

# Socioeconomic diagnosis of the 2010 jumbo squid artisanal fishery near Magdalena Bay, Baja California Sur, Mexico

## Diagnosis socioeconómica de la pesquería artesanal del 2010 del calamar gigante cerca de Bahía Magdalena, Baja California Sur, México

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### ABSTRACT

Between January and August of 2010 the southwestern side of the Baja California peninsula in Baja California Sur, Mexico experienced a temporary intense growth of jumbo squid (*Dosidicus gigas*). We documented the resulting fishery phenomenon by conducting interviews with 110 artisanal fishermen in the community of Puerto San Carlos using a structured paper interview instrument that employed qualitative research methods to better understand the economic, demographic, and geographical catch and fleet characteristics of this fishery. We also conducted six semi-structured interviews with seafood buyer-exporters. Data show that squid fisherman temporarily migrated to Puerto San Carlos from Santa Rosalia, B. C. S., Sonora, and Sinaloa where the artisanal jumbo squid fishery is rooted. Fishermen from Puerto San Carlos, Adolfo López Mateos, and various inland B. C. S. communities found economic opportunity in the abundance of squid near Magdalena Bay. The Catch Per Unit Effort was 0.57 (+/-0.29) t of squid per day, limited only by the size of boats. Product exporters paid as much as 6 mexican pesos/kilo (\$0.50 USD) at the onset of the fishery in January and February, and prices lowered to 2.5-3.0 mexican pesos/kilo (\$0.25 USD) during summer months. This research also identified the shipping routes of squid from Mexico to Asian markets. Official fisheries data gathered by SAGARPA showed that Puerto San Carlos' artisanal squid fleet caught and exported 19,208 metric t of squid in 2010, representing \$4.8 million USD.

**Key words:** Artisanal fishery, jumbo squid (*Dosidicus gigas*), Magdalena Bay, Mexico, socioeconomic analysis.

### RESUMEN

Debido a la abundancia del calamar gigante *Dosidicus gigas* (d'Orbigny, 1835) presente en la costa sudoccidental de la Península de Baja California entre enero y agosto del 2010, la pesca artesanal del calamar cerca de Bahía Magdalena, Baja California Sur, (B. C. S.) México, experimentó un crecimiento temporal intenso. Se documentó el fenómeno pesquero aplicando entrevistas a 110 pescadores en Puerto San Carlos utilizando una entrevista previamente estructurada, la cual es un instrumento que se emplea como método de investigación para comprender mejor la economía, demografía y geografía de la captura y característica de la flota de la pesca artesanal del calamar. También se reali-

zarón seis entrevistas semi-estructuradas con compradores y exportadores de mariscos. Los datos indicaron que los pescadores de calamar migran temporalmente a Puerto San Carlos desde Santa Rosalía, B. C. S., Sonora y Sinaloa, donde la pesca artesanal del calamar gigante está arraigada. Los pescadores de Puerto San Carlos, Adolfo López Mateos y varias comunidades de B. C. S. encontraron una oportunidad económica en la abundancia de calamar cercano a Bahía Magdalena. La captura por unidad de esfuerzo (CPUE) fue de  $0.57 (+/-0.29)$  ton calamar·día $^{-1}$ , limitado solo por el tamaño de la embarcación. Los exportadores de productos pagaron el precio más alto de 6 mexican pesos/kilo (\$0.50 USD) al principio de la pesquería durante enero y febrero, y el precio más bajo de 2.5-3.0 mexican pesos/kilo (\$0.25 USD) durante los meses de verano. Esta investigación también identificó las rutas de embarque del calamar desde México hasta los mercados de Asia. Los datos oficiales sobre la pesquería reunidos por SAGARPA, mostraron que la flota artesanal del calamar gigante de Puerto San Carlos capturó y exportó un total de 19,208 t de calamar en 2010, generando una derrama económica total de \$4.8 millón USD.

**Palabras clave:** Análisis socioeconómico, bahía Magdalena, calamar gigante (*Dosidicus gigas*), México, pesquería artesanal.

## INTRODUCTION

In the early 1970s in the Gulf of California the jumbo squid *Dosidicus gigas* (Orbigny, 1835) fishery became a commercially important export, yet was not formally established as a continuous fishery until 1994 (Lluch-Cota *et al.*, 2007). Actually, it is the fourth largest fishery in Mexico in terms of volume (Luna Raya *et al.*, 2009). This fishery annually takes place during the late spring, summer and fall (May to November) in the vicinity of Santa Rosalía, Baja California Sur (B. C. S.), Mexico, in the Gulf of California. High concentrations of the squid are also present in the late fall, winter, and until late spring in the central Gulf near Guaymas, Sonora (SEMARNAP, 1996, 1997, 1998, 1999, 2000; SAGARPA, 2001). Within the Gulf of California, the highest concentrations of squid are found along the west side in summer, later migrating to the

east coast of the Gulf (near the mainland) by winter (Markaida *et al.*, 2005).

During the winter of 2009/2010 jumbo squid was less abundant in the Gulf of California, and were found in large numbers near Magdalena Bay, on the west-central side of the Baja California peninsula in the Pacific Ocean (Fig. 1). The purpose of this research is to better understand (and to document) the economic and social outcomes of the resulting ephemeral fisheries phenomenon. The School for Field Studies-Center for Coastal Studies in Puerto San Carlos created a partnership with the Northwestern Center of Biological Research (CIBNOR), La Paz to conduct qualitative baseline research.

**Artisanal Fisheries in Magdalena Bay.** The Magdalena Bay region hosts several small artisanal fishing communities located both on

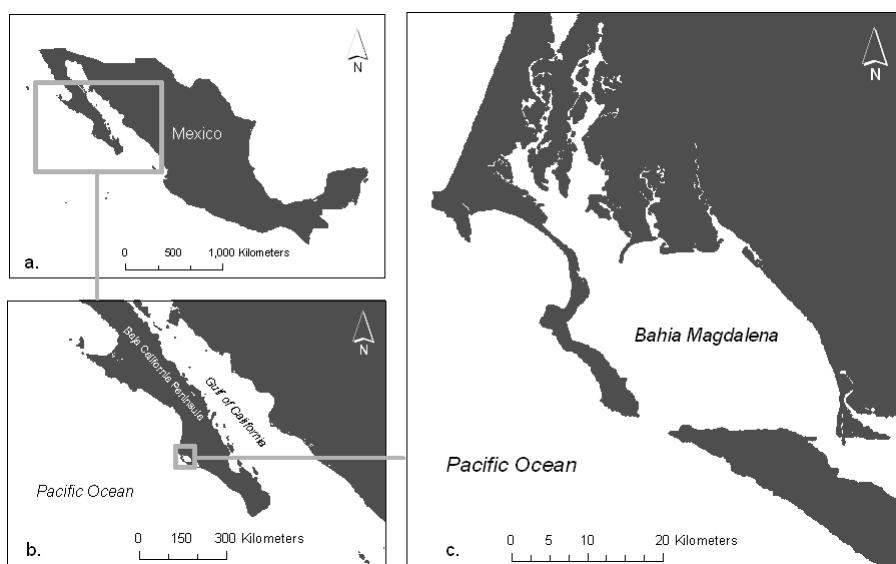


Figure 1. Location of Magdalena Bay, B.C.S. on the NW Pacific coast of México. Research was conducted at the School for Field Studies-Center for Coastal Studies, in the fishing community of Puerto San Carlos.

the mainland and outer islands. Our research was conducted in Puerto San Carlos (population 7,000), the largest fishing community in the Magdalena Bay region (INEGI, 2005). Puerto San Carlos is an industrial fishing port complete with three sardine canneries, multiple seafood exporters, a thermoelectric plant, over 300 fishing cooperatives, and a large pier sufficient for supporting industrial tankers that unload heavy diesel via an industrial pipeline to the thermoelectric plant.

Artisanal fisheries employ about 50% of the working population in Puerto San Carlos (García-Martínez & Chávez-Ortiz, 2007). However, most residents are dependent upon income generated by the fisheries sector and its related infrastructure, and as such, the fisheries sector is the dominant economic driver in the community. The community also hosts an annual whale and sea turtle festival and temporarily provides tourism jobs and opportunities in participatory sea turtle "voluntourism," sport fishing, bird watching, wilderness surfing, sea kayaking, and Gray whale watching (late January-mid March).

The artisanal fishing fleet (already present) in Puerto San Carlos were the first individuals to initiate the fishing of jumbo squid during the January 2010 season; fishermen from neighboring communities and states quickly arrived. This fleet was composed of fiberglass boats (pangas) manned by two to three fishermen using out-board motors and hand jigs (poteras) to capture jumbo squid (Morales-Bojórquez *et al.*, 2001). Additionally, seafood buyers and exporters, who traditionally conduct business in the Gulf of California, arrived in Puerto San Carlos. Eventually, a total of six seafood export companies purchased squid from January to August of 2010. This influx of income from the sale of squid had immediate (noticeable) economic and social outcomes for the community and artisanal fishing fleet. For instance, the community received a new automated bank teller, recently purchased pickup trucks graced the dusty streets of Puerto San Carlos, fishermen

had purchased new outboard motors, and the community even experienced the opening of a new brothel and discoteca.

**Historical presence of environmental variability and the arrival of jumbo squid to Magdalena Bay.** It should be noted that this research made no attempt to assess any biological or oceanographic conditions that may have contributed to the winter arrival of jumbo squid to the Pacific coast of central B. C. S. The 1997/1998 El Niño event was the strongest since 1959 with temperatures as much as 2.5 °C above normal. For comparison purposes, the winter of 2010 also experienced an El Niño event, and during this time the Pacific Ocean in the Magdalena Bay region experienced warmer than average surface water temperatures. Overall in the Eastern Pacific, the winter of 2009/2010 exhibited a moderate to strong El Niño event with water temperatures as much as 1.8 °C above normal (NOAA, 2011).

The Secretary of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) fisheries data lists annual catches for jumbo squid in the Magdalena Bay region from 1998-2010 (Fig. 2). Data collected by SAGARPA between 2005 and 2010 show that squid were fished every year in the Magdalena Bay region. Prior to 2010, the largest annual catch of jumbo squid on record with the Puerto San Carlos Department of Fisheries Administration SAGARPA office was recorded in 1998 when 9,970 t of squid were landed. However, total squid tonnage in 2010 (19,208 t) was the largest recorded. Squid fishermen in Magdalena Bay also noted that in their opinion, 2010 was the best squid fishery since 1998. We also found through interviews with fishermen that squid fishing in this region was notable (in quantity) during the following winters: 1997/1998; 2000/2001; 2004/2005; 2006/2007; and 2009/2010. All of these winters experienced the effect of El Niño, except for the 2000/2001 season (NOAA, 2011). During the 1997/1998 season squid landing records from the Gulf of California indicated a low catch, while high concentrations of squid were detected near the

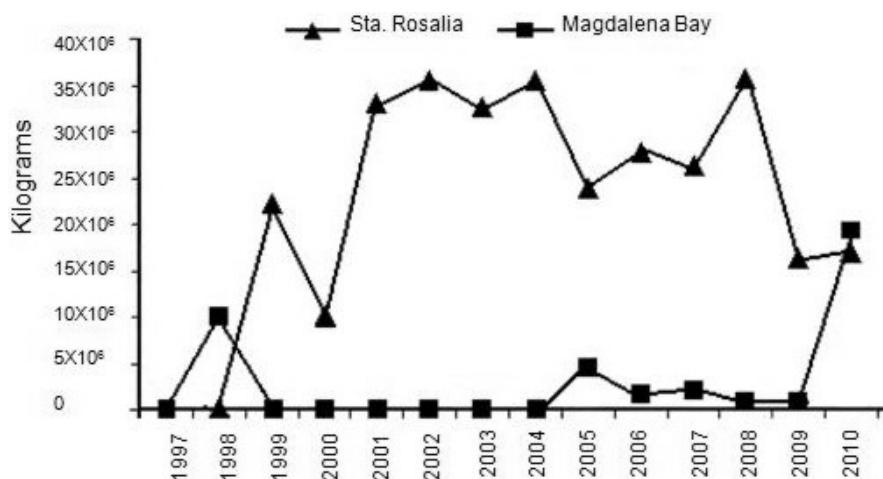


Figure 2. Annual catch of jumbo squid in Santa Rosalia and Magdalena Bay (in kilograms) (SAGARPA).

southwest coast of the peninsula (Morales-Bojórquez *et al.*, 2001). In June 2005 catches of squid in Santa Rosalia were also lower than average, while above average squid catches (4,560 t) were reported near Magdalena Bay (Bazzino *et al.*, 2010).

In other countries such as Chile, the ephemeral jumbo squid fishery has experienced large fluctuations. Reports by Fernández and Vásquez (1995) described resurgence in the Chilean squid fishery even after 20 years of squid absence. Over the last four decades several ommastrephid squid stocks have shown rapid regional expansion and contraction, driving variable boom and bust fisheries as documented in Magdalena Bay in 2010 with the jumbo squid. These include *Illex illecebrosus* (Lesueur, 1821) in the northwest Atlantic Ocean, *I. argentinus* (Castellanos, 1960) in the southwest Atlantic Ocean, *Todarodes pacificus* (Steenstrup, 1880) in the northwest Pacific Ocean, *T. sagittatus* (Lamarck, 1798) in the Norwegian fjords, and *Dosidicus gigas* (d'Orbigny, 1835) in the Peru and California Current systems. Possible explanations for the highly variable behavior of squid populations mentioned by Rodhouse (2008, p. 83) include: "(1) direct effects of environmental variability; (2) changes in prey availability, especially for the early life stages; (3) changes in predation, disease and parasitism; and (4) exploitation of predatory fish which might reduce predation pressure and thus create vacant niches into which the short-lived, ecologically opportunistic squid can expand".

Various research efforts have shown that recruitment variability in several squid species can be partly explained by environmental variability derived from synoptic oceanographic data. In respect to jumbo squid in the Eastern Pacific coastal upwelling system, the ephemeral jumbo squid fishery has grown rapidly during the last decade. Abundance and catch rates seem to be linked to the El Niño/southern oscillation (ENSO) cycle (Rodhouse, 2001). However, in the Gulf of California, Nevárez-Martínez *et al.* (2000) did not find a relationship between biomass, distribution, and water temperatures from the surface to 70 m in depth.

Additionally, research by Zeidberg and Robison (2007) showed that jumbo squid have also expanded their geographic range in the eastern North Pacific by arriving to the waters near central California. This sustained range expansion coincides with changes in climate-linked oceanographic conditions as well as a reduction in competing top predators. Waluda *et al.* (2006) reported that in Peruvian coastal waters that it is likely that variability in upwelling strength and the occurrence of cool core mesoscale oceanographic features are important for affecting jumbo squid distribution. More specifically, Waluda and Rodhouse (2006) reported that jumbo squid abundance is apparently strongly influenced by mesoscale variability linked to ENSO, with low levels of upwelling during the very strong El Niño of 1997/1998 leading to low catches of squid near Peru. These same authors observed that while unusually cool or warm conditions produce a reduction in the abundance of squid off the coast of Peru, catches increased

in other parts of the species range, notably off the coast of Central America (close to the Costa Rica Dome).

## MATERIALS AND METHODS

**Geographical Setting.** Magdalena Bay is a large (1,200 km<sup>2</sup>) and highly productive coastal bay located between 24°15' N and 25°20' N, and 111°30' W, and 112°15' W in B. C. S. (Fig. 1). The bay is sheltered from the Pacific Ocean by five barrier islands. The longest volcanic and dune covered outer islands include Isla Magdalena and Isla Margarita which form the large southern mouth of the bay near the fishing community of Puerto Magdalena.

**Instrumentation.** Interviews were conducted with a total of 110 squid fishermen respondents with a structured Spanish language interview (Creswell, 2009). The initial 25 pilot interviews have been incorporated in this total. The interviews consisted broadly of questions related to jumbo squid landing statistics and catch data, equipment used by the artisanal fishery fleet, the history of respondent involvement in the squid fishery and their other income generating activities (fishing or otherwise), as well as economic and demographic information about fishermen respondents and their families. The initial interview was piloted with 25 squid fishermen and later edited to clarify various questions and to include a map used by respondents to indicate the geographical location of squid landings in Magdalena Bay.

We conducted six semi-structured Spanish interviews with squid buyer-exporters company respondents (Creswell, 2009). Data collected from squid buyer-exporters were used to add contextual richness to the description of this fisheries and economic phenomenon as well as to better triangulate the data gathered from our 110 interviews with the squid fishermen respondents. The squid buyer-exporters interviews consisted broadly of questions related to the origin of the seafood companies, the prices paid to fishermen for squid in PCS, tonnages that companies exported from PCS, equipment used for packaging and transportation of squid, and domestic and international shipping and export routes. We conducted one structured interview with a representative from SAGARPA in La Paz, B. C. S. in order to better understand the governmental program for issuing squid fishing permits.

**Data collection and analysis.** A convenience and snowball sampling method (Creswell, 2009) was used to anonymously interview a total of 110 fishermen in PCS from June 2010 to August 2010. Faculty, interns, and students from the School for Field Studies-Center for Coastal Studies conducted approximately 50% of the interviews. Staff, faculty, and students working with CIBNOR conducted the remaining 50% of the interviews. Voluntary interviews were conducted with squid fishermen as they waited in line to sell their catch, in six separate locations throughout PCS. Interviews spanned approximately 10-15 minutes and answers were recorded directly onto a paper interview instrument. Interviews

with squid buyer-exporters were recorded with a digital voice recorder as well as recorded by hand.

All interviews were translated from Spanish to English and later coded to identify thematic trends in the responses; the responses were finally grouped according to our research inquiry areas. Data was organized using an Excel spreadsheet. Validity of our findings was further addressed by identifying accounts of discrepant information (deviant cases) (Creswell, 2009). Inclusion of outlying participant perspectives provides for a more holistic understanding of the variations in responses while allowing for a more contextualized and descriptive participant response framework. "The prevalence or lack of discrepant information therefore allowed for greater insights into the credibility of perceived patterns of phenomena identified by this research" (Schneller, 2008).

Our qualitative analysis below also employed Type 1 and 2 tabulations as prescribed by Silverman (2006). More precisely, we assigned percentages to the interview data to more accurately display a numeric prevalence of phenomenon.

## RESULTS

**The Squid Market.** Squid fisherman interview respondents explained that in the past (years prior to 2010) there were a variety of buyer-exporters purchasing squid directly from the squid fishermen, including: Pesquera Mexico/Moon, Korean companies from Santa Rosalia, and fishery cooperatives from both Sonora and Sinaloa; however, in 2010, a total of six squid buyer-exporter companies were purchasing squid from fishermen in Puerto San Carlos. These companies operated in the community from January, 2010 through August 20<sup>th</sup>, 2010. Squid buyer-exporters stationed semi-trucks and company personnel with scales in three main locations in Puerto San Carlos:

Location 1. Three buyer-export companies stationed their semi-trucks and personnel at the south end of Puerto San Carlos close to a popular boat launching beach, directly in front of the School for Field Studies campus.

Location 2. One buyer-exporter placed semi-trucks and personnel on a salt flat directly to the north of the Calmex sardine processing facility in Puerto San Carlos.

Location 3. Two buyer-exporters placed semi-trucks and personnel near the entrance of the "Muellecito," a small tourist pier used primarily in the winter for whale watching excursions. These companies did not use the pier for any purpose; rather we mention this landmark only as a point of reference.

**Interviews with buyer-exporters.** Pesquera Mexico/Moon. Pesquera Mexico has operated a permanent seafood processing facility for nine years in Puerto San Carlos, located on the main in-

dustrial/shipping pier. Pesquera Mexico is a Korean owned company employing 70 workers from both Puerto San Carlos and the nearby community of Ciudad Constitución. Pesquera Mexico buys squid and jellyfish in Guaymas, Sonora and typically purchases sardines in Puerto San Carlos when jumbo squid is not present. Pesquera Mexico reported that they paid \$3.0 mexican pesos (\$0.25 USD) per kilo all season for any of three jumbo squid body parts: head, mantle, and tentacles. The purchased squid were not cooked or processed in Puerto San Carlos at their facility; instead, squid was packed in plastic bags. Their trucks departed Puerto San Carlos daily with (at most) 27 t of squid, packed on ice (not frozen) to Ensenada, B. C., where the squid was later exported via boat to China, or via truck to Mexico City. The company reported that they purchased (on average) 30-50 t of squid daily from fishermen in Puerto San Carlos who were paid every three days. The company does not own boats and did not hire fishermen in Puerto San Carlos as company employees.

**Cooperative BioMar and Korean-owned Brumar de San Bruno.** Coop BioMar is based in Puerto San Carlos and was contracted to buy squid by Brumar, a Korean owned company operating a squid processing facility in San Bruno (near Santa Rosalia, B. C. S.). Brumar operates internationally, as well as in Guaymas, Sonora where they also purchase squid for export. Coop BioMar has been operating in Puerto San Carlos for 20 years, but we could not ascertain for how many years Brumar had been purchasing squid in Puerto San Carlos. In the winter the squid was shipped via truck, packed on ice (not frozen), to the Brumar squid processing facility in San Bruno (B. C. S.). This squid was later shipped to Mexico City via truck. Squid was purchased in parts: head, and fins with the mantle. Squid fishermen in Puerto San Carlos were paid \$5.0-\$6.0 mexican pesos/kilo. During the winter season these buyers reported that squid prices were high due to Semana Santa (Easter/Holy Week). Squid market price fell in the late spring and summer months. During this time squid was still shipped to Brumar's facility in San Bruno, B. C. S. where it left by truck to Ensenada, B. C., but was later exported by boat to Korea. Squid fishermen in Puerto San Carlos who sold to this buyer-exporter were paid on a daily basis. The company did not operate their own boats or employ their own fishermen in Puerto San Carlos.

**Korean-owned Hanjin Mexico.** Hanjin operates a squid processing facility in Santa Rosalia, B. C. S. and had not previously purchased squid in Puerto San Carlos. The company began their operation in July and paid fishermen \$2.0 mexican pesos/kilo for the mantle, and \$2.5 mexican pesos/kilo for the head. Hanjin paid fishermen on a daily basis for their catch. The company also purchases squid in Santa Rosalia, B. C. S. and in Peru. Hanjin reported that semi-trucks left Puerto San Carlos daily, with an average of 20-21 t of squid packed on ice (not frozen). Trucks arrived in Santa Rosalia B. C. S. where the squid was later processed and separated into head, fins and mantle. Hanjin later sent the squid

via refrigerated truck to Ensenada, B. C. where the final destination for the product was reported as "Asia."

**Mendivil Coop of Puerto San Carlos, BCS, Mexico.** Jose "Pepe" Mendivil operates a fishing cooperative in Puerto San Carlos with four pangas. 2010 was the first year this cooperative began purchasing and fishing for jumbo squid in the Magdalena Bay region. The cooperative only operates in the vicinity of Puerto San Carlos and typically fishes shrimp and scallops. The cooperative began purchasing squid in February, 2010 and was paying a range of prices over the course of the season: \$3.0 mexican pesos/kilo for a complete squid, \$2.0 mexican pesos/kilo for mantle and fins, and \$2.5 mexican pesos/kilo for the head. Squid was shipped laid flat on ice (not frozen) via semi-truck to Ciudad Constitución where a middle-man (*permisionario*) purchased the product for an unnamed Korean company. Trucks departed daily from Puerto San Carlos with a minimum of 10 t and a maximum of 20-22 t of product. The cooperative explained that the squid heads arrived at one plant and the mantle and fins to another plant. The cooperative representatives were not able to explain where the processing plants were located, or the final destination of the exported squid.

**Buyer 1 of undetermined name.** As mentioned above, one of the squid buyers was located on a salt flat near the Sardine Cannery in Puerto San Carlos. These buyers were reluctant to share any information about their squid buying and exporting operation, possibly fearing that researchers would be furnishing financial, operating, or workplace information to agencies or authorities. However, they did explain that they were only purchasing squid. They would not disclose the prices they were paying to fishermen, only that squid fishermen were paid daily. Representatives explained that the squid left Puerto San Carlos daily via truck to Santa Rosalia, B. C. S. "Because there are plants and seasonal work there". We could not ascertain the tonnage of squid leaving Puerto San Carlos via this company. Representatives of this buyer-exporter company reported that they also buy squid in Santa Rosalia and Mulege, B. C. S. They explained that squid eventually traveled to Ensenada, B. C. and later to Asia. Squid was packed on and under ice (not frozen), and separated into mantle and head. The company did not operate its own boats and did not hire fishermen in Puerto San Carlos.

**Buyer 2 of undetermined name.** Also reluctant to conduct an interview, this company was operating with a small panel truck near the tourist pier in Puerto San Carlos. Representatives explained that they also buy squid in Santa Rosalia, B. C. S. where the product is later shipped by truck to Ensenada, B. C. and on to Korea via boat. 2010 was their first year of purchasing squid in Puerto San Carlos, and they were only purchasing squid. This company began operating in Puerto San Carlos in July, towards the end of the season, and reported paying fishermen daily an average of \$3.0 mexican pesos/kilo for any combination of head, mantle,

and fins. The company reported at times paying as little as \$1.0 mexican peso/kilo for fins, \$2.0 Pesos/kilo for a whole squid, and as much as \$3.5 mexican pesos/kilo for head, mantle, and fins. This company reported shipping product to Guaymas, Sonora; Mexico City, Mazatlan, Sinaloa; and Guadalajara. Unfrozen squid was placed on top of ice inside the truck, separated by body part. The company explained that they do own boats and also employ fishermen, but only in Guaymas, Sonora.

**Demographics of the 2010 Puerto San Carlos artisanal jumbo squid fishing fleet.** This vein of our research describes the demographics of the fishermen working in the 2010 jumbo squid fishery. Due to the irregular quantity of product landed in the Magdalena Bay region, and recorded by the Puerto San Carlos office, it is important to also document the human effort that was required to facilitate this effort.

The average age of our all-male respondents (n= 110) was 34 years with a range of 18 to 78 years. More than half (62%; 69/110) of our total pool of respondents lived in the state of B. C. S., with the majority (79%; 54/69) of B. C. S. residents living in Puerto San Carlos (Fig. 3). The majority of our respondents had either a middle school (30%) or high school (33%) education; 34% of fishermen did not complete middle school.

In a typical year the average fisherman in our sample earned an average of \$11,090 Mexican Pesos each month (+/- \$1,000 USD per month) and had 2.83 dependents. This number takes into consideration that almost all of our respondents engage in other fisheries when jumbo squid are not present in the Magdalena Bay region. During squid season, fishermen earned on average \$1,040 Mexican Pesos each day (\$87 USD). Most of our respondents did not have children who were fishermen, more likely, these children were attending school, with squid fisherman having an average of 1.48 children attending school. Squid fishermen had an average of 3 other fishermen from their families also working in Puerto San Carlos.

The historical involvement and experience of respondents in the jumbo squid fishery showed that 28% of our respondents first worked in the squid fishery in Puerto San Carlos in 2010, indicating that for about 1/3 of our respondents, this was a new fisheries activity. During the last 10 years our respondents had been fishing squid for an average of 4.72 years. 21% (24/110) of respondents first engaged in squid fishing in San Carlos during the booming 1997/1998 squid fishing season. 26% (29/110) of fishermen in our study had fished squid for 10 or more years, the highest being 30 years. More broadly, outside of Puerto San Carlos, respondents had fished in 13 Mexican locations for jumbo squid (Fig. 4).

The associational attributes of artisanal jumbo squid fishermen and their fishing equipment indicated that 64% (67/105) of our respondents were members of a fisheries cooperative in B. C. S. There are a total of 340 fisheries cooperatives registered in Puerto

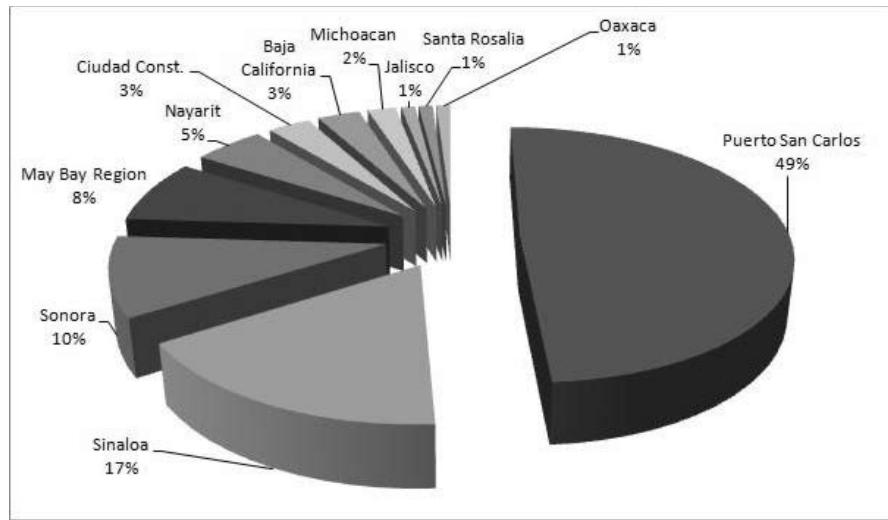


Figure 3. Current residence of participants in the 2010 Jumbo squid fishery (n = 110).

San Carlos. 33% (35/105) of our respondents were *independent fishermen* (permit holding fishermen not associated with a cooperative), while 3% (3/105) were *unregistered fishermen* (seasonal laborers). 25% (26/105) of our respondents owned their own boats and motors, with most fishermen owning 1 or 2 boats. 15 of these 26 fishermen lived in Puerto San Carlos, while the other fishermen who brought their boats to Puerto San Carlos to fish squid lived in Adolfo López Mateos, a northern fishing community inside of Magdalena Bay. Fishermen from Santa Rosalia only used and worked on boats based in the Magdalena Bay region. Additionally, we witnessed a small number (less than five) of large boats traditionally only used by the sardine fishery, that were being uti-

lized for catching squid, with fishermen utilizing hand lines. We were unable to contact fishermen working on these larger boats.

Overall, 51% (53/105) of respondents used pangas owned by a cooperative and 50% of respondents used cooperative motors. 6% (6/105) of respondents rented pangas and motors, 17% (18/105) borrowed pangas; and 19% (20/105) borrowed motors. The fishing equipment (potera) is a large jig assembled from two Japanese commercial jigs. Some jigs were as large as 50.8 cm (0.68 kg), while most were in the range of 20.32 cm (0.45 kg). The average price of a jig in Puerto San Carlos is about \$20 USD. The majority, 46% (48/105) of fishermen owned their own equipment,

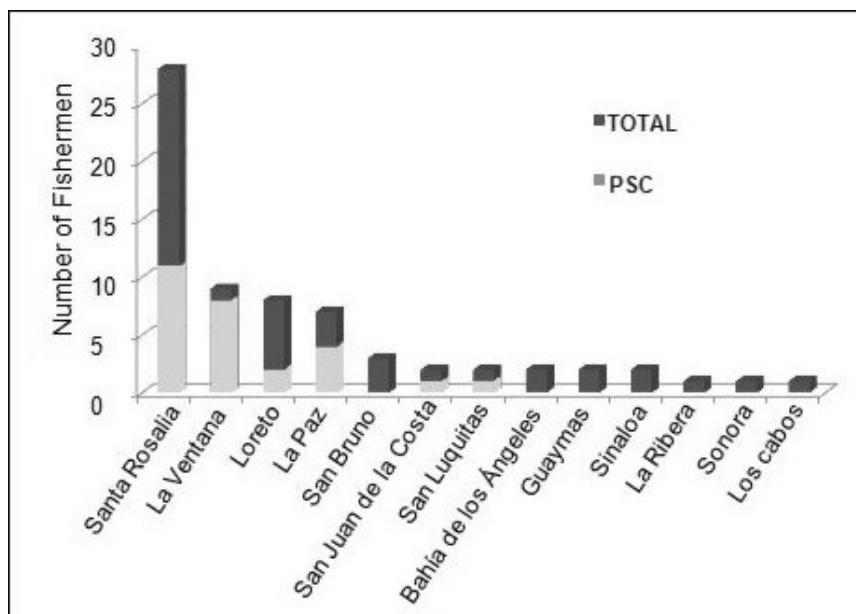


Figure 4. Locations of prior squid fishing activities of respondents (n = 64).

35% (37/105) used their coop's equipment, while 15% (15/105) borrowed or rented squid fishing equipment. 83% (87/105) of all fishermen bought fishing supplies in Puerto San Carlos at the Ferremar store. The average motor size in the fleet was a 90 HP engine with an average age of 3 to 4 years, and respondents spent an average of \$665 mexican Pesos (\$55 USD) daily on petrol.

**Jumbo squid fishing grounds near Magdalena Bay.** The mouth of Magdalena Bay is approximately 27 kilometers from the fishing port of Puerto San Carlos. The depth at the mouth of the bay is approximately (25 m dropping quickly to 100 m) 15 km west of the mouth. Our interview data shows that the average depth at which squid were caught was 40 fathoms, just west of the mouth of the bay. The range of depth for catching squid was 10 to 80 fathoms.

During the course of our fishermen interviews in June, July and August, squid fishermen were shown a map of the Magdalena Bay Region and asked to identify the exact location of their squid fishing activities. Fishermen indicated the general location and movement of the squid, and the associated squid fishing activity in the Magdalena Bay region. The squid and the artesanal fishing fleet gradually moved north from the mouth of Magdalena Bay in the direction of Punta Hughes from June to September. We do not have data for the location of the squid after the squid fishing season ended in September.

**Fishing season of jumbo squid.** Through interviews with fishermen we ascertained that jumbo squid were fished from January to September just west and north of the mouth of the bay. The spring months of March and April, and the summer months of June and July were the most productive months for fishing squid. August and September were listed as the least productive month due to the fact that squid had traveled too far northwest of Punta Hughes and were beyond the reach of the artisanal fishing fleet (Fig. 1). When open-air pangas are filled to capacity with squid, returning to Puerto San Carlos from beyond Punta Hughes is deemed far too risky.

**Fishing licenses and fees for jumbo squid.** According to SAGARPA (personal communication), renewal of a squid fishing license is \$746 mexican pesos (\$62 USD). Costs are added for the total number of boats fishing under the license, and costs are also added for tonnage. SAGARPA calculates the total net that each boat has included in their license: \$6.8 mexican pesos/mo. or \$82 mexican pesos annually. To clarify this, cooperative X has 3 boats included in its squid fishing permit and the average panga has an estimation of  $0.84 \text{ T} \times 3 \text{ boats} = 2.52 \text{ T}$ . This implies that they will pay for the rights for the use of this squid:  $2.52 \text{ T} \times \$82 \text{ mexican pesos} = \$206.64 \text{ mexican pesos} (\$17 \text{ USD annually})$

**Catch Per Unit Effort, average tonnages landed, and fleet size.** The Catch Per Unit Effort was  $0.57 (+/-0.29)$  kilograms of squid in a fishing fleet with an average panga size of 7 meters. The average daily reported catch of squid per panga was  $1.55 \text{ t} (+/- 0.43)$ . The

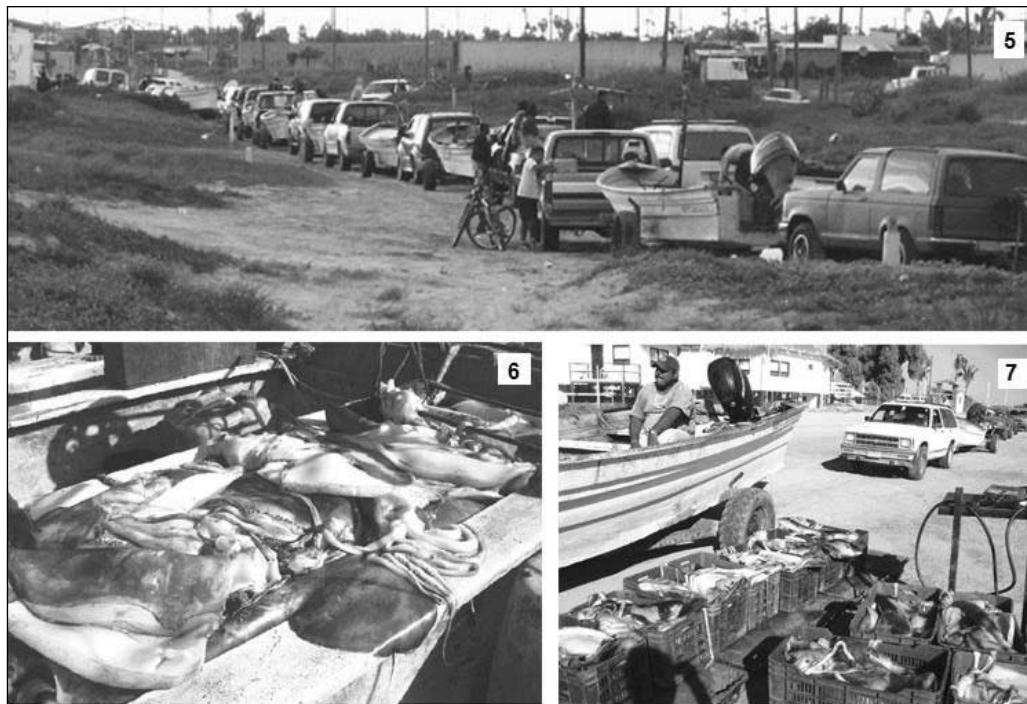
highest average daily catch reported by a fisherman was  $3.0 \text{ t}$  of squid, but this was the largest panga observed in the fleet (8.2 m). The average total trip time on the water was 6-8 hours. Towards the end of August squid had relocated to the northwest of Punta Hughes, and fishing trips expanded from 8 to 15 hours. The average number of fishermen in a panga was 2, and the average number of pangas fishing in one location (reported by fishermen), was 87 boats, with a range of 15 to 200 boats.

**Jumbo squid markets in Puerto San Carlos.** Sales of squid did not tend to present substantial problems to the artisanal fishing fleet. A handful of fishermen explained that they disliked having to wait three days to be paid by some buyers, and at times the price per kilo was too low, in their opinion. Most fishermen, however, explained that the lines for selling squid were too long. Through on-site observations over the course of eight months we observed fishermen waiting in lines for as little as half an hour, to as many as five hours. We calculated that the average wait time to sell squid was 2.1 hours. In most instances the squid was left uncovered and unrefrigerated in the sun, in the hull of pangas, exposed to insects. The long wait times and environmental conditions affecting the product could potentially present health risks to consumers (Figs. 5-7).

**Communications and safety components of the artisanal squid fishing fleet.** In January of 2010 five fishermen in Magdalena Bay drowned due to capsizing pangas. It is suspected that their pangas were swamped by waves and an overloading of product (squid and/or scallops) during inclement weather. After this incident the Port Captain required all pangas in Magdalena Bay to carry life vests or face a \$208 USD fine. All of our respondents reported having life vests on their boats, while one respondent reported that he also used a Global Positioning System device. Additionally, 66% of squid fishermen had cellular telephones on boats; 18% had radios on boats; 8% had both radio and cellular telephones on their boats; and 8% had no communication equipment on their boats.

The most common injuries, dangers, and problems reported for the artisanal squid fishing fleet were: cut fingers, dead motors, sinking/swamped boats, lack of boat lighting equipment, the danger of nighttime collisions, traveling far distances in the open ocean to catch squid, lack of space in the pangas for product, inclement weather (wind and high seas), fishermen falling out of their panga, and fishermen working in the artisanal fleet who had a general lack of experience and/or those who could not swim. Fishermen from the Gulf of California (Santa Rosalia, Mulege, etc.) who traveled to Puerto San Carlos to fish for squid explained that the seas in the Magdalena Bay region are much rougher than those typically found in the Gulf of California.

Only 16% (17/105) of respondents discussed recommendations for improving the fisheries equipment, including: using mo-



Figures 5-7. 5. The artisanal squid fishing fleet waiting in line to sell their product in Puerto San Carlos. 6. Squid left exposed to insects and the sun, waiting to be transferred to buyers. 7. Squid is placed on scales and later transferred to the buyer-exporter vehicles.

torized winches on pangas to land the squid, using larger pangas, increasing the use of weights used in strong ocean currents, and the possibility of working less hours.

## DISCUSSION

The purpose of this research was to document the economic, demographic, and fleet logistic characteristics of the artisanal jumbo squid fishery operating in the Magdalena Bay region in 2010. The jumbo squid fishery began operating out of Puerto San Carlos in January of 2010 when squid congregated close to the mouth of Magdalena Bay, and ended around September, 2010 when the squid had migrated to the north of Punta Hughes. Of major importance is the fact that the quantity of jumbo squid congregating in this region in 2010 was sufficient enough for external buyer-export companies, as well non-local fishermen to relocate temporarily to Puerto San Carlos. After gathering information from both the artisanal fishermen and SAGARPA, it was apparent that the jumbo squid fishery of 2010 was the largest catch recorded by the Department of Fisheries Administration office in Puerto San Carlos, as well as the longest jumbo squid fishing season (nine months). And as noted by our observations in the community, there was never an occasion when we observed a returning panga that was not almost entirely full with squid.

While the majority of our respondents from the artisanal squid fishing fleet were comprised of Puerto San Carlos and in-state residents, experienced fishermen were found to have traveled from other states in Mexico. In short, the arrival of jumbo squid and the related ephemeral fisheries phenomenon represented a new economic opportunity for some of the existing (albeit inexperienced) artisanal fishermen in Puerto San Carlos, as well as experienced visiting squid fishermen, and the importance of this should not be understated. Many fishermen from Puerto San Carlos explained to us that when they fish scallops, shrimp, and other fish species in the Magdalena Bay region, they face the possibility that they will return to port with empty boats, or lacking enough product to even cover the petrol expenses. Jumbo squid, from January to September of 2010, presented a sure economic bet for the local artisanal fishing fleet. With an average price/kg of \$3 Pesos, we estimate the total economic impact to the artisanal fishing fleet to be around \$57.6 million Pesos (\$4.8 million USD) which could partially explain the arrival of the new ATM machine in the town plaza.

Catches of jumbo squid in the Gulf of California were notably lower during the winters of 1997/1998 and 2009/2010. The Pacific coast of BCS near Magdalena Bay experienced strong El Niño events during both of these seasons, as well as blooms in the jumbo squid fishery.

A characteristic of the jumbo squid fishery is that it couples the attributes of the squid: a short lived species with unpredictable inter-year abundances and little known migratory patterns (Markaida, personal communication). In order to stay competitive, the Asian buyer-exporters that are permanently based in the vicinity of Santa Rosalia, and who typically buy squid from fishermen in Gulf of California, became flexible enough to expand their operations to Puerto San Carlos. Their economic activities in Puerto San Carlos, as well as the arrival of squid fishermen from the Gulf of California, followed the large migration of jumbo squid. While we were able to interview all 6 of the exporter-buyers, two were reluctant to discuss their export operations. A conspicuously absent company was the Chinese-owned Pesquera de Longing, S.A. which operates a squid processing facility in Santa Rosalia, B.C.

Since January, 2010 these 6 buyer-exporters reported paying as little as 1 Peso/kilo, and as much as 6 Pesos/kilo depending on the body part, season, domestic and foreign market demand, and other market conditions. We were able to identify the shipping routes of the product; exporters were shipping as much as 27 t of squid daily via refrigerated or ice packed semi-trucks to Santa Rosalia, BCS and later to Ensenada, B. C., and ultimately by boat to mainland Mexico and Asian markets.

Unfortunately, the buyer-exporter companies did not provide an efficient method for purchasing squid from the artisanal fleet. As a result of the long wait times we found potential food safety issues resulting from the mishandling of squid during buying and shipping. Squid at times was left exposed to 38+ °C degree full sun conditions, as well as insects, for over five hours. In the future, buyers should work to improve upon operational efficiency in order to reduce wait-time and the associated detrimental effects on the squid product. Further, squid fishermen should be encouraged by these companies to cover the product with tarps.

Not all pangas in the artisanal fishing fleet were economically immersed in the jumbo squid fishery. Of particular note, catarina scallop *Argopecten ventricosus* (Sowerby, 1842) continued to be taken in large quantities from Magdalena Bay throughout the spring and summer months of 2010. Migrant and resident workers from Puerto San Carlos and surrounding communities worked in the community during this time to dive for, and shuck scallops. In our related Magdalena Bay fisheries research we found that 2010 was also a banner year for scallop production.

This research has worked to create a baseline of information in regard to the jumbo squid fishery of 2010 in Magdalena Bay and to identify the social and economic outcomes of the phenomenon. Considering that most artisanal fishermen from Puerto San Carlos are engaged in fishing species other than jumbo squid during a typical year, the jumbo squid fishery presented a complementary economic opportunity (boom) for a span of nine months in 2010.

Further, as Magdalena Bay continues to face diminishing fish stocks in species that have long been overexploited, the squid fishery of 2010 offered a temporary, yet lucrative alternative economic opportunity.

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