

2018 GRAY WHALE ABUNDANCE IN LAGUNA SAN IGNACIO AND BAHIA MAGDALENA, MÉXICO

J. Urbán R.¹, S. L. Swartz², S. Martínez A¹., L. Vilorio G¹., and ¹A. Gómez-Gallardo U.¹

¹ *Programa de Investigación de Mamíferos Marinos. Universidad Autónoma de Baja California Sur,
La Paz, B.C.S., Mexico*

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

INTRODUCTION

The 2018 winter gray whale abundance in Laguna San Ignacio (LSI) 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 (BM) 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 expected.

During the breeding season single male gray whales will harass and disturb females with newborn calves, and the predominance of single breeding adult whales early in the winter in LSI may have displaced and/or restricted the entry of female-calf pairs in 2018.

Extreme tidal flows in 2018 affected the average water temperatures within in LSI which fluctuated widely with lows in the 15 C° to 16 C° to highs in the 20 C° to 21 C°. These wide and rapidly changing ranges in temperatures may have contributed to the observed low abundance of female-calf pairs and their early departures in this lagoon.

METHODS

Boat Surveys for Abundance Estimation: Boat surveys are conducted to estimate the minimum number of gray whales within the primary gray whale winter aggregation and breeding lagoons along the Pacific coast of Baja California during the winter breeding season (Urbán et al 2003, Fig. 1). Each survey utilizes a hand-held Global Position System (GPS) device to follow a

predetermined survey trackline line that passes through the deep water areas (i.e., > 2-m deep) utilized by gray whales in each lagoon. Observer and sighting protocols are specified for the unique characteristics of each lagoon and, are used to obtain and record counts of whales along each trackline. This survey method allows duplication of survey effort for comparison of within year survey counts along identical survey tracks in each lagoon, and the comparison with historical counts from previous years (Jones and Swartz 1984, Urbán *et al.*, 2003).

Boat surveys are conducted from 7-m long out-board powered boats (Pangas) which follow each predetermined survey trackline at a speed of 11-km/hr during the whale counts. Speed and course along the trackline are continuously verified using a hand-held GPS. This survey speed minimizes the likelihood that whales (which typically travel at 7 to 9-km/hr) do not move ahead of the survey boat and counted more than once, and it allows observers sufficient time to detect surfacing whales (Jones and Swartz 1984).

For each survey two pairs of observers (one pair searching to the left and one pair searching to the right sides of the boat) note the number of whales seen they pass abeam of the survey boat. A fifth person records each sighting on printed survey forms, noting: the time of each sighting, the number of whales in each group, their direction of movement, and whether they are single whales or female-calf pairs. The recorder also notes for each portion of the survey the prevailing environmental conditions (i.e., visibility, Beaufort sea state, wind direction, cloud cover, surface water temperature and depth. Surveys were not conducted, or if in progress aborted, when wind and sea state conditions exceeded Beaufort 3 sea state (winds greater than 18 km/hr with consistent white caps).

By convention, “female-calf pairs” (i.e., female whales with calves of the year) are counted 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 or juvenile animals. Counts of “adult whales” are the sum of all non-calf whales observed (i.e., single whales and female-calf pairs).

Laguna San Ignacio: Boat surveys in LSI follow a 30-km long trackline that begins at the north end of Isla Garzas in the northern most end of the lagoon (North End Basin) to the west end of

Isla Ana at Punta Holcombe at the lagoon entrance (Fig. 2). The survey trackline is divided into five “zones” or segments to record the distribution of the whales within the lagoon. Surveys require approximately three hours to complete. The maximum distance from the survey trackline to the 2-m depth contour along shore is 2.5 km and the minimum distance is 0.8 km; thus, water sufficiently deep to be inhabited by whales and both shorelines are visible to the observers at all points along the trackline. Whales in the "North End Basin" (north of the survey trackline) are counted from the centre of this inner lagoon basin by observers searching in 360-degrees around the stationary boat.

Bahía Magdalena: Boat surveys of gray whales in the BM lagoon complex in 2018 duplicated surveys done in the previous winters of 2016 and 2017. The surveys included three different areas where gray whales aggregate within the BM 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. 6).

RESULTS

Lguna San Ignacio: In LSI 13 surveys of gray whales were completed to monitor seasonal abundance and habitat use in 2018. Surveys began on 18 January and continued until 2 April (Table 1). The overall number of adult (non-calf) gray whales and their seasonal occupation of the lagoon was lower and shorter than seen in previous years from 2011 to 2017 (Fig. 3).

The counts of single adult whales (breeding males and females without calves) reached a maximum of 160 whales on 15 February (Fig. 4, Table 1), which was greater and occurred earlier in the season than the 120 single whales seen on 3 March 2017, but less than the 213 single whales observed on 12 February 2016.

In 2018 the highest count of females with calves of 49 pairs occurred late in the season on 23 March (Fig. 5, Table 1). The number of female-calf pairs seen in 2018 was far less than that observed in 2017 (107 pairs) and in 2016 (124 pairs). Female-calf pair counts in 2018 were

similar to those observed during the winter breeding seasons from 2007 to 2010 (Fig. 5) following the range wide “mortality event” in the late 1990’s (LeBoeuf et al. 2000).

As in previous winters, female-calf pairs occupied all areas within LSI in 2018, and shifted their distribution to the southern end of the lagoon nearest the entrance once the single breeding whales had departed by mid-March. Also as expected, the highest count of female-calf pairs was observed following the end of the birthing period, and occurred in late-February to early March as females and their older calves move into LSI from other areas at the beginning of their spring northward migration (Swartz 1986). Numbers of female-calf pairs declined until the end of the season in early April. Overall, the low number of female-calf pairs observed in 2018 was unexpected, and as was their early departure from the lagoon.

Bahía Magdalena: The 2018 boat surveys of gray whales in the Bahía Magdalena lagoon complex were conducted in three different areas during three different time periods approximately 1-month apart: Bahía Almejas in the south, Bahía Magdalena, and Canal de Santo Domingo in the north (Fig. 6) during three different time periods: 11-13 January, 5-7 February, and from 5-7 March (nine surveys in all) (Table 2 and Figs. 7). The highest counts of gray whales were obtained in February in Bahía Magdalena (59 adult whales: 58 single whales and 1 female-calf pair) and in Canal de Santo Domingo (29 adult whales: 20 single whales and 9 female-calf pairs), but in March in Bahía Almejas (33 adult whales: 31 single whales and 2 female-calf pairs) (Table 2, Figs. 7).

The 2018 distribution of gray whales was concentrated in: the Canal de Santo Domingo; La Bocana of Bahía Magdalena (the passage between the north end of Isla Santa Margarita and Punta Estrada); and in the area along the north shore of Isla Creciente and off of the eastern shore Isla Santa Margarita in Bahía Almejas (Fig. 8). The highest numbers of gray whale females with calves were consistently observed in the Canal de Santo Domingo: 3-pairs on 13 January; 9-pairs on 7 February; and 16 pairs on 7 March. Although the number of female-calf pairs in the Canal de Santo Domingo was noticeably less than were observed in this area in 2017 and 2016 (Table 5, Fig. 11).

Overall, in 2018 the numbers of whales observed in all three areas within the BM complex were notably lower than those observed in 2017, but similar to the low gray whale abundance observed there in the 2016 winter (Tables 3-5; Figs. 9-11). As was observed in LSI, few gray whales remained in the BM complex by mid-March, so abundance surveys were discontinued.

A few gray whales were observed in January and February around Cabo San Lucas at the southern end of Baja California during the winter of 2018, but exact numbers and locations were not reported (pers. Com. Jorge Urbán).

DISCUSSION

A number of factors may have contributed to the low counts of female-calf pairs of gray whales observed in LSI and BM in 2018. The timing and length of the gray whale migration along the Pacific coast of Baja California, the period of time the whales reside in Mexican coastal waters during the winter, and their abundance in the primary aggregation areas and breeding lagoons, are influenced by several factors, including Sea Surface Temperature (SST) (Salvadeo et.al. 2015, Urbán et al. 1999). In winters with cooler than average sea surface temperatures fewer whales utilize the northern aggregation areas and more whales migrating further south to utilize the more southerly aggregations areas, presumably to find warmer temperatures.

The 2018 winter at LSI saw a mix of cooler and warmer water temperatures inside the lagoons. Extreme tidal flows accompanying periods during the new and full moon phases, and extreme prevailing winds in 2018 affected the average water temperatures which fluctuated with lows from 15 C° to 16 C° to highs from 20 C° to 21 C° (Fig. 12). This wide range of temperatures and the rapid changes in temperature, if unsuitable for females with young calves, may have contributed to their observed low abundance and their early departures in this lagoon. However, similar fluctuations in the lagoon's water temperatures have occurred repeatedly since 2011-2017, and the abundance of female-calf pairs in LSI during all of those winters has been greater than in the 2018 winter (Fig. 5).

During the gray whales' winter breeding season single male gray whales will harass and disturb females with newborn calves, which generally results in a spatial segregation between these two

groups of whales within the lagoons (Jones and Swartz 1984, Swartz 1986). As in previous winters in LSI, female-calf pairs occupied all areas within the lagoon, and shifted their distribution to the lower lagoon nearest the entrance once the single adults had left the lagoon by mid-March. In 2018 the count of single breeding adult whales (including males) reached its maximum number of 160 whales on 15 Feb 2018, which was greater and occurred earlier in the season than the highest count of 120 singles whales observed the previous year on 3 March 2017. This abundance of single breeding adult whales inside the lagoon early in the season when females and their calves were entering the lagoon may have displaced and/or restricted the number of female-calf pairs inside LSI in 2018. However, the abundance of single breeding whales inside the lagoon in 2018 was similar to previous winters that also had higher counts of female-calf pairs that were apparently unaffected by the presence of the breeding whales (Fig. 4).

The abundance of female-calf pairs inside LSI in 2018 were lower than expected, and similar to the abundance observed during the winter breeding seasons from 2007 to 2010 following the range-wide “mortality event” in the late 1990’s (Fig. 5; LeBoeuf et al. 2000). Beginning in 2011, the numbers of female-calf pairs observed in LSI have increased following the low female-calf counts in the years immediately following the mortality event, suggesting that there has been a continuing recovery of breeding female gray whales (Urbán et al. 2011, 2015, 2016, 2017). However, while the counts of females and calves observed in LSI in 2018 were low, the whales appeared to be in good nutritional health, and any indication of nutritional stress or poor condition of the gray whales was not evident.

Counts of gray whales, both single whales and female-calf pairs, in Laguna Ojo de Liebre (LOL), the largest of the gray whale winter aggregation areas, were similar in 2017 and 2018, and no decline in the numbers of gray whales utilizing this lagoon were observed by the scientists who conduct the winter whale surveys (Table 6 and Fig. 13). The number of female-calf pairs that utilized OLO did not decrease substantially in 2018 as observed in LSI and BM.

As in previous years, the 2018 counts of female-calf pairs in LSI increased following the end of the birthing period in late-February to early March, and the departure of the breeding single whales at the end of March. This late season increase, while not large (highest count was 49-

pairs on 23 March) 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. A post-field season comparison of photographs of female-calf pairs from LSI with photographs obtained from other gray whale aggregation areas (e.g., Laguna Ojo de Liebre and Bahía Magdalena) will be undertaken to determine if females and their calves entered LSI from other aggregation areas.

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TABLES AND FIGURES

Figure 1. Primary gray whale winter aggregation areas and lagoons along the Pacific coast of Baja California, Mexico: Ojo de Liebre (Scammon's Lagoon); Laguna San Ignacio; and the Bahía Magdalena complex.

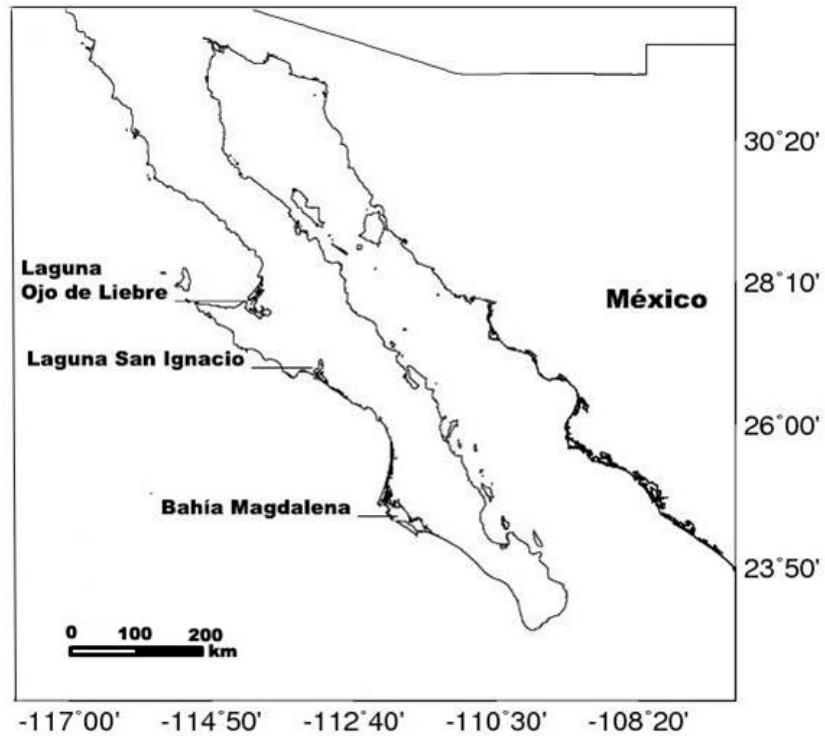


Figure 2. Boat survey trackline in Laguna San Ignacio. Counts in the “North End Basin” portion of the lagoon are obtained from a 360° scan of the area. The survey track line continues 30 km south from Isla Garzas (Zone 1) over the deepest portions of the lagoon to Punta Holcombe on the west end of Isla Ana at the entrance of the lagoon (Zone 5).

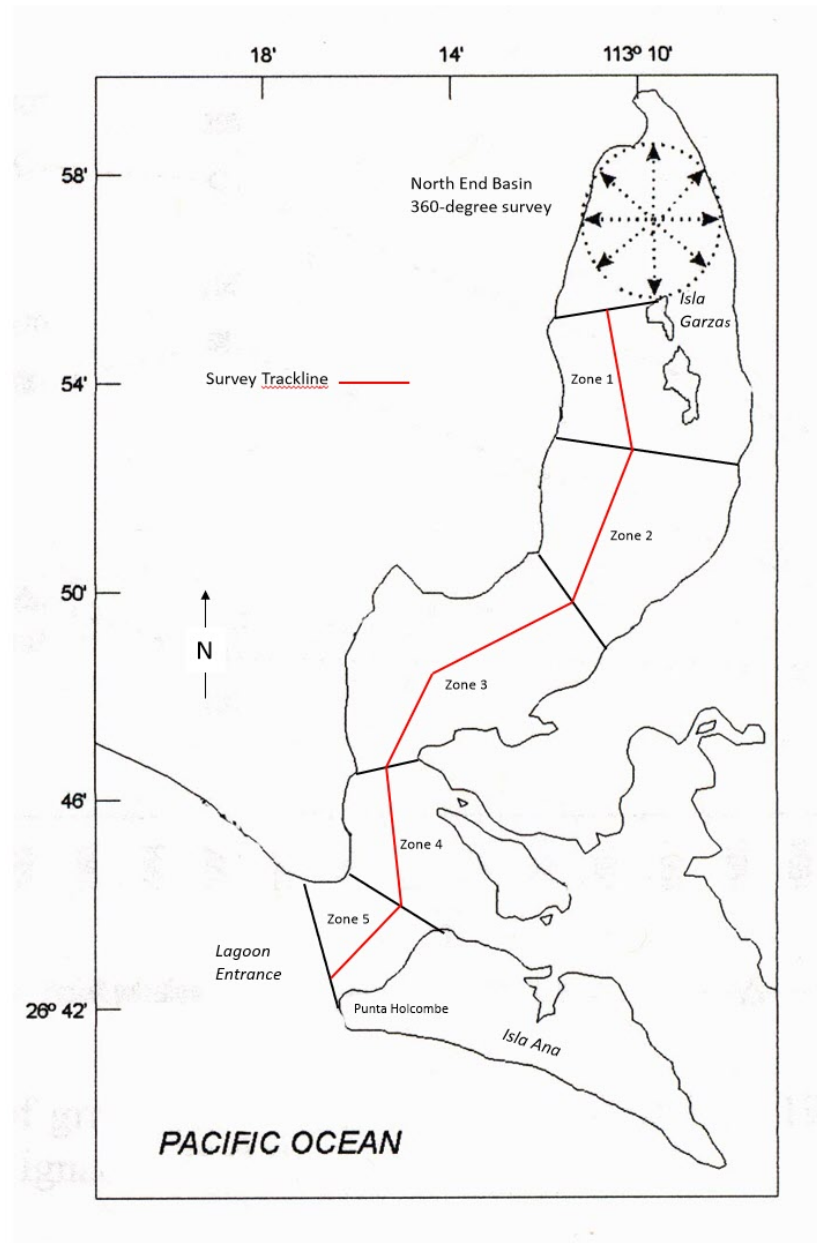


Table 1. Boat survey counts of gray whales (Female-calf pairs, Singles (whales without calves), and total Adults) in Laguna San Ignacio during the 2018 winter breeding and calving season. Number of female-calf pairs equals the number of calves observed.

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. Numbers of total adult whales (Adult males, females, and females with calves) counted in Laguna San Ignacio during the winter seasons: 2007-2018.

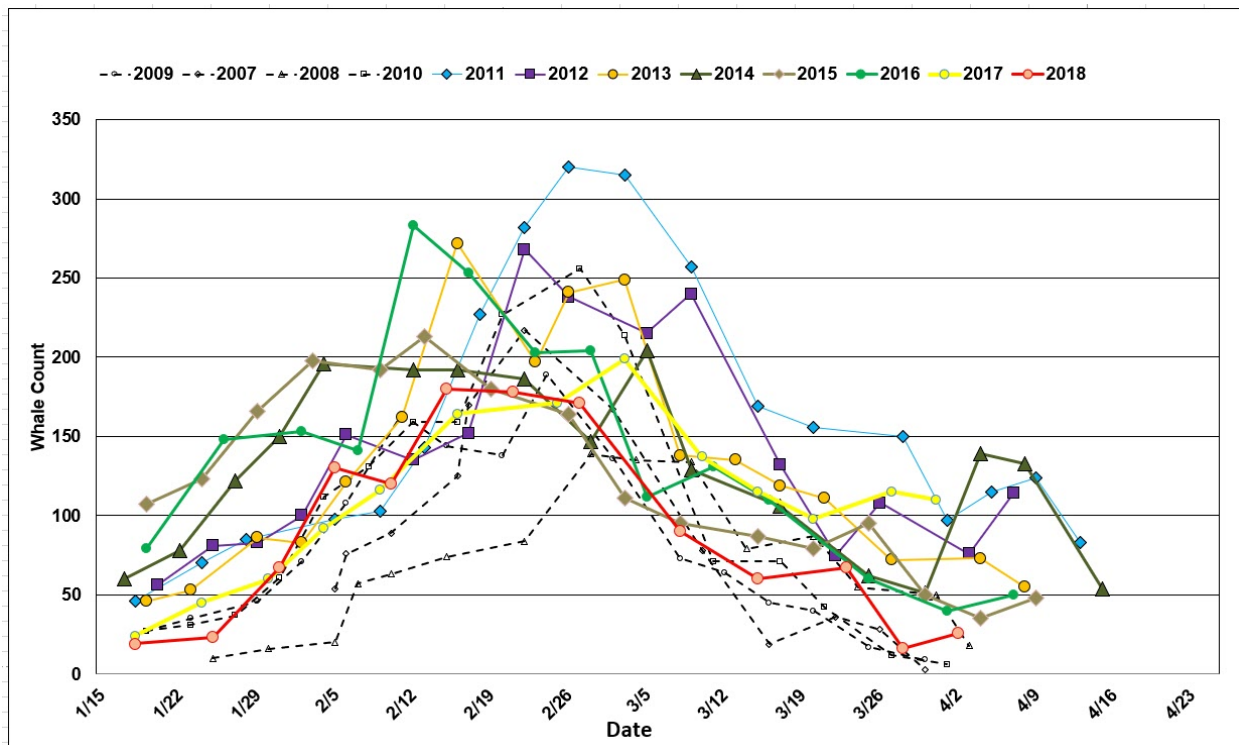


Figure. 4. Numbers of single whales (adult males and females without calves) counted in Laguna San Ignacio during the winter seasons: 2007-2018.

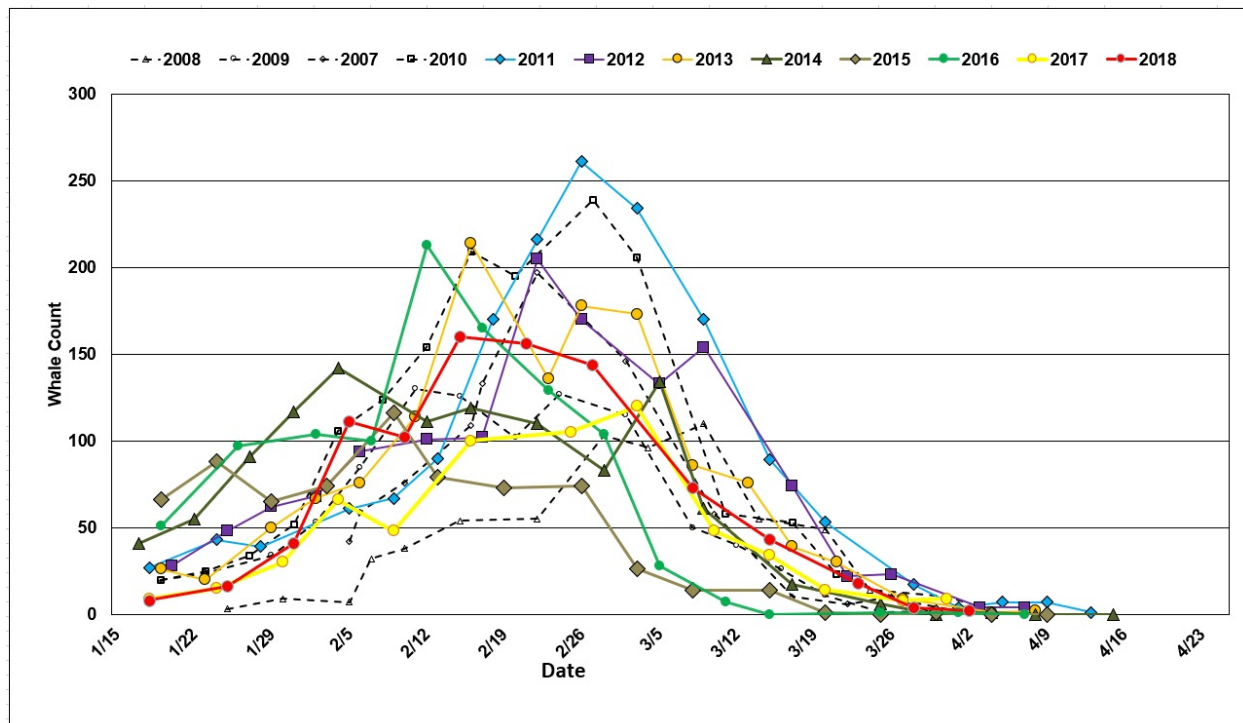


Figure. 5. Numbers of female-calf pairs (females with young of the year) counted in Laguna San Ignacio during the winter seasons: 2007-2018.

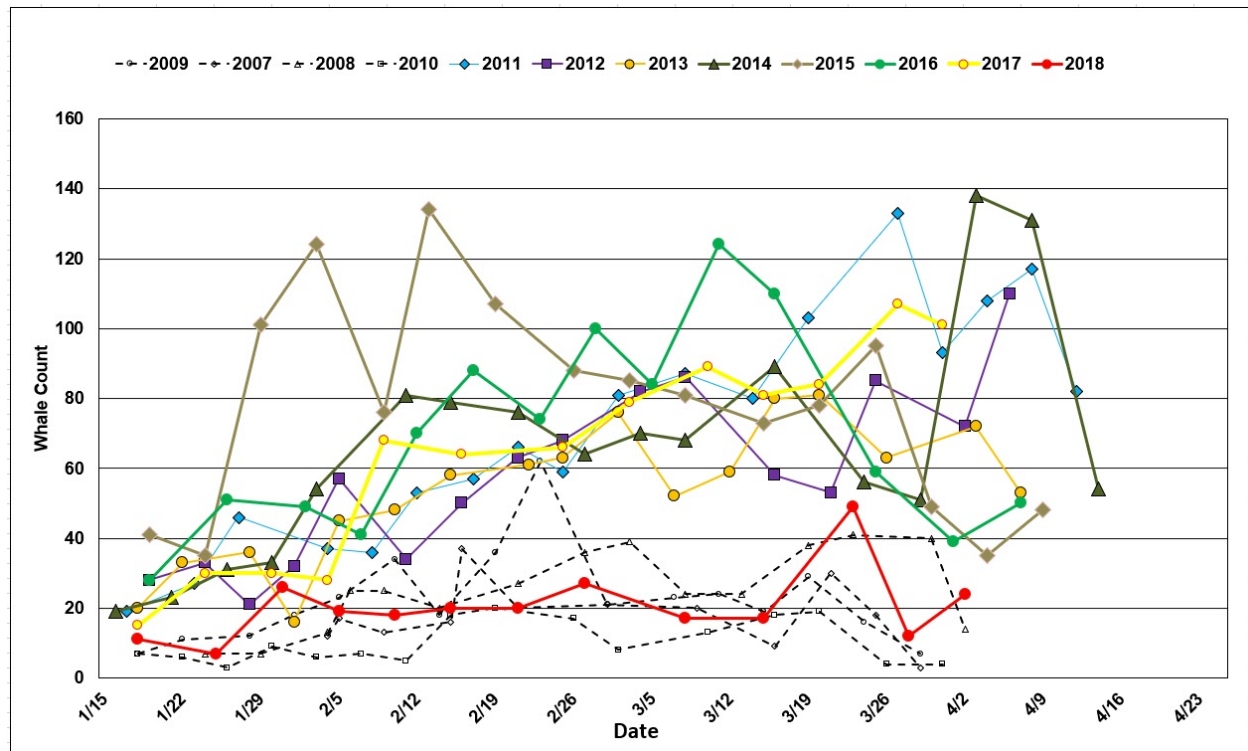


Figure 6. Boat survey tracklines for estimating gray whales in the Bahía Magdalena lagoon complex in three areas where gray whales aggregate: Canal de Santo Domingo in the north; Bahía Magdalena's center, west and southwest areas; and in Bahía Almejas in the south.

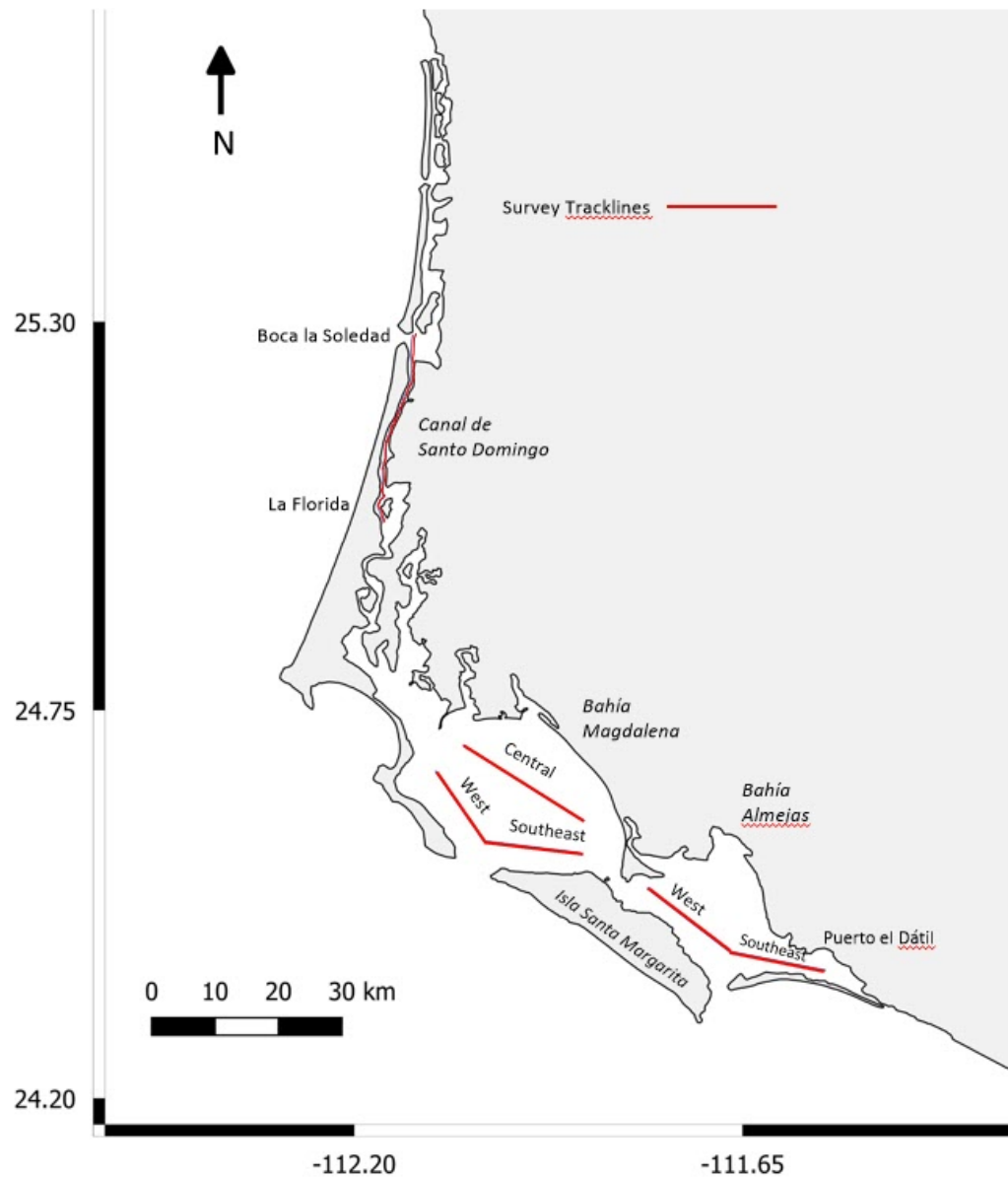


Table 2. Boat survey counts of gray whales (Female-calf pairs, Singles (whales without calves), and total Adults) in three areas within the Bahía Magdalena complex during the 2018 winter breeding and calving season. Number of female-calf pairs equals the number of calves observed.

	Area	Date	Female-Calf Pairs	Singles	Total Adults
2018	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

Figure 7. Boat survey counts of gray whales 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.

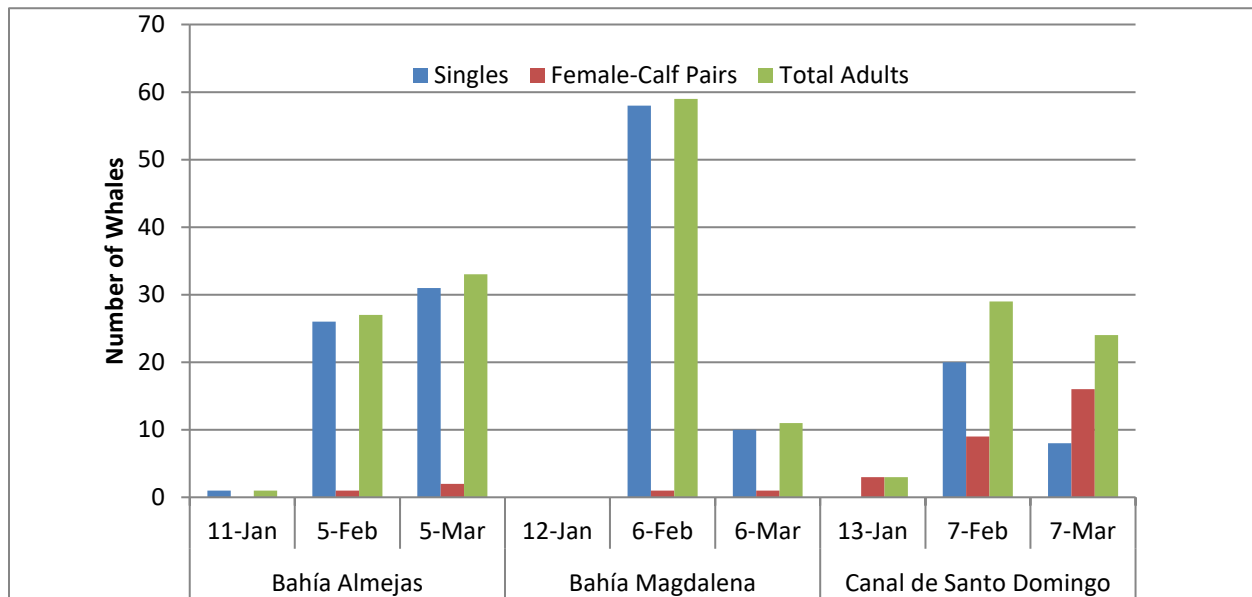


Figure 8. Gray whale sightings in the Bahía Magdalena lagoon complex and surrounded waters in the 2018 winter: Bahía Almejas (BA), Bahía Magdalena (BM) and Lopez Mateos (LM). blue circles = gray whale single animals; red circles = gray whale female-calf pairs.

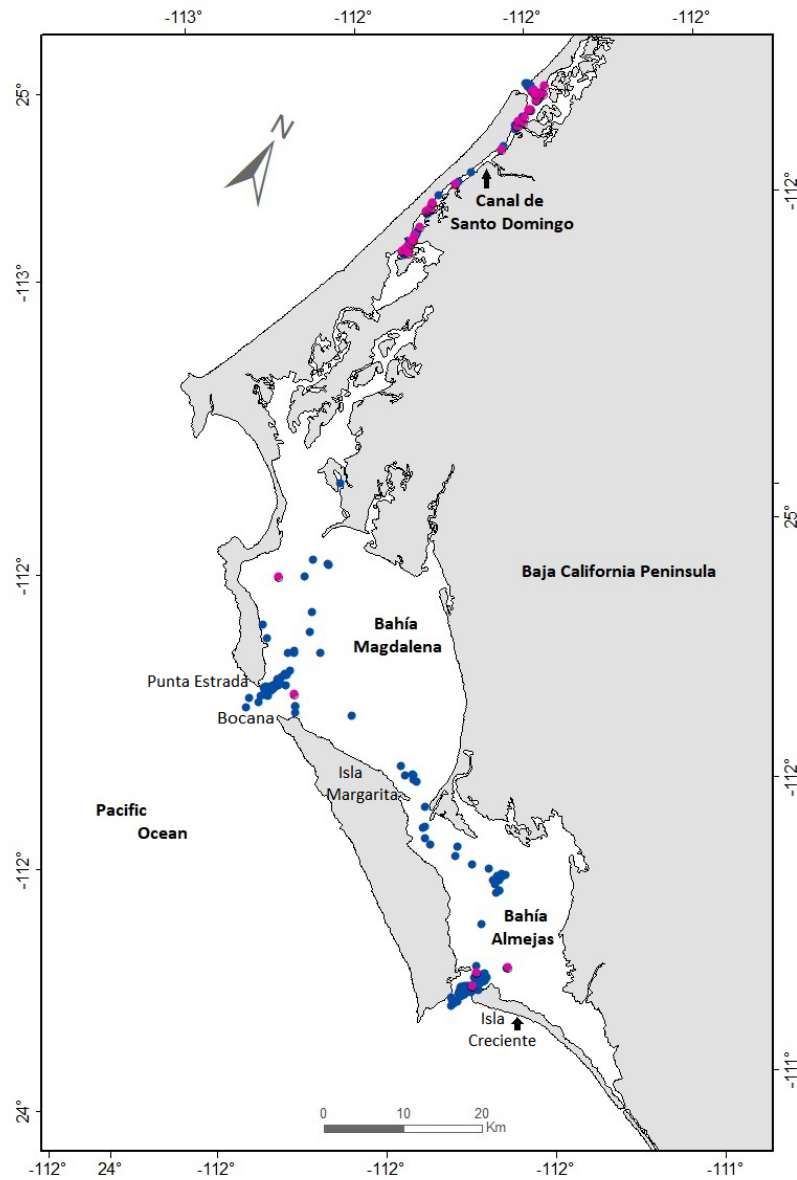


Table 3. Comparison of boat survey counts of gray whales in the Bahía Almejas portion of the Bahía Magdalena complex in the years 2016, 2017, and 2018. Number of female-calf pairs equals the number of calves observed.

Bahía Almejas				
Year	Survey Date	Singles	Female-Calf Pairs	Total Adults
2016	January	1	1	2
	February	7	7	14
	March	1	1	2
2017	January	21	7	28
	February	66	16	82
	March	108	13	121
2018	January	1	0	1
	February	26	1	27
	March	31	2	33

Figure 9. Comparison of boat survey counts of gray whales in the Bahía Almejas portion of the Bahía Magdalena complex in the years 2016, 2017, and 2018. Number of female-calf pairs equals the number of calves observed.

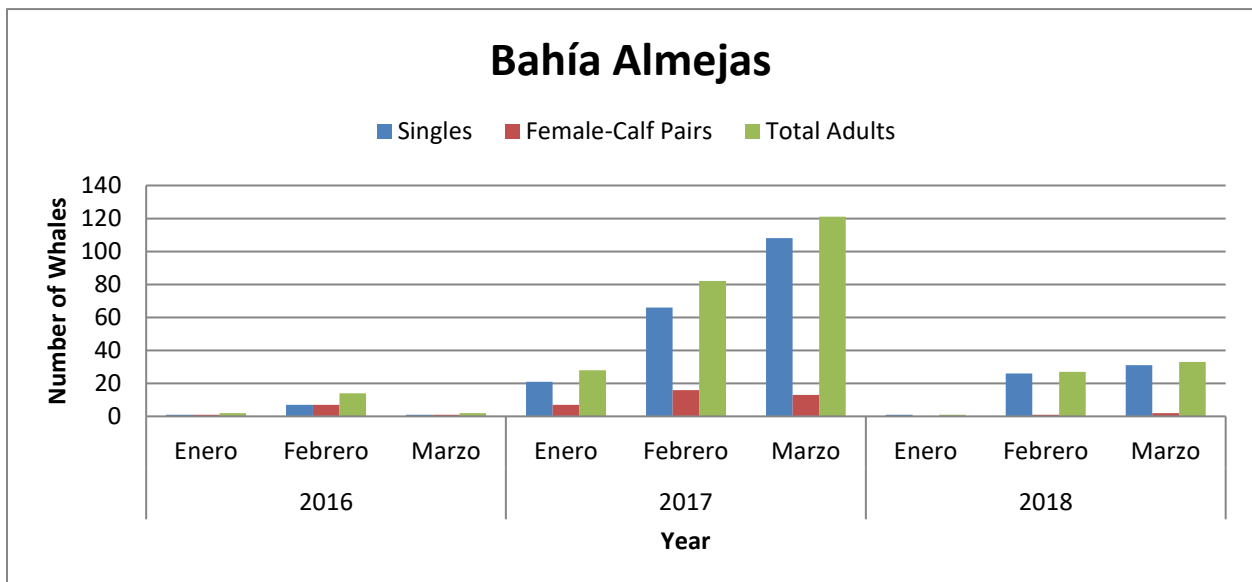


Table 4. Comparison of boat survey counts of gray whales in the central portion of the Bahía Magdalena complex in the years 2016, 2017, and 2018. Number of female-calf pairs equals the number of calves observed.

Bahía Magdalena				
Year	Survey Date	Singles	Female-Calf Pairs	Total Adults
2016	January	2	0	2
	February	14	1	15
	March	1	0	1
2017	January	16	2	18
	February	69	1	70
	March	48	4	52
2018	January	0	0	0
	February	58	1	57
	March	10	1	11

Figure 10. Comparison of boat survey counts of gray whales in the central portion of the Bahía Magdalena complex in the years 2016, 2017, and 2018. Number of female-calf pairs equals the number of calves observed.

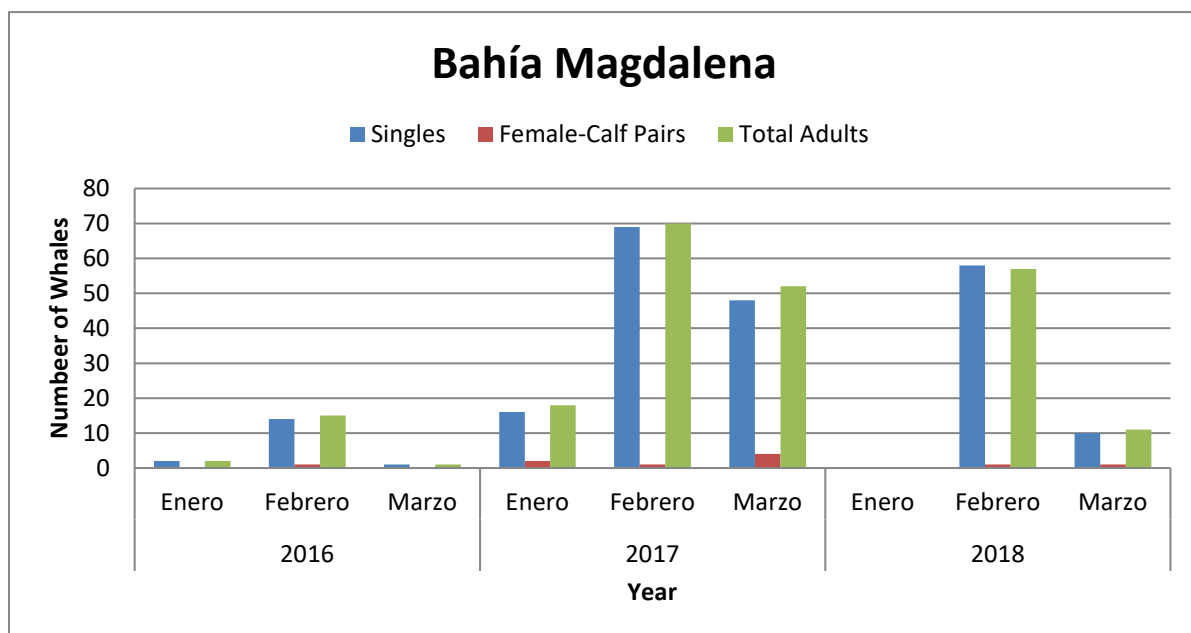


Table 5. Comparison of boat survey counts of gray whales in the Canal de Santo Domingo portion of the Bahía Magdalena complex in the years 2016, 2017, and 2018. Number of female-calf pairs equals the number of calves observed.

Canal de Santo Domingo				
Year	Survey Date	Singles	Female-Calf Pairs	Total Adults
2016	January	9	26	35
	February	4	55	59
	March	0	4	4
2017	January	6	3	9
	February	18	44	62
	March	13	34	47
2018	January	0	3	3
	February	20	9	29
	March	8	16	24

Figure 11. Comparison of boat survey counts of gray whales in the Canal de Santo Domingo portion of the Bahía Magdalena complex in the years 2016, 2017, and 2018. Number of female-calf pairs equals the number of calves observed.

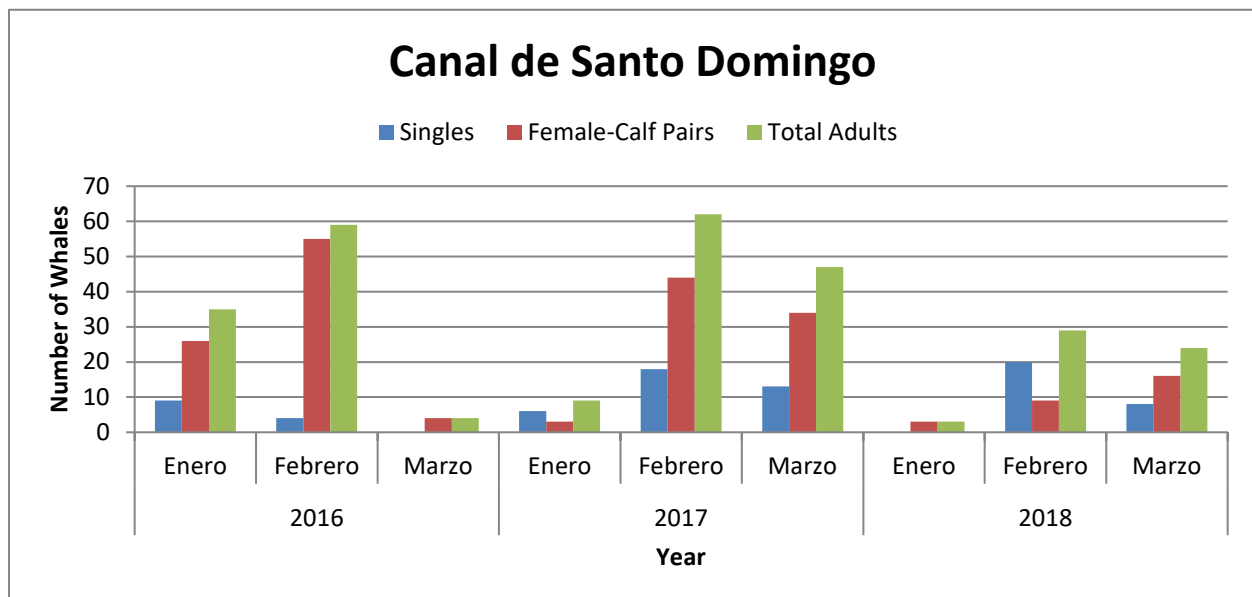


Figure 12. Average surface water temperatures (C°) in Laguna San Ignacio during gray whale abundance surveys in 2007 to 2018.

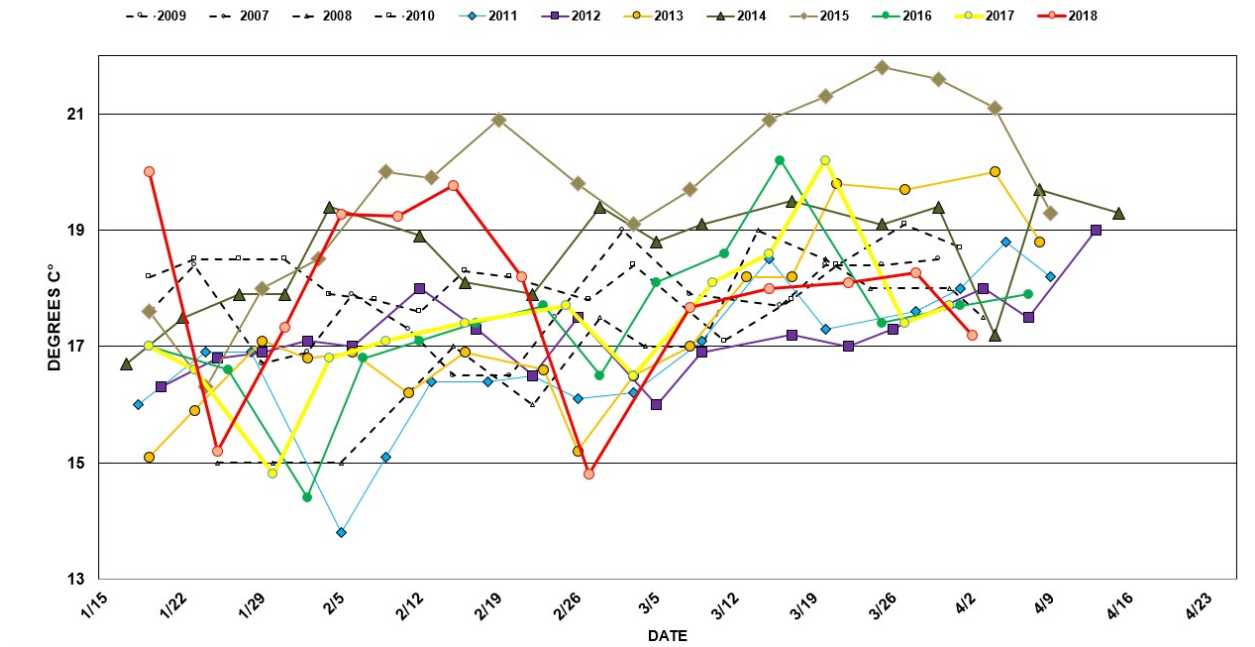


Table 6. Boat survey counts of gray whales in Laguna Ojo de Liebre during the winters of 2017 and 2018. Data provided by the Vizcaíno Biosphere Reserve, Guerrero Negro, Baja California Norte, Mexico.

Date	2017		
	Female-Calf Pairs	Single Whales	Total Adults
15-Jan			
16-Jan	109	90	199
22-Jan			
23-Jan	269	152	421
29-Jan			
30-Jan	430	180	610
6-Feb			
8-Feb	518	288	806
12-Feb			
13-Feb	533	271	804
20-Feb	632	309	941
21-Feb			
26-Feb			
28-Feb	666	234	900
5-Mar			
7-Mar	708	146	854
12-Mar			
13-Mar	470	86	556
22-Mar	188	33	221
28-Mar			
29-Mar	20	7	27
3-Apr	86	5	91

2018		
Female-Calf Pairs	Single Whales	Total Adults
67	79	146
131	135	266
350	195	545
515	242	757
602	238	840
436	207	643
691	299	990
447	109	556
400	151	551
136	9	145
158	2	160
68	8	76

Figure 13. Boat survey counts of gray whales in Laguna Ojo de Liebre during the winters of 2017 and 2018. Data provided by the Vizcaíno Biosphere Reserve, Guerrero Negro, Baja California Norte, Mexico.

