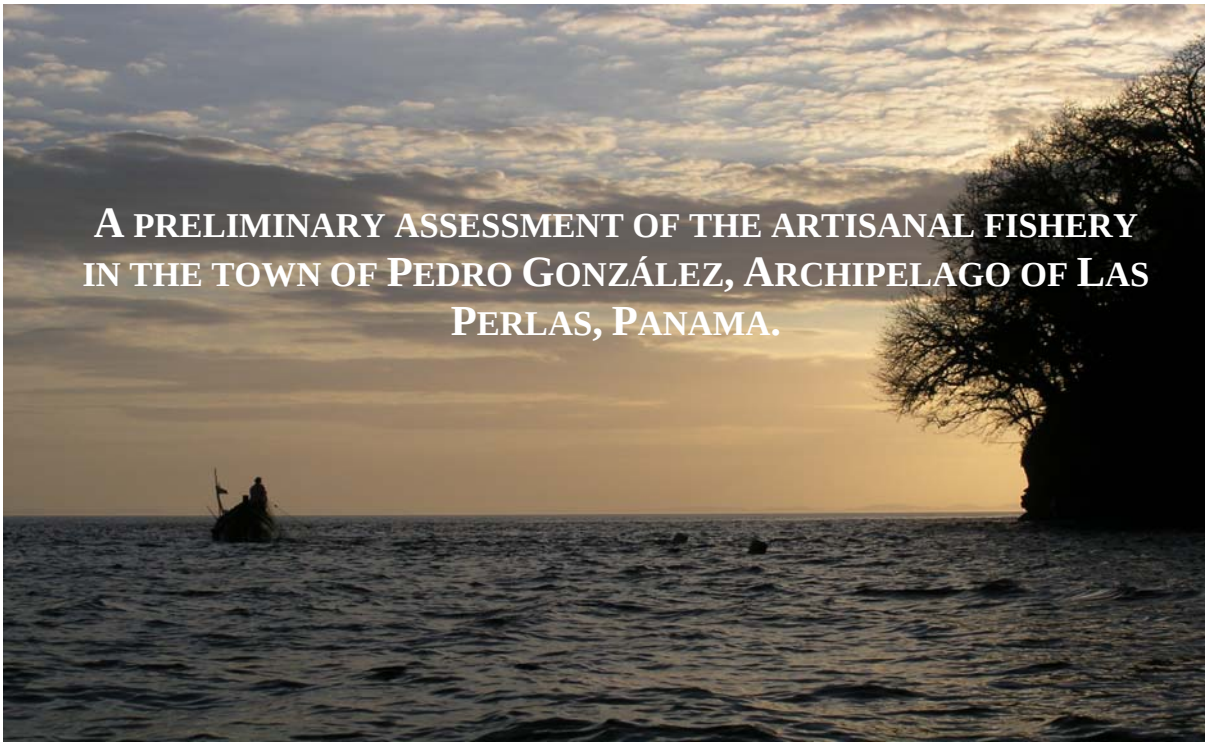

A PRELIMINARY ASSESSMENT OF THE ARTISANAL FISHERY IN THE TOWN OF PEDRO GONZÁLEZ, ARCHIPELAGO OF LAS PERLAS, PANAMA.

Dustin Raab & Dominique Roche
(e-mail: dustin.raab@mail.mcgill.ca, dominique.roche@mail.mcgill.ca)

Department of Biology, McGill University, 1205 Docteur Penfield Avenue, Montreal, Quebec, H3A 1B1, Canada

Host Institution:
Hector M. Guzmán
Smithsonian Tropical Research Institute
Apartado 2072
Balboa,
Republic of Panama
email: guzmanh@si.edu
Telephone: 507 212 8733
Fax: 507 212 8190/8791

Key words: fishery, fishing techniques, environmental impact, marine protected areas, conservation, post-harvest handling.

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A preliminary assessment of the artisanal fishery in the town of Pedro González, Archipelago of Las Perlas, Panama.

Dustin Raab & Dominique Roche

Host organization: Smithsonian Tropical Research Institute (STRI)

Under the supervision of Dr. H. M. Guzmán, at the STRI Naos Laboratories in Panama, we undertook a study of the fisheries around the island of Pedro Gonzalez, in the Archipelago of Las Perlas, for inclusion in the project *Zona de Manejo Especial* (ZME) *Archipiélago de Las Perlas.* This initiative seeks to establish a management zone containing the Archipelago, an area of high marine biodiversity in the Gulf of Panama. It will combine the fishing regulations with the creation of no take marine reserves in critical reproduction sites. Specifically, the aims of this study were: (1) provide a general description of the village of Pedro Gonzalez, (2) characterize the fishing methods and the fishing grounds used by the fishermen, (3) describe seasonal changes in use of these sites and methods, (4) identify and describe the species targeted and impacted by the artisanal fishery in the area, (5) characterize the targeted fish populations biometrically, and (6) identify the fate of the catch from the area of Pedro Gonzalez

In order to investigate fishing methods, fishing locations, composition and quantity of catches, as well as collect biometric data from targeted fish species, a total of 12 days were spent in and around the village of Pedro Gonzalez from Feb. 10 to Feb. 18, and from Mar. 13 to Mar. 18, 2005. Interviews (formal and informal) were carried out, personal observations noted, and boat expeditions were organized to fishing sites. The *Mercado de Mariscos* in Panama City was visited on five occasions where fish were opened for further biometrics on maturation state of fish populations in the Archipelago.

We identified 9 fishing techniques used in Pedro Gonzalez, the most common of which were gill netting, seine netting and droplining. In total 43 fish species were identified, 5 of which were distinguished as target species (*Caranx caballus* (n=204), *Sectator ocyurus* (n=148), *Elagatis bipinnulata* (n=101), *Haemulon maculicauda* (n=247), *Scomberomorus sierra* (n=24)). 26 boats from the village fleet were described. The seasonality of the snapper and grouper (*Lutjanus peru, Mycteroperca xenarcha*) usually falls between mid December and mid April, while pelagic species (e.g. *C. caballus, E. bipinnulata*) are caught mostly from January until April. This was delayed during the 2005 season due to a mild-effect El Nino event. There were 3 fates of catch originating in Pedro Gonzalez: (1) export through brokers, (2) local consumption, and (3) sale at the fish market in Panama City. In addition to size class distributions by length, regressions were created with biometric data for the 5 target species (all $P < 0.001$), and range of size and weight for non-target species. Insufficient data was acquired on reproduction for analysis (n=147).

Our detailed description of the fishery in Pedro Gonzalez provides information for consideration when implementing the ZME, such as the prevalence of net use in the area, and the ecological consequences of such fishing gear. Maps based on information from local fishermen serve to indicate important fishing grounds and reproduction sites, and communicate their willingness to collaborate in the conservation of their resources.

Evaluación preliminar de la pesquería artesanal en el pueblo de Pedro González, Archipiélago de Las Perlas, Panamá.

Dustin Raab & Dominique Roche

Anfitrión: Instituto Smithsonian de Investigaciones Tropicales (STRI)

Bajo la supervisión del Dr. H. M. Guzmán, de STRI en Panamá, hicimos un estudio sobre la pesquería alrededor de la isla de Pedro González, en el Archipiélago de Las Perlas para contribuir al proyecto *Zona de Manejo Especial* (ZME) *Archipiélago de Las Perlas.* Esta iniciativa trata de establecer una zona de manejo dentro del Archipiélago, un área de alta biodiversidad en el Golfo de Panamá. El objetivo de la misma es implementar leyes regulando la pesquería y crear reservas marinas donde se prohíbe la pesca en los sitios críticos de reproducción. Específicamente, los objetivos de nuestro proyecto son: (1) describir el pueblo de Pedro González, (2) caracterizar los métodos e identificar los sitios importantes de pesca, (3) documentar los cambios estacionales en el uso de artes y sitios de pesca, (4) identificar y describir las especies de peces y de mariscos de valor comercial, (5) caracterizar la biología pesquera (talla, peso, reproducción), e (6) identificar el destino de la pesca originada en el área de Pedro González.

Para investigar los métodos y los sitios de pesca, la composición y la cantidad de captura y obtener datos biométricos sobre las especies de mayor valor comercial, estuvimos 12 días en el pueblo de Pedro González entre Feb. 10 y 18, y entre Mar. 13 y 18, 2005. Hicimos entrevistas (formales e informales) y observaciones personales, además navegamos en panga hasta los sitios de pesca para obtener datos GPS, identificar organismos y colectar datos biométricos. Visitamos el Mercado de Mariscos en la ciudad de Panamá cinco veces para abrir peces y obtener datos sobre la reproducción.

Identificamos nueve métodos de pesca en Pedro González donde los más comunes fueron el uso de trasmallos y de bolicheros y la pesca con cuerda y anzuelo. En total identificamos 43 especies de peces, incluyendo cinco especies de mayor valor comercial (*Caranx caballus* (n=204), *Sectator ocyurus* (n=148), *Elagatis bipinnulata* (n=101), *Haemulon maculicauda* (n=247), *Scomberomorus sierra* (n=24)). Describimos 26 barcos de la flota de pesca del pueblo y la temporada de pesca de pargo y cherna (*Lutjanus peru*, *Mycteroperca xenarcha*) que ocurre generalmente entre la mitad de diciembre y la mitad de abril, y la de las especies pelágicas (ej. *C. caballus, E. bipinnulata*) que ocurre principalmente entre enero y abril. En este año de 2005, hubo un pequeño evento de El Niño causando un retraso de la estación de pesca normal. Identificamos 3 destinos de captura en el área de Pedro González: (1) para consumo local en el pueblo (2) para la venta en el Mercado de Mariscos en Panamá y (3) para exportación. Presentamos una comparación entre el peso y la talla y la distribución de los organismos por clase de talla por cada especie de mayor valor comercial (todos $P < 0.001$), además del ámbito de talla y de peso para especies de menor valor comercial. No tuvimos suficientes datos sobre la reproducción para realizar un análisis mas detallado (n=147).

Nuestra descripción detallada de las actividades de pesca artesanal alrededor de Pedro González incluye información importante para la implementación de la ZME como el uso de trasmallos en esta área y sus consecuencias sobre el ecosistema. Los mapas producidos indican los sitios mas importantes a proteger (sitios de reproducción) que incluyan las sugerencias de los pescadores locales sobre el uso de recursos.

Total number of days in the field: 15
Total number of days spent on the project in Panama: 34

1. INTRODUCTION

1.1 Marine reserves and coastal management

1.1.1 State of the World's fisheries and the ecological impact of fishing

For many years the Earth's coastal and marine environments have been considered one of the final unexploited frontiers of natural resources. At the opening of the twenty first century, however, this fantasy has begun to crumble in the face of reality. It is now believed that nearly half of all the global fisheries are overexploited, some of which are on the verge of, or are already, collapsing. According to Jackson et al. (2001), over fishing is the leading cause of ecological extinction in coastal ecosystems, and surpasses pollution, water quality degradation, and climate change as the worst of the anthropogenic disturbances to the world's oceans. It is further stated that ecological effects of overfishing can often be delayed as the process of fishing one species after another to critically low levels occurs, finally reaching the point of total ecosystem collapse. Pauly et al. (1998) refer to the progression of fishing down marine food webs, as the mean trophic level of fisheries catches has been declining over the past 50 years. As the juveniles of many pelagic species can be planktivorous, the reduction in the trophic level of catches can be seen as both a change in species composition, and a move towards the targeting of smaller, younger fish of the same species. As mature fish become scarce, the fecundity of the population decreases as well. Upon analysis, Pauly et al. (1998) found this process to be ecologically unsustainable, a continuation of which will lead inevitably to widespread fisheries collapse. Recently, strong pressure from fishermen to decrease the mesh size of gill nets to maintain catches in the Gulf of Panama testifies directly to this process (La Prensa, April 15 2005).

A further threat to global fish stocks lies in the fact that the catches of many fisheries are comprised of large volumes of by-catch, a topic addressed in a paper presented at a recent conference in Morocco on international fish trade and food security (Ababouch 2003). These are fish species taken incidentally to the targeted species, and much of this by-catch is discarded overboard, injured or dead, not because it is inedible but instead due to the fact that it is of less value than other species (Brown et. al, 1998). Brown et al. (1998) allude to this process, referring to the decrease in snapper (*Lutjanus sp.*) catches following an increase in shrimp fishing in the Gulf of Mexico. Snapper populations are decreasing likely due to by-catch of juveniles during shrimp trawling.

According to the document *The State of World Fisheries and Aquaculture 2002* (FAO 2005), 47 percent of fisheries stocks in the world were fully exploited at the time of the report, 18 percent of fisheries stocks were overexploited and heading for collapse if not already collapsed, and an additional 10 percent of stocks were significantly depleted. *The State of World Fisheries and Aquaculture 2004* (FAO 2004) offered no more than a reaffirmation of the 2002 numbers, the citation of concerns for livelihoods of those who rely on fishing for income, and doubt as to the sustainability of global fisheries catches. Clearly there is an urge to address this trend, and a pressing need for local, national and international measures to curb unsustainable fisheries.

1.1.2 Marine reserves

At the forefront of the available tools for addressing and reversing current global fisheries trends is the concept of marine reserves. Marine reserves have long been implemented in such cases where a region deemed worth protecting is thought to be in peril of destruction. This is generally obtained through the regulation of fishing practices within a defined area. It is argued that marine reserves can also serve to support nearby fisheries by acting as exporters of both adult fish, and younger larvae, into areas where there is an active harvest (e.g. Rakitin & Kramer 1996, Chapman & Kramer 1999, Russ et al. 2004). Russ et al. (2004) found that reserves could provide benefits to local fisheries in the form of larger catches, greater catch rates, and lower fishing effort. Overall they determined that there was an enhancement in the living standards of fishing villages located near reserves, by preventing overfishing and massive stock depletion. In a meta-analysis of literature on the success of marine reserves, Halpern and Warner (2002) found striking improvements in fish stocks and ecosystem health where reserves had been implemented in regions of ecological damage. These reserves may include strict no-take zones, areas of regulated fishing activity, or an amalgamation of the two management strategies into a single protected region.

1.1.3 Artisanal Fishing and Marine Reserves

One major concern in establishing a marine reserve in a harvested area is taking into account the impact on the lives of those who rely on the region for their livelihood. A reserve cannot function no matter how it appears on paper if there is no local adherence to regulations. Cooperation on behalf of local fishermen is more likely if they benefit from the establishment of a protected area (Linton 2003).

The Pacific coast of Panama receives pressure from commercial as well as artisanal fisheries, and this inevitably must be addressed when designing protected areas (Suman 2002). Complexities arise when regulating largely informal and undocumented fishing activities. It has been stated by Ruttenberg (2001) that commercial species targeted by artisanal fisheries, while not as devastating to fish populations as intense commercial fishing, can show decreases in both biomass and abundance over time, and it is towards this type of fishery that this paper is focused.

Using the Food and Agriculture Organization of the United Nations (FAO) definition as a guideline, we define artisanal fisheries as those which involve fishing households, small amounts of capital with small, low technology fishing vessels making short fishing trips close to shore, primarily for local consumption (FAO 1998a). Linton (2003) assessed the social aspects of illegal and ecologically damaging fishing practices in and around Coiba National Park (CNP) off the western Pacific coast of Panama. It was stated that in order to successfully implement conservation strategies in the region, the issues of overuse of resources and use of destructive fishing gear need to be addressed, as well as the general lack of knowledge regarding conservation among nearby communities. Pressure on the marine resources of CNP originates from

communities outside the established park boundaries, as is commonly the case for most reserves (Moretti 2002, Linton 2003). However, efforts to protect marine resources by establishing a protected area that includes fishing communities within its boundaries inevitably faces additional challenges, and necessitates close communication and cooperation with local fishermen.

1.2 Host institution

We undertook our internship under the supervision of Dr. H. M. Guzmán (Ph.D. biology, Newcastle University), marine biologist at the Smithsonian Tropical Research Institute (STRI) in Panama.

The history of STRI began at the start of the 20th century with the construction of the Panama Canal by the United States of America. Scientists from the Smithsonian Institution based in Washington were asked to conduct a biological inventory of the newly created Canal Zone in 1910. Subsequently, this survey was extended to include the entire Republic of Panama. During the 1920s and 1930s, Barro Colorado Island (BCI), created by the filling of the Lake Gatun reservoir, served as a research station for scientists from American universities and the Smithsonian Institution. What began in 1923 as small field station on BCI, in the Panama Canal Zone, is now one of the leading research institutions dedicated to understanding biological diversity in the tropics. (STRI 2005) Since 1946 STRI has developed marine science laboratories on both the Atlantic and Pacific coasts of Panama (Smithsonian Institution 2005).

Dr. Guzmán currently works at the Naos Laboratories and the focus of his research lies in ecology and population dynamics of coral reefs as well as human impacts on marine ecosystems, marine pollution, coastal management and conservation biology. At present time, along with Dr. J. Mair from Heriot-Watt University, his work focuses particularly on an initiative to protect the Archipelago of Las Perlas in the Gulf of Panama, as the issue of overfishing and habitat degradation in the area has become a topic of much concern. Currently underway at STRI is a large scale effort under the auspices of the UK's Darwin Initiative and Heriot Watt University, to create in some capacity a protected area both marine and terrestrial in the Archipelago. This project is known under the appellation *Zona de Manejo Especial Archipielago de Las Perlas*.

1.3 *Zona de Manejo Especial Archipielago de Las Perlas*

The Archipelago of Las Perlas comprises six villages that rely heavily on fishing as a means of subsistence and income: San Miguel, Casaya, Ensenada, La Esmeralda, Pedro González, and Martín Perez (Guzmán & Díaz unpublished data). In addition to industrial and artisanal fishing boats based on the mainland, these communities of fishermen exert a significant pressure on the marine resources of the Archipelago. To this point, no detailed study has attempted to describe the extent of anthropogenic impacts on the biodiversity of this environment. The Archipelago is renowned as a site of extremely high fish abundance due to strong nutrient upwelling typical between mid December until mid April, and at this specific time of year, fishing pressure is intensified

(H. Guzmán, pers. communication). Considerable amounts of fish are captured, but accurate estimates of stocks and of fishing effort have not yet been documented.

In terms of the marine environment of the Archipelago, the primary objective of the project *Zona de Manejo Especial Archipiélago de Las Perlas* lies in the establishment of a management area delimited by a polygon around the Archipelago (Appendix 2). This *Zona de Manejo Especial* (ZME) would combine the enforcement of strict fishing regulations in the majority of the area with the creation of no take marine reserves in critical reproduction sites (H. Guzmán pers. communication). Furthermore, the ZME would involve the protection of both marine and terrestrial habitats. The relatively new concept of integrated coastal management (ICM) involves a coordinated effort between institutions for the protection of coastal zones incorporating both land and water (Suman 2002). Traditionally there has been little communication between institutions protecting terrestrial habitats, and those protecting the aquatic, and as such, ICM could be a valuable tool in the effective development of a functional ZME.

1.4 The study site

1.4.1 The Archipelago of Las Perlas

The Archipelago of Las Perlas encompasses 18 principal islands in the Gulf of Panama. The largest is Isla del Rey followed by the Islands of San Jose and Pedro González (Appendix 1). The climate region of the Archipelago is classified as tropical humid, with as much as 94 percent of Isla del Rey still comprised of untouched primary forest (Guzmán & Díaz unpublished data). Within the marine environment of the archipelago lie areas of coral reefs, coral communities, rock, sand and mangroves. The Archipelago as a whole finds itself in a location of extremely rich aquatic fauna, and there occurs an upwelling in the dry season, when north winds prevail and bring colder, more saline and nutrient rich waters from deeper layers. (Guzmán & Díaz unpublished data) Of the 780 fish species found on the Pacific coast of Panama, 737 can be found in the Archipelago of Las Perlas (Robertson & Allen 2002).

Nineteen villages dot the islands, ranging in population from less than 10 to almost 700 people, and as a whole the archipelago is still relatively unpopulated (Guzmán & Díaz unpublished data). Approximately 69.8 percent of the total land in the archipelago is privately owned compared to 30.2 percent, which is under the ownership of the Panamanian government (Guzmán & Díaz unpublished data). In more recent years, the progressive increase in tourism in the area is affecting some islands more than others. The majority of the tourism industry in the Archipelago is located in the northern island of Contadora and in the south, on the Island of San Jose. Incontestably, the Island of Contadora supports the most tourist activity including two hotels and approximately 200 luxurious summer residences belonging to Panamanians and foreigners (Guzmán & Díaz unpublished data). The third hotel existing in the archipelago at present time is located on San Jose.

1.4.2 The village of Pedro González

The village of Pedro González, located on the north coast of the island of the same name, is populated by approximately 250 people, the majority of whom make their living by fishing and practicing subsistence agriculture in the hills to the interior of the island (Censos 2000, Guzmán & Diaz unpublished data). Most households are located within the village, however some houses and more rudimentary habitations are also situated inland, and a few fishing families have established themselves at Playa Don Bernardo (Appendix 1). For most of the year the community is composed by a majority of men, until the summer months when Panamanians from the mainland visit and the local population increases almost three fold (C. Jiménez, pers. communication). Typically men participate in fishing and subsistence agriculture. For the most part, however, it is in the rich coastal and marine environments, harboring many fish species of commercial importance, which the fishermen of Pedro González harvest to feed the community and earn money from the sale of fish to the local market and to exporters. Although many households own at least one small wood or fiberglass motor boat (*panga*) for fishing or transportation, this is not true of all families. Women spend more time than the men caring for the children, cooking and completing household tasks. Some frequently travel inland to work in the family owned plantations (*fincas*). The most commonly cultivated crops include plantain, coconut, pineapple, citrus, mango, sugar cane, rice, beans, as well as *ñame* and *yucca*. Chickens are raised inside the village, and green iguanas (*Iguana iguana*) are hunted, especially during the reproduction season (from the end of January through March (Munoz et al. 2003) as the meat and eggs are considered a delicacy. Very often, villagers sell or exchange the products they have in excess. Other goods that cannot be produced on the island can be purchased at the local stores which are supplied by boat every week from Panama.

A part from the concrete houses that compose it, the village holds three stores, a primary school, two churches (Catholic and Evangelical) and a building for public meetings. Two beaches flank the village: the largest one is of white sand and used for unloading boats when the tide is high, the other is rocky and located on the more sheltered side of the village where boats are unloaded and moored when the tide is low. On the former are situated two large fishing boats under construction and an *Autoridad Maritima de Panama* building, while the latter is preferred as a location for cleaning fish and shellfish and anchoring *pangas* overnight. The village port is known as San Antonio, where boats are beached for repair or long term storage, protected from storms by mangrove trees. As a general rule, boat owners remove the motor from their boats in the evening as thefts are not uncommon at night (villagers accuse Colombian narcotics traffickers of robberies). Due to its geographic location, is a known fact that the Archipelago occasionally shelters drug traffickers from Colombia who hide in the many rivers and coves of some of the less populates islands (C. Jiménez, H. Guzmán, pers. communications).

1.5 The present study in context

This study constitutes a preliminary assessment of the artisanal fishery in the village of Pedro González and its impact on the coastal and marine ecosystems of the

Archipelago of Las Perlas. Large gaps exist in the current understanding of fishing seasonality, locations, and methods in the Archipelago, all of which are essential pieces of information in any endeavor to establish a management plan such as the *Zona de Manejo Especial Archipiélago de Las Perlas*. It is in the context of this initiative that our study attempts to characterize the fishing activities in the area surrounding the village of Pedro González. In parallel to work conducted by C. Vega (unpublished data) in the village of La Esmeralda, this study comprises one of the first comprehensive analyses of the fisheries in the Archipelago of Las Perlas. At present time, the management plan *Zona de Manejo Especial Archipiélago de Las Perlas*, is under revision by national authorities in Panama (H. Guzmán, pers. communication).

Specifically, this study aims to (1) provide a general description of the village of Pedro González, (2) characterize the fishing methods and the fishing grounds used by the resident and non-resident fishermen, (3) describe seasonal changes in use of these sites and methods, (4) identify and describe the species of fish and shellfish targeted and impacted by the artisanal fishery in the area, (5) characterize the targeted fish populations in terms sex ratios and state of maturation, and finally (6) identify the fate of the catch in the area of Pedro González. In addition, the results of this study will be given to the community of Pedro González in the format of a simplified report in Spanish comprised of major tables and simplified versions of the graphs presented in this report.

2. METHODS

2.1 Study site and participants

In order to investigate fishing methods, fishing locations, as well as composition and quantity of catches a total of 12 days were spent in and around the village of Pedro González from Feb. 10 to Feb. 18, and from Mar. 13 to Mar. 18, 2005. The fishermen of Pedro González, who represent a significant source of fishing pressure in the Archipelago Las Perlas had a willingness to collaborate and provide assistance with our project.

With a surface area of 1490 ha, Pedro González ranks as third largest island in the Archipelago of Las Perlas. It is located on the west side of the archipelago, midway between the northern and southern most islands. The village itself is located on the north coast of the island, in front of the small island of Trapiche (Appendix 1). Housing was provided by Constancio Jiménez who rents a house located in the center of the village. C. Jiménez was invaluable in arranging the logistics of our fieldwork in addition to being a reliable source of extensive information.

2.1.1 Interviews: formal & informal

General information about the village and more specific knowledge about fishing related topics were obtained through informal conversations and interviews with residents of the village. All relevant information was recorded in a diary that was constantly updated throughout the stays. Children and adolescents had excellent knowledge of fishing techniques and names of different shellfish, mollusks and fish. In addition, they

provided useful information regarding the names of fishing boats. Most of this information was cross checked for accuracy. Women in general were very talkative and enjoyed sharing their knowledge with us. In addition to cleaning, filleting, drying and cooking fish, they care for the kids, sometimes work in the fields and are involved in collecting shells and cleaning mollusks when tides permit. Rarely do they take part in fishing activities. Information about fishing techniques, composition of catches, destination of catches and seasonal variation in species abundance was obtained primarily from interactions with fishermen in the village or during visits to fishing boats.

One formal interview was conducted with Mr. Carlos Escudero, a knowledgeable full time fisherman who still uses traditional methods of line fishing. Using the map of the Archipelago, he indicated fishing locations that we did not have the chance to visit, and provided valuable information about these areas. All information related to us in imperial units was converted into metric units.

2.1.2 Personal Observations

Throughout the visits to the community information was constantly gathered through personal observations. Details seen in the village and while on the water were constantly recorded in a diary. Fishing techniques, interpersonal interactions, and the daily rhythm of life in the village could all be understood in this manner. The two main beaches were visited multiple times per day to record the presence of new and undocumented boats. Boat names were recorded so as to provide quick reference in the future. In this way it was also possible to observe daily schedules such as times of departure and arrival of boats from various destinations. The information collected in this manner often formed the basis for questions and interviews brought up at later times with people in the village.

2.1.3 Boat expeditions (GPS data, Fish ID, Biometrics)

The main fishing sites visited by the fishermen of Pedro González were identified in two ways. As only a small portion of gill net catches are landed in the village and the bulk is sent directly to Panama City, it was necessary to employ a boat to travel to the fishing sites themselves. This was accomplished by hiring a guide and a boat of either wood or fiberglass hull and motor of 15 to 60 horsepower. All mother boat locations and the positions of nets encountered were recorded using a Garmin-765 global positioning system (GPS). In addition, fishing sites pointed out by the guide were also marked. With the use of a portable depth finder, the depths at all sites where it was possible to stop the boat were measured. All pertinent remarks made by the guide and other fishermen regarding composition of the catches and seasonal variability, estimated fishing effort per day, boat loading capacity, duration of fishing trip, fishing techniques used, estimated depth, physical features and substrate composition of the fishing sites were recorded. These day trips were undertaken on Feb. 12, Feb. 15 to 16, and Mar. 14 to 17.

When permitted by the fishermen, field equipment was set up on the deck of the mother boat to measure fish. Many fish species as possible were identified or photographed digitally for later identification, and biometric parameters were recorded.

The composition of the gill and seine net were divided into three categories: target species, non-target species and by-catch. The target species are those that are sought by fishermen, and make up a large portion of the overall catch. The non-target species are not specifically targeted, make up less of the overall catch, however still have commercial value, and can be a desirable component of the catch. By-catch includes all living and non-living material that either is brought to the deck, or is affected by interactions with the fishing gear below the surface. By-catch brought to the deck is often discarded into the sea, dead or injured (OECD 1996, FAO 1998a).

Sampling of fish was opportunistic due to limited numbers, and there was no opportunity for biased data selection. Data collection was limited to the parameters of fish species, body weight and fork length (FL) as it was felt that extending the length of time working on the deck would decrease the fishermen's will to collaborate the next day, and in the future. The parameter of FL was chosen to describe the length of all fish examined, as this avoids problems associated with measuring damaged caudal fins and is preferred for species with forked caudal fins (Holden & Raitt, 1975). Body weight was measured when a scale could be set up. Between 2 and 5 mother boats were visited each field day and data was gathered on 2 boats each time due to time constraints. As the catch was not cleaned before being placed in the hold, it was impossible to take viscera measurements and identify the sex of the animals.

Fish were weighed in pounds to the nearest 1/16 using a Baico spring scale of maximum capacity 40 lbs. All weight data was converted post hoc into metric units. An Ohaus compact scale model CS 2000 was used to weigh viscera and gonads to the nearest gram (error = ±1 g), when available. Fish length was measured first using a tape measure to the nearest 0.5 cm, and from Feb. 15 onwards using a 1 m ichthyometer to the nearest 0.1 cm. The tape measure was used when fish exceeded 1 m.

2.1.4 Fish entering the village

Fish entering the village were often directly taken into houses or cleaned in varying areas of the village, and as such these catches had to be examined immediately upon landing. Fish landings were rare and the landing schedule was inconsistent between days. On days when we were not out on the water, several young children were employed to notify us of catch arrivals. We also benefited from the help of the two village coastguards for information regarding activity on the waterfront. Whenever it was possible to clean the fish ourselves, or be present for the event, the weight of the viscera and the weight of the gonads were taken. When time permitted total length (TL) was also recorded. When shellfish were being collected the returning catches were examined at the beach location where they were cleaned. Samples of shellfish shells were collected for later identification.

2.2 The *Mercado de Mariscos*

In order to obtain data on the stage of maturity of the fish caught in the fishery at Pedro González, five visits were made to the fish market (*Mercado de Mariscos*) in

Panama City between March 4 and April 8. This fish market is the largest in the country and receives fish and seafood by truck and by boat from many regions of Panama. Typically, whole fish are purchased from the vendors at the market and brought to fish cleaners for gutting and preparing. It was possible to work along with the cleaners to access fish and take measurements. Most activity occurs at night, and visits to the fish market took place between 02:00 am and 06:30 am.

A working bench with sink was rented from a cleaner, and we worked primarily alongside and with the aid of two cleaners located next to us. Whenever species of interest arrived at the cleaners we were permitted to measure, weigh and remove the viscera of the fish. At times when many fish were being cleaned, it was possible to select a few and perform our study without impeding the work of the cleaners. As sampling was opportunistic, focal species data was acquired unselectively. Our help was appreciated as the task of the cleaners could be slightly accelerated when fish were returned to them cleaned. There were also down times when there was little business or species of fish different than those studied in Pedro González were being cleaned. Certain nights of the week the market is not as busy as others (Saturday to Sunday in particular) and this must be taken into account when working with time constraints.

The material used at the fish market was the same as that used in our field trips to the Archipelago with the exception of the ichthyometer. Fish were measured to the nearest 0.1 cm using a measuring tape held flat on the surface of the bench as there was insufficient space to use the ichthyometer. The weight and maturation stage of the gonads as well as the total weight of the viscera were recorded after each fish was gutted. With the exception of figures detailing sex and maturation stages of *Lutjanus peru* (Pachecko Tack & Rodríguez 1999) there exists little or no literature to identify different stages of maturation of our focal species. Characterization of the developmental stages of the fish observed was divided into three stages, designated as 1, 2 and 3 corresponding to immature, incipient maturation and advanced maturation respectively. In an effort to contribute new information on this topic, photographs were taken of different gonadal stages of development of certain species.

2.3 Data analysis

All fish species were identified with the use of the key Shorefishes of the Tropical Eastern Pacific (Robertson & Allen 2002) and specialists at the Naos laboratory of the Smithsonian Tropical Research Institute aided in the identification of fish, mollusk and bivalve species. Throughout this paper, fish names are referred to in scientific format. This avoids confusion of Spanish and English common names which vary between regions. Table 3 can be used for reference purposes.

Microsoft Excel was used to create all figures and calculate *P* values and equations of fish weight-length regressions. Fish lengths were measured to the 0.1 cm precision beginning on Feb. 15 (n=739), however regressions include earlier length data measured to the nearest 0.5 cm (n=217), as well. Although this is a weakness of our results, we believe the regressions produced remain acceptably accurate nevertheless.

3. RESULTS

3.1 Fisheries characterization

3.1.1 Fishing techniques

Fishing in the town of Pedro González is undertaken with a range of equipment, depending upon the species targeted, capital available, and personal preference. Nine prevalent methods of fish and seafood capture were identified: gill nets, drop lines, trolling lines, seine nets, small seines, beach seines, shrimp nets, diving, and mollusk-seashell collecting.

Gill nets (*trasmallos*):

The Artisanal fishery of Pedro González relied predominantly on the use of gill nets throughout the length of this study. With the exception of the few seine boats, all of the boats observed fishing for sale purposes were using this type of gear. It is believed that gill nets are used throughout the year at varying degrees. Catch from this fishery is intended for sale at the fish market in Panama. A gill net consists of a nylon mesh on average 25 m in length and 2 m wide with varying diagonal mesh sizes. Frequently, the fishermen of Pedro González may attach two nets vertically or horizontally to increase the total surface area for capture. Lead weights are fastened to its bottom while foam floaters provide buoyancy to the top, maintaining the net horizontally positioned in the water. Stretched mesh size ranges from 3 to 5 inches (7.6 to 12.7 cm): sizes between 3 and 4 inches (7.6 to 10.2 cm) are used for most targeted species such as *Caranx caballus, Sectator ocyurus, Elagatis bipinnulata, Haemulon maculicauda* and *Scomberomorus sierra* whereas sizes of 4.5 and 5 cm are used to capture larger fish such as *Sarda orientalis* and *Mycteroperca xenarcha* (C. Escudero, pers. communication).

Typically, a net is laid out by anchoring each of its ends to the seafloor and adjusting the depth with ropes; it may be positioned at the surface, in mid-water or near the seafloor. Two boys, one at each anchor, indicate its location to the fishermen and passing boats. Gill nets are preferentially positioned on a sandy bottom to prevent the mesh from getting caught and ripping on rugose substrates. Panamanian regulations prohibit fishermen to set gill nets at low depths because of the destructive effects on the seafloor (C. Jiménez, pers. communication). If wrongly positioned, deep gill nets (*trasmallos buzos*) are likely to get caught on hard substrate such as coral or rock, causing damage when the fishermen attempt to retrieve it and killing fish if it remains underwater.

Drop lines (*cuerda y anzuelo*):

Hand line fishing involves the use of a hook and line without a fishing pole or rod (Hasbrouck 1970, McClanahan & Mangi 2004); drop lining consists of fishing near the bottom using a weighted hand line (Hasbrouck 1970) and differs from trolling in that it is

done while the boat is stationary (anchored or drifting). Two types of drop lines are commonly used at Pedro González: *arañas* and branch lines. The *araña* consists of a lead weight with two or three integrated hooks. It can be used either baited, or without bait, in which case the fish is attracted by light reflecting on the lead itself. Branch lines consist of 3 to 4 hooks attached perpendicularly by short line segments to a line weighted at its end. The weight is intended to sit at the bottom while the baited hooks, equidistant from each other and the weight, rest no greater than 1 m above the substrate (Hasbrouck 1970). Standard hook sizes are most often #10. The customary bait (*carnada*) used for drop-lining consists of small sardines locally called *sardinas* (scientific name NA). They can be used dead, in which case they are kept in a cooler with ice, or alive, conserved in a compartment filled with water in the hull of mother boats. Line fishermen may also bait their hooks with squid when sardines become rare after the upwelling, at the end of March and during April. Squid are used only as an alternative strategy as they must be purchased. In comparison to gill nets, drop lines are advantageous in that they can be used near rocky bottoms with less risk of snagging and less cost if they are lost. Pargo (*Lutjanus sp*.) and cherna (*M. xenarcha*), prized species during the upwelling season, are targeted in such a manner, as these fish aggregate near rocky structures.

Trolling (*trolear*):

Trolling is done by dragging a heavy test hand line with an attached lure behind a moving boat. The use of trolling rods is not widespread in Pedro González. The number of lines used and the traveling speed depends on the size of the boat, the species targeted and the purpose of the fishery: commercial, artisanal or subsistence. The inhabitants themselves seldom use trolling for commercial purposes, however long line fishing boats that target pelagic species and shark frequently stop for supplies in Pedro González.

Trolling for leisure and personal consumption may occur while a boat is employed for other purposes; this can also generate income from the little tourism that reaches Pedro González. A range of artificial baits are used – from trolling lures to plastic tubing slipped over hooks. The major impediment to trolling in the Archipelago is the scarcity and the high price of fuel (up to $3.50 US per gallon) due to transportation costs from the mainland. One professional fisherman (C. Escudero) related that trolling is sometimes used to catch tuna and other large pelagic species. This type of fishing is undertaken only when the ocean is clear, particularly in November and December, before the upwelling season. C. Escudero indicated the use of 200-250 Lbs test line with #14 hooks when fishing tuna for the purpose of sale. Typically fishing is undertaken for 2 to 3 days, required to catch 900 to 1400 kg of tuna, before returning to Panama City to sell the fish. Yellow tuna (*Thunnus albacares*), a common catch, typically weigh between 14 to 18 kg but have very little monetary value, and are hence often given to relatives in the village.

Seine nets (*red negra*):

Seine nets trap fish by enclosing or encircling them with a long fencelike wall or webbing; the top of a seine net is buoyed upwards by a series of floats and the bottom is

weighted with leads weights or chain (Hayes 1983). Although requiring larger initial capital investments than all other methods of fishing, a number of boats from Pedro González participate in seining namely the *Don Jose*, the *Lina Christina* and the *Peregrino*. Seine fishing boats are termed *bolicheros*. According to C. Escudero, seining is commonly practiced near the Darién, at the border between Panama and Colombia. *Bolicheros* target pelagic schooling fish such as *C. caballus, S. ocyurus, E. bipinnulata, S. orientalis* and *E. lineatus* (C. Jiménez, pers. communication). Seine fishing boats operate by encircling schools with the seine which is then hauled onboard with a winch. They are frequently active at night, either during full moons or during dark nights when they use lights to attract the fish. The three observed *bolicheros* were not witnessed fishing during the day in the area of Pedro González or San Jose.

Cast nets (*tarallas*):

Small seine nets locally called *tarallas* serve to catch sardines as bait for drop line fishing. Generally, they are used directly from shore and also from boats, however these nets were never observed throughout the length of this study. Sardines are seldom eaten in Pedro González, with the exception of times when commercial species are scarce and the entirety of the artisanal catch is delivered for sale at the fish market in Panama (C. Jiménez, pers. communication).

Beach seines (*red de playa*):

Beach seines were not found to be a popular fishing method amongst the fishermen of Pedro González over the duration of our study. Beach seines are used in shallow waters where the net wall extends from the bottom to the surface; the beach serves as a physical barrier to help encircling the fish and for hauling the net onto shore to collect the catch (Hayes 1983). Local fishermen from the mother boat El Mana used this technique on one occasion during our second visit, during a time when daily catches from gill nets were considered low. This was employed as change of strategy in attempt at increasing the boat's total catch before leaving for the fish market the following day.

Shrimp nets (*red camaronera*):

No shrimp fishing was observed for the duration of our study as this activity typically occurs in the deeper waters at the periphery of the Archipelago. In the Archipelago of Las Perlas, this fishery targets the red shrimp (*camaron rojo, Pendalus sp.*) at various offshore sites (Appendix 2). The stretched mesh size of the nets used varies from $2^{3/4}$ inches (7.0 cm) for smaller shrimp to 3 inches (7.6 cm) for large shrimp (C. Escudero, pers. communication).

Diving (*bucear*):

Diving for commercial and subsistence purposes is practiced throughout the Archipelago of Las Perlas and is common amongst the fishermen of Pedro González. This includes spear fishing and hunting for octopus and lobster, each activity requiring

specific tools. The basic equipment for all divers consists of a mask, fins (frequently models designed for professional snorkeling), a snorkel (optional) and rubber gloves (optional). Two spear fishermen in Pedro González owned commercially manufactured spear guns (*chopos*); one a permanent resident who hunts to sell his catch to hotels in Contadora, the other a local living in Panama City who hunts for subsistence and leisure while visiting the Island. In addition to spearing large species of parrotfish, snappers and jacks (particularly *Caranx caninus* and *Caranx speciosus*), lobster, octopus and shellfish (especially oysters) are collected simultaneously. Local line and net fishermen also practice diving around Pedro González, mostly to catch lobster and octopus. Typically, they organize themselves in groups of two or three and leave in a small motorized support boat (*panga*, dugout canoe) for a half day or dive from the mother boat during spare time when out fishing for several days. All mother boats generally have at least one full set of diving gear onboard; on three visits to mother boats we witnessed a speared lobster on the deck. The tool used for spearing lobster is the *Figa*, a wooden pole with, at one end, a rubber band used for propelling and holding anchoring to the wrist, and at the other end, two metal points (*chuzos*) strongly attached with string. A *gancho* is used for extracting octopus when it retracts into its hole. This consists of a wooden handle fixed to a metal gaff hook.

Fishing for shellfish and seashells (m*ariscar*):

Fishing for shellfish occurs in two ways in Pedro González. Individuals or small groups of two or three people will collect shellfish for subsistence when they can reach fishing sites by foot, at times when beaches nearby the village uncover sufficiently. Larger, more organized groups of villagers may use *pangas* to reach otherwise inaccessible fishing sites. Larger scale fishing occurs approximately once every month, during three to four days when the tidal coefficient is high and large portions of sandbanks and rocky areas are exposed. This is even truer in the period of extreme tides termed *aguajes*, which generally occur during the dry season in Panama; however, these tides do not occur frequently (Felix Rodriguez, pers. communication). Both men and women participate actively in this type of fishing, which involves collecting the shellfish and breaking them open on the beach. Collection is done by foot and the fishermen typically probe the sand or the interstices between rocks by using a knife. Shellfish are put in individual containers, either plastic bowls or cooking pots, and then individual catches are concerted in larger plastic baskets of approximately 80 L. Although large groups may search together, each family usually keeps its own catch. Shellfish are used to make soup either for personal consumption or to be sold at social events and gatherings. People who own freezers and have access to electricity can conserve the cleaned shellfish frozen.

Seashell collection for the ornamental trade appears to be exclusively an individual activity. As villagers search the beaches neighboring the village at times of low tides, they also seize the opportunity to collect seashells, as this can be source of income. Children, men and women participate in this activity. The most suitable site to search for shells around the village appeared to be the sandbank connecting Pedro González to the islet of Trapiche, which uncovers at extreme low tides. Both this sand

stretch and the rocky shores or sandy beaches surrounding the small island are prime locations. Generally, seashells are sold in Contadora or to a boat from the mainland that anchors between the village and the islet of Trapiche. This boat of which the name was unidentified anchors for the 4 days of most pronounced tides each month.

3.1.2 Fishing fleet and logistics

The fishing fleet of the village of Pedro González consists of three types of boats: seine boats (*bolicheros*), mother boats and fiberglass or wooden open hull boats with outboard motors (support boats, *pangas)*. During the span of our study, we interacted almost exclusively with artisanal fishermen working onboard mother boats and artisanal or subsistence fishermen using *pangas* anchored in the village's small mooring (*muelle*). Since *bolicheros* were never seen fishing in the area near Pedro González and never prolonged their call in the village, it was impossible to study their catch. Thus, our study focuses mainly on the artisanal fishery involving mother boats and *pangas*, and the characterization of its form and function.

<u>*Bolicheros*</u>:

Bolicheros are the largest types of boats used in Pedro González; those observed measured above 10 m in length. Typically, the boats are designed with a deep hull to store the large quantities of fish caught with the seine net and a wide deck to accommodate a crew of up to ten men. *Bolicheros* are the only fishing boats in Pedro González equipped with inboard diesel engines. Seining requires the use of one support boat to aid in net deployment and recovery, which also acts as a launch to travel between the boat and shore.

<u>Mother boats:</u>

The use of mother boats is the most common method to fish with gill nets for domestic sale at the fish market. These boats measure 5 to 7 m and the hull is divided into several compartments to store the catch. Access to these holds is through traps on the deck (usually between 4 and 6). The hold capacity of each mother boat varies with the size of the boat and the amount of space allotted for other cargo; generally it ranges from 2200 to 4100 kg of fish. Mother boats are equipped with a single 2 stroke outboard engine ranging from 50 to 90 hp. A small cabin at the stern, often with 4 bunks, serves to protect the driver from the sun and allows the crew to rest when not at work. The Fishermen may also sleep on the deck or in the hull compartments when empty.

Fishermen may use mother boats for drop line fishing during the peak season for *pargo* and *cherna*. Fishermen from the island of Otoque were witnessed drop lining from mother boats on two occasions. Mother boats from Pedro González were not seen using hand lines at the time of our study. Generally the practice of drop lining allows for five people onboard a mother boat and there is no need for support boats. It was unclear whether mother boats are commonly used for trolling, but C. Escudero clearly mentioned

that he uses this type of boat to troll for large pelagic species such as tuna and large size *C. caballus*.

When fishing with gill nets, the average time spent fishing by the crew of a mother boat is between 3 to 5 days depending on how plentiful the net catches are. At the fish market in Panama, the captain purchases blocks of ice, which are stored in the hull in woven nylon bags. The ice serves to preserve fish as well as perishable food for the length of the trip. In addition to purchased supplies, fishermen will eat less valuable or damaged fish and collect coconuts or *pipas* on nearby beaches. The crew rarely sleeps on land as the Island of San Jose, where most gill net fishing takes place, is privately owned.

In this region artisanal fishing of pelagic species for the purpose of sale is undertaken for the most part with gill nets. Depending on the number of support boats (if any), the crew onboard mother boats ranges from 4 to 16 men. Boats from outside the village (from the mainland, the island of Otoque or Isla del Rey) were witnessed fishing with as little as 3 people onboard. In this case, the fishermen set and retrieve the nets directly from the mother boat. In contrast, fishermen from Pedro González use support boats with smaller outboard engines (15 to 60 hp) which ease the process of laying and lifting the nets as larger boats are more difficult to maneuver in the waves and current. When fishermen in the support boats collect the nets, they remove the catch from the net, placing both in the hull before returning to the mother boat where the catch is stored. Immediately upon arrival, fish are transferred in crates (*carnastas*) onto the mother boat, each containing approximately 45 kg each when filled to the top. Depending on the organization of the crew, each panga's catch may be weighed before it is placed in the hull. The fish is then covered with ice chipped off an ice block with a special scraping tool.

The daily schedule is typically separated into two net settings. The first takes place when nets are set in the evening between 4 and 6 pm, then collected after darkness between 8 and 11 pm. The second occurs overnight: the nets are set between 11 pm and midnight, and collected in the early morning after sunrise, from 6:30 to 10 am. The process of setting and collecting the nets can vary in duration depending on the number of nets and the working force of each mother boat. Fishing throughout the night is not uncommon, likely when there is greater than normal abundance of fish. Fishermen in work after nightfall by using a small light bulb attached to a pole, powered by a car battery, for illumination of their equipment.

The organization and the logistics of a mother boat involves many people, some directly active on the boat, providing the manual labor, and others, indirectly involved, providing the capital for the operations. Profits from each fishing trip are distributed amongst all stakeholders by division into parts. Gas, food and ice expenses are deducted from the gross profit after the fish is sold in Panama City. The owner (*dueño*) of the mother boat, often a more affluent resident of the village, receives a predetermined number of parts for the use of his boat. The captain (*capitan*) in charge of supervision and organization receives one and a half parts in light of his responsibility and as he must

always be onboard during trips to Panama. The captain is rarely the owner of the boat being operated. Fishermen (*marinos*) each receive one part. Those who rent boats and motors to the crew of the mother boat each receive half a part to one part depending on the nature of the equipment they rent and its reliability.

Open hull boats (*pangas*):

In addition to acting as support boats for mother boats, *pangas* are predominantly used for fishing in three circumstances: trolling, diving and catching *Lutjanus sp.* and *M. xenarcha* with drop lines.

The fishing fleet of Pedro González:

With the help of five children from Pedro González and comments by C. Jiménez, an incomplete but extensive list of the fishing boats in the village was produced. The list includes 26 boats, some of which we observed directly and others were related to us by the children (Table 2). All boats identified were observed anchored near one of the beaches of the village, or fishing in the proximity of the islands of Pedro González or San Jose. The only exception is the Lina Cristina, which was seen only at the fish market in Panama City. It is likely that the unidentified boats are mostly *pangas*. We likely failed to identify all *bolicheros* as they often fish at night and rarely halt for a prolonged time in the village. In addition, two mother boats, the names of which we could not determine, were being repaired and repainted in San Antonio (Appendix 1). There may be spelling errors in the names of the unidentified boats.

Table 1. Fishing boats from the village of Pedro González.

Boat name	Boat type	Total Capacity (Kg)	Captain's name	Total crew (# of men)
Niña Ania 3	NA	NA	NA	NA
Masambula	NA	NA	NA	NA
El Alibio	NA	NA	NA	NA
La Pelegrina	NA	NA	NA	NA
Niña Miladi	NA	NA	NA	NA
La Batipanga	NA	NA	NA	NA
Niño Felipin	NA	NA	NA	NA
La Puma	NA	NA	NA	NA
El Pique	NA	NA	NA	NA
El Rayo	NA	NA	NA	NA
El Cayate	NA	NA	NA	NA
El Autorante	NA	NA	NA	NA
Anoturna	NA	NA	NA	NA
Niña Ania	NA	NA	NA	NA
Don Francisco	NA	NA	NA	NA
Don Jose (pequeño)	NA	NA	NA	NA
Virgen de Lourdes	Panga (60 hp)	---	Roman Perez	---
Doña Ernestina	Mother boat	NA	NA	NA
Peregrino 5	Mother boat	2300	NA	4
Halcón del Mar	Mother boat	4100	Pablo	16
El Mana	Mother boat	2300	Rael	5

Pacific	Mother boat	2300	Gavino	5
Doña Marina	Mother boat	2300	Cholo	4
Don Jose (grande)	Bolichero	NA	NA	NA
Peregrino	Bolichero	NA	NA	NA
Lina Christina	Bolichero	NA	NA	NA

Other boats not belonging to fishermen from Pedro González were also identified fishing or stopping in the waters around the islands of Pedro González and San Miguel (Table 2).

Table 2. Fishing boats from outside the village of Pedro González.

Boat name	Boat type	Origin
Jesus Kadir	Mother boat	San Miguel
Doña Cecira	Mother boat	Chorillo
La Fe	Mother boat	Panama mainland
Don Isaura	Bolichero	Panama mainland
Delphin	Long liner	Panama mainland

3.1.3 Catch composition

Depending on the types of fishing gear or techniques used, there exist variations in the daily composition of the catch. Gill and seine net catch had more complexity than line catch in terms of species array. The relatively generalist techniques of net and line fishing contrasted with the more selective techniques of diving and spear fishing, shellfish and seashell collection.

Target, non-target and by-catch fish species are listed in Table 3, along with the principle methods of capture for each species. At the time of the study, gill net target species were *H. maculicauda, C. caballus, S. ocyurus, E. bipinnulata*, and *S. sierra*. The first four species were observed measured in the largest numbers coming from the nets, with our measured fish numbering 247, 204, 148 and 101 individuals respectively. There were 24 *S. sierra* observed over 12 days of field study, however this species was indicated to be commercially important and specifically targeted. As such we considered sierra to be a target species while other species more commonly observed than *S. sierra*, however not as desired as catch, were not. *Cynoscion sp.*, or snook, when caught, were indicated to be a desired species to sell at the market. This species, however, is not as abundant in the region as many others. There are changes in the species that are targeted based on the time of year and species occurrence. The snappers *L. peru* and *L. guttatus* as well as the grouper *M. xenarcha* become the primary target species as they become more common in the waters of the Archipelago, and are listed as alternate target species in Table 3. There were numerous non-target species observed in gill net catches, all of which had commercial value.

Table 3. Species observed in the fishery of Pedro González. Picture references figure in Appendix 4. Capture methods correspond to (1) gill net (2) seine net (3) trolling (4) drop line (5) spear fishing and diving (6) hand collection.

Local/Spanish Name	Scientific Name	English Name	Picture	Capture Method(s)
Target Species				
Caracol	*Haemulon maculicauda*	spot-tail grunt	1	1
Cojinua	*Caranx caballus*	green jack	2	1,2,3
Salema	*Sectator ocyurus*	blue-striped sea-chub, rainbow sea-chub	3	1
Salmon	*Elagatis bipinnulata*	rainbow runner	4	1
Sierra	*Scomberomorus sierra*	Pacific sierra	5	1
Alternate target species				
Cherna	*Mycteroperca xenarcha*	broomtail grouper	6	1,4
Pargo mancha	*Lutjanus guttatus*	spotted rose snapper	7	1,4
Pargo rojo	*Lutjanus peru*	Pacific red snapper	8	1,4
Non-target species				
Barracuda	*Sphyraena ensis*	Mexican barracuda	9	1
Parrilete melvera	*Auxis rochei eudorax*	bullet mackerel	10	1,2,3
Blanco	*Caranx otrynter*	threadfin jack, thread pompano	11	1,4
Bojala	*Seriola rivoliana*	almaco jack, Pacific amberjack	12	1,3
Bonito	*Euthynnus lineatus*	black skipjack tuna	13	1,2,3
Boquipenda	*Caranx speciosus*	golden jack	14	1,5
Bequeath	unknown	unknown		1
Chopa	*Kyphosus sp.*	sea chub	15	1
Cojinua raya	*Caranx vinctus*	cocinero jack, striped jack		1
Congo	*Cathorops sp., Arius sp.*	sea-catfish	16	1
Copote	unknown	unknown		1
Corvina	*Cynoscion phoxocephalus*	weakfish	17	1
Jurel	*Caranx caninus*	Pacific crevalle-jack	18	1,4,5
Lisa	*Mugil sp.*	mullet	19	1
Macabí	*Albula sp.*	bonefish	20	1
Marao	*Tylosurus sp.*	houndfish	21	1
Mero pintado, Cabrilla pinta	*Epinephelus labriformis*	starry grouper	22	1
Morena	*Muraena clepsydra*	hourglass moray	23	5
Ojigordo	*Caranx sexfasciatus*	bigeye crevalle-jack, bigeye trevally	24	1
Pargo amarillo	*Lutjanus argentiventris*	yellow snapper	25	1,4
Pargo viviano	unknown	unknown		1
Pez tigre	*Epinephelus analogus*	spotted grouper	26	1
Pezloro sp. 1	*Scarus perrico*	bumphead parrotfish	27	1,5
Pezloro sp. 2	*Scarus rubroviolaceus*	bicolor parrotfish	28	1,5
Pezloro sp. 3	*Scarus ghobban*	bluechin parrotfish	29	1,5
Pluma	*Calamus brachysomus*	Pacific porgy	30	4
Róbalo	*Centropomus sp.*	snook	31	1
Roncador, pargo Roncador	*Lutjanus novemfasciatus*	Pacific cubera snapper	32	5
Salmonete	*Mulloidichthys dentatus*	Mexican goatfish	33	1

Wanco blanco	*Sarda orientalis*	striped bonito	34	1,2,3
By-catch				
Corvina blanca	unknown	unknown		1
Muñeca real, angel real	*Holacanthus passer*	king angelfish	35	1
Pez erizo	*Diodon sp.*	porcupinefish	36	1
Rayas		rays		1
Soldado panameño	*Myripristis leiognathos*	soldierfish	37	1
Shellfish				
Almeja	*Megapitaria aurantiaca*	golden calista	38	6
Caracol piña	*Hexaplex brassica*	cabbage murex	39	6
Conchuela	*Argopecten circularis*	pacific calico scallop	40	6
Ostra perlera	*Pinctada mazatlanica*	pearl oyster	41	6
Pie de burro, vuelve loco	*Vasum caestus*	unknown	42	6
Pulludo	*Muricopsis radix*	unknown	43	6
Unknown	*Periglypta multicostata*	many-ridged venus	44	6
Unknown	*Thais melones*	unknown	45	6
Seashells				
Caracol	*Jenneria pustulata*	unknown	46	6
Caracol de letras	*Oliva porphyria*	tent olive	47	6

By-catch was also observed infrequently during visits to boats. It is likely that this occurs even more commonly than our observations would indicate, as the by catch is frequently discarded overboard as the nets are brought in. Many times it was not possible to observe net recovery, only the arrival of support boats with fish to the mother boat. When it was possible to observe net recovery, among the by-catch were identified reef fishes such as a *Holacanthus passer*, *Myripristis leiognathos*, and hard corals as well as sea fans. Corals were smashed out of the nets using wooden clubs, and on one specific occasion on Feb. 16 a net had become tangled in an area of high coral density. The discarding of fish with a lower commercial priority than others was observed once, as a species known locally as *corvina blanca* (species non identified) were thrown back into the water due to a shortage of space in the hold for additional fish. During times of less productive fishing, however, this species would not have been discarded. Twice fishermen spoke of having rays tangled in their nets, referring to this as a sporadic occurrence. Rays drown in the gill net, and are shaken out as the net is recovered from the water. Most ray species were referred to as *manta rayas*, however the one observed tangled ray was a smaller species.

Less information was gathered on the catch composition of seine net fishing based in the village. This technique focuses on pelagic fish species, and the only observed specie originating from a seine fishing boat was bonito. These boats are also believed to target *C. caballus* (C. Escudero, H. Guzmán, pers. communication). Line fishing targeted pelagic species through trolling activities, as well as bottom species by drop lining. Spear fishing catches most often targeted reef fishes, pelagic fishes and lobsters. Species such as *C. speciosus, Lutjanus novemfasciatus, Seriola rivoliana, C. caninus, Scarus sp.*, octopus and lobster comprised much of the spear fishing catch.

In addition to direct observations of fish species in the village and on the water, a list of all species that are caught in the village for consumption was provided to us by C. Jiménez. Some of these species were observed, while others were not seen during visits to the village and could be targeted at different times of year. All fish indicated by C. Jiménez that were not observed are available in Appendix 5. Details as to their scientific and English names are provided where possible. Local Spanish names could not be matched to all indicated species in the region.

Shellfish and seashell collection which occurred during the periods of lowest tide each month included the species of mollusks listed in Table 3 for both consumption and the ornamental trade. There was also evidence in the form of discarded shells on one beach of the village where shellfish of at least one species were cleaned in large numbers. These shellfish are no longer abundant; however they once comprised a significant portion of the collected species. These belonged to scallops of the *Argopecten sp*. (Guzmán & Diaz, unpublished data).

3.1.4 Fishing Locations

Fishermen from Pedro González use specific fishing grounds at different times of the year, depending on the abundance of fish and the species targeted. This was both readily observable, and emphasized in informal interviews during our study. Both visits to Pedro González fell at a seasonal transition period when the fishery was changing from the use of gill nets to that of drop lines for *Lutjanus sp.* and *M. xenarcha*.

During the first trip (Feb. 10-18), species targeted by gill netting were abundant and the fishery was concentrated around the island of San Jose. It is around this island that most gill net fishing occurs at times when sea and tide conditions allow nets to be safely set their near the coast, as demonstrated by the GPS coordinates on the map in Appendix 2. The entirety of the coast of San Jose is fished by boats from Pedro González as well as boats that come from the mainland and from the island of San Miguel. Prime spots around the island are La Bodega, Rio Faro and Rio Pescado (Appendix 1). The periphery of the island as well as the west coast of the island of Pedro González is considered excellent grounds to dive for lobster. Appendix 3 contains the dates at which the sites were marked, details regarding the type of fishing and general characteristics of each location.

At times when currents from tides are too strong or fishing is poor around San Jose, the village boats prefer to set their nets closer to the island of Pedro González as was observed on the second trip to the region (March 13-18). Preferred sites for fishing with gill nets around Pedro González include the area north of the island of La Señora, the inlet across the bay from the port of San Antonio and the southern tip of the island, west of three beaches, two of which are called Playa Brava and Playa Blanca (Appendix 1). The entire west coast of Pedro González can be trolled for pelagic species.

When the fishery changes to one of primarily *Lutjanus sp.* and *M. xenarcha*, fishing techniques and locations change as well, and gill nets are abandoned in favor of drop lines. As a general rule, the periphery of San Jose Island represents good locations for catching these species (C. Escudero, pers. communication). *Lutjanus sp.* and *M. xenarcha*, when they enter the archipelago in large numbers, are targeted in front of the village of Pedro González, further offshore the west coast of Pedro González and in the strait separating the islands of Pedro González and San Jose.

Sites indicated as important during a formal interview with C. Escudero are found in Appendix 1. Important comments regarding each one are presented in the legend of the same Appendix. In addition to locations within the Archipelago, C. Escudero mentioned travel to the Darién to fish for periods of up to 20 days as an occasional occurrence.

Major locations where shellfish are collected including Playa Don Bernardo, Isleta Trapiche and beaches on the islands of Casaya and Bayoneta are shown in Appendix 1.

3.1.5 ***Fisheries seasonality***

The fisheries in which the artisanal fishermen of Pedro González take part are highly seasonal, and are driven by the yearly upwelling event which brings to the surface cooler nutrient rich waters from depth, typically from mid December to mid April. The upwelling results in high productivity of plankton, which was easily observed during both the February and March field trips. Large blooms of plankton could be seen in the Bahia de Panama on Feb. 19, observable as red tides. There were noticeable flotillas of large filter feeding plankton such as salps and jellyfish in the waters around the Island of San Jose from Mar. 14 to 17.

Sardines (multiple species; not identified) follow the abundances of plankton, and are found closer to shore during the periods of cooler water temperatures. As the season progresses, larger species of sardines move to inshore waters in the region. This is the signaling factor for the beginning of the *L. peru* season, and coincides with increased gill net catches around the Island of San Jose (C. Escudero and C. Jiménez, pers. communications). Typically, the *L. peru* fishing season begins at the end of December, and *L. peru* are fished heavily in the waters surrounding the Island of Pedro González and the Island of San Jose. *M. xenarcha* are also caught at this time. On Mar. 16, two boats were visited while fishing in waters between the Islands of Pedro González and San Jose. There was little catch on board, but that which could be observed was comprised solely of *L. peru*. At this time of year, according to the fishermen of Pedro González, there should have been a greater density of boats in this area, and landings of *L. peru* in the village (C. Jiménez, pers. communication). The *L. peru* fishery near Pedro González began at the start of April this year, considerably later than the previous year, which saw the beginning of abundant landings in the month of February (H. Guzmán, pers. communication).

The fishery for *C. caballus* and *E. bipinnulata* occurs mainly from January to April, when *C. caballus* reaching up to 3 kilograms are caught. It was unclear if other target and non-target species are seasonal, or available year round in the Archipelago. The sardine season begins to taper off in the months of March and April, at which point fishermen begin to use squid as bait for drop lining activities (C. Escudero, pers. communication). Red shrimp (*Pandalus sp.*) are fished in November, December and January as well as April, May and June in the offshore waters surrounding the Archipelago (Ministerio de Comercio e Industrias 1990, H. Guzmán, pers. communication). It is likely that there exist seasonal fisheries not addressed above, due to an inability to conduct a yearlong investigation within the temporal restrictions of this study. Figure 1 identifies the seasonal fisheries that were observed during the study period. This figure represents a template containing only partial results to which future information can be added, as additional data is gathered.

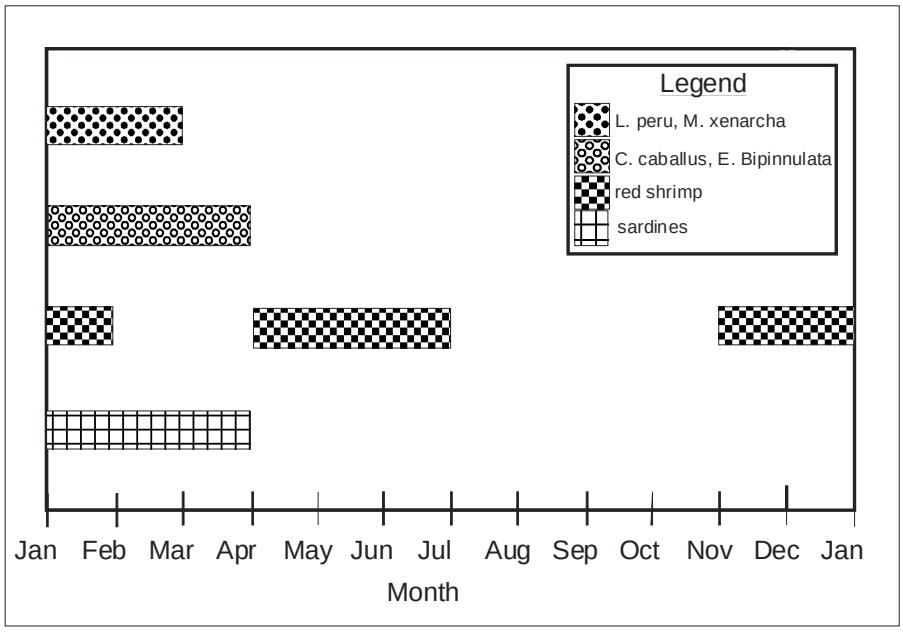

Figure 1. Seasonality of fisheries in Pedro González. Tentative chart – requires additional information regarding seasonality of other fisheries.

A weak warm-episode El Niño event occurred in 2004-2005, which has resulted in sea surface temperature (SST) anomalies in the Gulf of Panama, and tropical and equatorial Pacific Ocean (NOAA 2005, http://www.cpc.ncep.noaa.gov). During the field trips to the region there were noticeable indirect effects of this event. The *L. peru* season was delayed by approximately two months, to the beginning of April, and this was a cause for concern for many fishermen (C. Jiménez, pers. communication). Qualitatively, there was a marked difference in the temperature of the water between the first and second visits, with the temperature being notably higher on the second trip. It was related to us that the water is normally cooler at this time of year than was being experienced (C. Jiménez, pers. communication).

3.1.6 ***Fate of Catch***

There are multiple routes for fish to travel once caught in the Archipelago. While the catch from subsistence line and spear fishing is eaten, given away or sold in the village of Pedro González, gill net caught fish that are collected in the holds of mother boats are destined for the fish market in Panama City (*Mercado de Mariscos*). After a typical fishing trip the mother boats make a brief stop in Pedro González. The purpose of this call is to retrieve goods such as empty bottles to return to the city, and to drop off small amounts of fish to give to family members or sell in the village. The majority of the fish in the hold is brought to the fish market, a journey that takes an average of six hours. Fish arriving at the fish market in this manner are not cleaned, and still contain all viscera. Once reaching the fish market, fish are sold directly out of the hold at the docks behind the fish market to vendors, with stalls either inside or outside the market building. Restaurants also purchase their fish directly on the docks. The public can purchase fish by weight from vendors either inside the fish market, where the vendor will clean them, or from the vendors outside where the fish are kept in unrefrigerated bins during sale hours. From the vendor stands outside, the fish that are purchased are not cleaned, and the customer must bring them to the cleaning area. Approximately 15 to 20 people work at cleaning, cutting and filleting the fish. As a general procedure, the client pays by weight for the service. As far as could be observed, fish are kept for up to five days in the hold without cleaning, before unloading. They may then spend further days in the fish market before being purchased and cleaned.

Certain species of fish do not follow this route of sale, and are instead intended for export. *L. peru*, *L. guttatus* and *M. xenarcha* are three examples of such species. These fish are cleaned immediately following their catch, and are purchased by brokers directly from the village. The fish are then transported to the mainland for freezing and exportation, often to the United States. This mode of sale nets a larger profit for fishermen, as higher prices are commanded for the species in the United States than in Panama.

3.2 Fisheries assessment

In total, biometrics data was collected for 957 fish within 35 species. Sample sizes are larger for target species; 204, 101, 247, 24, 148, for *C. caballus, E. pipinnulata, H. maculicauda, S. sierra*, and *S. ocyurus* respectively. Weight-body length regressions and distributions of specimens according to their body length were calculated for each target species (Figures 2 and 3). The size distributions tend to show a skew towards smaller specimens for each species with the exception of *S. sierra*, where specimens observed are more uniformly distributed across size classes. However, this may be an artifact of a small sample size for this particular species.

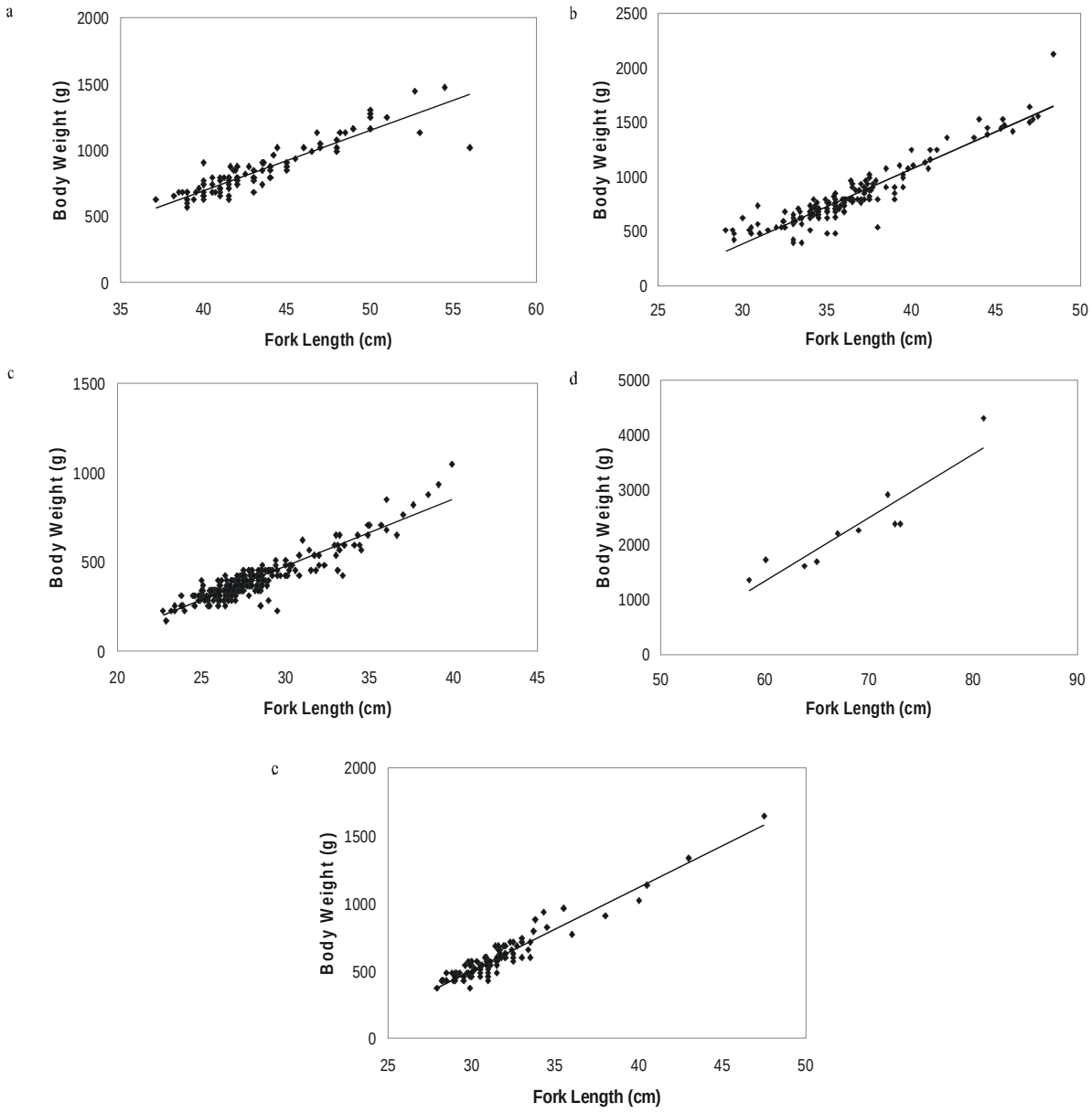

Figure 2. Weight-Length regressions for (a) *C. caballus* (n=151) y = 68.3x – 1658, r^2= 0.88, *p* = <0.001; (b) *E. bipinnulata* (n=99) y = 45.4x - 1118, r^2 = 0.83, *p* = <0.001; (c) *H. maculicauda* (n=245) y = 37.6x - 653, r^2 = 0.85, *p* = <0.001; (d) *S. sierra* (n=10), y = 115.8x - 5603, r^2 = 0.85, *p* = <0.001; (e) *S. ocyurus* (n=109) y = 61.7x - 1349, r^2= 0.91, *p* = <0.001; where y is body weight in g and x is FL in cm.

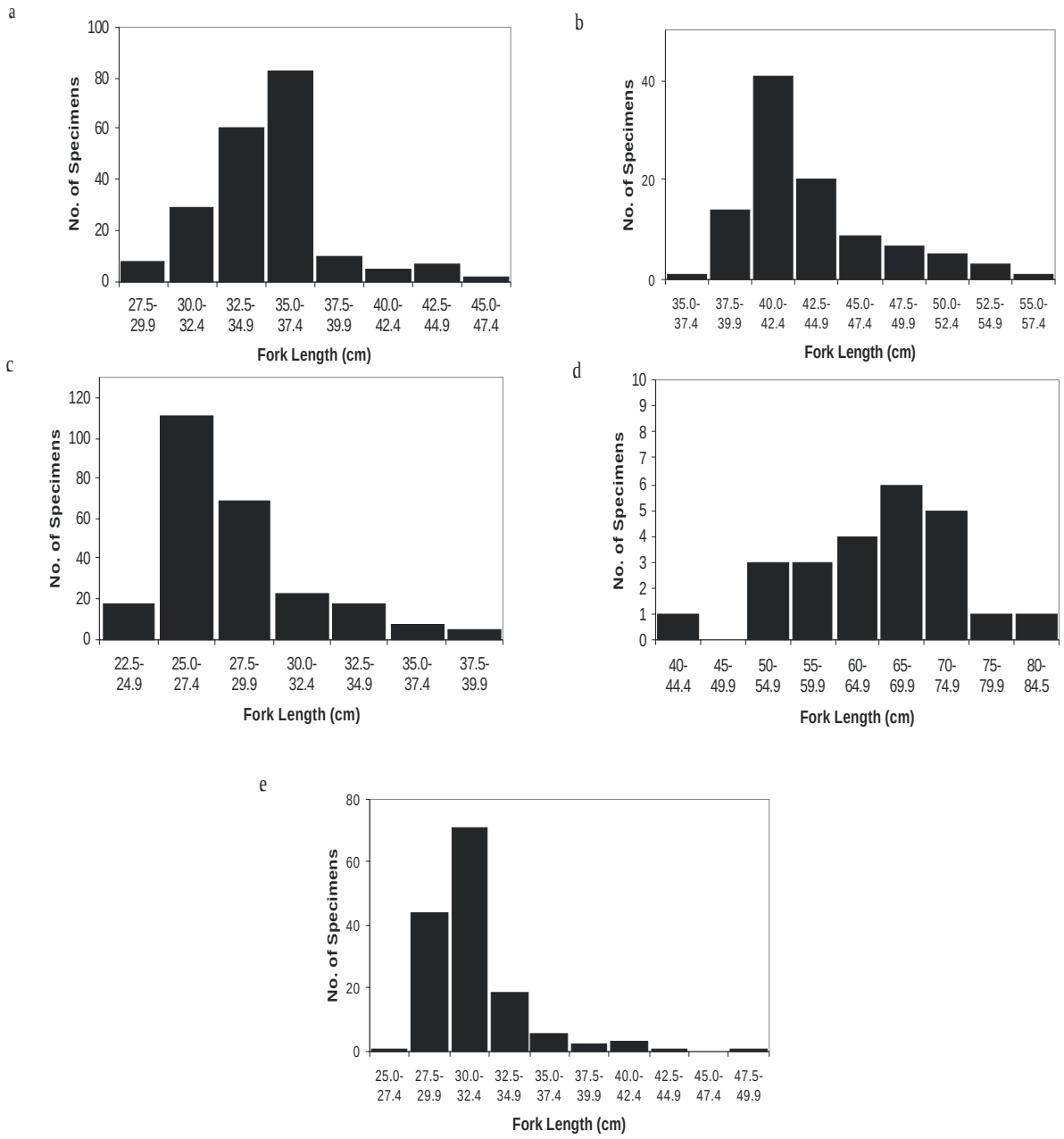

Figure 3. Size distributions for population samples of (a) *C. caballus* (n=204); (b) *E. bipinnulata* (n=101); (c) *H. maculicauda* (n=247); (d) *S. sierra* (n=24); (e) *S. ocyurus* (n=148).

The range in size for all species observed was also determined. On several instances it was impossible to set up the scale because of field constraints. Thus, out of the total sample size (n=957), 122 fish lack weight measurements. For this reason, the weight ranges of several species in table 4 lack values.

Table 4. Species of fish for which biometrics were collected in this study; unidentified specimens do not figure in italics and some fish could only be identified at the genus level. The number of fish with weight measurements and those lacking weight measurements as well as the range in length (FL) and weight (min. – max.) is indicated for each species.

Species	Amount with weight	Amount without weight	Min.		Max.	
			Length (cm)	Weight (g)	Length (cm)	Weight (g)
Aguja (*Tylosurus* sp.)	5		89.8	1616	112.5	2750
Boquita	1		16.4	113		
Caranx caballus	151	53	28.0	NA	48.4	2126
Caranx caninus	5		26.9	454	28.9	567
Caranx otrynter	5	1	41.5	1304	65.5	NA
Caranx sexfasciatus	20		20.6	113	39.9	879
Caranx speciosus	1		57.1	3969		
Caranx vinctus	1		29.8	454		
Chopa (*Kyphosus* sp.)	1		21.8	255		
Copote	1		33.5	850		
Corvina blanca	14		48.0	765	71.3	3062
Cynoscion phoxocephalus	12	3	43.5	850	79.5	3515
Elagatis bipinnulata	99	2	37.1	624	56.0	1021
Epinephelus analogus	1		17.5	85		
Epinephelus labriformis	10		26.0	255	35.0	765
Euthynnus lineatus	40	3	56.0	2155	70.5	3969
Haemulon maculicauda	245	2	22.7	227	39.9	1049
Lisa *(Mugil* sp.)	2		35.0	680	39.0	907
Lutjanus argentiventris	5		28.5	340	39.0	1021
Lutjanus guttatus	37		21.5	NA	55.7	2240
Lutjanus novemfasciatus	1		57.6	4876		
Lutjanus peru	10		23.6	227	42.5	1077
Macabi (*Albula* sp.)	5		48.0	709	54.5	1162
Mulloidichthys dentatus	1		31.8	624		
Muraena clepsydra	1		110.0	2693		
Myripristis leiognathos	1		14.1	28		
Pargo viviano	1		22.0	198		
Sarda orientalis	6		43.9	1276	63.5	NA
Scarus ghobban	3		40.0	1474	52.6	3402
Scarus perrico	5		43.2	1899	63.1	4621
Scarus rubroviolaceus	4		33.6	822	41.2	2041
Scomberomorus sierra	10	14	43.9	NA	81.0	4309

Sectator ocyurus	109	39	27.3	NA	47.5	1644
Seriola rivoliana	15	1	36.5	907	65.2	5131
Sphyraena ensis	10		59.0	1247	72.0	1814

Results regarding the maturation state of fish are not presented in this study as too few specimens were observed (16 species, n=147). Difficulties of gathering data at the fish market when working in conjunction with the fish cleaners originated from unpredictability of the busy hours, difficulty in accessing a working area at this time and the impossibility to focus on a particular species. As large sample sizes and time-series are required for a thorough analysis of maturation stages in fish populations, the data acquired during this study can serve to produce a photographic index of the different gonadal stages of the species observed throughout this study, and raw data can be made available on request.

4. DISCUSSION

The results of our study are mainly descriptive in nature. Time spent in the field, served to acquire valuable information on the village of Pedro González, the methods employed by the fishermen living there, as well as principal fishing locations, fishing seasons, and targeted fish species. With the undertone of the idea to contribute to the development of a protected area, our data can be considered in discussion of the establishment of gear restrictions, spatial and temporal fishing restrictions, as well as protected species.

The prevalence of net use in the village of Pedro González was an unexpected discovery, based on what had previously been understood about the fishery. While many fisherman claim to be against the use of gill nets (>80% according to a socio-economic assessment; H. Guzmán, pers. communication), this was the principal technique for fishing observed during the two visits to the region (February-March). Gill nets, in their lack of selectivity for the species that are caught, almost always result in the discard of non-desirable by-catch. This was observed on more than one occasion in the waters around the islands of Pedro González and San Jose, and results in unnecessary pressure upon the stocks of non-commercial species. Gill nets that had become fouled on rocks or coral reefs were an occasional sight during visits to fishing locations. While the value of the nets often meant that fishermen were willing to expend great deals of energy to recover them, there are inevitably parts of, if not entire, nets that remain ensnarled on the seafloor. Brown et al. (1998) cite examples of gill nets remaining in the water for up to 10 years after loss, catching and killing fish just as effectively as they were designed to do before loss. The implementation of restrictions on the use of gill nets, or their outright banning, would be an ideal solution ecologically, however the reliance upon this mode of fish capture by the local fishermen means an alternative must be presented that can support their livelihoods. At present time, a number of gill nets used in the area of Pedro González do not adhere to national regulations implemented in 1991 that prohibit the use of nets of all type (for catching fish and shrimp) below stretched mesh size of 3 inches

(Decreto Ejecutivo N° 41; Articulo Primero and Resolución N° 001 del 18 de Abril de 2005). In addition, the law also prohibits the use of gear employed to spear lobsters with *chuzos*, allowing only live capture (Decreto Ejecutivo N^{o} 15, Articulo Cuarto).

While rarely encountered during field work, larger seine boats, *bolicheros*, must be addressed as a significant source of pressure on regional fisheries. According to Guzmán and Díaz (unpublished data), operators of *bolicheros* have been accused by smaller scale fisherman of discarding back into the sea all non-target fish species, however at a scale much larger than encountered with the gill net fishermen. Some countries have begun to adopt 'no discard' policies regarding non-selective fishing methods (Brown et al. 1998). These mandate the retention of all non-target and undesirable species, regardless of their value, in order to apply pressure towards the improvement of techniques for selectivity, or the halting of practices that yield high proportions of by-catch to target species.

Through the development of maps from local knowledge of locations with importance to specific fish life stages, the idea of spatial restrictions in fish harvest can be implemented. Regions that are known to have high concentrations of juvenile fish can receive different protection levels from those areas that harbor mostly mature individuals. As discussed in Russ et al. (2004), reserves can act as exporters of both adult fish, and younger larvae to support nearby fisheries where an active harvest is taking place. Within a larger protected area, dedicating recruitment areas as no take marine reserves while restricting the use of destructive fishing methods in other areas could allow efficient coastal management and support local populations reliant on artisanal fisheries for their livelihood.

The idea of fishery closure often is used in conjunction with management plans, and these can take into account temporal as well as spatial distributions of fish stocks. The specific times of year during which target species are present in the region of Pedro González could lend itself to the concept of placing restrictions on the harvest during certain seasons, when species may be in vulnerable life history stages, such as mature reproducing individuals or juveniles. A major complication to this process, and one that affected the nature of this study itself, is oceanographic and climatic variability such as the ongoing weak warm-episode El Niño event that started during the early months of 2005. While the study was originally to focus on the *L. peru* and *M. xenarcha* fishery of Pedro González, with hopes for a detailed characterization of the fish populations, this was not possible due to a delay of the start of the aforementioned season by approximately two months. In addition to this delay lengthening the amount of time that other species would receive fishing pressure from local fishermen, climatic variability has implications for the establishment of temporal fisheries closures. We recommend seasonal flexibility in specific closure times, along with systems to facilitate public awareness and compliance are possible solutions to this obstacle.

Taking stock of the species present in the catches of artisanal fishermen allows a snapshot of the marine communities most affected by fishing pressure. Catch composition is a necessary base of knowledge before management can be implemented

on a species level. As the issue of reducing the legal gill net size begins to capture national attention in Panama, this can be seen as indicative of a gradual decrease in the size of fishes being captured. The process of fishing down a stock inevitably leads to total ecosystem collapse (Jackson et. al 2001), and there is little doubt that this is occurring in the Gulf of Panama at present. This is exemplified by the high pressure on *C. caballus*, from both gill and seine net fishing around the islands of Pedro González and San Jose. Landings of *C. caballus* nearly tripled between the years 2001 and 2002 at the national level in Panama (AMP 2003), while specimens reaching large sizes are becoming increasingly rare (C. Escudero, pers. communication). The unsustainability of such fishing practices puts the communities reliant on coastal resources in a difficult position, but also one that can aid in the facilitation of dialogue between those most affected by the implementation of a reserve, and those who seek to do so. Regulations such as slot limits, which dictate a certain size range of fish that can be legally harvested, could be enforced at the market end of the process, thus giving fishermen a monetary incentive to slow the fishing down process.

Several sanitary problems were observed throughout the length of this study pertaining to the handling and storage of fish over the duration of their transport from fishery to market. Fishing techniques, specifically the use of gill nets, set in the water for periods of time greater than an hour, often retrieve fish already dead, and lead to a time lapse between retrieving the net and storing the fish in ice. This process is prolonged when nets get caught on the substrate and sometimes extends long after sunrise when ambient temperatures become high. On the market end, fish can be held without ice by vendors outside the fish market until sale. Several fish cleaned during this study appeared to be in various stages of decomposition, producing putrid smells and on multiple occasions already having viscera protruding from a severely degraded belly. On one occasion a cleaner refused to clean a fish due to its highly degraded state.

Food security in the products of fisheries was addressed specifically at the 2003 Expert Consultation on International Fish Trade and Food Security held in Casablanca, Morocco (FAO 2003). It was discussed that in many developing countries, including those with active fisheries, food safety and quality programs have received little attention. Furthermore, in most exporting countries, amongst which Panama can be included, resources and international support have been used to ensure fish safety and quality for fish export, while very little or none at all is devoted to domestic markets (Ababouch 2003).

Surti et al. (2001) examined the effect of storage at tropical ambient temperature on the quality and shelf life of the spotted coral grouper (*Plectropomus maculatus)*. The results of this study revealed that the storage life of *P. maculatus* reached 18 days when stored immediately in ice, however a 2-h delay before cooling the fish in ice approximately halves its shelf life; every further hour of storage at ambient temperature further reduces the shelf life by approximately 1 day. Tambunan & Rijal (1972) found that total volatile basic nitrogen, (TVBN), a by-product of degrading flesh, was higher in ungutted compared to gutted skipjack tuna (*Katsuwonus pelamis*).

Historically, fisheries management has focused on the process of production that occurs in the water; post catch processing and marketing were not taken into consideration (Kent 2003). More recently, however, the Code of Conduct for Responsible Fisheries adopted at the Twenty-eighth session of the FAO Conference on October 31 1995 has contributed to expand the vision of fisheries management into considering not only production but also post-harvest practices and trade (article 11) (FAO 1995). Gutting fish immediately after catch and assuring adequate storage during transportation are two feasible steps towards improving the quality of fish arriving to market (FAO 2005). As ice is the most common and practical means to preserve fresh fish in both tropical and temperate climates (Surti et al. 2001), governmental policies should both necessitate and facilitate access to this resource. As poor initial storage has marked effects on subsequent storage even in proper conditions, especially in tropical climates, we urgently recommend that special attention must be given to this topic by regulatory government agencies (AMP, MIDA).

Quantitative data represents a smaller portion of our overall results, however it holds no less importance. Although no strong conclusions can be drawn from the assessment of the fish stock in the area of Pedro González and San Jose islands, our study provides preliminary information with relevance to future investigations. Willis et al. (2003) stated that the major weakness of studies advocating the benefits of marine reserves lies in the lack of time series to compare the "before" and "after" state of the ecosystem. If this issue is to be addressed and the value of coastal management plans which integrate marine reserves demonstrated, there is a need to continue our effort in characterizing the Archipelago of Las Perlas. It is through such efforts that the states of threatened environments can hope to improve.

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6. REFERENCES

Ababouch L. 2003. Impact of Fish Safety and Quality on Food Security. Contribution paper presented at the Expert Consultation on International Fish Trade and Food Security, Casablanca, Morocco, 2003. <http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/006/Y4961E/Y4961E00.HTM>

Brown SK. Auster PJ, Lauck L, and Coyne M. 1998. Pressures on coastal environments: ecological effects of fishing. National Oceanic and Atmospheric Administration (NOAA) State of the Coast Report, 1. Silver Spring, MD: NOAA

Carocci F. 2001. Fisheries Technology: Fish Capture Technology: Types of fisheries. UN Atlas of the Oceans, Fisheries and Aquaculture. <http://www.oceansatlas.org/servlet/CDSServlet?status=ND0xMjMwNi4xMzg5MyY2PWVuJjMzPWRvY3VtZW50cyYzNz1pbmZv>.

Censos. 2002. Dirección Nacional de Estadísticas y Censo, Contraloría General de la República de Panamá. Censos Nacionales de Población y Viviendas. 14 de Mayo de 2000.

Chapman MR and Kramer DL. 1999. Gradients of coral reef fish density and size across the Barbados Marine Reserve boundary: effects of reserve protection and habitat characteristics. Marine Ecology Progress Series. 181:81-96.

Decreto Ejecutivo N^{o} 15. 1981. Ministerio de Comercio e Industrias. Ministerio de Comercio e Industrias de Panamá.

Decreto Ejecutivo N^{o} 41. 1991. Ministerio de Comercio e Industrias. Ministerio de Comercio e Industrias de Panamá.

FAO (Food and Agriculture Organization of the United Nations). 1995. Code of Conduct for Responsible Fisheries. Rome. <http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/005/v9878e/v9878e00.htm> (2005-04-17)

FAO. 1998. Guidelines for the routine collection of capture fishery data. FAO Fisheries Technical Papers. 382: 113 p.

FAO. 2002. The State of World Fisheries and Aquaculture 2002. <http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/005/y7300e/y7300e00.htm>

FAO. 2003. Report of the Expert Consultation on International Fish Trade and Food Security, Casablanca, Morocco, 2003. FAO Fisheries Report no. 708. Rome. 213p. <http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/006/Y4961E/Y4961E00.HTM>

FAO. 2004. The State of World Fisheries and Aquaculture 2004. <http://www.fao.org/documents/show_cdr.asp?url_file=//DOCREP/007/y5600e/y5600e01.htm@For>

FAO. 2005. Website on Code of Conduct for Responsible Fisheries. <http://www.fao.org./fi/agreem/codecond/codecond.asp>

Fujita H. 2004. Japan Internacional Cooperation Agency. <http://project.jica.go.jp/costarica/2151004E0/ > (2005-04-10)

Guzmán HM, Diaz ML. 2005. Zone de manejo especial Archipelago de Las Perlas. Unpublished.

Hasbrouck GM. 1970. Subsistence fishing among the San Blas Kunas, Panama. Masters Thesis. University of California, Berkeley.

Halpern BS and Warner RR. 2002. Marine reserves have rapid and lasting effects. Ecology Letters. 5: 361-366.

Hayes ML. 1983. Active fish capture methods. Chapter 7 in Nielsen LA and Johnson DL (eds) Fisheries Techniques. 1983. American Fisheries Society. Bethesda, Maryland. 468 p.

Holden MJ and Raitt DFS. 1975. Manual of fisheries Science Part 2 - Methods of Resource Investigation and their Application. Food and Agriculture Organization of the United Nations. Rome, June 1974.

Jackson JBC, Kirby MX, Berger WH, Bjorndal KA, Botsford LW, Bourque BJ, Bradbury RH, Cooke R, Erlandson J, Estes JA., Hughes TP, Kidwell S, Lange CB, Lenihan HS, Pandolfi JM, Peterson CH, Steneck RS, Tegner MJ and Warner RR. 2001. Historical Overfishing and the Recent Collapse of Coastal Ecosystems. Science. July 27: 629-638.

Kent G. 2003. Fish Trade, Food Security and the Human Right to Adequate Food. Contribution paper presented at the Expert Consultation on International Fish Trade and Food Security, Casablanca, Morocco, 2003. <http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/006/Y4961E/Y4961E00.HTM>

La Prensa April 15, 2005. Zabdy Barría. Gobernador permite uso de trasmallos ilegales, AMP cuestiona la decision.

Linton J. 2003. ARTICLE DRAFT, To be submitted to Coastal Management, 6/18/03, Protection of Panama's Coiba National Park: Considering the Resource Users from the Community of Bahía Honda

McClanahan TR and Mangi SC. 2004. Gear-based management of a tropical artisanal fishery based on species selectivity and capture size. Fisheries Management and Ecology. 11: 51-60.

Moretti GS. 2002. Identifying and understanding resource users of Panama's Coiba National Park. M.S. thesis for the Duke University Nicholas School of the Environment and Earth Sciences.

Muñoz EM, Ortega AM, Bock BC and Páez VP. 2003. Demografía y ecología de anidación de la iguana verde, *Iguana iguana* (Squamata: Iguanidae), en dos poblaciones explotadas en la Depresión Momposina, Colombia. Revista de Biologia Tropical. 51(1):229-240.

NOAA Climate Prediction Centre (National Oceanic and Atmospheric Administration). 2005. El Nino/Southern Oscillation (ENSO) diagnostic discussion, April 7, 2005. <http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/index.html> (2005-04-17)

OECD (Organisation for Economic Co-operation and Development). 1996. Synthesis report for the study on the economic aspects of the management of marine living resources. Adhoc Expert Group on Fisheries. AGR/FI(96)12.

Pacheco Tack RL, Rodríguez CC. 1999. Contribución al conocimiento de la biología pesquera del pargo rojo (*Lutjanus peru*) de Pacifico de Panamá. Scientia (Panama). 14(1):17-38.

Pauly D, Christensen V, Dalsgaard J, Froese R and Torres Jr. F. 1998. Fishing down of marine food webs. Science. 6 February. 279:860-863.

Rakitin A. and Kramer DL. 1996. The effect of a marine reserve on the distribution of coral reef fishes in Barbados. Marine Ecology Progress Series. 131:97-113

Resolución No. 001 del 18 de Abril de 2005. La Comisión Nacional de Pesca Responsable de la Autoridad Marítima de Panamá.

Robertson DR, Allen GR. 2002. Shorefishes of the tropical eastern Pacific: an information system. Smithsonian Tropical Research Institute, Balboa, Panama.

Russ GR, Alcala AC, Maypa AP, Calumpong HP, White AT. 2004. Marine reserve benefits local fisheries. Ecological-Applications. 14(2):597-606.

Ruttenberg BI. 2001. Effects of artisanal fishing on marine communities in the Galapagos Islands. Conservation-Biology. 15(6):1691-1699.

Smithsonian Institution. 2005. History and Culture. <http://www.si.edu/history_and_culture> (2005-05-17)

Smithsonian Tropical Research Institute. 2005. Home Page. <http://www.stri.org/english/about_stri/index.php> (2005-05-17)

Suman D. 2002. Panama Revisited: Evolution of Coastal Management Policy and Legislation. Ocean & Coastal Management 45: 91-120.

Surti T, Taylor AKD and Ma'ruf Farid W. 2001. The effect of storage at tropical ambient temperature on the quality and shelf life of grouper (*Plectropomus maculatus*). International Journal of Food Science and Technology. 36: 517-522.

Tambunan PT and Rijal S. 1972. Pengesan Ikan. Laporan Penelitian Teknologi Perikanan. 2: 24-33. In: Surti et al. 2001.

Willis TJ, Millar RB, Babcock RC and Tolimieri N. 2003. Burdens of evidence and the benefits of marine reserves: Putting Descartes before des horse? Environmental-Conservation. 30(2):97-103.

APPENDIX 5

Fish names provided by C. Jiménez identified as thoroughly as possible.

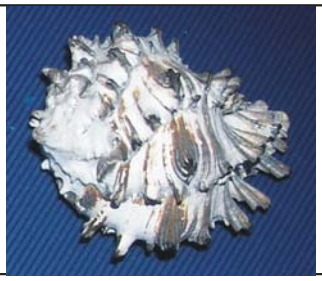
Local Spanish name	Scientific name	Other Spanish name(s)	English name(s)
Achote	unknown	unknown	unknown
Aguja	*Makaira sp.*	unknown	marlin
Arenque	1. *Harengula thrissina*	arenque plumita, sardineta plumita	Pacific flatiron herring
	2. *Opisthonema libertate*	sardina-gallera común	Pacific thread herring,
Bacalao	unknown	unknown	unknown
Bagre	*Arius sp.*	congo, cominata	sea-catfish
Balbero	unknown	unknown	unknown
Caballito	*Hippocampus ingens*	caballito del Pacífico Oriental	Pacific seahorse
Cabezón	unknown	unknown	unknown
Cabrilla	too many sp.	unknown	unknown
Cajero	*Larimus sp.*	unknown	drum
Casón	unknown	unknown	unknown
Chabelita	unknown	unknown	unknown
Cocote	unknown	unknown	unknown
Cominata	*Arius sp.*	congo, bagre	sea-catfish
Gilguero	unknown	unknown	unknown
Guabina	*Nebris occidentalis*	corvina guavina	Pacific small-eye croaker
Guajú	*Acanthocybium solandri*	sierra golfina	wahoo
Jaboncillo	*Pseudogramma sp.*	unknown	reef-bass
Lenguado	too many sp.	unknown	flatfish
Lucumí	unknown	unknown	unknown
Mangletero	unknown	unknown	unknown
Palmera	*Seriolella violacea*	cojinoba palmera	palm ruff
Pompano	*Trachinotus sp.*	unknown	pompano
Perro	*Lophiodes caulinaris*	rape de rabo manchado, pez-perro bocón	Pacific anglerfish
Pezgallo	*Nematistius pectoralis*	pejegallo, papagallo, pejepluma, plumero	roosterfish
Pezvela	*Istiophorus platypterus*	pez-vela del Pacífico	Pacific sailfish
Seda	unknown	unknown	unknown
Tablón	unknown	unknown	unknown
Tiburón	too many sp.	unknown	shark
Trompeta	*Aulostomus chinensis*	pez-trompeta del Pacífico/Chino	Pacific/Chinese trumpetfish
Vieja	*Pomadasys sp.*	ronco	grunt
Violin	unknown	unknown	unknown

APPENDIX 4 (f)

Photographic reference of species observed in the fishery of Pedro Gonzalez (majority of photographs are authors own and from Fujita H (2004))

41.

42.



43.

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APPENDIX 4 (e)

Photographic reference of species observed in the fishery of Pedro Gonzalez (majority of photographs are authors own and from Fujita H (2004))

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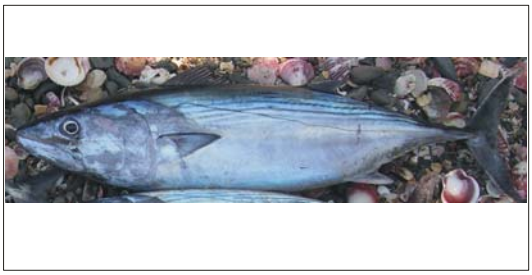

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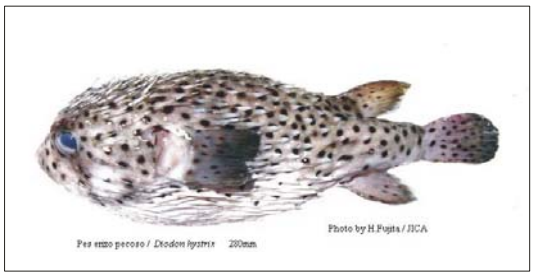

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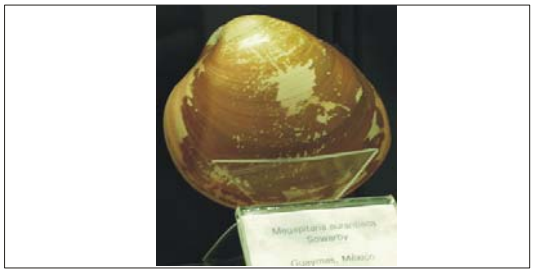

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APPENDIX 4 (d)

Photographic reference of species observed in the fishery of Pedro Gonzalez (majority of photographs are authors own and from Fujita H (2004))

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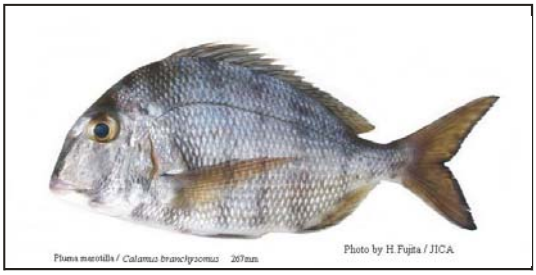
29.



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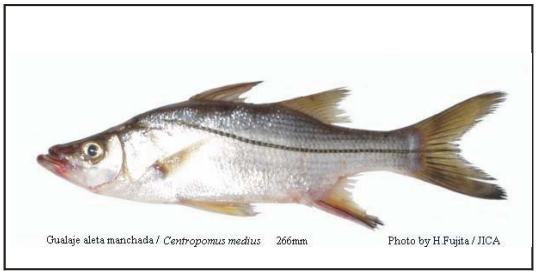

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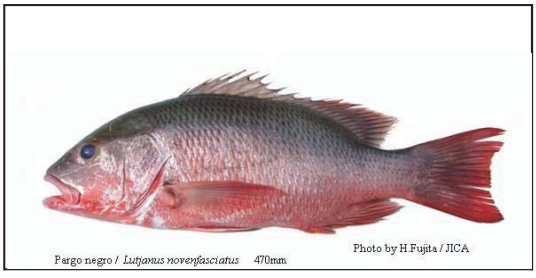

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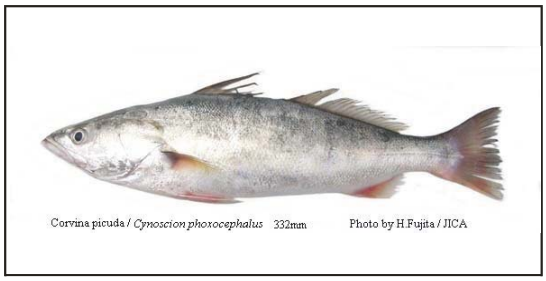
APPENDIX 4 (c)

Photographic reference of species observed in the fishery of Pedro Gonzalez (majority of photographs are authors own and from Fujita H (2004))



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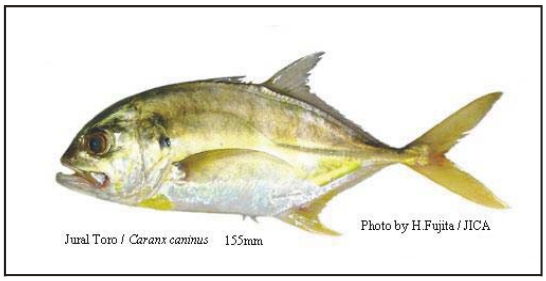

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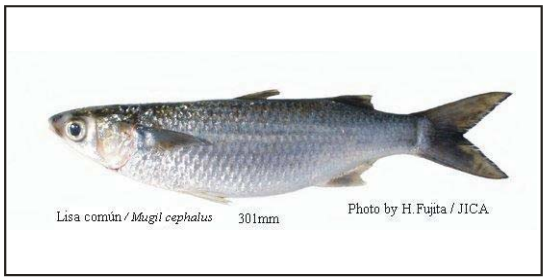

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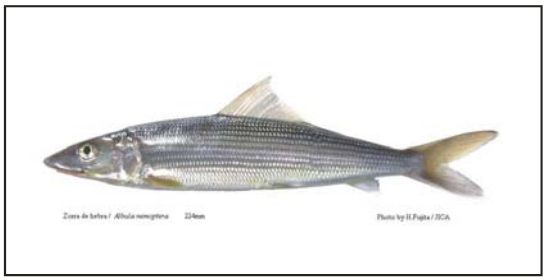

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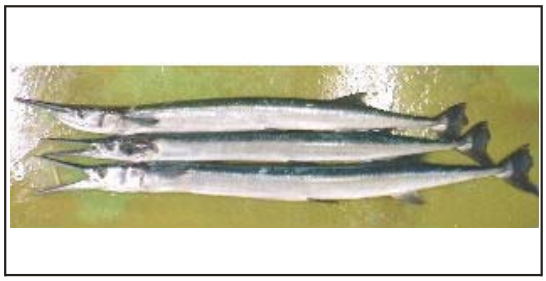

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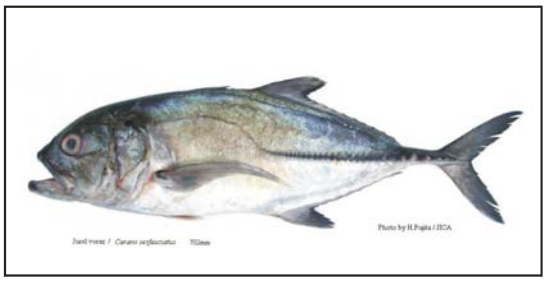

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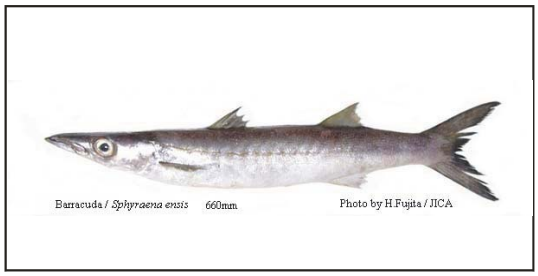
Photographic reference of species observed in the fishery of Pedro Gonzalez (majority of photographs are authors own and from Fujita H (2004))



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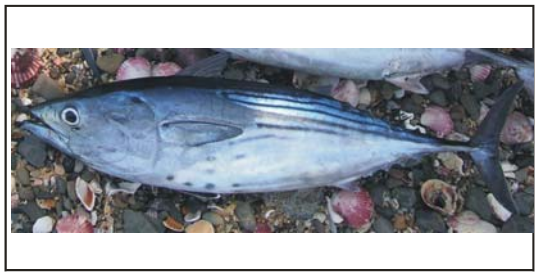

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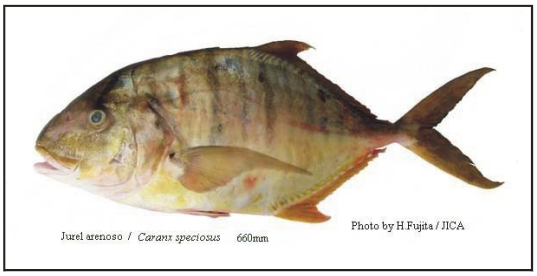

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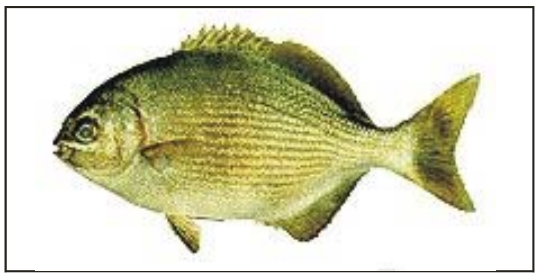

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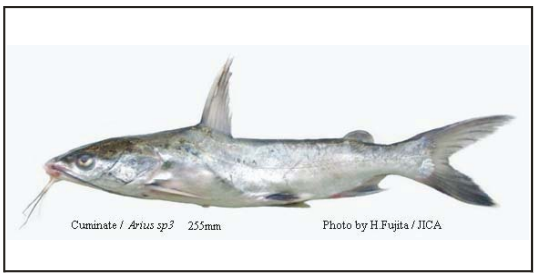
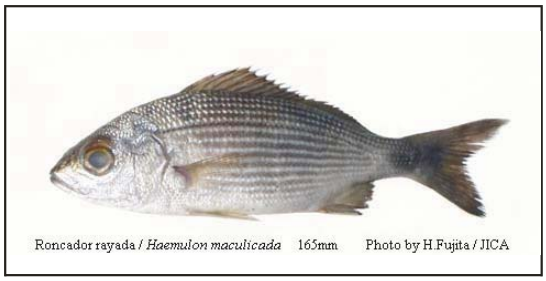


16.

APPENDIX 4 (a)

Photographic reference of species observed in the fishery of Pedro Gonzalez (majority of photographs are authors own and from Fujita H (2004))



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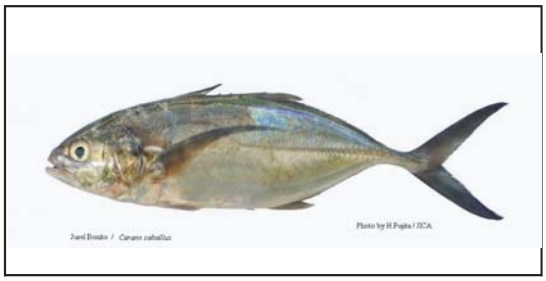

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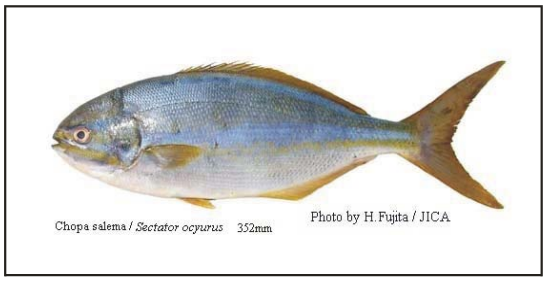

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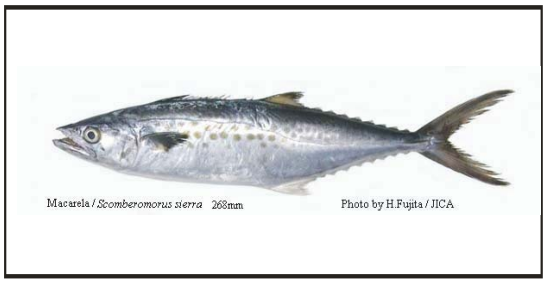

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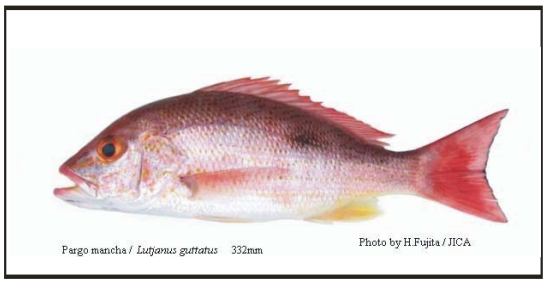

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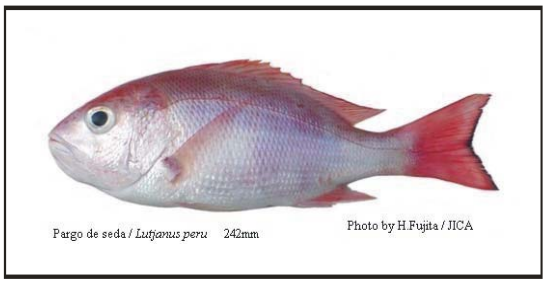


8.

APPENDIX 3

GPS coordinates of fishing sites and landmarks in the area of Pedro Gonzalez

Location	ID on GPS	Latitude (D−M'S.ss")	Longitude (D−M'S.ss")	Depth (m)	Symbol	Time (am)	Date
Pedro Gonzalez Harbor	PGH	N08−24'34.46"	W079−06'18.87"		Harbor	6:16	12-Feb-05
Net Location 1	PG8NET	N08−12'30.11"	W079−06'39.62"	8.5	Fishing Location	7:03	12-Feb-05
Net Location 2	44	N08−12'29.00"	W079−06'37.30"	8.5	Fishing Location	?	12-Feb-05
Net Location 3	PG9NET	N08−12'15.32"	W079−07'01.27"		Fishing Location	7:06	12-Feb-05
Motherboat (Halcon del Mar)	PGMTB	N08−12'32.28"	W079−06'56.52"	15.2	Waypoint	7:09	12-Feb-05
Net Location 4	PGNET4	N08−12'03.10"	W079−06'45.79"	9.5	Fishing Location	7:24	12-Feb-05
Net Location 5	PGNET5	N08−12'17.04"	W079−07'27.11"	14.5	Fishing Location	7:31	12-Feb-05
Net Location 6	PGNT7M	N08−12'10.05"	W079−07'28.56"	7	Fishing Location	9:12	12-Feb-05
Net Location 6b	PGNT10	N08−12'11.13"	W079−07'40.30"	10	Fishing Location	9:13	12-Feb-05
Net Location 7 - Rio del Faro	P10	N08−13'25.02"	W079−08'26.17"	12	Fishing Location	9:26	12-Feb-05
Net Location 8 - occasional Otoque fishing location (unoccupied)	P11	N08−14'02.70"	W079−08'44.79"	16	Fishing Location	9:28	12-Feb-05
Net Location 9	P13	N08−15'20.87"	W079−07'55.39"	6	Fishing Location	9:38	12-Feb-05
Motherboat (El Mana)	MTB2	N08−15'28.25"	W079−07'55.20"		Waypoint	9:40	12-Feb-05
Fishing Location 10 - possible underwater hump	P16	N08−18'47.63"	W079−07'37.31"	5.5	Fishing Location	11:16	12-Feb-05
Fishing Location 11	P17	N08−18'47.88"	W079−07'37.72"	16	Waypoint	11:17	12-Feb-05
Fishing Location 12	P18	N08−20'51.13"	W079−08'45.72"	65	Fishing Location	11:31	12-Feb-05
Fishing Location 13 - possible underwater hump	P19	N08−22'25.35"	W079−08'33.21"	41-55	Fishing Location	11:40	12-Feb-05
Fishing Location 14	P20	N08−22'36.90"	W079−08'22.29"	37	Fishing Location	11:43	12-Feb-05
Fishing Location 15	P21	N08−23'58.46"	W079−08'12.54"	21.5-25	Fishing Location	11:49	12-Feb-05
Fishing Location 16	P22	N08−26'02.81"	W079−07'28.92"	32.5	Fishing Location	12:12	12-Feb-05
Fishing Location 17	P23	N08−26'55.40"	W079−06'29.47"	22.5	Fishing Location	12:18	12-Feb-05
Pedro Gonzalez Harbor	45	N08−24'32.64"	W079−06'15.82"		Harbor	5:50	15-Feb-05
Motherboat (Peregrino 5 [P5]), Net	201	N08−18'41.18"	W079−06'19.06"		Fishing Location	6:36	15-Feb-05

Location 1							
P5 Net Location 2	202	N08−18'20.88"	W079−06'01.04"		Fishing Location	6:38	15-Feb-05
P5 Net Location 3	203	N08−18'08.25"	W079−05'50.53"		Fishing Location	6:40	15-Feb-05
Motherboat (Jesus Kadir) Net Location 1	205	N08−15'39.76"	W079−04'23.42"		Fishing Location	6:56	15-Feb-05
Gavino Net Location 1	206	N08−12'07.79"	W079−07'23.41"		Fishing Location	7:51	15-Feb-05
Gavino Net Location 2	207	N08−12'45.78"	W079−08'11.09"		Fishing Location	8:02	15-Feb-05
Motherboat (Gavino)	208	N08−13'17.87"	W079−07'55.79"		Fishing Location	9:03	15-Feb-05
2 Chorillo Motherboats*	209	N08−14'47.07"	W079−08'37.18"		Fishing Location	9:19	15-Feb-05
Lobster Fishing	210	N08−18'50.22"	W079−06'28.31"		Fishing Location	9:53	15-Feb-05
Net off Pedro Gonzalez coast 1	301	N08−22'23.83"	W079−05'27.00"	11.5	Fishing Location	6:14	16-Feb-05
Dolphin sighting	302	N08−17'00.39"	W079−08'08.93"		Waypoint	6:55	16-Feb-05
Chorillo net 1	303	N08−16'25.74"	W079−07'59.72"		Fishing Location	6:59	16-Feb-05
Chorillo net 2	304	N08−16'11.74"	W079−07'58.54"		Fishing Location	7:02	16-Feb-05
Chorillo net 3 - Dona Cecira caught on coral	305	N08−16'04.34"	W079−07'55.06"		Fishing Location	7:04	16-Feb-05
Chorillo net 4	306	N08−15'23.58"	W079−08'18.85"	10.5	Fishing Location	7:08	16-Feb-05
2 Chorillo Motherboats* (1 net in coral)	307	N08−15'20.14"	W079−08'21.75"		Waypoint	7:11	16-Feb-05
Gavino + Motherboat from Panama coast	308	N08−15'28.69"	W079−07'54.48"		Waypoint	7:25	16-Feb-05
Motherboat from Chorillo (Dona Cecira) cleaning net of coral	309	N08−15'05.58"	W079−07'56.37"		Waypoint	9:21	16-Feb-05
Rio Pescado (new fishing location for 2nd Chorillo Motherboat)	310	N08−16'58.73"	W079−08'02.44"		Waypoint	10:52	16-Feb-05
Motherboat (Peregrino 5 afternoon/night location)	311	N08−18'42.14"	W079−06'21.40"		Waypoint	11:10	16-Feb-05
Playa Don Bernardo	PLAYDB	N08−23'45.77"	W079−05'17.34"		Beach	16:35	17-Feb-05
Dona Marina motherboat location	401	N08−24'26.15"	W079−05'36.63"		Fishing	7:08	14-Mar-05
La Fe motherboat location - net fouled on corals	501	N08−18'15.44"	W079−06'05.77"		Fishing	7:06	16-Mar-05
El Mana net loacation	502	N08−22'11.39"	W079−05'45.75"		Fishing	7:41	16-Mar-05
El Mana motherboat loacation	503	N08−22'29.74"	W079−05'40.19"		Fishing	7:50	16-Mar-05

Fishing location	504	N08⁻25'22.18"	W079⁻07'33.09"	Fishing	9:15	16-Mar-05
Pargo fishing location	507	N08⁻22'24.45"	W079⁻08'14.97"	Fishing	11:42	16-Mar-05
Dona Marina motherboat location	601	N08⁻18'33.30"	W079⁻07'20.65"	Fishing	7:21	17-Mar-05
Dona Marina net location	602	N08⁻17'46.23"	W079⁻07'59.35"	Fishing	7:51	17-Mar-05
Dona Marina net location	603	N08⁻17'26.13"	W079⁻08'02.54"	Fishing	7:55	17-Mar-05

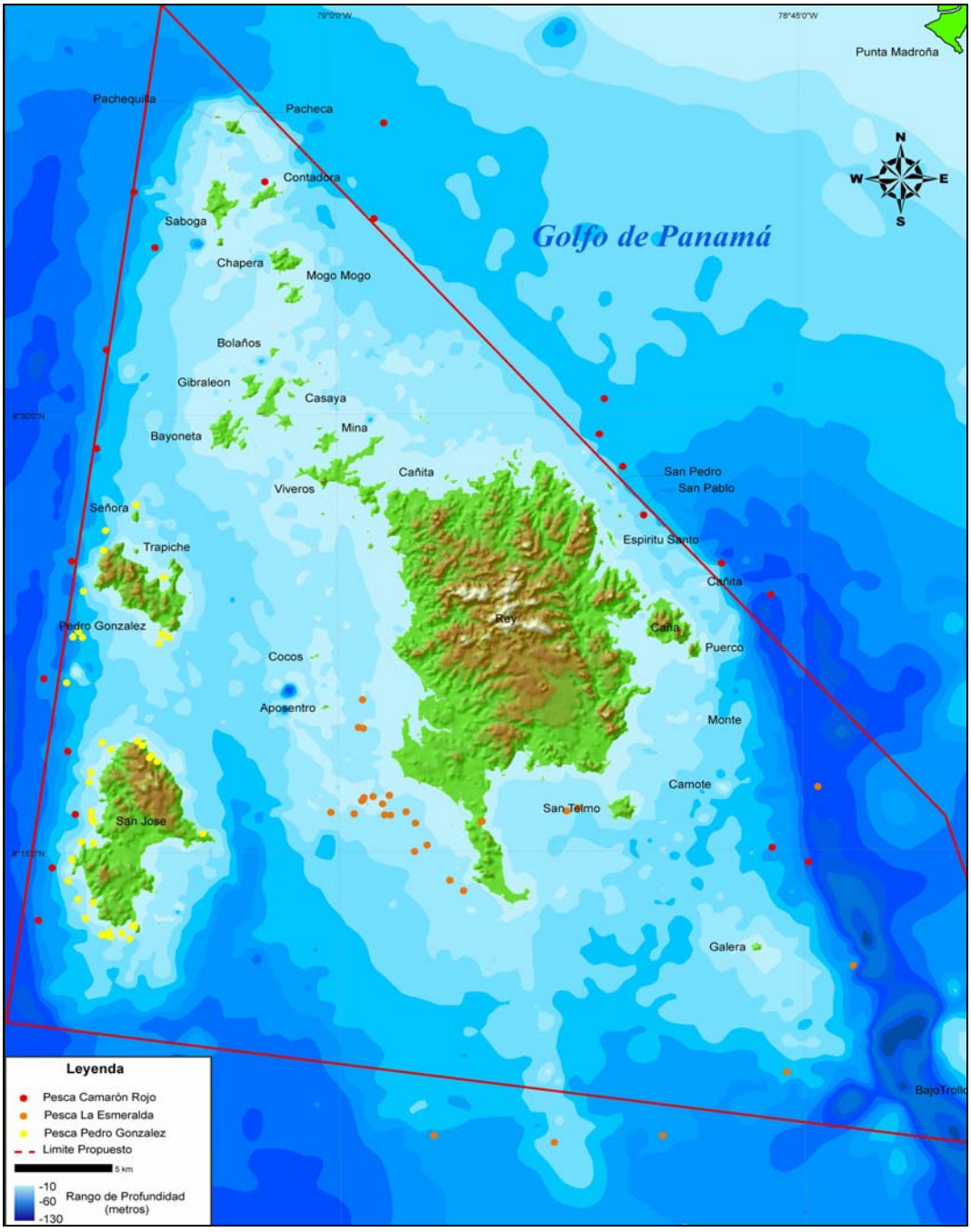
⁻ = degrees

* = 2 Chorillo motherboats were the same on both Feb 15 and 16

P16-P23 are mainly pargo and cherna fishing locations, when in season

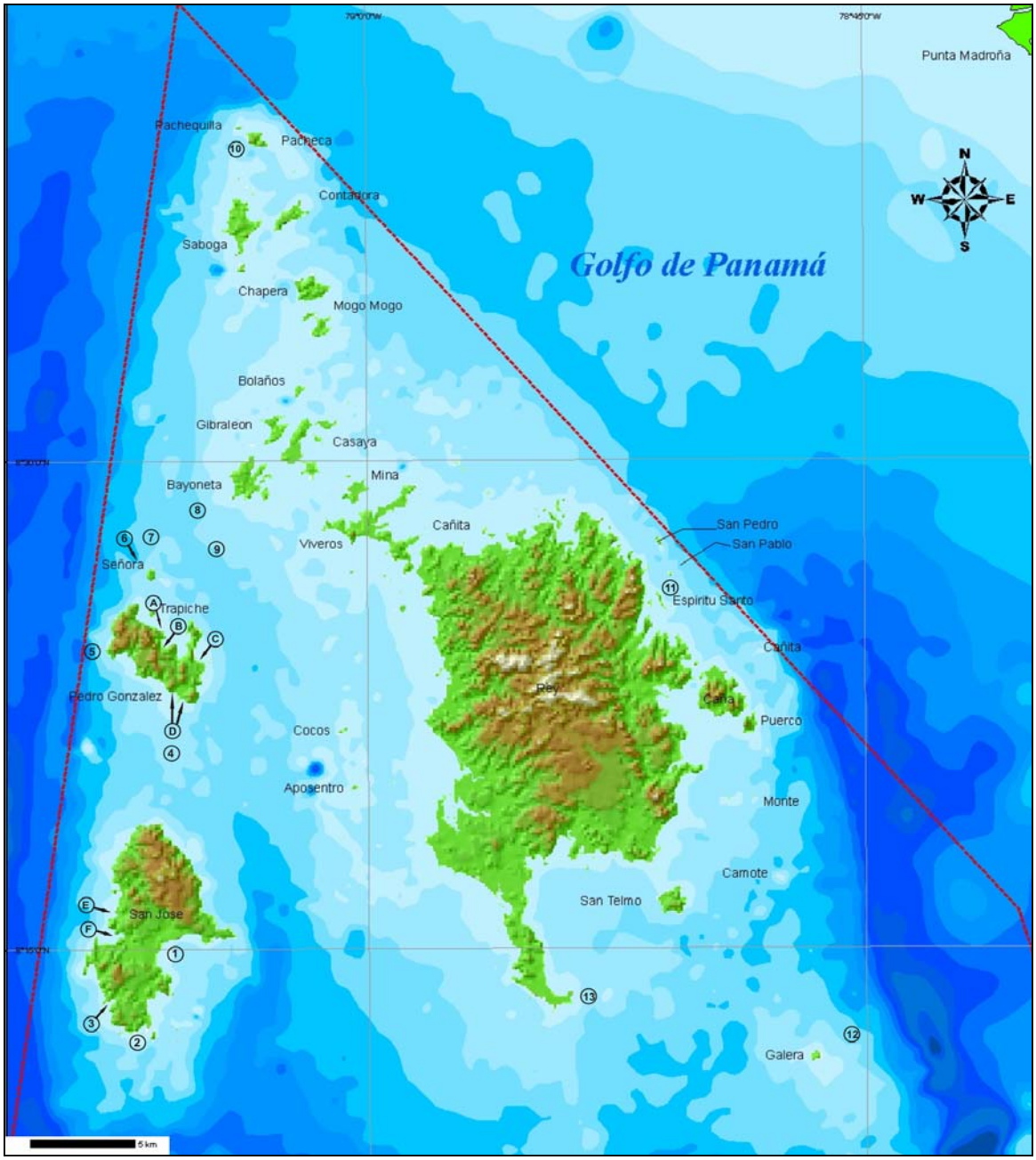
APPENDIX 2

GPS recorded fishing sites in the area of Pedro Gonzalez.



APPENDIX 1

Fishing sites and landmarks in the area of Pedro Gonzalez.



Legend

ID number	Site	Comments
1	Playa Grande	• best at night
2	Punta el Belero	• best in the day • water is always colder here
3	Rio Faro	• depth ~ 40 m (22 *brasas*) • C. Escudero caught a 62 kg grouper (*mero*) here • site for fishing for large *cojinua*
4	Baja de Kenke	• rock in water (*kenke* means breeding site) • depth ~ 27 m (14-15 *brasas*) • breeding site for pargo (deposit their eggs here) • good fishing for *cherna*
5	Totumico	• rock in water that attracts fish • Punta Oeste: depth ~ 16 brasas, fishing for *corvina*
6	fishing site	
7	fishing site	
8	fishing site	• presence of rocks (shallower) where fish aggregate
9	fishing site	• rock in water • good fishing for *mero* and *pargo mancha*
10	fishing site	• *Ambulu* (red fish with larger eyes) and *cherna* are caught here
11	fishing site	• rock there is called El Empaliza • close to San Pablo Island • good fishing for *cherna* and *pargo mancha*
12	Galera	• rock in water • good fishing for *pargo*, *cherna*, and many other fish types
13	Punta Coco	• 2 hours from Pedro Gonzalez by boat (can be traveled to and fro in 1 day) • depth ~ 13 m (7 *brasas*), pargo to 57 m (31 *brasas*) (max depth)
A	Town of Pedro Gonzalez	
B	San Antonio harbor	
C	Playa Don Bernardo	
D	Playa Brava, Playa Blanca	
F	La Bodega	• protected site where mother boats anchor • excellent fishing location
E	Rio Pescado	• protected site where mother boats anchor • excellent fishing location

A PRELIMINARY ASSESSMENT OF THE ARTISANAL FISHERY IN THE TOWN OF PEDRO GONZÁLEZ, ARCHIPELAGO OF LAS PERLAS, PANAMA.

Dustin Raab & Dominique Roche

Please send a thank you note to:

Héctor M. Guzmán
Smithsonian Tropical Research Institute
Apartado 2072
Balboa,
Republic of Panama

Carlos Guevara
Smithsonian Tropical Research Institute
Apartado 2072
Balboa,
Republic of Panama

Felix Rodriguez
Smithsonian Tropical Research Institute
Apartado 2072
Balboa,
Republic of Panama

Ernesto Peña
Smithsonian Tropical Research Institute
Apartado 2072
Balboa,
Republic of Panama

Ross Robertson
Smithsonian Tropical Research Institute
Apartado 2072
Balboa,
Republic of Panama