



**Laguna San Ignacio
Ecosystem Science Program**

A Project of the Ocean Foundation in Baja California Sur, Mexico



www.sanignaciograywhales.org

**2018 RESEARCH REPORT FOR
LAGUNA SAN IGNACIO & BAHÍA MAGDALENA,
BAJA CALIFORNIA SUR, MÉXICO**



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Progress On Goals And Objectives

Historically the Laguna San Ignacio Ecosystem Science Program's (LSIESP) observations, surveys and photographic-identification research provide information on the gray whales each winter, but these activities were limited to describing presence or absence of the whales in their the winter aggregation areas of Laguna San Ignacio and Bahía Magdalena, Baja California Sur, Mexico. During the 2018 winter LSIESP researchers began new collaborative projects that utilize new technologies and methods that expand research capabilities for documenting and evaluating gray whale communications, behavior, bioenergetics, body condition, growth, and reproductive health. These projects will provide the baseline data that will allow detection of changes in these principal life history and health parameters as a means to identify evidence of stress and disturbance resulting from changing environmental conditions, human activities, or some combination of factors.

Highlights from 2018 winter research season include:

- * Abundance and distribution surveys in Laguna San Ignacio (13th year) and in the Bahía Magdalena complex (6th year);
- * Photographic identification surveys to evaluate gray whales' use of lagoon habitat, site fidelity to specific areas, range-wide movements, calving rates, body condition, and age estimation;
- * Simultaneous behavior observations and real-time recordings of whale vocalizations to understand the context and significance of specific calls;
- * Initiated the use of UAV-DRONES to measure whales to evaluate maternal condition and investment in calf growth;
- * Used non-invasive "Digital Tags" with suction cups to document fine-scale gray whale movement in three dimensions, to understand whale bioenergetics and evaluate effects of exposure to human activities;
- * Sampled gray whale "blows" to evaluate respiratory steroids as indicators of fitness, reproductive health, stress levels, and contaminants.
- * Continued collection of bottlenose dolphin photographs to evaluate status, movements, distribution, abundance, philopatry, and group composition of the resident population.
- * Successfully removed fishing lines, buoys, and a lobster trap from a gray whale calf, saving its life.
- * Continued community lectures on the LSIESP gray whale research for eco-tour groups, university students, staff of the Mexican El Vizcaíno Biosphere Reserve, and the annual community meeting at Laguna San Ignacio.

Leadership and Research Staff



Laguna San Ignacio 2018 gray whale research team.

The 2018 research teams for the Laguna San Ignacio Ecosystem Science Program (LSIESP) and the Programa de Investigación de Mamíferos Marinos (PRIMMA) at the Universidad Autónoma de Baja California Sur, La Paz, B.C.S., México were directed by Drs. Jorge Urbán R., Steven Swartz, Alejandro Gómez-Gallardo U., Sergio Martínez Aguilar (Laguna San Ignacio), and Lorena Viloria Gómora (Bahía Magdalena). Gray whale field researchers included: at Laguna San Ignacio, Natalia Serna, Raquel Soley, Edson Alberto Hernández López, Alin Alejanola Delgado Garcia, Daniela Benot, and UAV Drone pilots Fabien Vivier and Fabian Missael Rodríguez González ; and in Bahía Magdalena, Mariana Hidalgo Reza, Lizbeth Sánchez Eliseo, Yessica Cota Loera, Camilla Muñoz, Omar García Castañeda, and Jorge Acevedo.

Additional collaborating researchers included: The acoustics and behavior observation research led by Dr. Aaron Thode and Ludovic Tenorio-Hallé from Scripps Institute of Oceanography, La Jolla, California; Dr. Fredrik Christiansen, of Murdoch University, Murdoch, Western Australia, Fabien Vivier and Fabian Missael Rodríguez González conducted the Unmanned Aerial Vehicles (UAV-Drones) aerial photogrammetry project to measure growth and body volume of female and calf whales to estimate body condition/health, and energy conversion/transfer from females to calves; Dr. Lars Bejder and Aude Pacini from the University of Hawaii at Manoa, Ohau, Hawaii, and Pernille Meyer Soerensen conducted the pilot study to use suction-cup attached digital-tags or “D-tags” to record fine-scale gray whale activity and movements in 3-dimensions, vocal behavior, and calf suckling rates to estimate resting, traveling, and nursing rates for gray whales; and Dr. Celine Godard-Coddington and her students from Texas Tech University, Lubbock, Texas collected exhaled respirations from gray whale “blows” to obtain samples of organic steroid hormones from the whales to evaluate gray whale health, reproductive condition, and identify biochemical indicators of stress (e.g., cortisol).

This 2018 research was supported by grants from The Ocean Foundation and The Whaleman Foundation, private individual donors, with in-kind support for logistics provided by Searcher Natural History Expeditions, Baja Discovery, and Kuyima Eco-Tourismo, Inc. Field research was conducted under Scientific Research permits issued by the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT), Subsecretaría de Gestión Para La Protección Ambiental, de México.

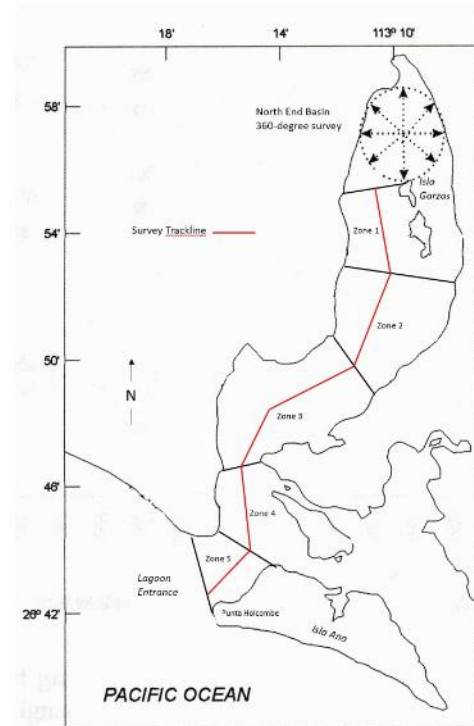
Gray Whale Abundance Monitoring

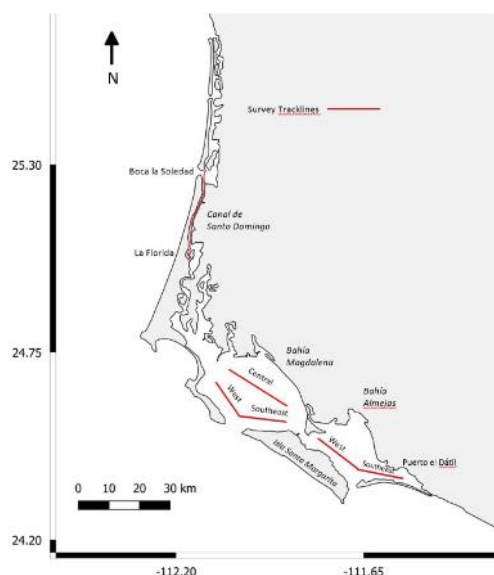


Each winter boat (panga) surveys are used to monitor of gray whale abundance, distribution and reproduction in Laguna San Ignacio and Bahía Magdalena. LSIESP's boat survey program represents the longest continuous time series of quantitative habitat use information for any cetacean population (2006 to present). These surveys form the basis to document and evaluate trends in the whales' use of, and the management of these marine protected areas.

Boat surveys in Laguna San Ignacio were conducted from a 7-m long open "panga" powered by a 75-hp outboard motor. Each survey followed a 30-km long predetermined Global Position System (GPS) track-line at a constant speed of 11-km/hr, and required approximately 3-hrs to complete. During each survey two observers scanned the water on each side of the panga and noted the whales when they passed the beam of the panga. A third individual recorded for each sighting: the time, number of whales, whether they were singles or female-calf pairs, and ambient weather and visibility conditions. Whales were counted in the northernmost portion of Laguna San Ignacio from the anchored panga with observers scanning the area with binoculars in 360° for 20-min. (Fig. 1). Also noted were other marine mammals (e.g., dolphins & sealions), sea turtles, and boats (i.e., fishing and eco-tourist).

Figure 1. Gray whale boat/panga survey track-line in Laguna San Ignacio.





Boat surveys of gray whales in the Bahía Magdalena lagoon complex in 2018 duplicated surveys conducted in the previous winters of 2016 and 2017. The surveys included three different areas where gray whales aggregate within the Bahía Magdalena lagoon complex: Canal de Santo Domingo in the north from Boca la Soledad south to La Florida; in Bahía Magdalena's center, west and southwest areas; and in Bahía Almejas in the south from a point in the center of the bay south of Puerto el Dátil north to a point north-east of Puerto Cortés on Isla Santa Margarita (Fig. 2).

Figure 2. Gray whale survey boat/panga tracks in the Bahía Magdalena lagoon complex in 2018.

In 2018, 13-surveys were completed in Laguna San Ignacio between 18 January and 2 April (Table 1). The greatest count of single whales observed was 160-adults on 15 February (Fig. 3), and the highest count of females with calves was 49-pairs on 23 March (Fig. 4).

Table 1. Boat survey counts of gray whales (Female-calf pairs, Singles (whales without calves), and total Adults) in Laguna San Ignacio during the 2018 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-18 | 11 | 8 | 19 |
| 2 | 25-Jan-18 | 7 | 16 | 23 |
| 3 | 31-Jan-18 | 26 | 41 | 67 |
| 4 | 5-Feb-18 | 19 | 111 | 130 |
| 5 | 10-Feb-18 | 18 | 102 | 120 |
| 6 | 15-Feb-18 | 20 | 160 | 180 |

| | | | | |
|----|-----------|----|-----|-----|
| 7 | 21-Feb-18 | 20 | 156 | 178 |
| 8 | 27-Feb-18 | 27 | 144 | 171 |
| 9 | 8-Mar-18 | 17 | 73 | 90 |
| 10 | 15-Mar-18 | 17 | 43 | 60 |
| 11 | 23-Mar-18 | 49 | 18 | 67 |
| 12 | 28-Mar-18 | 12 | 4 | 16 |
| 13 | 2-Apr-18 | 24 | 2 | 26 |

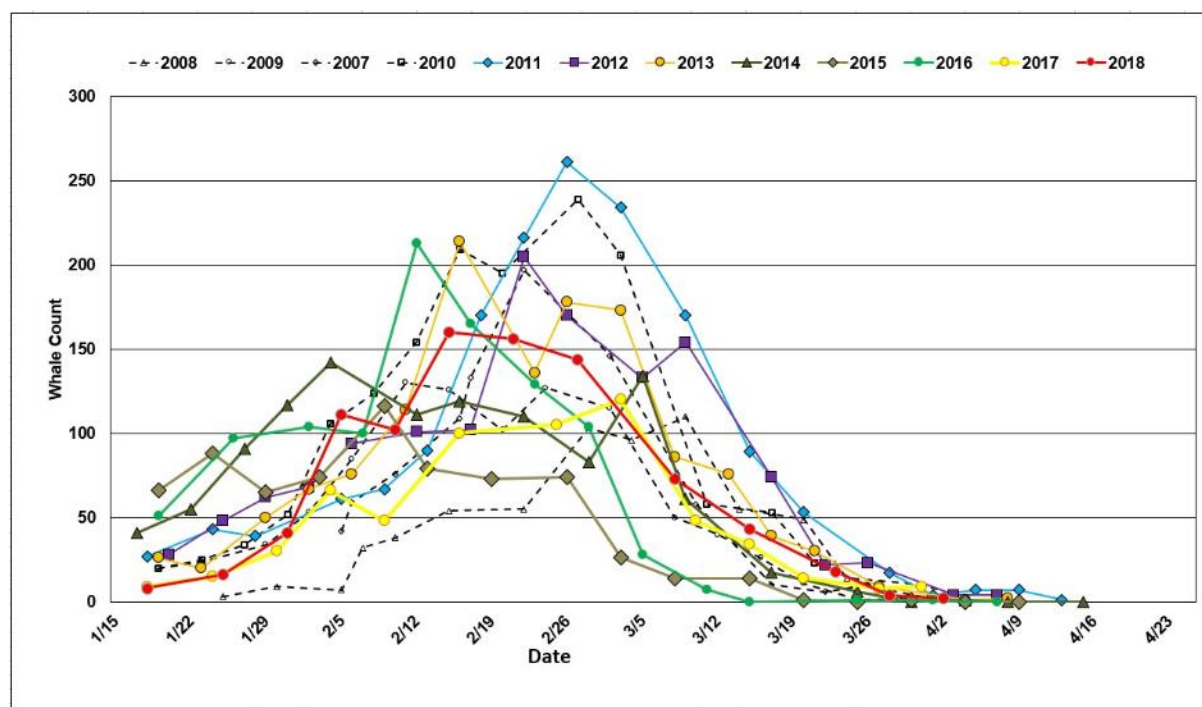


Figure 3. Survey counts of single adult gray whales (non-female-calf pairs) in Laguna San Ignacio 2007-2018.

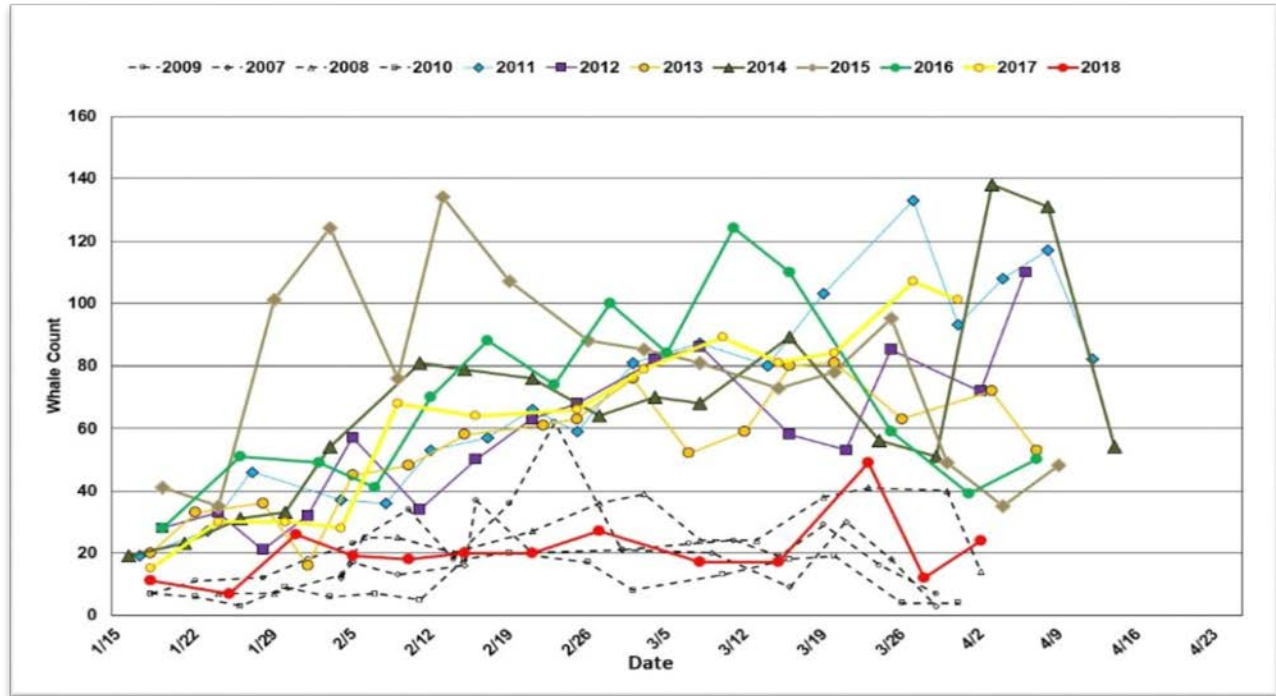


Figure 4. Survey counts of gray whale female-calf pairs in Laguna San Ignacio 2007-2018.

The 2018 winter gray whale abundance in Laguna San Ignacio was characterized by numbers of single adult breeding whales similar to that observed in recent years, but numbers of female-calf pairs were lower than expected compared to previous winters, and they departed from the lagoon early. Similarly, counts of gray whales in the Bahía Magdalena lagoon complex to the south were lower than observed in recent past winters, and the gray whales also departed from this aggregation area earlier than in the previous winter (Fig. 5).

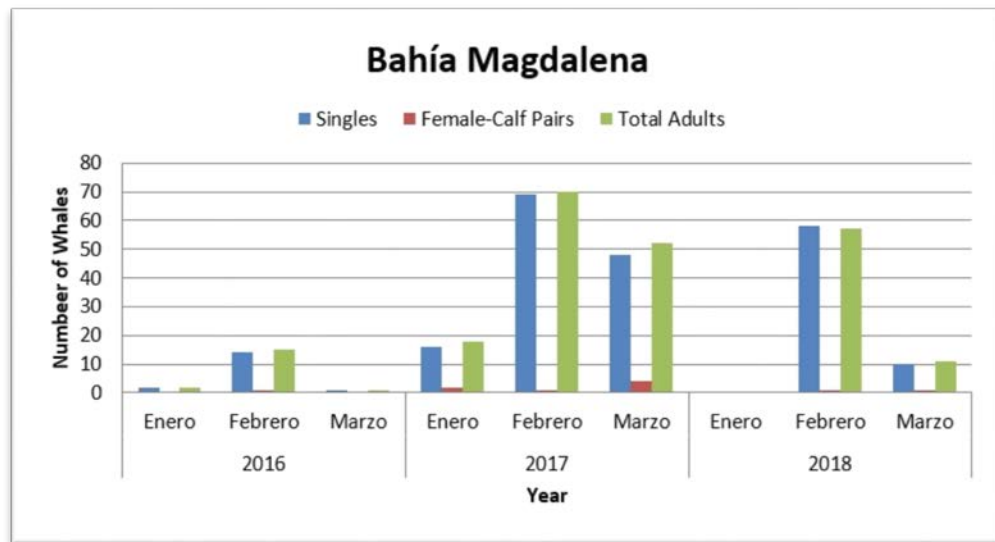


Figure 5. Survey counts of gray whales in Bahía Magdalena in 2016, 2017, and 2018.

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 2018 winter breeding and calving season. Number of female-calf pairs equals the number of calves observed.

| Area | Date | Female-Calf Pairs | Singles | Total Adults |
|------------------------|-----------|-------------------|---------|--------------|
| Bahía Almejas | 11-Jan-18 | 0 | 1 | 1 |
| | 5-Feb-18 | 1 | 26 | 27 |
| | 5-Mar-18 | 2 | 31 | 33 |
| Bahía Magdalena | 12-Jan-18 | 0 | 0 | 0 |
| | 6-Feb-18 | 1 | 58 | 59 |
| | 6-Mar-18 | 1 | 10 | 11 |
| Canal de Santo Domingo | 13-Jan-18 | 3 | 0 | 3 |
| | 7-Feb-18 | 9 | 20 | 29 |
| | 7-Mar-18 | 16 | 8 | 24 |

During the breeding season single male gray whales are known to harass and disturb females with newborn calves. The predominance of single breeding adult whales early in the winter in these lagoons may have displaced and/or restricted the entry of female-calf pairs into these areas in 2018. Gray whale abundance and distribution is also influenced by sea temperature (Urban et al. 1999 and 2011). Extreme tidal flows in 2018 affected the average water temperatures within in Laguna San Ignacio and Bahía Magdalena which fluctuated widely with low temperatures in the 15 C° to 16 C° range to high temperatures in the 20 C° to 21 C° range. These wide and rapidly changing ranges in temperatures may have also contributed to the observed low abundance of female-calf pairs and their early departures from the breeding lagoons.

Read the entire 2018 gray whale abundance report to the International Whaling Commission on our website – IWC-SC 67B/CMP/09: visit

www.sanignaciograywhales.org/research/publications



Photo-Identification, Photo Archiving and Research



Digital photography allows the documentation of individual whales and continues to be one of the most powerful and useful research tools. Over time, photographs provide the basis for evaluating the time individual gray whales spend in a specific lagoon aggregation area, fidelity to specific areas, female calving intervals, minimum age estimation, body condition, and movements among aggregation/feeding/breeding areas throughout the specie's range.

All gray whale photographs from each winter are archived, placed into digital catalogs, compared with the catalogs from 2006-2017, and compared with photo ID catalogues of Laguna Ojo de Liebre, Bahía Magdalena, and the Western North Pacific gray whale population to determine the number and movements of gray whales that are utilizing these lagoon areas. All photo-ID catalogs are posted on the LSIESP website at:

www.sanignaciograywhales.org/research/photo-id-catalogs/

Catalogs are available to researchers for review and to search for matches with photographs of gray whales from other portions of the species range (e.g., Arctic, Western Pacific, etc.).

Laguna San Ignacio: Photographic identification (Photo-ID) effort in Laguna San Ignacio during the 2018 winter included 273-survey hours over 59-days. A total of 8,658 digital images were obtained from 602-gray whale sightings that yielded 684-individual whales. These included 598-single whales what averaged 5.2-days in the lagoon (range 1 to 20-days), and 86-females with calves that averaged 43.2-days in the lagoon (range 1 to 80-days) (Table 3).

Bahía Magdalena Complex: Researchers working in the Bahía Magdalena region obtained 9,171-digital images from 589-sightings of gray whales during 27-days and 187-hours of observations in the 2018 season. From these images, 412-individual whales were identified (382-single whales and 30-female-calf pairs), representing significantly more single whales and fewer females-calf pairs in this region in 2018 compared to the previous winter. The average minimum residency was 4-days for female-calf pairs, and 3-days for single whales.



Table 3. Photographic identification effort and preliminary results for Laguna San Ignacio and the Bahía Magdalena complex and surrounding areas. NA = not available; TBD = to be determined.

| AREA | Laguna San Ignacio | Bahia Magdalena Complex |
|--------------------------------------|--------------------|-------------------------|
| No. Survey Days | 59 | 27 |
| No. Effort Hours | 273 | 187 |
| No. Images | 8,658 | 9,171 |
| No. Sightings | 602 | 589 |
| No. Individual Whales | 684 | 412 |
| No. Single whales | 598 | 382 |
| Single whales' mean days in area | 5.2 (1-20) | 3 |
| No. Female-calf pairs | 86 | 30 |
| Female-calf pairs' mean days in area | 43.2 (1-80) | 4 |

Calving Interval Estimation: The estimated gray whale calving was $2.11 \pm \text{SD} = 0.40$ years during the 1977-1982 time period (Jones 1990) when the population was estimated to be around 20,000 whales. Photographs of known breeding females obtained from 2005-2017 were used to develop a revised estimate of female calving-interval of $2.39 \pm \text{SD} = 0.58$. This sample of 356 females produced 736 calves between 2005 and 2017, and of these 20% of the calves were born between 2005 and 2010, while 80% of the calves were born between 2011 and 2017 (S. Martinez, unpublished data). This suggests that female gray whales are breeding more frequently in the years following the range-wide mortality event of 1998-2000 (LeBoeuf et al. 2000) when the population had declined to approximately 16,500 whales (Durban et al. 2015).

Individual Age Estimation: The minimum ages of breeding female gray whales were determined from photographs obtained during the 1977-1982 (Jones and Swartz 1984), the 1996-2000 (Urban et al. 2011), and the 2005-2018 (LSIESP) time periods. Seventeen females from the earliest time period (1977-1982) were photographically matched (recaptured) in recent years, and their minimum age was estimated to range from 26 to 46 years (Martinez et al. In Press).

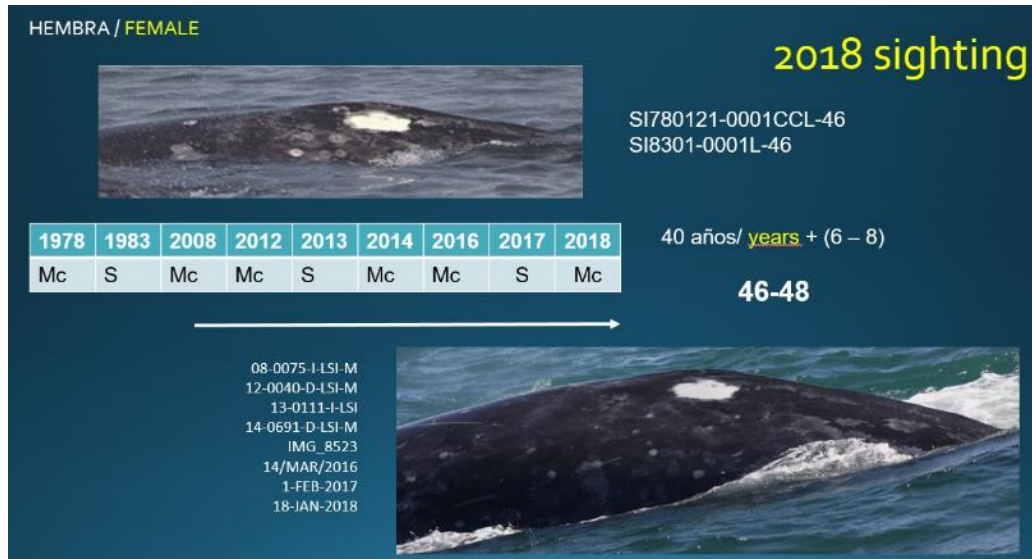


Figure 6. Female gray whale first photographed with a calf in 1978 and most recently photographed in 2018 again with a calf, suggesting her minimum age is 46-48-years.

In 2017 and 2018 additional known females were recaptured (photographically matched) and their estimated minimum ages from the time of the earliest photograph to the most recent photograph were updated, confirming minimum ages ranging from 27 to 48-years (Fig. 6), and that these females are continuing to reproduce and visit Laguna San Ignacio with their new calves each winter. These are the oldest photographic identification data for any living gray whales, and clearly demonstrate the fidelity of breeding female gray whales to Laguna San Ignacio.

Monitoring Bottlenose Dolphin (*Tursiops truncatus*) Population



Digital photographs of bottlenose dolphin (*Tursiops truncatus*) dorsal fins obtained in 2018 included 70-sightings and a maximum group size of 25 individuals, and an average group size of 5 individuals including female-calf pairs. The Laguna San Ignacio Bottlenose dolphin catalogue currently contains 296-individual dolphins, and it is being analyzed by UABCS researcher Fabian Missael Rodríguez González to estimate the size and distribution of the bottlenose dolphin population in Laguna San Ignacio, and Gabriela Noemi Salazar Sanchez is investigating dolphin group dynamics. These photographs will be compared with

bottlenose dolphin photographs contained in the NOAA Tursiops Photo-ID Catalog for Ensenada, Mexico to Northern California, U.S.A. to estimate the relationship of the animals observed in Laguna San Ignacio to Bottlenose dolphin residing along the coast of the Californias (Rodríguez Gonzáles et al. 2018). Visit:

www.sanignaciograywhales.org/research/photo-id-catalogs/

Tower Project: Paring Behavior and Acoustics



In 2018 Ph.D. candidate Ludovic Tenorio, his major professor Dr. Aaron Thode of Scripps Institution of Oceanography initiated a project to compare specific gray whale vocalizations with the whales' behavior and interactions during the winter months in Laguna San Ignacio. Pairing observations of gray whale behavior with simultaneous directional acoustic recordings will provide the first opportunity to associate specific whale calls and call rates among conspecifics to evaluate the whales' vocal behavior in the context of their breeding behavior in the winter months.

Aaron, Ludovic and their research assistants will observe gray whale surface behavior from a 5-m tall observation tower located on the north-side of Punta Piedra in the lower lagoon adjacent to the regulated "whale-watching zone" (Fig. 7). The tower was provided by Kuyimá Eco-Turismo, Inc. and transported from the town of San Ignacio to the lagoon, and ultimately to Punta Piedra by an army of community volunteers. Aaron and Ludovic installed an array of directional hydrophones in front of the tower that allows the recording of gray whale vocal behavior in real time, and the determination of which whale(s) are calling during the various

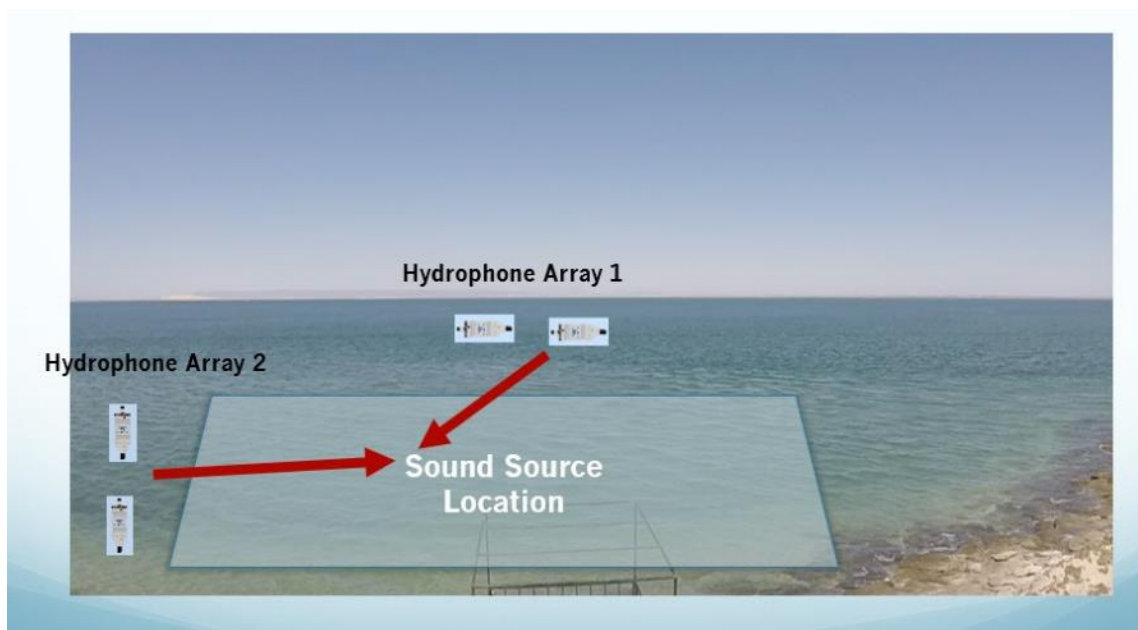
behaviors observed from the tower. Behavior observations are recorded on a notebook computer running a custom-made software program that documents in real time a wide array of gray whale surface behaviors, numbers of whales in groups, movements, directions, duration of sightings, etc. They are particularly interested in investigating the vocal exchanges between new mother whales and their calves as the calves develop and grow during the winter. This project is the first step toward developing an understanding the whales' use of various vocalizations to communicate. Watch the tower video at:

www.sanignaciograywhales.org/project/videos/

Figure 7. The view from the observation tower of the main transit channel used by gray whales as they move past Punta Piedra in Laguna San Ignacio.



Figure 8. The orientation of hydrophone arrays to localize the source of whale calls in front of the observation tower on Punta Piedra in Laguna San Ignacio.



Estimating Body Condition, Growth, and Energetic Cost of Reproduction



Reproduction plays a major role in any species' life history strategy. The reproductive cycle of baleen whales is closely linked to their feeding-migration-breeding 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. To do this, Dr. Fredrik Christiansen, of Murdoch University, Murdoch, Western Australia, Fabien Vivier and Fabian Missael Rodríguez González began an Unmanned Aerial Vehicle (UAV-Drones) aerial photogrammetry project to measure growth and body volume of female and calf whales to determine relationships between maternal rate of loss in energy reserves and calf growth in gray whales (*Eschrichtius robustus*) for female-calf pairs in Laguna San Ignacio (Fig. 9). View UAV-Drone video at: www.sanignaciograywhales.org/project/videos/



Figure 9. LSIESP Drone pilots Fabian Missael Rodríguez González and Fabien Vivier launch the UAV to photograph gray whales in Laguna San Ignacio.

Using methodology developed by Christiansen et al. (2018), in 2018 they measured the body volume of gray whales from UAV-Drones during 452 flights (83.6h) and recorded 292 body condition measurements of 254 solitary individuals (animals with no calf) and 377 body condition measurements of 63 mother and calf pairs. Forty-five female-calf pairs were measured on average 3-to-4 times during the 3-month winter calving season, with an average of 17-days between measurements. From these data, growth curves (length and width) will be determined for the calves through the breeding season. Losses and gains in body volume of individual mother-calf pairs will be quantified to estimate the volume conversion efficiency from females to calves, as well as maternal investment in their calves through the breeding season (Vivier et al. 2018).

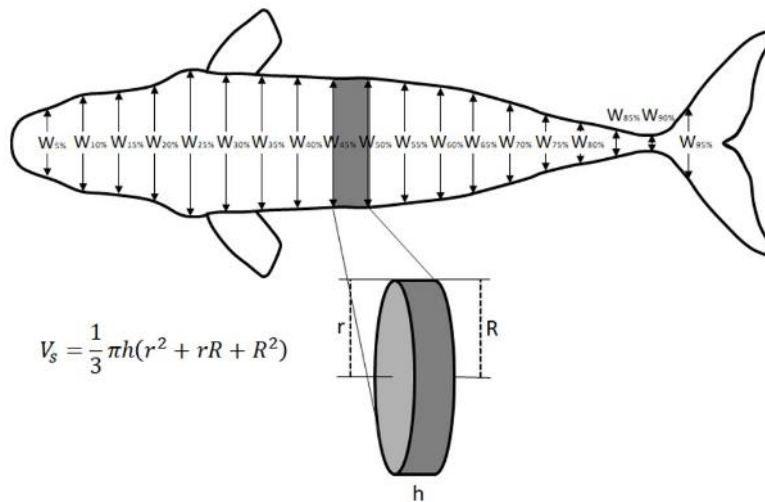


Figure 10. Method of estimating body volume from length and width measurements obtained by UAV-Drones for gray whales.

The long-term research program at Laguna San Ignacio (40-years) has produced calving histories for individual female gray whales over many years. It will be possible to compare UAV measurements of body condition and long-term reproductive history from photo-ID data for individual female gray whales as a means to assess possible effects of age, number of calves produced and inter-calving interval on their reproduction efficiency. This line of investigation will provide insights into challenging and complex questions about gray whale fitness at different ages, and changes in female whale breeding efficiency over time which may be correlated with variation in climate and environmental conditions that influence the availability of gray whale prey, feeding requirements, mother-to-calf energy transfer, and calf survivorship which could not previously be investigated.

Movements, Nursing Rates and Vocal Behavior of Gray Whale Mothers and Calves



Figure 11. The D-Tag with suction-cup attachments (upper left), and the method of applying the D-Tags.

Dr. Lars Bejder and Aude Pacini from the University of Hawaii at Manoa, Ohau, Hawaii, and Pernille Meyer Soerensen conducted a two-week pilot study to evaluate the use non-invasive suction-cup attached digital-tags or “D-tags” to record fine-scale gray whale activity and movements in 3-dimention, vocal behavior, and calf nursing rates to estimate the time whales spend resting, traveling, and nursing their calves (Figs. 11 & 12). This information will contribute to our understanding of the bioenergetics of the whales, and it will allow the detection of changes in the maternal behavior of females to their calves that could be affected by human activities in the lagoon (Bejder et al. In Prep). Watch D-Tagging Video at:

www.sanignaciograywhales.org/project/videos/

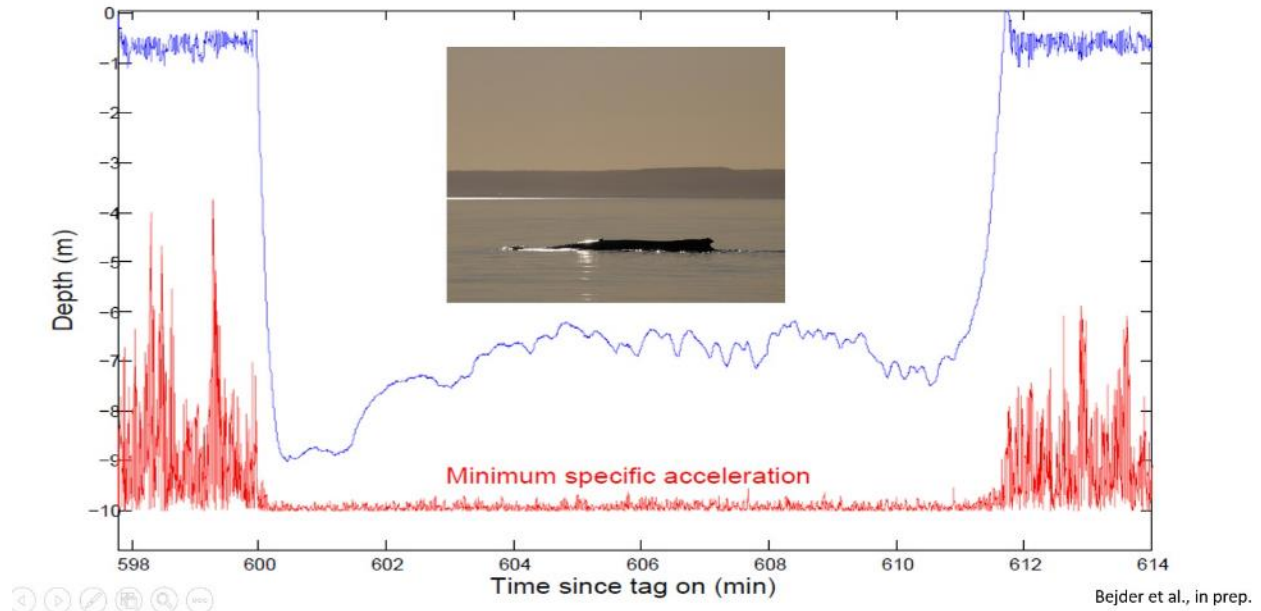
In 2018 they attached and recovered D-Tags to/from six mother whales and five calves (one D-tag attached to a calf was lost). The average time tags were attached to the females was 8-hrs and 35-min., and for calves was 6-hrs and 10-min. (Table 4).

Table 4. D-Tags and duration of tracking for 11-gray whales (6-mothers and 5-calves) in Laguna San Ignacio.
Whales tagged (n=11; 6 moms and 5 calves)

| Animal Number | Mom or calf | Tag duration (hr:min) | |
|---------------|-------------|-----------------------|--------------------------|
| 1 | Calf | 12:10 | |
| 2 | Mom | 7:51 | |
| 3 | Mom | 8:02 | |
| 4 | Calf | 5:20 | |
| 5 | Mom | 14:00 | |
| 6 | Calf | 5:32 | Calf average: 6hrs 10min |
| 7 | Mom | 6:46 | |
| 8 | Calf | TAG LOST | Mom average: 8hrs 35min |
| 9 | Mom | 6:23 | |
| 10 | Calf | 0:31 | |
| 11 | Mom | 7:00 | |

Figure 12. Example of the fine-scale data on movements and swimming behavior of a humpback whale obtained by the use of a “D-Tag” (from Bejder et al. In Prep)

Type of data: example from humpback whales in Australia



Blow Sampling to Evaluate Reproductive Fitness and Stress



Dr. Celine Godard-Coding and her students from Texas Tec University, Lubbock, Texas, with assistance from LSIESP researchers collected samples of exhaled respirations from gray whale “blows” and skin samples to analyze and compare organic steroid hormones contained in the respired air and skin from the whales. The goal is to assess whether the fitness

information provided by the analysis of stress hormones and reproductive hormones collected from the whales' exhalations can provide a non-invasive alternative to traditional biopsy sampling of skin and blubber. This innovative research will provide an additional comparative method for evaluating gray whale health, reproductive condition, and for identifying biochemical indicators of stress (e.g., cortisol).

Combining the steroid levels measured from the whales' blows (e.g., reproductive hormones and cortisol), with growth and behavior information from the UAV Drone photogrammetry and D-Tags fine-scale behavior will help researchers establish normal levels of activity, growth, condition, and biochemical status for gray whales during the reproductive season. This baseline information will provide a means to detect future changes in these parameters that could result from environmental stressors (e.g. climate change) and/or human related stressors (e.g., development and eco-tourism).

Disentanglement & Rescue Efforts

During a gray whale abundance survey in Laguna San Ignacio on February 10th a mother and calf pair were observed, and it was clear that the calf had several fishing lines wrapped around its body and it was dragging a round fishing float. The next day a dis-entanglement Team composed of LSIESP researchers located the mother-calf pair in the lagoon, and they began their attempt to remove the lines and float from the calf (Fig. 13a-b). After four hours of effort, the team successfully removed 21-m of fishing lines, a large float, and a wire lobster trap from a gray whale calf, saving its life (Fig 14 a-b). This female whale and her calf remained in the lagoon area following this incident, and they were observed to be "gear free" and in good health in the following weeks. Watch the video of this rescue at:

www.sanignaciograywhales.org/project/videos/



Figure 13 a-b. UAV Drone photograph of the gray whale calf entangled in fishing gear (left) and LSIESP researchers cutting the float line to free it from the whale (right).

The regulations of the Vizcaíno Biosphere Reserve do not permit the use of fishing lines, floats, traps or nets inside of the lagoon during the winter months while the gray whales are in residence. However, as the whales migrate along the outer coast, they encounter various types of lines and nets, and occasionally they become entangled in these.

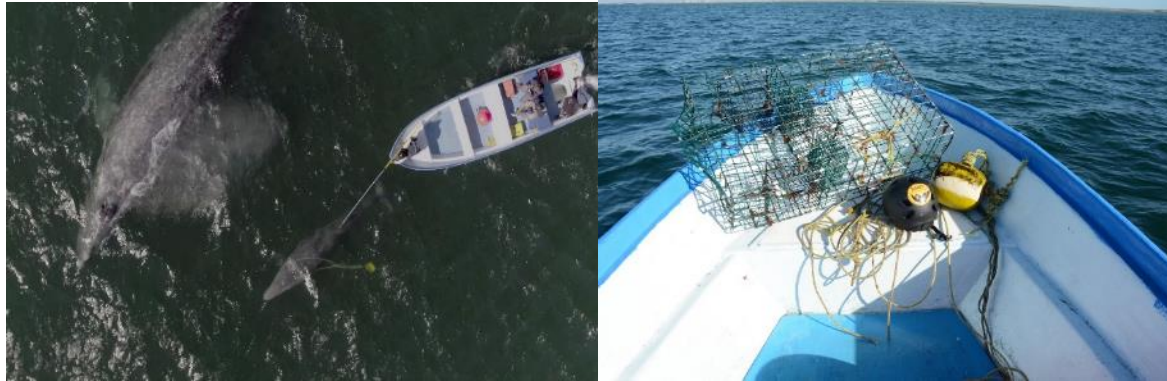


Figure 14 a-b. UAV Drone photograph showing LSIESP researchers removing fishing lines from a gray whale calf (left), and the lines, float, and lobster trap removed from the whale (right).

In 2014 the Natural Resource Defense Council supported a series of workshops sponsored by the International Whaling Commission to train teams of panga operators, including LSIESP researchers, in methods to safely remove fishing gear from gray whales. To date LSIESP researchers have successfully removed fishing lines, gear and floats from 7-gray whales inside of Laguna San Ignacio.

Community Outreach and Education



LSIESP's outreach and education activities continue to disseminate research findings to interested public, eco-tour visitor groups and naturalists (e.g., Andiamo, Natural Habitat Adventures, NRDC, and others), the local community, and the staff of the El Vizcaíno Biosphere Reserve.

LSIESP researchers are routinely asked to provide information on the various scientific investigations underway at the lagoon, and the most recent findings. The annual community “Reunion” meeting continues to be well attended (over 100 people in 2018). Several student groups from Mexican (e.g., UABCS) and other universities (e.g., University of Zurich) visited LSIESP’s “Francisco ‘Pachico’ Mayoral” Field Research Laboratory where they received lectures and instruction from LSIESP researchers. Presentation topics included: marine mammals, vertebrate biology, natural history, desert ecology, and marine protected area conservation and management. The LSIESP research program also contributed information to public and private science and education organizations (e.g., The Whale Museum in La Paz, B.C.S., the Langley Whale Center Pacific Northwest, International Whaling Commission’s Scientific Committee, El Vizcaíno Biosphere Reserve in Baja California, etc.).



Figure 15. LSIESP researchers recovering the gray whale skeleton.

Three stranded gray whales (one adult and two juveniles) were found in LSI in 2018. LSIESP researchers recovered, cleaned and prepared an entire gray whale skeleton which was received for public display by The Whale Museum in La Paz, Baja California Sur (Fig. 15). Students from the Universidad Autónoma de Baja California Sur, devoted part of their time at the lagoon to participate in a community clean-up project, collecting plastic and other trash from the beaches and the desert around the lagoon, and delivering this trash to the local waste disposal facility in the Ejido Luis Echeverría Álvarez (Fig. 16).



Figure 16. UABCS students and advisors pick-up plastic and other trash from the beach in Laguna San Ignacio.

View all of the 2018 Community Reunion Presentations at:

www.sanignaciograywhales.org/research/publications/

Academic Training

LSIESP's mission includes training the next generation of wildlife scientists and conservationists. To date student researchers participating in the LSIESP research programs have completed 6 Ph.D. degrees, 5 Master's degrees, and 8 undergraduate theses. In addition, these researchers have published numerous scientific papers and presented talks and posters at professional scientific conferences including: Society for Marine Mammalogy, Mexican Marine Mammal Society (SOMEMMA), and Scientific Committee of the International Whaling Commission.



Visit the LSIESP website at www.sanignaciograywhales.org/research/publications/ to view and read all of the reports and findings resulting from the 2018 winter research program, and previous years' research, at Laguna San Ignacio and Bahia Magdalena.

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