

The value of evidence about past abundance: marine fauna of the Gulf of California through the eyes of 16th to 19th century travellers

Andrea Sáenz-Arroyo^{1,2}, Callum M. Roberts², Jorge Torre¹, Micheline Cariño-Olvera³ & Julie P. Hawkins²

¹Comunidad y Biodiversidad A.C., Boulevard Agua Marina #297 entre Jaiba y Tiburón Colonia Delicias C.P. 85420, Guaymas, Sonora, México; ²Environment Department, University of York, York YO10 5DD, UK; ³Universidad Autónoma de Baja California Sur, Área Interdisciplinaria de Ciencias Sociales, Apartado Postal 19-B, La Paz 23080, Baja California Sur, México

Abstract

Eyewitness accounts written by early travellers to 'the new worlds' provide valuable insights into how seascapes once looked. Although this kind of information has been widely used to chart human impacts on terrestrial ecosystems, it has been greatly overlooked in the marine realm. Here we present a synthesis of 16th to 19th century travellers' descriptions of the Gulf of California and its marine wildlife. The diaries written by conquerors, pirates, missionaries and naturalists described a place in which whales were 'innumerable,' turtles were 'covering the sea' and large fish were so abundant that they could be taken by hand. Beds of pearl oysters that are described had disappeared by 1940 and only historical documents reveal the existence of large, widespread, deep pearl oyster reefs, whose ecology and past functions we know little about. Disqualifying the testimonies of early visitors to a region as 'anecdotal' is dangerous; it may lead to setting inappropriate management targets that could lead to the extinction of species that are rare today but were once much more abundant. Moreover, it represents unfair historical judgement on the work of early natural historians, scholars and scientists. We suggest that the review and analytical synthesis of reports made by early travellers should become part of the pre-requisites for deciding how to manage marine ecosystems today.

Correspondence:

Andrea Sáenz-Arroyo, Comunidad y Biodiversidad A.C., Boulevard Agua Marina #297 entre Jaiba y Tiburón Colonia Delicias C.P. 85420 Guaymas, Sonora, México
Tel.: +52 622 224 4989
Fax: +52 622 222 4990
E-mail: asaenz@cobi.org.mx

Received 1 Nov 2005
Accepted 1 Mar 2006

Keywords extinction, historical ecology, over-exploitation, shifting baseline syndrome

Introduction	129
Methods	129
The diaries of the early visitors	129
Results	132
Infinite numbers of whales	132
Turtles covering the sea	133
A place like Newfoundland	138
The enemies of pearl divers	138

Pearl oysters: the collapse of a fishery that endured for two millennia	139
Porpoises in the southern Gulf of California?	140
Discussion	142
Acknowledgements	143
References	143

Introduction

It is only recently that we have started to recognize that ecological monitoring by itself is a poor tool to understand human impacts on coastal ecosystems (Pauly 1995; Jackson 1997; Carlton 1998; Jackson *et al.* 2001; Pitcher 2001; Lotze 2004; Lotze and Milewski 2004; Sáenz-Arroyo *et al.* 2005a). Referring to the former abundance of green turtles *Chelonia mydas* (Cheloniidae) nesting in the Caribbean, Jeremy Jackson illustrates the difference between how we see the seascape today and how early Europeans visiting America witnessed it (Jackson 1997). The observation of a visitor in the 1600s affirmed that vessels that had lost their course as a result of bad weather could recover it simply by following 'the noise which these creatures [green turtles] make in swimming to attain the Cayman isles' (Jackson 1997). Highly impressed by this quote, it stimulated us to ask questions. Did other contemporary diaries draw a similar picture of how the New World once looked? Did early visitors make notes on the abundance of other large and vulnerable animals such as whales, seals or large fish? Being aware of the ominous consequences that can arise in conservation policy for vulnerable species as a result of 'the shifting baseline syndrome' (Pauly 1995; Baum and Myers 2004; Sáenz-Arroyo *et al.* 2005b), we think that a pre-requisite for trying to manage marine ecosystems should be to put together early testimonies on how the seascape once looked. We certainly think that this is crucial for trying to better understand the effects of human impacts on coastal ecosystems.

Here we present a review of the published diaries of some of the early travellers who visited the Gulf of California, an enclosed sea northwest of Mexico (Fig. 1). This is likely to represent only a small fraction of what is available and still waiting to be discovered in other archives such as *Archivo de Las Indias* in Sevilla, Spain or *Archivo General de la Nación*, in Mexico City. Any further information that

is subsequently revealed will help strengthen the findings of this paper.

Methods

From July 2002 to April 2004, we visited four main libraries to collect most of the diaries, letters and books presented in this review: Biblioteca de las Californias in La Paz, Baja California; Fondo Reservado of Biblioteca Nacional of Universidad Autónoma de México (UNAM) in Mexico City; Bancroft Library at the University of California, Berkeley in the USA; and the Bodleian Library at Oxford in the UK.

The diaries of the early visitors

For almost 500 years, the Gulf of California, alternatively known as 'The Sea of Cortez,' has been visited by explorers who left testimonies of what they observed in the course of their travels (Lindsay and Engstrand 2002). Some of the earliest reports belong to Spanish conquerors who travelled to the mythic 'island' of California. Although Hernán Cortez himself visited the area in 1535, he left no diary (Wagner 1924). Some of the earliest accounts of Spanish exploration were from the crew on Francisco de Ulloa's Expedition to the Gulf of California in 1539. Commanding three large vessels, *The Santa Agueda* with a capacity of 120 tonnes, *the Trinidad* with 32 tonnes and *Santo Thomas* with 20 tonnes, Ulloa was sent by Cortez to explore the geography of this 'island.' The account provided by Ulloa himself (Wagner 1924) and another one written by one of his contemporaries, Captain Francisco Preciado [Hakluyt 1600 (reprinted 1906)], gives particularly good geographic descriptions and provides important testimony about the marine megafauna that they saw. Subsequent Spanish travellers to the area have written about the great general marine diversity they observed and also described the extensive banks of

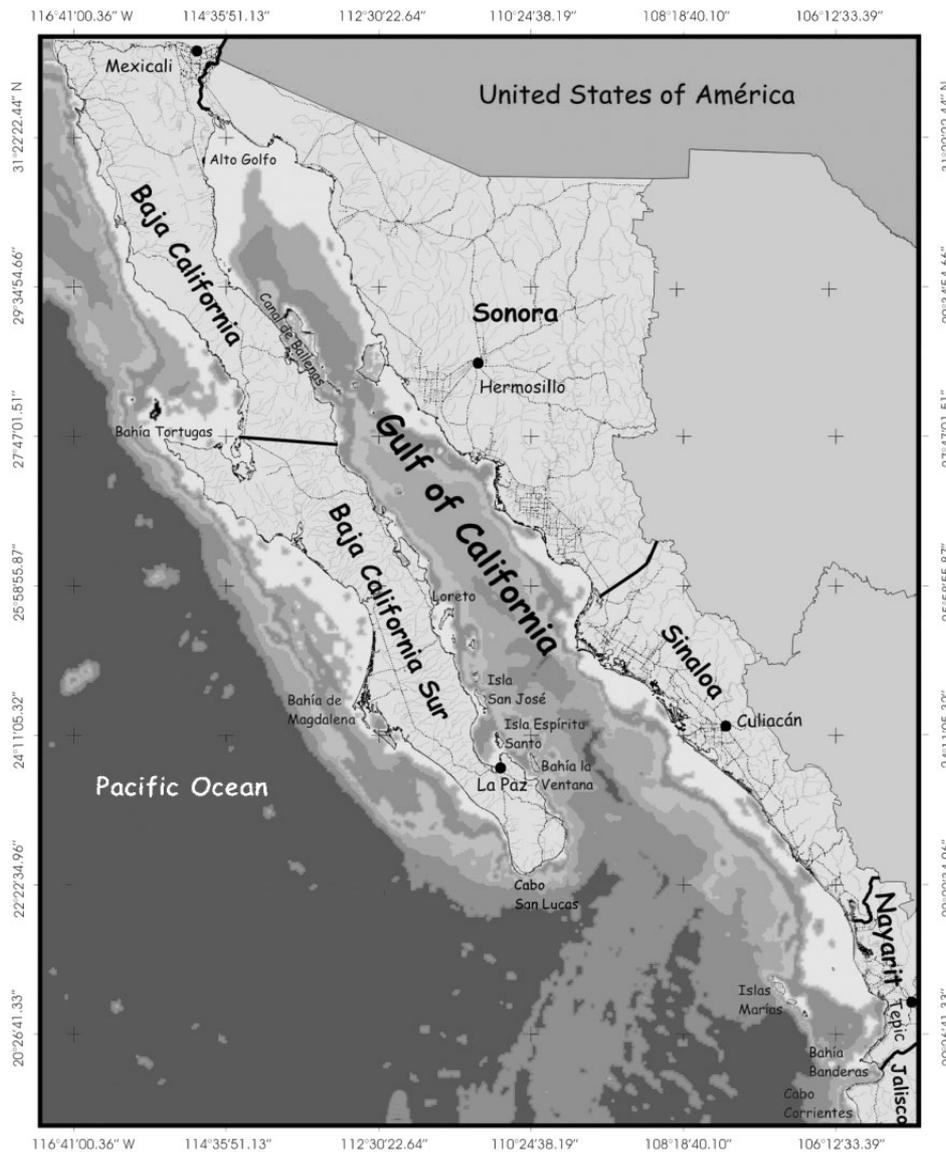


Figure 1 The Gulf of California.

pearl oysters, which they sought. Some of the ones we found useful were diaries written by Antonio de la Ascención, Francisco de Ortega, Esteban Carbonel and Nicolas de Cardona [de-la-Ascención 1602 (1970); Carbonel 1632; Cardona 1632 (1974); de-Ortega 1636 (1970)].

By the end of the 17th century, after many failures to establish colonies and the first report of an alarming depletion of the coastal pearl stocks (Cariño-Olvera 2000), Spanish expeditions to the area were significantly reduced, and the region attracted the attention of European buccaneers

(Gerhard 1990). During this period, privateers or buccaneers had two main reasons to frequent the area. The first was that for the entire 18th century this enclosed sea offered several good harbours, almost unvisited by Spaniards, where captains could careen their ships or get protection from nasty weather (Gerhard 1963). The second reason was due to Thomas Cavendish's successful enterprise in the late 1580s in capturing 'the Manila boat,' a Spanish vessel that each year carried gold, jewels and other wealth between Manila and Acapulco. By the 17th century this enterprise had become a

legend among English seamen [Rogers 1711 (1970)].

Pirates frequently made detailed journals of their expeditions in distant oceans. On returning home, the epic accounts of their trips were warmly welcomed by the publishers. Examples include books by Thomas Cavendish, Woodes Rogers, William Dampier, Edward Cooke and George Shelvocke.

Some buccaneers left important descriptions not just of the natural world, but of the culture of the inhabitants they encountered (Fig. 2). Among them are diaries from Woodes Rogers and his companions at the beginning of the 18th century [Dampier 1697 (1968); Rogers 1711 (1970); Cooke 1712 (1969)] and George Shelvocke's journal published in 1726 [Shelvocke 1726 (1928)]. Concerned with

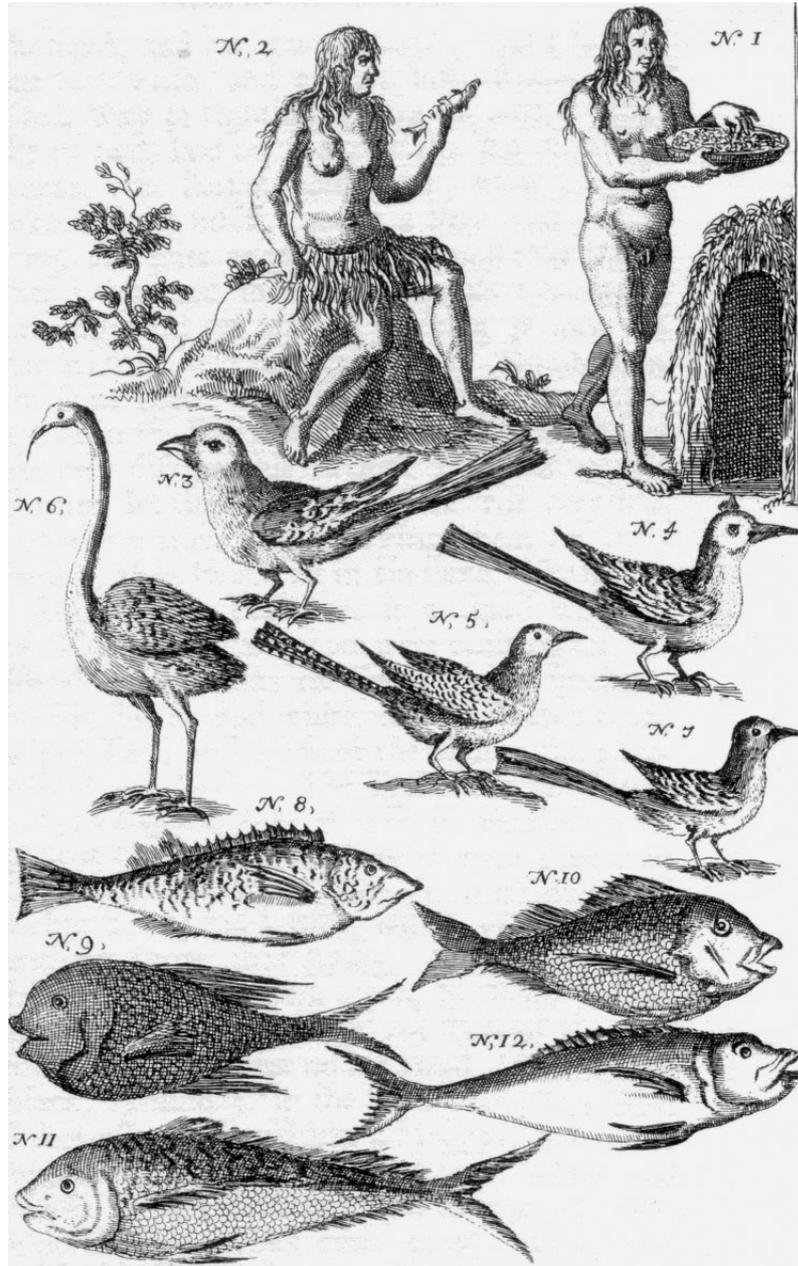


Figure 2 From Captain Edward Cooke's description of Baja California's people and natural history [Cooke 1712 (1969)].

keeping their crews well fed and healthy (scurvy was a serious problem on long voyages in these times), the captains' diaries paid special attention to the abundance of species they used as food, such as turtles and groupers. Edward Cooke's and later George Shelvocke's diaries went even further, making detailed descriptions of the area's natural history and early inhabitants. These constitute some of the region's first ethnological descriptions (Fig. 2) and provide an important insight into the past abundance of several species.

Eighteenth century was the time when missions were established in Baja California. Missionaries, who spent their lives trying to establish the first agricultural societies in this deserted peninsula, made detailed descriptions of Baja California's natural history and the cultures of its inhabitants. Although not seamen or navigators, their observations on the feeding habits and fishing methods of the early Californians provided an interesting insight of how the seascape might have looked in the 1700s. Examples are the diaries, books and letters left by Miguel del Barco, Francisco Javier Piccolo, Johann Jakob Baegert, Francisco Javier Clavijero and José Longinos [Piccolo 1702 (1962); del-Barco 1757 (1988); Baegert 1771 (1952); Clavijero 1789 (1971); Bernabéu 1994]. All of them, except Baegert's diary, which is conspicuous by his negative view of everything he observed in this land, are notable for their impressions of the abundance and richness of the sea surrounding Baja California. However, with the Jesuits expulsion in 1768 and the early 19th century missions' secularization (1800–1830), missionaries disappeared from the area and with them an important source of natural history descriptions also disappeared.

Finally, the diaries of scientific expeditions sent to explore the fisheries resources in the area also provide important insight into the past abundance of marine fauna. Some examples are James Colnett's 1798 diary of an expedition to explore the possibility of expanding the English sperm whale fishery at the end of the 18th century [Colnett 1798 (1968)]; Browne's compilation 'Resources of the Pacific Slope,' including Alexander S. Taylor's extensive information about Lower California (Browne 1869), Captain Scammon's book on hunting marine mammals in the area at the end of the 19th century [Scammon 1874 (1968)]; José Maria Esteva's 1857 examination of the pearl fishery (Esteva 1857); Alexander B. Agassiz's diary of his 1889 expedition

in the *Albatross* (Agassiz 1889); and Leon Diguët's observations between 1888 and 1894, published in 1912 (Diguët 1912).

Results

Infinite numbers of whales

Large whales were frequently quoted by travellers in the 16th to 18th centuries as 'infinite in number,' 'the multitude seen' or 'impossible to be counted' [de la Ascención 1602 (1970); Clavijero 1789 (1971); Colnett 1798 (reprinted in 1968)]. Some of the place names arising from these observations are still in use today. An example is a channel near the middle of the peninsula, where according to Clavijero's diary 'the multitude of whales seen by sailors in that narrow space of sea which is between the peninsula and the island of Angel de la Guardia causes this sea to be named *Canal de Ballenas* (whale channel)' [Clavijero 1789 (1971); Clavijero (1789) 1990]. He observed that because no whales had been caught he could not state what species they were but that 'in consideration of what is said about them they may belong to that species to which Linnaeus gave the name '*physalus*' [Clavijero (1789) 1990]. He was perhaps right, as recent researchers have studied a population of 148 marked fin whales *Balaenoptera physalus* (Balaenopteridae) at Canal de Ballenas (Thershy *et al.* 1990).

The number of whales before whaling operations started in a region appears to have been very large. The diary of Francisco Preciado, captain of one of the vessels from the Ulloa Expedition, recorded three large pods of 'above 500 whales' that followed his ship for about 1 h 'which were so huge, as it was wonderful' [Hakluyt 1600 (reprinted 1906)]. By contrast, the largest pods of whales seen today are sperm whales, *Physeter macrocephalus* (Physeteridae), which rarely number more than 12 adult females accompanied by their young (Reeves *et al.* 2002).

At the onset of commercial whaling in the Gulf of California, at the end of the 18th century, whales were apparently so large that even the most experienced whalers found it difficult to identify them. In his 1798 diary, James Colnett wrote 'I am ready to confess that I was deceived respecting the species of whale which I saw when I was on the coast before; and at this time the hump-back whale was so much larger than generally believed, and spouted in a manner so different from their usual mode of throwing up the water, that the most

experienced fisherman I had on board believed them to be black whale¹ and pursued them as such; and I very much doubt whether that species of whale, which the Spaniards call the small whale, is any other than blackfish [pilot whales]. This opinion was confirmed by a whaler, with whom I fell in company some time after. He had come down the coast of California, and boasted of the number of spermaceti whales which he had seen.... but he soon satisfied my doubts on the subject: for being with me on the board of *the Rattler*, and seeing a shoal of black fish he insisted they were spermaceti whales' [Colnett 1798 (reprinted in 1968)]. After his deliberation about species size and identification, Colnett gives more testimony about the incredible size of the whales he observed in these waters 'We cruised between the Cape Corrientes, the South cape of the Gulf of California, and the northernmost of Maria Isles, till the seventh of November, and saw great numbers of spermaceti whales, some of them the largest we had ever seen, but we may be truly said to be unfortunate, as we only killed two of them' [Colnett 1798 (1968)].

When the first Spanish explorers arrived, they also described sea lions *Zalophus californianus* (Otariidae) as being incredibly abundant (Table 1). The observation by Francisco de Ulloa in 1539 at San Luis Gonzaga Bay of 'so many sea lions that were I to say there were a hundred thousands, I think I would not be exaggerating,' speaks by itself. Taking into account that by 2001 the entire sea lion population of Lower and Upper California was around 175 000 (Reeves *et al.* 2002) and just 31 000 for the Gulf of California (Seal Conservation Society 2004), this number in a single bay is very impressive. The abundance appears to have continued until the second half of the 19th century when sea lions began to be hunted for commercial purposes on both coasts of Lower California [Scammon 1874 (reprinted in 1968); Zavala-Gonzalez and Mellink 2000]. In 1874, Captain Scammon wrote about the sea lions 'great numbers were taken along the coast of Upper and Lower California, and thousands of barrels of oil obtained.' His description continues by saying that 'the number of seals slain exclusively for their oil would appear fabulous, when we realize the fact that it requires on an average, throughout the season, the blubber of

three or four Sea Lions to produce a barrel of oil' [Scammon 1874 (reprinted in 1968)]. The account of Leon Diguët, a French chemist hired by the copper mine 'El Boleo,' who became intrigued by the ethnology and natural history of Baja California (Lindsay and Engstrand 2002), is also interesting testimony to the effects of commercial exploitation on sea lion populations. In 1912, writing of his observations made in 1884–1894 'Otaria, named in this country as sea lion, was very abundant in the Baja California western coast in other times; today, as a result of intense destructive hunting, it is rare and tends to disappear. Forty years ago, every promontory and rocky reef sprinkling the coast constituted what is called *Loberas*, namely, refuges where sea lions used to rest in herds. As a consequence of the incessant hunting, *Loberas* had one by one disappeared from the coast and now are just found in some remote islands' (Diguët 1912). In recent times, sea lion populations have undergone a recovery in the area, increasing by at least fourfold since the 1970s, to reach numbers now estimated at about 31 000 individuals (Reeves *et al.* 2002). However, based on early accounts quoted above, numbers still lie far below those observed by the first explorers.

Turtles covering the sea

The first important descriptions of sea turtle populations in the Gulf of California come from the diaries of pirates [Dampier 1697 (1968); Gerhard 1963; Rogers 1711 (1970); Cooke 1712 (1969)]. Sea turtles were a favourite source of protein for the buccaneers and helped them combat the symptoms of scurvy. Tres Marias Island, a small archipelago located around 90 km west of Cape Corrientes (Fig. 1), was a favourite site to catch and store great quantities of sea turtles while water containers were refilled. The diaries of Edward Cooke and Woodes Rogers provide testimony that these islands were an important breeding ground for green turtle *C. mydas agassizi* (Cheloniidae) and possibly for hawksbill *Eretmochelys imbricata* (Cheloniidae) [Rogers 1711 (1970); Cooke 1712 (1969)]. They reported taking about 100 females in a night as provisions for the following weeks. Peter Gerhard also reports that in La Paz Bay, French buccaneers spent weeks repairing their ships and eating turtles which at that time 'swarmed around' (Gerhard 1963). In the missionaries' diaries, both green turtles and hawksbills are mentioned as commonly exploited by local Indians

¹Black whale was one of the early names of sperm whales. Today the maximum size of this species is a little larger than that of the humpback whale *Megaptera novaeangliae*.

Table 1 Historical observations of marine life in the Gulf of California.

Place	Date	Quote
Whales		
Close to Cabo San Lucas	Early April 1540	'Having pass the point of this port our captain thought it good to launch forth into the main Ocean: yet although we ran a swift course, above 500 whales came athwart of us in 2 or 3 schools within one hour space, which were so huge, as it was wonderful, and some of them came so near into the ships, that they swam under the same from one side to another, whereupon we were in great fear, lest they should doe us some hurt, but they could not because the ship had a prosperous and good wind, and made much way, whereby it could receive no harm, although they touched and stroke the same.' [Hakluyt 1600 (1906)]
Gulf of California	1602	'In ancient maps this place is named " <i>Erseñada o Seno de Ballenas</i> " and this is because along the coast until Mendocino Cape [whales] are so abundant that counting will be impossible and you will not believe it unless seen by you...' [de-a-Ascención 1602 (1970)]
Cabo San Lucas Bay	1602	'...there are, as I have said, infinite numbers of great whales and great abundance of great sardines that are, as is said, the common food of whales, and may be, for this reason there are here such a great abundance....' [de-la-Ascención 1602 (1970)]
Canal de Ballena, Angel de la Guarda Island	1789	'The crowd of whales observed by sailors in the narrow space between Angel de Custodio island, inspired its name <i>Canal de ballenas</i> ; since none had been ever fished we do not know which species are they; however, in attention of what is described about them I think this is the species that Linneo called <i>physalus</i> .' [Clavijero (1789) 1990]
Close to Cabo San Lucas	4 October 1793	'On the fourth of October in latitude 23° 15', we made the coast of California. ...on our passage we saw a few turtles, with killers ² , porpoises and blackfish ³ ; the latter were innumerable as we approached the land.' [Scammon 1874 (1968)]
Sea lions		
San Luis Gonzaga Bay, 29° 48'	28 September 1539	'I found it to be a port as fine and big as could be. Once inside it is so closed in on all sides that the sea is not visible.... Inside I found so many seals ⁴ that were I to say there were a hundred thousands, I think I would not be exaggerating. For this reason we call it the Puerto de Lobos' (Wagner 1924)
A 'white island' four leagues ⁵ north from Tiburon Island	1632	'Through the night strange noises, like dogs tending livestock were heard from the shore. At sunrise we saw a small white island and I took the ship's boat with some of the personnel and went to it. We found a great number of sea lions, so many that we almost could not reach the shore without passing over them' [Cardona 1632 (1974)]
Lower California	1869	'Seals ⁶ swarm by myriads everywhere and this branch of the industry has been heretofore almost entirely neglected' (Browne 1869)
Turtles		
La Paz Lagoon	Few weeks after 11 September 1688	'During the next few weeks the buccaneers rested from their endeavours in the shallow lagoon at the south end of La Paz Bay, catching the sea turtles that swarmed about.' (Gerhard 1963)
Marias Islands	11 October 1709	'Capt Dover went himself and sent his servant with his necessities abroad the <i>Dutchess</i> . In the evening they came to sail and carried above 100 large turtles that we brought to them in our boats for victualling to save salt provisions.' [Rogers 1711 (1970)]
Marias Islands	October 1709	'There are several sorts of sea-tortoises as the green, which is sweetest and the best; next to it is the logger-head... the hawks-bill and other sorts are very strong and consequently not so agreeable or wholesome as the above mentioned. Some sea tortoises weigh near 400 pounds and are sometimes taken at sea, sleeping on the water or else ashore by turning them on their backs so they cannot turn it again. We sometime took 100 tortoises in one night ashore and kept some of them six weeks without meat or water.' [Cooke 1712 (1969)]
Close to Cabo San Lucas	12 October 1793	'I make this cape by the mean of a number of observations of Sun, Moon and Stars in latitude 22° 45' and Longitude 110. The sea, at this time, was almost covered with turtles and other tropical fish' [Colnett 1798 (1968)]
Port San Bartolomé ⁷	April 1889	'The U.S.S <i>Ranger</i> arrived at this point at the same time as the <i>Albatross</i> and with her large seine 167 turtles were captured in a seine haul' (Agazzis 1889)

Table 1 Continued.

Fish	Place	Date	Quote
	Close to Espiritu Santo Island, probably La Paz Bay	Around the end of November 1539	'And this day we saw our ship called the <i>Trinity</i> which rode 2 leagues distant from us, which so soon as she saw us, set sail, and we came together and rejoiced greatly. They brought us great quantity of grey fishes, and of another kind, for at the point of these mountains they found a fishing which was very wonderful, for they suffered themselves to be taken by hand: and they were so great that every one had much ado to find room to lay fish in' [Hakluyt 1600 (1906)] ⁸
	Cabo San Lucas Bay	1627	'In this port they take very much sardine that, running from the big fish it gets so close from land, that lads can take a great quantity in just two palms deep' (Carbonel 1632)
	Near Cape Corrientes, 'a small island, not more than half mile from the shore and about four leagues ⁹ to the northward of the Cape'	28–29 February 1686	'Here our Strickers (sic) struck 9 or 10 jewfish; some we did eat and the rest we salted and the 29th day we filled 32 tunnes of very good water' [Dampier 1697 (1968)]
	Gulf of California	Early 18th century	'The manta ray is named for having an extensive, thin and flexible body like a mantle or blanket ¹⁰ . It has been said of this fish, that when it discovers a diver under water, tackles, holds and embraces him with its own body, without letting him return to the surface anymore' [del-Barco 1757 (1988)]
	Revillagigedo Islands	December 1793	'With all this abundance of fish, it is a matter of some difficulty to obtain them, from the number and size of the sharks who frequently seized the whole of our prey, before we could draw them out of the water' [Colnett 1798 (reprinted in 1968)]
	Baja California waters	1869	'Some of the sharks of the upper gulf are said to be as large as middling-sized California whales, and to weigh over 1000 lbs. There are great numbers of them in certain parts, and they are exceedingly dangerous to pearl-divers, boatmen, and fishermen, both on the ocean coast below Cedros Island and among the islands of the gulf. Great numbers of the different species of sharks abound in every bay and harbor, and there is no doubt that the manufacture of shark-oil could be most profitably carried on' (Browne 1869)
	Baja California waters	1869	'... shoals of fish frequent the shores in such abundance, that the surface is often agitated for hundreds of yards by a school playing almost within arm's reach of the sands' (Browne 1869)
	Baja California waters	1869	'The manta ray ¹¹ is an immense brute, of great strength, cunning and ferocity, and is more of the terror of the pearl-divers than any other creature of the sea. It measures from nose to tail as much as 20 feet at maturity, nearly five eighths of which consist an immensely long and spinous covered tail; the animal has been found to weigh 1000 lbs and to require 60 men to lift it by tackles and blocks on board of a British man-of-war' (Browne 1869)
	Revillagigedo Islands	March 2 1889	'No sooner was a line thrown into the water than hundreds of fishes would dart toward the bait... they were acting, and several times succeeded in parting the lines. We had been fishing only a short time when many sharks appeared about us and did much damage to our gear. Returning to the ship we found the crew had taken several hundred fish including a number of large shark... sharks were exceedingly abundant and troublesome, and the utmost care had to be exercised to prevent their carrying away our gear' (Agazzis 1889)

Table 1 Continued.

Place	Date	Quote
Pearl oysters	1632	'Along the seacoast of the interior region, over a distance of one hundred leagues all that one sees are heaps of pearl oysters. ... along this coast and its islands are found enough piles of empty mother-of-pearl shells to load many ships. They are the size of a small plate and full and complete they would weigh from one two pounds' [Cardona 1632 (1974)]
	1632	'They [Indians] took out some shells from two to three brazas ¹² in which there were grains of seed pearls of very beautiful cast, and they showed us such large shell mounds, that with shells of this coast many ships could be loaded' [de-la-Nava (1632) 1975]
	1633	'...this bay is about four leagues long and the Indians took us to a pearl-bed inside the bay; the pearl-bed is about two leagues in length and four to eight fathoms in depth ...native divers got oysters and pearls of different types...' [de-Ortega 1636 (1970)]
	1702	'Along the coast and especially in the adjacent islands are so many pearl-beds that can be counted by thousands and had been blank, for almost two centuries, of human desires...' [Piccolo 1702 (1972)]
	2 April 1889	'The pearl fishery is the principal industry of La Paz giving employment to 500 men. About \$100 000 [American dollars] are secured yearly in this vicinity' (Agazzis 1889)
Other oysters	1757	'There is another oyster called <i>burro</i> ¹³ , found in the bottom of the sea so strongly attached to the rocks that a burly tool is needed. Of this oyster it is said that it is normally open and, if a diver accidentally puts his feet over, it closes suddenly with great strength, trapping the unwary that falls into this trap without being allowed to escape: and, since it is underwater, little time is needed for the prisoner to lose his life' [del-Barco 1757 (1988)]
Marine life in general	1702	'The Californians [that live] close to the sea benefit from having very good fish, that sea is greatly fecund. There is plenty of tuna that comes to the hands on the shore. There is abundance of whales in this sea that are observed in each step taken. Turtles of all types are present and in the beaches there are mountains of different shells, the great majority of those of pearls' [Piccolo 1702 (1972)]
	1709	'The bay has plenty of albacores, dolphins, mullets, breams and other sorts of fish, which the natives are very dexterous at striking from their floats...' They also dive and bring plenty of pearl oysters from the rocks' [Cooke 1712 (1969)]
	Between 1791 and 1792	'Hawksbill turtles are the commonest gift and meal of Indians from some missions, and so are the great abundance of fish like cabrilla (a species of cod), eels, sardine, snappers and sole fish' (Bernabéu 1994)
		'The ones [marine species] that intimidate divers are jewfish, sharks, manta rays and tiger shark' (Bernabéu 1994)
		'The coasts are stored with sea lions (<i>Phoca</i>), sea otters, whales or small whales (<i>ballena</i>); from the edible fish, sardine (<i>clupea</i>) (this is so abundant that there are continuously seen many quintals washed on the beach) ¹⁴ , flying fish (<i>exos</i>), snappers (<i>Sparus</i>), groupers (<i>Sparus</i>), flounder, manta rays and sharks (<i>Squalus</i>)' (Bernabéu 1994)
	1869	'The three great beast of the California seas are immense and ferocious sharks, or tiburonnes, thirty feet long, the terrible manta ray, devil fish, or great ray and the greatest octopods or eight-armed cart-wheel-shaped squids, so famous in marine traditions' (Browne 1869)
Some strange creatures	1757	'The upper body of the Mullier fish has the shape of a woman from above and the lower body from a common fish. Because we found it dry and smashed like a cod fish, we could not do very much anatomy. Even though it appears the face, neck, shoulders and white breast, as wearing a corset but having naked the breast; though I do not remember if pimples were present. The rest was covered in scales and ended in a tail like any fish. Its size was about two <i>palomos</i> ¹⁵ and almost like cod in width' [del-Barco 1757 (1988)]

Table 1 Continued.

Place	Date	Quote
Both coasts of Baja California peninsula	1869	<p>'One of the curious and interesting animals of the gulf waters is a species of dugong, called by the Spaniards <i>mulier</i> and <i>woman of the sea</i>, and which almost answers to the sailor-myths of the mermaid. It is found all the way from near San Blas up to the island of the Sal Si Puedes, and was first noticed by Grijalva, one of Cortez's California captains in 1532, and has been frequently mentioned as seen and even caught from that time to the present. From the descriptions given, it appears never to exceed ten pounds in weight, eyes large and soft in expression, a greyish dull-white color for the upper body, breast similar to those of man or women, head similar to a dog or a sea otter, skin smooth and the body, like such a fish as the salmon, and covered with scales down to the end of the tail, which is half moon figure. The dimensions of this curious animal appears never to have exceeded three feet, at least of such as have been described as handled or closely observed, and they are so shy as rarely to have been taken.' (Browne 1869)</p> <p>'The eight-armed octapod, or great squid, shaped like some gigantic spider, inhabits the rocky holes and cavities of the sea shore, particularly where, sheltered by headlands and islets, the force of the surfs and swells is broken, and among the sea weeds, and they can quietly watch for their prey. At all ages this beast is dangerous, but at maturity it attains an immense size and is the fountain head of whalemens fish-yams and said to come up to the size of a 74-gun frigate and can attack and throttle a sperm-whale' (Browne 1869)</p>

¹*Ballena* is whale in Spanish.

²In Scammon's book, The Marine Mammals of North America (1874), killer is identified as Orca whale *Orcinus orca*. (Delphinidae)

³In Scammon's book, Blackfish is identified as pilot whale *Globicephala macrorhynchus* (Delphinidae).

⁴They may have been California sea lions and not seals. In Francisco de Ulloa's text, he said that because of the amount of 'lobos' in the bay they give it the name of 'Puerto de Lobos,' which is literally translated as 'Sea Lion Port.'

⁵A league equals 3 nautical miles (5556 m).

⁶Again the reference may be to sea lions.

⁷This appears to be the American name for 'Turtle Bay,' located a few miles south from Scammon Lagoon. Although it does not belong to the Sea of Cortez, the account is relevant to the amount of turtles found at that time.

⁸In the Ramusio edition, the side comment was 'A wonderful fishing place like Newfoundland.' Grey large fish that look like cod could have been a type of grouper, such as the Gulf grouper.

⁹One league equals 3 nautical miles.

¹⁰Manta in Spanish means blanket.

¹¹He was surely referring to the Giant manta that is the only one that could have reached this size.

¹²Fathoms.

¹³Concha burro is the local name for the purple lip rock oyster *Spondylus califer* (Spondylidae). It is described in local guides to sizes of about 15–25 cm. The ones referred to could have been larger.

¹⁴One quintal equals to 48.95 kg or 107.9 pounds.

¹⁵Palmo was an ancient unit of measurement and was 22.5 cm, the standard length from the thumb to the little finger.

[del-Barco 1757 (1988); Bernabéu 1994; Clavijero (1789) 1990]. Miguel del Barco describes commercial exploitation of hawksbills for their carapaces and how a jewellery industry developed in the mainland. José Longinos in his 1757 and 1792 diaries listed the hawksbill turtle as one of the species that was commercially exploited. Today, hawksbill turtles are extremely rare in the Gulf of California (Seminoff *et al.* 2003). A four-year study at several localities within the Gulf, and also on the Pacific Ocean, which included nighttime surveys of nest sites, found only 27 specimens, of which 10 were dead (Seminoff *et al.* 2003).

Great turtle abundance continued being reported up to the end of the 18th and into the 19th century. In 1798 James Colnett wrote that at the time he cruised from Cabo San Lucas to Cabo Corrientes the sea was 'almost covered by turtles and other tropical fish' [Colnett 1798 (1968)] and just at the end of the 19th century the US research vessel *Ranger* caught 167 turtles in a single haul of their seine in a place close to Bahía Tortugas (Agazzis 1889).

A place like Newfoundland

Fish were also extremely abundant when the first explorers reached the Gulf of California, and some of the early testimonies are hard to believe today. Again Francis Preciado travelling with Ulloa in 1538 provides a particularly interesting account that is noted by his editor in a side comment as 'A wonderful fishing place like Newfoundland' [Hakluyt 1600 (1906)] (Table 1). Thanks to the description made by the Italian navigator John Cabot, in 1497 Newfoundland was known in all Europe as a place 'swarming with fish [that they] could be taken not only with a net but in baskets let down [and weighted] with a stone' (Mowat 1984). So too, apparently, was the Gulf of California. In the South, perhaps in a place close to La Paz Bay, Ulloa's crew described a place where their colleagues 'brought us great quantity of grey fishes, and of another kind; for at the point of these mountains they found a fishing which was very wonderful, for they suffered themselves to be taken by hand: and they were so great that every one had much ado to find room to lay fish in' [Hakluyt 1600 (1906)]. A large grey fish that looks like cod could have been a type of grouper, such as the Gulf grouper *Mycteroperca jordani*. Our own research provides evidence that this large and vulnerable fish was extremely abundant until the 1960s, when a market for it

developed in North America, precipitated its rapid demise (Sáenz-Arroyo *et al.* 2005a).

Some of the most important food for the 17th century buccaneers was provided by large and predatory reef fish, like the goliath grouper *Epinephelus itajara*, formerly named jewfish. Today, these are extremely rare and difficult to find. Very different from the time of Captain William Dampier when his crew, for example, 'struck 9 or 10 jewfish' in a small island near Cape Corrientes [Dampier 1697 (1968)]. Dampier made a specific description of this 'jewfish' which confirms it to be the same as the goliath grouper. He describes the animal as 'a very good fish, and I judge so called by the English because it hath scales and fins therefore a clean fish according to the Levitical law, and the Jews at Jamaica buy them and eat them very freely. It is a very large fish, shaped much like cod, but a great deal bigger; one will weigh 3 or 4 or 5 hundred weights. It hath a large head, with great fins and scale, as big as a half crown, answerable to the bigness of his body. It's is very sweet meat, and commonly fat. This fish lives among rocks' [Dampier 1697 (1968)]. Such large reef predators persist in accounts of the 18th to 19th century missionaries, where the goliath and other large groupers were considered as abundant species which posed a threat to pearl divers [del-Barco 1757 (1988)]. Other fish also mentioned as bountiful in the diaries of 16th to 19th centuries travellers include tuna that would come into fishers hands [Piccolo 1702 (1962)], and sardines so plentiful that when schools were hunted by predators 'hundreds of kilos were washed onto the beach' (Bernabéu 1994).

The enemies of pearl divers

Sharks were always being mentioned as part of the Gulf of California marine fauna and described as a threat faced by pearl divers (Table 1). However, the abundance of these predators is not as notable in this area as around some of the offshore islands. Early explorers often commented on the abundance of sharks in Galapagos, Cocos and other Eastern Pacific Islands. At the Revillagigedo archipelago, for example, located about 370 miles west of the mouth of the Gulf of California, sharks were so abundant that fishers could hardly catch anything without it being taken by them [Colnett 1798 (1968); Agazzis 1889] (Table 1). By contrast, we did not find any specific comment in the early diaries of Spanish conquerors, pirates and missionaries on shark abundance and size in the Gulf of

California. It took until the 19th century for us to find the first important account of the past great abundance of sharks in the Gulf of California. In an 1857 report on the pearl fishery, bull sharks *Carcharhinus leucas* (Carcharhinidae) and hammerhead sharks *Sphyrna* spp. (Sphyrnidae) were listed among the 'enemies' of pearl divers (Esteva 1857). Apparently, they were so common that by law pearl ship owners were obliged to carry in each boat 'a harpoon, a hook and a chain, needed to fish and kill sharks, bull sharks and other marine monsters.' If any diver was 'eaten for not complying with these precautions' the captain was subjected to a 200 pesos fine (Esteva 1857). In his 1869 *Historical Summary of Lower California*, Alexander Taylor made reference to 'sharks of the upper Gulf waters [that] are said to be as large as middling sized California whales and to weigh over 1000 lbs' (Browne 1869). In his opinion, a profitable business based on shark oil production could be sustained in the area (Table 1). The prolific abundance of sharks was also recorded by the first expedition of the steamship *Albatross* by fish expert Alexander B. Agassiz who noticed that in the port of Guaymas 'all fish taken during the winter months are caught with hook and lines, but in summer seines only are used. This change is made to avoid the destruction of the gear by sharks' (Agassiz 1889).

In contrast to omissions concerning sharks, details about the giant manta *Manta birostris* (Mobulidae) have occurred in several accounts about the Gulf of California since the early 17th century. Francisco de la Ascension in his 1602 voyage described one very large and strong manta that got entangled in the anchor rope and pulled the ship until it killed itself on shore [de la Ascension 1602 (1970)]. His measurements recorded the animal as being about 6 m wide and too long and having the mouth as 'a half moon' [de la Ascension 1602 (1970)]. This was perhaps the same species which Shelvocke described at the end of his 1726 account of Puerto Seguro (Cabo San Lucas) as 'a monstrous kind of flat fish sunning himself on the surface of the water near the shore' [Shelvocke 1726 (1928)]. His account tells that 16 or 17 Indians were needed to take it out of water and that by his nearest computation, the animal was 14 or 15 feet broad but not so much in length with a 'hideous large mouth' [Shelvocke 1726 (1928)]. Francisco Clavijero described this animal as a 'species of manta rays and, as far as I know, it is a real manta the specimen father Labat called prodigious ray and measured in the Caribbean island of

Guadalupe. It has 12 feet width and 9 and a half feet length from its mouth to the beginning of its tail. ...its tail had fifteen feet and is skin, stronger to that of a bull, its armed with strong spines resembling nails' [Clavijero (1789) 1990]. The manta ray is often mentioned as an 'enemy' to pearl divers [de Barco 1757 (1988); Esteva 1857; Browne 1869], and while we now know it to be a harmless planktivore, it is hardly surprising that in former times its enormous size would have made it a creature of frightening legend (Fig. 3).

Pearl oysters: the collapse of a fishery that endured for two millennia

Pearl oysters *Pinctada mazatlánica* (Pteriidae) and *Pteria sterna* (Pteriidae) are probably the species for which most published evidence can be found of past abundances far greater than those seen today (Esteva 1857; Monteforte and Cariño-Olvera 1992; Cariño-Olvera 2000). Archaeological evidence shows that pearl oysters were exploited by early Californians for at least 1400 years before they became commercially extinct (Rosales-Lopez and Fujita 2000). The potential for riches, provided by pearls, was an inspiration for many of the Spanish expeditions to this area. One of the first in 1632 reports a coastal seascape where 'over a distance of one hundred leagues all that one sees are heaps of pearl oysters' [Cardona 1632 (1974)] (Table 1). The seascape created by these large pearl oyster beds is difficult for us to imagine today. It appears that they were immense structures, similar to those described from Chesapeake Bay (Jackson *et al.* 2001) that had existed for millennia. All this was decimated by a fishery that collapsed by 1939 (Monteforte and Cariño-Olvera 1992). From 1632 to 1636, Captain Francisco de Ortega made three trips to the Baja California Peninsula to describe the 'placereres o comederos,' the Spanish name for pearl beds ([de-Ortega 1636 (1970)]. He found 30 pearl beds along 600 km of shore, and one that lay south of San Jose Island wrote 'was about two leagues in length and four to eight fathoms in depth' [de Ortega 1636 (1970)]. A league is 3 nautical miles and a fathom 6 feet. Nicolas Cardona, another 17th century pearl seeker, wrote that the pearl beds of the Gulf of California were 'not formed as are those of Isla Margarita or Rio de Hacha [Venezuela] but rather in these beds, oysters are found in bunches of twenty more or less' [Cardona 1632 (1974)]. These

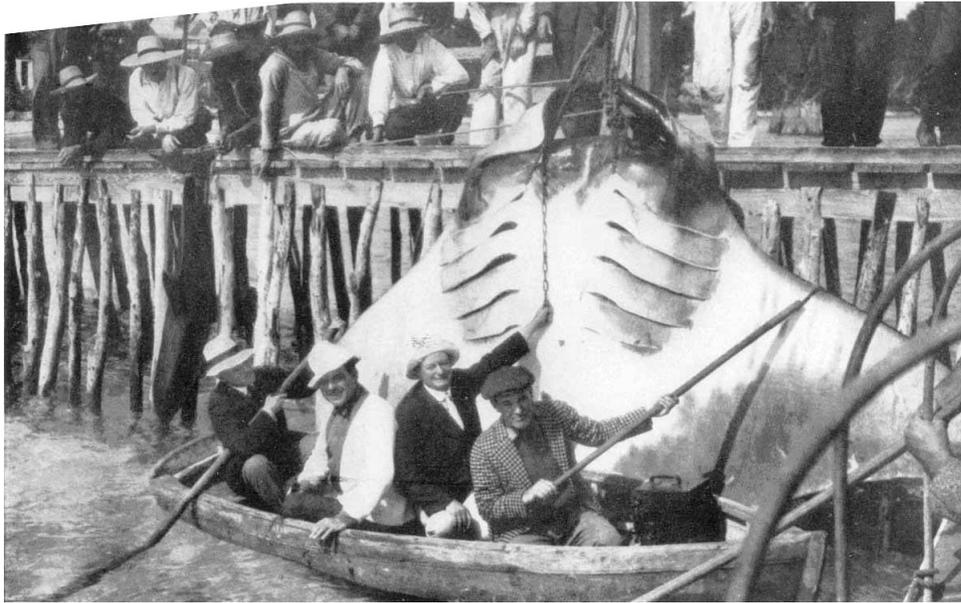


Figure 3 Huge manta rays from an early 20th century article on its fishery in the Gulf of México (La-Gorce 1919). Although this plate is not from the study area, it helps to illustrate the size of past specimens. Picture reprinted with permission, National Geographic.

old testimonies together with some recent recollections that we have obtained from old fishers help confirm that the pearl oyster beds were indeed large reef structures that have now disappeared. An historical estimate suggests that by the beginning of the 20th century, 2500 million pearl shells had been exported from the Gulf of California (Monteforte and Cariño-Olvera 1992). By comparison, a recent survey for pearl oysters, carried out at 65 different sites around La Paz and in the southern bay of La Ventana, only recorded 2150 oysters from 10 sites, giving an average density of 0.05 individual per m^2 (Monteforte and Cariño-Olvera 1992). Our own work between 2001 and 2003, consisting of more than 200 logged dives at 12 different sites found 64 individual pearl oysters.

Porpoises in the southern Gulf of California?

In Shelvocke's 1726 journal of his visit to Baja California, we found a drawing that was described as an 'Indian of California, fishing' [Shelvocke 1726 (1928)] (Fig. 4a). Immediately the so-called 'fish' in the picture reminded us of the vaquita *Phocoena sinus* (Phocoenidae), a small porpoise, confined to the upper Gulf of which now only 500–600 individuals are thought to remain (Fig. 4b) (Reeves

et al. 2002). However, Shelvocke's illustration was made in the Bay of Cabo San Lucas which is at the southernmost point of the Baja Peninsula (Fig. 1). Apart from vaquita, there are two other porpoises of similar shape that are known to exist today in the eastern Pacific: the harbour porpoise *Phocoena phocoena* (Phocoenidae), living in the northern temperate and subarctic waters, from Monterey Bay to the Chukchi Sea and the Burmeister's porpoise *Phocoena spinipinnis* (Phocoenidae), living 5000 km from vaquita, in the Southern hemisphere (Reeves *et al.* 2002). Despite this modern porpoise biogeography, in 1874 Captain Scammon wrote that the bay porpoise, *Phocoena vomerina* (Phocoenidae), were 'found as far as Bahía Banderas and about the mouth of Piginto River', on the coast of Mexico (Latitude $20^{\circ} 30'$) [Scammon 1874 (1968)]. In addition in 1899, in a detailed description of Tres Marias Island, naturalist Edward W. Nelson wrote that the porpoise *Phocoena communis* (Phocoenidae) 'were common around the shores of Tres Marias and also in bays and mouths of streams or lagoons' and 'seen in schools of 10 to 30 or 40 individuals' (Nelson 1899). Vaquita was not distinguished as a different species from the harbour porpoise until 1958 (Norris and McFarland 1958). Despite these two historical references of porpoises

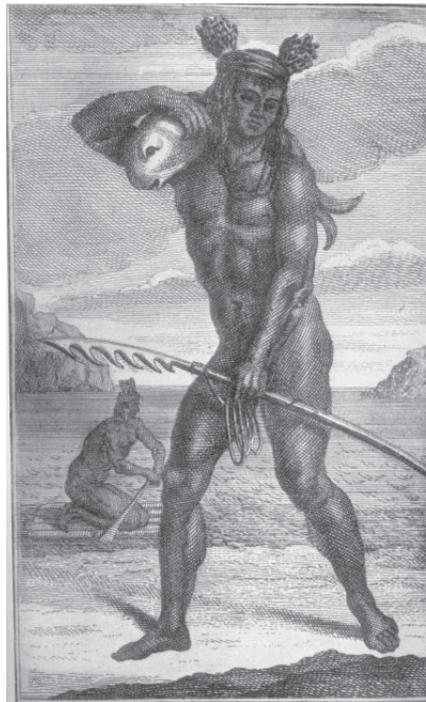


Figure 4 (a) Shelvocke's 'fish' [Shelvocke 1726 (1928)]; (b) modern fisher with a vaquita (Picture from Jesus Camacho at <http://www.vaquitamarina.org/imagenes.php>).

in the southern Gulf of California, a 1980 publication on the natural history of vaquita concludes that this species had an historical and current distribution in the upper Gulf of California and that these historical sightings were probably misidentifications (Brownell 1986). This modern paper argues that, as for some other species living in the upper Gulf of California, vaquita might be composed of a disjunct population that was isolated after the latest cooling period in the late Pleistocene (Walker 1960) The hypothesis could fit perfectly if it were not for Scammon's detailed description of the bay porpoise

'with head somewhat pointed but destitute of the slender, elongated beak of the *Delphinus bairdii*...that resembles of both the *Orca* or the white-headed grampus...' that clearly refers to a porpoise as does Nelson's meticulous descriptions in his natural history of Tres Marias. Is it right that we should be more ready to believe that scientists from the past have failed in their species identification rather than that today's modern scientists could be wrong about the possibility that vaquita or other porpoise species were once more widely distributed? These historical accounts, the similarity of

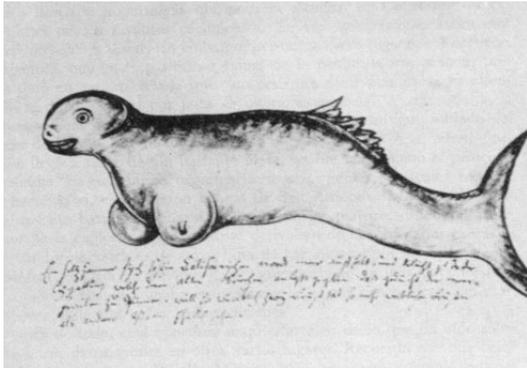


Figure 5 Pez Mullier [del-Barco 1757 (1988)].

Shelvocke's drawing with vaquita and current archaeological evidence of early Californians hunting dolphins (Porcasi and Fujita 2000), encouraged us to enter into e-mail discussion with some of the most experienced researchers on vaquita. We put to them the possibility that this species or the common porpoise might have had a southern Gulf of California distribution up to at least the 19th century. The first reaction, typical of today's biologists, was that Scammon and Nelson might have identified the porpoises incorrectly. Scammon was a highly experienced whaling captain who wrote the seminal work on marine mammals of the west coast of North America [Scammon 1874 (1968)]. They also argued that past fishing technology was incapable of reducing a species range distribution. However, after lengthy discussion and addressing the possibility that the small wetlands visited by them might have also suffered a rapid degradation, two of the researchers agreed to form an interdisciplinary team to look at the past distribution of porpoises in archaeological middens.

Discussion

Sixteenth to 19th century diaries of travellers to the Gulf of California are consistent in describing a marine environment in which large and vulnerable species such as whales, turtles, large fish and pearl oysters were much more abundant than today. Although all these animals are still seen in the Gulf of California, none of them accord in abundance with the sort of descriptions, e.g. 'infinite in numbers,' 'plentiful' or 'impossible to count' that were made by early pioneers. Nowhere in the world do turtles now 'cover' the sea [Colnett 1798 (reprinted

in 1968)], nor are sardines anymore chased onto beaches in the Gulf (Bernabéu 1994). Counting the number of whales that might conceivably be observed on a normal journey is today something that could usually be performed on the fingers of one hand.

Since the middle of the 20th century, the popular belief in ecology has been that large species, particularly top predators, are naturally rare (Colinvaux 1980). The explanation, based on the second law of thermodynamics, observes that huge animals often required large quantities of energy that is provided by lower trophic levels (Colinvaux 1980). Although these physical relations in the trophic chain are difficult to discredit, changes in the shape of the pyramid of size as a result of overhunting have not been assessed properly. Modern ecological analysis has also tended to underplay the extreme vulnerability of these large, slow-growing animals to human hunting (Musick 1999). Daniel Pauly and Jay Maclean (2003) explain how after one century of unsustainable fishing in the North Atlantic, food web pyramids have been 'squashed out,' diminishing the abundance of all trophic levels. The system then switches from Odum's 'mature' stages – in which niches tend to be filled and primary production is efficiently consumed – to much less stable and efficient eutrophic systems (Pauly and Maclean 2003).

Although, it is likely that some of the early travellers' testimonies were 'salted' by the spirit of adventure affecting some writers, the observations that were written concur with the type of marine fauna once found in the Gulf of California. Disqualifying the accounts as just 'anecdotes' dismisses the only first-hand information we have on the natural history of species from the distant past. It also applies unfair judgement to the work of past natural historians. These descriptions were written by the most prominent men of their time, most of them strongly committed to the advancement of knowledge. Even buccaneers like William Dampier were actually far removed from the bandit image that they are generally credited with today. In 1968, the President of the Hakluyt Society wrote of Dampier that he 'was devoted to close observations of winds and tides, geography, plants and animal life' [Dampier 1697 (1968)]. Indeed, Dampier's accurate and thorough descriptions of many species make them easily recognizable today and suggest that his other observations are equally reliable.

By contrast, some historical beasts described by past travellers clearly challenge our current zoological understanding. Take, for example, the *Pez Mullier* (Fig. 5), a 'fish' described by 18th century missionaries as something similar to a cod, a dugong or a mermaid (See section on 'strange creatures' in Table 1) and appearing in records until the 19th century. However, in the majority of the cases, modern science is able to test hypotheses on whether a species could once have been much more abundant or if they were distributed in sites currently unvisited by them. One method is to look in shell middens for the presence of species that are mentioned historically but are absent in modern faunas (Wolff 2000). Another method is to study marine sediments to look for long-term variations in species particularly vulnerable to climate fluctuations (Homegren-Urba and Bamgartner 1993). It is also now possible to elucidate how big a population might have been from its current genetic diversity, as has recently been carried out for whales (Roman and Palumbi 2003). By using simple paleoecological techniques, we can also answer the always-controversial question whether or not abrupt declines in animal populations were 'common' before human influences. A good example is illustrated by an elegant study, inspired by the rapid decline of staghorn coral *Acropora cervicornis* (Acroporidae) that is happening today (Greenstein *et al.* 1998). This coral, previously one of the major Caribbean reef builders, is now down by between 80 and 98% of its 1970 baseline cover (NOAA 2003). Researchers surveying the taxonomic composition of healthy, stressed and Pleistocene coral reefs found that although healthy coral reefs are closely comparable to what they used to look like in the Pleistocene, there is no Pleistocene counterpart to the rapid decline of *Acropora* that has affected reefs in the late 20th Century (Greenstein *et al.* 1998).

Using an historical approach to appraise human impacts on natural ecosystems requires ecologists to apply a different perspective on their normal approach to gathering data. Historical research is dependent on data from a variety of disciplines, collected by a variety of different methods and implies losing the apparent rigour provided by using single ecological techniques (Carlton 1998; Jackson *et al.* 2001; Pitcher 2001; Pandolfi *et al.* 2003; Lotze and Milewski 2004; Lotze *et al.* 2005; Sáenz-Arroyo *et al.* 2005a). Nevertheless, it is worthwhile. Detached from this long-term historical perspective, any tests of hypotheses on ecosystem

degradation will be unrepresentative of true change even with sophisticated and rigorous data collection.

Some of the descriptions we found in this research, such as those about pearl oyster beds, could be used to set immediate conservation targets. For example, experimental rebuilding of some of these beds could help us understand how their absence might have affected the whole community structure and the population abundance of other reef organisms. In other cases, we possibly will want to search for further evidence to settle management or conservation targets. Some of the information might be found at the historical archives in Spain or México City. The archaeological or paleontological record provides also another important source of information to look for further evidence. What seems important here, as other authors increasingly suggest (Carlton 1998; Jackson *et al.* 2001; Pitcher 2001; Pandolfi *et al.* 2003; Lotze and Milewski 2004; Lotze *et al.* 2005), is to avoid letting our current modern perspective mislead us into believing that marine ecosystems have only recently started to be affected by human actions. We must rid ourselves of the concept that management and conservation actions can be based only on studies of recent population sizes [Beverton and Holt 1954 (1993)]. Instead, we should design and adapt them for an ever-changing variety of life which humans have influenced since prehistoric times (Jackson *et al.* 2001).

Acknowledgements

We thank Consejo Nacional de Ciencia y Tecnología – México (CONACYT) and The Pew Charitable Trusts for supporting this research. We thank José Esteban Castro at the Centre for Mexican Studies in Oxford for his hospitality during the work performed at the Bodleian Library. José Campoy kindly provided the picture of the modern fisher with vaquita. Candido Rendón helped with searching archives in La Paz and Raul Ulloa in mapmaking. We are particularly grateful for the edits and suggestions made by two anonymous reviewers', which significantly helped improve our manuscript.

References

- Agazzis, A.B. (1889) *Report of A.B. Alexander, fishery expert. Report of the Investigations of the U.S Fish Commission Steamer Albatross for the Year Ending June 30, 1889* No 274 51st Congress, 1st session. Government Printing Office, Washington, DC.

- Baegert, J.J. [1771 (1952)] *Observations in Lower California, translated from the Original German with an Introduction and Notes*. University of California Press, Berkeley & Los Angeles, 218 pp.
- Baum, J.K. and Myers, R.A. (2004) Shifting baselines and the decline of pelagic sharks in the Gulf of Mexico. *Ecology Letters* **7**, 135–145.
- Bernabéu, S. (1994) *Diario de las Expediciones a las Californias de José Longinos (1792)*. Ediciones Doce Calles, Madrid, 315 pp.
- Beverton, R.J.H. and Holt, S.J. [1954 (1993)] *On the Dynamics of Exploited Fish Populations*. Chapman & Hall, London, 533 pp.
- Browne, J.R. (1869) *Resources of the Pacific Slope: A Statistical and Descriptive Summary of the Mines and Minerals, Climate, Topography, Agriculture, Commerce, Manufactures, and Miscellaneous Productions, of the States and Territories West of the Rocky Mountains. With a Sketch of the Settlement and Exploration of Lower California*. H.H. Bancroft Company, San Francisco, 674 pp.
- Brownell, R.L. (1986) Distribution of the Vaquita *Phocoena sinus* in Mexican waters. *Marine Mammal Science* **2**, 299–305.
- Carbonel, E. (1632) Relación que dio el Piloto Esteban Carbonel al Virrey de Nueva España Marqués de Cerralvo. In: *California II. Documentos para la Historia de la Demarcación Comercial de la California 1611–1670* (ed. W.M. Mathes), Ediciones José Porrúa Turanzas, Madrid, pp. 339–355.
- Cardona, N. [1632 (1974)] *Descriptions of Many Northern and Southern Lands and Seas in the Indies, Specifically of the Discovery of the Kingdom of California* (translated and edited by M. Michael), Dawson's Book Shop, Los Angeles, CA, 111 pp.
- Cariño-Olvera, M.M. (2000) *Historia de la Relaciones Hombre Naturaleza en Baja California Sur 1500–1940*. UABCS, La Paz, BCS, 229 pp.
- Carlton, J.T. (1998) Apostrophe to the Ocean. *Conservation Biology* **12**, 1165–1167.
- Clavigero, F.J. [1789 (1971)] *The History of Lower California*, translated from the Italian by Sara E. Lake. Manessier Publishing Company, Riverside, CA, 413 pp.
- Clavijero, F.X. [(1789) 1990] *Historia de la Antigua o Baja California*. Editorial Porrúa, Mexico City, 262 pp.
- Colinvaux, P.A. (1980) *Why Big Fierce Animals Are Rare*. Princeton University, Princeton, New Jersey, 224 pp.
- Colnett, J. [1798 (reprinted in 1968)] *A Voyage to the south Atlantic and Round Cape Horn into the Pacific Ocean for the Purpose of Extending the Spermaceti Whale Fisheries and Other Objects of Commerce*. N. Israel, Amsterdam, 179 pp.
- Cooke, E. [1712 (1969)] *A Voyage to the South Sea and Round the World in the Years 1708 to 1711*. Da Capo Press, New York, 431 pp.
- Dampier, W. [1697 (1968)] *A New Voyage Round the World*. Dover Publications Inc., New York, 376 pp.
- dela-Ascención, A. [1602 (1970)] Relación Descriptiva de California Según Datos Obtenidos Durante el Segundo Viaje de Sebastián Vizcaíno, y Normas para la Pacífica Ocupación de la California. In: *California I. Documentos para la Historia de la Demarcación Comercial de la California 1583–1632*, II (ed. W.M. Mathes). Ediciones José Porrúa Turanzas, Madrid, pp. 1175–1185.
- del-Barco, M. [1757 (1988)] *Historia Natural y Crónica de la Antigua California*, 2nd edn. UNAM, Mexico City, 475 pp.
- de-la-Nava, D. [1632 (1975)] Opinion given by Licentiate Diego de la Nava. In: *Spanish approaches to the Island of California (1628–1632)*, (ed. W.M., Mathes). The Book of California, San Francisco, pp. 53–59.
- de-Ortega, F. [1636 (1970)] Primera, Segunda y Tercera Descripción y Demarcación de las Islas Californias. In: *California II. Documentos para la Historia de la Demarcación Comercial de la California 1611–1670* (ed. W.M. Mathes). Ediciones José Porrúa Turanzas, Madrid, pp. 402–486.
- Diguët, L. (1912) *Territorio de Baja California. Reseña Geográfica y Estadística. La República Mexicana*. Librería de la Viuda de C. Bouret Paris/México, 39 pp.
- Esteve, J.M. (1857) Memoria sobre la Pesca de la Perla en Baja California. In: *Informes Económicos y Sociales sobre Baja California 1824–1857* (ed. D. Trejo-Barajas). UABCS, UABC, SEP, Mexico DF, pp. 213–258.
- Gerhard, P. (1963) *Pirates in Baja California*. Editorial Tlalpan, Mexico City, 11 pp.
- Gerhard, P. (1990) *Pirates of the Pacific (1575–1742)*. University of Nebraska Press, Lincoln and London, 274 pp.
- Greenstein, B.J., Curran, H.A. and Pandolfi, J.M. (1998) Shifting ecological baselines and the demise of *Acropora cervicornis* in the Western North Atlantic and Caribbean province. *Coral Reefs* **17**, 249–261.
- Hakluyt, R. [1600 (reprinted 1906)] Francis de Ulloa. In: *The Principal Navigations Voyages Traffiques and Discoveries of the English Nation*, Vol. IX (ed. R. Hakluyt). James MacLehose and Sons, Glasgow, pp. 207–278.
- Homegren-Urba, D. and Bamgartner, T.R. (1993) A 250-year history of pelagic fish abundances from the anaerobic sediments of the central Gulf of California. *CalCOFI Reports* **34**, 60–68.
- Jackson, J.B.C. (1997) Reefs since Columbus. *Coral Reefs* **16**, S23–S33.
- Jackson, J.B.C., Kirby, M.X., Berger, W.H. et al. (2001) Historical overfishing and the recent collapse of coastal ecosystems. *Science* **293**, 629–637.
- La-Gorce, J.O. (1919) Devil-fishing in the gulf stream. *National Geographic* **35**, 476–488.
- Lindsay, G.E. and Engstrand, I.H.W. (2002) History of scientific exploration in the sea of Cortés. In: *A New*

- Island Biogeography of the Sea of Cortés* (ed. E. Ezcurra). Oxford University Press, New York, pp. 3–13.
- Lotze, H.K. (2004) Repetitive history of resource depletion and mismanagement: the need for a shift in perspective. *Marine Ecology-Progress Series* **274**, 282–285.
- Lotze, H.K. and Milewski, I. (2004) Two centuries of multiple human impacts and successive changes in a North Atlantic food web. *Ecological Applications* **14**, 1428–1447.
- Lotze, H.K., Reise, K., Worm, B. et al. (2005) Human transformations of the Wadden Sea ecosystem through time: a synthesis. *Helgoland Marine Research* **59**, 84–95.
- Monteforte, M. and Cariño-Olvera, M.M. (1992) Exploration and evaluation of natural stocks of pearl oyster *Pinctada mazatlánica* and *Pteria sterna* (Bivalvia:Pteridae): La Paz Bay, South Baja California, Mexico. *Ambio* **21**, 314–320.
- Mowat, F. (1984) *Sea of Slaughter*. Atlantic Monthly Press, Boston, Massachusetts, 406 pp.
- Musick, J.A. (1999) Ecology and conservation of long lived marine animals. In: *Life in the Slow Lane: Ecology and Conservation of Long Lived Marine Animals. Proceedings of the Conference on Conservation of long lived marine animals* (ed. J.A. Musick). American Fishery Society, Bethesda, MD, pp. 1–7.
- Nelson, E.W. (1899) Mammals of the tres Marias Islands. In: *Natural History of the Tres Marias Island*, 14 (ed E.W. Nelson). Government Printing Office, Washington, pp. 15–20.
- NOAA. (2003) *Ecosystem Assessment Division*. "Conserving The Nation's Living Marine Ecosystems". Available at: <http://www.nmfs.noaa.gov/habitat/ecosystem/AcorporaWorkshop.htm> (accessed on 27 September 2004).
- Norris, K.S. and McFarland, W.N. (1958) A new harbour porpoise of the genus *Phocoena* from the Gulf of California. *Journal of Mammalogy* **39**, 22–39.
- Pandolfi, J.M., Bradbury, R.H., Sala, E. et al. (2003) Global trajectories of the long-term decline of coral reef ecosystems. *Science* **301**, 955–958.
- Pauly, D. (1995) Anecdotes and the shifting baseline syndrome of fisheries. *Trends in Ecology and Evolution* **10**, 430.
- Pauly, D. and Maclean, J. (2003) *In a Perfect Ocean. The State of Fisheries and Ecosystems in the North Atlantic Ocean*. Island Press, Washington, DC, 175 pp.
- Piccolo, F.M. [1702 (1962)] Informe y Relación Sucinta que de la Nueva Conversión, Estado y Progresos de la California Hizo y Presentó a la Real Audiencia de Guadalajara, por su Orden El Padre Francisco Maria Pico de la Compañía de Jesus. In: *Informe del Estado de la Nueva Cristiandad de California* (ed. E.J. Burrus), Colección Chimalistac (No. 14), Editorial José Porrúa Turanzas, Madrid, pp. 45–79.
- Pitcher, T.J. (2001) Fisheries managed to rebuild ecosystems? Reconstructing the past to salvage the future. *Ecological Applications* **11**, 601–607.
- Porcasi, J.P. and Fujita, H. (2000) The dolphin hunters: a specialized prehistoric maritime adaptation in the southern California Channel Islands and Baja California. *American Antiquity* **65**, 543–566.
- Reeves, R.R., Stewart, B.S., Clapham, P.J. and Powell, J.A. (2002) *National Audubon Society. Guide to Marine Mammals of the World*. Alfred A. Knopf, New York, 526 pp.
- Rogers, W. [1711 (1970)] *A Cruise Voyage Round the World*. Dover Publications, New York, 320 pp.
- Roman, J. and Palumbi, S.R. (2003) Whales before whaling in the North Atlantic. *Science* **301**, 508–510.
- Rosales-Lopez, A. and Fujita, H. (2000) *La Antigua California Prehispánica: la vida costera del Conchalito*. Instituto Nacional de Antropología e Historia, Mexico City.
- Sáenz-Arroyo, A., Roberts, C.M., Torre, J. and Cariño-Olvera, M.M. (2005a) Fishers' anecdotes, naturalists' observations and grey reports to reassess marine species at risk: the case of the Gulf grouper in Gulf of California, México. *Fish and Fisheries* **6**, 121–133.
- Sáenz-Arroyo, A., Roberts, C.M., Torre, J., Cariño-Olvera, M.M. and Enríquez-Andrade, R. (2005b) Rapidly shifting environmental baselines among fishers of the Gulf of California. *Proceedings of the Royal Society of London Series B-Biological Sciences* **272**, 1957–1962.
- Scammon, C.M. [1874 (1968)] *The Marine Mammals of the North-Western Coast of North America: Described and Illustrated, Together With an Account of the American Whale-Fishery*. Dover Publications Incorporation, New York, 319 pp.
- Seal Conservation Society. (2004) *Seal Conservation Web Page. California, Galápagos and Japanese Sea Lions. 2004*. Available at: <http://www.pinnipeds.org/species/zalophus.htm> (accessed 14 September).
- Seminoff, J.A., Nichols, W.J., Resendiz, A. and Brooks, L. (2003) Occurrence of hawksbill turtles *Eretmochelys imbricata* (Reptilia: Cheloniidae), near the Baja California Peninsula, México. *Pacific Science* **57**, 9–16.
- Shelvoke, G. [1726 (1928)] *A Voyage Round the World by the Way of the Great South Sea, The Seafarers' Library*. Cassell & Company Ltd, London, 262 pp.
- Thershy, B., Breese, R.D. and Strong, C.S. (1990) Abundance, seasonal distribution and population composition of Balaenopteridae whales in the Canal de Ballenas, Gulf of California, Mexico. *Report of the International Whaling Commission* (special issue), 369–375.
- Wagner, H.R. (1924) The voyage of Francisco de Ulloa. *California Historical Society Quarterly* **3**, 3–307.

- Walker, B.W. (1960) The distribution and affinities of the Marine Fish and Fauna in the Gulf of California. *Sistemática Zoology* **9**, 123–133.
- Wolff, W.J. (2000) The south-eastern North Sea losses of vertebrate fauna during the past 2000 years. *Biological Conservation* **95**, 209–217.
- Zavala-Gonzalez, A. and Mellink, E. (2000) Historical exploitation of the California Sea Lion, *Zalophus californianus* in Mexico. *Marine Fisheries Review* **62**, 35–40.

Erratum

In Fish and Fisheries Volume 7, Issue 2, the following error was published in the first paragraph on page 138.

Miguel del Barco describes commercial exploitation of hawksbills for their carapaces and how a jewellery industry developed in the mainland. José Longinos in his 1757 and 1792 diaries listed the hawksbill turtle as one of the species that was commercially exploited.

The text was incorrect and should have read:

In his 1757 diary Miguel del Barco describes commercial exploitation of hawksbills for their carapaces and how a jewellery industry developed in the mainland. Also José Longinos in his 1792 diary listed the hawksbill turtle as one of the species that was commercially exploited.

There was also an error in the attribution of one reference:

Agazzis, A.B. (1889) *Report of A.B. Alexander, fishery expert. Report of the Investigations of the U.S Fish Commission Steamer Albatross for the Year Ending June 30, 1889* No 274 51st Congress, 1st session. Government Printing Office, Washington, DC.

This should be quoted as:

Alexander, A.B. (1892) *Report of A.B. Alexander, fishery expert. Report of the Investigations of the U.S Fish Commission Steamer Albatross for the Year Ending June 30, 1889* No 274 51st Congress, 1st session. Government Printing Office, Washington, DC.

All references to Agazzis, 1889 should be read as Alexander, 1892 throughout.

We apologize for this error.