2020 IN REVIEW

MML Marine Mammal Laboratory

NOAA FISHERIES

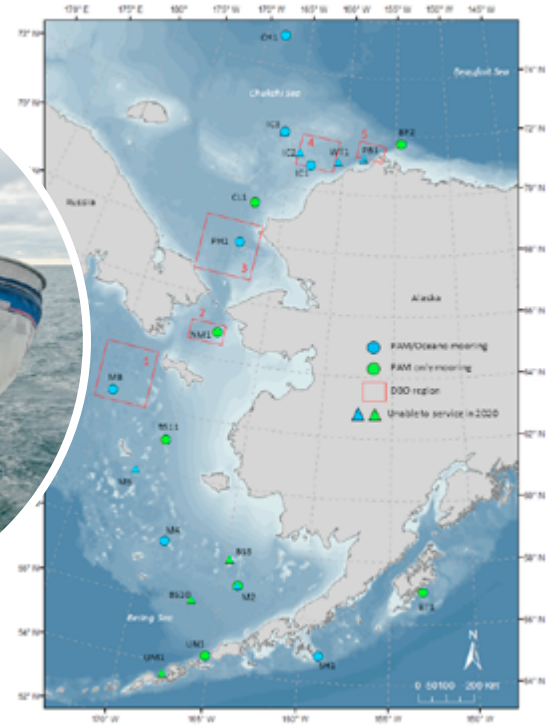
Alaska Fisheries Science Center

The Marine Mammal Laboratory, a division of the Alaska Fisheries Science Center, conducts research on whales, seals, sea lions, and porpoises off the coasts of Alaska, Washington, Oregon, and California. We collect data on marine mammal behavior, population dynamics, life history, migration patterns, distribution, and trends in abundance.

2020 Highlights

Recovering bongo nets

Recovering a biophysical/ passive acoustic mooring

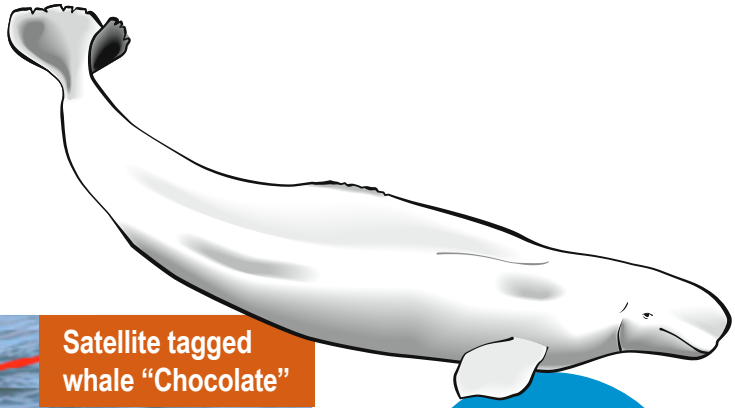


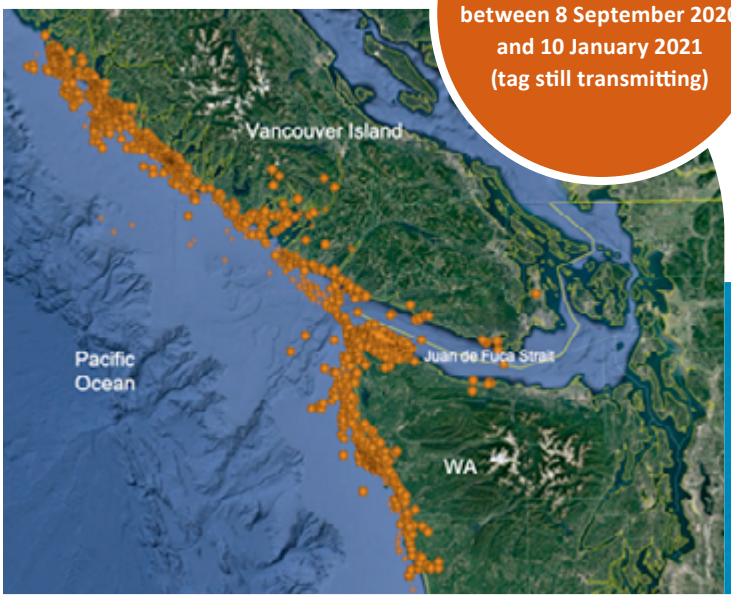
Successfully Completed a 25 Day, 6,000 Kilometer Cruise on the NOAA Ship *Oscar Dyson*

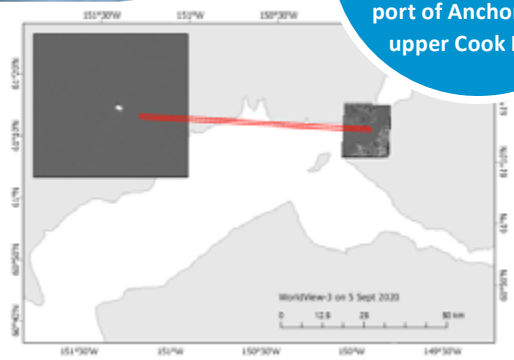
A dramatically scaled back staff carried out a variety of scientific operations throughout the Gulf of Alaska, Bering Sea, and Chukchi Sea, including Distributed Biological Observatory Regions 1-5. We deployed 24 moorings and recovered 26, including oceanographic, passive acoustic, and active fish acoustic instrumentation, to learn more about marine mammal movements and their habitat. We also deployed two satellite-tracked drifters. Oceanographic sampling included 68 CTD casts run for nutrient, oxygen, and chlorophyll-A sampling. We collected 24 environmental DNA and 30 harmful algal bloom samples as a subset of these casts. Fifty zooplankton tows were conducted using bongo nets. We also made underway seabird and mammal visual observations. We provide seabird data to our partners at U.S. Fish and Wildlife Service to support their research mission.

Photo-Identifying the Gray Whale Pacific Coast Feeding Aggregation

From late June through September, we conducted photo-id surveys along the Washington and Oregon coasts. We collected 8,162 photos to identify Pacific Coast Feeding Aggregation gray whales for mark-recapture models of population abundance estimation used in Stock Assessment and International Whaling Commission reports.







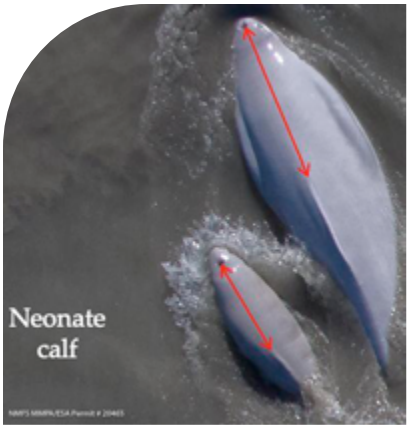
WorldView-3 satellite image collected on 5 September 2020 showing beluga whales near the port of Anchorage in upper Cook Inlet.

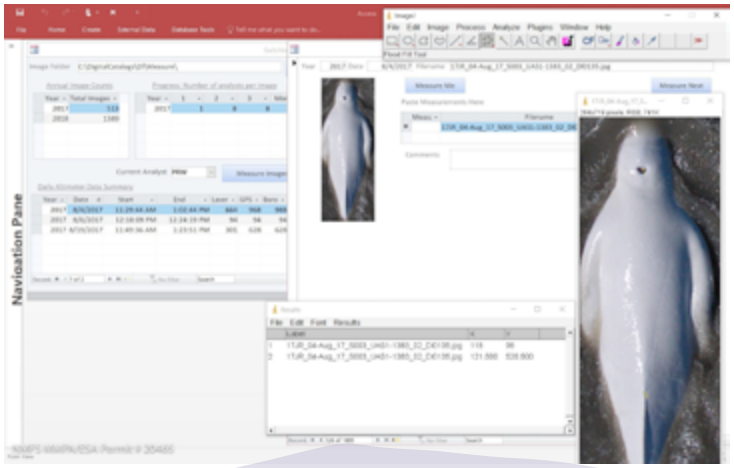
Satellite-tagging of the Gray Whale Pacific Coast Feeding Aggregation

In September, California Current Ecosystem program and Cetacean Assessment and Ecology program staff satellite-tagged three gray whales off the Washington coast as a pilot study. We are evaluating tag attachment methods and tracking movements of the whales in coastal waters of Washington, Oregon, and British Columbia. We obtained 4,651 locations over 163 transmission days. The tracking data will inform NOAA Fisheries in its management of the Pacific Coast Feeding Aggregation sub-population of gray whales.

Investigating the Use of Satellite Imagery to Understand Cetacean Distribution

A collaborative effort involving multiple NOAA Fisheries Science Centers and other agencies was initiated in 2020 to investigate the potential of using very high resolution (VHR) satellite imagery to assess cetacean distribution over a large spatial scale. Collectively the team has successfully acquired several terabytes of satellite imagery over seasonal hotspots of bowheads, beluga, and North Atlantic right whales. The ultimate goal is to use deep learning for operational detection of key cetacean species to fill key gaps in our knowledge of cetacean distribution in remote areas and during seasons where traditional surveys are not effective or are prohibitively expensive. Completion of this project will require end-to-end innovations in software, image storage and access via cloud services, data workflows and image processing, artificial intelligence, and statistics.





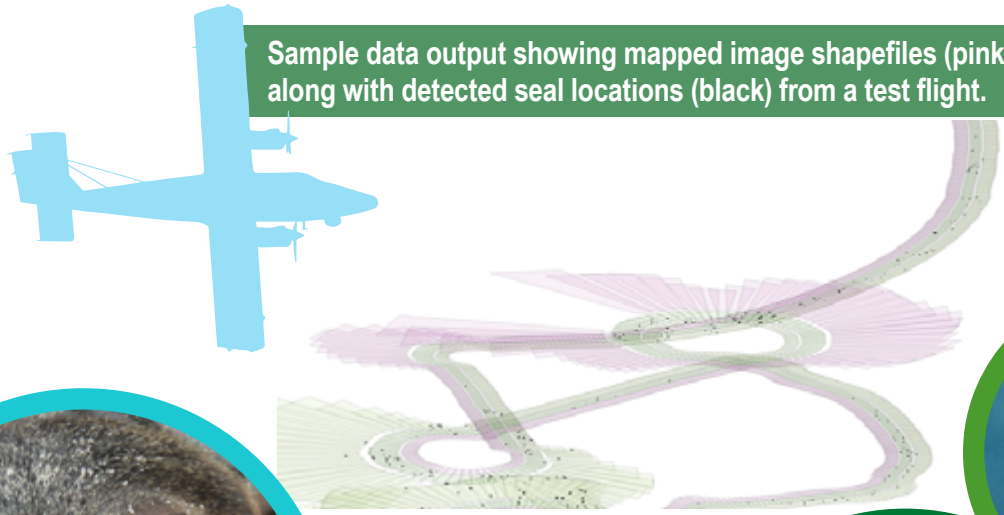
Advancing Data Management and Processing of Cook Inlet Beluga Imagery

We developed a new database to streamline the processing of photographs of Cook Inlet beluga whales for photo-identification matching and photogrammetry measurements. After coding photographs for whale color, the number of marks, and other features that could assist with individual identification, a semi-automated system creates a list of candidate matches from the catalogue for each new ID-photo. The correct match was found in the top 9 candidate matches the majority of the time, saving substantial time matching photos. Previously processed ID-photos from 2017 (2,164) and 2018 (655) were transferred into the new database. Unprocessed 2018 (2,815) photos were taken through the matching process. Photographs from 2017-18 (4,975) are now ready for photogrammetry measurements of relative length (blowhole to dorsal ridge). For 2019 photos, 10,636 photos were screened, cropped, and rotated, leading to 2,367 photos with useful images of Cook Inlet beluga whales to be matched to the catalog. The new database, in combination with additional processing enabled by a reduction in field work and a short-term increase in labor due to availability of multiple summer interns, will facilitate new photogrammetric and mark-recapture analyses planned for 2021.

Unmanned Aerial System digital image from survey of Steller sea lion breeding colony at Rogue Reef, Oregon. Large blond animal at the left edge of the image is a territorial bull, other large animals are adult females with their dark brown pups.

Using Unmanned Aircraft Systems to Survey Steller Sea Lion Populations in Washington and Oregon

From Late June through September, we conducted Unmanned Aircraft Systems surveys to collect photo imagery for assessing Steller sea lion abundance and demographics. We counted 3,169 pups from 2,645 images. Photos of branded Steller sea lions taken during the surveys will be used to refine mark-recapture survival estimates.



Sample data output showing mapped image shapefiles (pink and green) along with detected seal locations (black) from a test flight.

Multispectral aerial imaging system (KAMERA) integrated onto the NOAA Twin Otter, N56RF. Thermal infrared cameras along with machine vision color and ultraviolet cameras are pictured in the open air belly port (above) with acquisition and image processing computers in the cabin (left).

Surveying California Sea Lion and Northern Fur Seal Population Abundance in California Channel Islands

In July, we conducted aerial surveys of San Miguel and San Nicolas Islands to estimate the number of California sea lion and northern fur seal pup births in 2020. A total of 25,149 California sea lion pups and 1,936 northern fur seal pups were counted from 12,838 images.

Testing an Airborne, Multi-Spectral Imaging System for Surveying Seals and Polar Bears on Ice Habitats

Polar Ecosystem Program staff completed significant updates and testing of an imaging system that collects georeferenced color, infrared, and ultraviolet images. Data are then incorporated into machine-learning models for automated detection, classification, and counting of polar bears and seals. Deep learning models were refined to detect and classify bearded seals, ringed seals, and polar bears in real time for surveys of the Beaufort Sea in 2021. The complete system was integrated into the NOAA Twin Otter including a custom camera mount accommodating multiple aerial imaging projects at MML.

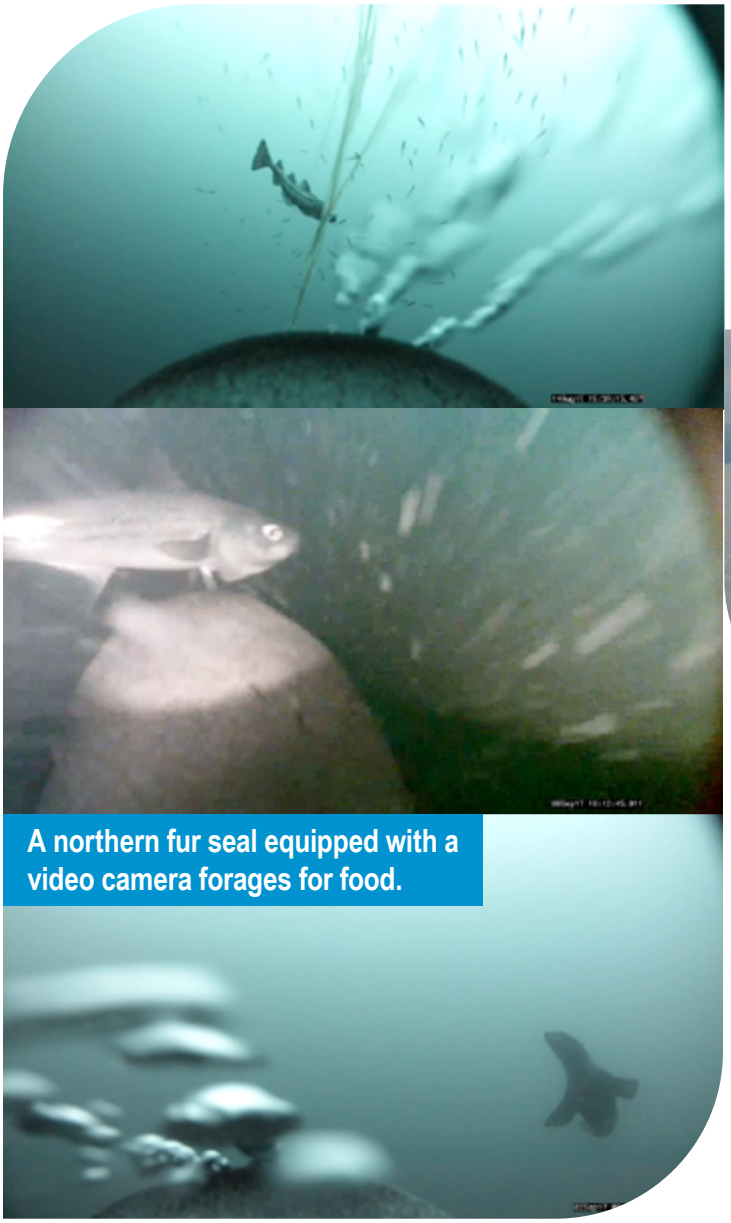
Contents of a northern fur seal scat sample viewed under a microscope at 10x power. The numerous tiny vertebrae and skeletal structures are from juvenile fish, likely *Gadus* sp. and *Hexagrammos* sp. Grains of sand and other small bits of beach debris can also be seen.

Providing New Insights on Northern Fur Seal Food Habits

The Alaska Ecosystems Program is completing a comprehensive analysis of northern fur seal food habits on Bogoslof Island and the Pribilof Islands between 1987 and 2012. The dataset includes more than 7,000 fecal (scat) and regurgitate (spew) samples collected from rookery beaches during the summer breeding season. Using new methods and identification tools in 2020, we reviewed the contents of 1,362 diet samples; counted, sided (left or right), and graded the condition of 7,179 walleye pollock cranial bones; and measured 1,307 of those cranial structures to estimate the size of pollock consumed by fur seals. This study will provide new insights into spatial and temporal variation in northern fur seal diet. It will help us to better understand the role of this species in the eastern Bering Sea ecosystem.

Conducting an Aerial Survey of Harbor Seals on Ice

Through careful assessment and mitigation of COVID-19 risks, Polar Ecosystems Program staff safely conducted an aerial survey of harbor seals on ice calved from glaciers in Alaskan fjords. This habitat is changing rapidly, and the seals had not been surveyed since 2015. About 10,500 km of survey track line were flown to complete the survey. The team collected 110,000 color, infrared, and ultraviolet images that will be processed to determine seal abundance and trends.



A northern fur seal equipped with a video camera forages for food.

Building our Understanding of Northern Fur Seal Foraging Behavior Through Video Analysis

Alaska Ecosystems Program scientists analyzed over 62 hours of video data recorded by cameras worn by northern fur seals on St. Paul and St. George Islands. These videos give us a glimpse of underwater life of fur seals from the depleted Eastern Stock as they search for prey in the Bering Sea. We analyzed the videos to identify prey capture attempts, prey size, and species consumed. These data will be linked with measures of prey availability collected from saildrones and research surveys to help us learn more about factors that influence northern fur seals' ability to find food. These efforts will build our understanding of relationships between northern fur seals and their prey resources in the Bering Sea. This is essential to develop ecosystem-based conservation approaches for this depleted species.

Advancing the Use of Artificial Intelligence to Process Marine Mammal Calls

The Marine Mammal Laboratory acoustics team and their partners made significant advancements in processing cetacean acoustics data through artificial intelligence. The new program "INSTINCT" was developed to automatically identify calls. This program can be applied to large archival marine mammal acoustics datasets for a variety of applications. It is sufficiently robust to allow for transferability to different noise regimes and soundscapes. We deployed the program to investigate a recently discovered and rare call type potentially attributable to the critically endangered North Pacific right whale; over 9000 positive detections of the call type were found while searching over 80 mooring years of data. The application of INSTINCT to identify this call type in recordings, including manual verification, reduced the workload by 96 percent relative to a manual analysis (3 months compared to 6 years, respectively).

In a separate effort, analysis of the Cook Inlet beluga passive acoustic data was shifted to artificial intelligence (AI) methods in partnership with Microsoft AI for Good. Datasets of 6 to 8 months in duration were traditionally processed with basic signal detectors that required manual validation of detections. The process required on average 78 hours per dataset. A machine learning model consisting of four neural networks is now replacing the detection and validation process. This new approach completes the data analysis in 13 hours on average per dataset, saving 84 percent of data analysis time. This partnership is ongoing and next steps are focused on incorporating a classifier for killer whale, humpback whale, and 9 classes of anthropogenic noise sources into the model.

Publications

Although most field projects had to be canceled due to the pandemic, Marine Mammal Lab staff made use of the time by producing 90 scientific publications on the results or statistical methods for assessment of protected species and their habitat.

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March 2021