PRELIMINARY REPORT OF THE 2007 GRAY WHALE STUDIES AT LAGUNA SAN IGNACIO, B.C.S., MEXICO.

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ABSTRACT

Laguna San Ignacio is located in the west coast of Mexico's Baja California Peninsula and it is one of the four main calving-breeding lagoons of the eastern North Pacific gray whale (*Eschrichtius robustus*). Preliminary results are presented for the 2007 gray whale winter research season, and include: abundance estimates, density and distribution of the whales within this lagoon, photographic identification studies, and observations of "skinny" whales. Twelve complete census surveys of the lagoon were conducted from February 5 to March 30, 2007. These boat surveys followed a standard transect and methodology to determine minimum whale abundance and distribution, and to allow comparisons with historical surveys conducted during the periods of peak whale abundance in February between 1978 to 2006. The maximum count of adult whales was 217 on 22 February (197 "single" whales and 20 cows with calves). The highest count of single whales was 197 and occurred on 22 February, and the highest cow-calf pairs count was 37 on 17 February. The high count of adult whales was 46% less than the highest recorded count of 407 adult whales on 14 February 1982, and occurred later in the season than 10 of the previous February highest count surveys suggesting a continuing decline in the number of whales utilizing this lagoon and a delay and shortening of the winter occupation of the lagoon by whales. Counts of female calf pairs also demonstrated declines from 137 pairs counted on 14 February 1982 to 37 pairs on 17 February 2007, or a decline of 73%. These findings could reflect the overall decline in the eastern North Pacific population and/or a differential use of the San Ignacio lagoon compared to other breeding lagoons and coastal areas during the winter. The distribution of whales within the lagoon at the time of the maximum adult whale count was: 63% in the lower zone nearest the entrance, 30% in the middle zone and 7% in the upper zone furthest from the entrance. This represents a change in the utilization of the lagoon since the highest historical count in 1982 when 50% of the whale utilized the lower zone, 16% used the middle zone, and 34% utilized the upper zone (Jones and Swartz 1984). This change in distribution is largely the result of fewer females with calves observed in the lagoon at the peak of the season. Of the 743 whales identified from photographs, 501 were single whales, 212 cow-calf pairs, and 30 were of undetermined status (*i.e*., individuals that for some reason could not be assigned to one of the previous group classes). Determination and analysis of minimum residence time is in progress and will be completed later this year. Some gray whales exhibited "skinny whale" characteristics suggesting some degree of resource limitation could be affecting their health and female productivity.

INTRODUCTION

Laguna San Ignacio is located in the west coast of the Baja California Peninsula in Mexico and it is currently the only one of the four calving-breeding lagoons of the Eastern Pacific gray whale (*Eschrichtius robustus*) that remains mostly undeveloped. San Ignacio lagoon has a long history of commercial fishing by several fishing cooperatives, and since the mid-1990s a significant eco-tourism industry that focuses on winter whale-watching has developed in the lagoon (Dedina and Young, 1995). The lagoon lies within the Vizcaino Desert Biosphere Reserve, Mexico's largest refuge administrated by Secretaria de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAT) (Fig. 1). This is a popular destination for recreational whale watching which began in the mid-1970s. Beginning in the mid-1990's and continuing to the present, seven land-based "eco-tourism" camps operate whale watching tours throughout the winter gray whale occupation of the lagoon (January through April), and a few boat-based "natural history" tours from the United States also conduct whale-watching tours in Laguna San Ignacio (Dedina and Young, 1995).

Detailed studies of demography and phenology of gray whales were conducted during the winter occupation in Laguna San Ignacio from 1978 to 1982 (Jones and Swartz, 1984), and resumed from 1996 to 2000 (Urban *et al*. 2002), 2003, and 2005 and 2006 (Urbán unpublished data).

The intent of the 2007 studies was to describe and evaluate the current use of Laguna San Ignacio by the gray whales in the context of the last 25-years, and to evaluate the overall health of the lagoon ecosystem as a habitat for breeding whales. Here, we report preliminary results of the 2007 gray whale winter research program on abundance, density and distribution of the whales, photographic-identification studies, and observations on the apparent health of some whales exhibiting evidence of the "skinny whale" syndrome.

METHODS

Boat Surveys (census)

Twelve complete census surveys of the lagoon to determine whale abundance and distribution were conducted during the period February 5 and March 30, 2007. The surveys were conducted by following a standard survey transect (Fig. 2) and observer methodology to allow comparison with previous survey counts from 1978-1982 (Jones and Swartz 1984) and 1996-2006 (Urban *et al*. 2002, and unpublished). No complete whale surveys were conducted in the years 1983-1995, or in 2001-2002, or 2004.

For each survey a standard transect line was followed using a 7-m boats powered by an outboard motor, travelling at an estimated speed of 11 km/hr. Speed and transect course were verified using a hand-held GPS (Global Position System) device. 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 thus be counted more than once. The transect line ran along an imaginary line drawn through the lagoons deep water areas (i.e., > 2.0 m deep) from the breaker line at the lagoon entrance to Isla Garzas at the north end of the lagoon. Each survey required about 2.5 to 3.0 hr to complete. The maximum distance from the transect line to the 2 m depth contour along shore was 2.5 km and the minimum was 0.8 km. Thus, waters inhabitable by whales and both shorelines were clearly visible at all times within the lagoon (it was assumed that essentially all animals within 2.5 km of the trackline were seen). Whales in the "North End" of the upper lagoon (north of the transect termination) were counted from a stationary location located at the centre of the upper portion of the lagoon by observers searching in 360-degrees around the stationary boat (Fig. 2). Surveys were aborted when sea conditions exceeded Beaufort 3 sea state (winds greater than 18 km/hr and consistent white caps).

By convention, we considered "cow-calf pairs" (*i.e*., female whales with calves of the year) 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 animals.

Analysis Procedure

Counts of gray whales during the 2007 winter season were analyzed as total adult (non-calf) whales, single whales, and female-calf pairs counted in the entire lagoon, and as the number counted within each of the three primary zones (*i.e*., the lower, middle, and upper lagoon zones including the north end area) (Fig. 2). The number of whales in each zone and the total for 2007 were compared with counts from previous years.

Photographic Identification

Gray whales possess individually unique pigmentation and markings that can be used to identify and document the presence of specific individuals in the lagoon. When surveys for abundance and distribution were not being conducted, efforts were directed at obtaining photographs of individual whales. Photographs of the visible portions of the whale´s backs were taken with 35 mm digital SLR cameras with 70-300 mm telephoto zoom lenses. Any unique or outstanding scars or other conspicuous natural markings were also photographed.

Individual whales were distinguished by comparing the natural markings located on the middle of the dorsal back region of the whale. Photographs were taken of both the left and right sides of the whales, and when possible, photographs of both sides of the same individual were obtained. The best photographs from the right and left sides of each whale (for each sighting) were selected, assigned a unique sequential identification number, and archived into a digital computerized photographic database. Each photograph for an individual whale was coded according to the type of markings and their locations on the body (*e.g*., unique pigmentation of the skin, mottling, scarring, and barnacles, scars, etc.).This database was then searched by the types of markings on individual whales compared with other whales with similar markings to identify photographs of the same whale obtained during the same year or in other years (*i.e*., matches).

Health Assessment

Whales exhibiting characteristics of mal-nutrition (food resource limitation) and/or disease (i.e., "skinny whales") as described by Weller *et al.* (2000) were observed during the census and photographic identification surveys in 2007. Once recognized, efforts were made to obtain photographs of the entire body of such whales to document and to evaluate their health. "Skinny" symptoms varied among individuals but included at least one or more of the following diagnostic features: (1) an obvious sub-dermal protrusion of the scapulas from the body with associated thoracic depressions at the posterior and anterior insertion points of the flipper; (2) the presence of noticeable depressions on concavities around the blowholes and head; and (3) a pronounced ridge along the neural/dorsal spine of the lumbar and caudal vertebrae resulting in the appearance of a “bulge” along the lateral flank (Weller *et al*. 2000; Brownell and Weller 2001) (Fig 1). The percent of whales exhibiting "skinny" characteristics will be estimated from the total number of these whales photographed divided by the total number of distinct individual whales ("skinny" and not "skinny) photographed during the photo identification surveys.

RESULTS

Abundance

Counts of gray whales from boat surveys are used as an index of the minimum abundance of whales within the lagoon during the winter breeding season.

The maximum count of adult whales was 217 on 22 February (197 "single" whales and 20 cows with calves). The highest count of single whales was 197 and occurred on 22 February, and the highest cow-calf pair count was 37 on 17 February (Table I, Figs. 3-5). The high count of adult whales was 46% less than the highest recorded count of 407 adult whales on 14 February 1982, and occurred from one to 19 days later in the season in 10 of the previous 14 February surveys suggesting a continuing decline in the number of whales utilizing this lagoon along with a delay and shortening of the winter occupation of the lagoon by whales.

Distribution

Whale counts were always greatest in the lower zone nearest the lagoon entrance from the sea and decreased towards the upper zone in the interior of the lagoon. The distribution of whales within the lagoon at the time of the maximum adult whale count on 22 February was: 63% in the lower zone nearest the lagoon entrance, 30% in the middle zone and 7% in the upper zone furthest from the entrance. This represents a change in the utilization of the lagoon since the highest historical count on 14 February 1982 when 50% of the whale utilized the lower zone, 16% used the middle zone, and 34% utilized the upper zone (Jones and Swartz 1984). This change in distribution is largely the result of fewer females with calves observed in the lagoon at the peak of the season (37 cow/calf pairs on 17 February 2007 compared to 137 on 14 February 1982 (Tables I-II, Fig.6).

Lower zone

At the time of the maximum adult whale count on 22 February, 63% of the count (126 single whales and 10 cow-calf pairs) occupied the lower zone. As in previous years, the single whales were the principal occupants of the lagoon during February each season. During the first survey on 5 February, 29 single whales and 7 females with calves were counted in the lower zone. From this day on, the counts of single whales in the lower zone increased to a peak of 126 on 22 February, and then their numbers decreased to a low of 9 single whales on 27 March and none were counted during the last survey on 30 March. Counts of females with calves in the lower zone increased from 7 on 5 February to 19 pairs on 22 March. Only one female-calf pair was counted in the lower zone during the last survey on 30 March (Tables I-II, Fig. 6).

Middle zone

At the maximum adult count, 30% of the count was in the middle zone (60 single whales and 6 female-calf pairs). During the first survey on 5 February 9 single whales and one cow-calf pair was counted in this zone. The counts of single whales increased in this zone to a maximum of 60 on 22 February, after which counts of single whales in this zone declined to one whale on 26 March and none counted during the last survey on 30 March. Counts of female-calf pairs in the middle zone increased from one pair on 5 February to 12 pairs on 17 February, and then decreased to 7 pairs on 22 March and none counted in this zone during the last two surveys on 26 and 30 March (Tables I-II, Fig. 6).

Upper zone

Seven percent (7%) of the maximum count on 22 February was from the upper zone (5 female-calf pairs and 11 single whales). Historically this zone has been occupied by female-calf pairs, however in 2007 single whales and female-calf pairs were mixed in this zone. The counts during the first survey on 5 February included 4 female-calf pairs and 4 single whales. Counts in this zone increased to 33 adult whales on 17 February (15 female-calf pairs and 18 single whales), and then declined to 2 female-calf pairs on 30 March. Generally speaking, the abundance of whales in the upper zone was the lowest recorded compared to all the historical surveys (Tables I-II, Fig. 6).

Photographic Identification - Residency

A total of 2428 digital exposures were taken, from which 743 different individual whales were identified. These included 1156 from right side photographs and 735 from the left side photographs. Only 121 whales were photographed from both sides. However, these may include some individuals that were photographed on more than one day (Fig. 6). The analysis of repeat sightings of the same individuals on different days is in progress, and the number of re-sightings of these individuals will decrease the number of unique whales observed and photographed in the lagoon in 2007.

Of the 743 identified whales, 501 were single whales, 212 cow-calf pairs, and 30 were of undetermined status *(i.e*., duals that for some reason could not be assigned to one of the previous group classes). Determination of minimum residence time, or intervals between the first and last sighting of individual whales is in progress and will be completed later this year after a full analysis of the 2007 photographic identification information.

Health Assessment

A preliminary review of the 2007 photographic data indicated that a number of individual whales exhibited obvious signs of mal-nutrition and/or disease that has been termed evidence of the "skinny whale syndrome" (Weller et al. 2000) (Figs. 7-10). While most gray whales observed within Laguna San Ignacio appeared to be normal, some individuals possessed noticeable "post cranial depression" and hump in the dorsal neck region of the body. Others were observed with protruding leading edges of their scapula, and concave rather than convex profiles to their dorsal flank areas. The completion of the 2007 photographic identification data will allow the determination of the percent of gray whales observed that exhibited these characteristics, and an evaluation of how wide-spread these features are among those whales that frequented this breeding lagoon.

DISCUSSION

The counts of gray whales residing within Laguna San Ignacio during the 2007 winter season were noticeably lower than in any previous years counts dating back to 1978, and this was especially true of female-calf pairs (which are equivalent to calf-counts) (Table III). This decreasing trend in the number of whales observed in the lagoon could be a reflection of the overall decline in the NEP gray whale population since its peak abundance in 1997-1998 (Fig. 11) and/or a shift in the winter distribution of gray whales to areas other than Laguna San Ignacio. While it is well documented from the central California population census counts that following a population wide mortality event in 1999-2000 (LeBoeuf *et al.,* 1999) the ENP population declined almost one-third from approximately 30,000 to 18,000 individuals by 2001-2002 (Rugh *et al*. 2005). Unfortunately, systematic surveys to count gray whales throughout their winter range and specifically in the breeding lagoons of Baja California have not been conducted since the 1979-1980 winter (Jones and Swartz 1984), and thus it is not possible to determine if gray whales may have shifted their winter distribution from Laguna San Ignacio to other breeding lagoons and coastal areas. Photographic identification studies suggest that, historically, both single adult whales and females with calves of the year can circulate within the Baja California breeding lagoons and coastal areas within the same winter, and that they may visit alternate areas across years (Jones 1990; Jones and Swartz 1984).

Other factors that could affect the number of gray whales observed in Laguna San Ignacio include changes in the phenology of their migrations resulting from changes in the distribution and availability of prey (Highsmith *et al*. 2006; Grebmeier *et al.* 2006), the influence of sea surface temperature on migratory behaviour during El Nino/La Nina events (Urbán *et al*. 1999), and/or human activities within the lagoon during the winter whale breeding season (Urbán and Gómez-Gallardo 2000).

Historically the Chukchi Sea and the Chirikov Basin in the northern Bering Sea were known as the ENP gray whales' primary feeding grounds due to high densities of whales observed there during the summer (Braham 1984, Kim and Oliver 1989, Moore et al 2000), and the whales' ampelicid amphipod prey (Grebmeier *et al*. 1989, Highsmith and Coyle 1990). Throughout the 1990s the benthic productivity of the Chirikov basin declined precipitously, due to either overgrazing by the whales (Highsmith *et al.* 2006) or an ecosystem regime shift in the Bering Sea (Grebmeier *et al.* 2006), or some combination of factors. Moore *et al.* (2003) report that only the southern Chukchi Sea supported dense aggregations of gray whales, and that gray whales are now foraging in areas heretofore not considered their primary feeding areas or primary prey species (Moore, *et al.* 2007).

Highsmith and Coyle (1992, 1994) predicted that the growing gray whale population of the 1990s would not be supportable at its historical primary feeding sights, and that the ENP population may have approached or even exceeded the limits of the available prey base, or carrying capacity by the turn of the century (LeBoeuf *et al.* 2000; Moore *et al.* 2001; Perryman *et al.* 2002). Disruption of the flow of nutrient rich waters that feed primary and secondary production and support the Arctic benthic communities on which gray whales fed historically could have implications for ENP gray whale calf production and survivorship (Highsmith and Coyle 2006). Dramatic changes in the oceanography of the Arctic associated with global climate change have occurred in recent decades (Green and Pershing 2007), and specifically in the Bering Sea (Grebmeier *et al.* 2006) where marine wildlife populations are apparently responding to the resulting environmental changes. Responses include declines in gray whale abundance on their former primary summer feeding areas in the Chirikov Basin and dispersal to other foraging areas (Moore *et al*. 2007).

Low gray whale calf counts in Laguna San Ignacio and during their northward spring migration are especially troublesome, as they could indicate a reduction in the reproductive potential of the population. Perryman *et al*. (2002) observed that gray whale calf production appears linked to summer ice conditions in the Arctic which may limit pregnant female whales' access to prey resources in some years, and subsequently lower calf survivorship. Their observation suggest that short-term, annual changes in oceanic sea ice conditions along with longer-term basin scale changes may ultimately affect gray whale productivity. Our observations of "skinny" gray whales in Laguna San Ignacio also suggest that prey resource limitation is a factor in the health and status of the population. Vulnerability to parasites and disease associated with prey switching and overall stress could affect gray whale productivity and survivorship (F. Gulland, S.E. Moore and T. Rowles, *pers. Comm*.). Low calf counts could be indicators that some gray whale females are unable to obtain sufficient energy resources to conceive, or if pregnant to bring calves successfully to term. Brownell and Weller (2002) suggest that resource limitations may result in a three-year rather than the normal two-year reproductive cycle in western north Pacific gray whales.

Shorter-term oceanic temperature changes may also have an effect on gray whale migration timing, distribution, and production. The Pacific ENSO or Equatorial Northern and Southern Oscillation events result in an anomalous warming of the sea surface temperature during one year, the El Nino, followed by a cooling event the following year, or La Nina (Philander 1985, 1990). These events can influence the phenology, productivity, and survivorship of marine animals, including gray whales. Urbán *et al*. (1999) documented a decrease in the number of gray whale females with calves visiting Laguna San Ignacio during the 1997-1998 El Nino and 1998-1999 La Nina events, along with increases in gray whale mortality, and a general shift in the winter distribution of gray whales to the northern areas during the warmer El Nino, and a shift to more southern areas during the cooler La Nina.

Human activities within Laguna San Ignacio could also influence the number and duration of stay of gray whales during the winter months. Whale-watching tourism, fishing, and scientific research all occur within Laguna San Ignacio during the winter breeding season of the gray whales, and all contribute to the underwater noise to the lagoon habitat. In the short-term, the gray whales respond to this boat traffic in one of two ways: they generally ignore the whale-watchers and other boats; or they approach the boats and allow the passengers to pet and massage them in episodes termed "friendly whale behaviour"

(Jones and Swartz 1984) which continues to be a popular feature for whale-watchers and eco-tourists to this day.

Beginning in 1978, whale-watching has been regulated by permit in Laguna San Ignacio, and restricted to the lower zone nearest the lagoon entrance (Jones and Swartz 1984). The remaining interior two-thirds of the lagoon remains sanctuary where whale-watching is not permitted. By 1996 Mexico had in place regulations that specified: specific areas where whale-watching activities are permitted (*i.e*., the Lower Zone); the length of the whale-watching season; the number and type of whale-watching boats permitted; and the maximum duration of a single whale-watching trip (*i.e*., 2-hrs) (Urbán and Gómez-Gallardo 2000). In addition to whale-watching in the Lower Zone, fishing and research permits are issued each year which allow these activities throughout the entire lagoon, however, their numbers are relatively few compared to the number of whale-watching permits issued. The numbers of fishermen have fluctuated annually, although the exact numbers are not well documented. All of these boats do contribute outboard motor noise to the ambient noise levels in the lagoon each winter season.

Jones and Swartz (1984) noted the potential for detrimental consequences to gray whales from human activities within their breeding lagoons, and sought to evaluate the biological considerations that could contribute to such effects during their field studies from 1978 to 1982. They looked at the frequency of commercial whale-watching vessel visitation to the lagoon during this period, and noted that whale-watching vessels and their pangas were active 67% of the time, on average. They detected no changes in the distribution of the whales within the lagoon zones, and no changes in mortality of adult or calves that could be associated with the whale-watching activities. They found no conclusive evidence that gray whales moved out of the areas of whale-watching activities, and they concluded at that time whale-watching activities did not seem to pose a threat to the gray whales' continued use of Laguna San Ignacio.

From 1996 to 2000 eco-tourism based whale-watching increased in Laguna San Ignacio so that there were no days without whale-watching boats operating (Urbán and Gómez-Gallardo 2000), and the number of gray whales utilizing the lagoon also declined by 30% during this period. Gómez-Gallardo (2004) examined the trends of single whale counts and females calf pair counts during the period 1996-1997 and 1978-1982 and suggested that the increase in whale-watching activities that take place in the main areas of the lagoon could have contributed to the decrease of single whales .Urbán and Gómez-Gallardo (2000) suggested the variation in the abundance of whales in the lagoon was due to natural modification in the timing and movements of whale in response to environmental factors and/or human activities such as whale-watching. While they could not demonstrate a direct causal relationship between whale-watching and the fewer number of whales observed in the lagoon, they noted the potential for disturbance and recommended that monitoring programs continue to track the trends in whale-watching activity and trends in the number of whales utilizing the lagoon.

We conclude that following its apparent recovery from depletion, the ENP gray whale population is now responding in several ways to environmental changes and possible over utilization and decline of its primary food resources. These responses include decreased abundance since the mid-1990s, reduction in the production of calves, changes in the timing of migration and distribution of ENP gray whales on the winter breeding range, and the presence of "skinny" individuals within the population. We concur with our colleagues that, gray whales by nature of their coastal migrations and specific gathering areas in the winter breeding and summer feeding ranges lend themselves to the study and monitoring of changes in their phenology, movements, productivity, and behaviour, and these in turn can tell us much about changes in the marine ecosystems gray whales frequent. As such, gray whales are key "indicators" or "sentinel" species that can tell us much about of the health and status of their north Pacific ecosystem. The study of gray whales also provides opportunity for "…novel" insight into large whale population dynamics, behavioural ecology, and the capacity of a mysticete species to explore disparate forage opportunities and respond to environmental changes" (Moore *et al.* 2007).

ACKNOWLEDGEMENTS

We gratefully acknowledge of our volunteers Mariela Brito, Loana Mariam Lerch, Katia Galindo, Liliana Paredes, Margarita Aguliar, Klara Jansson for assisting with the field work during the 2007 winter season. The Pacific Life Foundation and The Ocean Foundation provided financial support. Logistic support and field laboratory facilities were provided by Kuyima Eco-Tourismo, the Summer Tree Institute, and Searcher Natural History Tours. The project was conducted under the authorization of Mexican research permit No.00506 from the Subsecretaría de Gestión Para La Protección Ambiental, Dirección General de Vida Silvestre.

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Table I. Census survey counts of gray whales in Laguna San Ignacio, B.C.S., during 2007 winter.

		Lower Zone		Middle Zone		Upper Zone		Totals	
		Sing.	Cow-c p.	Sing.	Cow-c p.	Sing.	Cow-c p.	Sing.	Cow-c p.
5	Feb	29	7	9	1	4	4	42	12
6	Feb	27	11	27	4	5	2	59	17
10	Feb	41	5	24	4	11	4	76	13
16	Feb	82	8	21	7	6	1	109	16
17	Feb	69	10	46	12	18	15	133	37
22	Feb	126	10	60	5	11	5	197	20
2	Mar	91	16	51	4	4	1	146	21
10	Mar	30	9	24	8	4	3	58	20
17	Mar	10	6	0	2	0	1	10	9
22	Mar	4	19	2	7	0	4	6	30
26	Mar	9	18	1	0	0	0	10	18
30	Mar	0	1	0	0	0	2	0	3

Table II. Maximum February survey counts and distribution of gray whales from 1982, 1996 and 2007.

Zone	Cow-calf pairs			Singles			Total Adult whales		
	14 Feb 82	2 Mar 96	22 Feb 07	14 Feb 82	2 Mar 96	22 Feb 07	14 Feb 82	2 Mar 96	22 Feb 07
Lower	15	33	10	187	84	126	202	117	136
Medium	15	31	5	52	25	60	67	56	65
Upper	107	28	5	31	6	11	138	34	16
TOTAL	137	92	20	207	115	197	407	207	217

Table III. Preliminary number of photographs and recaptures in Laguna San Ignacio, B.C.S. February –April 2007 (* = in process).

Group class	Left side		Right side		Total	
	Photos	Recaptures	Photos	Recaptures	Photos	Recaptures
Singles	545	*	841	*	1386	*
Cow-calf pairs	177	*	304	*	581	*
Unknown	13	*	11	*	24	*

Total	735	*	1156	*	2428	*

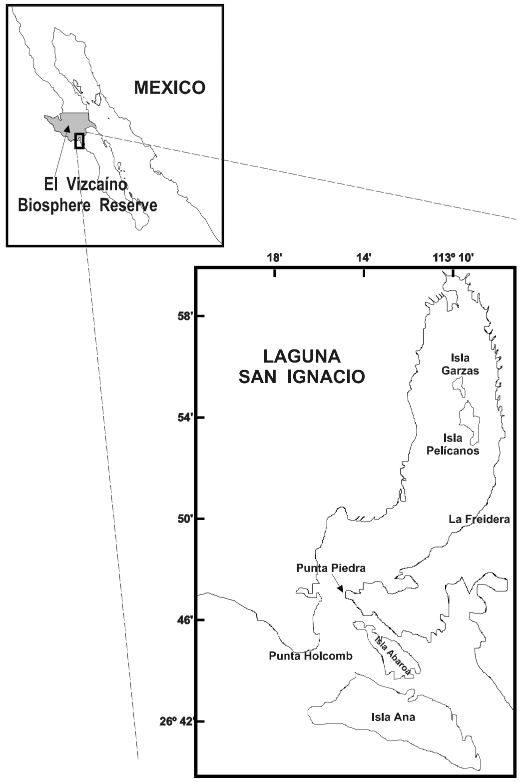

Figure 1. Study site.

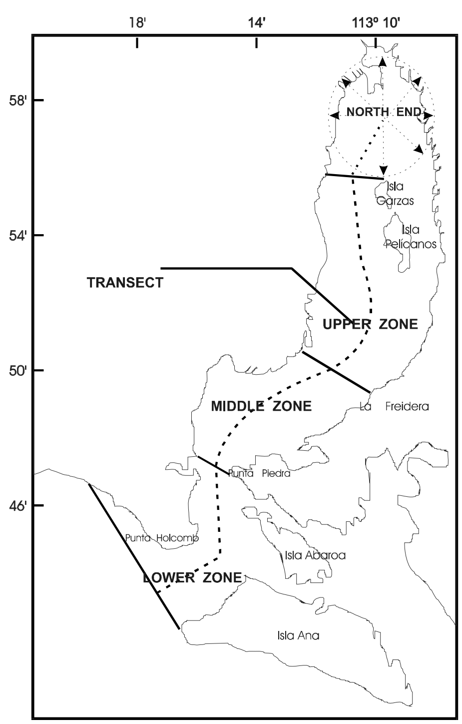

Figure 2. Boat survey transect for counting gray whales in Laguna San Ignacio.

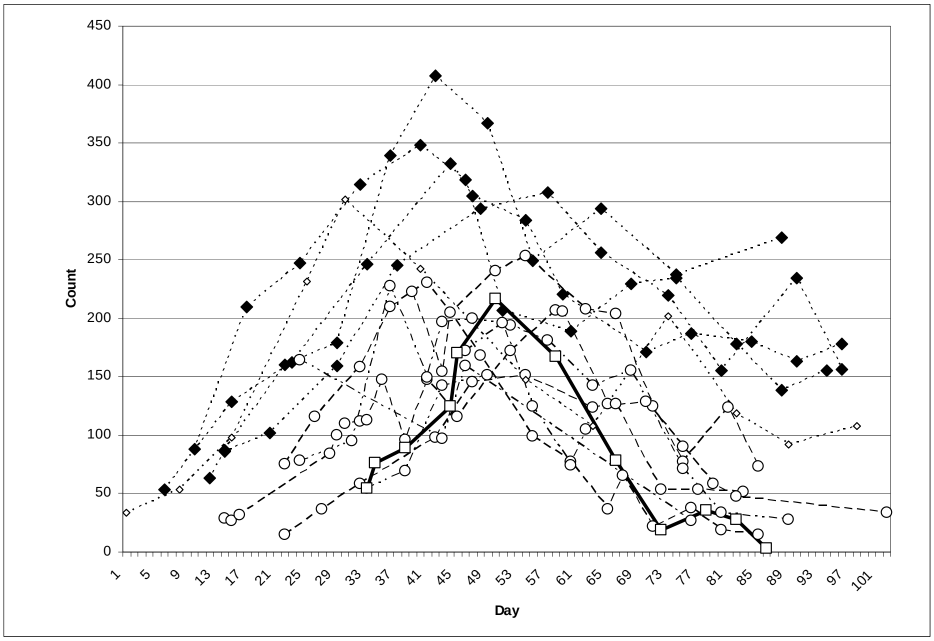

Figure 3. Number of adult whales counted in census surveys of Laguna San Ignacio between 1978 and 2007. Black diamonds = 1978-1982 surveys; White circles = 1996-2006 surveys; White squares = 2007 survey counts. Day 1 = 4 January; day 102 = 15 April.

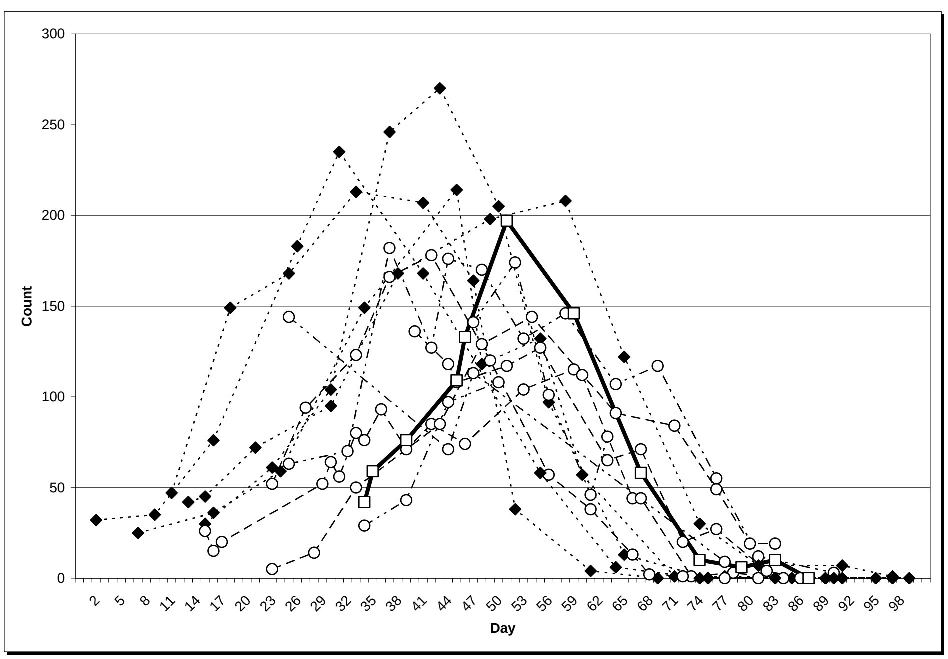

Figure 4. Number of single whales counted in census surveys of Laguna San Ignacio between 1978 and 2007.

Black diamonds = 1978-1982 surveys; White circles = 1996-2006 surveys; White squares = 2007 survey counts. Day 1 = 4 January; day 98 = 11 April.

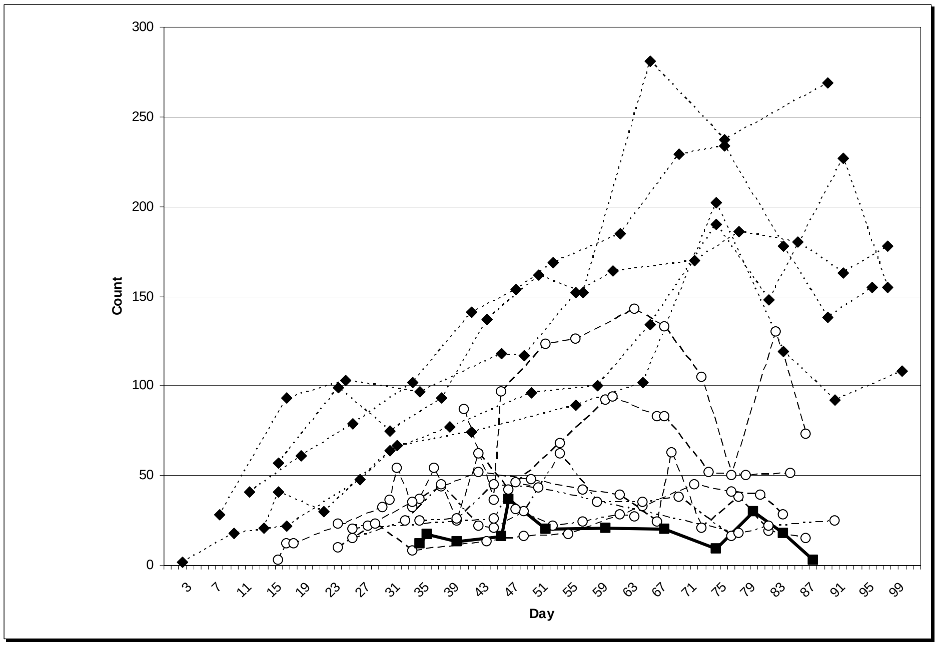

Figure 5.Number of female-calf pairs of gray whales counted in census surveys of Laguna San Ignacio between 1978 and 2007. Black diamonds = 1978-1982 surveys; White circles = 1996-2006 surveys; Black squares = 2007 survey counts. Day 1 = 4 January; day 98 = 11 April.

Lagoon Surface	Whale´s Density		
Lower 17.5 Km^2	11.5	6.7	7.8
Middle 22.9 Km^2	2.9	2.4	2.8
Upper 46.6 Km^2	3.0	0.7	0.3

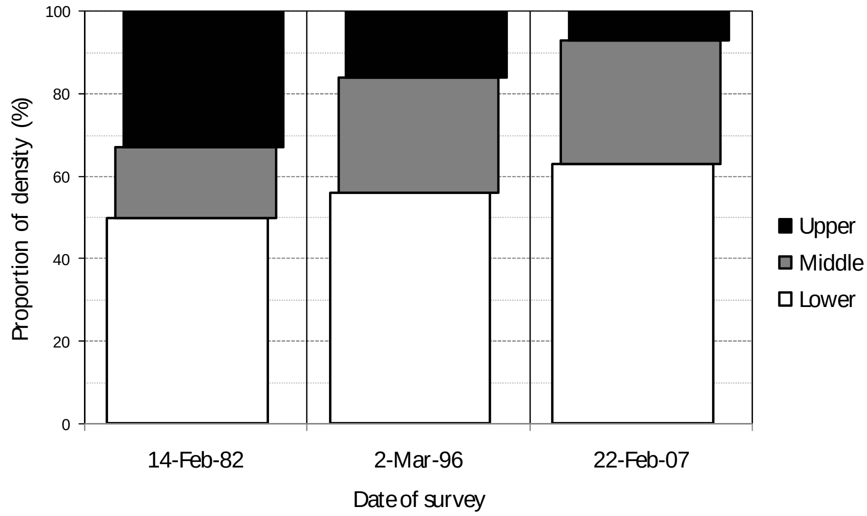

Figure 6. Changes in percent and density (whales/Km^2) of adult gray whales counted in February census surveys in 1982, 1996 and 2007.

Figure 7. Example of normal gray whale head, neck and shoulder region.

Figure 8. Example of a “skinny whale” observed in Laguna San Ignacio in 2007showing sub-dermal protrusion of the scapula and concavities around the blowholes and neck.

Figure 9. Example of a “skinny whale” observed in Laguna San Ignacio in 2007 showing concavities along the flank and ridge along the neural/dorsal spine.

Figure 10. Example of a “skinny whale” observed in Laguna San Ignacio in 2007 showing a pronounced depression posterior and lateral to the blowholes.

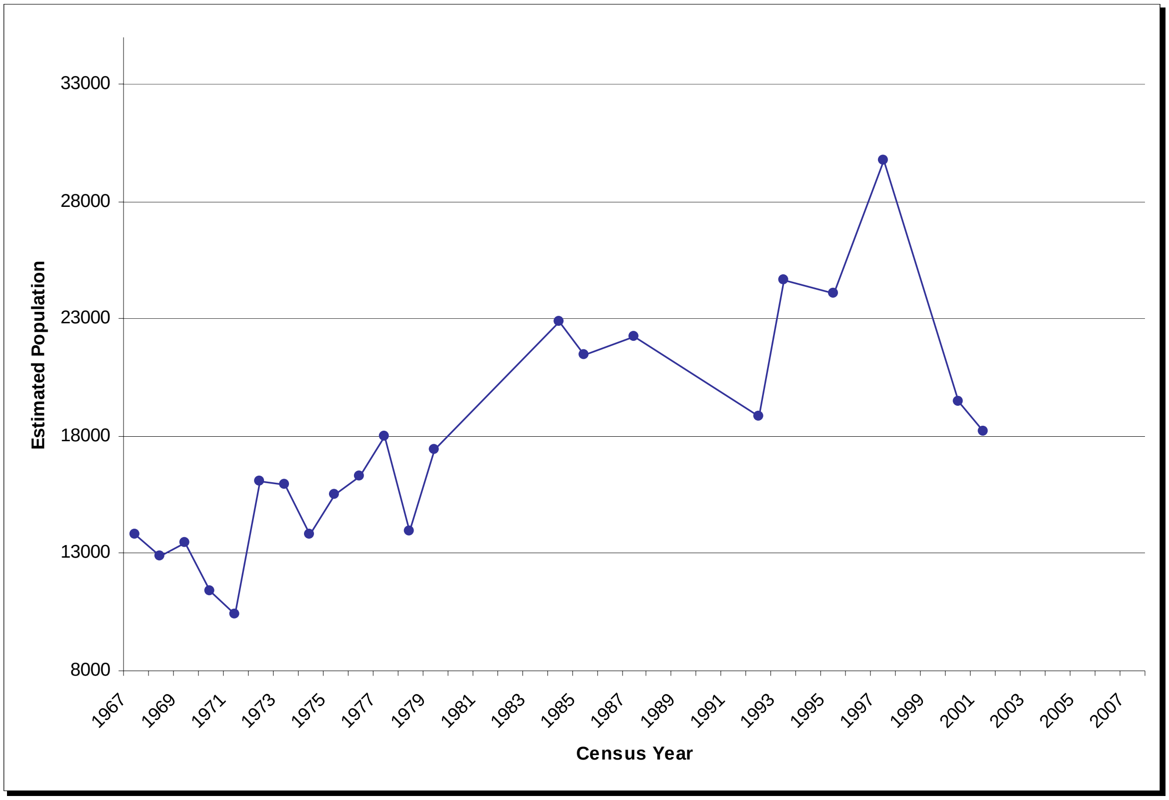

Figure 11. Estimates of the gray whales in the eastern North Pacific population based on visual census of the fall migration past the Granite Canyon, California observation station between 1967/1968 to 2001/2002 (from Rugh *et al.* 2005).