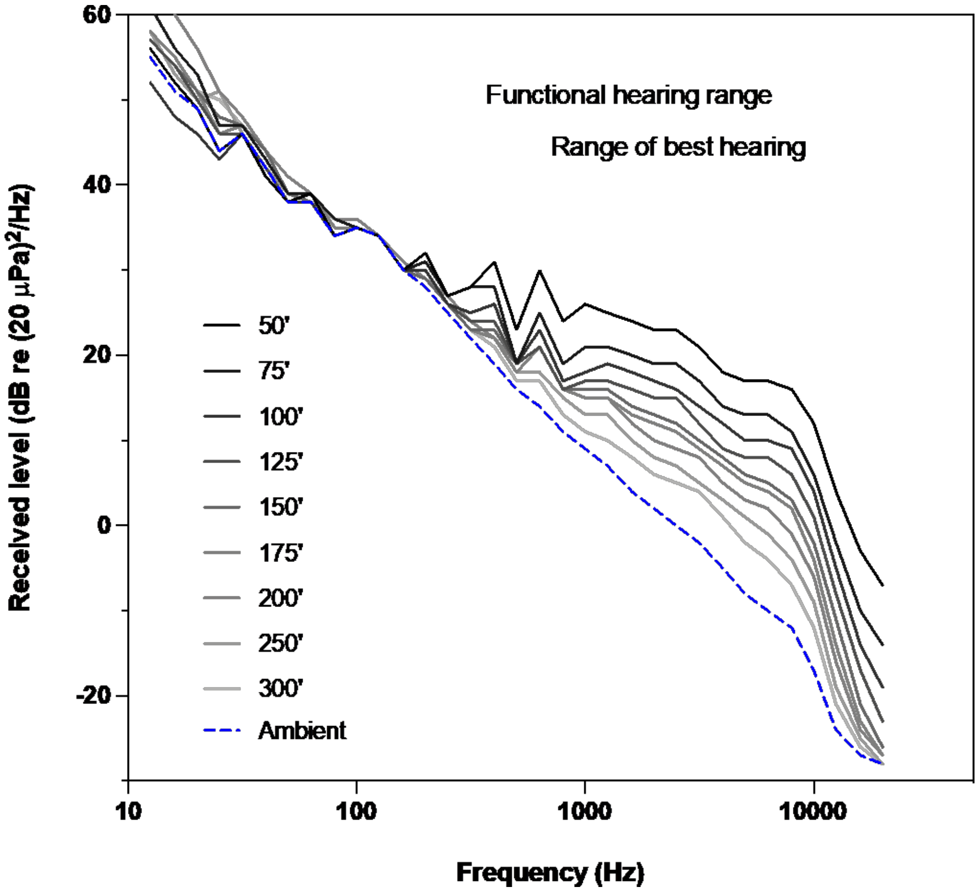


Figure 3. -- Calibrated measurements of noise associated with ambient outdoor conditions at Long Marine Laboratory and the DJI Mavic 2 Enterprise Advanced drone, holding at fixed positions ranging from 50 ft to 300 ft above the sound recorder.

## ACKNOWLEDGMENTS

We are grateful to everyone at Long Marine Laboratory at UCSC for the extensive support during our trip. We especially thank Colleen Reichmuth, Maddie Meranda, and Brandi Ruscher -- we would not have been able to accomplish all of our objectives and collect the data needed to complete the UAS body condition project without the immense help they provided. This project would not have been possible without the support of Michael Cameron, the AFSC’s Polar Ecosystems Program Lead.

## CITATIONS


Boveng, P. L., Bengtson, J. L., Buckley, T. W., Cameron, M. F., Dahle, S. P., Kelly, B. P., Megrey, B. A., Overland, J. E., & Williamson, N. J. 2009. Status review of the spotted seal (*Phoca largha*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-200, 153 p.

Boveng, P. L., Bengtson, J. L., Cameron, M. F., Dahle, S. P., Logerwell, E. A., London, J. M., Overland, J. E., Sterling, J. T., Stevenson, D. E., Taylor, B. L., & Ziel, H. L. 2013. Status review of the ribbon seal (*Histriophoca fasciata*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-255, 174 p.

Boveng, P. L., Ziel, H. L., McClintock, B. T., & Cameron, M. F. 2020. Body condition of phocid seals during a period of rapid environmental change in the Bering Sea and Aleutian Islands, Alaska. Deep Sea Research Part II: Topical Studies in Oceanography 104904. https://doi.org/10.1016/j.dsr2.2020.104904

Cameron, M. F., Bengtson, J. L., Boveng, P. L., Jansen, J. K. (John K., Kelly, B. P., Dahle, S. P., Logerwell, E. A., Overland, J. E., Sabine, C. L., Waring, G. T., & Wilder, J. M. 2010. Status review of the bearded seal (*Erignathus barbatus*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-211, 246 p.

Mueter, F. J., Planque, B., Hunt Jr, G. L., Alabia, I. D., Hirawake, T., Eisner, L., Dalpadado, P., Chierici, M., Drinkwater, K. F., & Harada, N. 2021. Possible future scenarios in the gateways to the Arctic for Subarctic and Arctic marine systems: II. Prey resources, food webs, fish, and fisheries. ICES Journal of Marine Science 78(9): 3017–3045.

Rantanen, M., Karpechko, A. Y., Lipponen, A., Nordling, K., Hyvärinen, O., Ruosteenoja, K., Vihma, T., & Laaksonen, A. 2022. The Arctic has warmed nearly four times faster than the globe since 1979. Communications Earth & Environment 3(1): 1–10.

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