

Abundance and mortality of gray whales at Laguna San Ignacio, Mexico, during the 1997-98 El Niño and the 1998-99 La Niña

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RESUMEN

Este trabajo presenta los cambios observados en la abundancia y mortalidad de las ballenas grises en la Laguna San Ignacio durante 1998 y 1999. En estos años se realizaron 28 censos semanales (febrero 8 a marzo 28) y se consideraron los registros de ballenas muertas de 1996-99. La abundancia de las ballenas sin crías (solitarias) fue similar en estos dos años; sin embargo, para las ballenas con cría se observó una disminución significativa en su abundancia además de un retraso en su pico de abundancia. El número de crías muertas fue similar al observado en estudios previos, pero la proporción de la mortalidad de ballenas adultas fue mucho más alta (60%). La tasa mínima de mortalidad de crías en 1998 y 1999 ha sido la más alta registrada en estudios previos en esta laguna, 1977-82 y 1996-97. Se plantea la hipótesis de que los eventos de El Niño y La Niña tuvieron un efecto en la mortalidad y en las condiciones nutricionales de las ballenas, así como en su área de distribución invernal.

PALABRAS CLAVE: Ballena gris, distribución, mortalidad, El Niño, La Niña, Laguna San Ignacio, Península de Baja California.

ABSTRACT

Abundance of gray whales in Laguna San Ignacio during 1998 and 1999 was obtained during 28 weekly surveys (February 8 to March 28), and mortality records from 1996-99. Single whale numbers were very similar without significant changes from year to year, but for mother-calf pairs the peaks were delayed and significantly lower. The number of dead calves was similar to previous studies, but there were more adult dead whales in 1999 (60%). The minimum calf mortality rates in 1998 and 1999 were higher than in the 1977-82 and 1996-97 seasons. We submit that El Niño and La Niña events had an effect on the mortality and nutrition of whales, as well as on their winter distribution.

KEY WORDS: Gray whale, distribution, mortality, El Niño, La Niña, Laguna San Ignacio, Península de Baja California.

INTRODUCTION

El Niño events can strongly affect the abundance and distribution of various animal species (Arntz and Fahrbach, 1991). The strongest El Niño of this century, in 1982/83, had a strong impact on marine mammal species off Peru, with increased mortality and changes in distribution e. g. for the southern sea lion (*Otaria byronia*) and the South American fur seal (*Arctocephalus australis*) (Arntz and Fahrbach, 1991). In Mexico, Tershy *et al.* (1991) described an increased abundance of fin whale (*Balaenoptera physalus*) and Bryde's whale (*Balaenoptera edeni*) in the Canal de Ballenas, Gulf of California.

During the 1982-1983 El Niño, counts of gray whales in Laguna San Ignacio decreased by 50% from 1978-82 levels, representing a decrease of 59% or more in the number of females with calves using the lagoon. However, industrial noise playback experiments and significant commercial fishing activity in the lagoon during 1984 obscured the reasons for the whale number decrement (Jones *et al.* 1994; Swartz, 1990).

The changes in the abundance of gray whales in Laguna San Ignacio are related to the general distribution of these whales in the Mexican Pacific. If the distribution pattern during 1996 and 1997 is taken as normal, the breeding season of 1998 (an El Niño year) featured a shift in the general distribution pattern toward northern latitudes. Very few whales remained in the southern range, including Bahía Magdalena, and there were unusually high numbers, including calves, off southern California and northern Baja California. The opposite happened during the breeding season of 1999, a La Niña year: gray whales were found in places and latitudes where they are not usually present, like the northern Gulf of California and Bahía de Banderas, off the mainland coast. These changes in the distribution patterns are probably related to higher sea surface temperatures (SST) in 1998 and lower SST in 1999.

In this study we present data on abundance and mortality on gray whales in Laguna San Ignacio, Baja California Sur, Mexico (Figure 1), during 1996/97 (a normal year) and during the strong ENSO cycle 1997-1999, which include the El Niño event 1997/98 and the following La Niña of 1998/99.

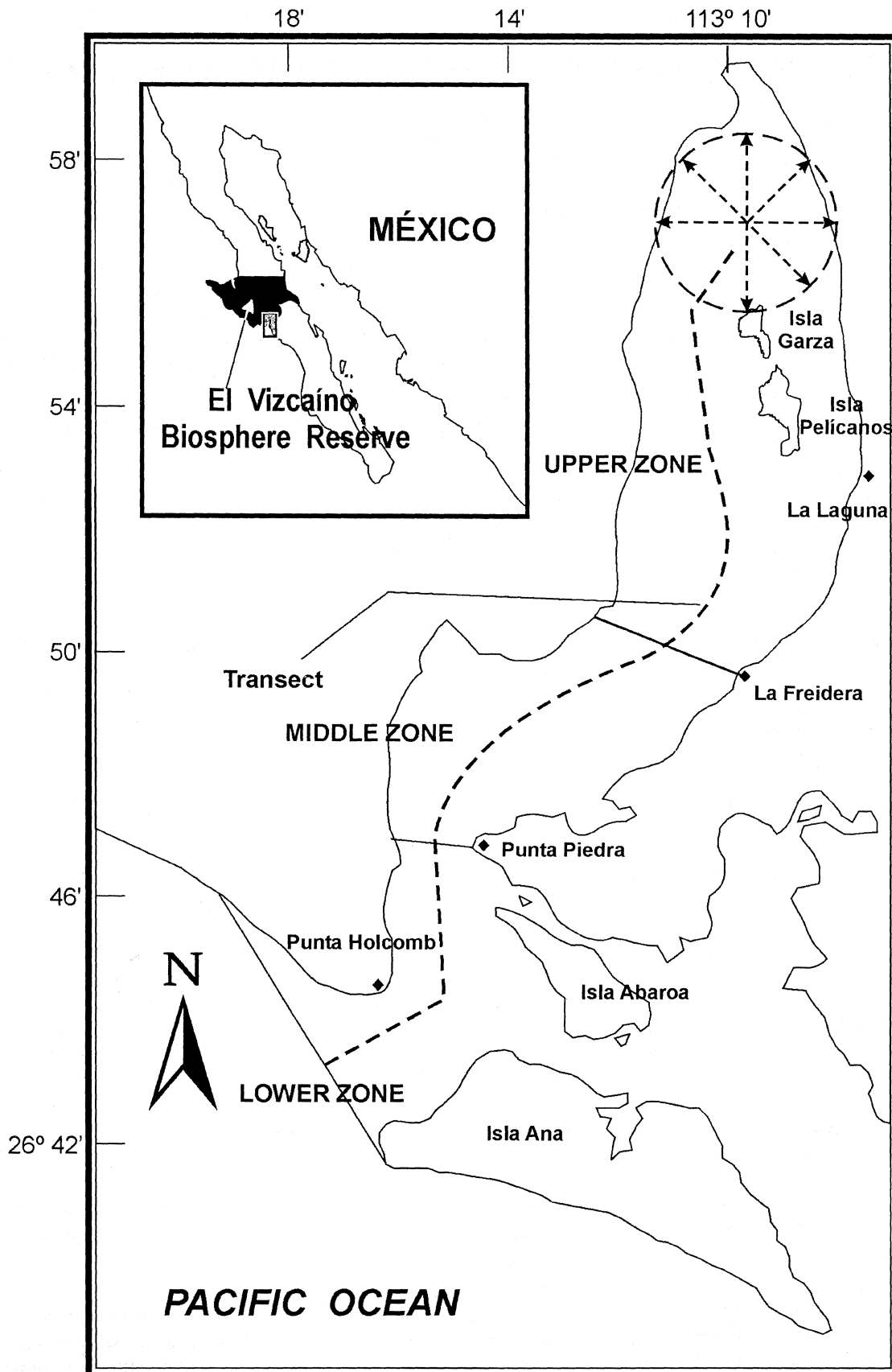


Fig. 1. Laguna San Ignacio, B.C.S., Mexico, showing the transect for gray whale counts.

OBSERVATIONS

Twenty-eight complete censuses from 1996 to 1999 (one per week during 7 weeks between February and March of each year, when the whales were more abundant in the lagoon), were used to determine whale abundance and distribution changes within San Ignacio lagoon. We distinguished between whales with calf (mother-calf pairs) and whales without calf (single whales). The surveys followed line transects and were conducted by boat, using the geographical lagoon division and the methodology described by Jones and Swartz (1984) and Urbán *et al.* (1997) (Figure 1). Coastal areas were surveyed in order to find stranded whales. Stranded whales were measured, sexed and classified according to the stranding condition code of Geraci and Lounsbury (1993): code 1, live animal; code 2, carcass in good conditions; code 3, fair (decomposing, but organs basically intact); code 4, poor (advanced decomposition); and code 5, mummified or skeletal remains.

Gray whale counts from 7 weekly transects (February 8 to March 28) per year were used as an index of adult whales abundance within the lagoon during four winter seasons (1996 to 1999). The maximum combined counts were recorded between the second week of February (week I) for 1998 to the first week of March (week IV) for 1996. The highest number of whales was recorded in 1997 but the lowest in 1999 (Table 1, Figure 2). During 1998 the peak number of adult whales was not significantly different from that of 1997 and was higher than in 1996. The numbers decreased constantly until the last survey. In 1999 the lowest numbers of adult whales were recorded, but the trend in their abundance was less pronounced than in 1998.

An unexpected number of single whales was registered in the second week of February (I) in 1998, with a very

marked decrease until the third week of March (Figure 3). Other years showed very similar patterns and numbers, with peak number between the end of February (III) and beginning of March (IV).

The peak number of mothers with calves occurred in the first week of March (IV) of 1996 and 1997, while in 1998 and 1999 it occurred one week later (V), and with lower numbers than in 1996 and 1997 (Figure 4).

Considering the total number of adult whales inside Laguna San Ignacio during the four years of study, we did not see substantial changes in their abundance, except in 1997 (Figure 5). Since single whales were always predominant in both categories, and no significant change in their abundance was seen ($H_{(3, n=28)}=2.4027, p=0.4931$) (Figure 6), the total number of whales over the years looks similar. However, the mother with calves displayed obvious and significant shifts in their numbers ($H_{(3, n=28)}=21.3437, p=0.0001$) (Figure 7).

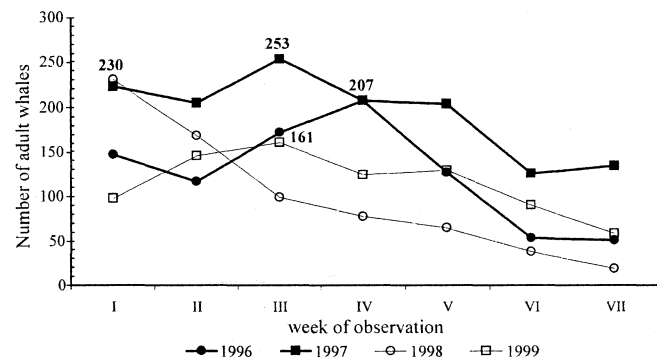


Fig. 2. Number of gray whales (only adults) counted in weekly surveys (February 8 to March 28) in Laguna San Ignacio, B.C.S., Mexico, during 1996 to 1999 winter seasons.

Table 1

Number of mother-calf pairs (Mc), single whales (Si) and total adults (Adl), during 28 weekly surveys from February 8 to March 28 of 1996-1999 (winter season) in Laguna San Ignacio, B.C.S., Mexico

Week	1996			1997			1998			1999		
	Mc	Si	Adl	Mc	Si	Adl	Mc	Si	Adl	Mc	Si	Adl
I	62	85	147	87	136	223	52	178	230	13	85	98
II	42	74	116	97	108	205	48	120	168	16	129	145
III	68	104	172	126	127	253	42	57	99	17	144	161
IV	92	115	207	143	65	208	39	38	77	33	91	124
V	83	44	127	133	71	204	62	2	64	45	84	129
VI	50	3	53	109	16	125	38	0	38	41	49	90
VII	51	0	51	130	4	134	19	0	19	39	19	58

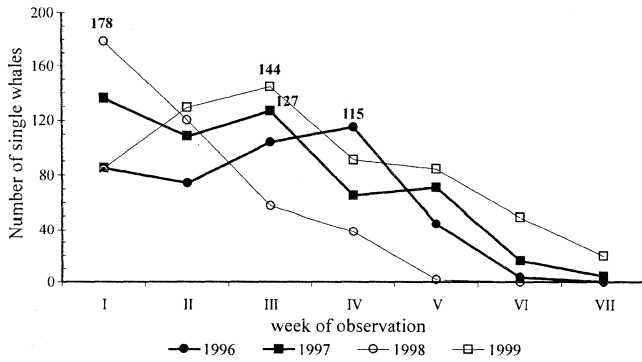


Fig. 3. Number of single whales counted in weekly surveys (February 8 to March 28) in Laguna San Ignacio, B.C.S., Mexico, during 1996 to 1999 winter seasons.

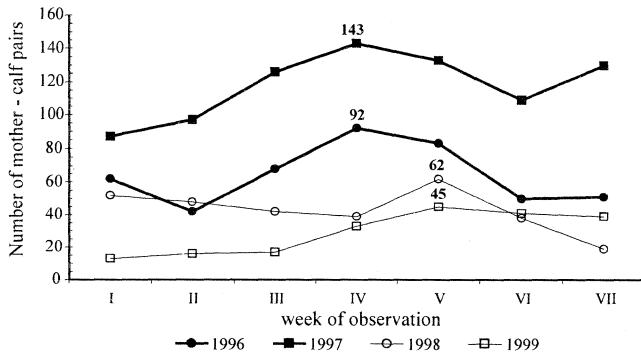


Fig. 4. Number of mother-calf pairs counted in weekly surveys (February 8 to March 28) in Laguna San Ignacio, B.C.S., Mexico, during 1996 to 1999 winter seasons.

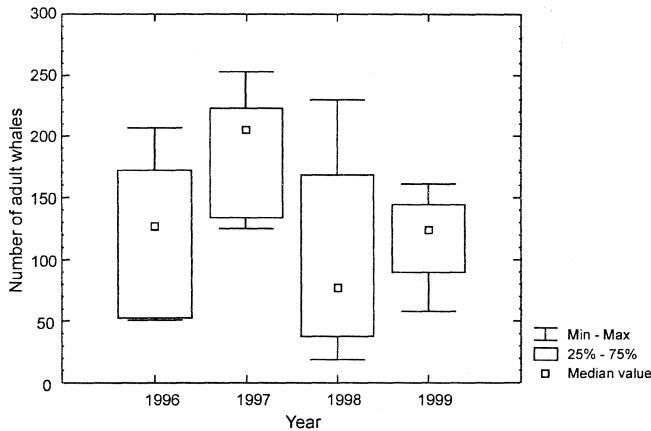


Fig. 5. Number of adult whales inside the lagoon during the four years of study.

Whale mortality

During the study, we found three dead calves in 1996, six calves and one adult in 1997, three dead calves in 1998,

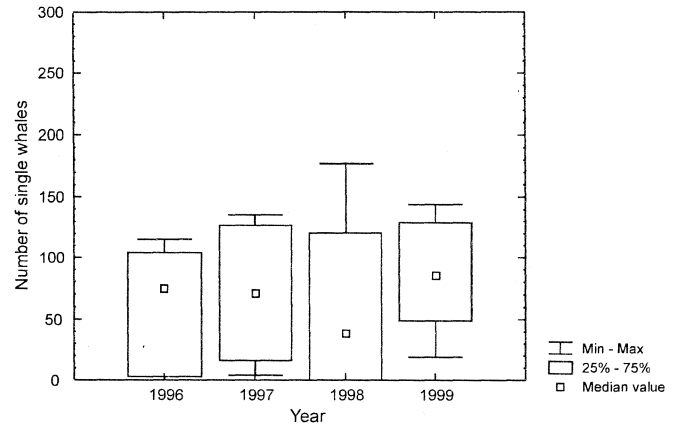


Fig. 6. Number of single whales inside the lagoon during the four years of study.

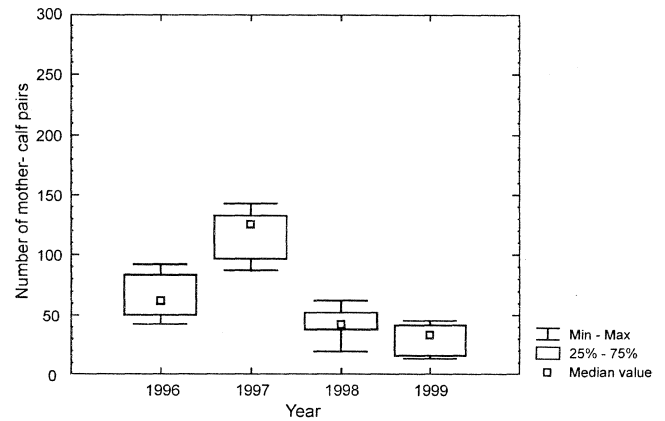


Fig. 7. Number of mother-calf pairs inside the lagoon during the four years of study.

and two dead calves and three adults in 1999 (Table 2). As in Rice and Wolman (1971), and Jones y Swartz (1984); animals between 3 and 8.9 m were yearling calves, immatures between 9 and 10.9 m, and adults larger than 11 m.

In relation with age class, note the absence of immature dead whales during 1996 to 1999. The number of dead calves was similar as in previous studies. The most important change corresponded to adult dead whales found in 1999 (60%), two females and one of unknown sex, and the presence of only two calves, a newborn (4.2 m) and an estimated 3-4 months old calf (Figure 8).

For comparison with previous studies, we estimated the minimum calf mortality rate for each season, by dividing the number of dead calves per season by the estimated gross calf production per season (number of living calves at the maximum combined count + number of dead calves per season) (Swartz and Jones, 1981; 1983). The minimum calf

Table 2

Summary of length and sex composition of dead gray whales found in San Ignacio Lagoon, B.C.S. (January-March 1996; February-March 1997; January-April 1998; January-April 1999)

	Date	Age class	Sex	Length (m)
1996	January 31	calf	-	-
	February 1	calf	-	-
	March 15	calf	-	-
1997	February 13	calf	male	4.5
	February 16	calf	female	5.0
	February 17	calf	female	4.6
	February 21	calf	male	4.7
	February 23	adult	male	12.1
	February 27	calf	male	5.7
	March 15	calf	male	5.0
1998	January 21	calf	male	4.1
	January 27	calf	female	4.0
	February 14	calf	female	4.0
1999	February 6	calf	female	4.2
	February 18	adult	?	12.5
	March 4	adult	female	12.0
	March 15	adult	female	14.1
	March 28	calf	female	8.0

mortality rates in 1998 and 1999 were higher than during the 1987-82 and 1996-97 seasons (Figure 10). In other words, the minimum calf mortality rate was higher during the "El Niño" and "La Niña" events.

DISCUSSION AND CONCLUSIONS

The number of mother-calf pairs in San Ignacio lagoon in winter 1999 was the lowest recorded in the monitoring programs, which began in 1978. Only 45 mother-calf pairs were counted in early March 1999, at the time of maximum number of mother-calf pairs. By way of comparison, the maximum number of mother-calf pairs totalled 92 in 1996, 126 in 1997 and 52 in 1998. The mean maximum count of mother-calf pairs during the period 1978 to 1982 was 113 (Jones and Swartz, 1984; 1986; Jones *et al.*, 1994; Urbán *et al.*, in press).

As for abundance of gray whale by age/class group in the Laguna San Ignacio, mother-calf pairs were the most affected. Newborn whales are more sensitive to water temperature fluctuations, and they and their mothers may prefer higher latitudes with cooler waters during El Niño and lower latitudes with warmer waters during La Niña (Urbán *et al.* 1999; Le Boeuf *et al.* 2000). Similar changes in relative abundance of gray whales during 1997-1998 were detected in Bahía Magdalena, a breeding and nursing area on the west coast of the Baja California Peninsula (Gardner and Chavez, 2000). Note three dead adult whales, at least two of them females, during 1999. This is consistent with

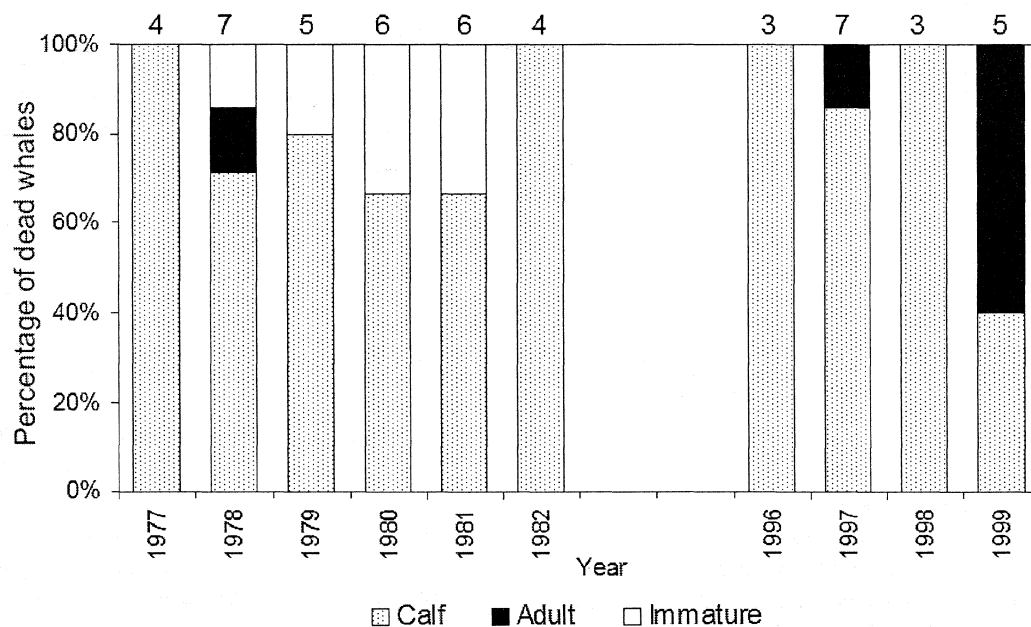


Fig. 8. Percentage of dead whales found in San Ignacio Lagoon between 1977-1982 (Jones and Swartz, 1984) and 1996 to 1999 (numbers inside the column is the total dead whales).

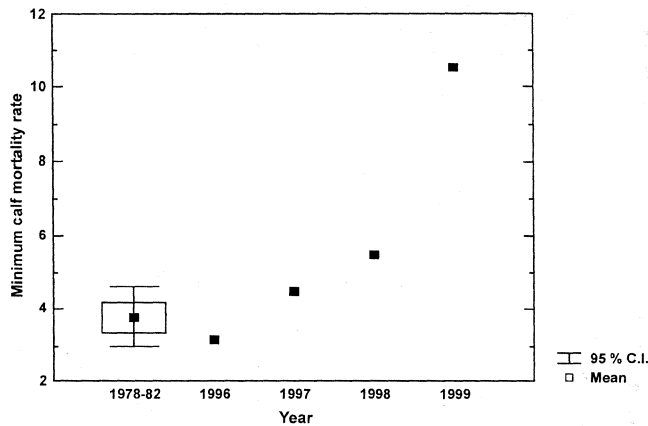


Fig. 9. Minimum calf mortality rate estimated in 1996, 97, 98 and 1999; and comparison with 1978-82 reported by Jones y Swarts (1984).

the mortality of gray whales off the coast of Baja California Peninsula during the same breeding season, when more than 70 dead adult whales were recorded, more than 75% females (Pérez-Cortés *et al.*, 1999). In general there was a high adult gray whale mortality in all the eastern distribution area (Le Boeuf *et al.*, 2000; Guland *et al.*, 2002).

During the 1999 season we observed several emaciated adult whales, with unusual feeding behaviours inside Laguna San Ignacio (Urbán *et al.*, in press). Emaciated gray whales were also observed in the west coast of the United States (Moore *et al.*, 2001). In other places in the Mexican Pacific there were also unusual observations of gray whales feeding, as happened in Bahía de los Angeles in the northern Gulf of California (Sánchez-Pacheco *et al.*, 2001). These facts, together with the decrease in the abundance of the mothers with calves, the increase of the adult female mortality, and the increase of the minimum calf mortality rate, lead us to hypothesise that El Niño and La Niña events had an effect on the nutritional conditions of the whales. (Le Boeuf *et al.*, 2000; More *et al.*, 2003). Grebmeier and Dunton (2000) demonstrated a reduction on the availability of food resources during 1998-99, especially on amphipods community biomass in the central Chirikov Basin in the Bering Sea, the main feeding area of the eastern gray whale population; and Perryman *et al.* (2002) found, based on aerial photographs of southbound gray whales, that they were thinner in 1999, than in 1997 and 1998.

Inadequate nutrition and body reserves may be especially hard on gestating or nursing adult females, who require additional resources (Rice and Wolman, 1971; Lockyer, 1984). This would be reflected in increased mortality and reduced calf production (Brambell, 1948; Stein and Susser, 1975). Fewer pregnant females were observed in 1999 than in 1997 and 1998 during aerial survey of southbound whales

in California (Perryman *et al.* 2002). Together with the low number of mothers with calves registered since 1978 in Laguna San Ignacio, this suggests that recruitment was low in 1999.

In conclusion, we propose that 1997-1999 El Niño and La Niña events had at least two important effects on the eastern gray whales. There was a shift in winter distribution as a result of changes in the SST; and there was an increase in mortality and decrease in calf production due the reduction of prey abundance in their feeding grounds.

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