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Killer whales (*Orcinus orca*) predation on mysticetes in the Gulf of California, Mexico

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Abstract

Killer whales (*Orcinus orca*) prey on various whale species in the world's oceans. Here, we present seven cases of mysticetes preyed upon by killer whales on the continental coast of the Gulf of California. Five fin whales (*Balaenoptera physalus*), one Bryde's whale (*B. brydei*), and one gray whale (*Eschrichtius robustus*) were preyed upon and partly consumed in the same way over 17 years in different areas of the coast of Sonora, Mexico. The methodology included direct inspection of stranded or floating whale carcasses, analysis of predation marks, and review of videos provided by local fishermen. The notorious way in which whales were preyed upon by cutting and ripping large portions of blubber and skin layers is similar to how the whalers used to flense whale carcasses. No internal organs were consumed, although the tongue was consumed in each event. Most attacks occurred in shallow waters, coinciding with high productivity/upwelling areas. These events provide evidence on killer whales' hunting behavior and consumption patterns, highlighting the importance of shallow waters and selectivity of the skin/blubber and tongue as preferential food, which contributes to understanding the trophic interactions of cetaceans in the Gulf of California.

Keywords:
baleen whales, hunting technique, scarring, whale skin

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Introduction

Killer whales in the Gulf of California (GC) consume a wide variety of prey, including fish such as rays (*Mobula* spp.) and several species of stingrays (Higuera-Rivas et al., 2023), common dolphinfish (*Coryphaena hippurus*), yellowtail amberjack (*Seriola lalandi*) (Guerrero-Ruiz, 2013), whale shark (*Rhincodon typus*), prickly shark (*Echinorhinus cookei*), and bull shark (*Carcharhinus leucas*) (Ayres et al., 2024; Pancaldi et al., 2024; Lara-Lizardi et al., 2025). They also prey on sea turtles such as the olive ridley (*Lepidochelys olivacea*) and leatherback turtles (*Dermochelys coriacea*) (Esquivel et al., 1993; Sarti et al., 1994), and several marine mammals, as common (*Delphinus* spp.) and bottlenose dolphins (*Tursiops truncatus*), Bryde's (*Balaenoptera brydei*), minke (*B. acutorostrata*), fin (*B. physalus*), blue (*B. musculus*), gray (*Eschrichtius robustus*), and humpback (*Megaptera novaeangliae*) whales, and California sea lions (*Zalophus californianus*) (Silber et al., 1990; Jefferson et al., 1991; Guerrero-Ruiz et al., 1998; Guerrero-Ruiz, 2013; Pitman et al., 2023).

Based on photo-identified individuals, four associations of killer whales, or "communities" (*sensu* Guerrero-Ruiz et al., 1998), occur in the GC: 1) the northern part of the Gulf, Canal de Ballenas, and Midriff area, 2) Isla San Pedro Mártir and Guaymas region (Basin), 3) Bahía de La Paz, Loreto and adjacent areas, and 4) mouth of the Gulf of California, from Cabo Corrientes on the mainland to Cabo San Lucas on Baja California Peninsula (Guerrero-Ruiz, 2013). These groups are not static; several individuals identified by Guerrero-Ruiz et al. (1998) and Guerrero-Ruiz (2013) were later observed in the open sea and coastal region of Guaymas (Gallo-Reynoso, unpubl. obs.). This suggests the possibility of different killer whale pods moving throughout the area for food (Fig. 1).

Of the mysticetes (baleen whales) reported as prey of killer whales in the Gulf of California, fin and Bryde's whales are found year-round inside the GC (Vidal & Pechter, 1989; Urbán & Flores-Ramírez, 1996; Gallo-Reynoso et al., 2005). Fin whales constitute a genetically isolated population estimated at approximately 400 individuals (Bérubé et al., 2002; Rivera-León et al., 2019) that move seasonally within the Gulf (Pettis et al., 2000; Urbán et al., 2001). Photo-identification evidence indicates that most fin whales spend the winter and spring in the southern and central Gulf (Arredondo-Sáinz, 2019), and the summer in the Midriff area (Gallo-Reynoso et al., 2005), while data for fall is insufficient for conclusions (Tershy et al., 1990). Such a pattern follows the location of areas of high productivity caused by marine upwellings (Pettis et al., 2000; Urban et al., 2001; Ladrón de Guevara et al., 2015) that occur yearly, during winter and spring months along the eastern coast and during summer and fall months on the western coast of the GC (Maluf, 1983; López-Martínez et al., 2023).

Bryde's whale has been reported in many areas of the Gulf of California (Urbán & Flores-Ramírez, 1996; Gallo-Reynoso et al., 2005). Acoustic profiles and molecular studies together with observational data have suggested the existence of two populations, one in the northern area of the Gulf with resident individuals, and the other in the south in the mouth of the Gulf, probably related to individuals from the Pacific Ocean (Dizon et al., 1995; Urbán & Flores-Ramírez, 1996; Viloria-Gómora et al., 2021). This species has also been observed in areas where fisheries of small pelagic species take place along the eastern coast of the Gulf of California (Gallo-Reynoso, 1991).

Fin and Bryde's whales also reside during the summer months in Canal de Ballenas in the northern area of the Gulf, in higher densities than other parts of the Gulf (Tershy et al., 1993; Gallo-Reynoso et al., 2005; Ladrón de Guevara et al., 2015). Both species have been found in the Midriff area, where high rates of primary production cause rich phytoplankton and zooplankton biodiversity (Álvarez-Borrego et al., 1978), and abundant small pelagic fish, crab larvae (infraorder Brachyura), red pelagic crabs (*Pleuroncodes planipes*), euphausiids (*Nyctiphanes simplex*), and small pelagic fish such as northern anchovies (*Engraulis mordax*), Pacific sardines (*Sardinops sagax*), and other five species of small pelagic fishes (Lanz et al., 2008) that have been reported in the diets of these baleen whales (Gallo-Reynoso, 1990; Gallo-Reynoso et al., 2005; Ladrón de Guevara et al., 2015; Rubio-Rodríguez et al., 2018).

Blue, gray, humpback, and minke whales are known to occur inside the GC (Vidal et al., 1993; Vidal & Gallo-Reynoso, 2006). Blue whales occur in winter-spring on the southwestern side of the GC in the waters of the Bahía de Loreto National Park, and

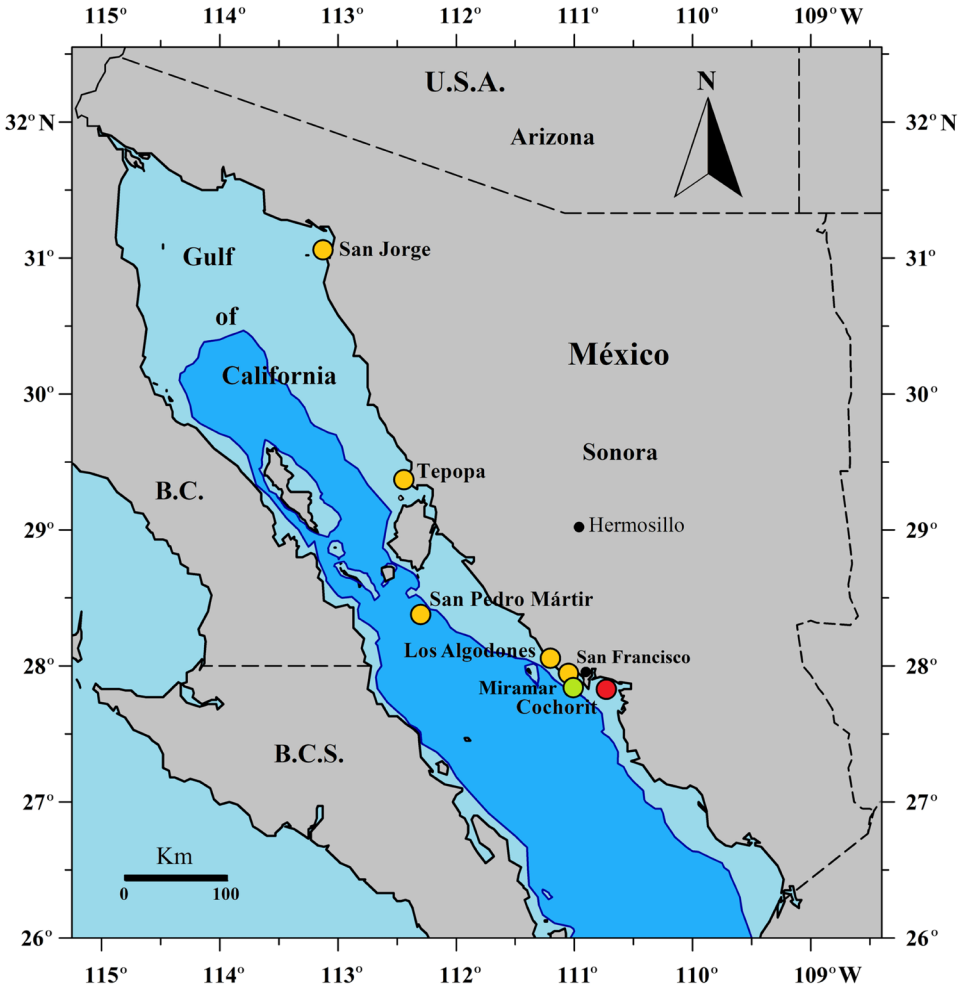

Figure 1. Location of strandings of baleen whales showing incision marks and evidence of being preyed upon by killer whales (*Orcinus orca*) in the Gulf of California. Yellow dots represent the observations of stranded fin whales (*Balaenoptera physalus*), the red dot is the Bryde's whale record, and the green dot is the gray whale record. The 100-fathom bottom limit is shown.

use the area for calving (Gendron et al., 2001), have also been observed in the northern central GC in a feeding ground foraging on krill (Vidal & Gallo-Reynoso, 2006), with several observations in the upper GC (Silber et al., 1994). Analysis of song frequency suggests that blue whales move from the southern region (Punta Pescadero) towards the northern region (Ballenas Channel and Tiburón Island) (Paniagua-Mendoza et al., 2017). It has been suggested that environmental changes could explain the variation in the number of blue whales in the Gulf of California (Whittome et al., 2024).

Gray whales travel inside the GC; the species has been observed mainly during winter and occasionally in other seasons (Vidal et al., 1993). The species had calving grounds on the southeastern coast of the GC, with 30 calves counted in 1954, reducing their numbers in 1971. A posterior observation of five calves with their mothers inside the GC was reported in 1995 (Findley & Vidal, 2002). These authors also mention the presence of killer whales near these calving grounds in southern Sonora during the gray whale's calving season. Mellink & Orozco-Meyer (2002) made a summary of 11 sightings of gray whales in the central and northern part of the GC. They describe a group of 15 gray whales in the area of Punta Jaguey, south to Bahia San Jorge in the northeastern coast of the GC, where the whales performed behaviors that suggested foraging on shallow waters. The whales remained there for two weeks. From February to April 2025, at least five gray whales were observed feeding in shallow waters (3 to 15 m) on the coast of Guaymas, particularly at San Francisco Bay (Gallo-Reynoso & Barba-Acuña, pers. obs., 2025). Humpback whales are occasionally observed in the middle and upper Gulf of California, sometimes foraging together on krill with fin whales (Gallo-Reynoso et al., 2005). They are frequently observed around the tip of Baja California Sur, Bahía de Banderas, and inside the GC at Islas Marías and Isla Isabel during winter-spring when the whales congregate for calving and mating (Zavala-Alarcón et al., 2021). Finally, minke whales are also found year-round in the northern GC (Vidal et al., 1993; Vidal & Gallo-Reynoso, 2006) but are rarely reported; the species is probably subject to predation by killer whales, as stated by Silber et al. (1990).

A recent work on fatal killer whale attacks on fin whales in several areas of the world, including the Gulf of California, described attacks in the Baja California coast inside the GC (Pitman et al., 2023). In this article, we account for the predation of mysticetes by killer whales using a combination of stranding data and video records in the waters of the coast of the state of Sonora, in the continental side of the Gulf of California, Mexico.

Material and Methods

The study area included the coast of Sonora State in México, which is found in the eastern coast of the Gulf of California, with 1,209 km of coast, where we have been attending strandings of marine mammals since 1995. The evidence of mysticetes preyed upon by killer whales was obtained from attending six strandings of dead whales following notifications by fishermen or local authorities in different areas of the coast, and from the analyses with VLC media player© of one event consisting of six videos (total of 08:34 min) taken with a mobile phone, provided to us by a fisherman on the attack and killing of a Bryde's whale by a pod of killer whales. Stranded or floating dead whales were inspected by us to determine the cause of death (Figs 2 to 7). We measured total length and determined the age class of all the individuals, except for one, whose sex could not be determined because of the decomposition stage. Photographs of the predation marks on different body sections were taken for further descriptions. Descriptions of the scars and wounds observed on the bodies of the baleen whales were done using the terminology from Corsi et al. (2022) as parallel shallow scars.

Results

Seven killer whale predation events were examined, for the period 2008 to 2025, with fin (n = 5), Bryde's (n = 1), and gray (n = 1) whales being targeted (Table 1). The strandings occurred in the middle (n = 6) and northern (n = 1) Gulf of California (Table 1; Fig. 1). Six events took place during the winter-spring seasons,

Figure 2. Deep and long surface incisions produced by the teeth of killer whales (*Orcinus orca*) on the skin of an adult female fin whale (*Balaenoptera physalus*). This flensing allowed killer whales to tear large sections of skin and blubber from the fin whale.

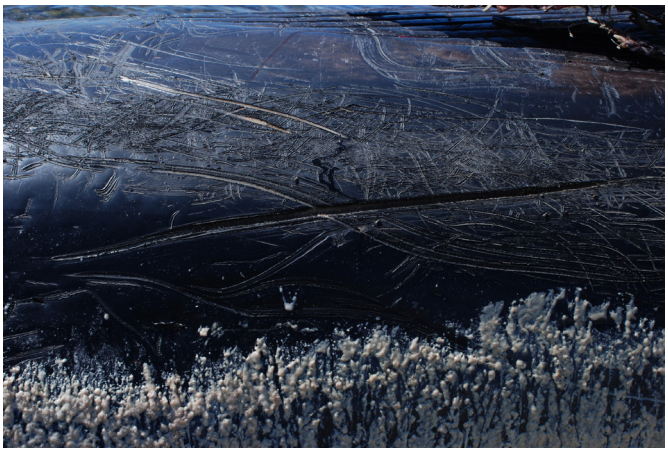

Figure 3. Multiple incisions or scarring produced by the killer whale's (*Orcinus orca*) teeth in probable attempts to tear and remove sections of skin and blubber of a fin whale's (*Balaenoptera physalus*) body. Los Algodones, Guaymas. March 2008.

Figure 4. Large triangular portions of skin and blubber were removed from the body of an adult female fin whale (*Balaenoptera physalus*). The dorsal fin can be appreciated. Los Algodones, Guaymas. March 2008.

Figure 5. The same method used by killer whales (*Orcinus orca*) to peel long sections of skin and blubber of an adult female fin whale (*Balaenoptera physalus*) was observed in the field at Bahía San Jorge. March 2008.

Figure 6. Subadult Bryde's whale (*Balaenoptera brydei*) killed on 18 March, 2024, and a day after being killed and partially eaten by a pod of 15 killer whales (*Orcinus orca*). Note the skin and blubber removed by the killer whales. The tongue was consumed entirely.

Figure 7. Adult female gray whale (*Eschrichtius robustus*) stranded at Miramar Bay in Guaymas, Sonora. The whale shows signs of having been killed and partially eaten by killer whales (*Orcinus orca*). Skin and blubber removed; missing tongue, apparently eaten.

and one occurred in early summer. Three of the fin whales stranding areas correspond to areas where they congregate to forage on krill over large upwelling zones on the coast of Sonora. The video of an attack on a Bryde's whale occurred in an area known for its abundant small pelagic fish (Fig. 1). Of these, two of the probable fin whale killings occurred in 30 to 80 m-deep waters with rocky bottoms where upwellings occur; another was probably attacked in shallow water (-30 m deep) with sandy bottom, a characteristic of the upper Gulf of California. And two occurred at unknown areas of the middle GC, as carcasses can travel for considerable distances before stranding at Isla San Pedro Martir and Cabo Tepopa.

The attack on a Bryde's whale happened near Cochorit beach in waters 12 m deep. It was videotaped in March of 2024 and consisted in a pod of 15 killer whales, with at least four large males that chased and attacked on the whale's flanks; one of the large males prevented the whale from breathing as this killer whale stumped on top of the Bryde's whale in several occasions until the latter was floating on its side with one of its tail lobes in the air, then assumed to have drowned as breathing was no longer evident. This was similar to a predation event by killer whales on another Bryde's whale described by Silber et al. (1990) in the upper Gulf of California. Once it was dead, the four large males of the referred pod fed on it, then a group of females with calves, and then a group that seemed to be medium-sized individuals, probably juveniles, and subadults.

The regional stranding network reported the gray whale stranding to us. All evidence on this attack came from the examination of its carcass. We attended the stranding at Miramar Bay, Guaymas (central Sonora) on 22 April 2025. However, a week before, a pod of killer whales was observed on several days and captured in video off the coast of Guaymas, near Isla San Pedro Nolasco, killing a long-beaked common dolphin (*Delphinus delphis bairdii*). It is unknown where this gray whale was attacked by this pod and the probable location.

Fin whales, the Bryde's whale, and the gray whale carcasses exhibited "scarring" or rake marks on the skin (Corsi et al., 2022). We found deep longitudinal and "S"/oblique shaped scars along

Table 1. Summary of seven baleen whales found stranded and partially eaten by killer whales (*Orcinus orca*) on the Gulf of California. Sites are arranged north to south.

Location	Date and Geographic location	Species	Age and sex	Total length (m)	Notes
Bahía San Jorge	28 Mar 2008 31°03′34.78″ N, 113°07′35.64″ W	*B. physalus*	Adult female	17	Tooth marks of large and small killer whales. Tongue missing.
Tepopa	02 Dec 2012 29°22′11.03″ N, 112°26′32.68″ W	*B. physalus*	Unsexed subadult	15	Tooth marks of killer whale and scavenger sharks. Tongue and baleen section missing.
Isla San Pedro Mártir	24 Apr 2007 28°22′37.61″ N, 112°18′01.92″ W	*B. physalus*	Adult male	18	Tooth marks of an adult killer whale. Tongue missing.
Los Algodones	13 Mar 2008 27°59′116″ N, 111°08′605″ W	*B. physalus*	Adult female	15	Tooth marks of an adult killer whale. Lips and tongue missing.
San Francisco, Guaymas	27 Jun 2012 27°57′16.48″ N, 110°58′45.85″ W	*B. physalus*	Unsexeadult	18	Tooth marks of killer whales and scavenger sharks. Tongue and baleen are missing.
Cochorit, Guaymas	19 Mar 2024 27°53′15.191″ N, 110°47′56.311″ W	*B. brydei*	Subadult male	16	Video of the attack by killer whales. No tooth marks. Tongue and skin blubber are missing.
Miramar, Guaymas	22 Apr 2025 27°54′25.86″ N, 110°57′29.34″ W	*E. robustus*	Adult female	14	Raking and killer whale tooth marks. Tongue and skin blubber are missing.

the whales' bodies, accompanied by shallow longitudinal scars and multiple rake marks in several directions likely made with the killer whales' teeth (Fig. 3). We also found large scars of a triangular shape in the central flanks of the whale's body, just below the dorsal fin, where the whale's skin and blubber chunks were presumably cut and ripped off by killer whales (Fig. 4). Also, large sections of skin and blubber were ripped off from the body like "flensing", and the missing tongue in all stranded whales confirms that killer whales preyed upon them (Figs 2 to 7).

Killer whales consumed the skin and blubber layers along the flanks and other portions of the whales' bodies, such as the dorsal area. Conical bites were extensive over the entire gular region of the fin whales, and large cuts on the lips and jawbones were evident in three cases, presumably done by killer whales to open the mouth of the baleen whale and tear off bits of the tongue, which in all cases had been consumed completely (Table 1). In some instances, jawbones were devoid of their lips and associated skin. Areas rarely eaten were the gular and the upper rostrum, dorsal fins, flippers, and caudal lobes (Figs 2 to 7).

Scavenger sharks' bites were observed on two fin whale carcasses, in the Bahía San Francisco (Guaymas) and Tepopa strandings (Table 1).

Discussion

Evidence of harassment and killing of several species of whales exists from the Gulf of California. Vidal & Pechter (1989) described the harassment by three killer whales of a pod of fin whales in the open ocean near Tojahui in the southern coast of Sonora. The killer whales attacked two fin whales, while the other 18 fin whales moved outside the area. The depth of the area was 50 m, and the authors suggested that the attack was unsuccessful because the whales moved fast and steadily to the west, to deeper areas. Findley & Vidal (2002) described the harassment of a juvenile fin whale that later died near Bahia de Yavaros after stranding itself to escape from the predators. The description provided by fishermen and the video supplied to us documenting the attack and killing of an adult Bryde's whale complements the information from a similar predation event described in Silber et al. (1990) in the northern GC.

We have not found reports or any other documented instances in which such long and triangular cuts were found on the body of a dead whale and thus seem to be an unequivocal sign of feeding by killer whales. Pitman et al. (2023) compiled and described the bites and flesh chunks taken from adult fin whales by killer whales, but no long cuts are visible on stranded fin whales on their account. They also found a stranded healthy adult fin whale with no marks, similar to the description from Findley & Vidal (2002) of a young fin whale that stranded itself to escape the killer whales. Pitman et al. (2023) describe scars made by killer whales to fin whales in their predatory attempts; therefore, it is essential to note that using scar characteristics is a standard methodology to investigate predator-prey relationships between baleen and killer whales. For example, Corsi et al. (2022) used this method to study predator-prey interactions in humpback, blue, and gray whales in the northeastern Pacific Ocean. However, the deep long, triangular clean cuts we observed in the preyed-upon whales in the GC appear to be unique and may reflect specific feeding strategies employed by killer whales in this region.

Five of the predation events documented in this article occurred in shallow waters; two occurred at unknown locations, one stranding in a far offshore island, and the other, the gray whale killed, might have happened in a coastal shallow area.

Attacking in shallow water helps prevent the targeted prey whale from escaping by diving deep; it also makes the dead whale more accessible for feeding as it lies on the shallow bottom, which is consistent with tall blows that indicate long dives/apneas performed by killer whales, as observed in the 2024 video-recorded attack. A feeding hierarchy was evident in this case, with the large males feeding first, as noted in other killer whale predation cases (Jefferson et al., 1991). However, this seems to depend on the number of killer whales participating in the predation event (Jefferson et al., 1991). The contrary has been observed in killer whale pods where calves were allowed to feed first on the whale's body (Jefferson et al., 1991).

All seven whales examined by us were "flensed" in a similar way; the skin and blubber layer were ripped apart from muscle and bone, identical to that done by whalers in the whaling industry, by removing long sections of skin and blubber of the whales, separating it from the whales' muscles and bones for processing (Dozier, 1977).

Although we are presenting seven predation events, they are spaced far apart in time, which means that fin, Bryde's, and gray whales in the GC somehow can escape these predators elsewhere in the Gulf, perhaps by fleeing at high speed (Vidal & Pechter, 1989) or diving deep. Fin whales in the Gulf of California are capable of diving to 180 m, as shown by Croll et al. (2001) and records of deep dives to 120 m to forage on krill (*Nyctiphanes simplex*) as observed by us in an echosounder (Gallo-Reynoso, unpub. data). Bryde's whales are known to dive to depths of 173 m (Alves et al., 2010) in the Azores, also while foraging. Off Guaymas (off Miramar Bay), dives of more than 50 m deep have been recorded, while individuals of the species feed on small pelagic fishes (Gallo-Reynoso, unpub. data). As these mysticete whales can dive deep, they might escape the chasing killer whales in deep areas of the Gulf of California (Vidal & Pechter, 1989). Anyhow, killer whales are able to dive deep too, about 160 m to herd fish to shallower areas (Nøttestad & Similä, 2001) or to search for jumbo squid (*Dosidicus gigas*) to 260 m in the GC (Gallo-Reynoso, unpub. data). As both killer whales and mysticetes can deep-dive, it is therefore perhaps more a question of chasing energy expenditure, related to energy gain by predation of a large prey (Carbone et al., 2007). The reason killer whales aim specifically for the skin-blubber layer, lips, and whole tongue of their baleen whale targets seems to relate to the more energy-rich parts of their prey. According to Sih (1980), in Jefferson et al. (1991), this might maximize net energy gain from their prey. To hunt and kill large prey to obtain energy-rich food intake, killer whales might herd the whales to shallow locations to surround them and prevent their escape and chase the whale until it is tired and with a reduced diving capability as described by Jefferson et al. (1991), similar to the attack observed on the Bryde's whale videos near Cochorit beach.

The increasing access to underwater cameras, drones, and cameras on mobile phones has facilitated the recording of ecological events and has helped document the behavior of killer whales and some species of their prey base in the Gulf of California (Ayres et al., 2024; Lara-Lizardi et al., 2025). In this compilation of killer whale predation events on stranded mysticetes whales in the Gulf of California, citizen science played an essential role, specifically the video sent by fishermen, who, having access to video recording on their mobile phones, are now able to share their findings with scientists.

This research presents evidence of seven predation events on mysticetes by killer whales in the Gulf of California, revealing attack patterns to obtain energy-rich prey and the description of the parts of the whales that were methodically ripped off, such as long portions of skin and blubber, and the removal of the whale's tongue as food. This constitutes an advance in understanding killer whales' predation relationships with large cetaceans in the GC. This information will help us understand the distribution of these trophic interactions and ecological processes along the Gulf of California.

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