Gray whale (*Eschrichtius robustus*) at calving sites in the Gulf of California, México[1]

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ABSTRACT

Records of gray whales (*Eschrichtius robustus*) at and near their two known calving sites in the Gulf of California (Sea of Cortés), México, are reviewed up to 1995. The sites of Tojahui/Yavaros (Sonora) and Bahía Santa María (Sinaloa) represented the most distant calving grounds regularly visited by the species. Prior observations (mainly in the 1950s and 1960s) revealed relatively small but seasonally consistent numbers of whales, with maximum counts, including calves, of 30 individuals at Bahía Santa María in 1954, and 17-19 at Tojahui/Yavaros in 1955, 1963 and 1971. Observations (initiated in 1979) as well as interviews with longtime local residents and fishermen, document a decline in numbers and occupancy times of whales, especially cow/calf pairs, visiting these sites. In contrast, 19th century whaling records indicate that many more gray whales were found seasonally along these coasts. The recent decline, leading to the apparent disappearance, is likely to be due to human-induced disturbances related to accelerated regional socio-economic development, with associated increases in artisanal and industrial fishing activities and other forms of maritime traffic. Within less than four decades of their 'discovery', it appears that no gray whales have returned to calve at these sites since the mid-1980s. Barring an unlikely change in regional fishing practices, this apparent abandonment of calving sites on the northwest coast of mainland México suggests that any anticipated further increase in population size of the eastern North Pacific stock may be unwarranted.

KEYWORDS: GRAY WHALE; GULF OF CALIFORNIA; ABUNDANCE; DISTRIBUTION; REPRODUCTION; POPULATION; TRENDS; HISTORY

INTRODUCTION

The gray whale (*Eschrichtius robustus*) is well-known for its long-distance annual migration, from principal summer feeding grounds in boreal seas bordering Alaska and Siberia to principal winter reproductive areas along the west coast of the Baja California Peninsula in northwestern México. Many investigators have concentrated their observations on this coastal whale in its extensive bay and lagoon habitats of Baja California Sur, in sheltered waters that serve as major mating, calving and nursery sites, and where relatively large numbers of individuals can be observed, censused and studied during winter months. Much of what is known about the species in the southern part of its range derives from such studies (e.g. Gilmore, 1960; Norris *et al.*, 1977; Rice *et al.*, 1981; Jones and Swartz, 1984; Jones *et al.*, 1994; Urbán-R *et al.*, 1997). The major calving sites (Fig. 1) are: Laguna Ojo de Liebre (with 53% of the total calves), Laguna Guerrero Negro (9%), Laguna San Ignacio (11%) and Boca de la Soledad/Estero de Santo Domingo (12%), and the minor sites (each with less than 6%) of Ensenada de San Juanico, Bahía Magdalena, Bahía Almejas and Bahía Santa Marina (Rice *et al.*, 1984).

Less well known is the extended migration of a small portion of this eastern North Pacific gray whale stock around the tip of the Baja California Peninsula into waters of the Gulf of California. These whales enter the major part of what Gilmore (1960) termed the 'extra-limital wandering area' for the population, which also includes a few isolated sightings from more southern localities along the Pacific coast of mainland México and at the oceanic Revillagigedo Islands.

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This paper reviews the available information on gray whales at their two calving sites in the Gulf of California.

Historical information comes from: (1) historical records of commercial whaling (*ca* 1850s-1870s) reviewed by Henderson (1972; 1984); (2) information that was forthcoming following the 'discovery' of these calving sites by scientists in 1954 (Gilmore and Ewing, 1954; Gilmore, 1960; Gilmore and Mills, 1962; Gilmore *et al.*, 1967; Gard, 1976; Gilmore Collection, no date; R.L. Brownell, Jr., pers. comm.); and (3) interviews with longtime local fishermen and residents, some of whom were living at Bahía Santa María between the late 19th century and the early years of the 20th.

Recent information is based on observations conducted for this study (1979-1995) as well as many interviews with fishermen and residents at both calving sites and nearby areas. Occurrence and abundance of gray whales at these sites has been discussed previously, in part, by Findley *et al.* (1982), Findley and Vidal (1983), Swartz (1986), Vidal and Findley (1988; 1989), Vidal (1989) and Vidal *et al.* (1993).

CALVING SITES IN THE GULF OF CALIFORNIA

Observations conducted during this study focussed on the two localities along the northwestern coast of mainland México where gray whales were, until recently, known to consistently congregate and calve (mating behaviour has never been observed at either locality). These sites represent the extreme geographical limits consistently reached by the reproductive part of the southward-migrating stock: the relatively restricted area of open coast off Tojahui and the

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nearby lagoon (*laguna, estero, bahía*) of Bahía de Yavaros, Sonora; and the extensive coastal lagoon complex of Bahía Santa María (Reforma), Sinaloa (Fig. 1).

After reviewing 19th century whaling records, Henderson (1972: pp. 165-166, pp. 175-177, p.190, table 1; 1984: p.170, p.174, table 1) reported that whalers pursued the gray whale (and other species, mainly humpback whale, *Megaptera novaeangliae*) along the Pacific coast of northwestern México as far south as the Islas las Tres Marías and Bahía Banderas, Nayarit/Jalisco. Principally during the 1850s and 1860s, some vessels sailed to the Gulf of California and the Mexican mainland coast where relatively small catches were obtained; about 200 whales (not including calves) during approximately 25 trips (Henderson, 1972; 1984). Henderson (1972; 1984) noted that while catches were always more important along the west coast of Baja California, several trips were made into the Gulf of California. Dedina and Young (1996) cite an 1861 letter by the territorial governor of Baja California, T. Riveroll, sent to Mexican President Benito Juárez, that includes a complaint of whaling ships along both coasts of the peninsula, albeit mainly in the bays and lagoons of the Pacific coast. Henderson (1972, p.190) estimated that prior to commercial exploitation, a maximum of about 500 gray whales annually visited calving sites in the Gulf of California, sites almost certainly including the bays and coastal lagoons of Yavaros (Sonora) and Santa María, Altata/Pabellón, Navachiste/San Ignacio (Henderson, 1972, pp. 30-31) and Topolobampo/Ohiura (Sinaloa) and possibly other lagoons on the eastern side of the Gulf, such as Agiabampo on the coast between northernmost Sinaloa and southernmost Sonora (Fig. 1), and possibly even some of the (fewer) bays and lagoons along the largely rocky southeastern coast of Baja California Sur.

As noted by Henderson (1972, p.30), and evident during research visits to Tojahui/Yavaros and Bahía Santa María during this study, gray whales are well known to local fishermen, who refer to them as *ballenas pintas* ('spotted whales'). Gilmore and Ewing (1954) were the first to report

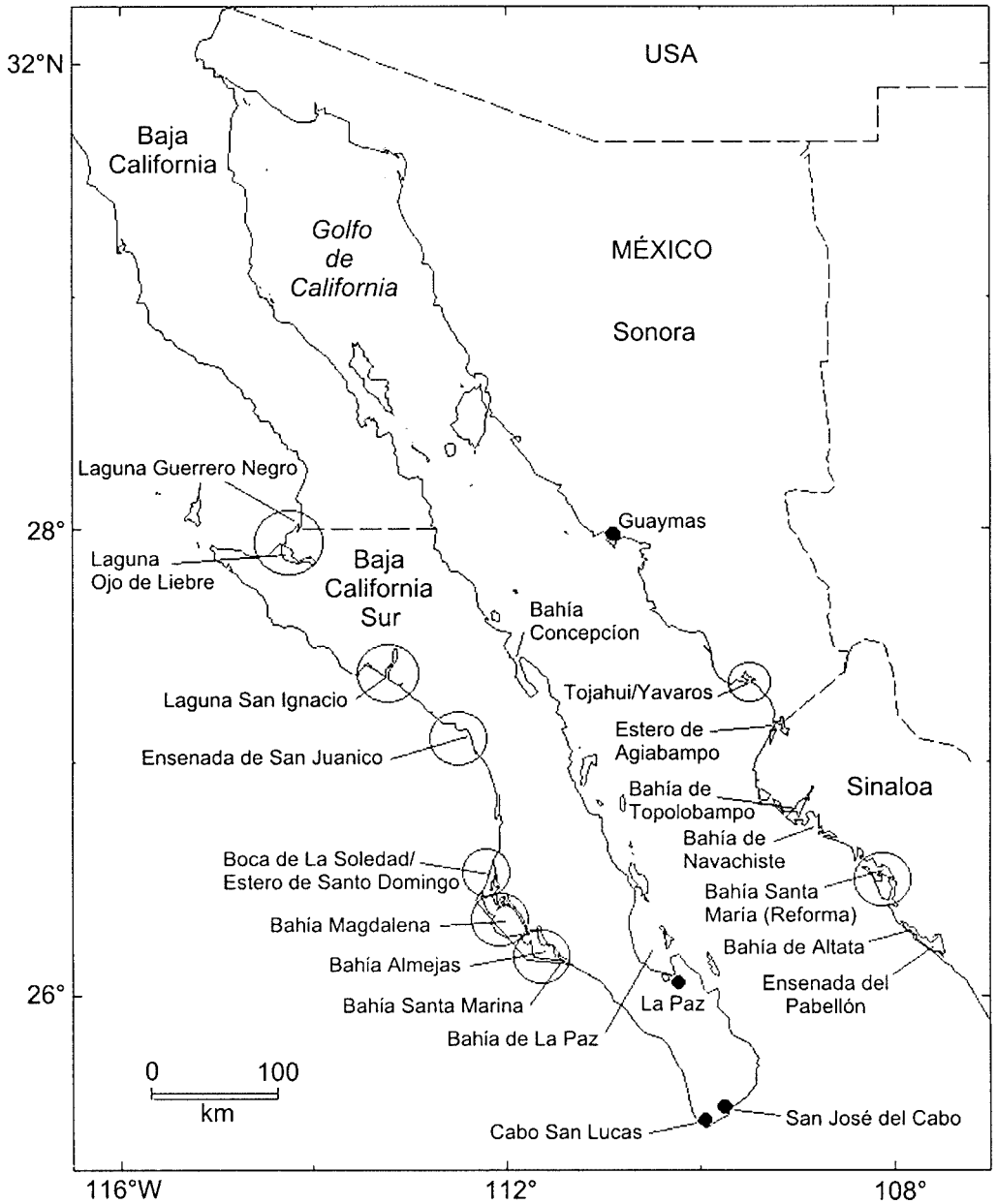

Fig. 1. Gray whale calving localities in northwestern México. Six circles on the west coast of Baja California Sur enclose principal mating/calving/nursery sites. Two circles on the west coast of mainland México enclose calving/nursery sites in Sonora and Sinaloa.

in modern literature the aerial observations of small numbers of gray whales, mainly cow/calf pairs, at or nearby these sites in 1954. During a few subsequent years, limited (mainly one overflight) censuses were continued by Gilmore and/or collaborators at these two calving/nursery sites (Gilmore, 1960; Hubbs and Hubbs, 1967). These observations terminated after the 1962 season at Bahía Santa María (Gilmore and Mills, 1962; Gilmore Collection, no date), but counts were continued (largely by Al Harrison) until the 1971 season at Tojahui/Yavaros (Gilmore *et al.*, 1967; Gilmore Collection, no date; R.L. Brownell, Jr., pers. comm.). A period of several years followed when no systematic observations were made, with the notable exception of counts for 1975 at both sites reported by Gard (1976). Although the majority of observations were short-term, they corroborated the seasonal presence of small numbers of whales at both sites, with the separate counts usually not exceeding 15 individuals, including calves, with maxima of 17-19 at Tojahui/Yavaros in 1955, 1963 and 1971 (Gilmore *et al.*, 1967) and 30 at Bahía Santa María in 1954 (Gilmore and Ewing, 1954).

Tojahui/Yavaros, Sonora

Study area

The main concentration of gray whales in this region (Fig. 2) has been the bight-like Ensenada de Tojahui (*ca* 26°37'N; 109°23'W), in an area about 10km SE of the major regional fishing port and bay of Yavaros. This relatively spatially restricted concentration seasonally occurred off that part of coastal Mayo Indian lands known as Tojahui, located between the fishing camp of Bajerobeta and the village of Las Bocas, in the Municipality of Huatabampo, Sonora. Viewed from a boat off Tojahui, the coast appears as a low, unmarked expanse of coastal thornscrub; the only topographical relief provided by the far-distant high mountain range of the Sierra de Alamos on the eastern horizon. At Tojahui, two abandoned and dilapidated houses of masonry (*Las Casonas de Tojahui*) stand on low (3-5m), eroding bluffs behind a narrow sand beach containing scattered small outcrops of mudstone. The bluffs (and soils inland) are of generally unconsolidated fine-grained alluvial sediments (likely deposited as part of an ancient distributary delta of the formerly large Río Mayo), and are occasionally intersected by outwashes such as the mouths of the Arroyos de Tojahui and Bajerobeta (Fig. 2). Seaward, the sandy-silty bottom slopes gradually; a depth of only 8m was measured at a distance of 2km offshore.

Sightings and strandings

The gray whales observed from shore and small boats at this site tended to be about 1-1.5km offshore, although Gilmore *et al.* (1967) and local fishermen (pers. comm.) reported them slightly closer inshore in earlier years. Fishermen state that several years ago, when more whales visited the site, they were also frequently observed a short distance to the south, off Punta Jimarohuisa and Las Bocas (Fig. 2).

Table 1 (see p. 37ff.) presents gray whale counts in this area for the 1975-1995 seasons made during this study, and also includes those made during previous studies.

Two days during the 1980 season and one day during the 1981 season were spent in an unsuccessful shore watch at Las Bocas, but have been included in Table 1 to emphasise (what was not fully recognised at the time) the whales' preference for the site directly off Tojahui. Although a few recent sightings have been made nearby, such as off Huatabampito and near the mouth and inside Bahía de Yavaros (Table 1; Fig. 2), the main concentration of whales was consistently off Tojahui. The maximum number of gray whales observed by us at this site was eight (3 cow/calf pairs and 2 solitaries), during the first two days of March 1981. A good photographic record of these individuals was obtained.

A more intensive observational effort was undertaken at Tojahui during the 1982 season; a 7m observation tower was constructed at the larger abandoned house and one of the

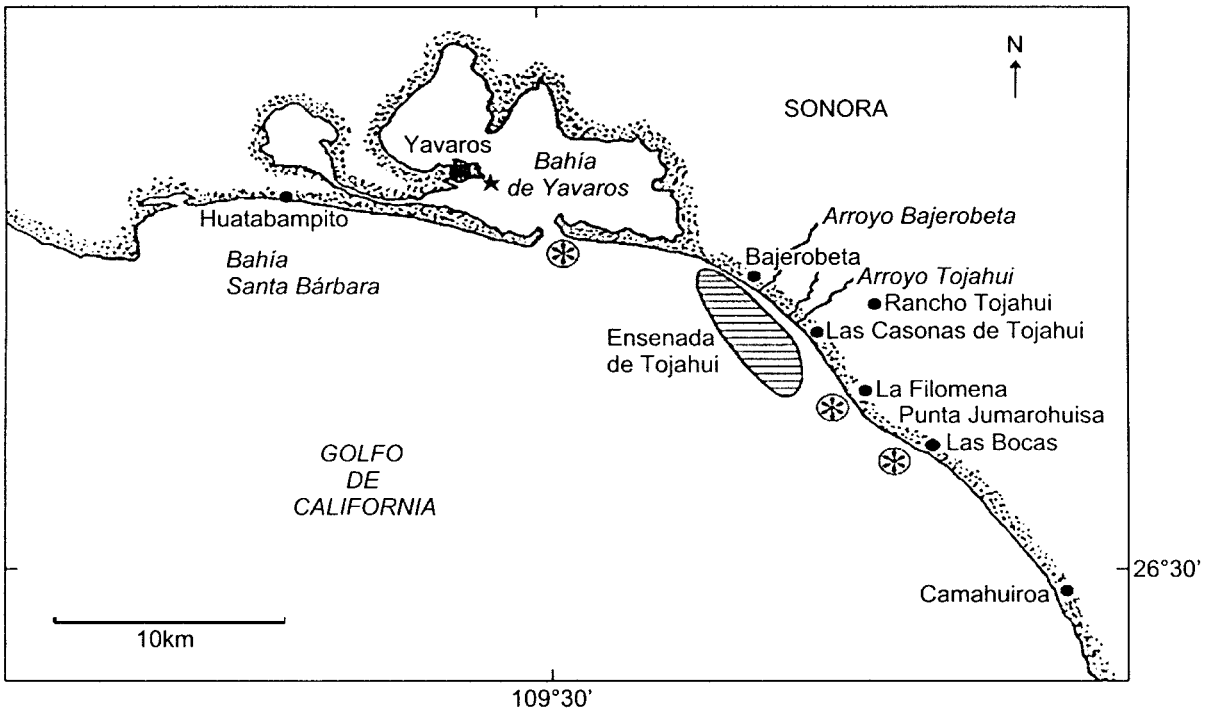

Fig. 2. Locality of gray whale calving site of Tojahui/Yavaros, Sonora. Hatched area encloses sightings during 1979-1987 seasons. Star in Bahía de Yavaros indicates sightings in 1983. Encircled asterisks indicate three strandings (one immature each) (see Table 1 and text).

authors (OV) took up semi-continuous residence. Several site visits were also made by the other author and students of the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM)-Campus Guaymas. In addition, several reliable informants (principally longtime resident Sr. Gonzalo Rojo), who daily fish the area, reported their sightings or absence of sightings. However, even with the increased 1982 effort, during the 61 days spent at Tojahui, a total of only two cow/calf pairs and a solitary adult were seen (Table 1). The presence of these whales off Tojahui was often sporadic during the 36-day period between initial and final sightings (21 January and 25 February), with the cow/calf pairs and the solitary adult moving seemingly independently into and out of the observational area. During 16 days of this 36-day period, at least one cow/calf pair (probably the same pair) was present, but only occasionally along with the other pair and/or the lone adult. Most of these five whales were present during the period 21-30 January, but all had left the site on 31 January. On this and the following day, a pod of killer whales (*Orcinus orca*) including a large male, was observed in the area. Killer whales have been reported to harass and sometimes attack gray whales (e.g. Scammon, 1874; Morejohn, 1968; Poole, 1984), and the latter have been shown to avoid the underwater sounds of the former (Cummings and Thompson, 1971; Jones *et al.*, 1994). It is possible that the gray whales temporarily vacated the area off Tojahui due to the presence of these predators. Whether or not the gray whales took refuge inside Bahía de Yavaros or elsewhere is not known, but three days later, on 4 February, all five whales returned to the observational area off Tojahui. However, one of the cow/calf pairs departed the following day and was not seen again. For nine non-consecutive days during the period 5-25 February, the remaining cow/calf pair was observed at the site (temporarily absent, or no observers present, during the other days), but the solitary adult was present on only two of these days (16 and 17 February). This cow/calf pair was not seen again in the area after 25 February. Unfortunately, photographs suitable for identification were not obtained of any of these individuals.

To test the possibility that these whales had moved far offshore, on 2 March a transect was made in a fishing skiff (*panga*) directly off Tojahui to a distance of *ca* 15km. No gray whales were sighted, but a pod of three female or immature killer whales was encountered harassing a pair of fin whales, *Balaenoptera physalus* (Vidal and Pechter, 1989). It is unknown if any of these killer whales were the same as those sighted previously, but these sightings verify the (at least) temporary presence of this predatory species in the region, and may explain the sporadic presence and relative early departure of the five gray whales from the site.

Several months later, during November 1982, two small immature gray whales stranded in this region. These, and another such stranding in April 1976, are noted in Table 1 and Fig. 2, and are discussed below.

Although the 1983-season sighting effort at Tojahui was less than in 1982, several site visits, including several parallel-to-shore transects in *pangas* between Tojahui and Yavaros, were made by the authors and other ITESM personnel. Nevertheless, no whales were seen and all information on gray whales in the area was provided by local fishermen at Tojahui and residents of Yavaros (Table 1). At Tojahui, a total of only three or four whales, including at least one cow/calf pair, was reported, seen on only two days during late January. Notably, killer whales were again in the area; a pod of four individuals, including a large male, was seen by G. Rojo, on 24 January. Two residents of Yavaros reported gray whales inside Bahía de Yavaros (Table 1; Fig. 2) during the days *ca* 19 and 20, and 27 January. Although Gilmore *et al.* (1967) hypothesised that the original concentration of calving gray whales in this region was principally inside Bahía de Yavaros, and Henderson (1972) alluded to whales there, the 1983 reports constitute the first definitive sightings from inside this lagoon, and suggest that these individuals were seeking refuge from the killer whales. It is not known whether the presence of killer whales in the area was the cause of the apparent absence of these few gray whales from the area off Tojahui after 27 January.

The observations from 1984-1988 were also relatively restricted; all information for this period resulted from several short-term visits to the area and from personal communications with reliable local informants. For 1984, the maximum number of whales observed for one day was six (3 cow/calf pairs) on 29 January. Again, presence of the whales off Tojahui was sporadic between the initial and final sightings (20 January and 12 February), with at least one of the cow/calf pairs seen during a non-consecutive eight-day period. The last whale observed was an immature (estimated 7m) at Punta Jimarohuisa on 12 February. This was probably the same individual that had become entangled in a gillnet off Las Bocas and had been released by fishermen two days previously. For the 1985-1987 seasons, numbers of gray whales (all from reports by informants) were (Table 1): for 1985, two unaccompanied 'adults' off Tojahui on *ca* 11 January, and an 'adult' (one of the previously sighted two?) off Bajerobeta on 15 January; for 1986, one 'adult' off Bajerobeta in early January and 'some cow/calf pairs' during February; for 1987, 'some whales' (including at least one cow/calf pair) in late January and early February. It was not possible to visit Tojahui by land during the 1988 season, and thus no reports from informants were obtained. On 18 February, an aerial observation over Tojahui, Yavaros and nearby Bahía Santa Bárbara produced no gray whale sightings.

No data were forthcoming for the 1989 season, but information for the 1990-1995 seasons was obtained by interviewing (in 1994 and 1995) reliable informants and by on-site visits during the 1994 season by two students reporting to one of the authors (OV) (Table 1). The six resident fishermen, including G. Rojo, interviewed in February 1994, stated that no gray whales had been seen in the area during the prior four years, and one of them, R. Valenzuela, mentioned that the only inshore whale seen by him during that time was a juvenile *quila* (fin whale) which he witnessed (February 1993) stranding itself on the beach following a chase by a *bufeo* (killer whale) (a vertebra of the fin whale was later retrieved and deposited in the Marine Vertebrates Collection of ITESM-Campus Guaymas). No gray whales were sighted at Tojahui during a total of 116 hours of effort by the two ITESM-Campus Guaymas students, F. Cardoza and A. Romero, over a total of 10 days in February/March 1994, and none were seen during the 1995 season by the principal informant (G. Rojo) interviewed by one of the authors (OV) in June 1995 (Table 1).

Discussion

A review of all sightings at Tojahui/Yavaros (Table 1; Gilmore *et al.*, 1967) shows no precise timing of arrival and departure dates (earliest definite sighting, 12 January 1957; latest, 1 May 1962). Nevertheless, it seems probable that whales normally arrived around the middle of January.

Despite some sightings in April and one on 1 May, the whales appeared to usually depart by the middle of March (Table 1). However, the sporadic presence and apparent early departures of the few individuals off Tojahui during the 1982-1987 seasons, if not due at times to the presence of killer whales, may indicate a trend of decreasing site fidelity for gray whales normally visiting the site. The Tojahui/Yavaros gray whales may have been relocating to other calving areas.

As in most other mysticetes, the gray whale is predominately a biennial breeder (e.g. Reilly, 1984). Photo-identification studies in the calving/breeding lagoons suggest that most adult females are site-specific, with the same females usually returning to the same lagoon to give birth on alternate years (e.g. Jones and Swartz, 1983; 1985). This biennial breeding trait led Gilmore *et al.* (1967) to speculate that two groups of females, of about the same group size, each occupy Tojahui/Yavaros in alternate years. But, lacking identifiable photographs of individual whales, these authors were unable to verify their hypothesis. Likewise, the hypothesis could not be tested in this study due to a poor photographic record of the increasingly less-abundant and more-difficult-to-approach whales in the years following 1981.

Since no mating behaviour had been observed among the gray whales at Tojahui, Gilmore *et al.* (1967) hypothesised that mating probably occurs in one year off Cabo San Lucas at the tip of the Baja California Peninsula (see also Norris *et al.*, 1983; Urbán-Ramírez *et al.*, 1990) or in the area of Bahía Magdalena, Baja California Sur (Fig. 1), and, subsequently, the pregnant females cross the Gulf of California to the 'Yavaros' area the following year (after their normal migration to and from northern waters) to give birth. It is not known from which direction the whales observed at Tojahui arrived during this study, but, if valid, the report of a sighting on 10 January 1983 of 'a few gray whales (*ballenas pintas*) among several fin whales (*quilas*)' far seaward of Tojahui/Yavaros, may indicate a more-or-less direct crossing of the southern Gulf of California by gray whales enroute to this area. However, this report may be suspect since pregnant females normally migrate as solitaries, and the report was of a 'group' of gray whales (number unspecified). No other reports of far-offshore sightings of this species are known in the Gulf of California.

No mating behaviour has been reported for gray whales in the Gulf of California and southward along the mainland coast of México (although a probable such observation exists for near Roca Partida, part of the oceanic Revillagigedo Archipelago, in April 1960 [notes in Gilmore Collection]). It appears that for northeastern Pacific gray whales the southern limit for this behaviour is off Cabo San Lucas at the tip of the Baja California Peninsula (Norris *et al.*, 1977).

Although occasional births of gray whales have been reported along the southerly migration route and outside the natal lagoons (e.g. Leatherwood and Beach, 1975; Sund, 1975; Shelden *et al.*, 1996), compared to the nearly landlocked lagoons of Baja California, the relatively exposed open-coast calving site at Tojahui is unusual. A plausible hypothesis offered by Gilmore *et al.* (1967) is that the original calving site in this region was located inside Bahía de Yavaros, but that increased fishing and other maritime activities at the rapidly developing port of Yavaros likely forced the whales to abandon this lagoon and relocate to the nearby area off Tojahui.

In 1920, Yavaros was an insignificant port serving as a fuel-storage depot, but later (beginning in the 1960s) developed into an important fishing centre in the economy of northwestern México (West, 1993, fig. 37 and p.158, footnote 97). In addition to high levels of contaminants in the form of domestic and industrial sewage from the town of Yavaros and nearby cities, pesticides and fertilisers from drainage canals of surrounding farmlands, and residual oils, fuels and waste waters from its many fishing boats and fish-processing plants (Segovia, 1997), the bay of Yavaros today serves as an important regional port for deep-draft vessels such as sardine purse-seiners (second in importance for this fishery in all of México) and shrimp trawlers, as well as for numerous 5-6m skiffs (*pangas*) utilised in the coastal artisanal (principally gillnet) fisheries. In September 1996, an aerial census revealed a total of 1,066 *pangas* working along the nearby short stretch of coast between Bahía Santa Bárbara and Camahuiroa[2] (Fig. 2).

Boat traffic continues to increase in this area, and semi-continuous dredging operations to clear and deepen the channel leading into the bay have added to an increasing level of underwater noise. Among other scientists, Myrberg (1990a; b) has cautioned that (presumably similar) increased noise levels create conditions of annoyance and disturbance for several species of marine animals, including gray whales. Since acoustical communication is almost certainly necessary to maintain contact between gray whale mothers and their newborn calves (Dahlheim, 1987), human-induced underwater noise may interfere with this and other important social behaviours. Dahlheim (1983) and Dahlheim *et al.* (1984) reported that gray whales in Laguna San Ignacio (evidently necessarily) became more vocal when exposed to man-made noises, and Jones *et al.* (1994) and Dahlheim *et al.* (1995) found that most gray whales, especially cow/calf pairs, abandoned Laguna San Ignacio for a year in response to a month of underwater playback experiments of noises from outboard motors of boats, industrial activities and other sources, including killer whale vocalisations. As mentioned previously, the only records of gray whales inside Bahía de Yavaros were at a time when killer whales were sighted in the area outside this coastal lagoon.

Although shrimp boats have occasionally been seen trawling close inshore at Tojahui, fishing activities there are mainly limited to close-inshore deployment and retrieval of gillnets by local fishermen working from outboard motor-powered *pangas*. Gillnet fishing is increasing along this entire stretch of coast, and may be the primary reason for the few gray whales once utilising this site to have apparently located slightly farther offshore as compared to earlier years and, also, why they were recently rarely seen even slightly farther south at Punta Jimarohuisa and Las Bocas. Disturbance from high-powered *pangas* and gillnet fishing may have played an important role in the decrease in number of gray whales that seasonally occupied, and now apparently avoid, this calving site. Table 1 includes two definite records of gillnet entrapment of individuals at or near Tojahui (a calf in 1978, and another immature on 10-11 February 1984), as well as three records of strandings of immatures (in 1976 and November 1982) for which cause of death is unknown but may or may not have involved gillnet entrapment. Incidental capture in gillnets may thus have been an important cause of mortality for calves and immatures at this and other areas in the Gulf of California (e.g. a videotape made in 1989 by K.C. Balcomb of an immature entangled and released from a gillnet in the region of La Paz, Baja California Sur), and has been documented in other parts of the migratory route of the species (e.g. Brownell, 1971; Talbot, 1985; Dedina and Young, 1995).

[2] J.M. García and M.A. Cisneros, pers. comm.

Counts of gray whales (maximum number sighted/stranded per season) between 1954 and 1995 made at Tojahui/Yavaros are compared in Fig. 3. Notwithstanding considerable variability in sighting effort and observer bias over these years, the recent decrease in the number of gray whales is evident, and has led to the apparent abandonment of this calving site. A similar trend and result appears to have occurred at the other Gulf of California calving site of Bahía Santa María.

Bahía Santa María (Bahía Reforma), Sinaloa

Study area

This extensive lagoon complex (mid-point *ca* 25°03'N; 108°08'W), located in the Municipalities of Angostura and Navolato in central Sinaloa, fronts a wide, low-lying coastal plain almost totally dedicated to agriculture (Fig. 4). Behind the long and narrow, sand dune-crested barrier island of Altamura, several mangrove-lined islands and islets flank the major tidal channels and extensive sand and mud flats. In general, the entire lagoon complex is known as Bahía Santa María (or Bahía Reforma, especially the part fronting the major regional fishing town of La Reforma), but other names have been applied to certain sections (see Fig. 4). A linear distance of about 32km (the approximate length of Isla Altamura) separates the southern and northern mouths of the lagoon. At both entrances, especially the northern one, sand bars and shoal areas flank the relatively narrow tidal channels penetrating the interior of the lagoon.

Sightings and strandings

Local fishermen reported that gray whales formerly arrived at the northern part of the lagoon in January-February and departed in March-April. Similar information was obtained from fishermen by James Mills during visits to the area in the 1960-1962 seasons (Gilmore Collection, no date). A few whales have stranded or been seen at or near the southern entrance to the lagoon, but the main concentration, at least in recent years, was at the northern extremity.

During transects of the lagoon in *pangas*, all sightings of cow/calf pairs (and almost all sightings of gray whales) were made around the northern entrance, in or near the main tidal channel (Fig. 4). Until early February 1989, when the stranding of a 12.37m male occurred, fishermen at the fishing camp of Yameto, near the southern entrance (Punta Varadito), reported that no gray whales had been seen there since about 1974. Evidently, another adult stranded there around that year. The only other known recent occurrence there was a small immature seen in the main tidal channel of that entrance on 12 February 1989.

Discussion

Although, in comparison to the Tojahui/Yavaros site, observations at Bahía Santa María were more sporadic and of shorter duration, the number of gray whales visiting the latter site also has decreased to apparent abandonment. Notwithstanding the relatively high counts for 1954, 1960 and 1982, this conclusion is based on observations and interviews with several local informants who have fished the area for many years, including some elderly gentlemen who have lived in La Reforma their entire lives. All informants agree that gray whale numbers in Bahía Santa María have decreased drastically, especially since the early 1950s. Before that time, many more whales came into the lagoon, and several could even be seen in the innermost waters fronting La Reforma, where they are never seen today. One informant, A. Camacho, adamantly stated seeing 'hundreds' of gray whales in the lagoon around the year 1942. Another resident, P. Bohórquez, whose family was one of the first to settle at La Reforma, remembered his father telling him of a time (*ca* 1910) when so many whales were in the lagoon that it was necessary to be constantly alert while navigating his small fishing sailboat in order to avoid colliding with them. Similar information was obtained from fishermen by J. Mills (*in litt.* to Gilmore, 19 September 1962, Gilmore Collection, no date): A. Obezo remembered seeing gray whales in the lagoon from *ca* 1910, and J. Santos (88 years old at the time of the interview) remembered seeing the whales as a child, *ca* 1880.

These reports agree with the logs of whaling captains who, at times during the 1850s and 1860s, pursued the gray whale (and other species) along this mainland coast of México as

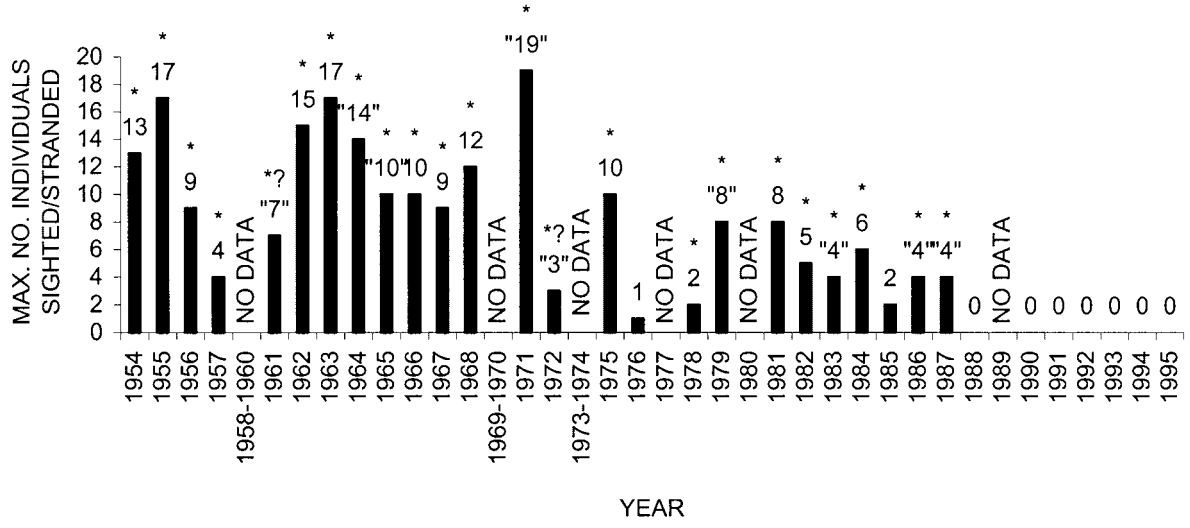

Fig. 3. Maximum number of gray whales sighted/stranded per season, 1954-1995, at Tojahui/Yavaros, Sonora (uncorrected for sighting effort). Numbers in quotation marks indicate close estimates (see Table 1 and text). Asterisks indicate at least one cow/calf pair included in count (but uncertainty of this indicated by question mark).

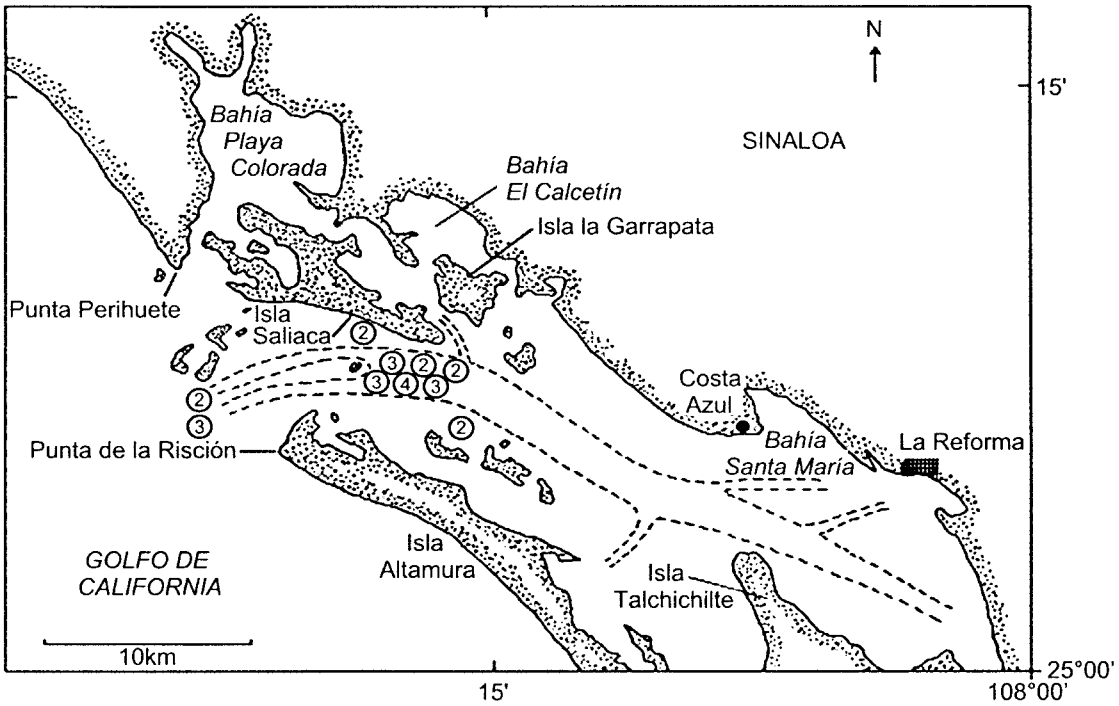

Fig. 4. Locality of gray whale calving site in northern half of Bahía Santa María (Reforma) lagoon complex, Sinaloa. Encircled numbers indicate sightings during 1982 ('2'), 1983 ('3') and 1984 ('4') seasons (see Table 2 and text). Broken lines approximate tidal channels, 10-14+m deep in area of sightings (Alvarez-Arellano and Gaitán-Morán, 1994, fig. 31). Hatching indicates the major regional fishing town of La Reforma.

far south as Bahía Banderas, Nayarit/Jalisco. As reviewed in the scholarly works by Henderson (1972; 1984), those records are not detailed, but lead to the conclusion that, in comparison to recent years, mainland México calving/nursery sites such as Bahía Santa María once hosted considerably larger numbers of gray whales.

Based on his limited aerial observations and the also limited counts made from fishing *pangas* by Mills, and applying a theoretical rate of increase (11%) for the Baja California gray whales between 1953 and 1958, Gilmore (in Gilmore and Mills, 1962) calculated a theoretical 'population' of 72 adult gray whales for the year 1954, 145 for 1960, and 163 for 1961, for the whole Bahía Santa María lagoon complex. The latter two estimates more or less agreed with estimates made by local fishermen who reported to Mills, and it thus appeared to Gilmore that the number of gray whales visiting Bahía Santa María were increasing annually (while they were not increasing at the 'Yavaros' site). However, based on interviews with local residents for this study, it appears that Gilmore's estimate for 1954 was too low, and that rather than increasing, an actually larger number of whales had been visiting the lagoon but had begun to decline by the early 1960s or before. Comparing the earlier counts and estimates reported in Gilmore and Mills (1962) with his counts made in 1975, Gard (1976) also concluded that the number was decreasing. As with the Tojahui/Yavaros calving site, this decline in number of gray whales returning to Bahía Santa María may be correlated with dramatically increased fishing-boat traffic.

Although shoal areas at both entrances effectively bar safe passage of deep-draft vessels into the interior of the lagoon, several commercial shrimp boats have been seen trawling in the adjacent deeper waters. It is believed that the only semi-continuous dredging inside the lagoon has been at La Reforma, where an access channel was cut through the tidal mudflats to allow passage of the many artisanal fishing *pangas* to the dock area fronting a fish processing plant. Several fishermen at La Reforma, Yameto (at the southern entrance), and the fishing village of Costa Azul (Fig. 4) believe that the decrease in gray whales in the lagoon over the past several years is due to the increase in artisanal fishing and *panga* traffic. Interviews with these fishermen and the longtime resident Mexican government fisheries officer indicate that, around 1945, only approximately 50 fishing *pangas* (under sail or powered by relatively small outboard motors) were operating in the whole lagoon complex. Since then, a continual increase in fishermen (*ca* 3,000 in 1995), fishing cooperatives and modernised dockside facilities for processing catches (especially at La Reforma), brought the estimated number of *pangas* to about 1,000 in 1983 and to more than 2,000 in 1989.

Although a recent (September 1996) aerial census of *pangas* in and around Bahía Santa María by fisheries biologists M.A. Cisneros and J.M. García (pers. comm.) showed a lower number (1,385) than the estimate made in 1989 (perhaps due to a recently depressed regional economy), a still-high level of *panga* activity is evident. The majority of these *pangas* now use modern, high-powered (65-75hp) outboard motors, allowing high-speed transit over the entire lagoon complex. During autumn and winter months many of these *pangas* are involved in drift fishing for shrimp utilising relatively small fine-meshed trawl nets (*suriperas*) in the lagoon and potentially compete for space with cow/calf pairs of gray whales. A more negative effect on the whales, however, is the many *pangas* that daily exit and re-enter the lagoon. During early mornings and late afternoons, when gillnet (*red agallera*) and long-line (*cimbra*) fishermen are enroute to or returning from offshore fishing grounds, many high-speed *pangas* were seen transiting areas where observations of cow/calf pairs of gray whales were being made near the lagoon's northern entrance (Fig. 4). Almost invariably, this disturbance elicited an

evasive reaction by the whales. This behaviour involves rapid diving ('sinking') and prolonged submergence, followed by quiet surfacing with little or no observable or audible spout when only exposing a small area around the blowholes above the waterline, then, again, rapid submergence. The same or similar behaviour (which has been termed 'snorkelling') was mentioned by Hubbs and Hubbs (1967) and has been seen in Laguna San Ignacio, Baja California Sur, where it was interpreted as a reaction indicating that the whales felt molested in the presence of boats (S.L. Swartz, pers. comm., 2 February 1984). Similar behaviour has been observed for gray and fin whales in the presence of killer whales or of sounds produced by these predators, and has been interpreted as a protective mechanism (Cummings and Thompson, 1971; Vidal and Pechter, 1989).

It seems likely that the increased level of high-speed fishing-boat traffic in Bahía Santa María has been a major factor in the decrease in the number of gray whales utilising this lagoon as a calving/nursery area. Increase in boat traffic has also been implicated in the temporary decrease in gray whale numbers in several of the Baja California lagoons. At various times in recent years, fewer whales returned to or even temporarily abandoned Laguna Guerrero Negro, Laguna Ojo de Liebre and Bahía Magdalena, until boat activity was terminated or variously regulated (Gard, 1974; 1976; Bryant *et al.*, 1984). Furthermore, the behavioural changes, especially in vocalisations, preceding the abandonment/avoidance of Laguna San Ignacio by most of the gray whales, especially cow/calf pairs, during underwater noise experiments (Jones *et al.*, 1994), and the avoidance by whales of fishing boats powered by 40hp outboard motors running at high speeds in the same lagoon (Jones *et al.*, 1994), confirm the disturbing effect of high-level underwater noise on gray whales. As mentioned previously, the more numerous outboard motors in use in Bahía Santa María are even higher powered (usually 65 or 75hp) than most of those utilised by fishermen in Laguna San Ignacio.

Table 2 (see p. 39ff.) presents counts of gray whales in Bahía Santa María. The counts for this study began in 1982, and the (combined daily) maximum number observed was 20-22 individuals (10-11 cow/calf pairs) on 22 and 23 February, and 8 March of that year, all at or near the northern entrance of the lagoon. In 1983, the (combined daily) maximum was less, 12 (6 cow/calf pairs) on 19 and 20 February, and 5 March; again all at the northern mouth. Unfortunately, observations for the 1984-1989 seasons were limited to relatively few visits, including aerial searches on one day each of 1985, 1986 and 1988, when no whales were seen. The only records of gray whales in or near the lagoon during those six years show a complete absence of cow/calf pairs, and, for 1984, include only one sighting of a lone individual at the northern entrance, and the stranding of an immature north of there, both reported by reliable informants. For 1989, only the small immature mentioned previously was seen swimming in the southern entrance to the lagoon on 12 February, whilst a necropsy was performed on the 12.37m male that had stranded there a short time earlier (Table 2). Data for the following six years (1990-1995) were reported to one of us (OV) during a June 1995 interview with Sr. Javier Torres, a longtime resident and artisanal fisherman of La Reforma and principal guide within the lagoon complex during this study. Since the last working visit there in 1989, neither he nor (to his knowledge) any of his many fishermen colleagues had seen any gray whales inside or at either entrance to the lagoon, and that recently the northern mouth was often almost completely closed by gillnets.

The available data for maximum numbers of gray whales sighted/stranded per season in Bahía Santa María for the period 1954-1995 are compared in Fig. 5. As with similar data for the Tojahui/Yavaros calving site (Fig. 3), and notwithstanding variability in sighting effort and observer bias, the recent decrease in number of gray whales visiting the lagoon appears evident, especially for cow/calf pairs (last pair sighted in 1983), as does the apparent absence of all gray whales there since the 1989 season.

Although the gray whale has proven itself to be a remarkably resilient species, in light of reports on the continued general increase in the eastern North Pacific stock (e.g. IWC, 1998), the apparent recent abandonment of the calving/nursery sites in Sonora and Sinaloa may be noteworthy with regards to further increase in that stock. If it is assumed that the major calving/nursery lagoons in Baja California are once again nearing or may have already reached their carrying capacity in terms of spatial and/or behavioural limits for further accommodation of calving gray whales (i.e. they are 'saturated'), and because all coastal lagoons and similar sites in the Gulf of California that would seem suitable as calving/nursery refuges are experiencing the disturbing effects of increasing artisanal and/or industrial-scale fishing, thus promoting avoidance of these sites by gray whales, we are led to conclude that, barring an

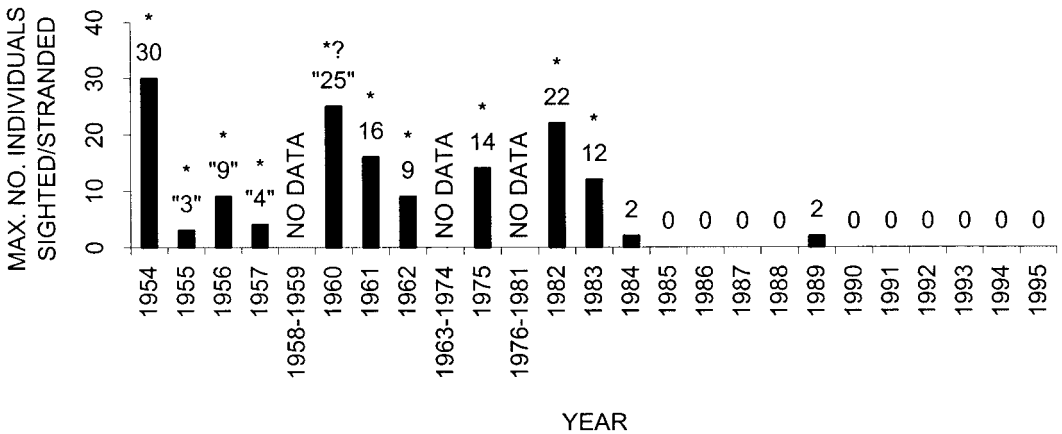

Fig. 5. Maximum number of gray whales sighted/stranded per season, 1954-1995, at Bahía Santa María (Reforma), Sinaloa (uncorrected for sighting effort). Numbers in quotation marks indicate close estimates (see Table 2 and text). Asterisks indicate at least one cow/calf pair included in count (but uncertainty of this indicated by question mark).

unlikely change in regional fishing practices, the present population in the eastern North Pacific will not substantially increase further.

CALVING TIMES

One of the females observed on 5 March 1983 in Bahía Santa María was notably smaller (*ca* 11m) and easily distinguished by the almost complete absence of barnacles (*Cryptolepas rhachianecti*). Her calf was also relatively small (*ca* 4m), devoid of barnacles, and likely had been born only a short time previously (Table 2). Rice *et al.* (1981) reported that in Laguna Ojo de Liebre most births occur until around 15 February, and estimated 27 January as the mean date for births. Following five consecutive long-term study seasons in Laguna San Ignacio, when only two calves were born after 15 February, Jones and Swartz (1984) concluded that births after that date are relatively rare. Considering the longer distance that pregnant females would have to travel to reach calving sites in the Gulf of California, it seems probable that relatively 'late' births, such as the probable one mentioned above, would not be unusual for Bahía Santa María and for the Tojahui/Yavaros site.

Fishermen in Bahía Santa María told of sighting gray whales in April of some years. These reports, together with definite sightings of cow/calf pairs at the Tojahui/Yavaros site in April and May (Table 1), suggest that in some years pregnant females arrived, gave birth and departed with their calves relatively 'late' from these Gulf of California calving sites. Jones and Swartz (1984) estimated the calving period for gray whales in Laguna San Ignacio as 4-4.5 months, including sightings in late April, early May and even June, and Poole (1984) reports some northward-travelling cow/calf pairs passing central California in late May. It therefore seems probable that some records of gray whales in the southern Gulf of California that would normally be considered 'unseasonable,' represent these later-migrating cow/calf pairs that were tardily initiating their migration to feeding grounds in boreal seas.

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We dedicate this paper to the memory of Raymond Maurice Gilmore (1 January 1907 to 31 December 1983).

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[Tables 1 and 2 on following pages]

Table 1

Counts, strandings and observational data on gray whales at Tojahui/Yavaros, Sonora, Mexico[1].

Year	Date	Observer(s) (method)	No. of whales		
			Cow/calf pairs	Others	Total
'Before 1940s -1970's'	'Arriving in Dec.'	F. Leyva (boats off Yavaros)	'max. of *ca* 8 whales/year'[2]		
1954	'2' Feb.[3]	R. Gilmore and G. Ewing (aeroplane)	6[3]	1	13[3]
	16 Feb.	C. and L. Hubbs and G. Ewing (aeroplane)	6	0	12
1955	'14' Feb.[4]	R. Gilmore and G. Ewing (aeroplane)	7	3	17
1956	26 Jan.	G. Ewing and F. Phleger (aeroplane)	4	1	9
1957	12 Jan.	G. Ewing and F. Phleger (aeroplane)	1	0	2
	25 Feb.[5]	R. Gilmore and G. Ewing (aeroplane)	2	0	4
1958-1960	No data				
1961	23 Feb.	A. Harrison (aeroplane)	'some spouts seen'		
	1 Mar.	J. Mills (boat)	'seven spouts'[6]		
1962	11 Feb.	A. Harrison (aeroplane)	'10 whales with some calves, *ca* 15?'		
	17 Feb.	J. Mills (boat)	3	3	9
	18 Feb.	A. Harrison (aeroplane)	'5 or 6 adults'[7]		
	8 Mar.	A. Harrison (aeroplane)	4	0	8
	11 Mar.	A. Harrison (aeroplane)	6	3	15
	8 Apr. [7]	A. Harrison (aeroplane)	4[8]	0	8[8]
	1 May[7]	A. Harrison (aeroplane)	'cows with calves'[9]		
1963	3 Feb.	R. Brownell and R. Boice (boat)	7	1	17
	'Feb.-Mar.'	A. Harrison (aeroplane)	3-4	*ca* 3	9-11
1964	28 Feb.	A. Harrison (aeroplane)	'5'[10]	0	'10'[10]
	8 Mar.	A. Harrison (aeroplane)	'6'[10]	2	'14'[10]
	22 Mar.	A. Harrison and R. Brownell (aeroplane)	2	1	5
1965	1 Feb.	A. Harrison (aeroplane)	1	0	2
	5 Feb.	A. Harrison (aeroplane)	3	0	6
	21 Feb.	A. Harrison (aeroplane)	4-5	0	8-10
	22 Feb.	A. Harrison (aeroplane)	4-5	0	8-10
1966	Early Feb.	A. Harrison (aeroplane)	4	2	10
	Mid-late Feb.	A. Harrison (aeroplane)	4	2	10
	6 Mar.	A. Harrison (aeroplane)	3	0	6
1967[11]	12 Feb.	A. Harrison (aeroplane)	4	1	9
	1 Mar.	A. Harrison (aeroplane)	'whales present' (but not counted)		
	9 Mar.	A. Harrison (aeroplane)	0	0	0
	16 Mar.	A. Harrison (aeroplane)	'whales present' (but not counted)		
1968[11]	18 Feb.	A. Harrison (aeroplane)	3	5	11
	9 Mar.	A. Harrison (aeroplane)	4	4	12
	30 Mar.	A. Harrison (aeroplane)	2	0	4
1969[11]	6 Apr.	A. Harrison (aeroplane)	0	0	0
	13 Apr.	A. Harrison (aeroplane)	0	0	0
1970	No data				
1971[11]	1 Feb.	A. Harrison (aeroplane)	6-7	5	17-19
	1 Mar.	A. Harrison (aeroplane)	-	-	*ca* 19
'*ca* 1972'	'Winter'	M. Robinson[12] (shore at Huatabampito)	'spouts seen, *ca* 2 or 3 whales'		
1973-1974	No data				
1975	25 Feb.	R. Gard, S. White, H. Griese, B. Mate[13] (aeroplane)	5	0	10
1976	Early Apr.	Local newspaper[14] (stranded at Las Bocas)	-	1[14]	1
1977	No data				
1978	'Winter'	G. Rojo (boat at Tojahui)	1[15]	0	2
1979	26 Feb.	L. and S. Findley, D. Arosemena, K. Crean *et al.*[16] (boat at Tojahui)	3	1-2	7-8[17]
1980	17-18 Feb.	L. Findley, O. Vidal and 13 students[16] (shore at Las Bocas)[18]	0	0	0
1981	28 Feb.	L. Findley, O. Vidal, D. Arosemena, M. Hatziolos and 40 students[16] (shore at Las Bocas)[18]	0	0	0
	1 Mar.	L. Findley, O. Vidal, D. Arosemena, M. Hatziolos and 40 students[16] (boat and shore at Tojahui)	3	2	8
	2 Mar.	L. Findley, O. Vidal, D. Arosemena, M. Hatziolos and 40 students[16] (boat and shore at Tojahui)	3	1	7
	'Mar.'	Local fishermen[19] (boat off Huatabampito)	0	1[19]	1
1982	24 Jan.-25 Feb.[20]	O. Vidal *et al.*[16] (boat and shore at Tojahui)	2	1	5
	ca 10 Nov.	G. Rojo, O. Vidal, P. Aguilar, L. Maroñas[16] (stranded at La Filomena)	0	1	1[21]
	ca 25 Nov.	L. Findley, O. Vidal *et al.*[16] (stranded near mouth of Bahía de Yavaros)	0	1	1[22]
1983	*ca* 10 Jan.	J. Cipriano López[23] (boat off Yavaros)	'a few whales'		
	ca 18-19 Jan.	F. Leyva (*cf.* footnote 2) (shore at Yavaros)	1	0	2[24]
	19 Jan.	G. Rojo[25] (shore at Tojahui)	1	1	3
	26 Jan.	D. López[25] (shore and boat at Tojahui)	'about 4 whales'[26]		
	27 Jan.	Local resident (shore at Yavaros)	'3 whales'[24]		
1984	20-21 Jan.	G. Rojo[25] (shore at Tojahui)	1	0	2
	22 Jan.	O. Vidal, G. Rojo, G. Zuñiga, F. de Boer[16] (shore at Tojahui)	1	0	2

cont.

Table 1 continued

Year	Date	Observer(s) (method)	No. of whales		
			Cow/calf pairs	Others	Total
1984 (cont.)	23-24 Jan.	G. Rojo[25] (shore at Tojahui)	1	0	2
	26 Jan.	L. Findley and J. Valverde[16] (aeroplane at Tojahui)	0	1?	1?[27]
	28 Jan.	O. Vidal, L. Findley, G. Rojo, M. Morrissey *et al*.[16] (shore at Tojahui)	1	0	2
	29 Jan.	O. Vidal, L. Findley, G. Rojo, M. Morrissey *et al*.[16] (shore at Tojahui and boat between there and the mouth of Bahía de Yavaros)	3	0	6
	8 Feb.	G. Rojo[25] (shore at Tojahui and Bajerobeta)	2	0	4
	10-11 Feb.	Local fisherman[28] (shore and boat at Las Bocas)	0	1	1[29]
	12 Feb.	O. Vidal, G. Rojo, K. Gárate, R. Halffter[16] (boat at Punta Jimarohuisa)	0	1	1[*cf.* 29]
1985	*ca* 11 Jan.	R. Valdéz[30] (boat at Tojahui)	0	2	2
	15 Jan.	R. Flórez and D. Quijano[31] (shore at Bajerobeta)	0	1	1
1986	'Early Jan.'	G. Rojo[25] (shore at Bajerobeta)	0	1[32]	1
	'Feb.'	G. Rojo[25] (shore at Bajerobeta)	'some pairs'[33]	-	4?[33]
1987	'Late Jan.-early Feb.	G. Rojo and D. López[25] (shore and boat at Tojahui)	1[34]	'some others'[35]	4?[35]
1988	18 Feb.	O. Vidal, L. Findley, J. Morelli (aeroplane at Tojahui-Yavaros-Bahía Santa Bárbara)	0	0	0
1989	No data				
1990-1993	'Winters'	G. Rojo and D. López[25], R. Valenzuela, P. Sánchez, R. Rubio and Rosalino[36] (shore and boats at Tojahui, Bajerobeta and Las Bocas)	0	0	0
1994	12-14 Feb.	F. Cardoza and A. Romero[37] (shore and boat at Tojahui)	0	0	0
	26-27 Feb.	F. Cardoza and A. Romero[37] (shore at Tojahui)	0	0	0
	5-6 Mar.	F. Cardoza and A. Romero[37] (shore at Tojahui)	0	0	0
	12-13 Mar.	F. Cardoza and A. Romero[37] (shore at Tojahui)	0	0	0
1995	'Winter'	G. Rojo[25] (shore and boat at Tojahui and Bajerobeta)	0	0	0

[1] Table, in part, modified from table 1 of Gilmore *et al.* (1967, p.202) for the period 1954-1966, but not including their dates on which no whales ('0') were seen (dates usually very early or very late in the season). The proper locality name for their counts is (Ensenada de) Tojahui [Gilmore *et al.*, 1967, p.201; Gilmore Collection in San Diego Natural History Museum, San Diego, California; R.L. Brownell, Jr., pers. comm., Apr. 1986]. Locality shown in Fig. 2. Data for years 'Before 1940s-1970s', 1967-1969, 1971, '*ca* 1972', and 1976-1995 published here for the first time.

[2] Long-time resident and former fisherman of Yavaros, reported this approx. max. number of whales seen around the mouth of Bahía de Yavaros for any one year, except *ca* 1966 when 'about 20 whales' were seen there. He further stated that 'fewer whales appeared in some years' (pers. comm., Jan. 1983).

[3] From Gilmore *et al.* (1967, table 1), but date appears as 'Feb. 3' in Gilmore and Ewing (1954, p.14). Notes in Gilmore Collection for 3 Feb. 1954 refer to five cow/calf pairs and solitary adult for total of 11 individuals; the additional cow/calf pair (to total 6 pairs) is explained in footnote '1' of table 1 in Gilmore *et al.* (1967, p.202) as being sighted nine miles south of the other whales.

[4] From Gilmore *et al.* (1967, table 1), but date appears as 'Feb. 27' in Gilmore (1960, p.28) and notes in Gilmore Collection.

[5] From Gilmore *et al.* (1967, table 1), but date appears as 'Feb. 27' in notes in Gilmore Collection.

[6] Not reported in Gilmore *et al.* (1967). Nevertheless, Mills (*in litt.*, including a photograph, to Gilmore, 15 Mar. 1961, in Gilmore Collection) believed the spouts to be from gray whales. Considering the sighting date and the inshore position of Mills, we accept his identification.

[7] Not reported in Gilmore *et al.* (1967); Harrison pers. comm. to Mills who reported to Gilmore (*in litt.*, 19 Sep. 1962, in Gilmore Collection).

[8] Harrison reported to Mills (*cf.* footnote 7) groups of 'two adults and a calf'. However, in a later communication to Mills, he was unable to verify if it had been 'four groups each of two adults and one calf, or four groups each of one adult and one calf' (Gilmore Collection). We accept the latter as more plausible.

[9] Harrison did not count the whales, but did take photographs of several cow/calf pairs that he forwarded (*via* Mills) to Gilmore, who identified them as gray whales (Gilmore, *in litt.* to Mills, 29 Sep. 1962, in Gilmore Collection).

[10] In Harrison, *in litt.* to Gilmore, 11 Apr. 1964 (Gilmore Collection), these counts are: '4-5' cows with calves and two solitaries for total of '12-14' individuals (for 8 Mar.).

[11] Data for these years provided by R.L. Brownell, Jr., communicated to him by A. Harrison (*in litt.*: 12 Feb., 1 and 6 Mar. 1967; 11 Mar. 1969; 12 Mar. 1971). The two dates for 1969 are late in the season, which may account for no whales being seen; thus this year is considered a 'no-data year' for purposes of Fig. 3.

[12] Then of Dept. Biol. Sci., Univ. Arizona, Tucson (pers. comm., Aug. 1982).

[13] From Gard (1976, p.8, table 2).

[14] A poor, but identifiable photograph of a stranded immature, with caption stating 'between 6 and 7m long, … just prior to Easter week,' appearing in newspaper *Informador del Mayo* (Navojoa, Sonora), No. 6772, 3 Apr. 1976, p.1. Otherwise, no data for this year.

[15] The calf, entangled in a gillnet near shore, liberated by G. Rojo and other fishermen assisted by a shrimp boat. Meanwhile, 'another whale [most likely the calf's mother] waited nearby' (G. Rojo, pers. comm., Mar. 1981).

[16] All then from ITESM-Campus Guaymas.

[17] Count not more exact due to limited observational time (L. Findley, field notes). Some whales photographed.

[18] A continuous daylight shore watch was maintained at Las Bocas (Fig. 2) without success. Although no whales were sighted, these dates are included to emphasise (what we did not realise then) the marked preference of the whales for the area directly off Tojahui. Tojahui site was not visited on these dates.

[19] Persons knowledgeable of gray whale characteristics, reporting (pers. comms) the whale as 'large' (adult).

[20] This period represents the first and last days whales were sighted by ITESM personnel (principally Vidal, in semi-continuous residence) at Tojahui, including 16 days when whales were present at the site and 17 days when observers were absent or whales were temporarily absent (see text). No whales sighted on site visits on 12, 24, 27-31 Dec. 1981 and 6-19 Jan. 1982. Principal informant, G. Rojo, reported whales arrived 21 Jan. and sightings on 22 and 23 Jan. No sightings on 26-28 Feb. and 1-15 Mar., when observers (principally Vidal) were present.

[21] An immature (*ca* 6.19m, reported as '6.0m' in Vidal, 1991, p.14) stranded at La Filomena (Fig. 2). G. Rojo (pers. comm., Nov. 1982) reported carcass first seen on beach about this date; decomposed remains not seen by us until 20 Nov.; partial skeleton retrieved 25 Nov. (by which time head had separated from body). Partial skull (condylobasal length 1.4m) and most of skeleton now housed at ITESM-Guaymas (ITESM 821125). Total length estimated by 'multiplying condylobasal length by 100/23 or 4.35, which should give an estimate of body length accurate to within a few inches' (D.W. Rice, *in litt.* to us, 16 Jan. 1986).

[22] Another immature (*ca* 7.4m, estimated by same method in footnote 21) stranded near mouth of Bahía de Yavaros (Fig. 2). G. Rojo (pers. comm., Nov. 1982) reported carcass first seen on beach about this date; remains not seen by us until 12 Feb. 1983 when skull (condylobasal length 1.7m) and most of anterior skeleton excavated from beach, and 26 Feb. when posterior skeleton excavated; now housed at ITESM-Guaymas (ITESM 830212) [in Vidal, (1991: 14) month of collection in error (should be II, not 'XI', which is month of stranding in 1982)]. Based on estimated length, this individual represents a weaned 'calf' or a juvenile (see Sumich, 1986).

[23] Captain of the shrimp boat *Indio Mayo*, reported (pers. comm.) 'a few gray whales among several fin whales,' *ca* 37km off mouth of Bahía de Yavaros.
[24] These whales reported (pers. comms) as being inside Bahía de Yavaros, *ca* 200m off main boat dock at Yavaros.
[25] Long-time Tojahui/Bajerobeta area fishermen and reliable informants cooperating in our sighting programme. Knowledgeable of gray whale characteristics.
[26] This sighting and that of 19 Jan. represent the only ones at Tojahui for the 1983 season and perhaps indicate decreasing site-fidelity of the whales normally visiting there. No other sightings reported by other local fishermen (who daily fish the area) or by several biologists (principally Vidal and Findley) during site visits: 15-16, 22, 29-30 Jan.; 5-6, 12-13, 19, 26-27 Feb.; and 29 Mar. Also, local fishermen at Las Bocas reported (pers. comms, through 27 Feb.) no sightings there.
[27] Identification not confirmed due to brevity of sighting, but this close-inshore whale was probably a gray whale.
[28] Mainly L. López and A. Sandoval (pers. comms, 12 Feb. 1984), longtime fishermen at Tojahui/Las Bocas and knowledgeable of gray whale characteristics.
[29] An immature (*ca* 7m) entangled in a gillnet *ca* 70m off Las Bocas on 10 Feb.; liberated by local fishermen the following day. Almost certainly the same individual sighted near Punta Jimarohuisa on 12 Feb.
[30] Fisherman and resident of Las Bocas (pers. comm., Jan. 1985).
[31] Longtime fishermen at Bajerobeta and knowledgeable of gray whale characteristics, reported the whale as 'large' (adult) (pers. comms, Jan. 1985).
[32] G. Rojo (pers. comm., Mar. 1987) reported the whale as 'large' (adult).
[33] 'Some cow/calf pairs' interpreted as at least two pairs (for total of '4?' individuals) for purposes of Fig. 3.
[34] This cow/calf pair, at least, remained at the site during *ca* 5 days (G. Rojo, pers. comm., Mar. 1987).
[35] 'Some others' interpreted as at least two individuals (for total of '4?') for purposes of Fig. 3.
[36] Longtime fishermen and residents of the area. When interviewed, with G. Rojo and D. López (*cf.* footnote 25) by F. Cardoza and A. Romero (*cf.* footnote 37) in Feb. 1994, all six informants reported the complete absence of gray whales in the area at that time and 'during the last four years' (i.e., 1990-1993) (see text).
[37] ITESM-Campus Guaymas students reporting to O. Vidal. Sighting efforts: Feb. 12-14 (32hrs), Feb. 26-27 (32hrs), Mar. 5-6 (32hrs), Mar. 12-13 (20hrs).

Table 2

Counts, strandings and observational data on gray whales at Bahía Santa María (Reforma), Sinaloa, Mexico.

			No. of whales		
Year	Date	Observer(s) (method)	Cow/calf pairs	Others	Total
1954[1]	Early Jan.	G. Ewing and R. Menzies (aeroplane)	0	1	1
	5 Feb.	R. Gilmore and G. Ewing (aeroplane at south entrance)	2	3[2]	7[3]
	5 Feb.	R. Gilmore and G. Ewing (aeroplane at north entrance)	10	3	23[3]
1955	*ca* '27' Feb.[4, 5]	R. Gilmore and G. Ewing[6] (aeroplane at north entrance)	1	1[5]	3[5, 7]
	28 Feb.[8]	R. Gilmore and G. Ewing (aeroplane at both entrances)	0	0	0
1956	*ca* 15-16 Feb.[4, 9]	R. Gilmore and G. Ewing[6] (aeroplane at north entrance)	4	1	9[10]
1957[4, 11]	12 Jan.	G. Ewing and F. Phleger (aeroplane at north entrance)	0	1[12]	1
	ca 28 Feb.[4]	R. Gilmore and G. Ewing (?) (aeroplane)[13]	2	0	4[4, 11]
1958-59	No data				
1960	23 Feb.[14]	J. Mills (boat at north entrance)	'about 25 whales'[6, 15]		
1961	26 Feb.[16]	J. Mills (boat at north entrance)	7[17]	0	14
	27 Feb.[16]	J. Mills (boat at north entrance)	8[17]	0	16[18]
1962[19]	31 Dec. 1961 *or* 1 Jan.[20] and 4 Jan.[20]	Local fisherman[20]	1[20]	1?[20]	3?[20]
	19 Feb.	J. Mills (boat at north entrance)	0	1	1
	20 Feb.	J. Mills (boat at north entrance)	3	3	9
1963-74	No data[21]				
1975	25 Feb.	R. Gard, S. White, H. Griese, B. Mate[22] (aeroplane at north entrance)	7	0	14
1976-81	No data				
1982	22-23 Feb.	L. Findley, O. Vidal, D. Arosemena, G. Pechter (boat at north entrance)	7-8	0	14-16
	8 Mar.	L. Findley, O. Vidal, G. Pechter (boat at north entrance and outside)	3[23]	0	6
	8 Mar.	L. Findley, O. Vidal, G. Pechter (boat at south entrance and outside)	0	0	0
1983	19-20 Feb.	L. Findley, O. Vidal (boat at north entrance)	3	0	6
	5 Mar.	O. Vidal and five students (boat at north entrance)	4[24]	0	8[*cf.* 24]
	'*ca* 9, 14 + 21 Mar.'	Local fishermen (pers. comms) (boats at north entrance)	1[25]	0	2
	29-30 Mar.	O. Vidal and four students (boat at north entrance and outside)	0	0	0
	'*ca* 27 Dec.'	Local fishermen (pers. comms) (boats at north entrance)	0	1	1
1984	'Jan.'	Local fishermen (pers. comms) (boats at north entrance)	0	1	1
	'Early Mar.'	D. Ayón (shore north of north entrance)	0	1[26]	1
1985	2 Mar.	O. Vidal, M. Morrissey, J. Goodyear, J. Morelli (aeroplane at both entrances)	0	0	0
1986	Early Mar.	O. Vidal, L. Findley, J. Morelli (aeroplane at both entrances)	0	0	0
1987	1 Mar.	O. Vidal, D. López, H. Medellín (boat at north entrance)	0	0	0
1988	18 Feb.	O. Vidal, L. Findley, J. Maldonado, J. Morelli (aeroplane at both entrances)	0	0	0
1989	5 Feb.	O. Vidal, P. Cendón, G. Alvarez-Manilla, A. Laborde (stranded at south entrance)	0	1[27]	1
	12 Feb.	L. Findley, O. Vidal and 14 students (shore at south entrance)	0	1[28]	1
1990-1995	'Winters'	J. Torres[29] and other local fishermen (boats at both entrances)	0	0	0

[1] Gilmore and Ewing (1954, p.14).
[2] Includes one whale not seen during a previous flight on 3 Feb., other whales (including cow/calf pairs) probably the same ones seen on that date (*cf.* Gilmore, 1960, table 5).
[3] From these two counts, Gilmore (*cf.* footnote 6 below) estimated adult 'population' in the entire lagoon at this time as '72' (see text).
[4] From Gilmore (1960, table 5).
[5] *Ca* '27' Feb. (Gilmore, 1960, p.28 and table 5) appears as 'Feb. 27: one cow/calf pair and three solitaries (adults), for a total of five individuals' in notes in Gilmore Collection.
[6] From Gilmore and Mills (1962, p.27).

[7] This count reported [in error?, *cf.* footnote 5] as total for the entire lagoon in Gilmore (1960, table 5) and Gilmore and Mills (1962, p.27). Although flights were made over both lagoon entrances, whales were sighted only at the northern one.
[8] This flight, over both lagoon entrances, not reported in Gilmore (1960, table 5) or Gilmore and Mills (1962, p.27), but appears in notes in Gilmore Collection. Although only one day after the sightings on 27 Feb. no whales were seen.
[9] *Ca* 15 and 16 Feb. (Gilmore, 1960, table 5) appears as 'Feb. 3 and 4' in Gilmore and Mills (1962, p.27), and as 'Feb. 14 and 15' in notes in Gilmore Collection.
[10] Discrepancy in accounts: 'Nine whales' *ca*. 15 Feb [= 'Feb. 3' or 'Feb. 14'?, *cf.* footnote 9] in Gilmore (1960, pp.28-29; table 5) *vs* 'four whales' [probably the same individuals counted on 15 Feb.] *ca* 16 Feb. [= 'Feb. 4' or ' Feb. 15'?, *cf.* footnote 9] in Gilmore and Mills (1962, p.27).
[11] Another discrepancy in accounts: Gilmore and Mills (1962, p.27, 4th paragraph, 1st sentence) *vs* Gilmore (1960, pp.28-29; table 5). We have accepted the latter.
[12] An adult not reported in Gilmore (1960) and Gilmore and Mills (1962); pers. comm., Ewing to Gilmore (notes in Gilmore Collection).
[13] Not known if flight(s) covered only one or (probably) both lagoon entrances; counts given as totals in Gilmore (1960, table 5) and Gilmore and Mills (1962, p.27).
[14] 'Feb. 23' (Mills, *in litt.* to Gilmore, 30 Nov. 1960, Gilmore Collection) appears as 'one day in Feb.' in Gilmore and Mills (1962, p.27).
[15] 'The fishermen with Mills at N entrance estimated the entire 'population' [in whole lagoon] to be about 100' (Gilmore and Mills, 1962). From an estimate of 72 whales for 1954, Gilmore estimated the population in the whole lagoon to be 145 for the 1960 season (Gilmore and Mills, 1962, p.27) (see text).
[16] 26 and 27 Feb. (Mills, *in litt.* to Gilmore, 15 Mar. 1961, Gilmore Collection) appears as 'two days in Feb.' in Gilmore and Mills (1962, p.27).
[17] 'Seven cows with calves on the first trip, and eight on the second...' (Gilmore and Mills, 1962, p.27). We assume these represent the same individuals plus another cow/calf pair for total of eight pairs. However, Gard (1976, p.8) apparently assumed they represented different individuals, for a total of 15 (?) pairs.
[18] Local fishermen estimated 125 cow/calf pairs (no solitaries) in the whole lagoon at this time. From prior calculations (Gilmore and Mills, 1962), Gilmore estimated the population in the whole lagoon to be 163 for the 1961 season (see text).
[19] Mills, *in litt.* to Gilmore, 19 Sep. 1962, Gilmore Collection. Data for this season not reported in Gilmore and Mills (1962).
[20] 'Sr. Arturo Montoya of La Reforma reported this as the first day of the season when he saw a whale in the lagoon, and the first calf was seen Jan. 4' (Mills, *in litt.* to Gilmore, 19 Sep. 1962, Gilmore Collection); these thus represent minimum counts.
[21] *Ca* 1974, a 'large' gray whale stranded near fishing village of Yameto at the southern entrance to the lagoon; but 'none seen there in recent years' (resident fishermen, pers. comms, 8 Mar. 1982).
[22] Gard (1976, p.8 and table 2).
[23] Different cow/calf pairs than those seen 22 and 23 Feb. for total of 10-11 pairs seen in the 1982 season (Fig. 5).
[24] Includes a cow/calf pair seen 19 and 20 Feb. and three new pairs, one of which was a small cow and very small calf (apparently very recently born), for total of six pairs seen in the 1983 season (Fig. 5).
[25] Probably the same small cow and very young calf (*cf.* footnote 24) which arrived late and remained after departure of other pairs; last sighting was 21 Mar.
[26] Biologist D. Ayón (Facultad de Ciencias del Mar, Univ. Autónoma de Sinaloa, Mazatlán) reported this immature (*ca* 7m) stranded at La Casiona fishing camp, a few km north of the lagoon's northern entrance (pers. comm., 5 Mar. 1984).
[27] A recently stranded 12.37m male; necropsied by ITESM students and us (the skull, most of the skeleton and tissue samples housed at ITESM-Guaymas; ITESM 890212).
[28] An immature sighted during necropsy of the stranded male (*cf.* footnote 27).
[29] Long-time resident artisanal fisherman of La Reforma and often our guide within the lagoon complex (interviewed in June 1995 by O. Vidal), reported having seen no gray whales at either entrance, nor having heard of reports of any from his many fishermen colleagues, since our last working visit to the lagoon in 1989. He also mentioned that recently the northern entrance was often almost completely closed by gillnets.