

A note on gray whale distribution and abundance in the Magdalena Bay Complex, México during the 1997 winter season

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ABSTRACT

The goal of this study was to determine the distribution and abundance of gray whales, distinguishing between cow-calf pairs and single whales, in the different areas forming the Magdalena Bay Complex at Baja California Sur, Mexico. The lagoon complex comprises three well-defined zones: Santo Domingo Channel or Puerto Adolfo López Mateos region in the north; the central part properly known as Magdalena Bay; and the southern portion, Almejas Bay. The study period spanned eight weeks during the 1997 winter season. Fifteen surveys were conducted: 5 at Santo Domingo Channel, 7 at Magdalena Bay and 3 at Almejas Bay. Maximum combined counts by area and date were as follows: Santo Domingo Channel: 100 whales (83 cow-calf pairs and 17 single whales) on 27 February; Magdalena Bay: 81 whales (9 cow-calf pairs and 72 singles) on 14 February; and Almejas Bay: 109 whales (15 cow-calf pairs and 94 single whales) on 28 February. Santo Domingo Channel was the main calving zone within the lagoon complex and had the highest number of cow-calf pairs; for every count in this zone the number of cow-calf pairs was always higher than that of single whales. In contrast, Magdalena and Almejas Bays were mainly used for courtship and mating, or aggregation areas for young and immature whales. It is recommended that these studies continue and attempt to cover the entire season, and complete even coverage of all areas within the Complex. This will allow more effective management and regulation of human activities affecting gray whales within the Magdalena Bay lagoon complex.

KEYWORDS: GRAY WHALE; BREEDING GROUNDS; MONITORING; PACIFIC OCEAN

INTRODUCTION

Gray whales (*Eschrichtius robustus*) are today found only in the North Pacific (Mead and Mitchell, 1984). Two populations exist: the heavily depleted western stock (Weller *et al.*, 2002); and the abundant eastern stock that is subject to aboriginal subsistence whaling (IWC, 2004). The eastern gray whales regularly take refuge from the open sea by entering lagoons during their annual migration (Dedina, 2000). Their breeding grounds are located in Mexico, along the Baja California peninsula (Fig. 1). The main concentrations are the lagoons of Ojo de Liebre (53%), San Ignacio (11%), Guerrero Negro (9%), La Soledad estuary (17%), with the remaining 10% concentrated in the bays of San Juanico, Magdalena and Almejas (Rice *et al.*, 1981).

Magdalena and Almejas Bays were the site of the first gray whaling operations in the mid-19th Century. This was primarily due to the nature of the whaling operations (taking calves first), easy access and suitable water depths. It was only later, when the number of whales at these sites decreased, that the whalers began to use San Ignacio and Ojo de Liebre (Scammon's) lagoons (Henderson, 1984). After a break in harvesting about 1886, gray whaling resumed in 1914 with the highest intensity focused again on Magdalena Bay (Reeves, 1984).

Although the Magdalena Bay Complex has been considered a priority area for conservation by the Mexican Government and others, it is not included in the 2,700,000 hectare area that the state of Baja California Sur recognises under several conservation agreements (Breceda *et al.*, 1991).

Previous studies conducted on these breeding grounds for gray whales are scarce and most are focused on only part of the Complex (e.g. Norris *et al.*, 1983; Fleischer and Contreras U., 1986; Gardner and Chávez-Rosales, 2000).

In most of these studies, no distinction was made between the areas of the Complex that appear to be used by the whales in different ways. The primary aim of the present study was to provide information on the use, distribution and abundance of the gray whales in the lagoon complex during the winter of 1997, as a contribution towards the development of effective management plans for the region in the context of human activities.

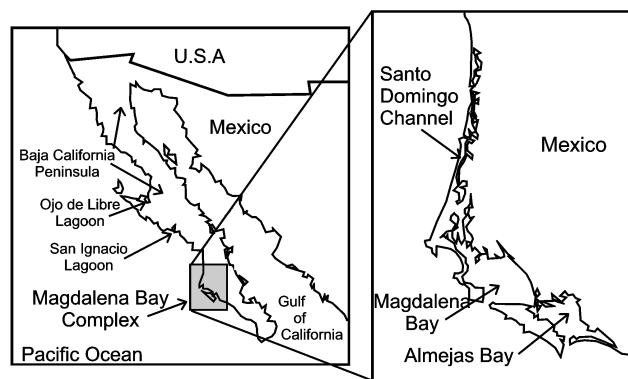


Fig. 1. The Baja California peninsula, showing the gray whale breeding sites: Ojo de Liebre and San Ignacio lagoons; and the Magdalena Bay Complex.

METHODS

Study area

The Magdalena Bay Complex is located on the western coast of the Baja California peninsula between 24°20'N-25°20'N and 111°30'W-112°10'W (Fig. 1). It includes three

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separate, well-defined areas from north to south: Santo Domingo Channel; Magdalena Bay; and Almejas Bay (Fleischer and Contreras U., 1986; Loreto *et al.*, 1996).

The Santo Domingo Channel, also known as La Soledad estuary, is approximately 32km² (Fig. 2). The town of Puerto Adolfo López Mateos is located in this area and fishing is the main economic activity. Whalewatching is conducted from the town between January and March. The area is connected to Magdalena Bay through a shallow and narrow channel formed by Magdalena Island (Rice *et al.*, 1981).

Magdalena Bay is 31km long and 22km wide and connects with the Pacific through a 6km wide mouth (Fig. 3). The town of Puerto San Carlos includes an energy plant and commercial docks, as well as several whalewatching companies. The bay is connected to Almejas Bay by La Gaviota Channel.

Almejas Bay is 22km long and 15km wide (Fig. 4). It is connected with the Pacific Ocean through Rehusa Channel, a 2km wide mouth. The entrances to Magdalena and Almejas Bays are formed by Margarita Island (Rice *et al.*, 1981). Puerto Cancun is an (almost) permanent fishing town – the human population here varies depending on the season's activities. Whalewatching is not permitted in the area.

The total area of the Complex is 1,370km², of which 1,030km² is at least 4m in depth. The oceanic influence is great due to the connections with the Pacific (Rice *et al.*, 1981).

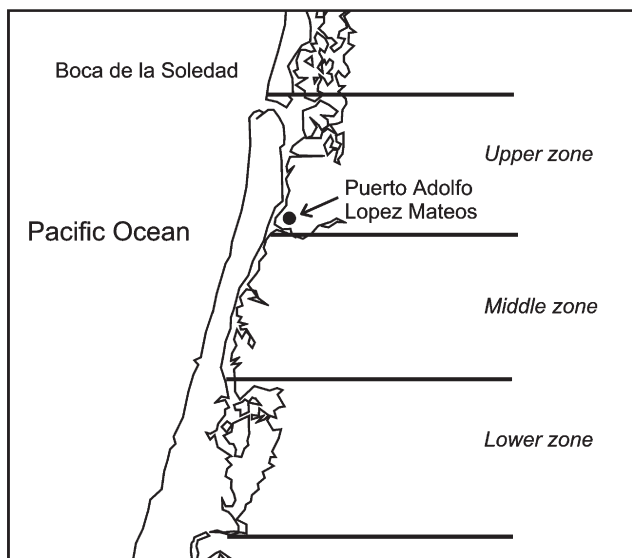


Fig. 2. Santo Domingo Channel and zones considered in this study.

Whale counts

Censuses were conducted following the methodology used by Jones and Swartz (1984) to study the distribution and abundance of gray whales. The same methods have been used on the other breeding grounds (Urbán-R *et al.*, 1997; 1998; 2001), thus the results are comparable among all the wintering sites.

The counts were conducted from 6-7m outboard engine vessels, sailing at a mean speed of 11km h⁻¹. The crew comprised the driver, two observers (one on each side of the vessel) and a recorder. In order to avoid double counting, whales were only recorded when at 90° from the transect line. With the aid of hand-held binoculars (10x), cow-calf

pairs and single whales were recorded separately. If there was doubt as to the presence of a calf, the sighting was recorded as a single whale. The start and end times of each survey and the exact location of each sighting was recorded. The different regions within the Complex were divided into zones to allow examination of any differences in distribution and abundance. Sightings effort terminated when the sea state was Beaufort 3 or higher.

Following Fleischer and Contreras (1986), the Santo Domingo Channel was divided into three zones (upper, middle and lower). A single transect was followed along the middle of the channel from Boca de la Soledad in the north to Devil's Bend in the south (Fig. 2). Since both coasts are visible all the time it was assumed that every whale along the transect was counted.

Given the large extent of Magdalena Bay, four zones (west, southeast, central and mouth) were designated after examining the distribution of the whales at the beginning of the season (Fig. 3). As shown in the figure, three transects were surveyed whilst at the mouth of the bay, circular scans were carried out when the vessel was stationary. The transects were located in zones which were of an adequate depth for whales. Although no other areas were systematically surveyed, they were checked to confirm the absence of whales.

Similarly, Almejas Bay was divided into three zones: west, southeast and mouth (Fig. 4). As shown in the figure, two transects were covered with circular scans occurring at two sites in the mouth region.

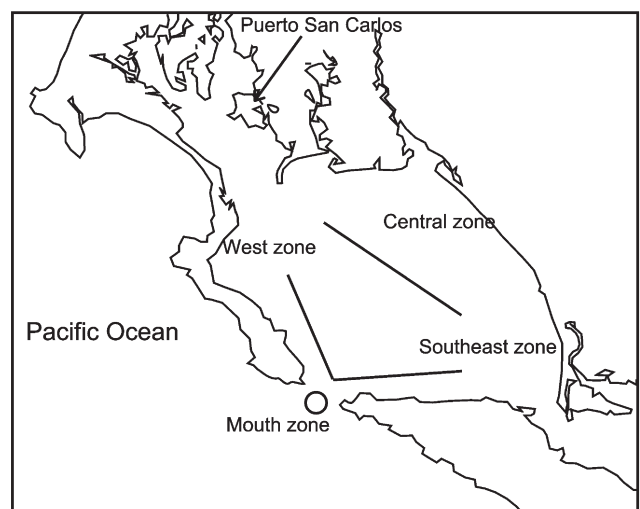


Fig. 3. Magdalena Bay and location of the transects.

RESULTS

The study period lasted for 8 weeks (13 February to 3 April 1997) during which fifteen censuses were completed (Table 1). Since the fieldwork started late in the season, it was not possible to determine the dates of the whales' arrival at the Complex, nor the exact length of stay.

The maximum combined counts (the highest sum of cow-calf pairs and single whales) were recorded as follows: 100 whales (83 cow-calf pairs and 17 singles) on 27 February at Santo Domingo Channel; 81 whales (9 cow-calf pairs and 72 singles) on 14 February at Magdalena Bay; and 109 whales (15 cow-calf pairs and 94 singles) on 28 February at Almejas Bay (Table 2).

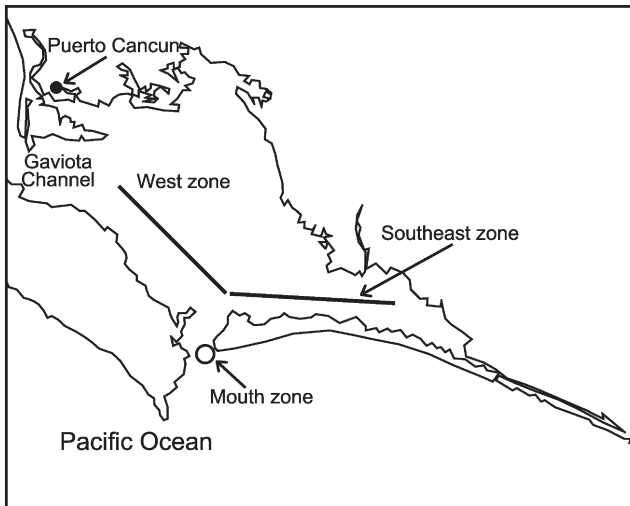


Fig. 4. Almejas Bay showing the position of the transects covered.

In order to determine if cow-calf pairs showed a preference for a particular region, percentages of these groups and single whales were compared in the maximum combined counts. As shown in Fig. 5, Santo Domingo Channel was mostly used by calving whales (83%) while Magdalena and Almejas Bays were dominated by single whales (89% and 86% respectively).

The highest maximum combined count for the three regions of the lagoon complex was observed at Almejas Bay.

Table 1

Number of gray whales by region, zone and type of whale at the Magdalena Bay Complex during censuses in the 1997 winter season. The counts for each area and zone are divided into single whales and cow-calf pairs (C-c).

Santo Domingo Channel									
Date	Upper		Middle		Lower		Total		
	Single	C-c	Single	C-c	Single	C-c	Single	C-c	
13 Feb.	9	31	3	22	0	0	12	53	
20 Feb.	3	10	10	13	3	26	16	49	
27 Feb.	8	46	8	27	1	10	17	83	
04 Mar.	10	41	11	27	2	7	23	75	
20 Mar.	0	20	0	5	0	1	0	26	

Magdalena Bay										
Date	West		Mouth		S-East		Central		Total	
	Single	C-c	Single	C-c	Single	C-c	Single	C-c	Single	C-c
14 Feb.	12	0	9	3	11	0	40	6	72	9
27 Feb.	6	0	4	0	0	0	16	0	26	0
06 Mar.	8	0	8	2	3	0	3	2	22	4
13 Mar.	4	0	0	0	0	0	4	0	8	0
20 Mar.	0	2	0	2	0	1	1	1	1	6
25 Mar.	1	1	0	0	2	0	0	2	3	3
03 Apr.	1	0	0	0	0	0	0	0	1	0

Almejas Bay									
Date	S-East		Mouth		West		Total		
	Single	C-c	Single	C-c	Single	C-c	Single	C-c	
28 Feb.	58	4	24	2	12	9	94	15	
07 Mar.	20	12	34	7	2	0	56	19	
19 Mar.	0	0	1	11	0	2	1	13	

Table 2

Summary of surveys conducted at Magdalena Bay complex. Counts of single whales (sgl.) cow-calf pairs (C-c) and sum of both are included.

Region	Number of surveys	Sum of whales for all surveys			Maximum combined count		Date	
		sgl.	C-c	Total	sgl.	C-c		
S. Dom.	5	68	286	354	17	83	100	27 Feb.
B. Mag.	7	133	22	155	72	9	81	14 Feb.
B. Alm.	3	151	47	198	94	15	109	28 Feb.

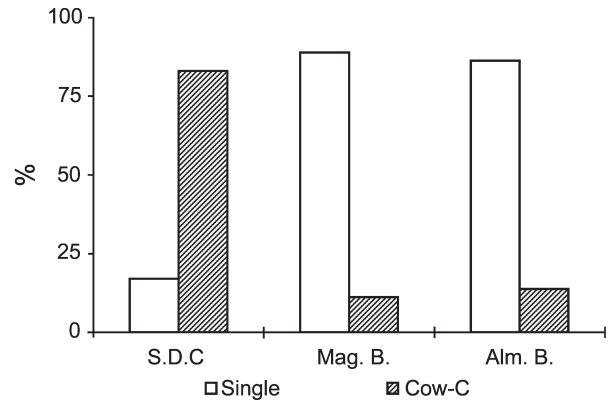


Fig. 5. Percentage of gray whales (single whales and Cow-calf pairs) during the maximum combined count at the different regions of the Magdalena Bay Complex: Santo Domingo Channel (S.D.C.) Feb 27; Magdalena Bay (Mag.B.) Feb 14; and Almejas Bay (Alm.B.) Feb 28.

Santo Domingo Channel

Abundance

Five censuses were carried out at Santo Domingo Channel between 13 February and 20 March. During the first census, 65 sightings (12 singles and 53 cow-calf pairs) were made. This accounted for 18.3% of the maximum combined count for the season. Total sightings of cow-calf pairs showed a general increase during February before declining during March; sightings of single animals increased up until early March before declining to zero by 20 March (Fig. 6; Table 1). Throughout the period, there were many more sightings of cow-calf pairs than singles and the former were seen throughout the study period whereas the latter were not present on the final survey.

Distribution

Maximum combined counts were as follows: 54 in the upper zone, 35 in the middle zone and 35 in the lower zone (Table 1).

Most of the whales were recorded in the upper zone, with cow-calf pairs more abundant than single whales. This area was determined to be the most important for calving in the lagoon complex in the winter of 1997 (Fig. 6; Tables 1 and 2).

UPPER ZONE

During the maximum combined count in this zone, 8 single whales and 46 cow-calf pairs were observed. This accounted for 54% of the whales in the area. Since this zone had the highest occupation (Table 1) it is clearly a calving zone within the region of Santo Domingo Channel.

MIDDLE ZONE

Eight single whales and 27 cow-calf pairs were recorded during the maximum combined count, accounting for 35% of the total. As for the entire Santo Domingo Channel, more

cow-calf pairs than single whales were observed in this zone. This zone accounted for most of the single whales in the region and has the second highest occurrence of cow-calf pairs (Table 1).

LOWER ZONE

Only 11% of the total whales observed during the maximum combined count were observed here: 1 single whale and 10 cow-calf pairs. During the study period more cow-calf pairs than single whales occupied this zone. The lowest counts for both cow-calf pairs and single whales in Santo Domingo Channel were recorded in the lower zone (Table 1).

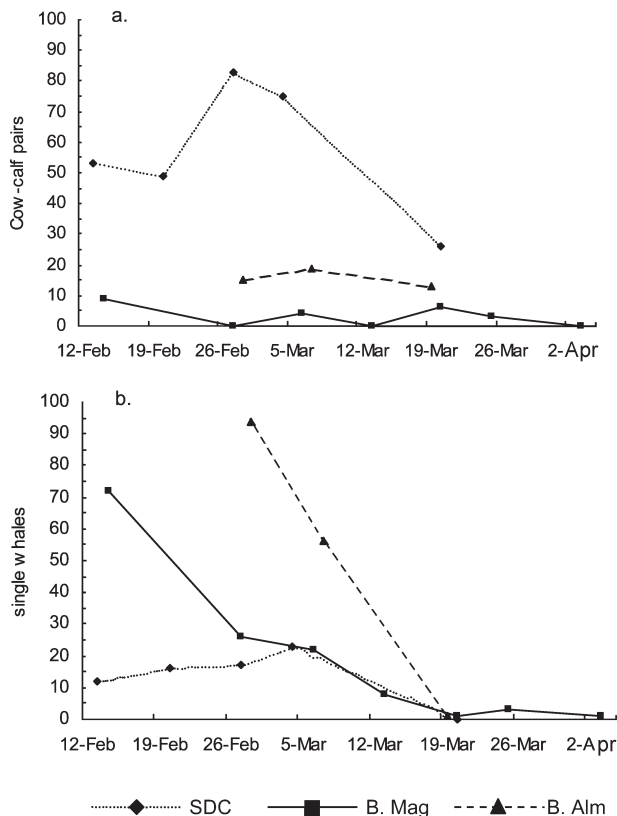


Fig. 6. Gray whale counts at the different parts of the Magdalena Bay lagoon Complex. (a) Cow calf pairs; and (b) single whales.

Magdalena Bay

Abundance

At the beginning of the study period, the number of both cow-calf pairs and single whales was higher than later in the season. The first count of 81 whales (72 singles and 9 cow-calf pairs) was the maximum combined count, recorded on 14 February. After this date the number of whales decreased.

The numbers of both single whales and cow-calf pairs decreased from February to the beginning of March. The number of single whales was higher than that of cow-calf pairs over the entire study period (Fig. 6).

Distribution

The maximum combined count was recorded as follows: 12 in the west zone, 12 at the mouth, 11 in the southeast zone and 46 in the central zone (Table 1).

WEST ZONE

Twelve single whales and no cow-calf pairs were recorded during the maximum combined count, accounting for 14.8% of the total. During the study period, the counts of single whales were always higher than of cow-calf pairs (Table 1).

MOUTH

The maximum combined count for this zone accounted for 14.8% of the whales: 9 singles and 3 cow-calf pairs. The single whales were more abundant than the cow-calf pairs. Almost one third (31.8%) of the cow-calf pairs in Magdalena Bay were recorded in this zone.

SOUTHEAST ZONE

Only 13.6% of the whales (11 singles and 0 cow-calf pairs) during the maximum combined count were observed in this zone. This zone was the least used by the whales in the region but single whales were found throughout the study period, decreasing in number towards the end of the season.

CENTRAL ZONE

Forty single whales and 6 cow-calf pairs made up the maximum combined count for this region, accounting for 56.8% of the whales. This was the main aggregation zone within Magdalena Bay. Single whales were particularly abundant at the beginning of the season. Although the number of single whales was higher than cow-calf pairs, this was the most important zone for calving at Magdalena Bay.

Almejas Bay

Abundance

Three surveys were conducted in this area from 28 February to 19 March 1997. The number of whales recorded on the first count was the highest: 109 whales (94 singles and 15 cow-calf pairs). For the following counts the number of single whales gradually decreased while the number of cow-calf pairs slightly increased (Fig. 6; Table 1).

Distribution

The maximum combined count distribution was as follows: 62 in the southeast zone, 26 at the mouth and 21 in the west zone.

Percentages of whales during the maximum combined count showed that most of the whales congregated in the southeast zone, where single whales were more abundant. In contrast, cow-calf pairs were more abundant in the west zone but the total number of whales in this region was the lowest during the combined count (Table 1).

SOUTHEAST ZONE

During the maximum combined count this zone accounted for 56.8% of the whales (58 singles and 4 cow-calf pairs). This was the highest number of whales observed in this part of the Complex (Fig. 5). This zone was the main congregation site for single whales and the second for cow-calf pairs (Table 1).

MOUTH

Twenty-four single whales and 2 cow-calf pairs were observed during the maximum combined count, accounting for 23.8% of the whales (Fig. 5). This zone was the second most important for single whales and the third for cow-calf pairs. Single whales were more abundant than cow-calf pairs (Table 1).

Towards the end of the season whales were observed gathering around two sandbanks in the Rehusa Channel called 'los filetes'. These shallow sites are close to the mouth of the bay and are separated from each other by approximately 1.5km. The changing direction of the currents in the zone and the accumulation of sediments allow the whales to 'rest' on the bottom, surfing almost effortlessly.

WEST ZONE

This zone accounted for 19.26% (12 singles and 9 cow-calf pairs) of the maximum combined count (Fig. 5). Both singles and cow-calf pairs were less numerous in this zone than in the rest of the bay (Table 1). The number of single whales was always higher than cow-calf pairs.

DISCUSSION

Although the three aggregation regions of the lagoon complex were surveyed several times, the counts were initiated late in the season. Thus it was not possible to determine the dates of arrival. Previous studies in the area indicate that gray whales are present at the lagoon complex from at least the beginning of January (Villa-Ramírez *et al.*, 1981; Fleischer and Contreras U., 1986). The late start also affected the attempt to estimate more accurately the peak dates of abundance.

The whales were evenly distributed in the three areas of the lagoon complex by the date of the maximum combined count. Out of the total 290 whales, Santo Domingo Channel accounted for 100 (34%), Magdalena Bay 81, (27%) and Almejas Bay 109 (37%). It is important to recognise the size differences for the various parts of the Complex: Santo Domingo Channel is the smallest and Magdalena Bay the largest. Thus, as pointed out by Dedina (2000) gray whales are found more densely congregated in the narrower Santo Domingo Channel.

The Magdalena Bay Complex is often referred to as a single wintering area for gray whales (Rice and Wolman, 1971; Jones and Swartz, 2002). This study shows that the three parts of the Complex should be considered as separate wintering locations for this species that are utilised by the whales in different ways. In contrast with Santo Domingo Channel, where more cow-calf pairs are observed, Magdalena and Almejas Bays are sites where more single whales were counted. Whale occurrence did not change to other areas during the 1997 winter, although this was noted for subsequent years by Gardner and Chavez (2000).

Santo Domingo Channel was clearly the most important calving area of the Complex having the greater number of cow-calf pairs throughout the season. This situation was unique for the entire lagoon complex. The same situation had been observed in 1981, 1982 and 1986 (Villa-Ramírez *et al.*, 1981; Fleischer and Contreras U., 1986). At San Ignacio and Ojo de Liebre lagoon, the other breeding grounds, the number of cow-calf pairs is greater usually only towards the end of the season when single whales are departing to the north (Urbán-R *et al.*, 1997; 2003). It appears that the upper and lower zones are the most important for the aggregation of whales whilst the middle zone is only the area where whales were seen in transit between zones.

No previous studies have been conducted in Magdalena and Almejas Bays. Since both areas are mostly used by single whales, these regions appear to be aggregation sites for courting and mating whales or for young and immature animals.

Thus it seems that the portion of Santo Domingo Channel utilised by gray whales during the winter, although very limited geographically, represents an important breeding location for the population.

The Santo Domingo Channel is the only region of the Complex where a similar study has been conducted. Fleischer and Contreras (1986) reported on whale censuses in the region between 11 January and 10 March 1983. The maximum combined count reported was observed on 10

February with 159 whales (33 singles and 123 cow-calf pairs). Although these counts were higher than those presented here, the rate of cow-calf pairs and single whales is similar.

Prior to this study, Almejas Bay had not received sufficient attention and the results in this paper show that is an important winter aggregation area. However, the presence of whales here might be more irregular due to its geographic situation at the southern limit of the normal gray whale wintering range. Any change in the population or in its distribution will certainly become evident in this particular area. It is pertinent to add that Almejas Bay is not open for whalewatching activities and there are no plans by the Mexican government to permit the activity in the foreseeable future (Diario Oficial, 2000).

Dedicated and continued surveys starting in late December or early January (including photo-identification effort to better examine movements and residency) would provide better data to determine arrival dates, occupation peak and total length of stay at the different parts of the Complex.

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