Disminución en la producción de crías de ballena gris (Eschrichtius robustus) en la laguna San Ignacio, BCS (2018-2022).

Sergio Martínez[1], Andrés González[1], Minerva Valerio[1], Regina Lobo[1],

Steven Swartz[2], Jorge Urbán[1]

1 Departamento Académico de Ciencias Marinas y Costeras. Universidad Autónoma de Baja California Sur, La Paz, B.C.S., México

2 Laguna San Ignacio Ecosystem Science Program (LSIESP), Darnestown, MD, USA

La producción de crías, es fundamental para el reclutamiento de nuevos individuos en cualquier población. La población americana de ballena gris (*Eschrichtius robustus*), ha presentado una fluctuación en el número de crías durante las últimas dos décadas, posiblemente relacionadas con Eventos de Mortalidad Inusual (UME) y su posterior recuperación. El presente trabajo muestra los resultados en la reducción del número de crías de ballena gris en la Laguna San Ignacio, BCS, obtenidas mediante dos métodos (foto-identificación y censos). El promedio anual de Hembras con cría foto-identificadas pasó de 225.7, SD 31.22 (2011 a 2017) a 53.6 SD 17.09 (2018 a 2022), lo que corresponde a 0.71 hembras con cría y 0.21 por hora de esfuerzo de foto-identificación respectivamente. Mientras que para los censos el promedio de Hembras con cría por censo, paso de 65.8, SD 28.8 a 12.7 SD 8.0. Esta reducción en el número de hembras con cría, puede deberse a la muerte de hembras sexualmente maduras, así como al incremento del intervalo de nacimiento registrado en años recientes.

Decline of Calf Production in Gray Whales (*Eschrichtius robustus*) in San Ignacio Lagoon, Baja California Sur, Mexico from 2018 to 2022.

Sergio Martínez, Steven Swartz, Jorge Urbán, Andrés González, Minerva Valerio, Regina Lobo

Calf production is fundamental for the recruitment of new individuals in any population. During the last two decades, North Eastern Pacific gray whale population (*Eschrichtius robustus*) has experienced fluctuations in the number of calves born each winter, possibly related to the Unusual Mortality Event (UME) and the slow replacement of breeding females. This work documents the reduction of the number of gray whale calves seen in San Ignacio Lagoon, BCS, obtained through two methodologies: photographic identification and abundance surveys. The annual average number of females with calves in photo-identification surveys decreased from 225.7 (SD 31.22) pairs during the period 2011 to 2017, to 53.6 (SD 17.09) pairs during the years 2018 to 2022, which corresponds to 0.71 females with calves, and 0.21 per hour of photo-identification effort, respectively. While the average abundance of females with calves observed in the abundance surveys went from 65.8 (SD 28.8) pairs to 12.7 (SD 8.0) during these same time periods. This reduction in the number of females with calves as well as the increase of the female whale birth interval observed in recent years could be due to the death of sexually mature females during the UME.

Assessment of Gray Whale Body Condition Using Aerial Photogrammetry

Fabian Rodríguez-González[1,2], Fabien Vivier[3], Fredrik Christiansen[4], Lars Bedjer[3], Sergio Martínez-Aguilar[1,2], Steven Swartz[1,2] and Jorge Urbán[1,2].

[1]Departamento de Ciencias Marinas y Costeras, Universidad Autónoma de Baja California Sur, La Paz, BCS 23081, Mexico

[2]Laguna San Ignacio Ecosystem Science Program (LSIESP), Darnestown, MD 20874, USA

[3]Marine Mammal Research Program, Hawaii Institute of Marine Biology, University of Hawaii at Mānoa, Kaneohe 96744, HI, USA

[4] Marine Mammal Research, Department of Ecoscience, Aarhus University, 4000 Roskilde, Denmark

The North Eastern Pacific gray whale (*Eschrichtius robustus*) population experienced a new Unusual Mortality Event (UME) declared by NOAA in 2019, which has been extended until 2022. Some studies suggest that the low availability of food has played an important role in this mortality. One way to understand the nutritional state of whales is by measuring their body condition. This work assesses the body condition of gray whales in Laguna San Ignacio, B.C.S., Mexico, through the use of aerial photogrammetry during the 2020 breeding season. From January to March, a total of 284 flights were carried out and 885 videos were taken using a DJI Inspire 2 with a range finder altimeter. A strong linear relationship between body volume (BV) and body length (BL) ($\log(BV) = -3.98 + 2.76 \times \log(BL)$) was obtained for all categories: lactating females, mature adults, juveniles and calves. Estimates show that lactating females were in good body condition at the beginning of the season (33.19 ± 3.25 %), while juveniles and adults were below the average (-0.03 ± 0.07 %, -0.09 ± 0.07 % respectively). Despite this, at the end of the breeding season, the loss of energy was not as demanding compared to previous years, suggesting that the whales decreased their reproductive activity to save energy reserves. Our body condition assessment indicated that the northeastern population of gray whales continues to be under nutritional stress. It is possible that multiple factors influence this UME and shows the importance to follow up on body condition studies on their feeding and breeding sites, as well as to monitor the availability and quality of their food resources.

Evaluación de la Condición Corporal de Ballena Gris Utilizando Fotogrametría Aérea

Fabian Rodríguez-González[1,2], Fabien Vivier[3], Fredrik Christiansen[4], Lars Bejder[3,5], Sergio Martínez-Aguilar[1,2], Steven Swartz[1,2] and Jorge Urbán[1,2].

[1]Departamento de Ciencias Marinas y Costeras, Universidad Autónoma de Baja California Sur, La Paz, BCS 23081, México

[2]Laguna San Ignacio Ecosystem Science Program (LSIESP), Darnestown, MD 20874, USA

[3]Marine Mammal Research Program, Hawaii Institute of Marine Biology, University of Hawaii at Mānoa, Kaneohe 96744, HI, USA

[4] Marine Mammal Research, Department of Ecoscience, Aarhus University, 4000 Roskilde, Denmark

[5]Zoophysiology, Department of Biology, Aarhus University, C.F. Møllers Allé 3, 8000 Aarhus C, Denmark

La población americana de ballena gris (*Eschrichtius robustus*) experimentó un nuevo Evento de Mortalidad Inusual (UME) declarado por la NOAA en 2019, el cual se ha extendido hasta el 2022. Diversos estudios sugieren que la poca disponibilidad de alimento ha jugado un papel importante en dicha mortandad. Una manera de conocer el estado nutricional de las ballenas es midiendo su condición corporal. El presente trabajo evalua la condición corporal de la ballena gris en la Laguna San Ignacio, B.C.S., México, mediante el uso de fotogrametría aérea en la temporada reproductiva 2020. De enero a marzo, se realizaron un total de 284 vuelos y se tomaron 885 videos mediante un dron DJI Inspire 2 con un altímetro range finder. Se obtuvo una fuerte relación lineal entre el volumen corporal (VC) y la longitud corporal (LC) ($\log(VC) = -3.98 + 2.76 \times \log(LC)$) para todas las categorías: hembras lactantes, adultos maduros, jóvenes y crías. Las estimaciones muestran que al inicio de temporada las hembras lactantes tuvieron una buena condición corporal (33.19 ± 3.25 %), mientras que los jóvenes y adultos se encontraron por debajo del promedio (-0.03 ± 0.07%, -0.09 ± 0.07 % respectivamente). No obstante, a final de temporada la pérdida de energética no fue tan demandante con respecto a años previos, lo cual sugiere que las ballenas disminuyeron su actividad reproductiva para ahorrar reservas energéticas. Nuestra evaluación de la condición corporal indicó que la población nororiental de ballena gris continua bajo estrés nutricional. Es posible que múltiples factores influyan en el presente UME, por lo que es importante dar seguimiento a estudios de condición corporal para sus sitios de alimentación y reproducción, así como monitorear la disponibilidad y calidad de su recurso alimenticio.

THE USE OF NEW TECHNOLOGY (UAV) FOR PHOTO-IDENTIFICATION OF GRAY WHALES (*Eschrichtius robustus*) IN MEXICO

Olguín-Hernández, J.A.[1], Martínez-Aguilar, S.[1], Rodríguez-González, F.M.[1] , Urban R., J.[1] and Swartz L., S.[2]

[1]Universidad Autónoma de Baja California Sur, La Paz, B.C.S., Mexico.

[2]Laguna San Ignacio Ecosystem Science Program, Maryland U.S.A.

Photogrammetry from Unmanned Aerial Vehicles (UAVs) has been used to obtain information on wildlife habitat use, abundance estimation, ethology, and health. This new technology has facilitated data collection in remote and challenging areas, like the ocean. Photo-identification (photo-id) from UAVs is a non-invasive method to identify individual animals from photographs of naturally occurring markings that are unique to each individual animal. This method has been used with gray whales (*Eschrichtius robustus*) since 1977 to collect information on their abundance, social dynamics, migration patterns, site fidelity, residence times, birth intervals, and to estimate minimal age. Beginning in 2017 a new photo-id methodology using UAVs was implemented to simultaneously observe and photograph both sides of the dorsal region of gray whales compared to traditional boat-based methods where only one side of the whale is observed at a time. Gray whale photo-id catalogues from 2017 to 2023 were compared with both the UAV and boat-based methods. These included 2,875 right and 4,648 left sides from traditional photo-ids versus 285 aerial photo-ids of the entire dorsal regions of the whales. Comparisons were facilitated with the software "Hotspotter" and confirmed visually. We found 611 right side and 718 left side recaptures between traditional and UAV aerial methods, *i.e.,* 928 additional whales were photo-identified with the new AUV aerial method than were identified by the traditional boat-based method. This new methodology will contribute new information that will complement and correct our understanding of the life history of individuals gray whales in Mexico, and potentially throughout the range of this species.

Interannual Variation in the Abundance of Adult and Calf Gray Whales (*Eschrichtius robustus*) in the Bahía Magdalena Lagoon Complex, B.C.S., Mexico

Viloria-Gómora, L.[1], García-Castañeda, O.[2], Swartz, S.[3] and Urbán R., J.[1]

[1] Departamento Académico de Ciencias Marinas y Costeras, Programa de Investigación de Mamíferos Marinos, UABCS.

[2] Posgrado en Ciencias de la Sostenibilidad, UNAM. Av. Universidad 3000, Ciudad Universitaria, Coyoacán, C.P. 04510, Ciudad de México, México

[3] Laguna San Ignacio Ecosystem Science Program, Maryland, U.S.A.

The Bahía Magdalena lagoon complex includes the Magdalena Bay (MB), Almejas Bay (AB), and the Santo Domingo Channel (CSD). This is the southernmost winter breeding and mating area of the gray whale. As of 2019, due to the high number of dead whales, an "unusual mortality event" (UME) was declared, which in addition to the dead whales, added a decrease in abundance, and in the production of calves compared to "normal" years. The objective of this work is to describe the interannual variation of the abundance of adult whales without calves (male and females without calves) and females with calves (female-calf pairs), during the period from 2019 to 2022. To achieve this objective, three abundance surveys were carried out each winter (January – March) for each site, counting individuals without calves and those with calves. The results revealed differences in the use of each area by different age and reproductive condition whales. MB is the area preferred by single adults for mating, with a maximum of 151 singles observed in 2019 and a minimum of 70 in 2020; the number of female-calf pairs observed in MB were from 1 to 3 pairs. For AB, an area preferred by juvenile individuals, a minimum of 242 single whales was observed in 2019 and a maximum of 540 singles observed in 2020; the number of females with calves varied from 4 to 1. In the CSD area, a preferred site for calving, a maximum of 19 female-calf pairs were observed in 2020 and a minimum of 3 pairs in 2022; the number of single whales in this area also decreased from 134 individuals in 2019 to 58 single whales in 2022. During the UME the body condition of the whales was observed to decline as evidenced by an increase in numbers of skinny whales, and this condition likely affected the production of calves. Observations in 2023 appear to indicate the condition and reproduction of the gray whales is recovering from the UME for this population.

Transdisciplinary beginnings of the Programa de Investigación de Mamíferos Marinos (PRIMMA) in favor of the conservation and improvement of whale watching.

Omar G. Castañeda, Posgrado en Ciencias de la Sostenibilidad, UNAM. Av. Universidad 3000, Ciudad Universitaria, Coyoacán, C.P. 04510, Ciudad de México, México. omar.castaneda@st.ib.unam.mx

Lorena Viloria Gómora, Departamento Académico de Ciencias Marinas y Costeras, Programa de Investigación de Mamíferos Marinos, lviloria@uabcs.mx

Jorge Urban, Departamento Académico de Ciencias Marinas y Costeras, Programa de Investigación de Mamíferos Marinos, jurban@uabcs.mx

Roberto López Espinosa de los Monteros, robertolopezedelosm@gmail.com

Whale watching (WW) is a tourist activity that grows at a rate of 6% annually worldwide and represents around 14% of nature tourism. Mexico is in the first three places in Latin America and Baja California Sur leads the list with more than 50% of the economic gains. In our country, NOM-131-SEMARNAT-2010 establishes the guidelines for carrying out this activity, however, monitoring and ensuring compliance is minimal. In the Mexican northeast there are more than 10 places where WW is carried out, some in very recent years and others for decades, for which these have different experiences, practices and needs. The objective of this work is to show the advances of the Programa de Investigación de Mamíferos Marinos (PRIMMA) of the UABCS, on participatory workshops, evaluations in compliance with regulations, surveys, interviews, and socio-economic information, developed in the communities involved in whale tourism. Since 2017, PRIMMA has taught workshops throughout the Mexican northwest in more than 10 sites on different topics of biology, monitoring, and conservation. In 2022 work was carried out focused on the communities that carry out gray whale watching in the Bahía Magdalena - Bahía Almejas BCS Lagoon Complex, in which biological monitoring and research were combined and complemented with the current social situation of these communities affected by the decrease in the number of gray whales, as this species is currently recovering from an unusual mortality event. The workshops seek to help guide WW towards a more sustainable and resilient activity, and it is being studied from a socio-ecological systems approach with multiple overlaps in sectors such as tourism, socioeconomic, political, research and environmental.

Keywords: Whale watching, gray whale, Bahía Magdalena- Bahía Almejas Complex, socio-ecological system