



Laguna San Ignacio
ecosystem science program
a project of The Ocean Foundation in Baja, Mexico

Con el apoyo de la Alianza



Universidad Autónoma de Baja California Sur
Departamento de Biología Marina
Programa de Investigación de Mamíferos Marinos

GRAY WHALES IN LAGUNA SAN IGNACIO AND BAHÍA MAGDALENA, B.C.S. MÉXICO. WINTER SEASON 2012.



FIELD REPORT

Scientific research and collection
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INTRODUCTION

Laguna San Ignacio is located in the west coast of the Baja California Peninsula in Mexico. The lagoon lies within the Vizcaino Desert Biosphere Reserve, Mexico's largest refuge administered by the Secretaria de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAT) (Figure 1). Beginning in the mid-1990's and continuing to the present, seven land-based "eco-tourism" companies operate whale watching excursions throughout the winter gray whale (*Eschrichtius robustus*) occupation of the lagoon (January through April), and a few boat-based "natural history" tours from the United States also conduct whale watching excursions in Laguna San Ignacio (Dedina and Young, 1995).

During the winters of 1978-1982 detailed studies on demography and phenology of gray whales that visited Laguna San Ignacio were conducted (Jones and Swartz, 1984), and then additional studies were conducted from 1996 to 2000 (Urbán, *et al.* 2002). The research performed from 2006 to 2012 described and assessed the use of Laguna San Ignacio by gray whales in the last 25 years, and evaluates the state of the lagoon ecosystem as a breeding area for whales. Research results included findings on the abundance, density, distribution and photographic identification (Photo-ID) of gray whales, as well as the nutritional condition of the whales: following the 1998 El Niño event, the occurrence of whales showing a certain degree of malnutrition was common, and contributed to the massive mortality event between 1998-2000. In 2012 we also began to monitor the use of Bahía Magdalena by gray whales; an area also visited by gray whales each winter for their breeding activities.

The gray whale monitoring research is part of the joint Project between the World Wildlife Fund – Telcel Alliance and the Laguna San Ignacio Ecosystem Science Program (LSIESP, visit website at www.lsiecosystem.org), a project of The Ocean Foundation. This year, gray whale monitoring in Laguna San Ignacio took place from January 18 to April 15 2012, and in Bahía Magdalena from January 25 to February 1st, from February 21 to March 1st and from the 17 to 20 March, 2012 (Figure 1). Gray whale research activities included: monitoring of abundance and distribution; assessment of residence time in the area; birth intervals; acoustic monitoring; environmental education and media outreach; and the annual meeting of researchers with the community.

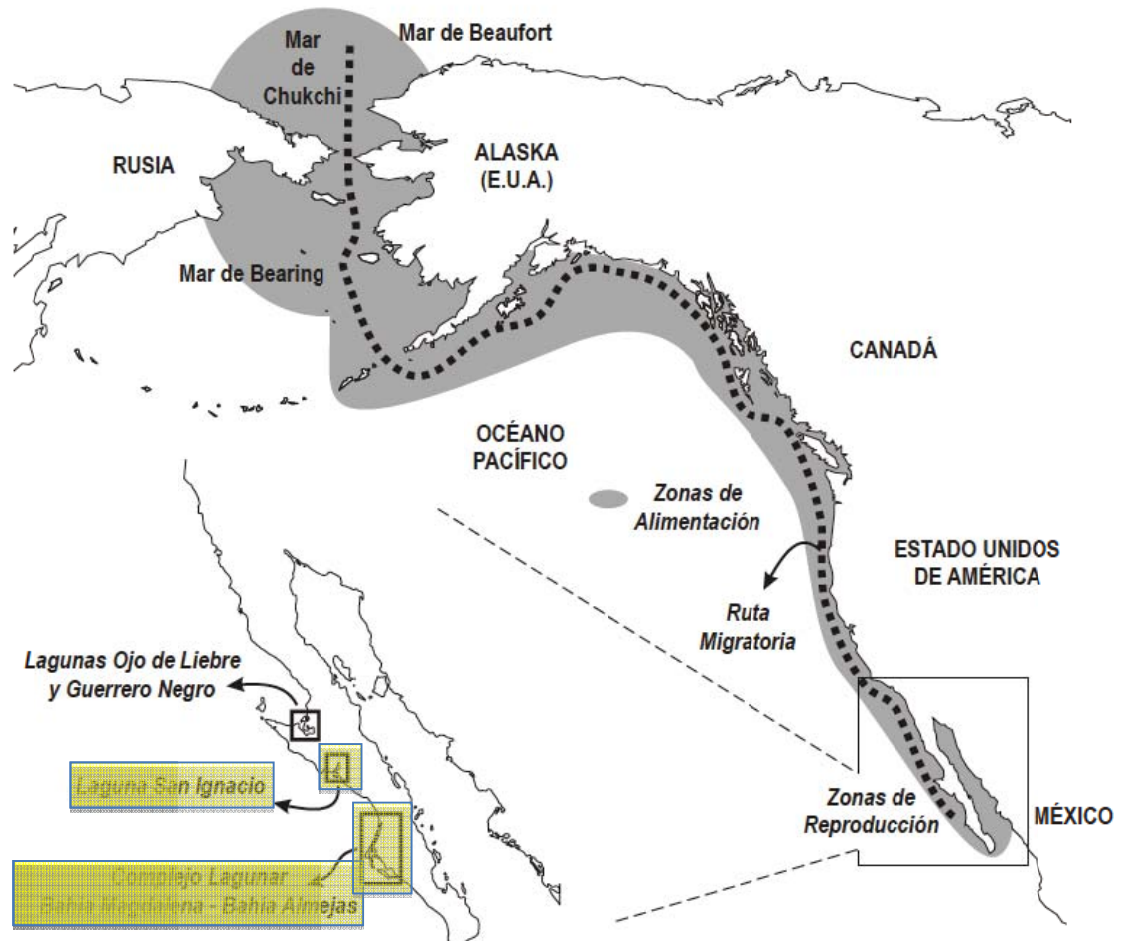


Figure 1. Winter aggregation areas on the west coast of the Baja California Peninsula, foreground Laguna San Ignacio and Bahía Magdalena (highlighted in yellow), locations where these studies were conducted.

METHODS

Boat surveys (abundance counts)

As in previous years, the gray whale surveys were conducted by following a standard survey transect and observer methodology (Figure 2) to allow comparison with previous survey counts from 1978-1982 (Jones and Swartz 1984) and 1995-2006 (Urban *et al.* 2002).

For each survey a standard transect line was followed using a 7-m boats powered by an outboard motor, travelling at an estimated speed of 11 km/hr. Speed and transect course were verified using a hand-held Global Position System (GPS) device. This survey speed minimizes the likelihood that whales (which typically travel at 7 to 9 km/h) do not move ahead of the survey boat and thus be counted more than once.

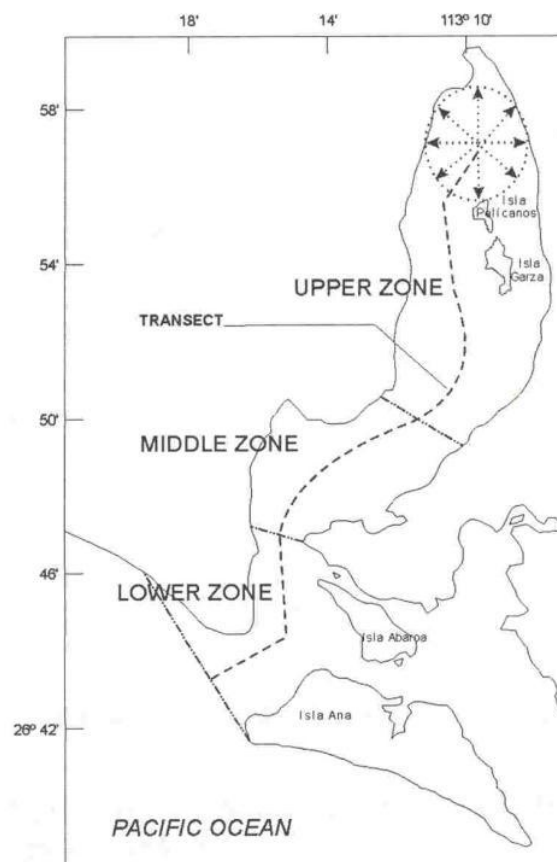


Figure 2. Gray whale survey transect line in Laguna San Ignacio.

The transect survey ran along an imaginary line through the lagoons deep water areas (i.e., > 2.0 m deep) from the breaker line at the lagoon entrance to Isla Garzas at the north end of the lagoon. Each survey required an average of three hours to be completed. The maximum distance from the transect line to the 2 m depth along shore was 2.5 km and the minimum was 0.8 km. Thus, waters inhabitable by whales and both shorelines were clearly visible at all times within the lagoon (it was assumed that essentially all animals within 2.5 km of the track line were seen).

Whales in the "North End" of the upper lagoon (north of the transect termination) were counted from a stationary location located at the center of the upper portion of the lagoon by observers searching in 360-degrees around the stationary boat (Figure 2). Surveys were aborted when sea conditions exceeded Beaufort 3 sea state (winds greater than 18 km/hr. and consistent white caps).

By convention, we considered "Mother-calf pairs" (i.e., female whales with calves of the year) as a single unit and counts of these pairs are equivalent to calf counts. "Single whales" refer to non-parturient females, adult males, and immature animals.

Two observers conducted surveys in LSI, one on each side of the boat (left and right), as well as an annotator who recorded the number of animals sighted by observers, their location, climate conditions and animal orientation. On occasions observers working in pairs were required in order to locate the multiple whales in large groups. The boat driver with the help of a GPS, followed the defined transect and kept the boat in course and constant speed, and also indicated to the observers and annotator the beginning and end of each portion of the survey transect (Figure 3).



Figure 3. Distribution of the crew to carry out surveys in San Ignacio Lagoon.

Analysis Procedure

Counts of gray whales during the 2012 winter season were analyzed as total adults (non-calf) whales, single whales (whale other than female-calf pairs), and female-calf pairs counted within each of the three primary survey zones (i.e., the lower, middle, and upper lagoon zones including the north end area) (Figure 1). Survey counts from 2012 were compared with those of previous years.

Residency, birth interval and health assessment.

Photographic Identification: Gray whales possess unique and individual marks and pigmentation that can be used to identify the presence of specific individuals within the lagoon. When whale surveys were not performed, effort focused on taking pictures of individual whales. Pictures were taken of the visible portion of the whale back with 35 mm SLR digital cameras equipped with zoom lenses of 70-300 mm. When particular marks or scars were very evident in other parts of the body these were also photographed. Individuals were distinguished by the comparison of their pigment pattern and the marks of the middle torso part of the whale. When possible, both sides were photographed (left and right) (Figure. 4).

The best photograph of each sighting and side was chosen to form part of the catalog, to which a unique and consecutive number was assigned. The picture and the corresponding information of the whale were saved in a digital photographic catalog and database. This database will serve in the search of those whales that show similar and unique scars, so individual whales with similar marks can be compared to those photographed in the same or previous years.



Figure 4. Photo-identification showing a gray whale's distinctive markings.

Residency: The minimum time of residence of whales in the lagoon was estimated from pictures taken throughout the season. Minimum residency time is defined as the minimum average time of stay inside the lagoon. Minimum residence time is estimated from the number of days between the first time a whale is photographed (“captured”) and the last time it is photographed (“recaptured”).

Recaptures of female whales with calves from previous years were considered to estimate the birth interval, which is estimated as the average time between years with calves (or the interval between times when a female is seen with and then without a calf.

Health Assessment: Whales exhibiting characteristics of mal-nutrition (i.e., food resource limitation) and/or disease (i.e., "skinny whales") as described by Weller *et al.* (2000) were observed during the census and photographic identification surveys in 2012. Once recognized, efforts were made to obtain photographs of the entire body of such whales to document and to evaluate their health. "Skinny" symptoms varied among individuals but included at least one or more of the following diagnostic features:

- 1) An obvious sub-dermal protrusion of the scapula from the body with associated thoracic depressions at the posterior and anterior insertion points of the flipper;
- 2) The presence of noticeable depressions on concavities around the blowholes and head;
- 3) A pronounced ridge along the neural/dorsal spine of the lumbar and caudal vertebrae resulting in the appearance of a “bulge” along the lateral flank (Weller *et al.* 2000) (Figure 5).

The percent of whales exhibiting "skinny" characteristics were estimated from the total number of these whales photographed divided by the total number of distinct individual whales ("skinny" and not "skinny") photographed during the photo identification surveys.



Figure 5. Morphological characteristics considered in determining the body condition of gray whales.

RESULTS

Abundance and distribution

Seventeen surveys were conducted in Laguna San Ignacio, during the winter season of 2012 (between January 20 and April 15). The highest count of adult whales was 268 whales recorded on February 22 (Figure 6, Table. 1).

Abundance varied according to the area (distribution) (Figures 7-9). In the upper lagoon area the overall abundance was lowest. With the exception of January, there was a predominance of mothers with calves in this area; this is likely due to the fact that on average it is a shallower area that is least affected by the tidal currents, and that could be used as a nursery area until the calf reaches the size and strength necessary to occupy in areas populated by adult whales. In this area the maximum combined count (total mother-calf pairs and single whales) was 65 adult whales that occurred on March 9 (Figure 7, Table. 2).

In the middle lagoon, the numbers of mother-calf pairs and Single whales increased during the season; the maximum count of 82 adult whales of both categories was observed on February 26. After this date the numbers of mother-calf pairs continued to increase in this area as the season progressed, reaching the peak in late March and early April of 29 and 26 pairs, respectively. This late season increase of mother-calf pairs is possibly due to the contribution of

individuals of the upper area and visitors from areas to the south of Laguna San Ignacio that are on their northward migratory journey (Figure 8, Table. 2).

The lower zone had the highest density and concentrations of gray whales throughout the winter season (Figure 9, Table 2). Whales in this area were mainly single whales, which showed a steady increase in January to their highest counts of 117 on February 22, and a second high count of 106 whales on March 9. Mothers with calves maintained a low presence in this area, but their counts did constantly increase to 87 pairs in the last survey conducted on April 13. Maximum combined count for this area was 135 adult whales on March 9.

Table 1. Number of adult whales counted in surveys conducted during winter of 2012. Calves are not included.

Survey date	Mothers with calves	Singles	Total adult whales
20-ene	28	28	56
24-ene	33	48	81
29-ene	21	62	83
02-feb	32	68	100
06-feb	57	94	151
12-feb	34	101	135
17-feb	50	102	152
22-feb	63	205	268
26-feb	68	170	238
05-mar	82	133	215
09-mar	86	154	240
17-mar	58	79	137
22-mar	75	53	128
25-mar	85	23	108
03-abr	72	4	76
07-abr	110	4	114
13-abr	95	0	95

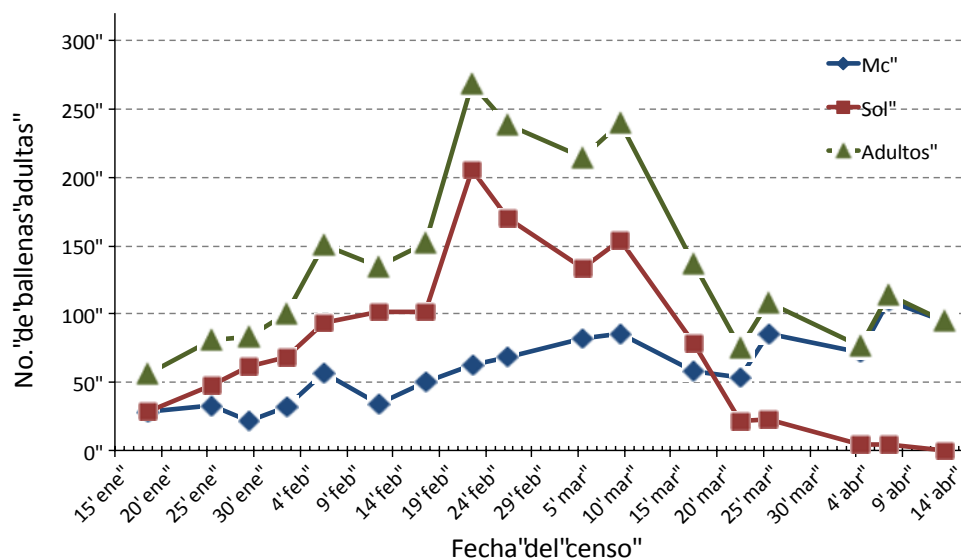


Figure 6. Number of whales counted in surveys conducted in winter of 2012 in LSI, differentiated by categories, adults are the sum of mothers with calves (Mc) and adult whales without calves, named singles (Sin).

Table 2. Number of whales counted in the upper, middle, and lower zones during the winter of 2012 in Laguna San Ignacio, differentiated by categories (Mc = mothers with calves, Sin = single whales, and Adults).

Zone	Upper		Middle		Lower		TOTAL		
	Mc	Sin	Mc	Sin	Mc	Sin	Mc	Sin	Adult
18 Jan	4	5	9	10	15	13	28	28	56
25 Jan	14	12	12	10	7	26	33	48	81
29 Jan	8	10	6	31	7	21	21	62	83
02 Feb	14	17	11	22	7	29	32	68	100
06 Feb	35	15	14	23	8	56	57	94	151
12 Feb	12	12	10	35	12	54	34	101	135
17 Feb	23	5	10	23	17	74	50	102	152
22 Feb	32	26	17	62	14	117	63	205	268
26 Feb	29	22	21	61	18	87	68	170	238
05 Mar	32	11	22	38	28	84	82	133	215
09 Mar	44	21	13	27	29	106	86	154	240
17 Mar	15	4	9	22	34	53	58	79	137
22 Mar	9	2	15	5	29	15	53	22	75
25 Mar	10	3	29	7	46	13	85	23	108
04 Apr	12	0	30	2	30	2	72	4	76
07 Apr	9	2	36	0	65	2	110	4	114
13 Apr	0	0	8	0	87	0	95	0	95

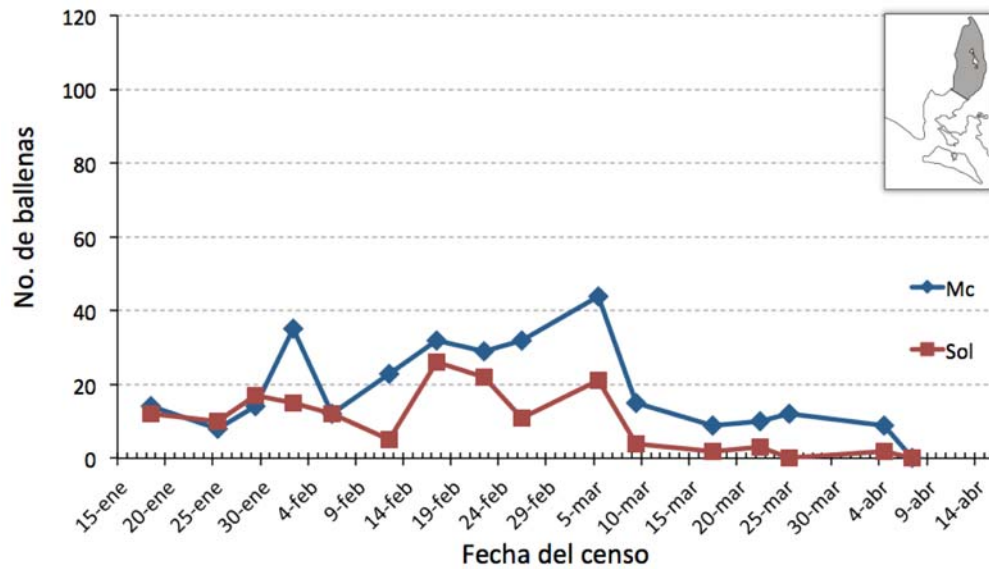


Figure 7. Whales counted (Mc and Sin) in surveys conducted in winter of 2012, in the lower lagoon.

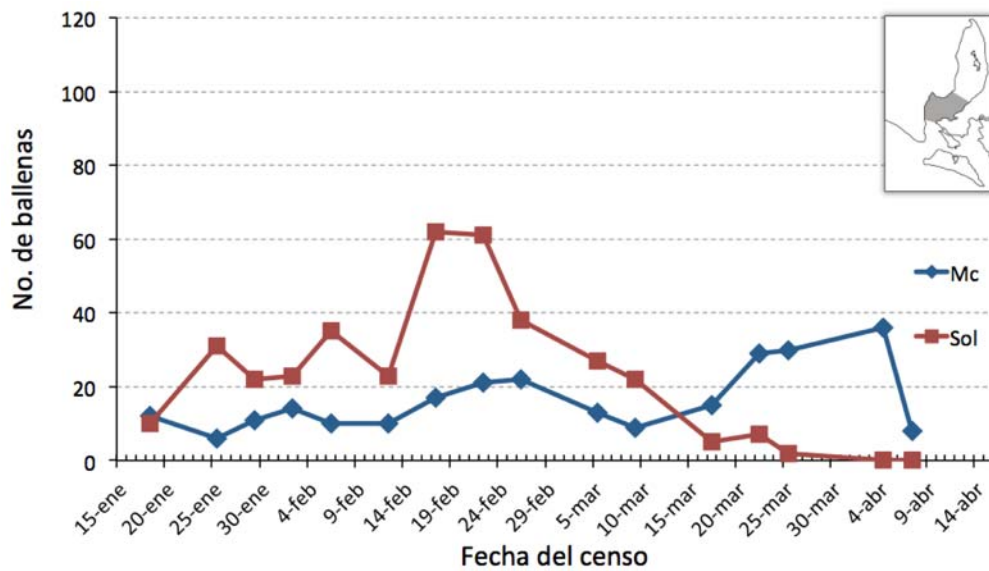


Figure 8. Whales counted (Mc and Sin) in surveys conducted in winter of 2012, in the middle lagoon.

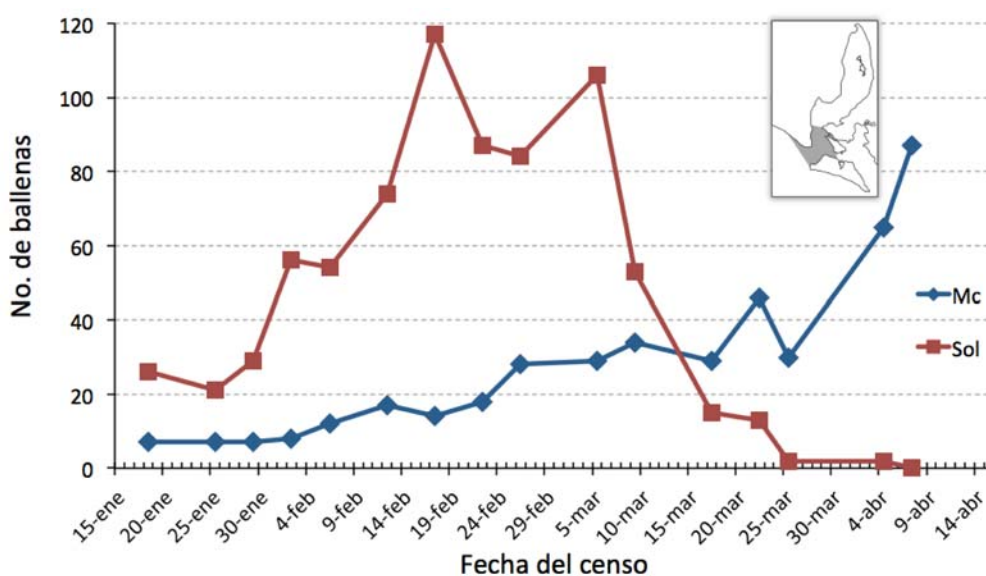


Figure 9. Whales counted (Mc and Sin) in surveys conducted in winter of 2012, in the upper lagoon.

Photographic Identification

The gray whale research team conducted 64 days of photo-ID surveys in Laguna San Ignacio, with a total of 359.3 hours of effort, in which there were 863 gray whale sightings. The research team operating in Bahía Magdalena conducted 18 days of photo-ID surveys, with 155.5 hours effort, in which 146 sightings were recorded (Table 3).

Table 3. Summary of the effort for the photo-identification work in Laguna San Ignacio and Bahía Magdalena.

Laguna San Ignacio				Bahía Magdalena		
Month	Days	Sightings	Effort (h)	Days	Sightings	Effort (h)
Jan	11	162	62.5	6	43	53.2
Feb	23	306	109.0	8	75	70.5
Mar	22	313	148.3	4	28	31.8
Apr	8	82	39.5	0	0	0

A total of 9,508 digital pictures were taken during fieldwork in Laguna San Ignacio, and 3,198 in Bahía Magdalena. The post-field analysis included a comparison of all photographs obtained from both areas, to develop photo-identification catalogues for each location for 2012.

A total of 670 different individuals (adults) were obtained for Laguna San Ignacio, of which 238 were females with calves, and 432 were single individuals (adult male or female), while in Bahía Magdalena 272 different individuals were identified, of which 41 were females with calves and 231 were single adults.

Residence

After comparing photographs taken in each area, the minimum residence time of each identified whale was estimated. For each whale that was photographed more than once, the time between recaptures among individual photographs was calculated as the number of days between the first and last picture taken. Once the minimum residence time of each whale was obtained, resulting minimum residence times for each whale were computed and an average minimum residence time calculated with its corresponding confidence interval.

The residence time of mothers with calves in Laguna San Ignacio was 22.13 ± 3.25 days. This was longer than the 2.11 ± 0.55 days calculated for single whales in Laguna San Ignacio (Table 4, Figures 10, 11). The estimated minimum residence time of mothers with calves in Bahía Magdalena was 3.51 ± 1.75 days, also higher than that of 1.26 ± 0.12 days for single whales, but very much shorter compared to residence times estimated in Laguna San Ignacio. This difference is unexpected considering that Bahía Magdalena is a historical gray whale breeding and winter aggregation area, and it suggests a higher turn-over or exchange of whales in that area (Table 4, Figures 12, 13).

Table 4. Minimum and maximum average residence by individual, congregation area, estimates were made with a confidence interval of 95%.

Residence	Laguna San Ignacio		Bahía Magdalena	
	Mc	Sin	Mc	Sin
Average	22.132 ± 3.257	2.111 ± 0.557	3.512 ± 1.756	1.262 ± 0.123
Maximum	81.0	67.0	27.0	7.0

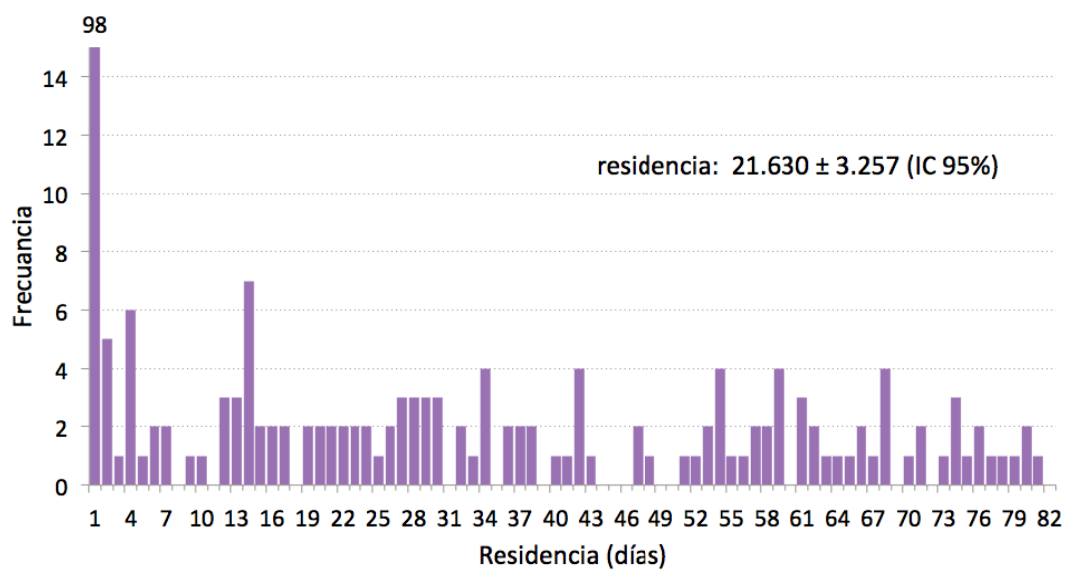


Figure 10. Residence frequency distribution of mothers with calves, determined from photographic recaptures in Laguna San Ignacio. Mean residence and its interval are reported.

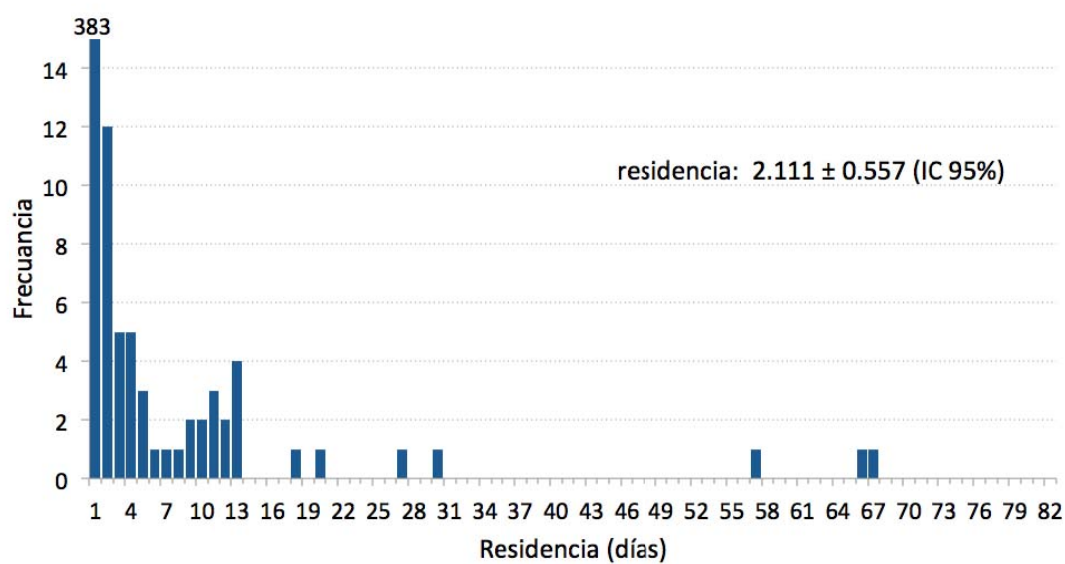


Figure 11. Residence frequency distribution of solitary, determined from photographic recaptures in Laguna San Ignacio. Mean residence and its interval are reported.

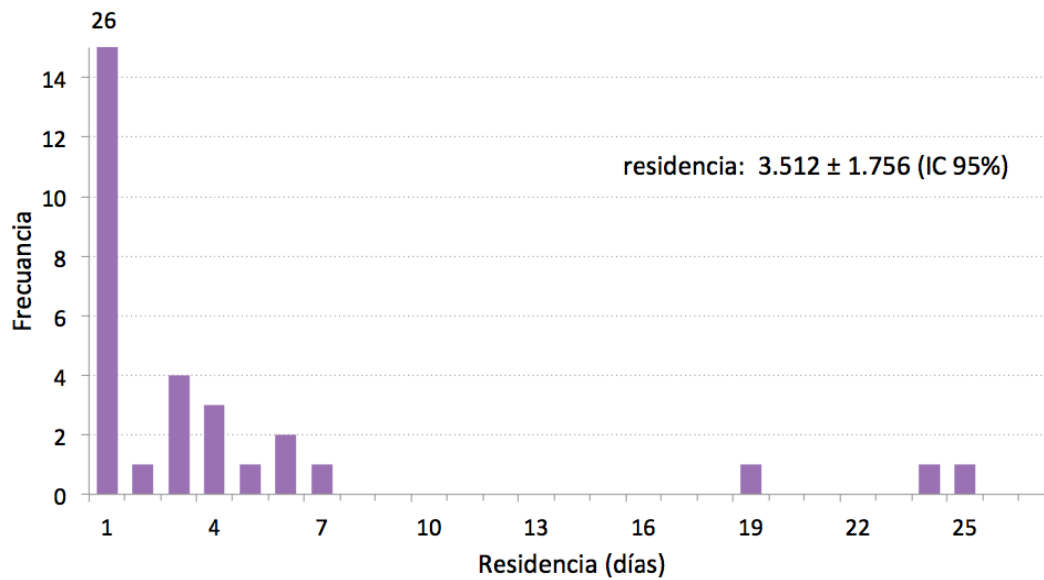


Figure 12. Residence frequency distribution of mothers with calves, determined from photographic recaptures in Bahía Magdalena. Mean residence and its interval are reported.

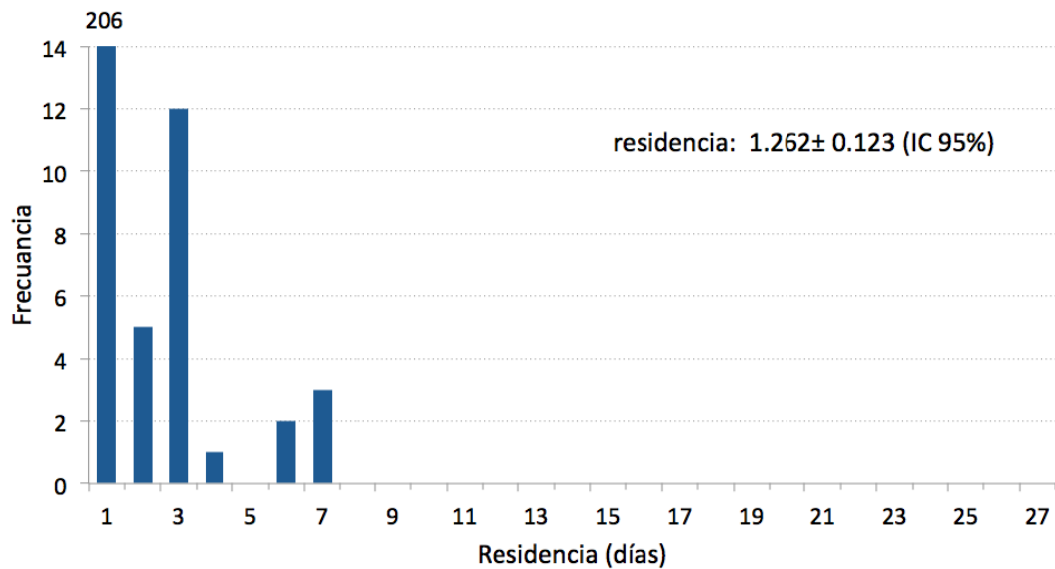


Figure 13. Residence frequency distribution of solitary, determined from photographic recaptures in Bahía Magdalena. Mean residence and its interval are reported.

Comparison between lagoons

As an important part of this year's monitoring, photographic catalogs from both congregation areas (Bahía Magdalena and Laguna San Ignacio) were compared to determinate the relationship and movements of gray whales between these areas. There were 14 recaptures of gray whale photographs between these two lagoon congregation areas, demonstrating and exchange of whales between them.

Of these recaptures, ten were mothers with calves, and four were single whales; all animals were first sighted and photographed in Bahía Magdalena and then re-captured between 7 to 24 days later in Laguna San Ignacio (Table 5).

Table 5. Individual gray whales photographically recaptured between Bahía Magdalena and Laguna San Ignacio.

Bahía Magdalena (Identification number)	Laguna San Ignacio (Identification number)	Recaptures dates between zones (BM / LSI)	Days between recaptures
12-0106-D-BM	12-0083-D-LSI-Mc	30-ene-2012 / 06-feb-2012	7
12-0214-D-BM-M	12-0134-D-LSI-Mc	24-feb-2012 / 06-mar-2012	11
12-0196-D-BM-M	12-0159-D-LSI-Mc	23-feb-2012 / 16-mar-2012	22
12-0235-D-BM-M	12-0171-D-LSI-Mc	27-feb-2012 / 22-mar-2012	24
12-0232-D-BM-M	12-0203-D-LSI-Mc	28-feb-2012 / 25-mar-2012	26
12-0257-D-BM-M	12-0210-D-LSI-Mc	01-mar-2012 / 30-mar-2012	29
12-0210-D-BM-M	12-0216-D-LSI-Mc	27-feb-2012 / 03-abr-2012	36
12-0187-D-BM-M	12-0219-D-LSI-Mc	22-feb-2012 / 04-abr-2012	42
12-0244-D-BM-M	12-0231-D-LSI-Mc	27-feb-2012 / 08-abr-2012	41
12-0265-D-BM-M	12-0237-D-LSI-Mc	18-mar-2012 / 14-abr-2012	29
12-0008-D-BM	12-0352-D-LSI-Sin	27-ene-2012 / 06-feb-2012	10
12-0058-D-BM	12-0364-D-LSI-Sin	29-ene-2012 / 07-feb-2012	9
12-0055-D-BM	12-0375-D-LSI-Sin	29-ene-2012 / 10-feb-2012	12
12-0160-D-BM	12-0383-D-LSI-Sin	01-feb-2012 / 10-feb-2012	9

Health Assessment

As part of photo-identification work, photographs of the whales' head and scapula were taken to estimate the proportion of whales that exhibited obvious signs of the "skinny whale syndrome" (i.e., nutritional stress) using the health assessment indicators and numerical evaluation method developed by Bradford et al. (2012). These indicators include an obvious

post cranial depression, protruding scapula edge, concave dorsal flanks along the body which are all indicators of a significant decrease of the whales' body fat reserves.

Data reviewed show that the number of gray whales exhibiting "skinny whale" characteristics has decreased in recent years, from 11%-12% in 2009-2010 to less than 3% of the animals photographed in 2012 (Table 6).

Table 6. Nutritional status of gray whales in LSI and BM.

Laguna San Ignacio				
	Normal	Acceptable	Poor	Unknown
Solitary (#)	188.00	90.00	17.00	137.00
Solitary (%)	43.52	20.83	3.94	31.71
Female with calf (#)	146.00	50.00	5.00	38.00
Female with calf (%)	61.09	20.92	2.09	15.90
Bahía Magdalena				
Solitary (#)	123.00	41.00	5.00	62.00
Solitary (%)	53.25	17.75	2.16	26.84
Female with calf (#)	32.00	8.00	0.00	1.00
Female with calf (%)	78.05	19.51	0.00	2.44

Acoustic Monitoring Program

The LSIESP acoustic researchers from SCRIPPS Institution of Oceanography conducted their 6th season of acoustic monitoring in Laguna San Ignacio. Two stationary recorders were placed at the bottom of the lagoon, and these collected acoustic data for a period of one month. The first recorder was deployed in the middle zone of the lagoon, where whale watching is prohibited; and the second recorder was placed in the whale observation area within the lower lagoon where eco-tour boats are permitted to operate. These recordings establish a database over time to determine the noise levels and frequencies of sound in the lagoon from natural and human sources, and to compare noise characteristics with the distribution and use of the lagoon by gray whales.

OTHER ACTIVITIES

Environmental Education and Outreach

As part of the LSIESP's community outreach, LSIESP researchers conducted environmental education classes with primary and secondary schools of the Ejido Luis Echeverría (Figure 14).



Figure 14. Talks held in the Ejido Luis Echeverría Primary School.

In March LSIESP and the Ecology Project International (EPI) collaborated to sponsor visits to Laguna San Ignacio for two groups of high school students from the town of San Ignacio. Each student group spent four days at the lagoon where LSIESP researchers taught them to conduct photographic identification research and abundance monitoring on gray whales in Laguna San Ignacio (Figure 15).



Figure 15. Ecology Project International (EPI) students present their projects at Laguna San Ignacio.

Outreach and media

This year several television and media groups visited San Ignacio Lagoon to learn about gray whales that congregate here, and to know more about gray whale monitoring research conducted by the LSIESP. Among these media groups were:

- The Nightline news team from ABC television network. They produced an news article and video on gray whale research at Laguna San Ignacio (Figure 16).
- The United States Public Broadcast System (PBS) who interviewed the LSIESP research team as part of a series of documentaries they are producing related to marine protected areas and sustainable development.
- Univision News made a report about the gray whales and ecotourism in Baja California.
- The Austrian Popular Science Magazine carried a story on gray whales in Mexico.

In addition, in 2012 Leigh Henry from World Wildlife Fund-US, and other representatives of WWF-International, visited the lagoon, and interviewed LSIESP gray whale researchers about their research and the conservation of this marine protected area. Likewise, Monica Echeverria of WWD-US produced a video about the gray whale research program in Laguna San Ignacio (view the WWF-US video at www.lsiecosystem.org/research/).

2012 Community Reunion at Laguna San Ignacio

On 4 March LSIESP researchers hosted the 6th Annual Community Reunion at the Kuyimita Campground Palapa to present brief talks on the research programs underway at the lagoon and to discuss local concerns and issues relating to the conservation of the lagoon. These meetings provide an opportunity for the local residents of Laguna San Ignacio to meet and discuss with the scientists the research that is conducted each winter in the lagoon. LSIESP researchers made several presentations on their research and discussed new information about gray whales and other topics related to the conservation of the lagoon ecosystem (Figure 16).

Approximately 60 attendees included members of the Eco-Tourism Operator's Association, Philanthropiece, the Vizcaino Biosphere Reserve, Pronatura-Noroeste, University of Siena-Italy, local school teachers and interested public.



Figure 16. Researchers discuss the science program at the annual community meeting at Laguna San Ignacio.

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