

RESEARCH NOTE

Unusual record of Pacific harbor seal (*Phoca vitulina richardii*) feeding on anchovy (*Engraulis mordax*) in the fishery of small pelagic fishes in the Gulf of California

Registro inusual de la foca común (*Phoca vitulina richardii*) alimentándose de anchoveta (*Engraulis mordax*) en la pesquería de pelágicos menores en el Golfo de California

Isai Barba-Acuña^{1*} and Juan Pablo Gallo-Reynoso¹

¹Laboratorio de Ecofisiología, Centro de Investigación en Alimentación y Desarrollo, A.C., Unidad Guaymas, Carretera al Varadero Nacional km 6.6, Colonia Las Playitas, Guaymas, Sonora, México, C.P. 85480. *isai.barba@ciad.mx

Abstract.- Pacific harbor seals (*Phoca vitulina richardii*) range in North America from Japan to Mexico. Here we report the first record of a Pacific harbor seal feeding on Northern anchovy (*Engraulis mordax*) inside a purse-seine net of a sardine fishing boat in the Gulf of California. This event was recorded on video on January 11th, 2010, near Estero Tortuga, Guasimas, Sonora (27°50'N, 110°39'W). Sea conditions were of El Niño Southern Oscillation; this record was likely due to El Niño, forcing seals to travel beyond their distribution range in search of alternate foraging areas.

Key words: *Phoca vitulina richardii*, foraging, *Engraulis mordax*, Gulf of California

INTRODUCTION

Four species of pinnipeds are found in Mexico: Pacific harbor seal (*Phoca vitulina richardii*), Northern elephant seal (*Mirounga angustirostris*), Guadalupe fur seal (*Arctocephalus philippii townsendi*), and California sea lion (*Zalophus californianus*) (Gallo-Reynoso *et al.* 2010, Arias del Razo *et al.* 2017). The California sea lion is the only resident pinniped in the Gulf of California (Szteren & Aurióles 2011).

Pacific harbor seals range from Japan to Isla Creciente in Baja California Sur, Mexico (Gallo-Reynoso & Aurióles-Gamboa 1984). This subspecies inhabits sand bars, estuaries, coastal lagoons, rocky coasts and the islands west of the Baja California peninsula. The islands where they reproduce are: Coronados, Todos Santos, San Martín, San Jerónimo, San Benito, Cedros, Natividad, San Roque and Asunción (Gallo-Reynoso 2000); occasionally, some seals have been spotted in the Gulf of California (Aurióles-Gamboa *et al.* 1993, Gallo-Reynoso *et al.* 2010).

In the decade of 1980, the estimated population size for Mexico was about 1,000 individuals (Gallo-Reynoso & Aurióles-Gamboa 1984); during 2009, 4,826 individuals were counted during the pupping season (Lubinsky-Jinich *et al.* 2017). Pacific harbor seals (*Phoca vitulina richardii* Gray, 1864) are protected in Mexico, listed under “special protection” (NOM-059-SEMARNAT-20110)¹.

This phocid is a top predator with a large population in North America. There is a growing interest in determining the foraging habits of this species, especially in relation to foraging on commercial fishes (Orr *et al.* 2004), although its dietary preferences across its range in Mexico, according to some reports, point to fishes and octopus as major prey items (Elorriaga-Verplancken *et al.* 2013, Alamán de Regules 2014, Durazo-Rodríguez 2015, Brassea-Pérez 2016).

Information on the biology, ecology and abundance of the Pacific harbor seal in Mexico is scarce (Gallo-Reynoso 2000, Fernández-Martín *et al.* 2016, Ruiz-Mar 2016, Arias del Razo *et al.* 2017, Lubinsky-Jinich *et al.* 2017, Pacheco-Sandoval 2017, Tapia-Harris *et al.* 2017). This note reports an unusual record of Pacific harbor seal behavior, the first about this pinniped foraging in the Gulf of California.

MATERIALS AND METHODS

On 11 January 2010, M. Duarte, captain of the sardine fishing boat “Sardina IX”, deployed a purse-seine net on small pelagic fish near Estero Tortuga, Las Guasimas, Sonora, Mexico (27°50'N, 110°39'W). Mr. Duarte captured on his cell phone a video⁽²⁾ of a seal inside the net when it was pulled aside the boat for fish to be suctioned and deposited in the freezer inside the boat.

¹Norma Oficial Mexicana NOM-059-SEMARNAT-2010. Protección ambiental - especies nativas de México de flora y fauna silvestres-categorías de riesgo y especificaciones para su inclusión, exclusión o cambio - lista de especies en riesgo”. Diario Oficial de la Federación. 30 de diciembre de 2010. <https://www.profepa.gob.mx/innovaportal/file/3552/1/nom-059-semarnat-2010__30-dic-2010.pdf>

²<[https://rbmo.uv.cl/resumenes/v533/Pacific harbor seal.3gp](https://rbmo.uv.cl/resumenes/v533/Pacific%20harbor%20seal.3gp)>

The video was sent to the Ecophysiology Laboratory at Centro de Investigación en Alimentación y Desarrollo, A.C. Unidad Guaymas, requesting an identification of the species of seal found inside the purse. The program Video to Picture Image Converter was used to convert the video to images, aiming at observing and determining the pinniped species involved in this fishing event.

RESULTS AND DISCUSSION

FIRST RECORD OF THE PACIFIC HARBOR SEAL FEEDING IN THE GULF OF CALIFORNIA

This paper reports a record of a Pacific harbor seal feeding opportunistically in the Gulf of California. On 11 January 2010, an individual was video-recorded near Estero Tortuga, Las Guásimas, Sonora, Mexico. The individual corresponded to a Pacific harbor seal adult that was feeding on Northern anchovy (*Engraulis mordax*) inside the purse-seine net of a fishing boat (Fig. 1). The species was determined based on the following characteristics: body relatively compact with short front and hind flippers, head rounded, color gray with light spots on the back, nostrils with a distinctive V-shape (Teilmann & Galatius 2018).

There are five previous records of Pacific harbor seals in the Gulf of California: Los Frailes and Los Islotes, in Baja California Sur (Gallo-Reynoso & Aurioles-Gamboa 1984,

Aurioles-Gamboa *et al.* 1993); at Isla San Pedro Mártir and the coastal locality of El Mármol, Sinaloa (Gallo-Reynoso *et al.* 2010); and its southernmost record in Cruz de Loreto beach, Jalisco, in May 2010 (comm. pers.)³. Four of these sightings were of newborns and young seals, except for one adult individual observed at Isla San Pedro Mártir (Gallo-Reynoso *et al.* 2010). In addition to the records from the Gulf of California, there are two records of Pacific harbor seals outside their reproductive range, in Magdalena Bay and Isla Guadalupe (Chavez-Rosales & Gardner 1999, Orr *et al.* 2018).

In a study of stable $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ isotopes from hair of Pacific harbor seal pups from Isla Natividad, Baja California, the values obtained indicate that harbor seals do not migrate, clearly showing that harbor seal females display coastal habits on that island (Elorriaga-Verplancken *et al.* 2016). Pacific harbor seals are capable of moving across long distances searching for foraging or reproductive areas (Hardee 2008). Satellite-instrumented males performed long-distance movements with a mean distance of 103.5 km (range 9.6-280.9 km, $n=16$), while females traveled an average of 22.9 km (range 6.0-41.6 km, $n=4$) (Peterson *et al.* 2012). Some records of this species show that they can occasionally travel across long distances of up to 520 km (Lesage *et al.* 2004), and 880 km (Gallo-Reynoso *et al.* 2010).

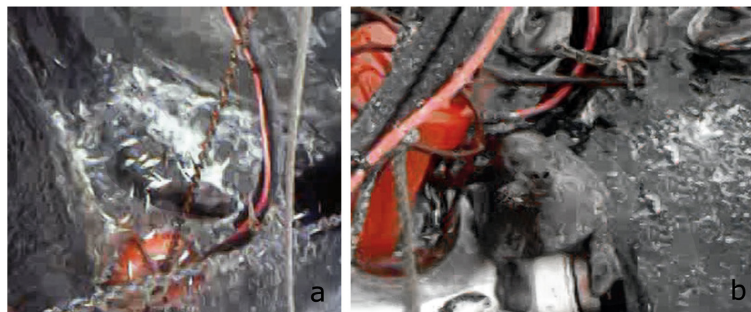


Figure 1. Adult harbor seal (*Phoca vitulina richardii*). a) Inside the purse, feeding on Northern anchovy; b) On top of the fish extractor, from where the seal slid back into the sea. Photography from the video recorded by Mr. Marco Duarte <[https://rbmo.uv.cl/resumenes/v533/Pacific harbor seal.3gp](https://rbmo.uv.cl/resumenes/v533/Pacific%20harbor%20seal.3gp)> / Foca común adulta (*Phoca vitulina richardii*). a) Dentro de la bolsa, alimentándose de anchoveta del norte; b) Sobre el extractor de peces desde donde la foca se deslizó hacia el mar. Fotografía a partir del video grabado por el Sr. Marco Duarte. <[https://rbmo.uv.cl/resumenes/v533/Pacific harbor seal.3gp](https://rbmo.uv.cl/resumenes/v533/Pacific%20harbor%20seal.3gp)>

³Personal communication P. Smolensky to Juan Pablo Gallo Reynoso, May, 2010, unpublished.

Sex, body size, local habitat conditions and environmental factors have an influence on the pattern and range of foraging of harbor seals (Thompson *et al.* 1988, Peterson *et al.* 2012, Sharples *et al.* 2012, Blanchet *et al.* 2014). When the video of the harbor seal was recorded in winter of 2010 on the coast of Sonora, the conditions at sea were typical of El Niño Southern Oscillation that lasted from June 2009 to May 2010 (Todd *et al.* 2011). The coast where the seal was found is nutrient-rich due to fresh water runoff during summer and coastal upwelling during winter-spring (Soto-Mardones *et al.* 1999); this suggests that the individual observed was likely present because the estuary is rich in fish and small squid species, being intensively used by California sea lions (*Zalophus californianus*) as feeding grounds in winter and spring.

MAIN PREY OF THE PACIFIC HARBOR SEAL IN MEXICO: OPPORTUNISTIC FEEDING OF ANCHOVY IN THE GULF OF CALIFORNIA

There are few studies on the foraging habits of Pacific harbor seals in Mexico. The main prey types consumed included fish of the families Paralichthyidae, Synodontidae, Achiridae, Belonidae, Clupeidae, Sebastidae, Ophidiidae, Batrachoididae, and Cottidae, and cephalopods of the families Octopodidae and Loliginidae (Table 1) (Elorriaga-Verplancken *et al.* 2013, Alamán de Regules 2014, Durazo-Rodríguez 2015).

In all these studies (Table 1), the foraging habits of seals were explored by sieving scats and identifying otoliths and cephalopod beaks, although this methodology could not yield the complete trophic spectrum; hence, other methodological approaches such as metagenomics, fatty acids and stable isotopes from scats and other tissue samples should also be applied to explain the foraging habits of seals (Bromaghin *et al.* 2013, Elorriaga-Verplancken *et al.* 2013, Brassea-Pérez 2016).

Using metagenomics, Brassea-Pérez (2016) found that marine invertebrates such as crustaceans (*Hemisquilla californiensis*, *Pleuroncodes planipes*, *Sicyonia laevigata*, *Penaeus vannamei*, *Crangon* sp., and infraorder Brachyura), cnidarian (*Chrysaora fuscescens*), and bivalves (Family Veneridae), as well as tunicates (*Soestia zonaria*), elasmobranchs (*Raja inornata*) and hagfishes (myxini) (*Eptatretus stoutii*), are potential types of prey for the Pacific harbor seal on islands of Baja California, which expands the known trophic spectrum for the Pacific harbor seal in Mexico.

The Northern anchovy (*Engraulis mordax*) is not a major prey item for the Pacific harbor seal in Mexico (Table 1); however, it is an important prey in some areas of the United States, such as San Francisco Bay, California (Gibble & Harvey 2015), San Juan Islands, and Drayton Harbor, Washington (Lance *et al.* 2012, Luxa & Acevedo-Gutiérrez

Table 1. Main prey types of the Pacific harbor seal in Mexico according to the prey importance index ($\geq 10\%$ IIMPI) obtained by different authors / Principales presas de la foca común en México de acuerdo al índice de importancia de presa ($\geq 10\%$ IIMPI)

Location	Main preys	Family	Author
Isla Natividad	Sanddab (<i>Citharichthys sordidus</i> and <i>C. stigmaeus</i>)	Paralichthyidae	Durazo-Rodríguez 2015
	Octopus (<i>Octopus</i> spp.)	Octopodidae	
	California lizardfish (<i>Synodus lucioceps</i>)	Synodontidae	Elorriaga-Verplancken <i>et al.</i> 2013
	Mazatlan sole (<i>Achirus mazatlanus</i>)	Achiridae	
	Red octopus (<i>Octopus rubescens</i>)	Octopodidae	
	California needlefish (<i>Strongylura exilis</i>)	Belonidae	
	Longfin sanddab (<i>Citharichthys xanthostigma</i>)	Paralichthyidae	
	Pacific sardine (<i>Sardinops sagax</i>)	Clupeidae	
Isla Todos Santos	California lizardfish (<i>S. lucioceps</i>)	Synodontidae	Durazo-Rodríguez 2015
	Rockfish (<i>Sebastes</i> spp.)	Sebastidae	
	Octopus (<i>Octopus</i> spp.)	Octopodidae	Alamán de Regules 2014
	Rockfish (<i>Sebastes</i> spp.)	Sebastidae	
	Market squid (<i>Doryteuthis opalescens</i>)	Loliginidae	
	California lizardfish (<i>S. lucioceps</i>)	Synodontidae	
Estero Punta Banda	Spotted cusk-eel (<i>Chilara taylori</i>)	Ophidiidae	Alamán de Regules 2014
	California lizardfish (<i>S. lucioceps</i>)	Synodontidae	
	Two-spotted octopus (<i>Octopus bimaculatus</i>)	Octopodidae	
	Market squid (<i>D. opalescens</i>)	Loliginidae	
Isla San Jerónimo	Sanddab (<i>C. stigmaeus</i>)	Paralichthyidae	Durazo-Rodríguez 2015
	Market squid (<i>D. opalescens</i>)	Loliginidae	
	Rockfish (<i>Sebastes</i> spp.)	Sebastidae	
	California lizardfish (<i>S. lucioceps</i>)	Synodontidae	
Isla San Roque	Octopus (<i>Octopus</i> spp.)	Octopodidae	Durazo-Rodríguez 2015
	Sanddab (<i>C. sordidus</i> and <i>C. stigmaeus</i>)	Paralichthyidae	
	Octopus (<i>Octopus</i> spp.)	Octopodidae	
	Plainfin midshipman (<i>Porichthys notatus</i>)	Batrachoididae	
	California lizardfish (<i>S. lucioceps</i>)	Synodontidae	
Isla Cedros	Rockfish (<i>Sebastes</i> spp.)	Sebastidae	Pablo-Rodríguez (2009) reports the presence of prey in only 2 scat samples with identifiable otoliths
	Spotted cusk-eel (<i>C. taylori</i>)	Ophidiidae	
	Scorpion fish (<i>Icelinus</i> sp.)	Cottidae	
	Toad fish (<i>Porichthys</i> sp.)	Batrachoididae	
	Shortbelly rockfish (<i>Sebastes jordani</i>)	Sebastidae	

2013). Northern anchovy occupies an important niche in the marine trophic web, and also plays a central ecological and fishery role in the California Current and the Gulf of California (Cotero-Altamirano 2000). The large variety of prey species and the regional differences are indicative of an opportunistic foraging behavior of the Pacific harbor seal (Steingass 2017).

In conclusion, this record of a Pacific harbor seal in the Gulf of California contributes new information on the distribution of this subspecies and likely use of areas for foraging outside its reproductive range, and illustrates new aspects of its interaction with fisheries. In addition, this record adds to the knowledge of this top predator under peculiar oceanographic conditions such as El Niño 2009-2010.

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