

Abstract.— A total 3236 km of boat and aircraft surveys was conducted in the northern Gulf of California in search of the vaquita *Phocoena sinus* in 1986–1988. Vaquita were seen on 51 occasions, representing an estimated 96 individuals. Forty-three porpoises (19 sightings) occurred during 1715 km of vessel transects, a rate of 2.51 individuals/100 km of surveys. The number of sightings relative to the extent of the survey emphasized the rarity of the porpoise and is a cause for concern regarding the vulnerability of the population. All sightings of vaquita occurred north of lat. 30°45'N, and all but two sightings (96.1%) occurred less than 40 km from San Felipe, Baja California Norte. Porpoises were observed in small groups (≤ 3 individuals) in all but five sightings. The mean group size was 1.9 ± 1.24 SD individuals, and the mode was 1. All sightings occurred in water depths of 13.5–37.0 m (\bar{x} 26.1 \pm 6.18 SD), with water clarity at these localities ranging from 0.9 to 12 m. Calves represented 9.37% of all individuals sighted. Unconfirmed sightings suggest that the porpoise is present in the southern Gulf of California. Fishermen interviewed in San Felipe, Baja California Norte, were familiar with vaquita, and some have caught the porpoise in gillnets.

Occurrence and Distribution of the Vaquita *Phocoena sinus* in the Northern Gulf of California

Gregory K. Silber

Institute of Marine Sciences, University of California
Santa Cruz, California 95064

The vaquita *Phocoena sinus* (Norris and McFarland 1958) is among the rarest and least understood of the Cetacea. In the 30 years following its initial description (Norris and McFarland 1958) very little new information about the porpoise had been obtained. Brownell (1986) reported that only 45 confirmed records of vaquita existed. These consisted of skulls and skeletons (Noble and Fraser 1971, Orr 1969) and about 20 reported sightings obtained between 1958 and 1986 (Norris and McFarland 1958, Norris and Prescott 1961, Villa-R. 1976, Wells et al. 1981). However, Brownell (1986) argued that only four of the sightings were valid.

Increased study of the porpoise in recent years has yielded new information through descriptions of recovered specimens (Magatagan et al. 1984, Brownell et al. 1987), reported sightings (Robles et al. 1986, Vidal et al. 1987, Silber 1988), and behavioral accounts (Silber et al. 1988). Norris and McFarland (1958) described the range of *P. sinus* as occurring in the upper Gulf of California and probably extending south along the Mexican coast, but Brownell (1986) maintained that the range was limited to the upper Gulf of California.

The vaquita population has been impacted by gillnetting activities and other forms of habitat degradation in recent decades (Brownell 1983, Barlow 1986). The species continues to experience mortality at an unknown rate in gillnets (Brownell 1983, Silber 1988) set primarily for totoaba *Totoaba macdonaldi* and various species of shark.

The objective for the initial year of the present study (1986) was to locate *P. sinus*, and subsequently (1987, 1988) to gather information on the ecology and distribution of the porpoise. Visual surveys were conducted from boat and aircraft in an attempt to determine the vaquita's distribution, range, and habitat utilization. Reported here are the results of three seasons of study on the vaquita conducted in the northern Gulf of California in the springs of 1986–88. I have also included a discussion of unconfirmed sightings in the southern Gulf that may reflect the historical range of *P. sinus*.

Materials and methods

Vessel surveys and sighting data

Boat surveys for *Phocoena sinus* were conducted in the northern Gulf of California using an 8-m Boston Whaler. A total of 1715 km of survey transects was conducted on 71 days during the three years (Figs. 1, 2a). The study was conducted in the spring months because (1) operational costs and logistic (e.g., boat time) restrictions limited field work duration, (2) conversations with fishermen in the upper Gulf in 1986 suggested that vaquita were most abundant (perhaps only present) in March–May, and (3) the number of sightings that we obtained (two porpoises in 485 km sur-

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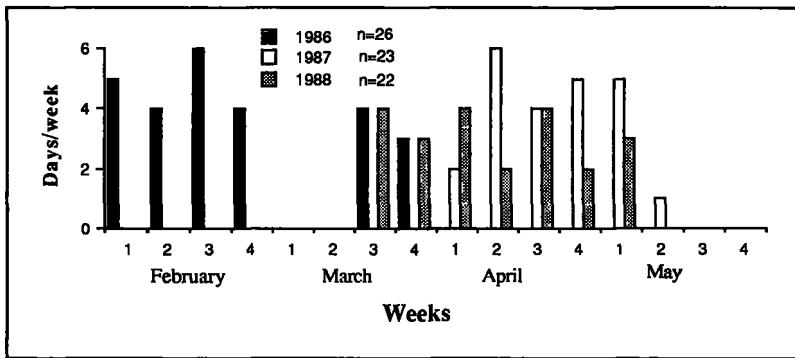


Figure 1

Number of days per week spent conducting transects and observations of *Phocoena sinus* in 1986, 1987, and 1988.

veyed) in February 1986 appeared to support information gathered from fishermen. For these reasons, the decision was made to concentrate survey efforts in March–May, when the likelihood of encountering the porpoise was believed greatest.

During vessel transects, two to four observers positioned 3.5 m above the water surface searched with unaided eyes and binoculars (7 and 10 \times) the area in front, and about 200–300 m on either side, of the vessel's track. Observers also regularly scanned to greater distances. During all surveys the vessel traveled consistently 10–11 km/hour. Transects conducted in 1986 were restricted primarily to nearshore areas. In subsequent field work inshore surveys were augmented by transects farther from shore.

For each porpoise sighting, the number of individuals seen was estimated and sighting locations were determined by triangulation from landmarks. Water depths were obtained with a JRC color video depth sounder or from a nautical chart. Water clarity (using a Secchi disc) and temperature were measured at most sighting locations. Sea states were obtained by visual estimate according to the Beaufort scale. No surveys were conducted when sea state exceeded Beaufort 3, and the majority were conducted in sea states of 1.

Aerial surveys

Limitations imposed by time, weather, and financial constraints prevented repeated vessel surveys south of lat. 30°30'. However, aircraft surveys were conducted as far south as lat. 29°34'N (Fig. 2b). A total of 1521 km was flown on three days, 3–5 May 1988, concentrating on the upper Gulf.

Fishermen interviews

Fishermen in San Felipe, Baja California Norte, and in the vicinity of La Paz, Baja California Sur, were interviewed in an attempt to obtain qualitative information with regard to the natural history, range, and

distribution of the vaquita. Questions were asked regarding type of fishing, target species, years of employment, and location of fishing. The men were asked if they recognized vaquita after viewing photographs of living and dead *P. sinus* and other odontocetes common to the area. The interviews were intended as general informational surveys of local knowledge to direct future study of vaquita and preliminary assessments of fishing effort and vaquita entanglement rates. Information derived from interviews with fishermen has been presented, although questioning methodology and sample sizes were insufficiently rigorous to draw definitive conclusions with regard to vaquita distribution.

Results

Vaquita sightings

Vaquita were seen on 51 occasions, representing an estimated 96 individuals during boat and aircraft surveys (Table 1). A total of 43 porpoises was seen while conducting vessel transects, a sighting rate of 2.51 individuals/100 km surveyed. The remainder of the sightings occurred while tracking porpoises, collecting other types of data, or otherwise not engaged in visual transects. The paucity of sightings relative to the extent of the survey emphasized the rarity of the porpoise.

All sightings of vaquita occurred north of lat. 30°45'N, and all but two sightings (96.1%) occurred less than 40 km from San Felipe, Baja California Norte (Fig. 2a). Most sightings (94.2%) occurred in sea states 0 or 1 (Fig. 3). In 90.2% ($n = 46$) of all sightings, porpoises were observed in small groups (≤ 3 individuals). Mean group size was 1.9 ± 1.24 SD individuals per group (Table 1) and the group size mode was one (Fig. 4). For 86.3% ($n = 44$) of all porpoise sighting locations, water depths ranged from 21 to 35 m ($\bar{x} 25.7 \pm 6.36$ SD; overall range 13.5–37.0) (Fig. 5), and most sightings occurred 11 to 25 km from the nearest shore

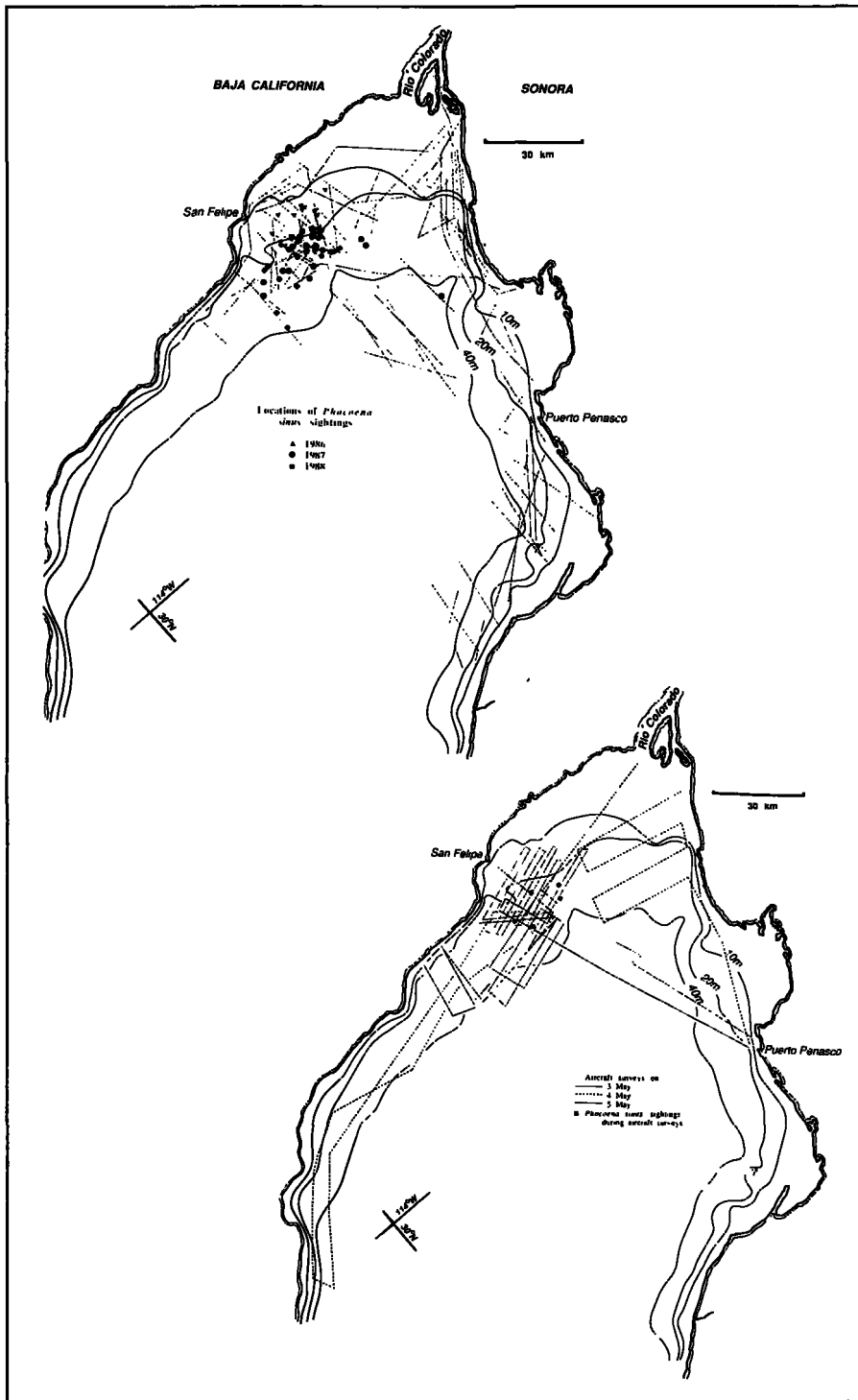


Figure 2
Phocoena sinus sightings and vessel transects conducted in 1986, 1987, and 1988 (top) and aircraft surveys on 3–5 May 1988 (bottom).

(\bar{x} 18.3 ± 6.10 SD; range 2.4–32.2) (Fig. 6, Table 1). Water clarity at sighting locations ranged from 0.9 to 12 m. During four vaquita sightings the boat's depth sounder indicated concentrated layers at 15 ($n = 2$), 23, and 25 m, possibly representing schooling bait fish or squid upon which the porpoises may have been feed-

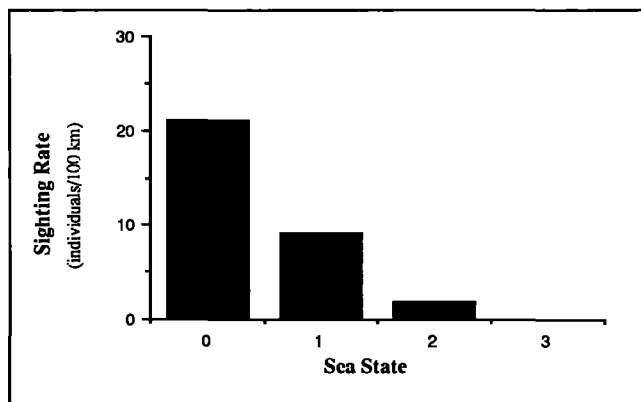
ing. On numerous occasions, vaquita surfaced in or alongside surface slicks or long bands of flat water surrounded by rippled water.

Calves represented 9.37% of all individuals. One very young calf was observed on 9 April 1987. It was estimated at <2 days old because of its size, a dorsal fin

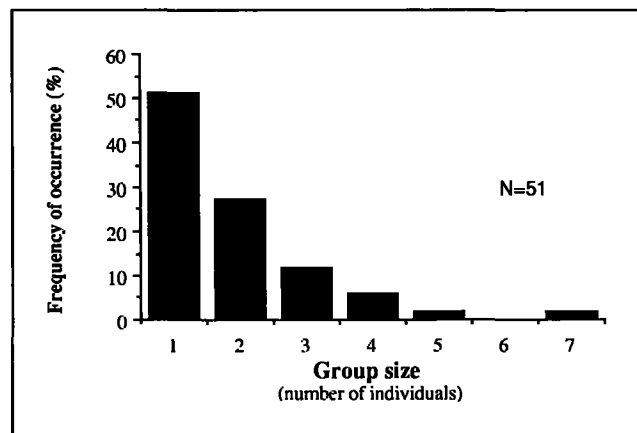
Table 1

Summary of all *Phocoena sinus* sightings in the northern Gulf of California, 1986-88. Group sizes are represented by mean, one standard deviation, and range.

Year and dates	Sightings	Distance to shore (km)	Depth (m)	Water temperature (°C)	Water clarity (m)
1986	<i>N</i>	16	16	12	12
2 Feb.-27 Mar.	\bar{x}	1.7	14.3	21.0	2.4
	SD	0.87	4.50	5.00	0.81
	Range	1-4	2.4-20.0	13.5-25.0	0.9-4.0
	Est. total ind.	27			
1987	<i>N</i>	22	22	12	13
8 Apr.-7 May	\bar{x}	2.1	19.3	27.5	8.2
	SD	1.57	5.71	4.73	2.46
	Range	1-7	15.3-32.2	20.0-37.0	5.0-12.0
	Est. total ind.	46			
1988	<i>N</i>	13	13	8	7
21 Mar.-5 May	\bar{x}	1.8	20.7	29.5	4.1
	SD	1.01	6.58	5.87	1.07
	Range	1-4	7.0-29.0	22.0-40.0	18.5-20.0
	Est. total ind.	23			
All years	<i>N</i>	51	51	32	32
	\bar{x}	1.9	18.3	25.7	5.0
	SD	1.24	6.10	6.36	3.10
	Range	1-7	2.4-32.2	13.5-40.0	0.9-12.0
	Est. total ind.	96			

**Figure 3**

Phocoena sinus sighting rate (individuals/100 km) relative to sea state.

**Figure 4**

Phocoena sinus group size.

that was not yet fully erect, and the ungainly manner in which it lifted its head from the water with each surfacing.

Aerial surveys

Eleven *Phocoena sinus* (five sightings) were seen during aircraft surveys. All aerial sightings took place between San Felipe and Rocas Consag, and none occurred farther south along the Baja peninsula coast (Fig. 2b), although much less effort was dedicated to this area in relation to the extreme upper Gulf. The

number of aircraft surveys was relatively small and non-random. Nonetheless, they served to support *P. sinus* distribution patterns observed during vessel surveys, failed to yield sightings south of the area surveyed by vessel, and illustrated the utility of aircraft as a platform of observation in future study and census of the species.

Sympatric vertebrates

Other marine vertebrates were seen near *P. sinus*;

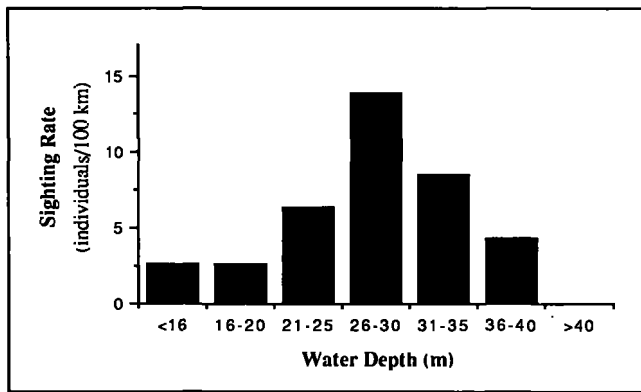


Figure 5

Phocoena sinus sighting rate (individuals/100 km) relative to water depth.

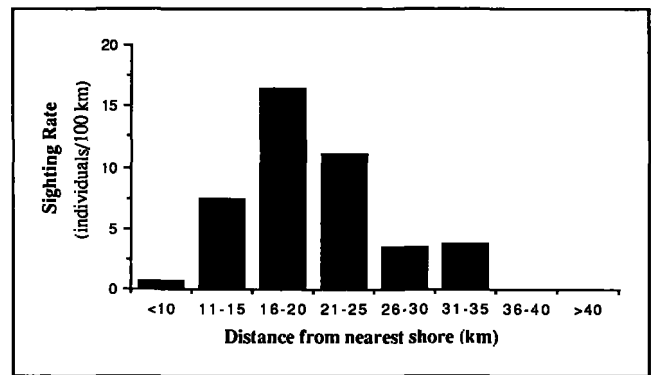


Figure 6

Phocoena sinus sighting rate (individuals/100 km) relative to distance from nearest shore.

affiliations that probably represent utilization of a similar habitat by two or more species rather than active association. Twice, Bryde's whales *Balaenoptera edeni* were seen <1 km from *P. sinus*, and three times common dolphins *Delphinus delphis* were observed <1.5 km from the porpoise. Numerous times black storm-petrels *Oceanodroma melania* and Bonaparte's gulls *Larus philadelphia* dipped into the wake of surfacing vaquita. Manta rays *Manta birostris* were seen once near porpoises.

In addition to vaquita, five other marine mammal species were common within the study area, including bottlenose dolphins *Tursiops truncatus*, common dolphins, fin whales *Balaenoptera physalus*, Bryde's whales, and California sea lions *Zalophus californianus*. There appeared to be a general segregation by location and water depth among the three most common odontocet species. The distribution of *P. sinus* overlapped that of *Delphinus* and *B. edeni*, but not that of *Tursiops* and *B. physalus* (Silber et al. In prep.). Bottlenose dolphins were consistently seen in more shallow water than were vaquita, and common dolphins were generally seen in greater, but comparable, water depths as vaquita. Data on sympatric marine mammals will be presented in greater detail elsewhere (Silber et al. In prep.).

Unconfirmed sightings and fishermen interviews

In February and April 1983 cetaceans that may have been *P. sinus* were seen near Cerralvo Island (24°10'N; 109°55'W) by a scientist who has extensive experience with marine mammals and Gulf of California fauna (G. Notarbartolo di Sciara, Piazza Duca d'Aosta 4, 20124 Milano, Italy, pers. commun., May 1984). In both sightings, the animals were 10–50 m from the observer.

They were described as being small, possibly possessing a blunt rostral profile, and surfacing "unobtrusively" in small groups. They were "quite distinct from *Tursiops*, *Delphinus*, or *Lagenorhynchus*" (G. Notarbartolo di Sciara, pers. commun., May 1984). If true, these unconfirmed sightings occurred in an area >850 km south of our southernmost sightings, and extend the present known range considerably.

Based on these observations, the decision was made to interview fishermen in the southern Gulf about the presence of vaquita. In 1987, 17 fishermen from La Paz were interviewed about their fishing practices and their knowledge of the vaquita (Table 2). In most cases the fishermen had spent considerable time on the water (fishing 4–6 days/week, 3–12 months/year, for 5–51 years; \bar{x} = 20.6 yrs). Fishermen in the La Paz area generally had no knowledge of vaquita; however, one man was familiar with the porpoise and indicated that he had seen it several times near San Jose Island (25°00'N; 110°40'W), 80 km north of La Paz. Unlike others interviewed, this man was one of two who had been fishing for over 50 years and he had worked in an area (the coast near San Jose Island) different from the other fishermen. In addition, his knowledge of the natural history of marine mammals was regarded as being accurate by the interviewer (D. Auriolles, Centro de Investigaciones Biológicas B.C.S., APO Postal 128, La Paz, Baja California Sur, México, pers. commun., June 1987). One fisherman described netting near San Jose Island a small cetacean that had rounded ("acorn-like") teeth, a feature characteristic of the genus *Phocoena*.

All fishermen interviewed in San Felipe ($n = 7$) expressed a knowledge of vaquita, and two said that they had entangled the porpoise while fishing for totoaba. Although taking totoaba is illegal, three men indicated that they continue to use gillnets for totoaba.

Table 2

Summary of interviews with fishermen in La Paz, Baja California Sur, and San Felipe, Baja California Norte, regarding fishing practices and knowledge of *Phocoena sinus*.

	San Felipe	La Paz
Number fishermen interviewed	7	17
Distance from home port (km)	\bar{x}	37.4
	SD	39.48
	Range	1-100
Number of years engaged in fishing	\bar{x}	17.8
	SD	12.50
	Range	6-35
Type of fishing	Gillnet, longline, hook-and-line	Longline, gillnet, trawl, diving
Target species	Shrimp ($n = 6$) Totoaba ($n = 3$) Shark ($n = 2$) Marlin ($n = 1$) Dorado ($n = 1$) Yellowtail jack ($n = 1$)	Spanish mackerel ($n = 14$) Shark ($n = 9$) Pacific manta ($n = 1$) Snapper ($n = 1$) Striped mullet ($n = 1$)
Fishing effort	12 mo/yr ($n = 4$) 3 mo/yr ($n = 3$)	12 mo/yr ($n = 11$) 10 mo/yr ($n = 1$) 3-6 mo/yr ($n = 3$)
Recognition of photos of <i>P. sinus</i>	Yes ($n = 7$)	Yes ($n = 1$); No ($n = 16$)
Estimated total porpoises killed	3-4	0
Common names used	Cochito, cochinito, and vaquita = <i>P. sinus</i>	Vaquita = <i>Kogia</i> or <i>Phocoena</i> spp. Duende = <i>Lagenorhynchus</i> Cochinito = <i>Delphinus</i> Cochito = <i>Globicephala</i>

The vernacular name for *P. sinus* tended to vary between communities and individuals. Fishermen in San Felipe referred to *P. sinus* as "cochito," "cochinito," and "vaquita." In contrast, for La Paz fishermen "vaquita" refers to *Kogia sinus* or *Phocoena* spp., whereas "cochinito" refers to *Delphinus delphis*, "cochito" to *Globicephala macrorhynchus*, and "duende," also meaning *P. sinus* in some communities (Magatagan et al. 1984), refers to *Lagenorhynchus obliquidens* (D. Auriolles, pers. commun., June 1987).

Discussion

Although surveys were conducted throughout the upper Gulf, sightings of *Phocoena sinus* were limited almost entirely to the western side. One or a combination of the following features may account for vaquita distribution patterns in the upper Gulf. Relative to the eastern shore, the western boundary exhibits lower surface temperatures (Robinson 1973) resulting partly from northward-bearing upwelled water from the Midriff Island region. With respect to the eastern coast-

line of the upper Gulf, the western perimeter is characterized by stronger north-south tidal currents year-round (Hendrickson 1973) which may contribute to increased mixing on the west coast.

Vaquita often surfaced near surface slicks, which are caused by tidally induced internal waves (Ewing 1950, Shanks 1983) or areas of convergence of different water masses, a common feature of the northern Gulf of California (Hendrickson 1973, Lepley et al. 1975). Surfacing near slicks has been noted in other cetaceans, including *Feresa attenuata*, *Steno bredanensis*, and *Pseudorca crassidens* (K.S. Norris, Cent. Mar. Stud., Univ. Calif., Santa Cruz, CA 95064, pers. commun., Aug. 1987). Concentrations of small marine organisms are associated with internal waves (Shanks 1983, 1988; Kingsford and Choat 1986). Vaquita and other cetaceans may be drawn to aggregated prey in these features.

It is believed by some researchers that the entire *P. sinus* population is limited to the upper Gulf, which represents the smallest range of any marine cetacean (Brownell 1986, Barlow 1986); however, the actual range remains unsubstantiated. Although presently

untested, I suggest that vaquita occur in the upper Gulf year-round, and although the majority of the population may have receded to the upper Gulf following a relatively recent decline in population size, some individuals are probably scattered throughout the Gulf as separate subpopulations or a sparsely dispersed single population. Reported sightings of *P. sinus* outside the northern Gulf (Scammon 1874, Norris and McFarland 1958, Norris and Prescott 1961, Villa-R. 1976; presented here) suggest the possibility of a greater historical range. However, extensive field work on cetaceans near the Midriff Islands, Guaymas, and Kino Bay areas has not yielded sightings of vaquita (L. Ballance, Dep. Biol., Univ. Calif., Los Angeles, CA 90024, pers. commun., May 1989; L.T. Findley, Escuela de Ciencias Marítimas y Alimentarias, Instituto Tecnológico y de Estudios Superiores de Monterrey, Unidad Guaymas, A.P. 484, Guaymas, Sonora, 85400 México, pers. commun., Nov. 1985; B. Tershy, Dep. Biol., Cornell Univ., Ithaca, NY 14853, pers. commun., Sept. 1987). Most phocoenids are cold-temperate water animals (Gaskin 1982), with ranges restricted to <math><20^{\circ}\text{C}</math>. Northern Gulf of California surface water temperatures in the summer and fall can exceed

Management recommendations

Exposure of the depleted *P. sinus* population to current levels of human impact may result in the demise of the species. Habitat degradation and pesticide contamination of the northern Gulf may contribute to the decline of *P. sinus*. However, vaquita mortality in gillnets (Brownell 1983, Robles et al. 1986, Silber 1988) may represent the most direct threat to the population, and increased efforts to reduce porpoise entanglement is imperative. Nets set for totoaba probably account for the highest percentage of incidental porpoise deaths. The totoaba is an endangered species and cannot be legally caught, sold, or exported. Nonetheless, illegal fishing continues due to the inability to enforce restrictions. Additional study is needed to quantify incidental mortality rates and to explore possible modifications of fishing amounts, timing, and technique. Vaquita sightings occurred predominantly in discrete locations and water depths. If widespread fishing bans are not possible, emphasis should be placed on excluding fishing from these areas. However, because maximum catch of totoaba also occurs in spring (Flanagan and Hendrickson 1976), there will be difficulty achieving compliance by fishermen. Rigorous sanctions on importation of totoaba bound for U.S. markets

are required. Additional boat and aircraft census surveys should be conducted to determine the vaquita population size, and to enhance current knowledge of the ecology of the porpoise. Large areas of the northern Gulf have been recommended for consideration as a Marine Sanctuary (B. Villa-R., Inst. Biol., Univ. Nal. Autón. México, A.P. 70-153, México, D.F. 04510, pers. commun., Feb. 1986), and these plans should be endorsed. Mexican and U.S. scientists should engage in joint efforts to monitor changes in the vaquita population size. Action by Mexican and U.S. governments, fishing cooperatives, cetacean biologists, and resource management personnel is necessary to preserve the species.

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Citations

- Barlow, J.**
1986 Factors affecting the recovery of *Phocoena sinus*, the vaquita or Gulf of California harbor porpoise. Adm. Rep. LJ-86-37, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, P.O. Box 271, La Jolla, CA 92038, 19 p.
- Brownell, R.L., Jr.**
1983 *Phocoena sinus*. Mamm. Species 198:1-3.
1986 Distribution of the vaquita, *Phocoena sinus*, in Mexican waters. Mar. Mammal Sci. 2:299-305.

- Brownell, R.L., Jr., L.T. Findley, O. Vidal, A. Robles, and S. Manzanilla N.**
1987 External morphology and pigmentation of the vaquita, *Phocoena sinus* (Cetacea: Mammalia). *Mar. Mammal Sci.* 3:22-30.
- Ewing, G.**
1950 Slicks, surface films and internal waves. *J. Mar. Res.* 9:161-187.
- Flanagan, C.A., and J.R. Hendrickson**
1976 Observations on the commercial fishery and reproductive biology of the totoaba, *Cynoscion macdonaldi*, in the northern Gulf of California. *Fish. Bull.*, U.S. 74:531-544.
- Gaskin, D.E.**
1982 The ecology of whales and dolphins. Heinemann Educ. Books, Exeter, NH, 459 p.
- Hendrickson, J.R.**
1973 Study of the marine environment of the northern Gulf of California. Contract rep. NAS5-21777, Goddard Space Flight Cent., Greenbelt, MD 20771. Avail. NTIS Publ. N74-16008, 95 p.
- Kingsford, M.J., and J.H. Choat**
1986 Influence of surface slicks on the distribution and onshore movements of small fish. *Mar. Biol. (Berl.)* 91:161-171.
- Lepley, L.K., S.P. Vonder Haar, J.R. Hendrickson, and G. Calderon-Riveroll**
1975 Circulation in the northern Gulf of California from orbital photographs and ship investigations. *Cienc. Mar.* 2:86-93.
- Magatagan, M.D., E.H. Boyer, and B. Villa-Ramirez**
1984 Revision del estado que guarda *Phocoena sinus* Norris and McFarland y descripción de tres nuevos ejemplares. *An. Inst. Biol. Univ. Nal. Autón. Méx.*, Ser. Zool. 55:271-294 [in Spanish, Engl. abstract].
- Noble, B.A., and F.C. Fraser**
1971 Description of a skeleton and supplementary notes on the skull of a rare porpoise *Phocoena sinus* Norris & McFarland, 1958. *J. Nat. Hist.* 5:447-464.
- Norris, K.S., and W.N. McFarland**
1958 A new harbor porpoise of the Genus *Phocoena* from the Gulf of California. *J. Mammal.* 39:22-39.
- Norris, K.S., and J.H. Prescott**
1961 Observations on Pacific cetaceans of Californian and Mexican waters. *Univ. Calif. Publ. Zool.* 63:291-370.
- Orr, R.T.**
1969 An additional record of *Phocoena sinus*. *J. Mammal.* 50:384.
- Robinson, M.K.**
1973 Atlas of monthly mean sea surface and subsurface temperatures in the Gulf of California, Mexico. *San Diego Soc. Nat. Hist. Mem.* 5, p. 4-97.
- Robles, A., L.T. Findley, O. Vidal, R.L. Brownell, Jr., and S. Manzanilla**
1986 Registros recientes y apariencia externa de la marsopa del Golfo de California, o vaquita, *Phocoena sinus*, Norris and McFarland, 1958. XI Reunión Internacional Sobre Mamíferos Marinos, Guaymas, Sonora. Avail. Instituto Tecnológico y de Estudios Superiores de Monterrey, Unidad Guaymas, A.P. 484, Guaymas, Sonora, 85400 México [Spanish and English abstract].
- Scammon, C.M.**
1874 The marine mammals of the northwestern coast of North America. J.H. Carmany, San Francisco, 319 p.
- Shanks, A.L.**
1983 Surface slicks associated with tidally forced internal waves may transport pelagic larvae of benthic invertebrates and fishes shoreward. *Mar. Ecol. Prog. Ser.* 13:311-315.
- 1988 Further support for the hypothesis that internal waves can cause shoreward transport of larval invertebrates and fish. *Fish. Bull.*, U.S. 86:703-714.
- Silber, G.K.**
1988 Recent sightings of the Gulf of California harbor porpoise, *Phocoena sinus*. *J. Mammal.* 69:430-433.
- Silber, G.K., M.W. Newcomer, and G.J. Barros**
1988 Observations on the behavior and ventilation cycles of the vaquita, *Phocoena sinus*. *Mar. Mammal Sci.* 4:62-67.
- Silber, G.K., M.W. Newcomer, H. Pérez-Cortés M., P.C. Silber, and G. Ellis**
In prep. Distribution of marine mammals of the northern Gulf of California. *Inst. Mar. Sci.*, Univ. Calif., Santa Cruz, CA 95064.
- Vidal, O., A. Aguayo, L. Findley, A. Robles, L. Bourillón, I. Vomend, P. Turk, K. Gárete, L. Maroñas, and J. Rosas**
1987 Avistamientos de mamíferos marinos durante el crucero "Guaymas I" en la region superior del Golfo de California, Primavera de 1984. Memoria X Reunión Internacional Sobre Mamíferos Marinos, 24-27 de Marzo de 1985, La Paz, Baja California Sur. Avail. Instituto Tecnológico y de Estudios Superiores de Monterrey, Unidad Guaymas, A.P. 484, Guaymas, Sonora, 85400 México, 196 p. [in Spanish, Engl. abstr.].
- Villa-R., B.**
1976 Report on the status of *Phocoena sinus*, Norris and McFarland 1958, in the Gulf of California. *An. Inst. Biol. Univ. Nal. Autón. Méx.*, Ser. Zool. 47:203-208.
- Wells, R.S., B.G. Würsig, and K.S. Norris**
1981 A survey of the marine mammals of the Upper Gulf of California, Mexico, with an assessment of the status of *Phocoena sinus*. Final rep. MMC-79/07 to U.S. Mar. Mamm. Comm., Wash. DC. Avail. NTIS PB81-168791, 51 p.