Laguna San Ignacio
Ecosystem Science Program
A Project of the Ocean Foundation in Baja California Sur, Mexico

# Annual Report of Gray Whale Research In Laguna San Ignacio and Bahía Magdalena, B.C.S., México During Winter 2024

Steven L. Swartz, Jorge Urbán R., Lorena Viloria, and Sergio Martínez A.

May 2024

**Our research activities and findings in the 2024 winter gray whale season include:**

**PAGE**

2024 PROGRAM SUMMARY. ……. .3

RESEARCH STAFF IN 2024……..4

GRAY WHALE ABUNDANCE & DISTRIBUTION……..5

PHOTOGRAPHIC IDENTIFICATIION RESEARCH……..12

MINIMUM AGE ESTIMATES FOR "OLD TIMER" WHALES……15

PHOTOGRAPHIC IDENTIFICATION FROM UAV-DRONES……16

GRAY WHALE UNUSUAL MORTALITY EVENT (UME): UPDATE……17

CETACEAN STRANDINGS & MORTALITY IN MEXICO 2024……19

BOAT-BASED BODY CONDITION ASSESSMENT……21

ACOUSTIC MONITORING AND RESEARCH……25

OUTREACH ACTIVITIES IN 2024……28

ACKNOWLEDGEMENTS……32

REFERENCE DOCUMENTS AND REPORTS……34

**Recommended Citation:**
Swartz, S., Martínez-Aguilar, A., Viloria-Gómora, L., and Urbán R., J. (2024). Annual Report of Gray Whale Research In Laguna San Ignacio and Bahía Magdalena, B.C.S., México. During Winter 2024. 35 pp. Available at:

https://www.sanignaciograywhales.org/

## 2024 PROGRAM SUMMERY

Declining gray whale body condition, low calf counts, and higher mortality rates were documented in Laguna San Ignacio (LSI) and in the Bahía Magdalena (BM) complex beginning in the winter of 2018 and were indications of the pending gray whale Unusual Mortality Event (UME) which continued from 2019 through 2023. Observations throughout the gray whale's range during the 2024 winter indicated an overall improvement in the whales' body condition, and fewer gray whale strandings. On this evidence, NOAA closed the gray whale UME in 2024 (NOAA Gray Whale UME Working Group 2024).

In the winter breeding and calving lagoons of Baja California, however, counts of female-calf pairs were the lowest recorded since our abundance surveys in these winter aggregation and breeding areas began in 2006, suggesting a major decline in the reproductive capacity of this population in recent years during the UME. In LSI the highest number of single adult (non-calf) whales counted in vessel surveys during 2024 was 201 whales on 25 February, which was higher than the counts observed at this time during the previous five winters of the UME. In contrast, counts of females with calves remained low in all areas. The 2024 calf counts were the lowest recorded in LSI numbering fewer than nine calves throughout the birthing period from January through February, with the highest count of only 15 female-calf pairs observed on 14 March. The highest gray whale survey count in BM was obtained on 24 February in the most southerly aggregation area of Bahía Almejas and was 243 single adult whales and no female-calf pairs. In central Bahía Magdalena gray whale counts were greatest on 23 February with 35 adult whales and no female-calf pairs. In the northern Canal de Santo Domingo, a high count of 17 single whales was observed on 19 February, and a count of only two female-calf pairs.

In this report we present our initial findings during the 2024 winter concerning the status of gray whales, their condition and reproduction, and our outreach.

# RESEARCH STAFF IN 2024

The Laguna San Ignacio Ecosystem Science Program (LSIESP) is a project of The Ocean Foundation in collaboration with the Programa de Investigación de Mamíferos Marinos (PRIMMA) of the Universidad Autónoma de Baja California Sur (UABCS), La Paz, B.C.S., México.

Drs. Jorge Urbán R., Steven L. Swartz, Sergio Martínez Aguilar (Laguna San Ignacio), and Lorena Viloria Gómora (Bahía Magdalena) directed the 2024 gray whale research. Collaborating researchers in 2024 included: at Laguna San Ignacio: Andrés Gonzáles Cisneros, Regina Lobo Barrera., Fabián Missael Rodríguez González, Job Olguin Hernández, Karen Y. Sánchez, and Noemi García. In Bahía Magdalena researchers included: Yazmín Julio Romero, Esthefania Alejandra Meza Orozco, Axel Adair Rosas Orozco, Aranza Paola Huerta Mendoza, Manuel Humberto Quintero Vega, and Francesca Díaz Cabal.

Drs. Fredrik Christiansen, of Denmark's Aarhus University, Department of Ecoscience, and Lars Bejder of the University of Hawaii at Manoa, Hawaii Institute of Marine Biology, continue to collaborate with our researchers on the application of UAV-drone photogrammetry methodology to measure cetacean growth, evaluate body condition, and measure the efficiency of energy conversion/transfer from female whales to their calves via mother's milk.

Our research was supported by grants from The Marisla Foundation, The Ocean Foundation, Natural Habitat Adventures Foundation, and private individual donors. In-kind support for logistics was provided by Kuyima Eco-Turismo, Searcher Natural History Eco-Tours, and Baja Discovery Whale-Watching. Field research was conducted under Scientific Research permits from the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT), Subsecretaría de Gestión Para La Protectión Ambiental, Dirección General De Vida Silvestre, de México.

Our gray whale research teams arrived in Laguna San Ignacio and Bahía Magdalena in mid-January to begin the 2024 gray whale research season. Our field research station at LSI, the "Francisco 'Pachico' Mayoral" field laboratory opened on January 16th and gray whale research activities continued through March 27th. Gray whale surveys and public outreach and environmental education workshops in Bahía Magdalena were conducted from January 11th to March 26th, 2024.

*Aerial View of our field research station Laboratory de "Francisco 'Pachico' Mayoral" located in the Kuyimita Campground on the south shore of Laguna San Ignacio.*

## GRAY WHALE ABUNDANCE & DISTRIBUTION IN LAGUNA SAN IGNACIO AND BAHÍA MAGDALENA

Boat surveys are conducted to document seasonal trends in gray whale abundance, and photographic identification methods are used to estimate the minimum number of individual gray whales visiting the primary gray whale winter aggregation and breeding lagoons. For the surveys, hand-held Global Position System (GPS) devices are used to follow predetermined survey track-lines in each lagoon area. In addition, observer and sighting protocols are specified for each lagoon's unique characteristics and are used to obtain and record whale counts along each track line. This method allows duplication of survey efforts to compare within-year survey counts along the survey tracks in each lagoon area and facilitates comparison with historical counts from previous years to document trends in the whales' use of these areas (Figs. 1 and 4).

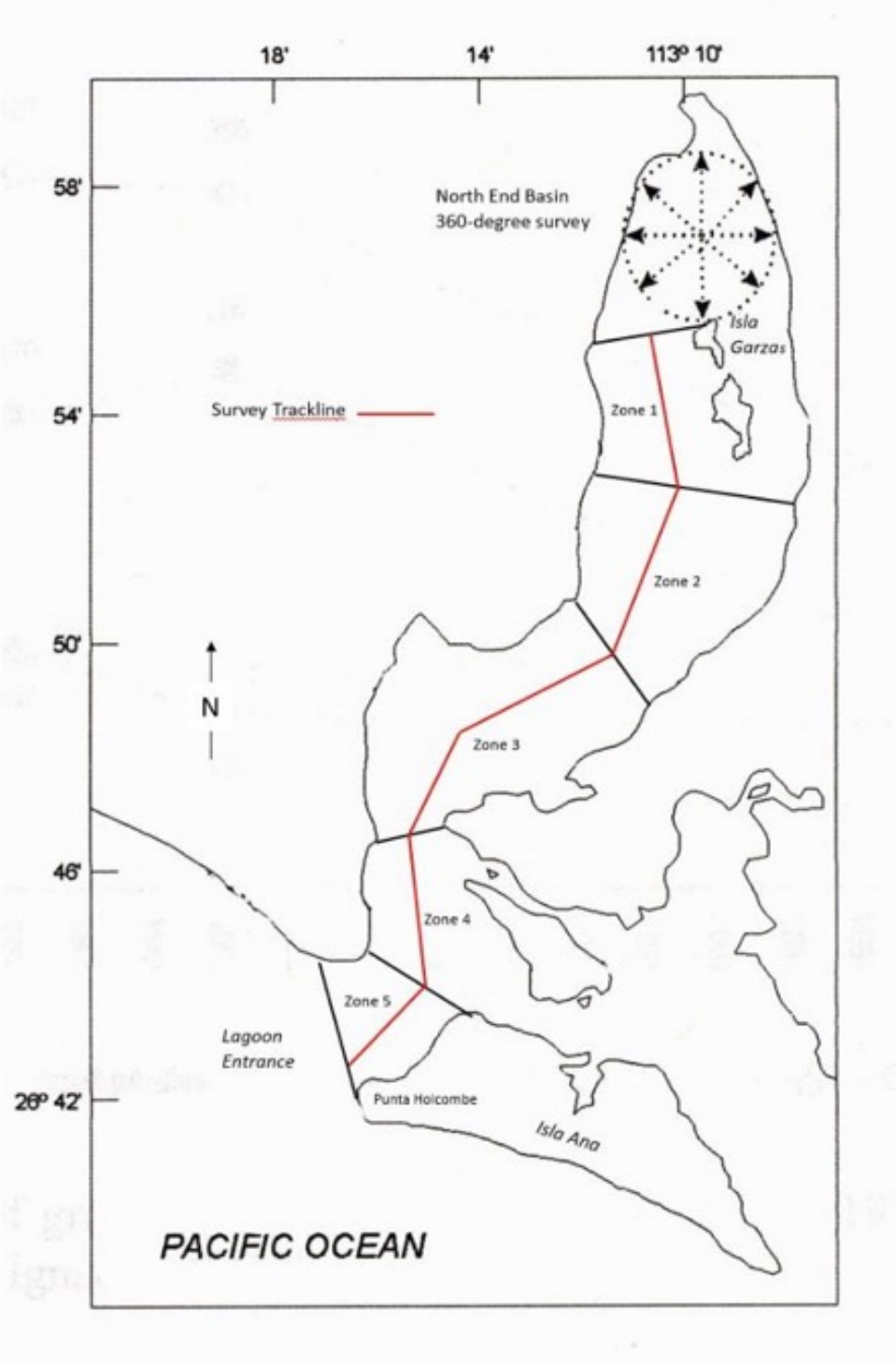


*Figure 1. Boat survey track-line for estimating minimum abundance of gray whales in Laguna San Ignacio. Counts of gray whales in the "North End Basin" portion of the lagoon are obtained from a $360^0$ scan of the area. The survey track line continues 30 km south from Isla Garzas (Zone 1) over the deepest portions of the lagoon to Punta Holcombe on the west end of Isla Ana at the entrance of the lagoon (Zone 5).*

**Laguna San Ignacio:** In LSI, 12 surveys of gray whales were completed in 2024 to monitor the seasonal abundance and habitat use. Surveys began on 18 January and continued until 20 March (Table 1). The arrival of gray whales began in mid-January and was similar to that seen previous winters from 2018 to 2023. However, departure times in 2024 were approximately two weeks earlier than in the UME years from 2019 to 2023 suggesting a trend of earlier departure in 2024 than during the period of the UME (Fig. 2).

The highest count of single adult whales (breeding males and females without calves) was 201 whales obtained on the 25 February survey (Fig. 2, Table 1). The numbers of these whales were generally lower to those observed in previous winters, with maximum counts ranging from 5 during the last survey on 20 March to the highest count of 201 on 25 February.

Counts of females with calves in LSI remained low throughout the entire 2024 winter season ranging from 2 to 9 pairs during January and February, with the highest number of 15 pairs counted on 14 March (Fig. 3, Table 1). Analysis of photographic identification data from previous winters indicate that some of the female calf pairs observed in LSI at the end of the season had previously been in the BM area. This "end of the season" increase of female-calf pair counts has historically occurred in LSI since the 1980's (Jones and Swartz 1984), however it did not occur during the UME from 2019 to 2023. The 2024 female-calf pair counts in LSI are the lowest number of pairs recorder for this lagoon since the surveys began in 2006.

*Table 1. Boat survey counts of gray whales: Female-calf pairs, Singles (whales without calves), and total Adults observed in Laguna San Ignacio during the 2024 winter breeding and calving season. Number of female-calf pairs equals the number of calves observed.*

| Survey | Date | Female-calf Pairs | Singles | Total Adults |
|---|---|---|---|---|
| 1 | 18-Jan-24 | 2 | 10 | 12 |
| 2 | 24-Jan-24 | 2 | 11 | 13 |
| 3 | 29-Jan-24 | 3 | 17 | 20 |
| 4 | 3-Feb-24 | 4 | 42 | 46 |
| 5 | 8-Feb-24 | 5 | 69 | 74 |
| 6 | 13-Feb-24 | 4 | 115 | 119 |
| 7 | 20-Feb-24 | 3 | 113 | 116 |
| 8 | 25-Feb-24 | 9 | 201 | 210 |
| 9 | 1-Mar-24 | 4 | 90 | 94 |
| 10 | 7-Mar-24 | 12 | 61 | 73 |
| 11 | 14-Mar-24 | 15 | 37 | 52 |
| 12 | 20-Mar-24 | 2 | 5 | 7 |

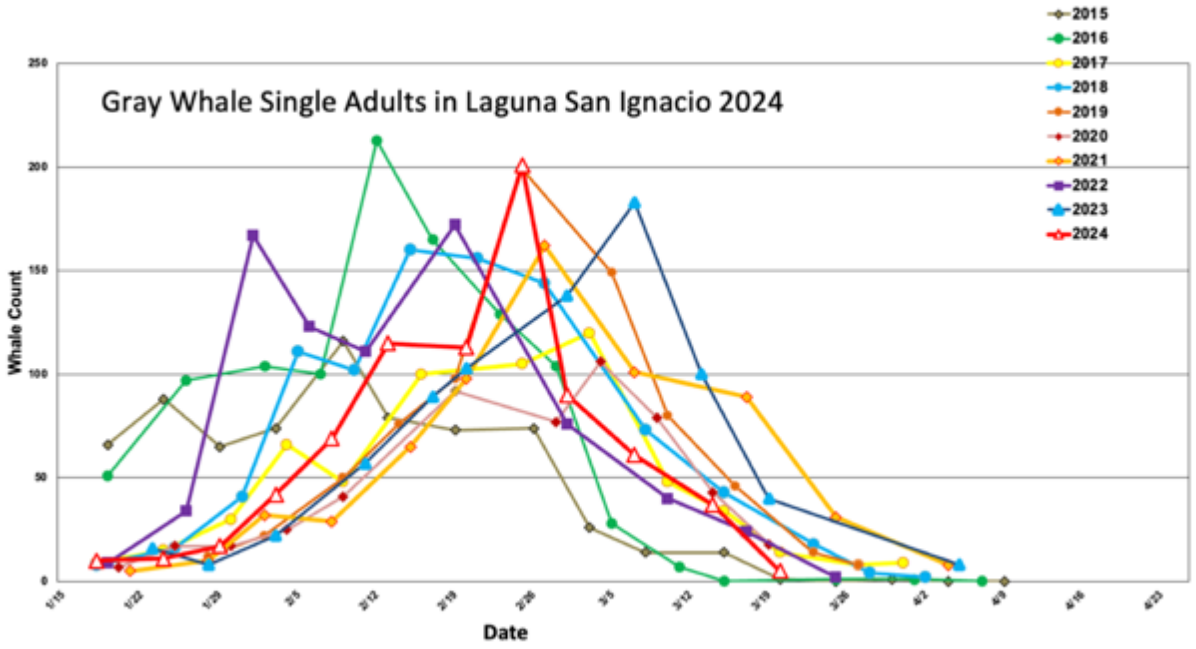


*Figure2. Counts of single adult whales observed in boat surveys in Laguna San Ignacio from 2015 to 2024.*

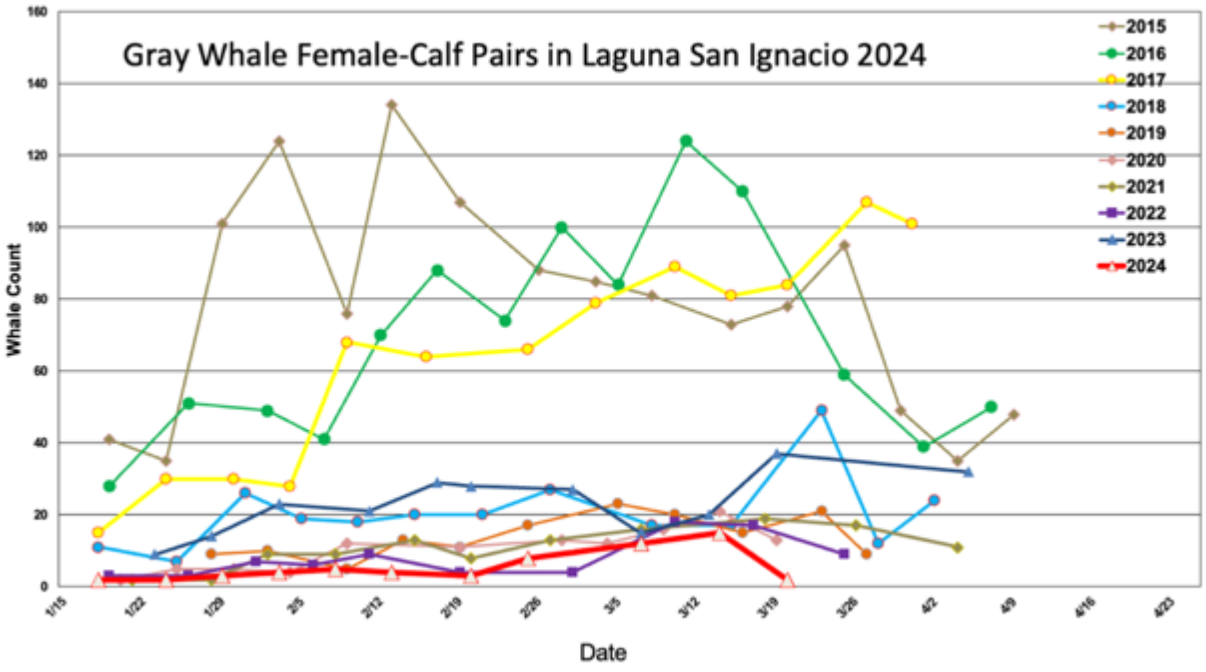


*Figure 3. Counts of female-calf pairs observed in boat surveys in Laguna San Ignacio from 2015 to 2024.*

Photographic identification data provides an additional method for estimating the number of individual gray whales that visit a particular aggregation and breeding lagoon during a winter. For example, while the largest number of single adult whales counted during the boat

surveys in LSI was 201 whales, 804 distinct individual single adult whales were identified from photographs obtained during the entire 2024 winter season. Similarly, the largest number of female-calf pairs counted in the boat surveys was 15 pairs, while 22 distinct females were photographed in the lagoon during the winter. See the "Photographic Identification" section on page 12 for more details.

**Bahía Magdalena:** The 2024 gray whale surveys in the BM lagoon complex were conducted in three different areas during four different periods (Fig. 4): 20-25 January, 4-6 February, 19-24 February, and 9-11 March (12-surveys in all) (Table 2, Fig. 5). The highest counts of gray whales were obtained on 24 February in the most southerly aggregation area of Bahía Almejas with 243 adult whales with no female-calf pairs observed. In central Bahía Magdalena, counts were greatest on 23 February with 35 adult whales and again no calves were observed. In Canal de Santo Domingo, the highest single whale counts from 17 individuals were obtained on the 19 February survey, along with 2 female-calf. Compared to previous years, gray whale abundance was generally low in all areas of BM after the first week in March, and further surveys were discontinued due to the departed from the BM complex earlier than in previous winters.

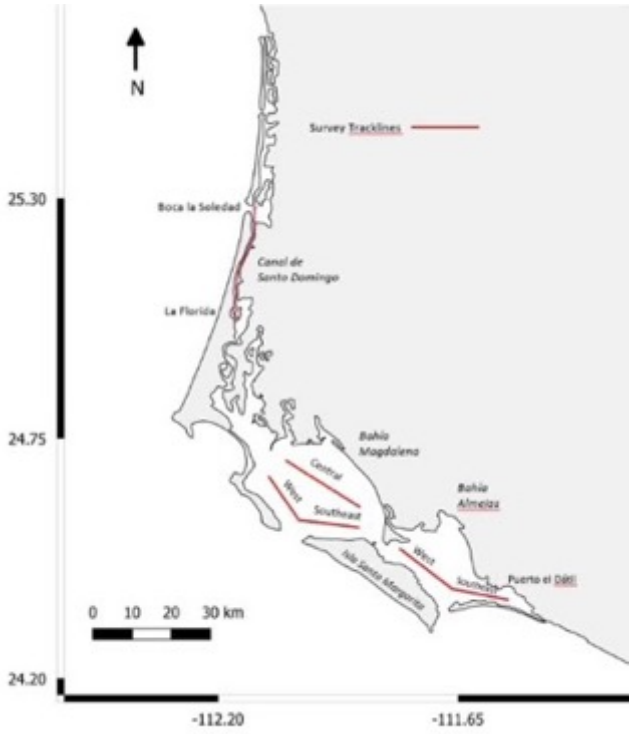


*Figure 4. Boat survey track-lines for estimating gray whale abundance and distribution in the Bahía Magdalena lagoon complex in three areas where gray whales aggregate: Canal de Santo Domingo in the north; Bahía Magdalena's center, west and southwest areas; and in Bahía Almejas in the south.*

*Table 2. Boat survey counts of gray whales (Female-calf pairs, Singles (whales without calves), and total Adults) in three areas within the Bahía Magdalena complex during the 2024 winter breeding and calving season. Number of female-calf pairs equals the number of calves observed.*

| LOCATION | DATE | FEMALE-CALF PAIRS | SINGLE WHALES | TOTAL ADULTS |
|---|---|---|---|---|
| **Bahía Almejas** | 25-Jan-24 | 0 | 64 | 64 |
| | 06-Feb-24 | 0 | 219 | 219 |
| | 24-Feb-24 | 0 | 243 | 243 |
| | 10-Mar-24 | 0 | 40 | 40 |
| | | | | |
| **Bahía Magdalena** | 20-Jan-24 | 0 | 1 | 1 |
| | 04-Feb-24 | 0 | 10 | 10 |
| | 23-Feb-24 | 0 | 35 | 35 |
| | 09-MAR-24 | 0 | 5 | 5 |
| | | | | |
| **Canal de Santo Domingo** | 21-Jan-24 | 0 | 0 | 0 |
| | 05-Feb-24 | 0 | 4 | 4 |
| | 19-Feb-24 | 2 | 17 | 19 |
| | 11-Mar-24 | 0 | 1 | 1 |

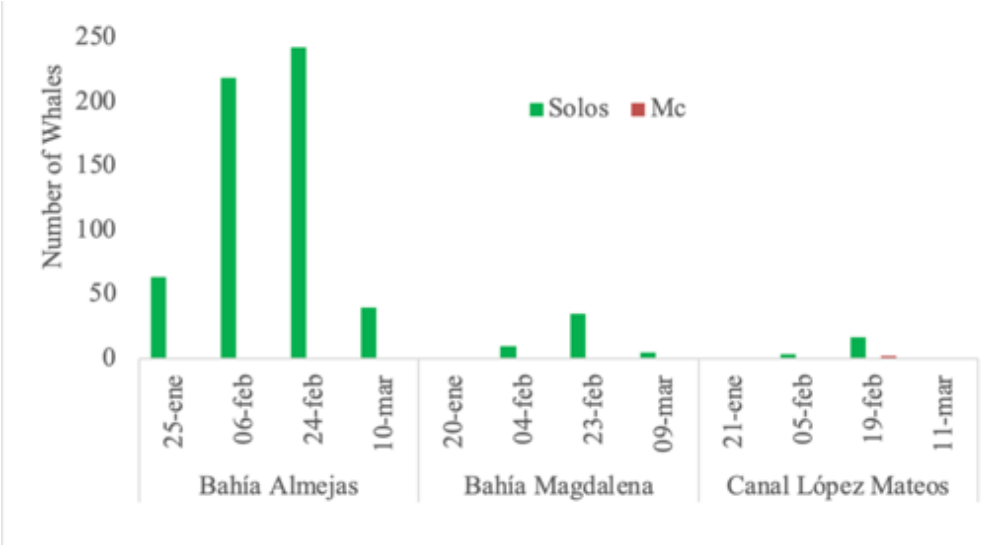


*Figure 5: Counts of Gray Whale in boat surveys in Bahía Magdalena during the 2024 season. Solos = Single adult whales without calves; Mc = Female-calf pairs; Ene = January; Feb = February; Mar = March.*

It is important to note that the total number of female-calf pairs observed in the BM complex increased from 5 in 2022 to 40 pairs in 2023, and then declined to only 2 pairs in 2024, further suggesting a reduction of the reproductive capacity of gray whale population during the UME of 2019-2023 (Fig. 6).

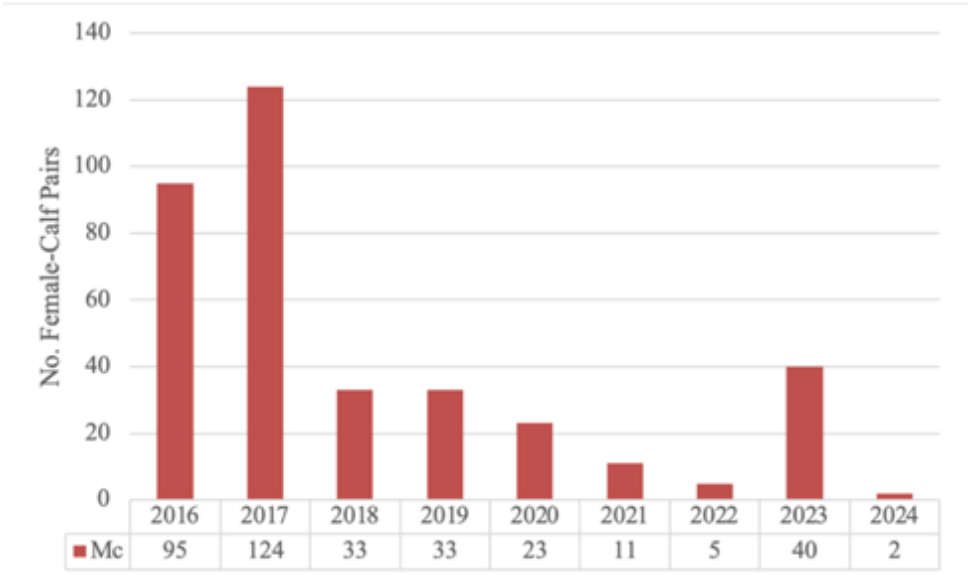


*Figure 6. The number of female-calf pairs observed in the Bahía Magdalena complex from 2016 to 2024.*

*For more details on gray whale abundance in these lagoon areas in 2024, see the following paper:*

**Urbán R., *et al*. (2024)**. 2024 Gray whale abundance in Laguna San Ignacio and the Bahía Magdalena lagoon complex, B.C.S., México. Rep. Intl. Whal. Commn. SC/69B/CMP/14.

# PHOTOGRAPHIC IDENTIFICATION RESEARCH

The naturally occurring pigmentation patterns, "white" scars, and other markings are characteristic for each individual gray whale and, because these are permanent features, they are used to identify individuals (Fig. 7). During boat-based photo-identification surveys digital photographs were taken of both the left and right sides of individual gray whales with Digital Single Lens Reflex (DSLR) cameras (e.g., Nikon D7500) fitted with Zoom telephoto lenses (e.g., 28mm-300mm). Shutter speeds of 1/1000 second and ISO setting at 400 are used to insure sharp images of the details of the markings on each whale.

All photographs are sorted and catalogued, especially noting those whales that are encountered and photographed multiple times during the winter season. The time periods between the first and last time an individual whale was photographed provides an estimate of the minimum amount of time that individual remained in the area, or a minimum residence time during that winter. Minimum residence times are calculated for single adults (males and females without calves), and for females with calves. Each catalog is then compared with catalogs from previous winters to identify individual whales that have visited an area in multiple years. Interannual sightings of whales are used to evaluate site fidelity to a particular lagoon or winter aggregation area, and a calving interval for breeding females. Photographs from both LSI and BM are compared to evaluate the exchange and movements of whales between these winter aggregation areas.

*Figure 7. Example of the distinctive markings on a gray whale that are used to identify individuals within and among winter breeding seasons.*

**Laguna San Ignacio Photographic Identification**: In LSI boat-based photo-identification surveys were conducted on 51 days in 2024, for a total effort of 253.9 hours, and yielded 411 sightings of gray whales. All 8,341 images obtained were sorted into catalogs and included 826 individual whales: 22 were females with calves of the year, and 804 were single adult whales (males and females without calves).

*Table3. Number of individual gray whales that visited Laguna San Ignacio between 2005 and 2024 estimated from photographic identification data.*

| Individual Gray Whales Visiting Laguna San Ignacio from Photo-ID Records | | |
|---|---|---|
| Ballenas grises individuales visitando la Laguna San Ignacio a partir de registros de identificación con foto- dentificación | | |
| Year / Año | Single Whales / Ballenas solitarias | Females with calves / Hembras con cria |
| 2005 | 271 | 114 |
| 2006 | 191 | 54 |
| 2007 | 272 | 74 |
| 2008 | 152 | 88 |
| 2009 | 440 | 75 |
| 2010 | 515 | 38 |
| 2011 | 321 | 187 |
| 2012 | 332 | 211 |
| 2013 | 292 | 183 |
| 2014 | 443 | 195 |
| 2015 | 230 | 274 |
| 2016 | 350 | 218 |
| 2017 | 305 | 195 |
| 2018 | 411 | 83 |
| 2019 | 575 | 40 |
| 2020 | 419 | 54 |
| 2021 | 500 | 43 |
| 2022 | 532 | 41 |
| 2023 | 535 | 83 |
| 2024 | 804 | 22 |
| TOTAL | 7890 | 2272 |

Beginning in 2023 numbers of female-calf pairs photographed in LSI began to increase, but then declined to 22 pairs in 2024, the lowest ever recorded for this wintering area since our surveys began in 2006. This decline in reproduction is presumed to be related to the Unusual Mortality Event (UME) that began in 2019 which was characterized by a range-wide increase in mortalities of adult female whales (see section on the Unusual Mortality Event on page 17 for more details).

Photographic identification data provides an additional method for comparing estimates of the total number of individual gray whales that visit a particular breeding lagoon and winter aggregation area. Table 3 lists the numbers of individual whales that visited and were photographed at least once in LSI during each 3-month winter breeding season from 2005 to 2024. The number of single adult whales (males and females without calves) have

remained relatively constant between 2009 (n=440) and 2023 (n=535) but increased to 804 single whales in 2024. In comparison, the number of females with calves ranged about 187-195 pairs from 2011 to 2017, but then declined significantly beginning in 2018 and continued to remain low with less than approximately 50 pairs photographed in the lagoon during the UME years from 2019 through 2022.

In 2024 the estimated average minimum residence time for females with calves was 32.7 days with a maximum residence time of 67 days. The average minimum residence time for single adults was 6.9 days with a maximum residence time of 33 days. Table 4 shows average and maximum residence times for gray whales in LSI in previous years from 2010 to 2024.

Between 2010 and 2023 the average residency times for females with calves range from 29.3 days (2016) to 43.4 days (2018), with maximum days between the first and last time they were photographed ranging from 60 days (2019) to 89 days (2014). Single adult whales spend much less time in a particular location with their average residency times being 5.2 days (2018) to 16.3 days (2011), with maximum residency times estimated at 20 days (2010) to 68 days (2015 and 2017).

*Table 4. Average and maximum residence times for gray whales photographed in Laguna San Ignacio: 2010-2023.*

| YEAR | SINGLE WHALES | | | FEMALE-CALF PAIRS | |
|---|---|---|---|---|---|
| | AVERAGE NO. DAYS | MAX. DAYS | | AVERAGE NO. DAYS | MAX. DAYS |
| 2010 | 6.9 | 20 | | 31.9 | 73 |
| 2011 | 16.3 | 72 | | 39.1 | 84 |
| 2012 | 11 | 67 | | 37.5 | 81 |
| 2013 | 9.4 | 56 | | 35.3 | 80 |
| 2014 | 7.6 | 34 | | 37.6 | 89 |
| 2015 | 9.6 | 68 | | 31.5 | 82 |
| 2016 | 8 | 31 | | 29.3 | 80 |
| 2017 | 13.2 | 68 | | 32.7 | 74 |
| 2018 | 5.2 | 22 | | 43.4 | 80 |
| 2019 | 6.4 | 34 | | 31.7 | 60 |
| 2020 | 6.7 | 44 | | 24.5 | 62 |
| 2021 | 9.3 | 62 | | 36.4 | 71 |
| 2022 | 7 | 30 | | 32.3 | 73 |
| 2023 | 6.4 | 33 | | 34.3 | 68 |
| 2024 | 6.9 | 33 | | 32.7 | 67 |

**Bahía Magdalena Photographic Identification**: In the BM study area, gray whale photo-identification surveys were conducted in three locations in 2024: central Bahía Magdalena, Bahía Almejas, and in Canal de Santo Domingo. The total effort for the season was 390 hours, during these surveys 182 gray whale sightings were made, and 11,271 digital images were obtained. From these images 748 individual whales were identified and include 750 single adults (males and females without calves) and 8 females with calves of the year. The estimated maximum residence time (time between the first and last photo-identification) was 7 days for females with calves and 9 days for single adult whales.

# Minimum age estimates for “Old Timer” whales

A female gray whale first photographed in LSI with a calf during the 1977 winter season has returned to this lagoon multiple times over a 47-year period. Most recently she was re-sighted and photographed in 2024 (Figs. 8a and 8b). This sighting allowed estimation of her minimum age of between 53-55 years. Such annual re-sightings of previously identified “old timer” whales allow the evaluation of long-term reproductive history for female gray whales
.

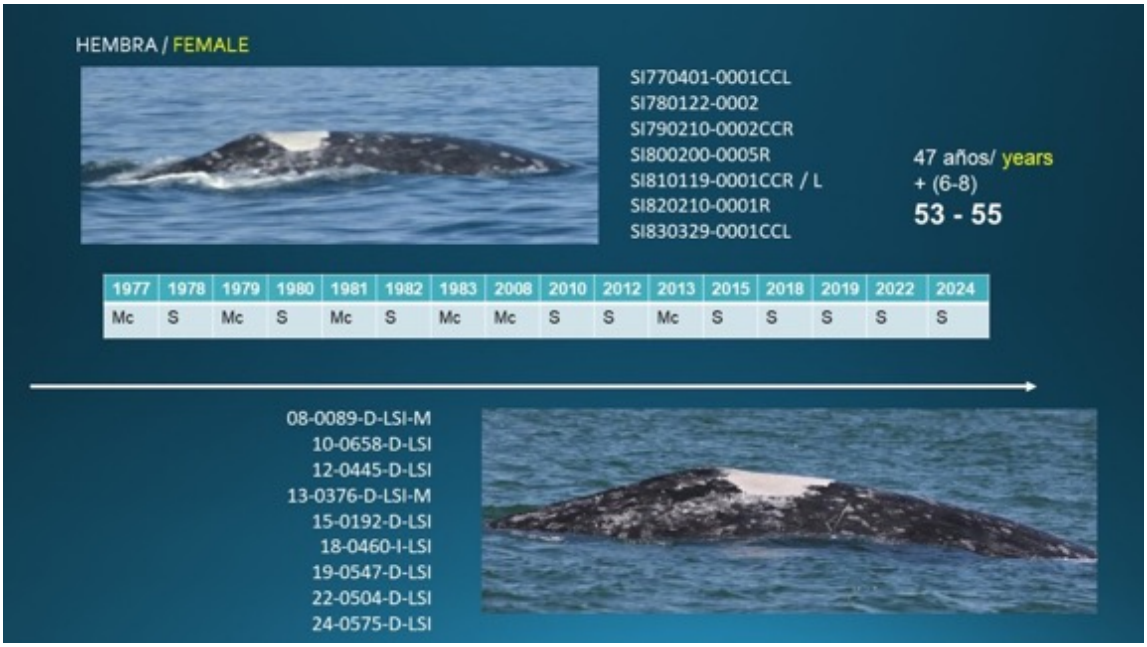


*Figure 8a (above) and 8b (below). A female gray whale first photographed in LSI in 1977 has been re-photographed in LSI lagoon on 16 occasions over 47 years, and her age is estimated at between 53-55 years.*

# PHOTO-IDENTIFICATION OF GRAY WHALES FROM UNMANNED AERIAL VEHICLES (UAV-Drones)

*Figure 9. Photo-Identification example of a whale's back photographed by UAV- drones.*

While similar to boat-based photo-identification, aerial photography from UAVs (drones) is another non-invasive method to photographically identify individual whales from their unique naturally occurring markings (Rodríguez-González and Olguín-Hernández, 2023). Beginning in 2017 UAVs with high-definition video cameras are used in gray whale winter aggregation areas to simultaneously observe and record both sides of the dorsal region of gray whales in a single image (Fig. 9).

A total of 572 UAV flights (216h) were conducted in Laguna San Ignacio in 2024 by flying two Mavic 3 Pro drones simultaneously for the first time (one for photo-Id and the other for body condition). From these data, 803 solitary individuals (animals with no calf) and 20 female and calf pairs were identified (Table 5).

*Table 5. Sampling effort and total number of photo-identifications from UAV-drones from 2017 to 2024.*

| YEAR | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|
| FLIGHTS | 61 | 452 | 562 | 285 | 76 | 290 | 289 | 572 |
| HOURS | 11.2 | 83.6 | 79.2 | 80.15 | 22.15 | 79.95 | 65.3 | 216.4 |
| SINGLE WHALES | 12 | 235 | 419 | 296 | 181 | 478 | 231 | 803 |
| FEMALE-CALF PAIRS | 22 | 62 | 35 | 46 | 16 | 30 | 55 | 20 |

From these images 565 body condition images were extracted and will be analyzed to obtain length, volume and body condition for each whale by age class (calf, juveniles, adults, lactating females) for 2024 season, and to compare with previous seasons (Fig. 10). See the LSIESP Annual Report for 2023 for the methodology used to evaluate condition from UAV photogrammetry data.

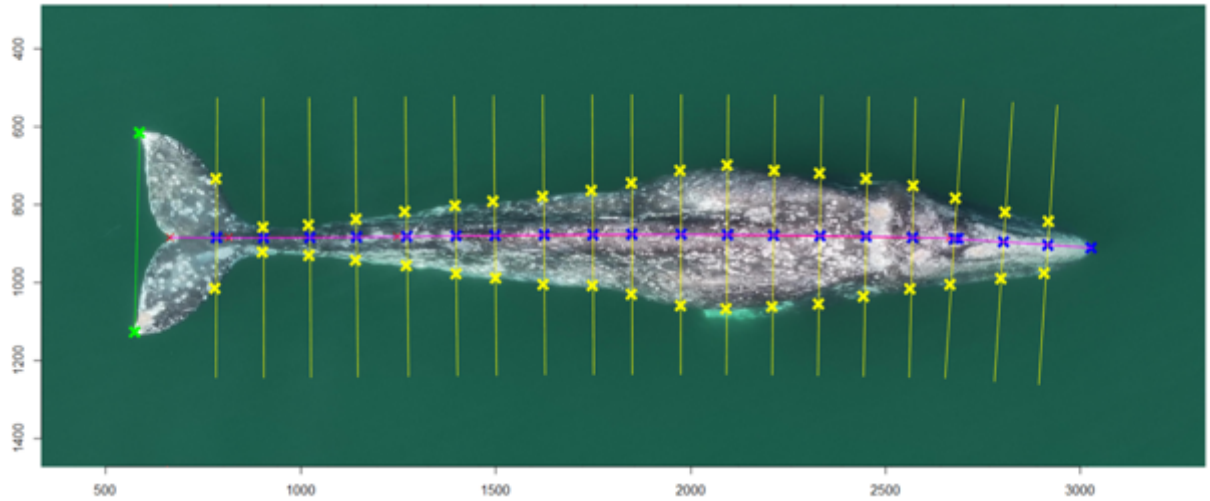


*Figure 10. An illustration of the method used to measure whale length and width from images obtained by drones, and used to calculate an individual whale's total body volume and evaluate overall body condition.*

## GRAY WHALE UNUSUAL MORTALITY EVENT (UME): UPDATE 2019-2023

During the last two decades, the North Eastern Pacific gray whale population has experienced two range-wide Unusual Mortality Events (UMEs): the first occurred from 1999-2000, with at least 319 stranded dead whales discovered in the breeding and calving areas in Mexico, and the second UME during the period from 2019 to 2023 when a minimum of 690 gray whales were discovered stranded throughout their range along the west coast of North America (Table 6., NOAA 2024). Of those stranded whales could be examined (n-189), 33.8% were emaciated and in poor nutritional condition, while 35.9% were in thin or fair condition, further suggesting that food resource limitation was contribution to the UME.

Reports in 2024 from throughout the population's range indicated a reduction in

strandings to baseline levels before the UME, and improved overall body condition of living whales prompting U.S. National Oceanic and Atmospheric Administration (NOAA) to declare that the gray whale UME of 2019-2023 was over.

*Table 6: Eastern North Pacific gray whale strandings by country from 2019 through April 2023 (From NOAA, Fauquier et al., 2024).*

| Country | 2019 | 2020 | 2021 | 2022 | 2023 | Total |
|---|---|---|---|---|---|---|
| Canada | 11 | 5 | 5 | 4 | 2 | 27 |
| U.S. | 122 | 79 | 55 | 47 | 44 | 347 |
| Mexico | 83 | 88 | 55 | 54 | 36 | 316 |
| **Total** | **216** | **172** | **115** | **105** | **82** | **690** |

Abundance estimate for the Eastern North Pacific population at the beginning of the UME was 20,500 in 2020, and had declined to an estimated to 14, 526 whales by 2023 (Stewart and Weller. 2021a and 2021b, Eguchi *et al.* 2022 and 2023) indicating that a significant reduction of the population occurred during the UME. Numbers of gray whale female-calf pairs observed also declined from 380 calves in 2021 to an estimated 217 in 2022, the lowest recorded in the NOAA time series that began in 1994 (Fauquier *et al.* 2024).

To date a single primary cause of the 2019-2023 gray whale UME has not been identified, and is likely the event had multiple contributors, including mortality linked to killer whale predation, fishing gear entanglements, vessel strikes, and poor body condition possibly associated with ecosystem changes in sub-Arctic and Arctic feeding areas. These changes likely contributed to the declining nutritional condition observed in live whales in the wintering areas of Mexico and to the deaths of stranded gray whale in all three countries, resulting in decreased production of calves and an overall decreased in the population's abundance.

Stewart *et al.* (2023) described two factors that may be responsible for the swings observed in the Eastern Pacific gray whale population. First, the whales feed on amphipods, a low-trophic-level crustacean prey that is affected directly by environmental fluctuations. Secondly, gray whales use a capital breeding strategy, in which they feed intensively during the summer and draw on stored energy reserves to fuel their long migrations and the costs of reproduction during the remainder of the year. Climate driven interannual variation in the duration of their feeding season, caused by the timing of sea ice formation and breakup, shifting of prey distributions, etc. can affect their ability to obtain and store enough energy during the summer feeding period.

Changing environmental conditions in the gray whales' northern feeding areas may be reducing the availability of food during the summer months, necessitating additional

searching time to find food (Moore *et al.*, 2022). While insufficient prey could contribute to the reduced reproduction and apparent decline in the body condition of gray whales, disease and environmental stressors *(e.g.,* climate change) are also likely major factors that drove the UME.

*More information on the gray whale UME and probable contributing causes, is available in the following articles:*

**Christiansen, F., et al. 2021.** Poor body condition associated with an unusual mortality event in gray whales. Marine Ecology Progress Series Vol. 658: 237-252. Available on LSIESP website: https://www.sanignaciograywhales.org/research/publications/

**Fauquier, D., et al. 2024.** Eastern North Pacific Gray Whale (*Eschrichtius robustus*): an update on the 2019-2023 Unusual Mortality Event. Rep. Intl. Whal. Commn. SC/69B/E/01.

**Moore, S.E. et al. 2022.** Changes in gray whale phenology and distribution related to prey variability and ocean biophysics in the northern Bering and eastern Chukchi seas. PLoS ONE 17(4): e0265934, doi;10.1371/journal.pone.0265934. 26pp.

**NOAA, 2024.** Gray whale Unusual Mortality Event (UME): 2019-2023 – CLOSED. Available online at: https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2023-eastern-north-pacific-gray-whale-ume-closed

## CETACEAN STRANDINGS AND MORTALITIES IN BAJA CALIFORNIA AND BAJA CALIFORNIA SUR: 2024

The number of strandings discovered in LSI were three: two adult gray whales and one Bottlenose dolphin (*Tursiops truncatus*) (Table 7). Five stranded cetaceans were discovered in the BM region in 2024: a juvenile gray whale 7.6 m at Campamento Isabel on Magdalena Island, and another on February 16 on Isla San Lorenzo. A third stranded gray whale was reported at the mouth of Bahía Almejas on March 11, however the research team could not access the whale due to bad weather. On March 16, 2024, a stranded juvenile humpback whale (*Megaptera novaeangliae*) 5.8 m long was discovered on Magdalena Island, and a stranded 1.7 m long common dolphin (*Delphinus delphis*) (Table 8).

*Table 7. Stranded dead cetaceans documented Laguna San Ignacio in 2024.*

| NUMBER | SPECIES | DATE | SEX | AGE CLASS |
|---|---|---|---|---|
| LSI-001 | *E. robustus* | 3-Feb-24 | Female | Adult |
| LSI-002 | *E. robustus* | 9-Mar-24 | Female | Adult |
| LSI-003 | *Tursiops truncatus* | 19-Mar-24 | Unknown--- | Calf |

*Table 8. Stranded dead cetaceans documented in Bahía Magdalena area in 2024.*

| NUMBER | SPECIES | DATE | SEX | AGE CLASS |
|---|---|---|---|---|
| BM-001 | *E. robustus* | 12-Feb-24 | Female | Juvenile |
| BM-002 | *E. robustus* | 16-Feb-24 | Female | Unknown |
| BM-003 | *E. robustus* | 11-Mar-22 | Unknown | Unknown |
| BM-004 | *M. novaeangliae* | 16-Mar-24 | Unknown | Juvenile |
| BM-005 | *D. delphis* | 16-Mar-24 | Unknown | Adult |

**Gray Whale Strandings in Mexico in 2024**: From 28 December 2023 to 11 April 2024, 21 stranded dead gray whales were reported from Mexican waters. These included calves, yearlings, and adults, of which 11 were females, four were males, and six were of unknown sex. (Table 9).

*Table 9. Stranded gray whales discovered in Baja California and Baja California Sur, Mexico in 2024.*

| NUMBER | DATE | FIELD ID | SEX | AGE CLASS | LENGTH (M) |
|---|---|---|---|---|---|
| 1 | 28-Dec-23 | VIZ-001 | --- | Adult | 12 |
| 2 | 7-Jan-24 | ENS-001 | --- | Calf | --- |
| 3 | 30-Jan-24 | LOL-001 | Female | Adult | --- |
| 4 | 3-Feb-24 | LSI-001 | Female | ADULT | --- |
| 5 | 7-Feb-24 | CAB-001 | --- | --- | --- |
| 6 | 12-Feb-24 | BM-001 | Female | Yearling | 7.6 |
| 7 | 16-Feb-24 | BM-002 | Female | Adult | 12 |
| 8 | 23-Feb-24 | LOL-002 | Male | Adult | 13.8 |
| 9 | 23-Feb-24 | LOL-003 | Male | Adult | 12.5 |
| 10 | 23-Feb-24 | VIZ-002 | --- | Adult | --- |
| 11 | 5-Mar-24 | LOL-004 | Female | Adult | 12.5 |
| 12 | 9-Mar-24 | LSI-002 | Female | Adult | 12.6 |
| 13 | 11-Mar-24 | BM-003 | --- | --- | --- |
| 14 | 20-Mar-24 | ENS-002 | --- | Yearling | 7.2 |
| 15 | 22-Mar-24 | LOL-005 | Female | Adult | 12.1 |
| 16 | 22-Mar-24 | LOL-006 | Female | Calf | 6.5 |
| 17 | 28-Mar-24 | LOL-007 | Female | Yearling | 7.5 |
| 18 | 29-Mar-24 | LOL-008 | Female | Adult | 13 |
| 19 | 30-Mar-24 | LOL-009 | Female | Adult | 12.3 |
| 20 | 9-Apr-24 | LOL-010 | Male | Adult | 12.4 |
| 21 | 11-Apr-24 | LOL-011 | Male | Adult | 12.2 |

## BOAT-BASED BODY CONDITION ASSESSMENT

The evaluation of a whale's body condition provides an indicator of its health and reproductive condition and is indirectly an indicator of the environment's health. During the 2024 season in Laguna San Ignacio, 826 gray whales were photographed, from which the body condition of 655 single adult whales (male or female without a calf) and 22 females with calves were evaluated and classified according to the amount of body fat present in three body areas (the head, scapula, and flank) (Lobo-Barrera, *et al.* 2024, Fig. 11).

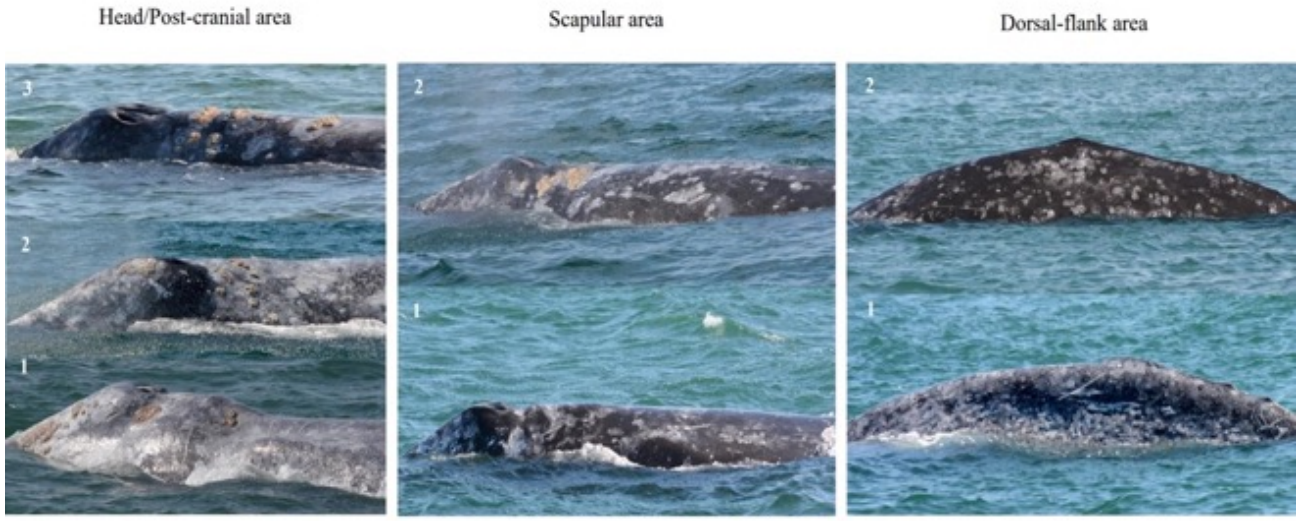


*Figure 11. Example of the numerical values assigned to determine body condition for the postcranial area (head), scapula and dorsal-flank. The highest values indicate the best condition.*

**Laguna San Ignacio Body Condition:** The percentage of single adult whales with "good body condition" was 60.6% (n=397), "fair" 34.8% (n=228) and "poor" 4.6% (n=30), and the body condition of females with calves was 81.8% "good" (n=18), 18.2% "fair" (n=4) and 0% "poor' (n=0) (Table 10). The percentage of single whales with "good" presented a small decrease compared to 2023 but was improved compared to the 2019-2023 period (Fig. 12). There was an increase in "fair" body conditions compared to 2023 but similar to 2019-2022 period; meanwhile, the percentages of whales with "poor" body condition decreased, being the lowest since the Unusual Mortality Event (UME) began in 2019.

Observations of female whales with calves in LSI in 2024 reflected a high percentage of "good" body condition (81.8%), but not the highest in the previous five winters that ranged from 50% to 95% (Table 10, Fig. 13). In addition, the percentage of females with calves observed in "fair" condition in 2024 is the highest in the last four years. However, it's worth noting that these females where first photographed at the end of the season, therefore their "fair" condition could be due to the energy loss due to additional months of lactation to feed

*Table 10. Number and percentage of gray whales by body condition category and group type (Females with calves and Single adult whales) photographed by boat in Laguna San Ignacio, B.C.S. Mexico from 2019 to 2024.*

| **Singles/ Year** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** |
|---|---|---|---|---|---|---|
| No. whales Photo-identified | 847 | 696 | 746 | 746 | 618 | 844 |
| No. whales categorized | 529 | 553 | 658 | 626 | 526 | 677 |
| Good Condition | 117 | 166 | 259 | 269 | 311 | 397 |
| | 22.1% | 33.3% | 42.1% | 43% | 70% | 60.6% |
| Fair Condition | 287 | 183 | 206 | 235 | 94 | 228 |
| | 54.3% | 36.7% | 33.5% | 37.5% | 21.2% | 34.8% |
| Poor Condition | 125 | 150 | 150 | 122 | 39 | 30 |
| | 23.6% | 30% | 24.4% | 19.5% | 8.8% | 4.6% |

| **Females with Calves/ Year** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** |
|---|---|---|---|---|---|---|
| No. whales Photo-identified | 41 | 56 | 43 | 42 | 83 | 22 |
| No. whales categorized | 40 | 54 | 41 | 42 | 82 | 22 |
| Good Condition | 20 | 38 | 41 | 38 | 68 | 18 |
| | 50% | 70.3% | 95.3% | 90.5% | 82.9% | 81.8% |
| Fair Condition | 20 | 13 | 2 | 4 | 11 | 4 |
| | 50% | 24.2% | 4.7% | 9.5% | 13.5% | 18.2% |
| Poor Condition | 0 | 3 | 0 | 0 | 3 | 0 |
| | 0% | 5.5% | 0% | 0% | 3.6% | 0% |

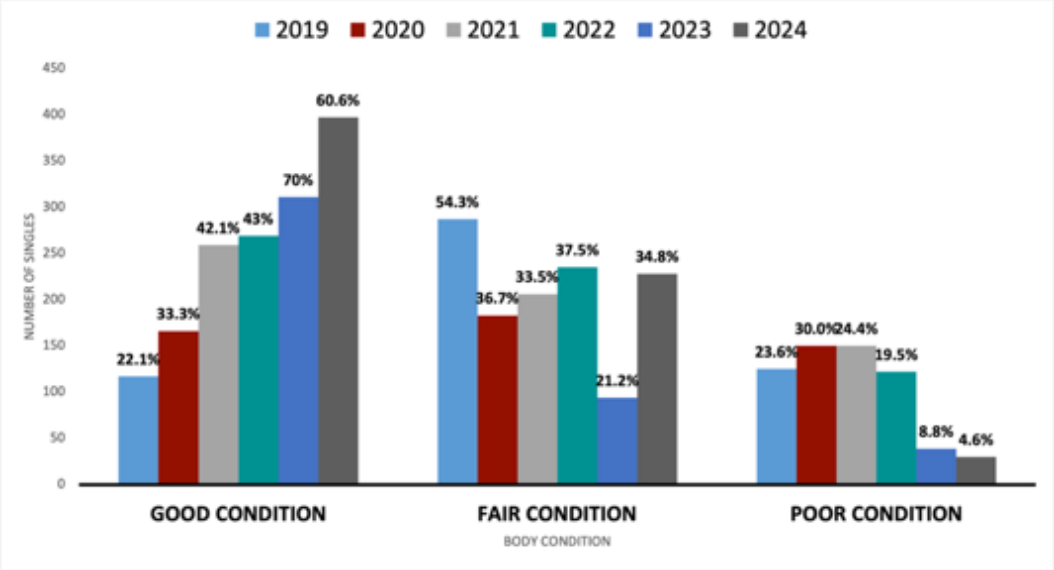


*Figure 12. The number and percentage of single whales' body condition from boat-based photographs in Laguna San Ignacio from the 2019 to 2024 winters*.

their calves. Similarly to the 2019, 2021 and 2022 seasons, no females with calves were observed in "poor" body condition in 2004. However, while their condition improved, there was a significant decrease in the number of females with calves observed this year, dropping from 83 in 2023 to only 22 in 2024, the lowest calf count ever observed since the monitoring of LSI started in 2006 (Martinez, *et al*. 2024, Table 3).

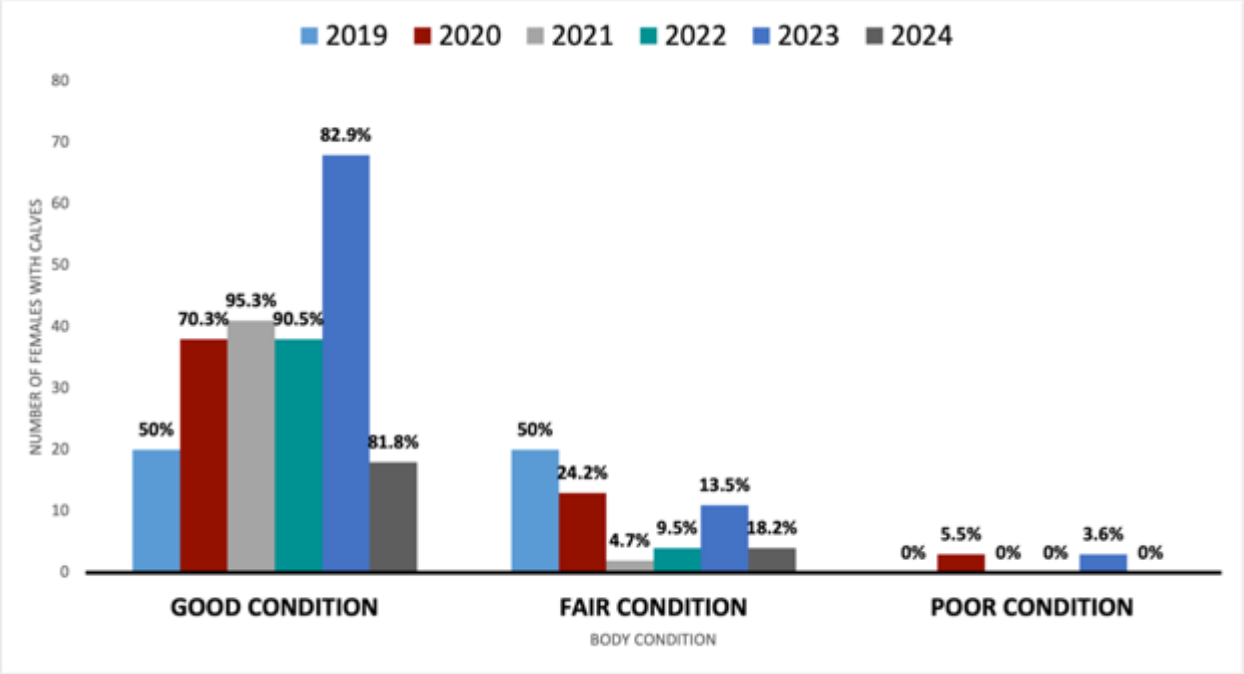


*Figure 13. Body condition of females with calves evaluated from boat-based photographs in Laguna San Ignacio from the 2019 to 2024 winters*.

*Photograph by Sergio Martínez-Agular 2023*

**Bahía Magdalena Body Condition:** During the 2024 winter season total of 758 gray whales were photographed in the three study areas of Bahía Magdalena and, of these the body condition was evaluated for 439 single adult whales, and 8 females with calves (Table 11). All of the females with calves had normal or acceptable body condition (Fig. 14), and only 7% (n=40) of the single whales exhibited poor condition (Fig. 15).

Table 11. Gray Whale Body Condition in Bahía Magdalena in 2024.

| Condition | Female-calf pairs | Single Adults |
|---|---|---|
| Normal | 7 | 195 |
| Acceptable | 1 | 204 |
| Poor | 0 | 40 |
| Undetermined | 0 | 311 |
| Totals | 8 | 750 |

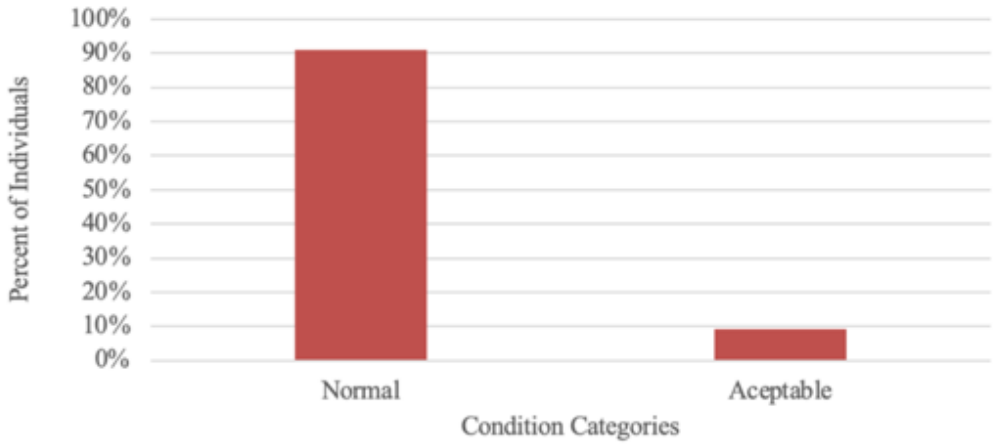


*Figure 14. Proportion of females with gray whale calves according to their body condition for the year 2024 in the Magdalena Bay lagoon complex, Almejas and La Soledad channel.*

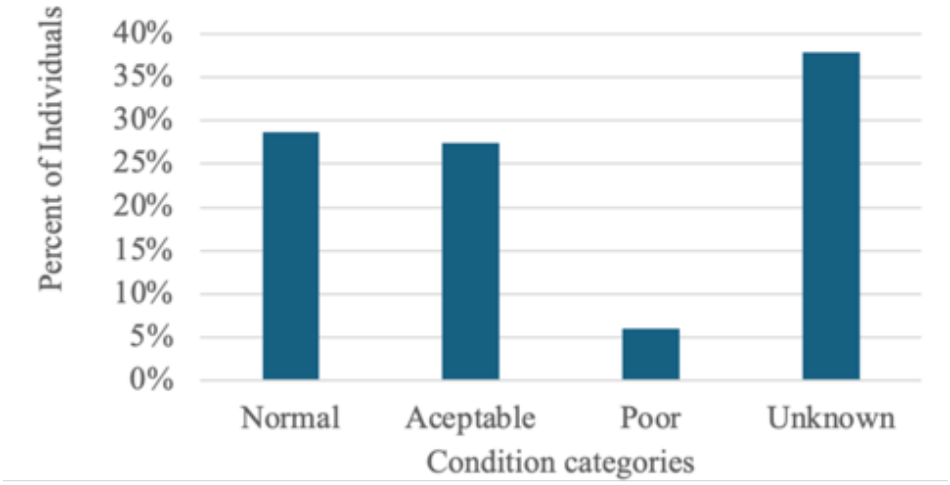


*Figure 15. Proportion of single gray whales according to their body condition classifications in the Magdalena Bay complex, Almejas and La Soledad channel.*

## ACOUSTIC MONITORING AND RESEARCH

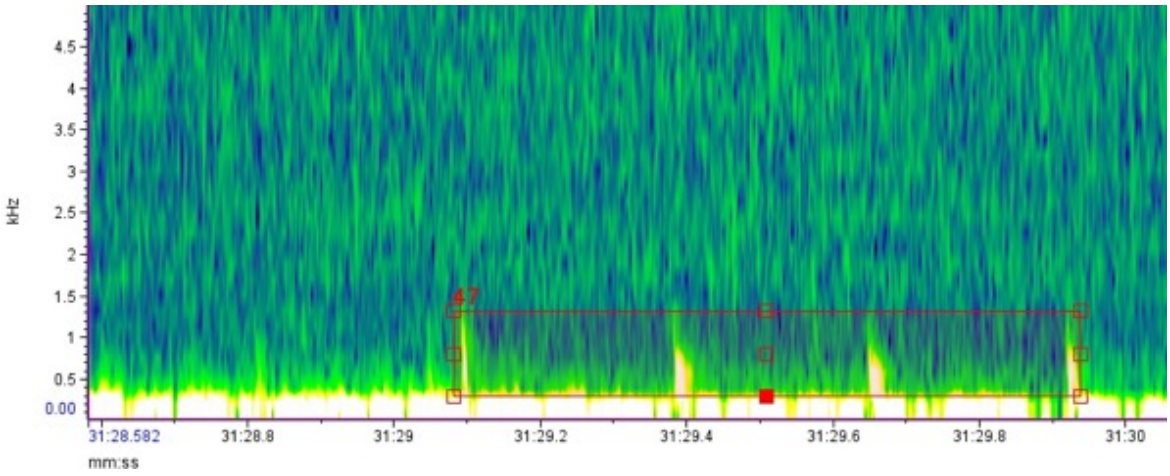


*Figure 16. Spectrogram of a gray whale "conga" calls recorded in Bahía Almejas during the 2024 gray whale winter season.*

**Laguna San Ignacio:** Beginning in 2005 Dr. Aaron Thode of Scripps Institution of Oceanography has led the investigation of underwater sound in LSI. His teams of graduate students managed to record biological, physical, and anthropogenic sources of sounds in the lagoon as part of a long-term effort to document sound sources and their levels in the lagoon and identify trends over time. Regarding gray whale vocal behavior, these researchers hope to match changes in the whales' acoustic repertoire across years with changes in the whales'

demographic composition across years. A goal is to identify whether specific sound types are associated with mating groups of whales, single animals, or female calf pairs.

In February 2024 the LSIEP team deployed two acoustic recorders in 13 m depth next to Punta Piedra, the same location that we have deployed since 2005, and close to the site of the original pioneering recordings made by Marilyn Dahlheim in the 1980s. The recorders sampled at 96 kHz and were thus able to record sounds from fish, dolphins, crustaceans, and gray whales. One recorder logged 45 minutes of data every hour until March 3, after which the second recorder began logging data through March 21. Thanks to the efforts of Fabian Aguilar, a local diver who works for Kuyima Eco-Tourismo, and LSIESP researchers, all the acoustic gear was successfully recovered on March 21, after most whales had left the lagoon. These multi-year recordings provide a unique long-term acoustic database for this marine protected area.

**Bahía Magdalena**: In 2024 acoustic monitoring of gray whales and underwater ambient sounds was initiated in this southern winter aggregation area. Underwater recording devices, SoundTrap ST600 STD – Long Term Recorder hydrophones, were placed at two locations in the Bahía Almejas region of BM. These instruments have a sensitivity of 20 Hz to 60 kHz and a sampling rate of up to 192 kHz/sec (Fig. 16). The two hydrophones were configured with a sampling rate of 4096 Hz, to make 5-minute recordings, with a 2-minute break between recordings, for 24 hours (1030 minutes of effective recording). Hydrophone 1 was placed at North Latitude 24.396528, West Longitude -111.584814, while Hydrophone 2 at North Latitude 24.373931, West Longitude -111.684675 (Fig. 18).

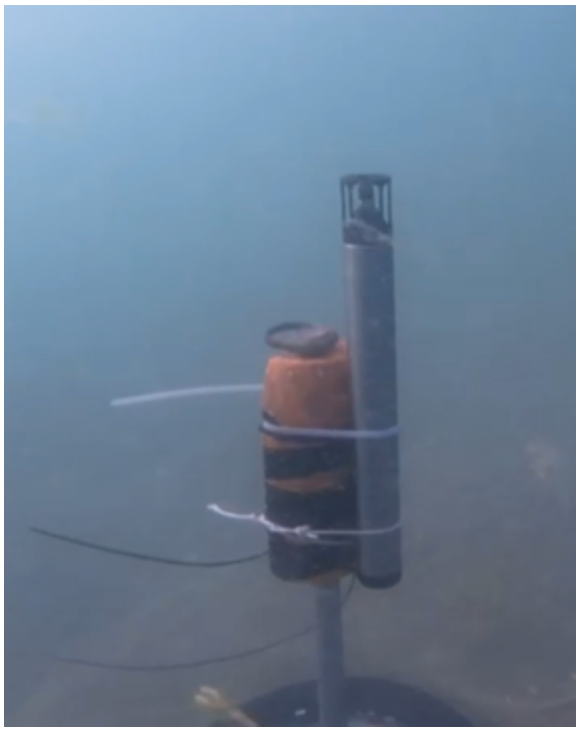

*Figure 17. Recording SoundTrap ST600 STD hydrophone placed in Bahía Almejas during the 2024.*

The instruments were fixed to the bottom with an anchoring system, and programmed to record for two periods of the 2024 gray whale breeding season: from January 29 to February 17, and from February 17 to March 16, 2024 (Figure 17). These underwater recordings will be the foundation of baseline underwater acoustic information for this region of Bahía Magdalena as the whale-watching eco-tourism programs continue to develop.

*Figure 18. The location of recording hydrophones in Bahía Almejas, Baja California Sur, Mexico. Hydrophone 1 (H1), Hydrophone 2 (H2).*

# OUTREACH ACTIVITIES IN 2024

*Figure 19. Aerial View of our field research station Laboratory "Francisco 'Pachico' Mayoral (above)." The muti-colored tents in the center of this photo belong to a group of undergraduate students from the Universidad Autónoma de Baja California Sur (UABCS) in La Paz that visit the lagoon on field trips to learn gray whale research methods. Student learn the utility of using UAV-drones to observe and photograph whale behaviors (below).*

**Laguna San Ignacio:** LSIESP researchers hosted two visiting undergraduate student groups from the Universidad Autónoma de Baja California Sur (UABCS) in La Paz, Baja California Sur (Fig. 19). As part of their academic curriculum these students received instruction to learn field research methods and analyses for gray whales, sea turtles, and avian fauna at the lagoon. At the invitation of Mr. Daniel Stetson of the Nicholas Endowment Fund, our scientists participated in two live broadcasts (English and Spanish) via satellite to schools in Mexico and the U.S. in which we described our gray whale research activities and the students were able to ask questions in real time.

LSIESP researchers made 16 presentations to select eco-tour groups visiting LSI in 2024, and we used social media (*e.g.,* website, Facebook and Instagram) to present "virtual" reports on gray whales and our research activities to interested public, eco-tourists and naturalists, the local communities, public media, and to wildlife managers.

Training the next generation of scientists and conservationists continues: Our graduate student researchers and colleagues presented research papers at scientific conferences including: the Mexican Society for Marine Mammal Science Conference held in May 2023 in Manzanillo, Colima, Mexico (Fig. 20). LSIESP researchers also submitted research reports on gray whale abundance and body condition to the 2024 meeting of the Scientific Committee of the International Whaling Commission held in Bled, Slovenia in April-May 2024.

*Figure 20. LSIESP and UABCS researchers that attended the May 2023 Mexican Marine Mammal Society (SOMEMMA) meeting at the University of Colima, Manzanillo, Colima, Mexico*

**Bahia Magdalena:** In December 2023 and January 2024, four instructional workshops were held for ecotourism and environmental education service providers (Fig. 21). The topic of these workshops was "Gray Whale Monitoring Results 2023: Current Gray Whale Status and 2024 Scenarios", with the aim of reminding communities about the results of Gray Whale Monitoring in 2023 and how 2024 was expected to be a Niño year with warmer water temperatures. A total of 56 people participated, 13 of whom were women.

*Figure 21. Participation of the communities of San Carlos, Puerto Chale and López Mateos in the talks given by PRIMMA, 2023 and 2024.*

Workshops were also given to whale watching tour guides in the city of La Paz, B.C.S., in which about 35 people participated. On this occasion, Dr. Sergio Martínez Aguilar from the Programa de Investigación de Mamíferos Marinos (PRIMMA), at the Universidad Autónoma de Baja California Sur (UABCS) spoke about the results of the gray whale monitoring program in LSI, where he is the field research director.

From February to March an additional six environmental education talks were given in collaboration with the Fundación MarVivo (Fig. 22) to schools: one at the primary level, three at the secondary level and two at the high school level.

*Figure 22. Environmental education lectures given at different educational levels.*

During panga gray whale surveys in BM coordinated with Fundación MarVivo, 4 people from the community of San Carlos and 10 high school students participated to learn about the methods for assessing gray whale abundance and distribution in the winter (Fig. 23).

*Figure 23. Students and participants in the gray whale assessment surveys.*

## ACKNOWLEDGEMENTS

The authors wish to thank all of the research teams from the Laguna San Ignacio Ecosystem Science Program and the Programa de Investigación de Mamíferos Marinos, Universidad Autónoma de Baja California Sur, La Paz, B.C.S., México that have worked each year to monitor the gray whales that reside within in Laguna San Ignacio and Bahía Magdalena during the winter months. This research was supported by grants from The Marisla Foundation, The Ocean Foundation, Natural Habitat Adventures Foundation, and private individual donors. In-kind support for logistics was provided by Kuyima Eco-Turismo, Searcher Natural History Eco-Tours, and Baja Discovery Whale-Watching. In Bahía Magdalena we collaborated with the Fundación MarVivo and Ecology Project International. Our heartfelt thanks to everyone for their support and encouragement of this gray whale research.

.

Our program is a project of the Washington D.C. based non-profit Ocean Foundation and a collaboration with the Marine Mammal Research Program (PRIMMA) at the Universidad Autónoma de Baja California Sur (UABCS) in La Paz, B.C.S., Mexico.

We are grateful to our family of sponsors whose generous support each year provides the means for the Laguna San Ignacio Ecosystem Science Program to conduct research on gray whales and their wintering lagoon aggregation and breeding areas in Baja California.

## YOU CAN MAKE IT HAPPEN:

*We urge you to consider becoming a supporter of our program by making a monthly donation through our fiscal sponsor The Ocean Foundation. Setting up your monthly donations is safe and secure at the following link: https://www.sanignaciograywhales.org/donate/. Thank You!*

*Please check our website www.sanignaciograywhales.org for additional news updates on our research findings as we prepare for the 2025 winter gray whale research season.*

**HAVE QUESTIONS OR WANT MORE INFORMATION?** Please contact us on our website and we will do our best to address your questions and provide more information on the gray whales and their winter breeding lagoons in Baja California:

https://www.sanignaciograywhales.org/contact-us/.

# REFERENCE DOCUMENTS AND REPORTS

Christiansen, F., *et al*. (2021). Poor body condition associated with an unusual mortality event in gray whales. Marine Ecology Progress Series Vol. 658: 237-252. Available on LSIESP website: https://www.sanignaciograywhales.org/research/publications/

Eguchi, T., Lang, A.R., And Weller, D.W. (2022). Abundance and migratory phenology of eastern North Pacific gray whales 2021/2022. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-668. https://doi.org/10.25923/x88y-8p07.

Eguchi, T., Lang, A.R., And Weller, D.W. (2023). Eastern North Pacific gray whale calf production 1994-2023. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-668. https://doi.org/10.25923/x88y-8p07.

Fauquier, D., *et al.* (2024). Eastern North Pacific Gray Whale (*Eschrichtius robustus*): an update on the 2019-2023 Unusual Mortality Event. Rep. Intl. Whal. Commn. SC/69B/E/01. SC/69A/CMP/.

Jones, M.L. and Swartz, S.L. 1984. Demography and phenology of gray whales and evaluation of whale-watching activities in Laguna San Ignacio, Baja California Sur, Mexico. Pp. 309-374 *In:* Jones, M.L., Swartz, S.L., and Leatherwood, J.S. *(eds.)* The Gray Whale. Academic Press, Inc., Orlando. 602 pp.

Lobo-Barrera, R., Martínez A., S, Swartz, S.L. and Urbán, R. (2024). Gray whales' body condition in Laguna San Ignacio, Baja California Sur, México following the Unusual Mortality Event of 2019-2023: 2024 Update. Rep. Intl. Whal. Commn. SC/69B/CMP/13. Available on LSIESP website: https://www.sanignaciograywhales.org/research/publications/

Moore, S.E., *et al.* (2022). Changes in gray whale phenology and distribution related to prey variability and ocean biophysics in the northern Bering and eastern Chukchi seas. PLoS ONE 17(4): e0265934, doi;10.1371/journal.pone.0265934. 26pp.

Martínez, *et al.* (2024). Report on activities to monitor the Gray Whale (*Eschrichtius robustus*) during the 2024 winter in Laguna San Ignacio, B.C.S., Mexico. Available on LSIESP website: https://www.sanignaciograywhales.org/research/publications/

NOAA (2024). Gray whale Unusual Mortality Event (UME): 2019-2023 – CLOSED. Available online at https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2023-eastern-north-pacific-gray-whale-ume-closed

Rodríguez-González, F.M. and Olguín-Hernández, J.A. (2023). Gray whale aerial monitoring using UAV-drones, season 2023. Available on LSIESP website: https://www.sanignaciograywhales.org/research/publications/

Stewart, J.D., Joyce, T.W., Durban, J.W., Calabokidis, J., Fauquier, D., Fernbach, H., Grebmeier, J.M., Lynn, M., Manizza, M., Perryman, W.L., Tinker, M.T., and Weller, D.W. (2023). Boom-bust cycles in gray whales associated with dynamic and changing Arctic conditions. Science 382, 207-211.

Stewart, J.D. and Weller, D.W. (2021a) Abundance of eastern North Pacific gray whales 2019/2020. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-639. https://doi.org/10.25923/bmam-pe91.

Stewart, J.D. and Weller, D.W. (2021b). Estimates of eastern North Pacific gray whale calf production 1994-2021. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-653. https://doi.org/10.25923/jebs-9k39

Urbán R., Viloria-Gómora, L., Martínez A., S, and Swartz, S.L. (2024). 2024 Gray whale abundance in Laguna San Ignacio and Bahía Magdalena lagoon complex, B.C.S., México. Rep. Intl. Whal. Commn. SC/69B/CMP/14. Available on LSIESP website: https://www.sanignaciograywhales.org/research/publications/