

Gray whale aerial monitoring using UAV-drones, season 2023.

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Reproduction plays a major role in a species life history strategy. The reproductive cycle of baleen whales is closely linked to their migration cycle as they exhibit one of the fastest mammalian offspring growth rates. Assessing the costs of reproduction of an individual over a breeding season, by monitoring changes in body condition, is an important first step to better understanding the health of the overall population (Christiansen *et al.*, 2021). In 2019 the Eastern North Pacific gray whale (*Eschrichtius robustus*) experienced an ‘unusual mortality event’ (UME), which has extended until 2022, where 608 whales were found dead along the west coast of Mexico, the United States and Canada (NOAA, 2023).

To contribute with information about the gray whales body condition of 2023 season in Laguna San Ignacio, B.C.S., Mexico, we conducted daily flights from January 19 to March 29 (except for days with bad weather), using unmanned aerial vehicles (UAV): a DJI *Inspire 2* with a Lightware SF11 altimeter adapted and a DJI *Mavic 3 Classic*. We took videos when the whales were on the surface with the camera at 90° in 4K.

An aerial photo-identification catalog was made for 2023 season. For it, we reviewed the videos of each flights during the all season and screenshots were taken when the portion of the back was completely visible, near or on the surface (Figure 1).



Figure 1. Photo-identification area used for the aerial gray whale catalog.

Each back was assigned a unique catalog number and they were grouped in different folders depending on the category (mothers with calf or “MC” and singles or “S”; Figure 2). The photographs obtained between each flight, day, throughout the season at the beginning and end were visually compared. With the dates of the photo-identifications, the residency time of the gray whales (mothers with calves and singles) was calculated using the data from the images from the first to the last time they were photographed.

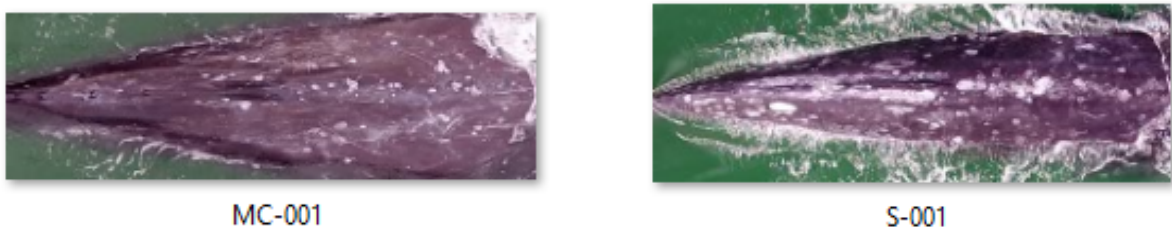


Figure 2. Examples of photo-identified whales in the catalogue: MC (mothers with calves), S (singles).

To assess the gray whale body condition, we reviewed each flight recorded in the season and screenshots were taken when the whales were found on the surface, with the contour perfectly visible in width and length and the body completely straight (Figure 3). The body condition images were stored in a catalog for later analysis in which the total length and width of the gray whales will be measured to obtain their volume and calculate the body condition by age classes (Figure 4).



Figure 3. Ideal photograph to use in the body condition catalogue.

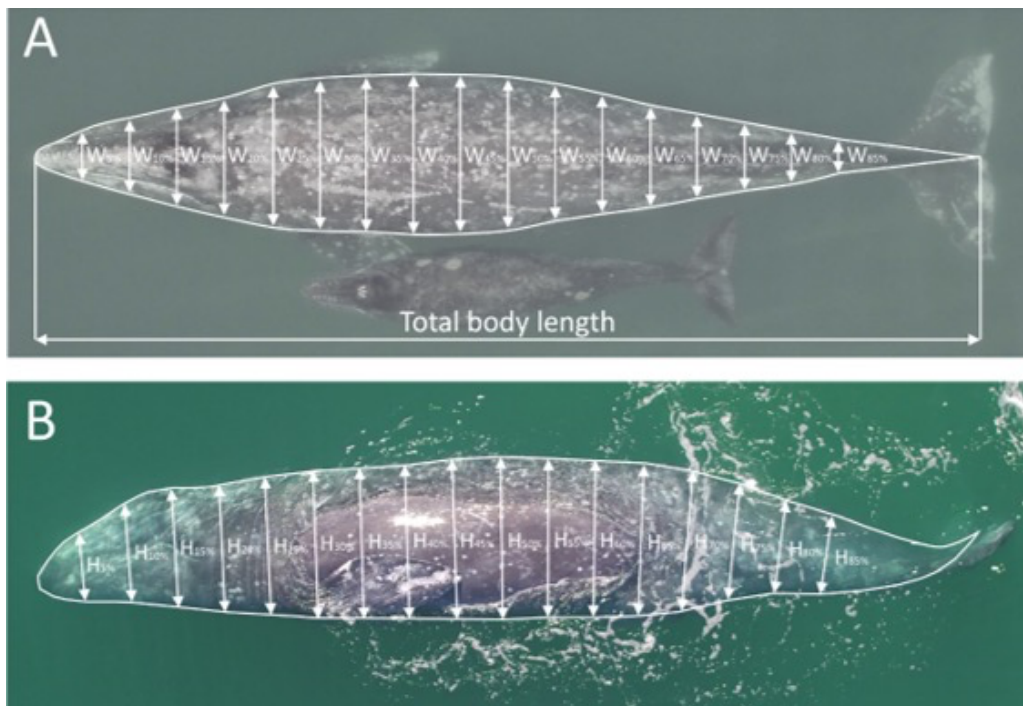


Figure 4. (A) The dorsal surfaces of a gray whale used to measure body length and width every 5% from the tip of the face to the notch of the caudal fin). (B) Gray whale in lateral position to measure the height (dorso-ventral distance) along the same measurement sites (image taken from Christiansen *et al.*, 2021).

Results

In the 2023 season, a total of 289 UAV flights (65h) were conducted. We identify 232 solitary individuals (animals with no calf) and 54 mother and calf pairs.

Table I. Sampling effort and total number of photo-identifications through the use of UAV-drones from 2018 to 2023.

| YEAR | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|--------------------------------|------|------|-------|-------|-------|------|
| Flights | 452 | 562 | 285 | 76 | 290 | 289 |
| Hours | 83.6 | 79.2 | 80.15 | 22.15 | 79.95 | 65.3 |
| Singles identified | 254 | 337 | 306 | 180 | 486 | 232 |
| Mother-calves pairs identified | 63 | 40 | 46 | 16 | 30 | 54 |

The residency time for mothers with calves was 30 days, while the single ones spent an average of 8 days (Table II).

Table II. Average residency time and total recaptures of mothers with calves and singles whales in Laguna San Ignacio 2023 season. n= number of individuals that had at least one recapture.

| Composition | n | Average residency time (95% CI) | Recaptures (95% CI) |
|---------------------|----|---------------------------------|---------------------------|
| Mothers with calves | 36 | 30.52 \pm 6.43 (max = 65) | 2.3 \pm 0.49 (max = 6) |
| Singles | 27 | 8.26 \pm 2.7 (max = 37) | 1.37 \pm 0.18 (max = 2) |

We obtained 462 body condition images which will be analysed to obtain length, volume and body condition by age class (calf, juveniles, adults, lactating females). We will compare the gray whale body condition with previous seasons and thus assess the body condition during the UME.

Stranding's

- We identified and took measurements of one dead stranded whale (Figure 5).

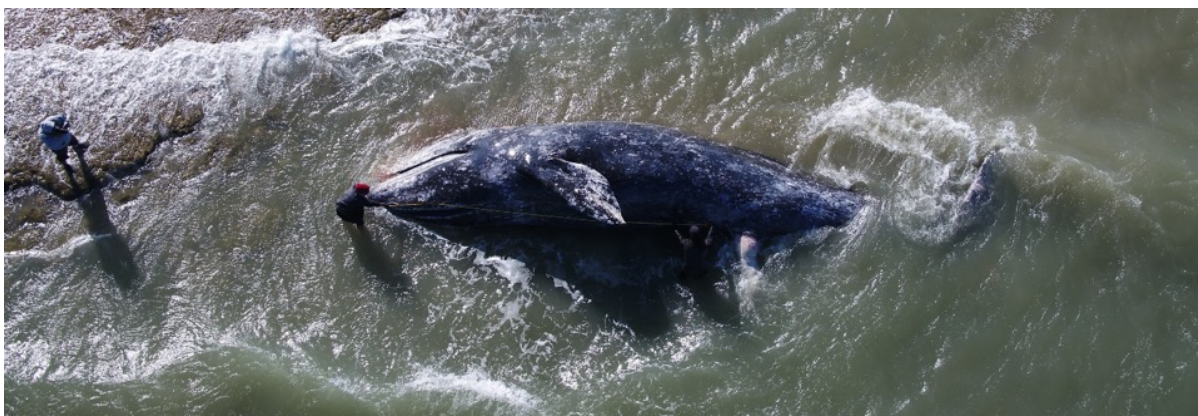


Figure 5. Stranded gray whale 2023 season.

Work in progress

A unique catalogue of aerial photo-identification was carried out, which include the years sampled since 2017. Up to the year 2022, a total of 1,620 different whales have been identified, of which 205 have been lactating females and 1,415 have been single ones. With the information of more than 40 years of the gray whale research program of Laguna San Ignacio, it is intend to compare the traditional method of lateral photo-id against aerial photo-ide as Job Olguín-Hernández's bachelor thesis.

Future objectives

- We intend link body condition and long-term reproductive history of individual female whales using a combination of long-term boat-based photo-identification records and UAV identification to assess possible effects of age, number of calves produced and inter-calving interval on their reproduction efficiency.
- We intend to quantify the loss and gain in body volume of whales to estimate the volume conversion efficiency from females to calves, as well as maternal investment in their calves through the breeding season.

Observations

In the 2023 season, we observed an increase in numbers of mothers with calves and a decrease in numbers of single whales photo identified. Mating behaviour was documented and feeding was not observed as in previous years. Visual observations indicate a high number of gray whales in a good condition even during the end of the season.

Moreover, we recorded videos of bottlenose dolphins (*Tursiops truncatus*) and California Sea Lions (*Zalophus californianus*).

Literature cited

Christiansen F., Rodríguez-González F., Martínez-Aguilar S., Urbán J., Swartz S., Warick H., Vivier F. & L. Bejder. 2021. Poor body condition associated with an unusual mortality event in gray whales. *Mar. Ecol. Prog. Ser.* Vol 658: 237-252.
<https://doi.org/10.3354/meps13585>.

National Oceanographic Atmospheric Administration. 2023. Gray Whale Unusual Mortality Event of 2019-2023. Sitio web: <https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2023-gray-whale-unusual-mortality-event-along-west-coast-and>.
Consultado: 02 de abril del 2023.

Drone specifications

DJI Inspire 2 (60.5 cm diameter, 3.3kg, www.dji.com)

20.8 Megapixels DJI Zenmuse X5s Micro Four Thirds camera with an Olympus M.Zuiko 25mm f1.8 lens and a polarized filter
A LightWare SF11/C laser range finder (weight: 35 g) was used to measure the altitude of the UAV above sea level.

DJI Mavic 3 Classic (34.7 cm diameter, 335.5g, www.dji.com)
20 Megapixels 24 mm f2.8-f11 len

Temporada 2023





