

## EXPLOITED FISHERIES: CRUSTACEANS, MOLLUSCS, CEPHALOPODS AND BEYOND

### The use of multi frequencies to study the Jumbo squid (*Dosidicus gigas*) in the Gulf of California

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The jumbo squid *Dosidicus gigas* supports an important fishery in the central region of the Gulf of California, Mexico. The use of hydroacoustics provides an important tool to assess biomass, and study distribution and abundance of this species. We present results of the use of two frequencies (120 and 38 kHz split beam) applied to identify the echo traces of the Jumbo squid in the Gulf of California. Results show that Jumbo squid echoes are stronger at 38 kHz than 120 kHz. The analysis of the subtraction of the echo strength from the two frequencies shows a normal distribution with a mean of +5 dB. This distribution was used as a guide to discriminate the echoes received from this cephalopod from other sources during a hydroacoustic survey in June 2013 and confirmed with the use of jigging.

### Analysis spatio-temporal of the population structure of *Farfantepenaeus notialis* (Pérez-Farfante, 1967) in the Caribbean Sea in Colombia

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Knowledge of the population parameters of exploited species contributes to the understanding of the ecological processes that affect their biological and fishery dynamics. Using the information of abundance by size class monthly of July (2004) - January (2005), somatic growth was analyzed monthly, variability of maturity, mortality, and the spatio-temporal distribution of densities (ind/km<sup>2</sup>), size (cm) and percentage of mature of *Farfantepenaeus notialis* in the southern Caribbean sea of Colombia, as well as its association with the sea surface temperature, depth, flow and rainfall. This species showed a size at first maturity 15.6 cm LT, the asymptotic growth curve (Von Bertalanffy function) showed rapid growth ( $L_{\infty} = 22$  cm and  $K = 2.4$  yr<sup>-1</sup>). High exploitation rate ( $E = 0.9$ ) was estimated. In terms of abundance, maturity and asymptotic size distribution, differences were found for weather seasons (dry and wet), being a direct relationship between environmental variables analyzed that occur in each weather season and the population parameters of this species. It is urgent to design responsible management strategies in order to achieve optimal exploitation of this resource.

### Variation of structure and population dynamics of the spiny lobster *Panulirus gracilis* on the South of Sinaloa

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En este estudio se analizaron 4 temporadas de pesca de langosta *Panulirus gracilis*, de noviembre 2007 a junio 2010. El área correspondió a la zona costera del sur de Sinaloa, entre 23°10'05"-23°29'01" N y 106°24'09"-106°40'05" O. Se examinaron 5506 organismos, de los cuales 2693 fueron machos y 2813 hembras. Las relaciones efectuadas entre la longitud del cefalotórax (LC) y el peso total (PT) se ajustaron a una ecuación de tipo potencial: población total  $PT=0.0019LC^{2.8077}$  ( $R^2= 0.9592$ ), machos  $PT= 0.0016LC^{2.8511}$  ( $R^2= 0.9434$ ) y hembras  $PT= 0.0019LC^{2.8015}$  ( $R^2= 0.938$ ). La LC osciló entre 51 y 111.2 mm, con la moda entre 70 y 75 mm; la mayoría de los organismos se encontraron de 65 a 80 mm. La talla de primera madurez varió de 68.75 a 74.45 mm de LC, teniendo en promedio 71.66 mm  $\pm 2.24$ , mientras que la mortalidad natural osciló entre 0.2 y 0.24  $\pm 0.4$ . La velocidad de

crecimiento fue diferente para cada temporada de pesca. Los resultados obtenidos indican que definitivamente es necesario considerar la variación interanual de los parámetros poblacionales de esta especie.

### **Density and spatial distribution variations of shrimp postlarvae *Litopenaeus* spp and *Farfantepenaeus* spp in the offshore of Sinaloa and Nayarit states, Mexico**

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A 177 Surface plankton tows and record of the sea surface temperature data were analyzed, provided from four shrimp research cruises in a period between July and August 2012. Surface temperature values were from 28.1 °C to 33.0 °C. The total filtrate volume was 4241.9 m<sup>3</sup>, the average volume filtered per set was 23.9 m<sup>3</sup>. Were analyzed 1.1421 organisms, 52.9% were blue shrimp postlarvae (*Litopenaeus stylirostris*), 22.9% white (*L. vannamei*), 22.3% brown (*Farfantepenaeus californiensis*) and 1.9% crystal (*F. brevirostris*). The relative density of species was obtained by means of the  $\Delta$ - distribution, blue shrimp had the highest average density in August with 0.535 org/m<sup>3</sup>, while the maximum average density of white, brown and crystal was obtained in July with 0.5151 org/m<sup>3</sup>, 0.6163 org/m<sup>3</sup>, and 0.0291 org/m<sup>3</sup> respectively. It founded that blue and white species had a wider spatial distribution on August, whereas brown and crystal were presented in July. Key words: Relative density, shrimp postlarvae,  $\Delta$ -distribution, offshore of Sinaloa and Nayarit.

### **Size structure of the blue crab (*Callinectes arcuatus*) populations, in the marine and the estuarine and lagoon environments of the south of the Gulf of California, Mexico**

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The data of the blue crab (*Callinectes arcuatus*) of the Gulf of California from April 2009 to October 2012 were analyzed. The records come from catch of the trawl shrimp fisheries and include the net trawl to small scale, used in shallow marine waters or near shore associated with estuarine and lagoons of Huizache-Caimanero system in the mouth of the Baluarte River and the Altata-Pabellón system in the mouth of the Culiacán River. It also includes data from commercial landings caught with crab's rings and cast net. With the information available it is analyzing the size distribution carapace width and then generates hypotheses about size structure patterns, modal groups, the central tendencies and variance by month average, by area, by ovigerous females, for females and totals. The ovigerous females were observed in the protected waters, in the near shore and the open sea. On the open seas is possible to observe three modal groups in around the 70, 80 and 100 mm of CW. The overall abundance of ovigerous females rises from January to a maximum in July and August and gradually descends until November. In this work is expanded the analysis to marine environment and is a new approach.

### **Size structure and modal groups in juvenile lobster *Panulirus inflatus* in the Bay of Mazatlan, Sinaloa, Mexico**

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Se realizaron dos muestreos nocturnos mensuales durante las mareas muertas, de julio del 2011 a junio del 2012, en la ensenada de Puerto Viejo, en la bahía de Mazatlán, Sinaloa, México. Se colectaron de forma manual 658 juveniles de *P. inflatus*, 280 machos y 378 hembras; la menor talla reportada fue de 9.1 mm de longitud del cefalotórax (LC), mientras que las tallas promedio fueron de 31.9 mm ( $\pm 8.1$ ) y 32.8 mm ( $\pm 8.9$ ) para machos y hembras, respectivamente. Se encontraron diferencias significativas en la estructura de tallas de los machos ( $D_{max}=0.148$ ;  $P<0.05$ ) y las hembras ( $D_{max}=0.083$ ;  $P<0.05$ ), aunque no se encontraron diferencias significativas entre las tallas por sexo ( $Z=1.34$ ;  $P>0.05$ ). La proporción sexual mensual no difirió significativamente de 1:1 ( $P>0.05$ ), excepto en octubre ( $P<0.05$ ). La determinación de los grupos modales se realizó por sexo. En la distribución de tallas mensual de los machos se identificaron hasta cuatro cohortes, mientras que para las hembras se encontró un máximo de tres cohortes. Existió reclutamiento de juveniles ( $<21$  mm de LC) durante gran parte del período de estudio, excepto en septiembre, noviembre y abril.

### **Interstitial invertebrates assemblage in exploited beds of cortés geoduck (*Panopea globosa*) from the upper Gulf of California**

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Geoduck harvest requires the use of a water jet. This extraction method had effects on the composition of the invertebrate's community of soft-bottom ecosystems. The purpose of the study is to characterize the invertebrate's assemblage in exploited geoduck beds. A total of 22 samples (11 in Puerto Peñasco, Sonora and 10 in San Felipe, B.C.) were taken with a sediment core (7.5 cm of diameter and 20 cm long) for micro invertebrates. Another 22 samples were taken from quadrants of 2 m<sup>2</sup> with an airlift suction sampler for bigger invertebrates; sediment was sieved with a wire mesh of 2 mm. Macro invertebrates were removed manually while the micro invertebrates were separated by a sediment suspension technique and sieved with a wire mesh of 355 micra. Samples were fixed with formaldehyde, dyed and preserved in alcohol. Species were identified, counted and weighted for each sample. Indices of diversity, richness, evenness, and dominance will be determined to set a base-line information for further comparison studies. Differences of invertebrate's assemblage between geoduck beds will be established. Previous results show that species richness is higher in Puerto Peñasco, although no geoduck recruits have been found. In San Felipe all samples had geoduck recruits.

### **Declining abundance and recruitment of American eels at the extremities of the range: Are eels declining in the southern part of the range?**

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American eels have declined dramatically in some regions over the past several decades, best documented in the upper St. Lawrence River-Lake Ontario, where the species is now classified as endangered. Elsewhere, some believe this might be only a local problem with a local explanation. We examined changes in abundance across the extremities of the range from the St. Lawrence River system and watershed to watersheds in the Gulf of Mexico,

Caribbean, Atlantic Seaboard, and other remote regions. Is the American eel declining in the subtropics and tropics? We document that eel declines are common at various extremities throughout the range. These are associated with declining recruitment, since extent and dispersal of active immigration are density-dependent. Where glass eel recruitment data are long-term, near the sources of recruitment (U.S. Atlantic Seaboard – NJ and NC), and decreases are less apparent, long-term changes in size and timing of recruits entering estuaries indicated significant temporal changes and trends. If recruitment and abundance data are from the extremities of the range and long enough, declines are apparent, widespread, and consistent with overall species decline, emphasizing a need to be extremely concerned about the status of this panmictic species and consider fisheries to be seriously threatened.

### **Detritus as the most important component in the assimilated diet of wild abalone on the Baja California Peninsula**

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Se utilizaron isotopos estables ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ ) para evaluar la importancia del detritus y las microalgas en la dieta de los adultos de *Haliotis fulgens* y *H. Corrugata*. También se compararon la variación temporal y espacial de estas mismas especies mediante la recolecta mensual de especímenes durante un ciclo anual (marzo 2012 - febrero 2013) en la localidad de la Bocana B.C.S., México y un muestreo en octubre de 2012 en la localidad de Bahía Tortugas. Los resultados mostraron que ambas especies de abulones presentan una dieta similar entre especies y localidades, por otro lado el análisis temporal mostró una clara estacionalidad en los valores de  $\delta^{13}\text{N}$  de *H. fulgens* mientras que *H. corrugata* presentó valores constantes. El resultado más sobresaliente fueron valores  $\delta^{13}\text{N}$  por debajo de sus potenciales presas (macroalgas) sugiriendo una importante contribución del detritus en la dieta asimilada de los adultos de abulón que de acuerdo el modelo de mezcla Stable Isotope Analysis en R es de  $\approx 60\%$ . Se discuten algunas implicaciones de nuestros resultados en el campo de la biología y acuicultura de estas especies.

### **Florida angler perspectives on resuming harvest of the protected, mangrove-dependent goliath grouper**

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The goliath grouper, a fish dependent on mangroves for much of its life history, experienced a near extinction event and has been protected from harvesting in US federal and state waters since 1990. Although recovery in US waters is uncertain, many anglers are calling for this fishery to be opened for recreational take. In 2015, the goliath grouper stock will be reassessed, and in addition to the scientific information necessary to make management decisions, it is important to quantify stakeholder perspectives. Understanding angler perceptions and motivations is essential for effective fishery management, as they can have large implications for angler behavior. The present study used a mail-based survey of the individuals in the Florida Fish and Wildlife Conservation Commission's saltwater angler license database (sample frame size of 475,091 individuals). After two waves of mailings ( $n = 1000$ ), a total of 164 individuals responded. Here, we quantify Florida recreational angler perceptions regarding the goliath grouper population status over time, we quantify opinions toward a theoretical goliath grouper fishery in Florida-state waters (including a willingness to pay for a harvest tag), and we examine the different underlying characteristics that influence the propensity to believe that the goliath grouper fishery should be open.

### **Distribution and abundance variations of shrimp postlarvae *Litopenaeus spp* and *Farfantepenaeus spp* in the Bay of Ceuta, Sinaloa, Mexico.**

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Biological sampling data of shrimp postlarvae from the Ceuta Bay, Sinaloa were analyzed, in the period from May to August 2012. 252 trawls between surface and bottom were performed using plankton net. On August the highest incidence of postlarvae, was 6,249 organisms, where blue shrimp specie was the most abundant with 37.7%. Highest densities were obtained on surface stratum recording 57.6% of the total collected, while in the bottom 42.4%. At the mouth of El Conchal estuarine system was found the greatest abundance of postlarvae recording 67.7% of all species, while in the mouth of Cospita estuarine system 32.3%. The relative density of species was obtained by means of the  $\Delta$ -distribution, where the highest average density of crystal, brown and white shrimp postlarvae were obtained in August with 0.335 org/m<sup>3</sup>, 0.220 org/m<sup>3</sup> y 0.184 org/m<sup>3</sup> respectively; while blue shrimp indicate the maximum density in June with 0.603 org/m<sup>3</sup>. Key words: Relative density, shrimp postlarvae,  $\Delta$ -distribution, Ceuta Bay.

### **Catchability coefficients trend from catch and effort data in shrimp fishery of the southeastern Gulf of California**

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The shrimp fishery in the southeast Gulf of California is considered fully exploited with a very high exploitation rate, with largest Mexican fleet of shrimp trawlers. When the management fisheries depend on annual stock assessments which are based on catch and fishing effort data, the fishing effort becomes a key input. If the estimates are biased due to does not take into account the effort creep, which would be affected by many factors, including gear, technology improvement, and skippers' knowledge, then the stock assessment could be flawed. This study evaluated the catchability changes occurred in the shrimp trawlers fishery between 1992 and 2011 through biomass dynamics models and Bayesian analysis. Catchability is assumed be directly linked to fishing power. The results suggest an increase in catchability (and hence efficiency) over time between 1% and 5% annual by on average 2.7% per year. If this fishing power increases is used to adjust nominal fishing effort when it used the number of trips, the nominal fishing effort instead of decreasing 10% because of retirement programs trips, this has remained constant over time. This kind standardized effort would be used to reassess abundance measures, especially of the shrimp stock.

### **Gulf of Mexico shrimp fishery compromised**

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Offshore shrimp fishery attained its maximum yield during the 1970's (35,000 tons). Main six shrimp species have been subjected to different fisheries along their life cycles. During the 1980's artisanal fishing effort added to offshore industrial one that had already reached its maximum levels. High total fishing effort caused growth, recruitment and

economic overfishing in five of the six species. Yield of white, pink and red spotted shrimp stocks collapsed to less than 10% of their mean annual catch. Only brown shrimp fishery is in a relative good state and majorly stands the shrimp fishery. High fishing combined pressure over the main species compromises the future of the Gulf of Mexico shrimp fishery. Reproductive potential is affected both by artisanal and industrial fishing. Comparatively, regulating artisanal fisheries has more impact on recovering spawning potential, but both are required. Urgent and renovated management strategies are needed to rebuild shrimp stocks that should contain: 1) Review of fisheries goals, 2) Reliable indicators of stocks conditions, 3) Actions to protect individuals of different ages to reduce growth overfishing and increase stock reproductive potential, 4) Dynamic strategies that could maximize shrimp yield in terms of social and economic context, 5) Enforcement of fisheries regulations.

### **The rise, fall and future of the jumbo squid (*Dosidicus gigas*) in the Gulf of California**

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The jumbo squid *Dosidicus gigas* supports an important fishery in the central region of the Gulf of California, Mexico. However, in recent years, landings of this species in the port of Guaymas, Sonora has declined significantly. We examined monthly landing records from January 1998 through December 2013 and related this record to monthly chlorophyll a from satellite imagery and wind speed from a local meteorological station. Results indicate that Jumbo squid catches were high between June 1998 and December 2004 associated with an extended period of high chlorophyll a concentrations and intense wind. From 2005 through 2011 landings were about 40% of previous captures. This decline is associated with a progressively decline of chlorophyll a and reduction of wind speed. At the end of 2011 captures of this species collapsed and have not recovered since. The collapse was associated to a significant decrease on wind speed, low productivity and the presence of warm waters from the south. It is believed that the future of this fishery depends now on the strength of the wind which induces productivity in the area as well on the implementation of regulations on catches of this cephalopod.

### **Economic performance of shrimp boats offshore along the Pacific coast of Mexico**

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The offshore shrimp fishery in the Gulf of California economically is the most important national fishery due to the high international market price, and third in volume production. The fishery consists of an artisanal fleet in inshore lagoons and the major national industrial fleet fishing in offshore waters. The fishery faces important problems like an overcapitalized and senile fleet, thus generating very low profit; also there is a crescent competition with the aquaculture shrimp production. This study analyzed and characterized representative shrimp vessels of the industrial fleet to determine and simulate their economic performance under public policy scenario of elimination to subsidy. We used the analytical method based on Production Representative Units (URP), which uses condensed economic information from a group of stakeholders with similar attributes to construct a representative vessel unit for the Mazatlán, Guaymas and Salina Cruz ports. The analysis simulation results indicated the most efficient vessel was in Guaymas, followed by Mazatlán and the least and most sensitive in Salina Cruz. This also shows a difference between the south and northwest Mexican pacific fisheries, especially in a differentiated access market and a fictitious marginal utility caused by fuel subsidies.