Developing a UAS-Based Approach for Surveying Northern Fur Seals in Alaska

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Principal Investigator: Katie Sweeney
U.S. Department of Commerce
NOAA Fisheries Alaska Fisheries Science Center
Marine Mammal Laboratory

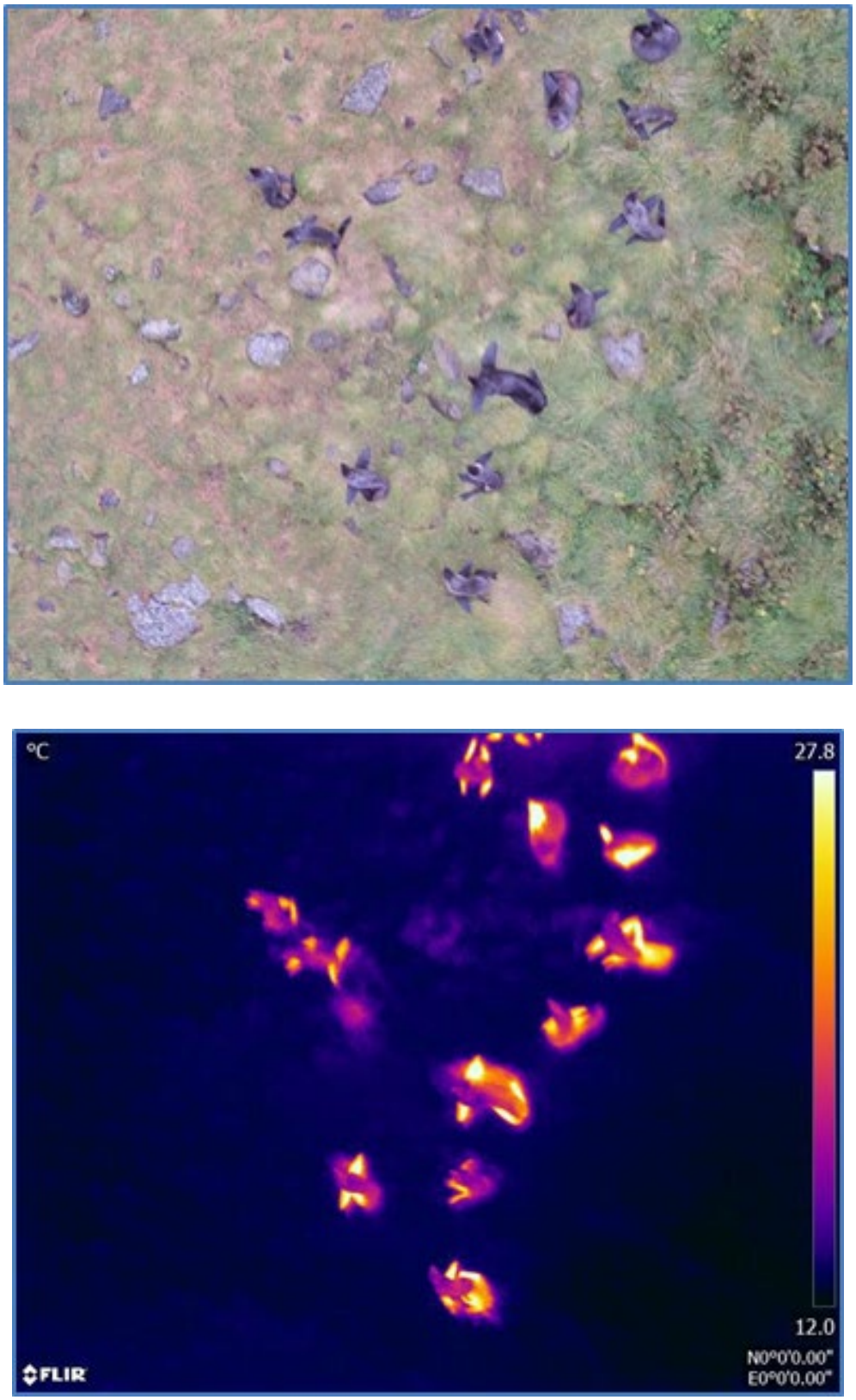
Aerial photo of northern fur seals and Steller sea lions captured with the APH-28 hexacopter during aerial surveys on Bogoslof Island, AK, an active volcano.

The northern fur seal population in the Pribilof Islands, Alaska has experienced drastic declines. In 2018, St. Paul Island fur seals reached the lowest pup production levels since 1915, while pup abundance in the Pribilof Islands has declined 50 percent since 1998. It is imperative that NOAA Fisheries continue to monitor and document this decline to identify potential threats to recovery and inform management decisions. Currently, population estimates are derived from biennial pup abundance surveys and are conducted on the ground, requiring the participation of more than 20 researchers and support staff for up to 21 days. This method is costly, labor intensive, and involves

disturbing the entire population of fur seals on both islands—an estimated 100,000 pups and many more adults and juveniles.

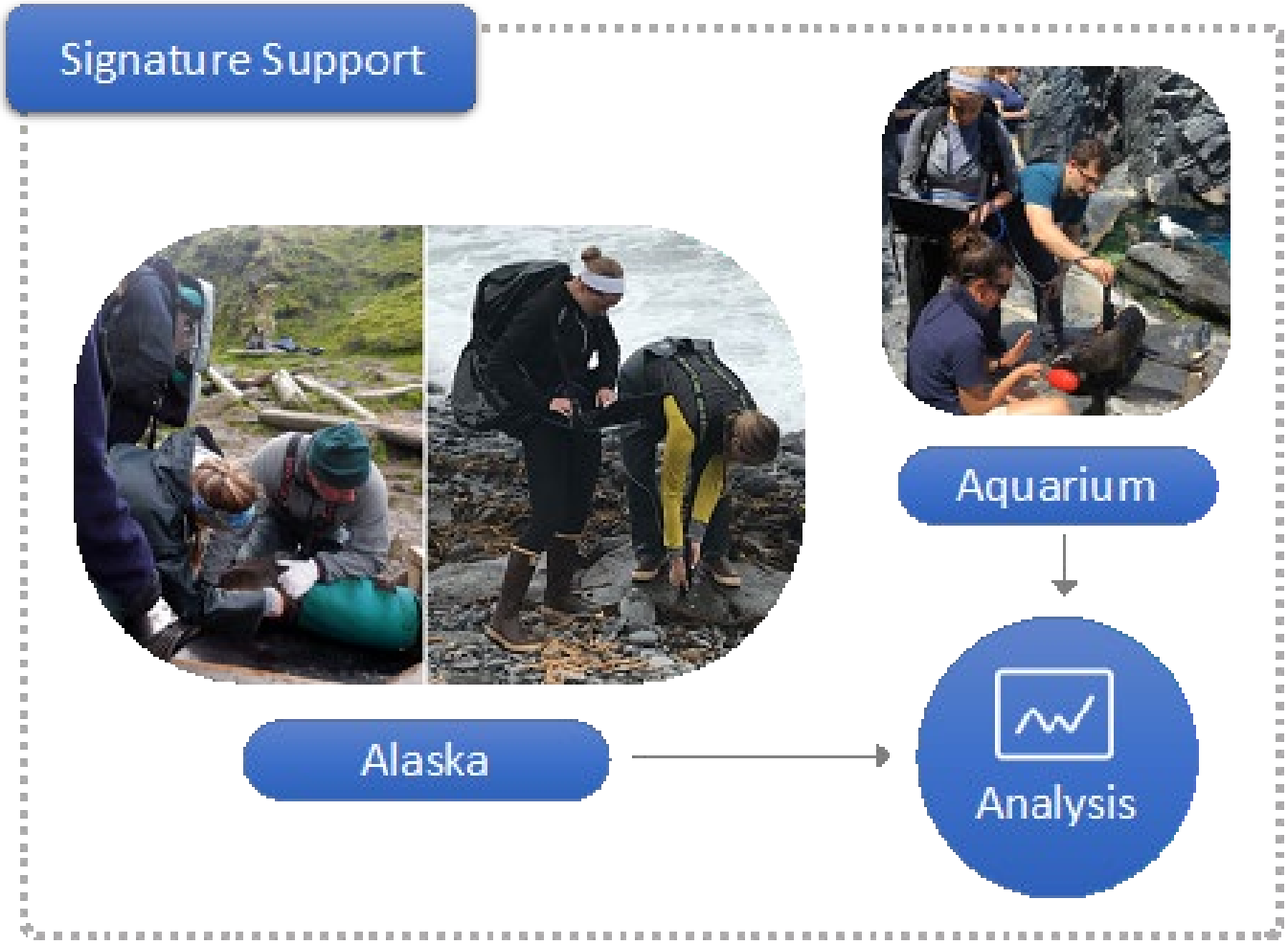
The ground survey team shearing pups for the mark-recapture abundance assessment.

In partnership with the UAS Program Office, NOAA Alaska Fisheries Science Center's Marine Mammal Laboratory (MML) is working towards developing a survey approach using unmanned aircraft systems (UAS). Past UAS testing efforts showed that traditional visual imagery is not sufficient for counting seal pups. In 2018, the UAS Program Office provided funding to procure a heavy lift UAS (Aerial Imaging Solutions APH-28 hexacopter) and FLIR DUO Pro R thermal sensor to conduct aerial surveys and compare the data taken by visual and thermal images with ground-based estimates collected with the traditional survey method. The heavy lift UAS provides for longer flight times and ability to carry heavier payloads. In 2019, MML used this system with a visual camera to conduct aerial surveys to compare with ground-based survey estimates (NOAA Fisheries has published a blog series on these efforts; read the first and second posts to learn more).



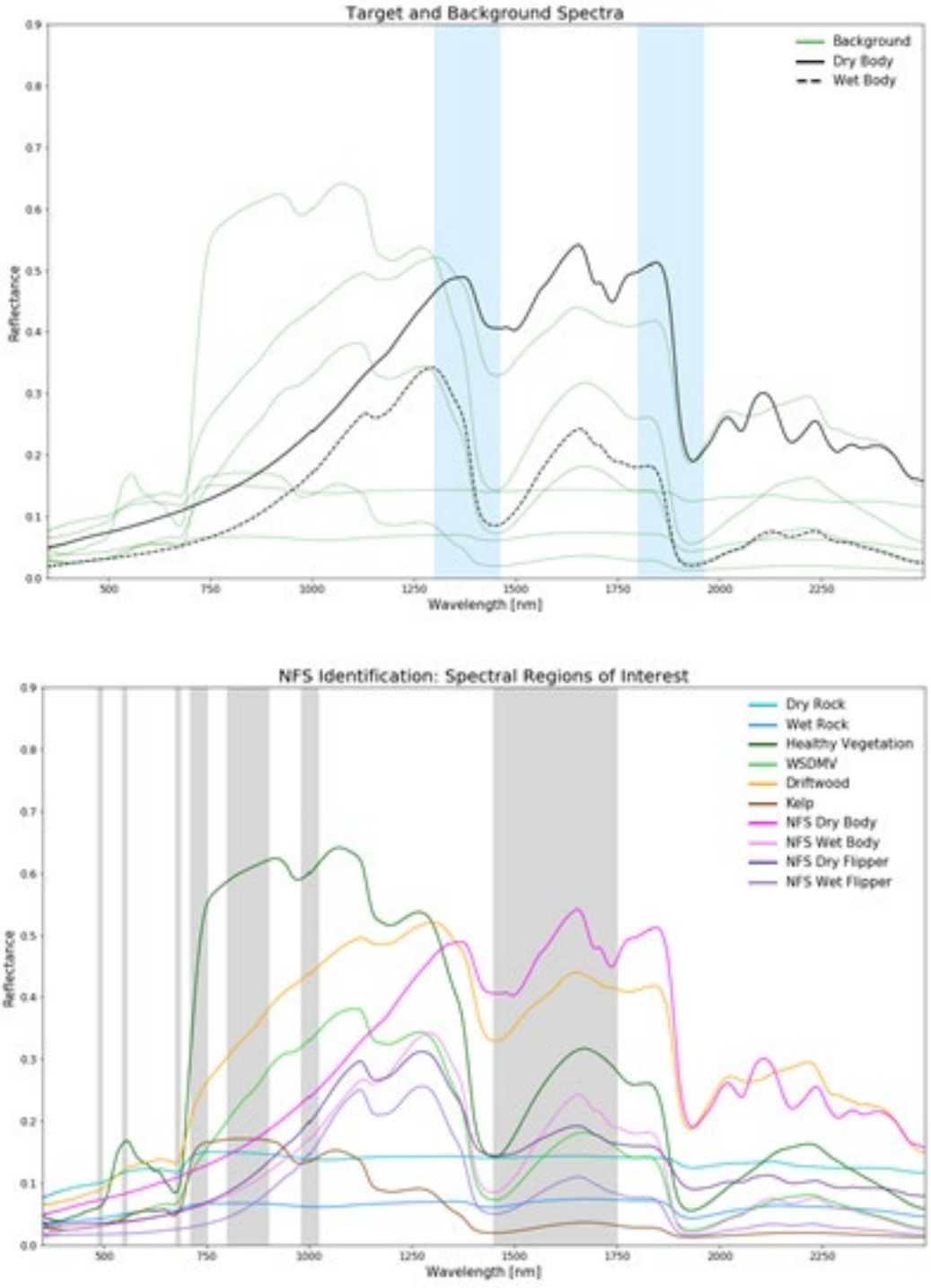
Visual (top) and thermal images (lower) captured of a northern fur seal rookery on St. George Island with the FLIR DUO Pro R sensor mounted to the APH-28 hexacopter.

The UAS Program Office funding also supported MML's effort to assess multi-spectral imaging as a tool for increased resolution of small black pups against the similarly colored background environment. MML Biologists coordinated with NOAA National Environmental Satellite, Data, and Information Service (NESDIS) Center, GeoThinkTank, and Connecticut's Mystic Aquarium to conduct ground-based research to collect spectral signatures of northern fur seals and their background habitat (see NOAA Fisheries' blog post here to learn more).



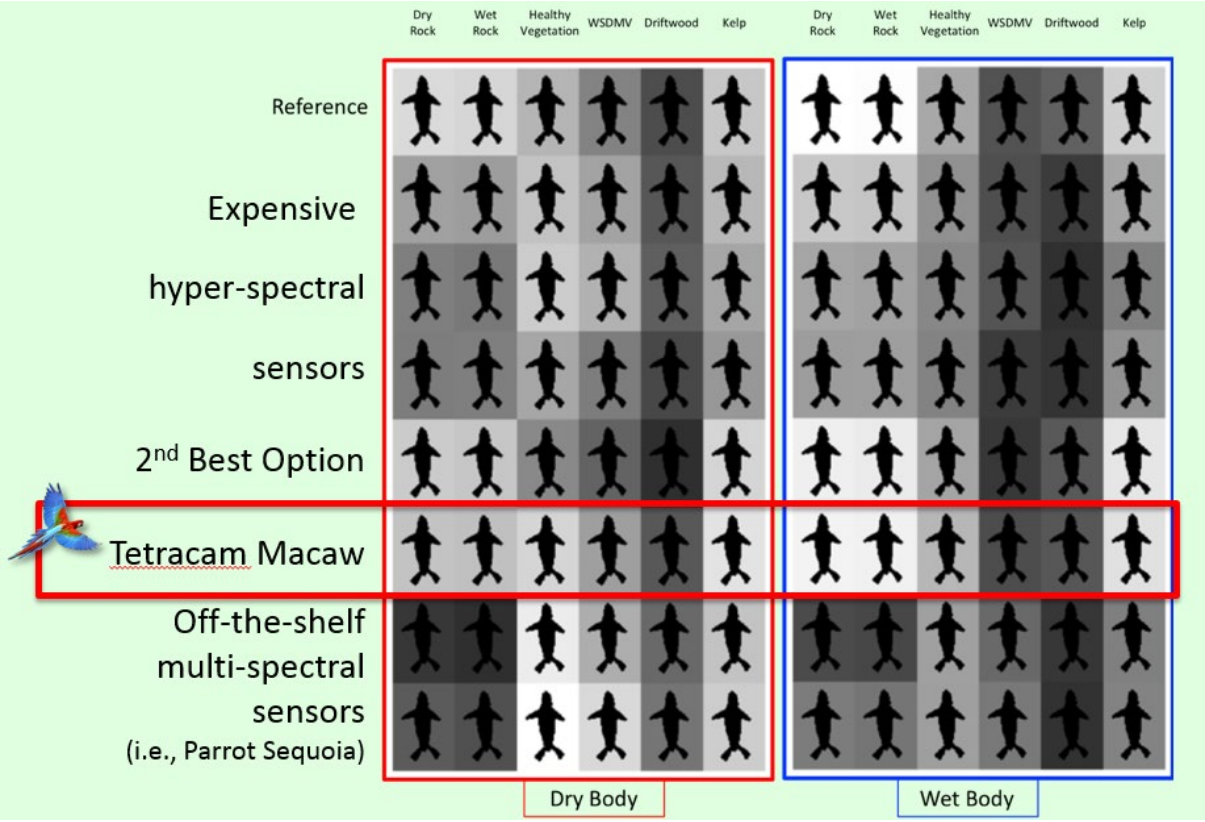
GeoThinkTank's workflow diagram for signature collection at the Mystic Aquarium and in Alaska of fur seals and their background. These signatures were used in analysis to assess the efficacy of multi-spectral imaging.

GeoThinkTank used this signature data to analyze and assess which wavelengths would be most beneficial for targeting fur seals from the background.



The summary of spectral signatures collected of fur seals and their background and areas unusable due to environmental factors (blue shaded bars; top). Collected spectral signatures and optimal wavelengths identified for targeting fur seals from the back ground (gray shaded vertical bars; lower).

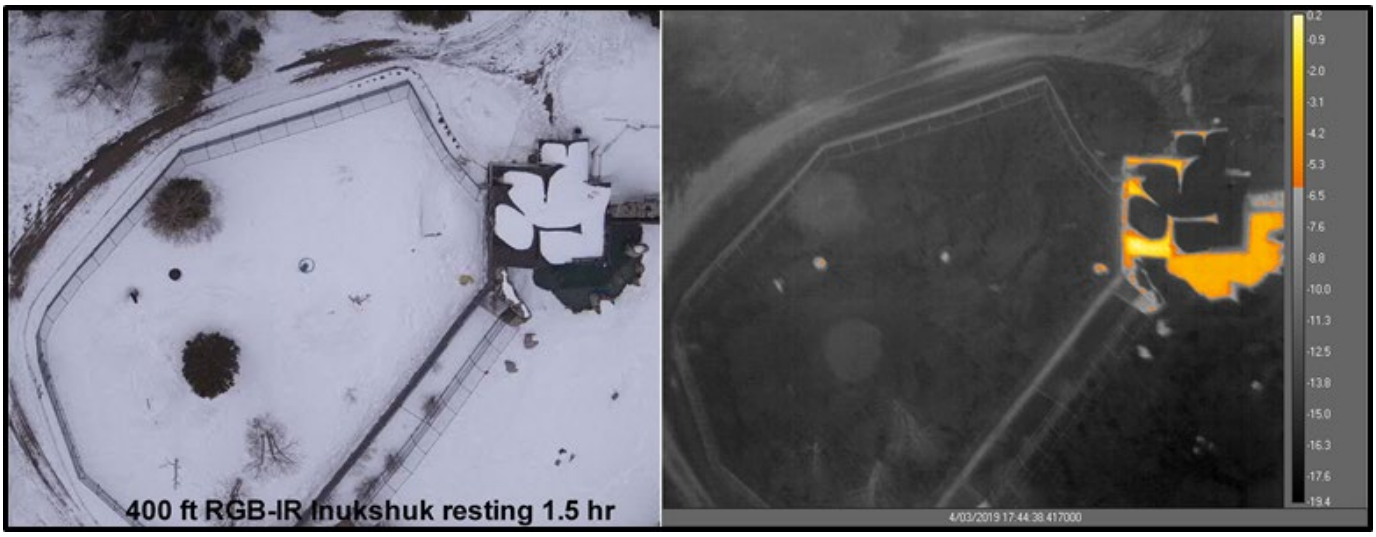
To test the efficacy of the wavelengths selected, a digital model of the environment and fur seals was created and virtual simulated aerial surveys were conducted with various multi-spectral sensors ranging from higher-end hyper-spectral sensors to off-the-shelf small UAS multi-spectral sensors primarily used for agriculture assessments.

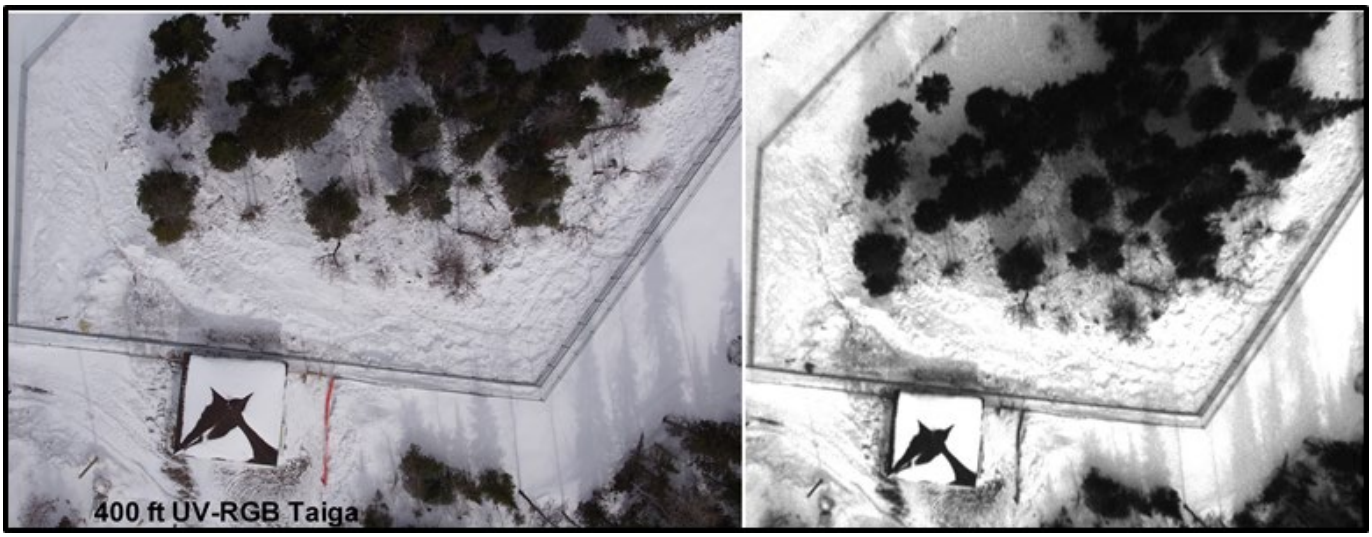


Multi-Spectral Imaging Assessment Report (04/2019) (Credit: GeoThinkTank).

The figure above shows assessment of various multi-spectral sensors available and their ability to identify dry (left, red box) and wet (right, blue box) fur seals against various backgrounds or substrates. The greater the contrast between the fur seal shape and the background, the easier it is to distinguish fur seal pups from the surrounding environment.

This multi-spectral assessment showed that off-the-shelf sensors would not be sufficient for identifying fur seals from the environmental background. Higher-end hyper-spectral sensors (which are quite costly and more complicated to use) were strong for some characteristics but the most optimal sensor identified is in the middle-ground of price, complexity and efficacy. The selected sensor (TetraCam Macaw) is an off-the-shelf sensor that captures visual, thermal, and targeted wavelengths that researchers can customize based on the multi-spectral assessment. The next step is to procure this sensor, and a UAS that can carry the payload and has adequate flight time duration. Once acquired the plan would be to conduct aerial surveys to collect imagery to use as a training set to implement machine learning techniques to automate image processing.





Aerial images of polar bears captured with the APH-22 and the FLIR DUO Pro R (thermal sensor, top and UV sensor lower) compared to visual images of the same area.

In another assessment MML also used the APH-28, visual and thermal sensors, along with an integrated UV sensor to capture imagery of polar bears at the Polar Bear Habitat in Cochrane, Ontario, Canada. MML found that UV imagery is beneficial (in conjunction with thermal and visual imagery) for identifying polar bears. This information will be used to augment ice seal surveys conducted by MML to better help identify polar bears.

Aerial Imaging Solutions APH-28 Hexacopter.

The rapidity of environmental and climate-related changes in the northern latitudes necessitates the need to find applicable and efficient techniques to monitor fragile and declining populations, like the northern fur seal on the Pribilof Islands, Alaska. The Marine Mammal Laboratory is trying to develop methods for population assessment that will minimize disturbance to the animals, improve efficiency and precision, and ultimately reduce logistical and economic constraints.