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2017 GRAY WHALE RESEARCH IN LAGUNA SAN IGNACIO AND BAHIA MAGDALENA, MÉXICO

J. Urbán R.[1], S. L. Swartz[2], A. Gómez-Gallardo U.[1], S. Martínez A[1]., and H. Rosales-Nanduca.[1]

[1] Programa de Investigación de Mamíferos Marinos. Universidad Autónoma de Baja California Sur, La Paz, B.C.S., México

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

INTRODUCTION

The long-term database developed during the past 12 winters by the Laguna San Ignacio Ecosystem Science Program (LSIESP) for gray whales facilitates the detection, and assessment of trends in abundance, distribution and in use of winter aggregation areas during the whales' winter breeding season. The 2017 winter is a good example, when the average water temperature was 2-3 degrees °C cooler than in 2016, known as the "La Niña" condition. The 2017 counts of gray whales in Laguna San Ignacio and Bahía Magdalena area were consistent with previous winters with cooler sea surface temperatures with fewer whales utilizing the northern aggregation areas and more whales migrating further south to utilize the more southerly aggregations areas. Some gray whales migrated south as far as Cabo San Lucas, while others entered the Gulf of California as far north as Bahia de La Paz. Three gray whales were reported to have crossed the Gulf of California to visit the mainland coast at Mazatlán during the 2017.

GRAY WHALE ABUNDANCE MONITORING

Laguna San Ignacio: Systematic boat surveys for gray whales have been conducted in Laguna San Ignacio during three time periods beginning in 1977 to 1982 (Jones and Swartz 1984), 2000 to 2003 (Swartz et al. 2008), and from 2006 to the present by LSIESP researchers (www.sanignaciograywhales,org) (Fig. 1). These surveys follow a standardized methodology that allows inter-annual comparisons, and they provide an index of the abundance of whales, their distribution, and duration of stay within the lagoons.

In Laguna San Ignacio 13 surveys of gray whales were completed to monitor seasonal abundance and habitat use in 2017. Surveys began on 19 January and continued until 31 March. The overall number of gray whales and their seasonal occupation of the lagoon was slightly lower than seen in previous years, presumably due to the cooler sea temperature, when more gray whales migrate further south to find warmer water (Fig. 2, Table 1). Higher counts of gray whales in the Bahia Magdalena complex to the south of Laguna San Ignacio support this conclusion (see below).

The counts of single adult whales (breeding males and females without calves) reached a maximum of 120 whales on 3 March (Fig. 3, Table 1). The highest count of females with calves of 107 occurred on 27 March (Fig. 4, Table 1). As in previous winters, female-calf pairs occupied all areas within the lagoon, particularly the northern upper lagoon area, but shifted their distribution to the lower lagoon nearest the entrance once the single adults had left the lagoon by mid-March.

Bahía Magdalena: The 2017 census surveys of gray whales in the Bahía Magdalena lagoon complex were conducted in three different areas (Bahía Almejas in the south, Bahía Magdalena, and Lopez Mateos in the north) during three different time periods: 17-26 January, 8-16 February, and from 27 February to 3 March (nine surveys in all) (Figs. 5 and 6). The highest count of gray whales was obtained on March 1 in Bahía Almejas, and was of 121 individuals (13 mother-calf pairs and 108 single whales), while the lowest count was 9 adult whales in Lopez Mateos in January, 6 singles and 3 mother-calf pairs. Mother-calf pairs were seen in all census surveys. The numbers of single animals observed in surveys of all three areas were notably higher in 2017 in comparison with 2016, when the highest count was of 14 single whales in February in Bahia Magdalena.

In addition, gray whales were observed around Cabo San Lucas at the southern end of Baja California, in the Gulf of California around Bahia de La Paz, and three individuals were observed off Mazatlán on the mainland coast of Mexico (pers. Com. Jorge Urbán).

PHOTOGRAPHIC IDENTIFICATION

Laguna San Ignacio: Photographic identification (Photo-ID) effort in Laguna San Ignacio included 265 hours over 56 days photographing gray whales in 2017. A total of 11,893 digital images were obtained from 489 gray whale sightings that yielded 646 individual whales. These included 428 single whales what averaged 11.4 days in the lagoon (range 1 to 68 days), and 218 females with calves that averaged 32.4-days in the lagoon (range 1 to 74 days) (Table 3).

Bahía Magdalena: Researchers working in the Bahía Magdalena region obtained 4,119 digital images from 203 sightings of gray whales during the 2017 season. From these images, 374 individual whales were identified (319 single whales and 55 female-calf pairs), representing significantly more single whales in this region in 2017 compared to the previous winter when only 74 single whales were counted. Of these 374 whales, 13 single whales and 23 mother-calf pairs were re-sighted two or more times in Bahía Magdalena lagoon complex during the 2017 season. Final numbers including the minimum time spent in the Bahía Magdalena region (estimated as the time between the first and last time a whale was photographed) will be determined during post-field season analysis (Table 3).

Calving Interval Estimation: The estimated gray whale calving was 2.11 $\pm$ SD = 0.40 years during the 1977-1982 time period (Jones 1990). Photographs of known breeding females obtained from 2005-2016 were used to develo pan estimate of female calving-interval of 2.46 $\pm$ SD = 0.58. This sample of 307 females produced 736 calves between 2005 and 2016, and of these 20% of the calves were born between 2005 and 2010, while 80% of the calves were born between 2011 and 2016 (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).

Individual Age Estimation: The minimum ages of breeding female gray whales were determined from photographs obtained during the 1977-1982 (Jones and Swartz), the 1996-2000 (Urban et al.), and the 2005-2016 (LSIESP) time periods. In 2017 five of these 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 35 to 47 years, 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.

As in previous years, all photographs from 2017 will be archived, placed into digital catalogs, compared with the catalogs from 2006-2016, 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 (www.sanignaciograywhales.org) and 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.).

Whale Dis-Entanglement: In 2017 two dis-entanglements of gray whale calves were attempted in Laguna San Ignacio. The first on March 4th was un-successful as the whale broke free of the dis-entanglement gear; however, this calf and its mother were re-sighted between 13 and 23 March and there was no gear on the calf. The second attempt on March 8th successfully removed approximately 26 m of float line and floats from a gray whale calf.

DISCUSSION

Trends of gray whale abundance along the Pacific coast of Baja California are influenced by Sea Surface Temperature (SST) in the winter (Salvadeo et.al. 2015, Urbán et al. 1999). The sea surface temperature recorded in both Laguna San Ignacio and Bahía Magdalena during the 2017 winter ranged from a low of 16° C to a high of 21° C, which was approximately 2.5° C colder than recorded in 2016 (Urbán et al. 2016). It is reasonable to conclude the warmer El Niño conditions that prevailed during the 2016 winter contributed to the early departure of gray whales from Laguna San Ignacio (Urbán et al. 2016), while the cooler SST or La Niña conditions that occurred in 2017 contributed to lower counts of gray whales in this lagoon, and higher counts of whale in Bahía Magdalena (this report). In contrast to Laguna San Ignacio, the number of gray whales utilizing the Bahía Magdalena area in 2017 was higher than observed there in 2016 and in previous years (Urbán et al. 2016 and 2015), and the distribution of whales was more

heterogeneous in comparison with 2016 (this report Figure 6). Another difference was that only one sighting of a single humpback whale (*Megaptera novaeangliae*) was made in Bahía Magdalena in 2017 compared to 19 humpback whale sightings in 2016.

Since 2010, the numbers of female-calf pairs observed in Laguna San Ignacio have increased following the low female-calf counts in the winter aggregation areas in the years immediately following the 1998-2000 range-wide mortality event (LeBoeuf et al. 2000, Swartz et al. 2008), suggesting that there has been a continuing recovery of breeding female gray whales (Urbán et al. 2011).

As in previous years, counts of female-calf pairs in Laguna San Ignacio continued to increase following the end of the birthing period in late-February to early March. This late season increase did not include new-born calves of the year, rather the increase included females with calves that appeared from their size and coloration to be 1-2 months old. This post-birth period increase of female calf pairs was first described by Jones and Swartz (1984). They compared photographs of female-calf pairs from Laguna San Ignacio with photographs obtained during the same year (1980) of female gray whales in aggregation areas to the north of Laguna San Ignacio (Laguna Ojo de Liebre and Laguna Guerrero Negro) and the southernmost aggregation area of Bahia Magdalena, and they found matches (re-captures) with the female gray whales photographed in Laguna San Ignacio late in the winner (i.e., after the birth period). These photographic re-captures along with late season declining numbers of females with calves in areas to the north and south of Laguna San Ignacio, led Jones and Swartz to conclude that the late season increase of females with calves in Laguna San Ignacio was due to an influx of female-calf pairs from areas to the north and south. They speculated that Laguna San Ignacio may serve as a sort of "staging area" before female gray whales start their northward spring migration with their calves (Jones and Swartz 1984, Swartz 1986).

In recent years, photographic re-captures of gray whales first photographed in Bahía Magdalena and subsequently photographed in Laguna San Ignacio during the same year, suggests that the direction of movement of these whales is "south to north" from Bahía Magdalena to Laguna San Ignacio. Of 85 individual whales (51 female-calf pairs and 24 single whales without calves)

photographed in both aggregation areas during the same winter, only 2 female-calf pairs were first seen in Laguna San Ignacio and then Bahia Magdalena, while of the whales (49 female-calf pairs and 24 single whales) were first photographed in Bahía Magdalena and then later in Laguna San Ignacio late in the breeding season (S. Martinez, un-published data). Unfortunately, in recent years there has been little photographic identification data available from Laguna Ojo de Liebre for comparison. Other than the original observations by Jones and Swartz (1984), any "south to north" late season movements from the northern aggregation area into Laguna San Ignacio is yet to be demonstrated.

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TABLES

Table 1. Survey counts of gray whales (Female-calf pairs, Singles (whales without calves), and total Adults) in Laguna San Ignacio during the 2017 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	19-Jan-17	15	9	24
2	23-Jan-17	30	15	45
3	30-Jan-17	30	30	60
4	4-Feb-17	28	66	94
5	9-Feb-17	68	48	116
6	16-Feb-17	63	100	163
7	25-Feb-17	66	105	171
8	3-Mar-17	79	120	199
9	10-Mar-17	89	47	136
10	15-Mar-17	81	34	125
11	20-Mar-17	84	14	98
12	27-Mar-17	107	8	115
13	31-Mar-17	101	9	110

Table 2. Number of Single gray whales (whales without calves), Female-calf pairs, and Adults) counted during surveys in the Bahía Magdalena complex and surrounding areas during the 2017 winter.

Survey Dates in 2017	Bahía Almejas	Bahía Magdalena	Lopez Mateos	Totals
Single Whales				
January 17-26	21	16	6	43
February 8-16	66	69	18	153
Feb 27-March 3	108	48	13	169
Female-calf pairs				
January 17-26	7	2	3	12
February 8-16	16	1	44	61
Feb 27-March 3	13	4	34	51
Adult Whales				
January 17-26	28	18	9	55
February 8-16	82	70	62	214
Feb 27-March 3	121	52	47	220

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	56	18
No. Effort Hours	265	181
No. Images	11893	4119
No. Sightings	646	203
No. Individual Whales	688	374
No. Single whales	428	319
Single whales' mean days in area	11.4 (1-68)	6.3 (1-18)
No. Female-calf pairs	218	55
Female-calf pairs' mean days in area	32.4 (1-74)	19.4 (1-41)

FIGURES

Figure 1. Standardized gray whale boat survey track line in Laguna San Ignacio. Counts in the northern portion of the lagoon are obtained from a 360^0 scan of the area. The survey track line continues south over the deepest portions of the lagoon from the northern area to the entrance of the lagoon: these are the Upper Zone, the Middle Zone, and the Lower Zone .

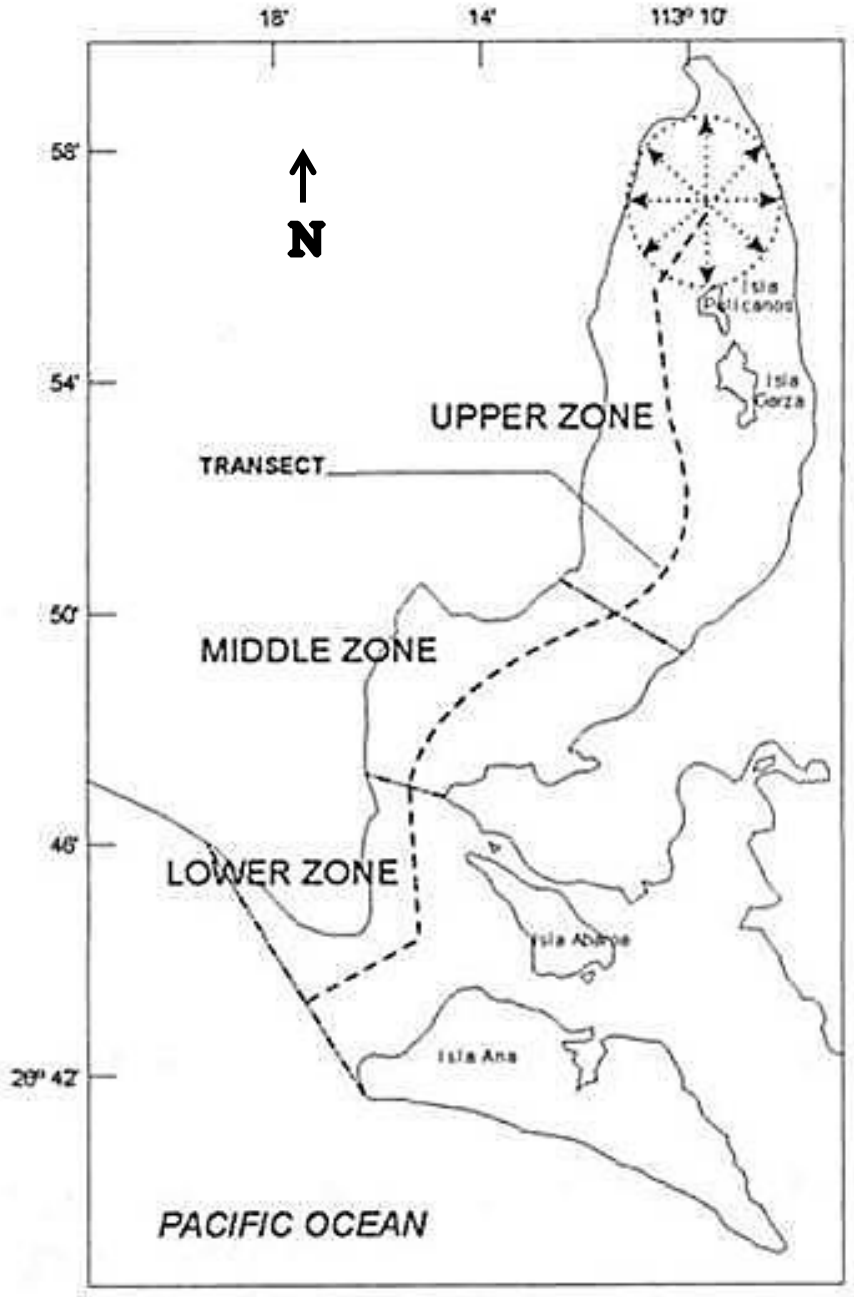

Figure. 2. Numbers of total adult whales (Adult males, females, and females with calves) counted in Laguna San Ignacio during the winter seasons: 2010-2017.

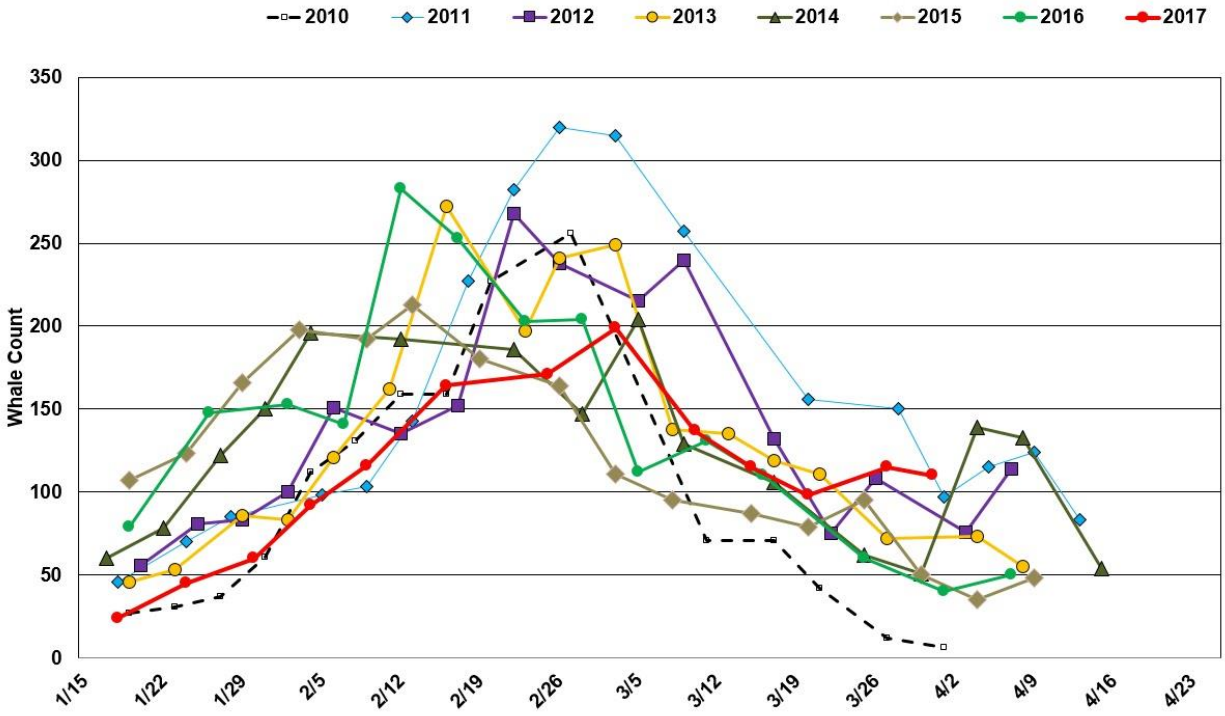

Figure. 3. Numbers of single whales (adult males and females without calves) counted in Laguna San Ignacio during the winter seasons: 2010-2017.

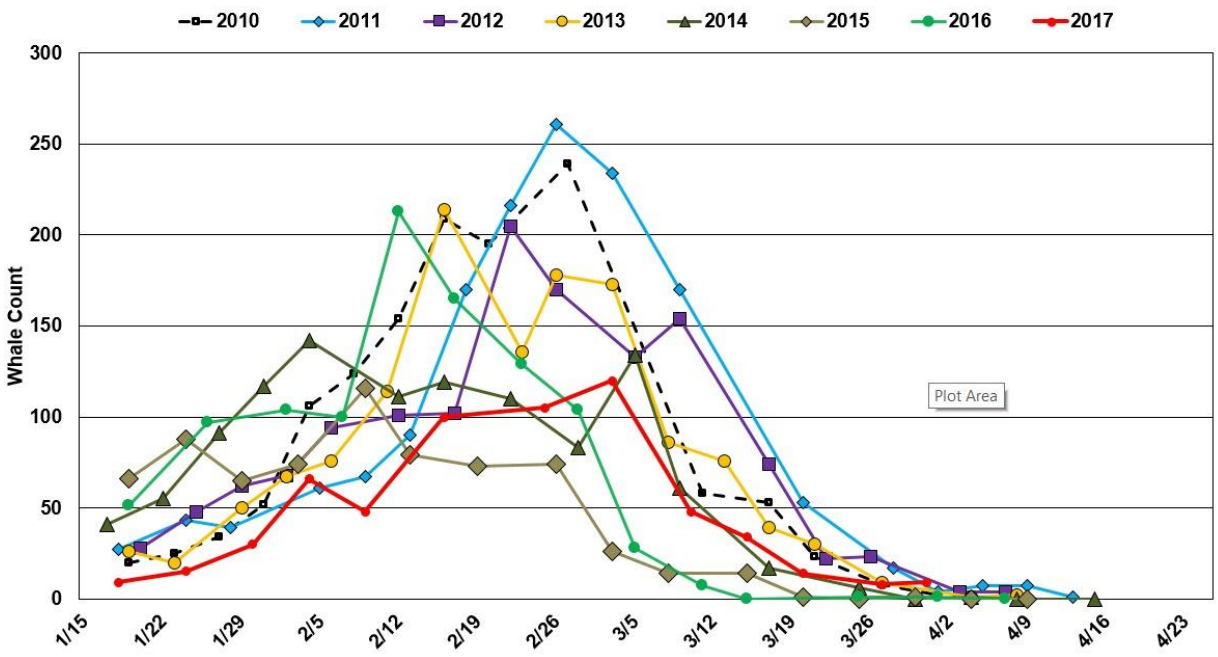

Figure. 4. Numbers of female-calf pairs (females with young of the year) counted in Laguna San Ignacio during the winter seasons: 2010-2017.

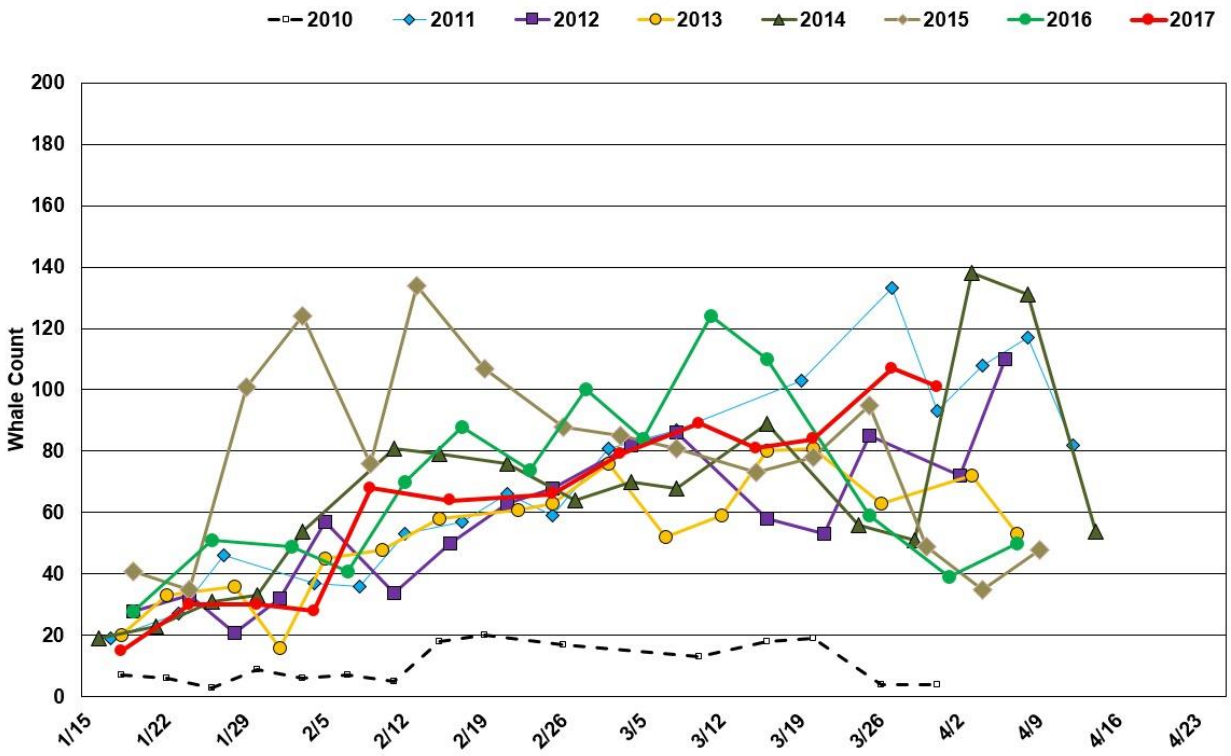

Figure 5. Gray whale boat survey track lines (red lines) in the Bahía Magdalena lagoon complex in the 2017 winter: Bahía Almejas (BA), Bahía Magdalena (BM) and Lopez Mateos (LM).

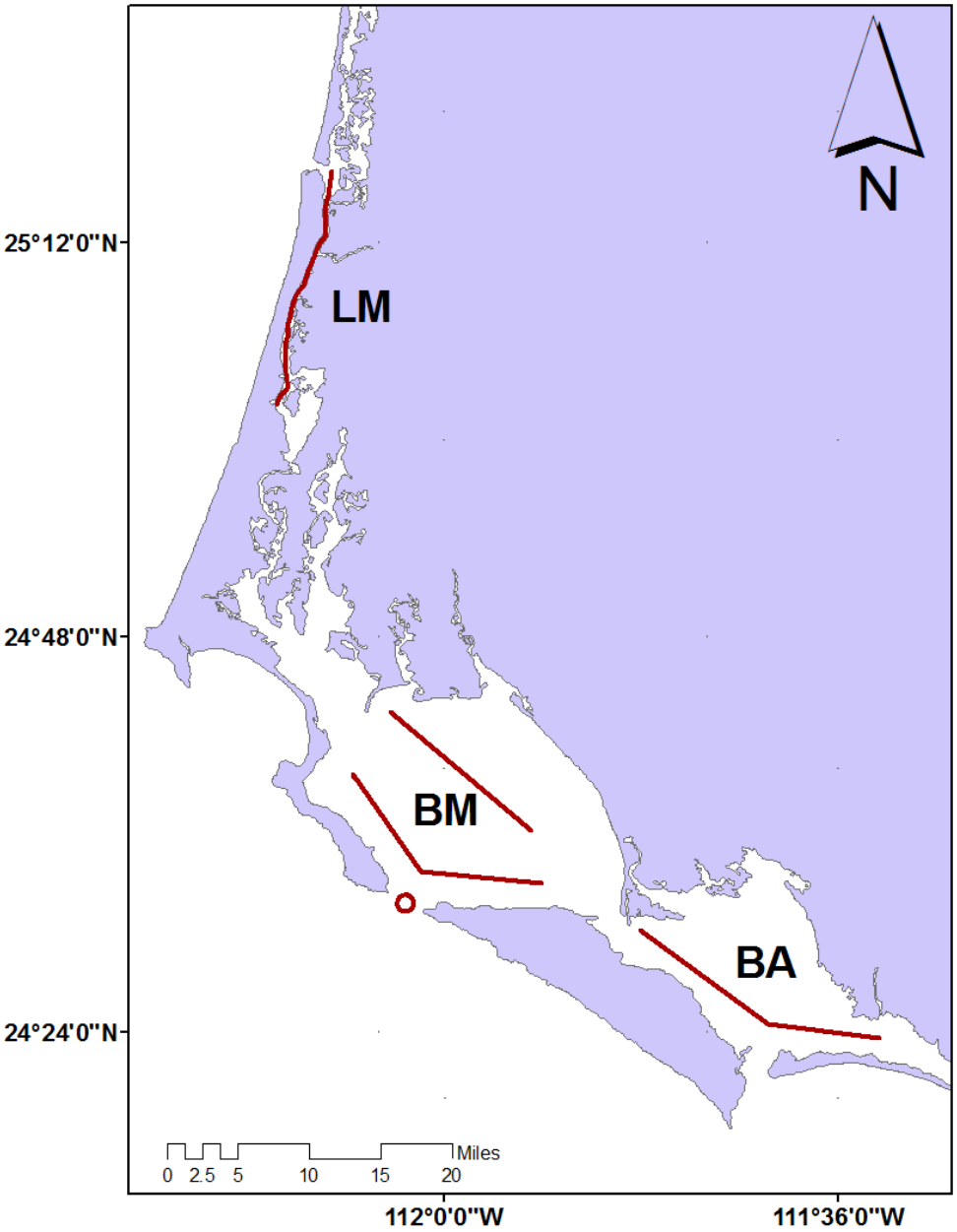

Figure 6. Whale sightings in the Bahía Magdalena lagoon complex and surrounded waters in the 2017 winter: Bahía Almejas (BA), Bahía Magdalena (BM) and Lopez Mateos (LM). blue circles = gray whale single animals; red circles = gray whale female-calf pairs; and green circles = humpback whales.