

2020 GRAY WHALE ABUNDANCE IN LAGUNA SAN IGNACIO AND BAHÍA MAGDALENA BAJA CALIFORNIA SUR, MÉXICO

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ABSTRACT

The winter gray whale occupation of Laguna San Ignacio (LSI) and Bahía Magdalena (BM) in 2020 was characterized by: delayed arrival of the whales to the lagoon; low numbers of calves-of-the-year; an increase in mortality, and an increased percentage of "skinny" single whales. Seven stranded dead whales were discovered in LSI, and four discovered in BM. Decreasing prey resources on the summer feeding grounds are possible contributors to the whales' delayed migration, low calf counts, "poor" body condition, and mortalities.

Key words: gray whales, calves, skinny whales, low reproduction, carrying capacity, Laguna San Ignacio, Bahía Magdalena.

INTRODUCTION

The 2020 winter gray whale abundance in LSI and BM was the third consecutive breeding season (2018, 2019, and 2020) that have been characterized by: 1) an approximate two week delayed arrival of the whales to the lagoons; 2) very low numbers of calves-of-the-year; 3) increased adult mortality in the lagoons (Martinez-Aguilar, et al. 2020), and 4) an increase in the percent of "skinny" adult whales observed compared to the previous seven winters (2011-2017) (Urban et al. 2018, 2019, Ronzón-Contreras et al. 2019, 2020).

Similarly, in the BM lagoon complex to the south, gray whales also arrived later in the winter, counts of calves were lower than observed in recent past winters, however, counts of single whales were greater than the previous winters (2018 and 2019)(Urban et al. 2018, 2019).

The increase in adult mortality in the lagoons, the increasing percentage of "skinny" or "emaciated" whales suggests that reduced prey availability, or the whales' inability to find and/or utilize food resources in the N. Pacific and Arctic may have contributed to reduced reproduction (number of calves), adult mortality, and the increase in the percentage of "skinny" whales observed during the 2018 to 2020 winter breeding/calving seasons in the whales' primary aggregation lagoons along the Pacific coast of Baja California, Mexico.

Low numbers of gray whale female-calf pairs observed in LSI and BM from 2018 to 2020 is similar to the decreased calf abundances observed during the winter breeding seasons from 2007 to 2010 following the range wide “unusual mortality event” (UME) of 1999 to 2000 (LeBoeuf *et al.* 2000), and the 2018 and 2019 observations proceeded the gray whale UME of 2019 (NOAA 2020). Overall, the low number of female-calf pairs observed in 2020 was unexpected, as were similar low calf counts in 2018 and 2019. Changing environmental conditions in the gray whales' northern feeding areas may be reducing the availability of food during the summer months, necessitating additional searching time to find food, and resulting in similar conditions leading up to the previous mortality event. Insufficient prey could also contribute the reduced reproduction and apparent decline in the body condition of some gray whales.

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 method allows duplication of survey effort for comparison of within year survey counts along identical survey tracks in each lagoon area, 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, thereby documenting the distribution of whale sightings along the trackline. 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 center of this area by observers searching in 360-degrees around the stationary boat.

Bahía Magdalena: Boat surveys of gray whales in the BM lagoon complex in 2020 duplicated surveys done in the previous winters from 2016-2019. 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 the north-east of Puerto Cortés on Isla Santa Margarita (Fig. 3).

Stranded Whales: Stranded whale in each lagoon were visited and, if possible, standard measurement and photographs were obtained. If the dead whales were not severely decomposed, tissue samples were obtain for analysis of lipid content.

RESULTS

Lguna San Ignacio: In LSI 11 surveys of gray whales were completed to monitor seasonal abundance and habitat use in 2020. Surveys began on 20 January and continued until 19 March (Table 1). The arrival of adult (non-calf) gray whales occurred in mid-January, approximately one week later than observed during previous winters, while their departure from the lagoon was similar to previous years. Their abundance was approximately 100 individuals, lower than counts of single adult whales from 2011 to 2017, except for the 2015 winter (Fig. 4).

The highest count of single adult whales (breeding males and females without calves) was 106 whales obtained on the 4 March survey (Fig. 5, Table 1). Numbers of these whales were lower than in previous winters, with a maximum count of approximately 100 individuals and no mid-winter peak at the end of February and early March. These whale counts suggest a decreasing trend for the number of single adult whales over the past three winters.

Counts of females with calves remained low throughout the entire 2020 winter season, with the greatest number of 21 female-calf pairs counted on 14 March 2020; the end of the season increase of female-calf pair counts typically seen in LSI did not occur in 2020, or in the previous two winters (Fig. 6, Table 1). The number of female-calf pairs seen in 2020 was far less than that observed between 2011 to 2017, when female-calf pair counts in March ranged from 50 to 60 pairs to just under 130 pairs (Fig. 6).

Bahía Magdalena: The 2020 boat surveys of gray whales in the Bahía Magdalena lagoon complex were conducted in three different areas during six different time periods: 18-20 January, 26-28 January, 8-10 February, 16-20 February, 26-28 February, and from 9-10 March (18-surveys in all) (Table 2). The highest counts of gray whales were obtained on 16 February in the most southerly aggregation area of Bahía Almejas with 176 adult whales, but no female-calf pair. In central Bahía Magdalena counts were greatest on 8 February with 40 adult whales and no calves. In Canal de Santo Domingo on 10 February 18 single whales and 6 female-calf pairs were counted. Gray whale abundance then declined in all areas and by the second week in March: 93 single adults and 1 female-calf pair were counted in Bahía Almejas; 2 single whales and no female-calf pairs counted in central Bahía Magdalena; and 7 single whales and 3 female-calf pairs in Canal de Santo Domingo (Table 2, Fig. 7).

The 2020 distribution of gray whales was concentrated in the areas along the north-eastern shore of Isla Creciente, off of the south-eastern shore Isla Santa Margarita in Bahía Almejas, and along the outer western coasts of Isla Margarita, and from the pass between Isla Margarita and Punta Estrada to the north as far as Bahía Santa Maria. The northern-most concentrations of whales were observed in the Canal de Santo Domingo (Fig. 8). As was observed in LSI, few gray whales remained in the BM complex by mid-March 2020, so abundance surveys were discontinued.

DISCUSSION

Since January 2019 and continuing to present, an increase of gray whale strandings occurred along the west coast of North America from Mexico through Alaska. Necropsies of dead whales provided evidence of emaciation for many of the dead whales. In May 2019 the U.S. National Oceanic and Atmospheric Administration's Fisheries Service (NOAA Fisheries) announced that the recent elevated stranding rate of gray whales along the West Coast of the United States constituted an Unusual Mortality Event (UME). In 2019, 123 gray whales stranded along the Pacific coast of the U.S., more than 11 times the 18-year average stranding rate of 14.8 whales/year. In total, 215 stranded whales were discovered in 2019 from Alaska to Baja California, and 98 additional strandings were reported in the first 5-months of 2020 (NOAA Fisheries 2020).

Observations of gray whales in LSI and BM detected indications an impending UME as early as 2018 and again in 2019. Specifically, their long-term abundance monitoring (15-years) and photographic-identification data confirmed significant declines of calf counts, increasing percentages of "skinny" and "emaciated" whales, and the late arrival of the whales to the Baja lagoons. Unfortunately these trends continued for a third winter during 2020: the number of mother-calf pairs in LSI hovered around 20-pairs, and the count of females with calves observed in BM was 22-pairs in 6 surveys; the arrival of the single whales in both lagoons was one to two weeks later than expected; and, the percent of "skinny" single whales jumped from 4.9%-6.7% during the years 2008-2011, to 23.6% skinny in 2019, and 30% in 2020 (Ronzón-Contreras *et al.* 2019, 2020). These observations suggest that in recent years the gray whales feeding in the Arctic and N. Pacific are not obtaining sufficient nutrition to survive and successfully reproduce

following their fall southward migration, a 3-4 month winter breeding season in Mexico, and a northward spring migration to their summer feeding range.

Similar low calf counts were observed from 2007-2010 following the 1998-2000 range-wide UME when an estimated 33% of the N.E. Pacific population was lost (LeBoeuf *et al.* 2000, Gulland *et al.* 2005). In the winters following 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 and BM in 2018, 2019 and 2020 were low, the female whales and their calves that were present appeared to be in good (50%) to fair (50%) condition, and indications of nutritional stress or poor condition of these gray whale females and calves was not evident. Apparently were in sufficiently robust condition to bring their pregnancies to term, birth their calves, and nurse them, suggesting that unlike under-nourished whales, they had found sufficient food resources in the summers proceeding the birth of their calves.

A number of factors may have contributed to the low counts of female-calf pairs of gray whales observed in LSI and BM from 2018 to 2020. 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 reduction in the number of calves-of-the-year suggest a slowing of reproduction that could result from a reduction in the food-prey available to the whales in their summer feeding areas, and/or that the current size of the North Eastern Pacific population has exceeded the environmental "carrying capacity"(K) within their current range (Laake *et al.* 2009, Punt and Wade 2010). It is also possible that disease or other factors have compromised the whales' ability to maintain sufficient energy reserves to support their annual migrations from the summer feeding grounds to their winter breeding aggregations along Baja California's Pacific coast and its coastal lagoons.

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TABLES AND FIGURES

Table 1. Boat survey counts of gray whales: Female-calf pairs, Singles (whales without calves), and total Adults in Laguna San Ignacio during the 2020 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	20-Jan-20	2	7	9
2	25-Jan-20	5	17	22
3	30-Jan-20	5	17	22
4	4-Feb-20	4	25	29
5	9-Feb-20	12	41	53
6	19-Feb-20	11	92	103
7	28-Feb-20	13	77	90
8	4-Mar-20	12	106	118
9	9-Mar-20	16	79	95
10	14-Mar-20	21	43	64
11	19-Mar-20	13	18	31

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 2020 winter breeding and calving season. Number of female-calf pairs equals the number of calves observed.

	Area	Date	Female-Calf Pairs	Singles	Total Adults
2020 Gray Whale Survey Counts	Bahía Almejas	18-Jan-20	0	2	2
		26-Jan-20	1	13	14
		9-Feb-20	0	145	145
		16-Feb-20	0	176	176
		27-Feb-20	0	111	111
		9-Mar-20	1	93	94
	Bahía Magdalena	19-Jan-20	0	2	2
		27-Jan-20	0	6	6
		08-Feb-20	0	17	17
		17-Feb-20	0	13	13
		28-Feb-20	1	32	33
		09-Mar-20	0	2	2
	Canal de Santo Domingo	20-Jan-20	0	1	1
		28-Jan-20	0	3	3
		10-Feb-20	6	18	24
		20-Feb-20	1	8	9
		26-Feb-20	9	12	21
		10-Mar-20	3	7	10

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.

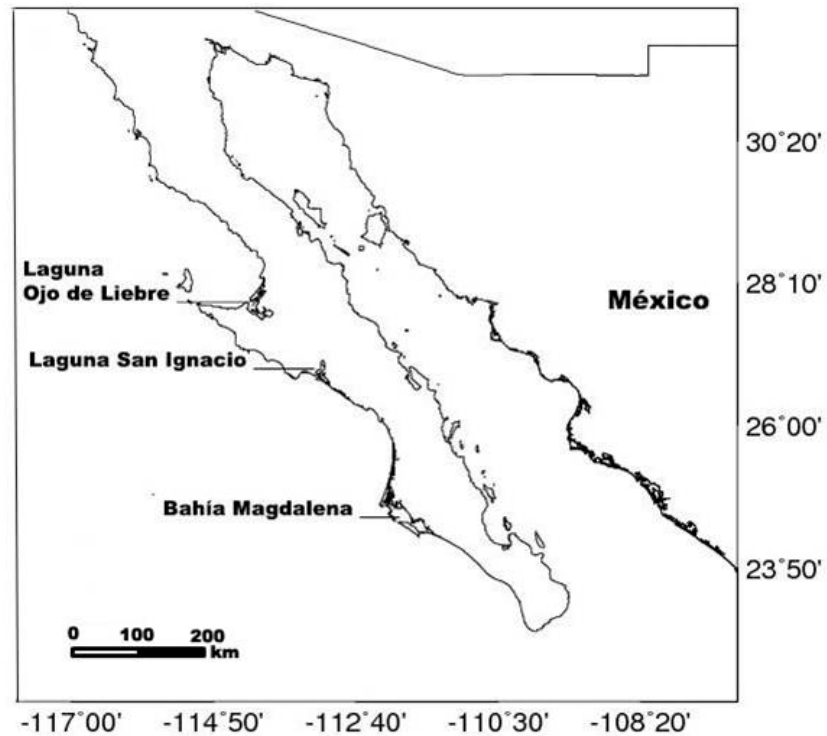


Figure 2. Boat survey track-line for estimating abundance of gray whales in Laguna San Ignacio. Counts of gray whales in the “North End Basin” portion of the lagoon are obtained from a 360° scan of the area. The survey track line continues 30 km south from Isla Garzas (Zone 1) over the deepest portions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

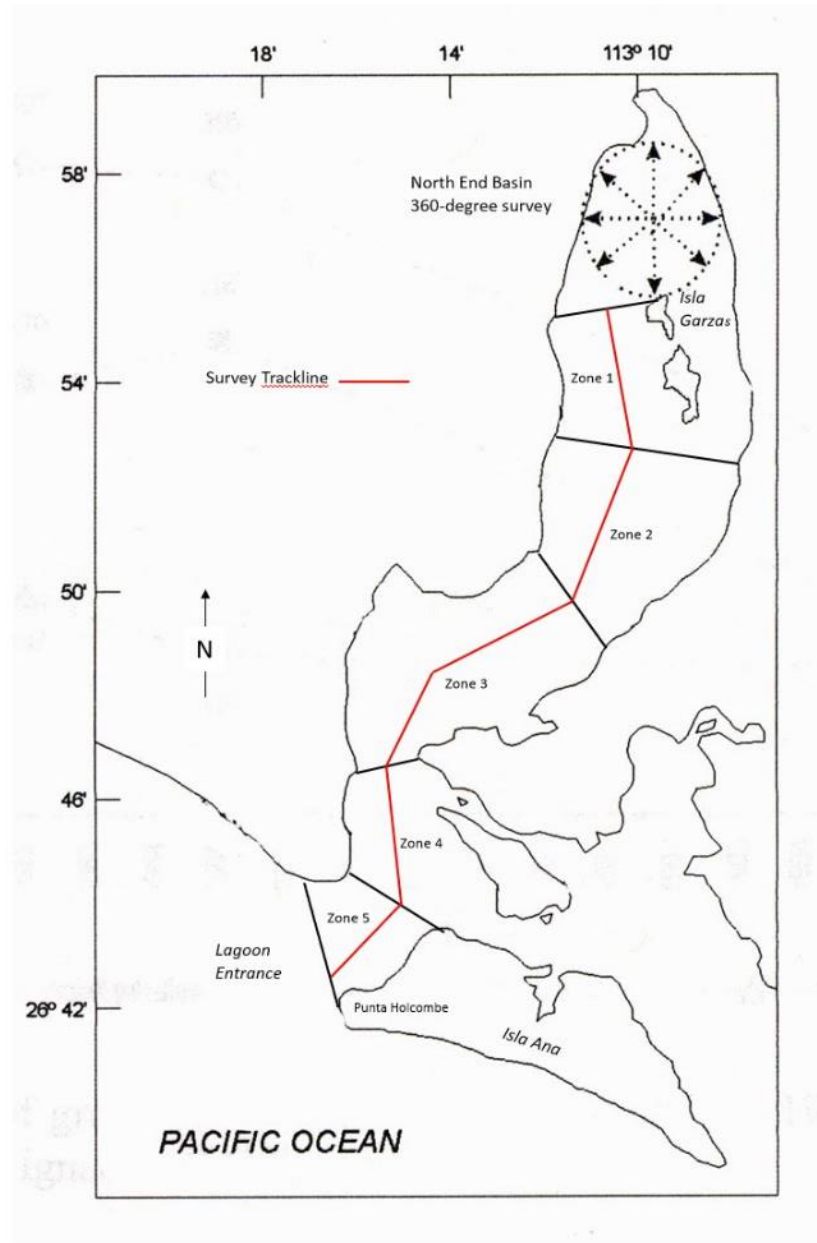


Figure 3. Boat survey track-lines for estimating gray whale abundance in the Bahía Magdalena lagoon complex in three areas where gray whales aggregate: Canal de Santo Domingo in the north; Bahía Magdalena's center, west and southwest areas; and in Bahía Almejas in the south.

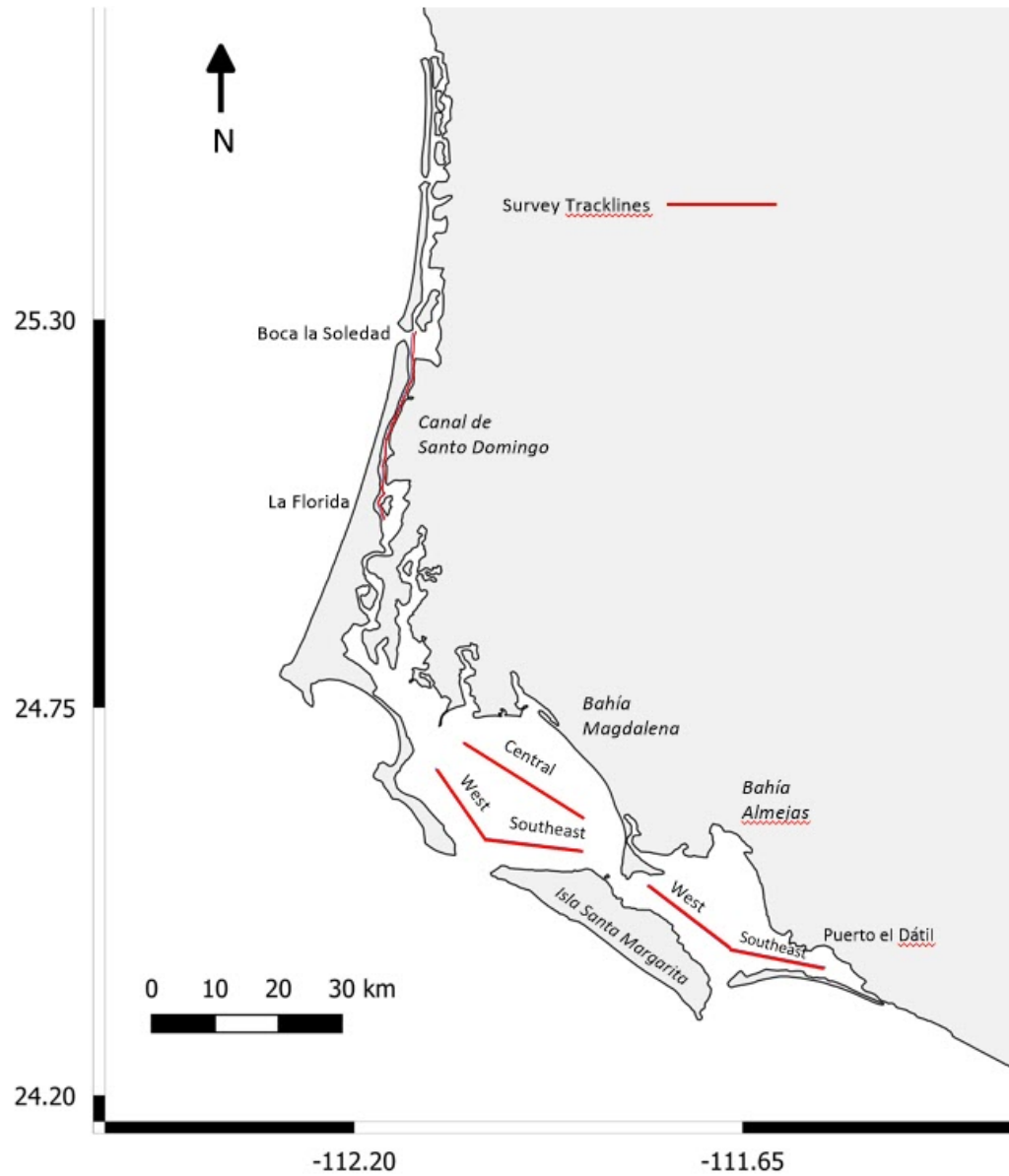


Figure. 4. Numbers of total adult whales (Adult males, females, and females with calves) counted in Laguna San Ignacio during the winter seasons: 2011-2020.

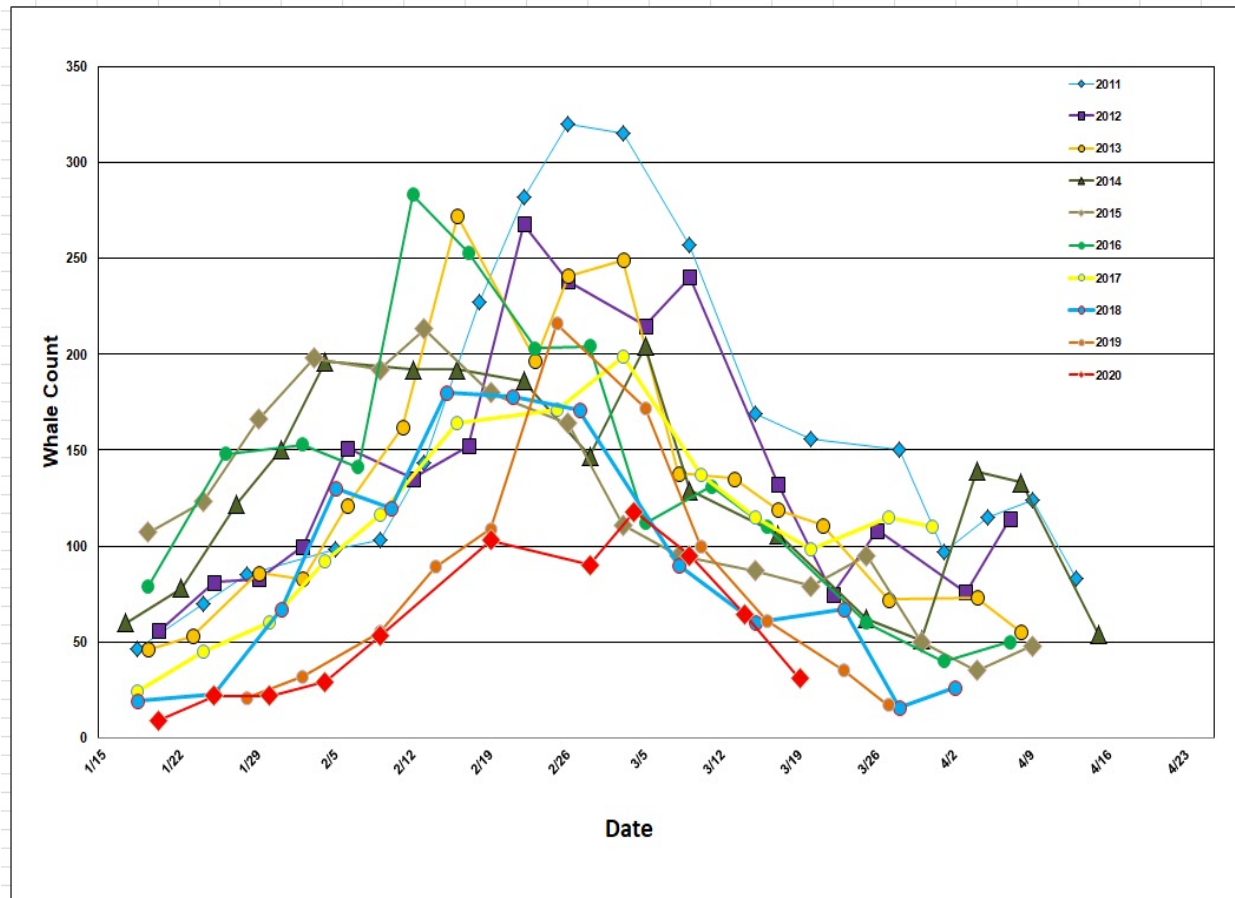


Figure. 5. Numbers of single whales (adult males and females without calves) counted in Laguna San Ignacio during the winter seasons: 2011-2020.

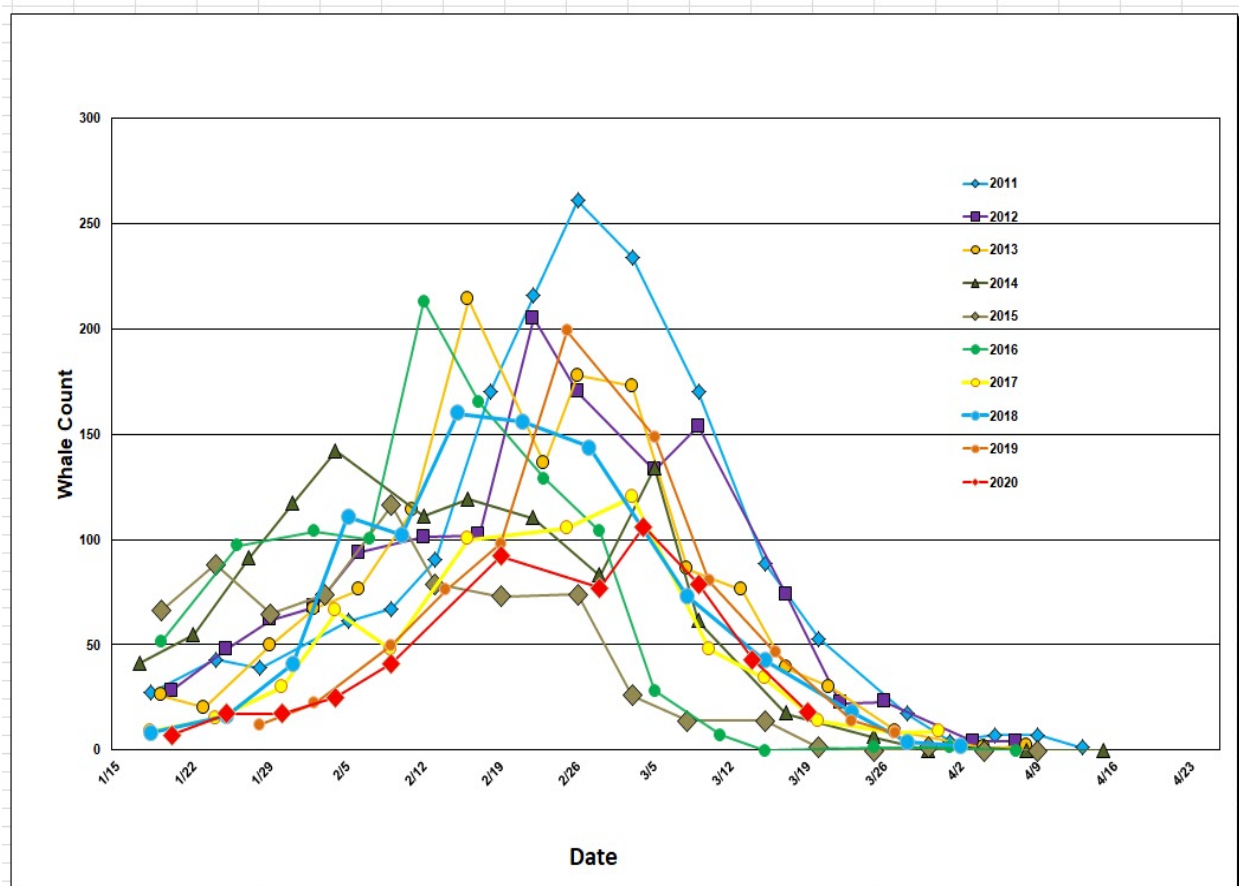


Figure. 6. Numbers of female-calf pairs (females with young of the year) counted in Laguna San Ignacio during the winter seasons: 2011-2020.

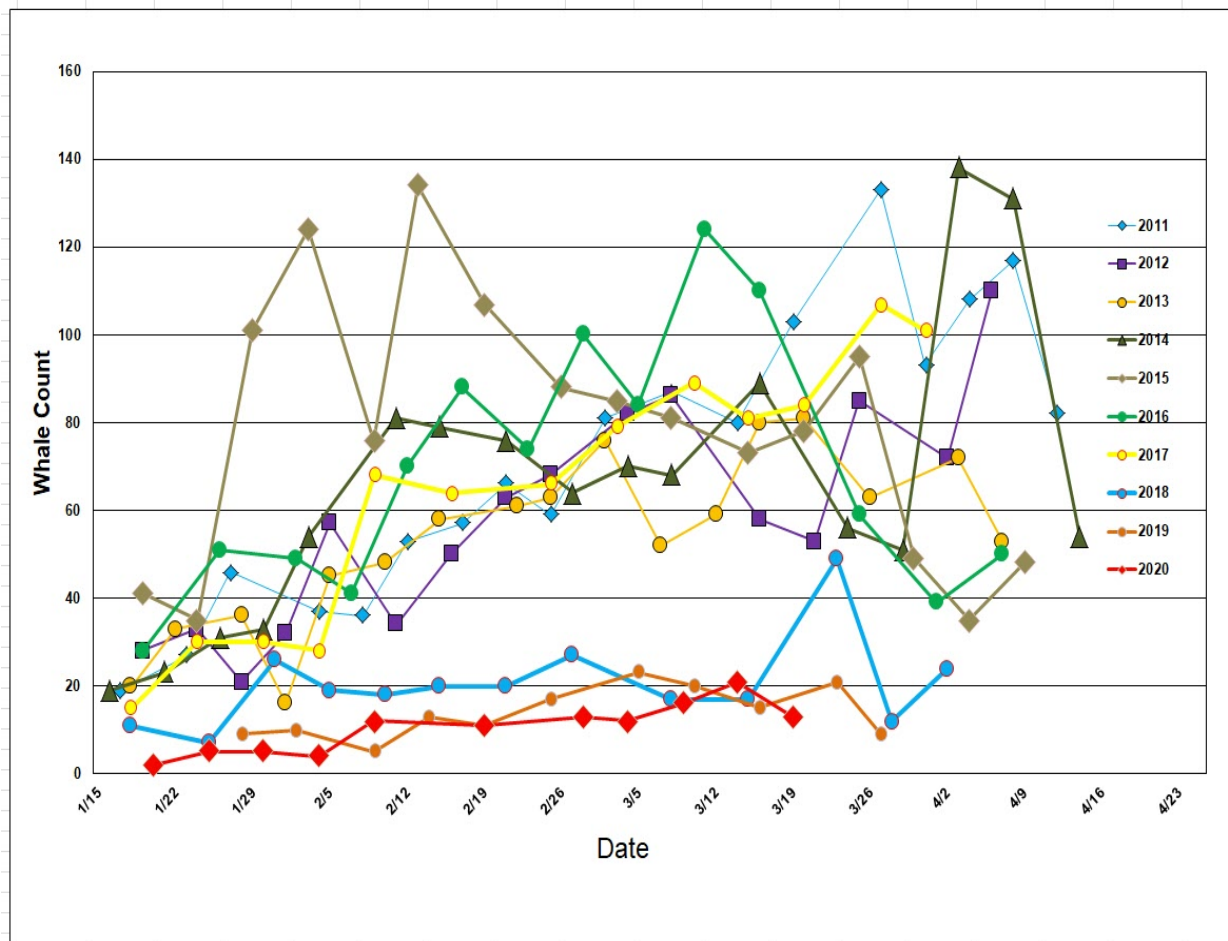


Figure 7. Boat survey counts of gray whales in three areas within the Bahía Magdalena complex during the 2020 winter breeding and calving season. Number of adult whales (Singles) without calves; female-calf pairs equals the number of calves observed. Total equals all adult whales with or without calves.

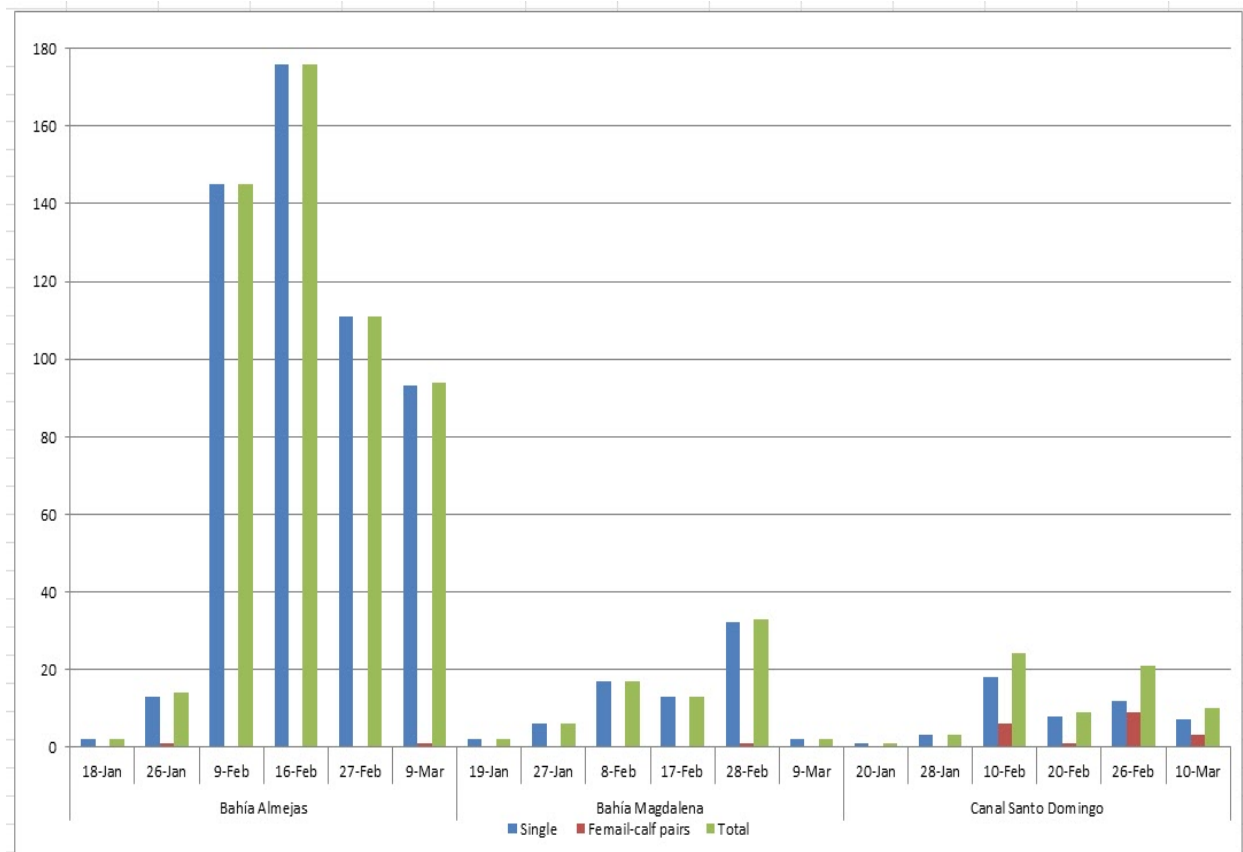


Figure 8. All gray whale sightings in the Bahía Magdalena lagoon complex and surrounded waters in the 2020 winter: Bahía Almejas (BA), Bahía Magdalena (BM) and Lopez Mateos (LM). blue circles = gray whale single animals; red circles = gray whale female-calf pairs.

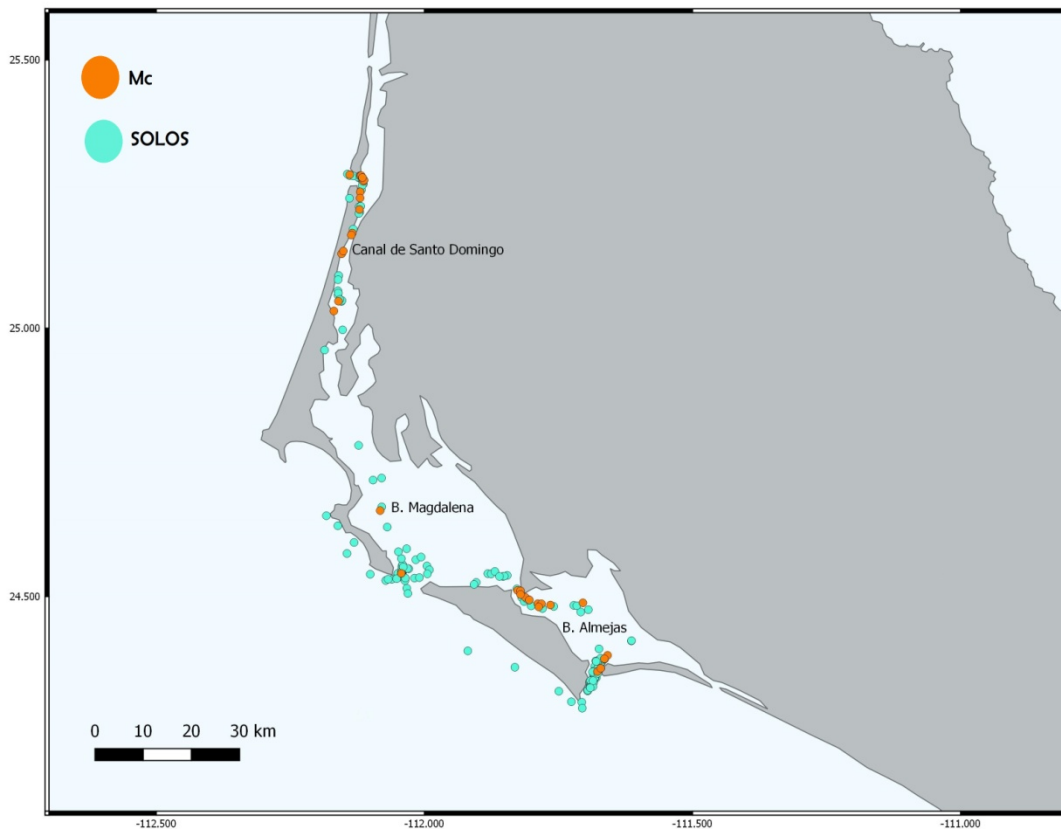


Figure 9A. Boat survey counts of gray whales in the Bahía Almejas portion of the Bahía Magdalena Lagoon complex during the 2016, 2017, 2018, 2019 and 2020 winter breeding and calving season. Number of female-calf pairs equals the number of calves observed.

* Survey dates in 2016 and 2017 are approximates.

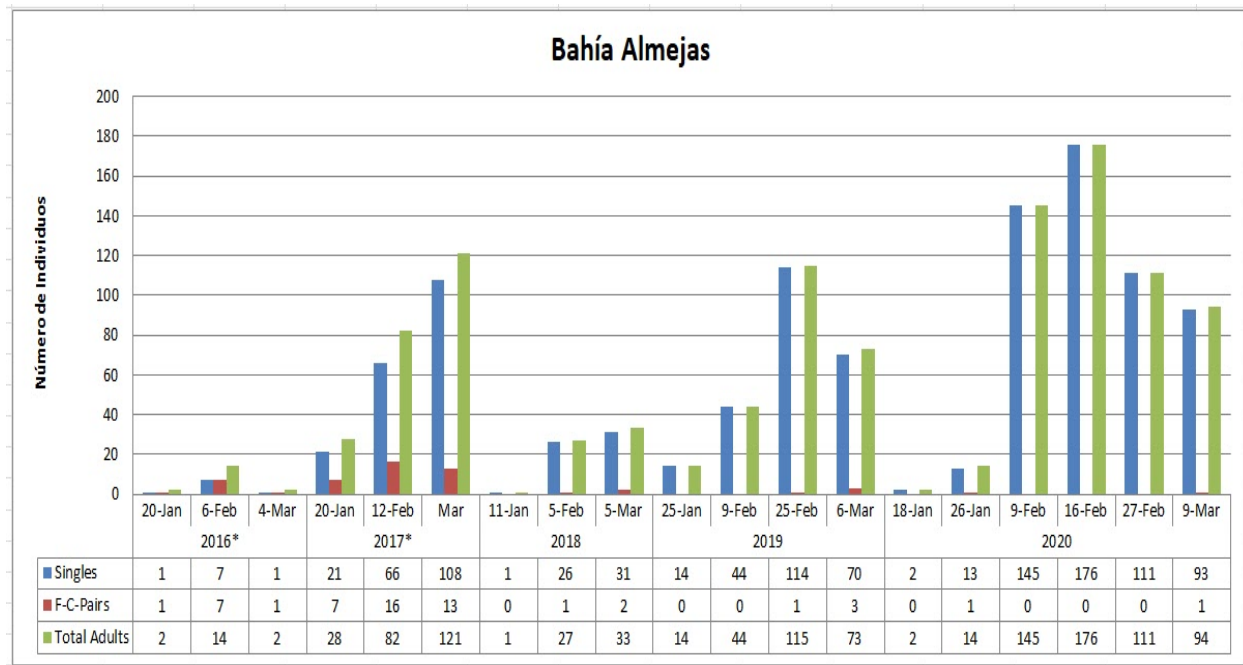


Figure 9B. Boat survey counts of gray whales in the Bahía Magdalena portion of the Bahía Magdalena Lagoon complex during the 2016, 2017, 2018, 2019 and 2020 winter breeding and calving season. Number of female-calf pairs equals the number of calves observed.

* Survey dates in 2016 and 2017 are approximates.

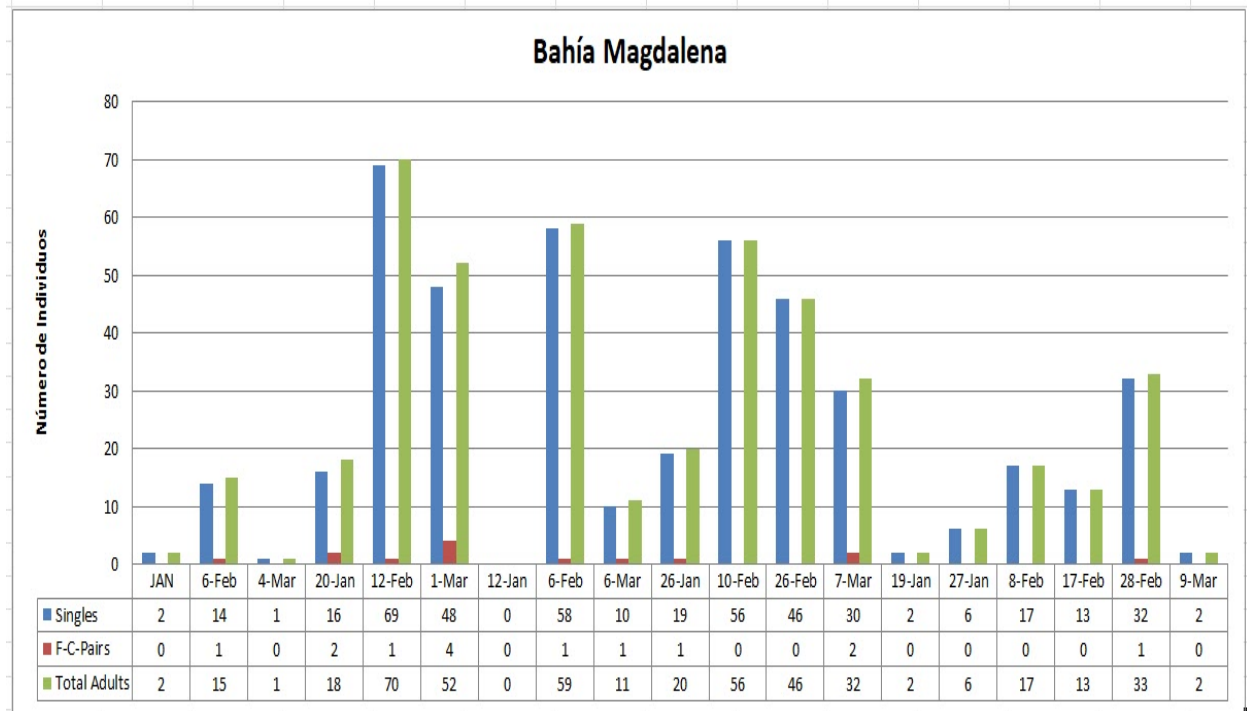


Figure 9C. Boat survey counts of gray whales in the Canal de Santo Domingo portion of the Bahía Magdalena Lagoon complex during the 2016, 2017, 2018, 2019 and 2020 winter breeding and calving season.

* Survey dates in 2016 and 2017 are approximates.

