Occurrence of Cuvier's Beaked Whales (*Ziphius cavirostris*) in Guadalupe Island, Baja California, México.

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ABSTRACT

Beaked whales are the least known of all cetacean families. This is due to the difficulty in observing and identifying them, and because they generally inhabit deep ocean waters. Guadalupe Island (GI) represents a potential habitat for beaked whales, since it lacks mostly of a continental shelf, reaching depths of 3,600m, and because there are deep submarine canyons around this oceanic island. In October, November, and December of 2006, 2007, and 2008, 24 sightings of Cuvier's beaked whales were recorded opportunistically during tracking expeditions for white sharks. In summer and autumn 2009 we started the first project to study beaked whales in GI. We recorded a total of 43 Cuvier's beaked whales sightings. All sightings records so far have occurred in the Bahía Norte between Punta Costilla and Punta Norte, mainly in front of Primer and Gemelos canyons. All sightings have been recorded between 0.55 and 2.1km from the coastline. 7 % of the total sightings were recorded during nighttime while tracking for white sharks were carried out. The group sizes ranged from 1 to 7 individuals (mean = 3), and the depths of the sightings ranged from 42m to 580m. The 22.3% of the sightings were mother and calf groups. In total, 32 Cuvier's beaked whales were identified (with video and photographs). Besides our records, there are previous opportunistic sightings of beaked whales reported in other seasons around GI and according to local fishermen, the beaked whales or "krikas" are common inhabitants of the island. Thus, GI is an important area for the occurrence of Cuvier beaked whales in Mexico and for study, the ecology of beaked whales to assess potential human activities to these species.

Cuvier's beaked whale (*Ziphius cavirostris*) is the most widely distributed beaked whale, with a cosmopolitan distribution throughout almost all temperate, sub-tropical and tropical waters of the world as well as sub-polar and even polar waters in some areas (Heyning 1989, MacLeod et al. 2006). Globally, it may also be is the most abundant species of the family Ziphiidae (Heyning 1989). However, there is scarce information on local distribution in many areas around the world.

Guadalupe Island is an oceanic island located in the Pacific Ocean, 260 km west of Baja California, Mexico at 29°00'N, 118°26'W (Figure 1). The waters around this island are a suitable habitat for beaked whales, since the continental shelf is extremely narrow, and depths of 3,600m are found close to shore (Pierson 1987). Furthermore, there is a series of deep canyons in different parts of the east coast, such as Primer Canyon and Gemelos Canyons, located both in the big bay of the northeast coast of the island. There are also other canyons in the middle part of the island, in Campo Lima, and at the southeast in the Corrales area (Gallo-Reynoso and Figueroa-Carranza 2005).

Before 2009, no specific research on beaked whales occurred at Guadalupe Island. Few reports of the presence of several species of this family of cetaceans have been opportunistic by researchers working on other species, like white sharks (*Carcharodon carcharias*) and Guadalupe fur seals (*Arctocephalus townsendi*). The first report on the presence of beaked whales in Guadalupe Island was a note published by Gallo-Reynoso and Figueroa-Carranza (1995). These sightings were recorded during expeditions to study Guadalupe fur seals. These authors recorded three sightings of a bottlenose whale (Hyperoodon sp.). The whales were observed in July, 1992 and 1993, close to the southeastern coast of Guadalupe Island. It was suggested that the occurrence of bottlenose whales this far north was associated with El Niño in 1992 and remnant waters during the post-El Niño year of 1993 (Gallo-Reynoso and Figueroa-Carranza 1995).

In 1998, the same authors reported 13 species of cetaceans, including the bottlenose whales, 11 of which were toothed whales (Gallo-Reynoso and Figueroa-Carranza 1998). Their study period focused on fur seals was in winter (February 1991-1992); spring (June 1983 and 1991); summer (July-August 1991, 1992, and 1993); and fall (November-December 1991 and 1992). Beaked whales were sighted 16 times. The Baird's beaked whale (*Berardius bairdii*) was the second most observed odontocete (after bottlenose dolphins) and represented 50% of the beaked whales sightings. Hyperoodon sp. represented 31.2%, followed by Cuvier's beaked whales (*Ziphius cavirostris*) 12.5%; and unidentified beaked whales 6.25%. All records, except one, were in summer (June and July) close to the coast. One sighting of Baird's beaked whale occurred in November (Gallo-Reynoso and Figueroa-Carranza 1998).

Gallo-Reynoso and Figueroa-Carranza (2005) compiled all their beaked whales' sightings in a book about Guadalupe Island. They added 41 days of observations, mainly from the east coast during winter and spring of 2000 and winter and summer of 2003. They reported seven sightings of Cuvier's, and one of Hubb's beaked whales, as well as one of an unidentified ziphiid. These animals were found mainly in summer in Corralitos, Campo Lima and Bahía Norte, areas characterized by the presence of submarine canyons.

In this note, we report the opportunistic sightings of *Ziphius cavirostris* recorded during a white shark research project from 2006 to 2008, and the results obtained in 2009 during a pilot study focused on the beaked whales of Guadalupe Island.

Tracking expeditions for white sharks in the east of Guadalupe Island were conducted from a variety of 6-7 m outboard-powered fiberglass skiffs (known as pangas) during October, November, and December of 2006, 2007, and 2008 by one of us (MHP). Only naked eye opportunistic sightings of beaked whales were made during these expeditions. Groups of animals were approached to determine location and group size, and to obtain photographs and underwater videos for species-identification. Unfortunately, sighting effort was not recorded. In summer and autumn 2009, the Marine Mammals Research and Conservation Group from The Instituto Nacional de Ecología, started the first beaked whale pilot project at Guadalupe Island (in collaboration with the white shark project). The beaked whale search effort was conducted from pangas and from a 15.5 m (above mean sea level) shore-based site with a SOKKIA DT510A theodolite and West Marine binoculars (7x50). A total of 336 km was covered during 46.2 hours of panga transects during June and August of 2009 (Figure 1). The shore-based search effort was conducted from 26.4 hours. In September and October of 2009, search effort was not recorded and was conducted only using pangas.

A total of 67 sightings of Cuvier´s beaked whales were recorded from 2006 to 2009 at Guadalupe Island. 7 % of the total sightings were recorded during nighttime while tracking for white sharks were carried out. These nocturnal encounters are unusual, and the first ones reported on the scientific literature to our knowledge. In the period between 2006 to 2008, previous to the pilot survey, only 24 opportunistic sightings of Ziphius were recorded during research on elasmobranches (Figure 2). In 2009, during the pilot survey, 43 Cuvier's beaked whales were recorded from pangas and from land based site in Guadalupe Island (Figure 2). The greater number of Ziphius sightings in 2009 in comparison to 2006 to 2008 could be as a result of increased searching effort focused on this species. Because the search effort was not systematic surveys, during the study period, we were unable to compare sightings rates with other studies on beaked whales. However, the total number of sightings reported here (67) is higher than the totals reported for surveys in other areas where survey effort was much higher [including the Southern Gulf of California (Barlow et al. 1997), Mediterranean Sea (Cañadas et al. 2002), Great Abaco, Bahamas (MacLeod et al. 2004), Hawai´i (Baird et al. 2006, McSweeney et al. 2007), Bay of Biscay (Kiska et al. 2007), southwest Gulf of California (Cárdenas-Hinojosa 2008) and San Clemente Island (Falcone et al. 2009)].

Contrasting to previous reports from Guadalupe Island, Cuvier´s beaked whales was the only species of the beaked whale family seen during our surveys. All encounters records, from 2006 to 2009 occurred in Bahía Norte between Punta Costilla and Punta Norte, mainly in front of Primer and Gemelos Canyons (Figure 2), where our survey effort has been concentrated (Figure 1). One sighting was encountered in Campo Lima. We found Cuvier´s beaked whales between 0.55 and 2.1 km from the coastline at depths from 42 to 580 m. The 22.3% of the sightings were mother and calf groups, and virtually all calves were recorded in 2009. Commonly, the animals did not avoid our boat, and we were able to record 30 underwater videos. In total, 32 individuals of Cuvier's beaked whales were identified (with video and photographs) and two individuals were sighted on two occasions with lapses of one and 22 days.

Ziphius group size in Guadalupe Island ranged from one to seven individuals with a mean of three. In the review of MacLeod and D'Amico (2006) on the beaked whale behaviour and ecology, they mentioned that the mean group size for Ziphius was 2.3 individuals (SD = 1.7; N = 189). Similar results recorded McSweeney et al. (2007) for the Hawai'i Island (mean = 2.57; SD = 1.26) and Cárdenas-Hinojosa (2008) for the southwest Gulf of California (2.4 individuals; SD = 14.7). It should then be noted that the mean group size reported in this note is higher in comparison to the previous reports , but lower than in San Clemente Island (mean = 3.8; SD = 2.4) (Falcone et al. 2009).

Another important observation occurred during the night, when a surface feeding event was recorded on October 7th 2007. A mature female (6 m long approximately) was seen very close to shore; in front of Primer Canyon; swimming slowly at the surface and feeding on a concentration of squids identified as *Leachia dislocata* (Family Cranchiidae; Figure 3). Some squids were dead and floating on the surface. The female approached to the boat as near as one meter away and after a near inspection it moved to the north slowly. According to MacLeod et al. (2003), this family of squids was one of the most frequently reported on dietary data available for 38 specimens of Cuvier's beaked whales from throughout the range of the species. This species of squid was reported as prey of the Laysan albatross (*Phoebastria immutabilis*) at Guadalupe Island. This seabird is a scavenger of the spawned-out adults during the daytime on the sea surface (Pitman et al. 2004). *L. dislocata* are available to albatrosses because, as in many squid species, females die after spawning and float to the surface (Nesis et al. 1988).

Another foraging display was observed in October 14th 2009. A group of *Z. cavirostris* was sighted in the northeast of Gemelos Canyons heading north. The depth of that area was 322 m. After 29 minutes, we re-sighted the group in approximately the same area, but in deeper waters (366 m). We found a mesopelagic silver hatch fish *Argyropelecus affinis* (Family Sternoptychidae; Figure 3) in the vicinity of the whales. This fish, which was alive and floating on the sea surface, had its swim bladder distended from its mouth, a sign of decompression. This is an oceanic and mesopelagic species found at 300-600 m at daylight (Badcock 1984). That sighting was recorded during the day, so we suggest that the beaked whales were foraging on schools of these fishes in deep waters, and the fish may have fled to escape the whales, resulting in its decompression (Figure 3).

These two foraging displays are the first record about the diet of Cuvier´s beaked whale at Guadalupe Island. Despite the two species never have been reported as prey items for Cuvier´s beaked whale, this new report is not extraordinary because the high diversity of prey found elsewhere in stomachs of Cuvier's beaked whales suggests that they may be opportunistic in their feeding habits (Heyning 2002).

Several features of habitat preferences of beaked whales are found at Guadalupe Island. It is an oceanic island exhibiting steep slope features such as submarine canyons and deep waters close to shore (Pierson 1987). Most of the sightings were recorded in front of submarine canyons (Figure 2). Similar to another species of beaked whales, the presence of Ziphius, has been correlated to habitats like oceanic islands (MacLeod and Zuur 2005, Baird et al. 2006). As well, the frequent use of submarine canyons has been documented for the northern bottlenose whales in the Gully region off the Nova Scotian shelf (Hooker et al. 1999, 2002), for the Blainville's beaked whale in the Bahamas (MacLeod and Zurr 2005), and for Cuvier's beaked whale in the southwest Gulf of California (Cárdenas-Hinojosa 2008), and in the Ligurian Sea (D'Amico et al. 2003). The deep-water habits and diving behaviors are directly related to foraging for squid and other benthic and deep water organisms (Mead 1989, Davis et al. 1998, Waring et al. 2001, Cañadas et al. 2002, Macleod et al. 2003, MacLeod and D'Amico 2006).

Therefore, we suggest that the occurrence of Cuvier´s beaked whale in Guadalupe Island is related to the presence and availability of prey resources, particularly in the areas of submarine canyons. This is supported by the two foraging displays observed and reported in this note. Furthermore, the visual observation of surface feeding on squids, as far as we know, is the first direct evidence reported of predator–prey interactions for this species.

Finally, local fishermen report that the whales or "krikas" are common inhabitants of the island. Thus, due to the bathymetric characteristics of the island and all the sighting records in the literature (including the ones reported here); Guadalupe Island is a major area for the occurrence of Cuvier beaked whales in Mexico. Furthermore, the presence of mother and calf groups and the observation of two foraging displays may indicate that Guadalupe Island is a breeding/feeding area for this species.

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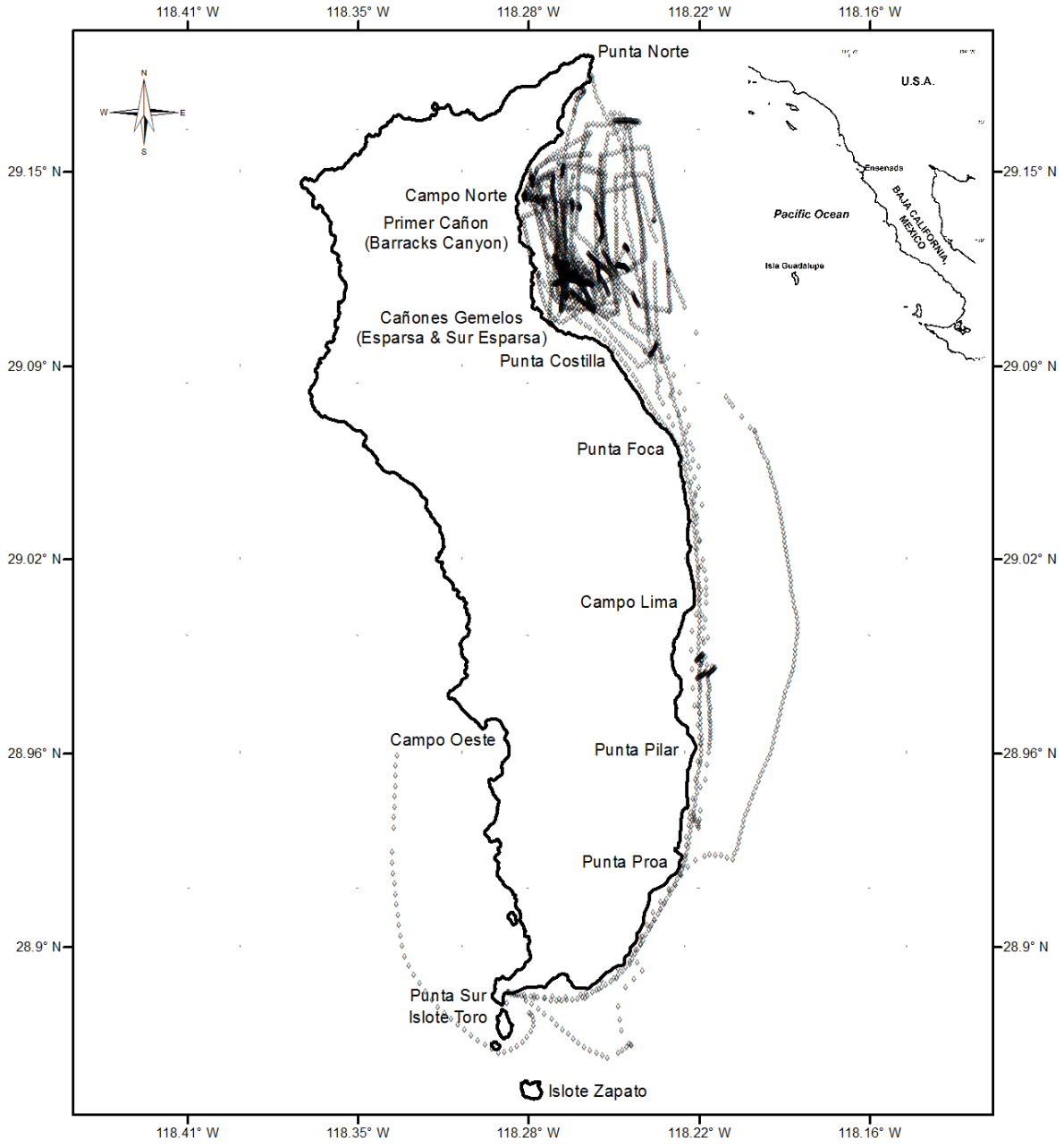

Figure 1. Map of Guadalupe Island and track lines of the search effort in June and August of 2009.

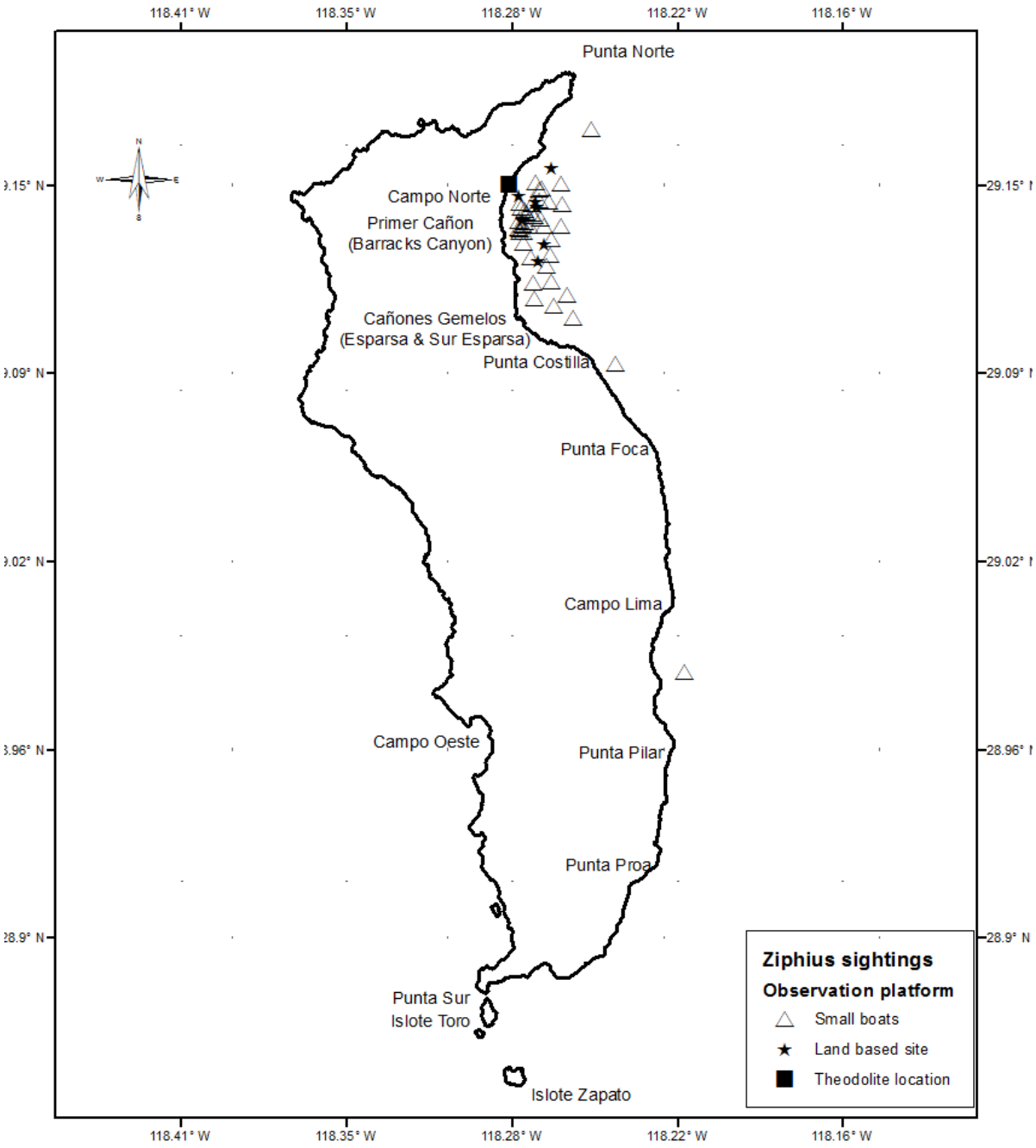

Figure 2. Opportunistic sightings of Ziphius from 2006 to 2008 and sightings recorded on pilot study during summer and autumn of 2009. Only eight geographic positions were recorded from the total of the opportunistic sightings.

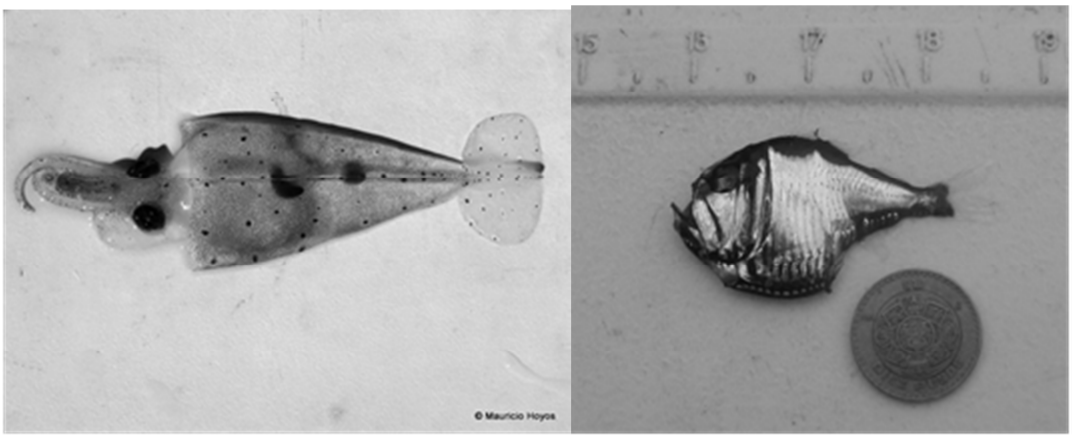

Figure 3. Prey items recorded for the Cuvier´s beaked whale in Guadalupe Island. Left: Individual of the ocean squid, *Leachia dislocata*, collected during the nocturnal feeding event of an individual of Cuvier´s beaked whale. Right: Individual of the mesopelagic fish, *Argyropelecus affinis*, collected in the area where a group of Cuvier´s was recorded in Gemelos Canyons.