The Status of Shark and Ray Fishery Resources in the Gulf of California: Applied Research to Improve Management and Conservation

Joseph J. Bizzarro, Wade D. Smith, Robert E. Hueter, John Tyminski, J. Fernando Márquez–Farías, J. Leonardo Castillo–Géniz, Gregor M. Cailliet, and Carlos J. Villavicencio–Garayzar

Moss Landing Marine Laboratories Tech. Pub. 2009–01 ISSN 1088-2413

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This research was made possible largely through funding provided by the David and Lucile Packard Foundation

August 31, 2007

Cover Photos:
Landings of smoothound sharks (*Mustelus* spp.) and a Pacific Angel shark (*Squatina californica*); fishermen placing salted shark fillets on drying racks

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Citation:
Bizzarro, J.J., Smith, W.D., Hueter, R.E., Tyminski, J., Márquez–Farías, J.F., Castillo–Géniz, J.L., Cailliet, G.M., Villavicencio–Garayzar, C.J., 2007. The status of shark and ray fishery resources in the Gulf of California: applied research to improve management and conservation. Moss Landing Marine Laboratories Tech. Pub. 2009–01.

An electronic version of this document can be found at:
http://psrc.mlml.calstate.edu/current-research/gulf-of-california/

ISSN 1088–2413

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ABSTRACT

Seasonal surveys were conducted during 1998–1999 in Baja California, Baja California Sur, Sonora, and Sinaloa to determine the extent and activities of artisanal elasmobranch fisheries in the Gulf of California. One hundred and forty–seven fishing sites, or camps, were documented, the majority of which (n = 83) were located in Baja California Sur. Among camps with adequate fisheries information, the great majority (85.7%) targeted elasmobranchs during some part of the year. Most small, demersal sharks and rays were landed in mixed species fisheries that also targeted demersal teleosts, but large sharks were usually targeted in directed drift gillnet or, to a lesser extent, surface longline fisheries. Artisanal fishermen were highly opportunistic, and temporally switched targets depending on the local productivity of teleost, invertebrate, and elasmobranch fishery resources. Major fisheries for small sharks (≤ 1.5 m, "cazón") were documented in Baja California during spring, in Sonora during autumn–spring, and in Sinaloa during winter and spring. Triakid sharks (*Mustelus* spp.) dominated cazón landings in the northern states, whereas juvenile scalloped hammerheads (*Sphyrna lewini*) primarily supported the fishery in Sinaloa. Large sharks (> 1.5 m, "tiburón") were minor components of artisanal elasmobranch fisheries in Sonora and Sinaloa, but were commonly targeted during summer and early autumn in Baja California and Baja California Sur. The pelagic thresher shark (*Alopias pelagicus*) and silky shark (*Carcharhinus falciformis*) were most commonly landed in Baja California, whereas a diverse assemblage of pelagic and large coastal sharks was noted among Baja California Sur landings. Rays dominated summer landings in Baja California and Sinaloa, when elevated catch rates of the shovelnose guitarfish (*Rhinobatos productus*, 13.2 individuals/vessel/trip) and golden cownose ray (*Rhinoptera steindachneri*, 11.1 individuals/vessel/trip) primarily supported the respective fisheries. The Sonoran artisanal elasmobranch fishery was the most expansive recorded during this study, and rays (especially *R. productus*) dominated spring and summer landings in this state. Seasonal catch rates of small demersal sharks and rays were considerably greater in Sonora than in other surveyed states. Many tiburón populations (e.g., *C. leucas*, *C. limbatus*, *C. obscurus*, *Galeocerdo cuvier*) have likely been overfished, possibly shifting effort towards coastal populations of cazón and rays. Management recommendations, including conducting demographic analyses using available life history data, determining and protecting nursery areas, and enacting seasonal closures in areas of elasmobranch aggregation (e.g., reproduction, feeding), are proposed. Without effective, enforceable management to sustain or rebuild targeted elasmobranch populations in the Gulf of California, collapse of many fisheries is a likely outcome.

Introduction

Elasmobranch fisheries have expanded in size and importance in response to recent global declines in traditional teleost stocks (Pratt and Casey, 1990; Fogarty and Murawski, 1998). Consequently, shark and ray populations are currently undergoing their greatest historical rate of reduction through fishing activities (Bonfíl, 1994; Stevens et al., 2000). Contemporary (1996–2005) worldwide chondrichthyan (elasmobranch and chimaera) landing estimates have ranged between 771–881 metric tons (t), totals that have more than doubled within the last forty years (FAO, 2005). Elasmobranchs constitute the great majority of these landings, with sharks and rays contributing similar amounts (Walker, 1998). In addition to documented yield, elasmobranch species are assumed to be caught in approximately equal mass as unreported landings or discards (Bonfíl, 1994). Incidental catch is considerable in pelagic swordfish and tuna (e.g., Nakano and Watanabe, 1992; Beerkircher et al., 2002; Schindler et al., 2002), demersal groundfish and squid (e.g., Brander, 1981; Quero, 1998; Walker and Hislop, 1998; Laptikhovsky, 2004), and shrimp (e.g., Ruffino and Castello, 1993; FAO, 2001; Stobutzki et al., 2002) fisheries.

Elasmobranch fisheries are largely unregulated, and catch records, when available, are often incomplete or generalized (Anderson, 1990; Compagno, 1990a; Musick et al., 2000; Stevens et al., 2000). Reported landings are mainly derived from mixed–species fisheries or incidental take, not directed fisheries, further complicating management (Bonfíl, 1994). The increasing exploitation of this group and lack of corresponding management measures is especially alarming because most elasmobranchs have life history traits (e.g., long life span, slow growth, low fecundity, late age at maturity) that may severely restrict their ability to sustain fishing pressure or recover from overexploitation (Holden, 1973, 1974; Cailliet, 1990;

Hoenig and Gruber, 1990; Walker and Hislop, 1998; Stevens et al., 2000; Cailliet and Goldman, 2004). Additionally, elasmobranchs are apex predators in many marine ecosystems (Compagno, 1990b; Cortés, 1999; Wetherbee and Cortés, 2004). Their removal may therefore have considerable and unpredictable ecosystem–level effects on species composition and diversity (Pauly et al., 1998; Stevens et al., 2000; Jackson et al., 2001). To sustain exploited elasmobranch populations, it is essential that species–specific landing information is documented and effective management plans are implemented.

Large–scale, industrialized fisheries for elasmobranchs gain more notoriety, but most reported landings are actually contributed by small–scale, artisanal fisheries (Bonfíl, 1994). In Mexico, an estimated 130,000 artisanal vessels harvest ~40% of the national marine catch (Arreguín–Sanchez et al., 2004). Although elasmobranchs contribute a relatively small proportion to overall Mexican fishery production (2.1–3.1% from 1996–2005), their relative contribution greatly exceeds the world average of 0.9% (FAO, 2005). Elasmobranchs are taken in mixed–species fisheries that generally target either large coastal and pelagic sharks with surface gear, or small coastal sharks and rays with bottom–set gear (Bonfíl, 1994; Holts et al., 1998; Márquez–Farías, 2002, Pérez–Jiménez et al., 2005a). Landings increased dramatically, from 9,100 t in 1970 to 45,250 t by 1996, but have since declined, averaging 35,264 t from 1997–2005 (FAO, 2005). Most of the yield (66.6% of total elasmobranch landings from 1996–2003) is taken from the Pacific coast (CONAPESCA, 2003), with the artisanal fishery accounting for almost 40% of total national shark production (Diario Oficial de la Federación, DOF, 2007) and virtually all directed batoid landings (F. Márquez–Farías, pers. obs.).

Although precise data are lacking, more elasmobranch tonnage is estimated to be landed in the Gulf of California (GOC) than in any other Mexican faunal region. Elasmobranch landings from the four states bordering on the Gulf of California (Baja California, Baja California Sur, Sonora, and Sinaloa) averaged 15,367 t per year from 1986–2003, accounting for 41.7% of the national total (CONAPESCA, 2003). The great majority of these landings were derived from the Gulf of California. Major artisanal fisheries for sharks and rays have developed in this region, with an unknown but considerable number of fishing camps established. Recent declines in artisanal fishery landings and anecdotal evidence suggest that targeted elasmobranch populations may have been overexploited (DOF, 2004). Management of these fisheries has been hampered in part by a lack of detailed, quantitative information on location and activities of artisanal elasmobranch camps, species composition of landings, and life history information of targeted species.

As Applegate et al. (1993) and Castillo–Géniz et al. (1998) noted for Mexican shark resources, nursery areas and regions of great seasonal and local abundance must be located and protected to sustain commercial species; a concept that applies equally to batoids. The GOC is thought to serve as crucial nursery habitat for a diverse assemblage of both resident and transient elasmobranch species (Villavicencio–Garayzar, 1996a; Bizzarro et al., 2007a; Márquez–Farías, 2007). It is therefore essential that quantitative baseline information (e.g., effort, species composition, total landings, biological characteristics of landed species) is determined for the local artisanal elasmobranch fishery so that it can be better monitored in the future. This information is also critical for the establishment of effective management plans for exploited elasmobranch species.

Widespread concern regarding overexploitation of elasmobranchs in Mexican waters has prompted the development of a federal management plan and underscored the need for fundamental information on targeted species. Historically, Mexican elasmobranch fisheries have been largely unregulated. A moratorium was placed on the issuance of artisanal shark fishing permits in 1993 (Castillo–Géniz et al., 1998) and was extended to larger industrial fishery vessels in 1998, and mobulids have been protected within twelve miles of the Revilligigedo archipelago since 1994 (Márquez–Farías, 2002). Because indirect evidence (e.g., loss of large shark species from landings, reduction in size composition of targeted species, decline in total landings) indicated that coastal shark populations had reached maximum sustainable yields or were overfished, national legislation (NOM–029) was enacted to conserve exploited elasmobranch stocks on May 15, 2007. This national plan established an improved record–keeping system for commercial shark fisheries, introduced logbooks for artisanal shark and ray fishing vessels, established specific fishing targets for commercial fleets, introduced temporal gear restrictions in shark and ray nursery areas, prohibited the landings of potentially vulnerable shark and ray species, and established a mandatory scientific observer program for shark vessels (DOF, 2007). However, the NOM–029 did not limit or establish any restrictions on fishing effort (number of vessels), the implementation of this legislation has already been delayed, and it is unclear if the fishery restrictions imposed by NOM–029 can be effectively enforced. In addition, biological information on exploited elasmobranchs in the Mexican Pacific is extremely limited (McEachran and Notarbartolo–di–Sciara, 1995; Compagno et al., 1995; PSRC, 2004). Unless recent management efforts are put into effect and ultimately successful, the depletion or collapse of exploited populations is a likely scenario.

To improve the understanding, conservation, and management of shark and ray populations in the GOC, a two–year study was undertaken during 1998–1999 to describe the extent and activities of the local elasmobranch fishery. Specific objectives of this project were to: 1) determine the locations and activities of elasmobranch fishing camps within the GOC; 2) determine the catch composition of sharks and rays from these camps, including species composition, sex, and size information; 3) design and implement a shark tagging program to locate potential nursery grounds and determine the extent of shark movements between the Pacific and the GOC; and 4) actively integrate research findings to promote sustainable resource utilization by providing detailed information and fishery management recommendations to the Mexican government.

Study Site Description

The GOC is a narrow 1,070 km long marginal sea situated between the Baja California Peninsula and the west coast of mainland Mexico (Figure 1). It was formed approximately five million years ago when the convergence of the Pacific, Farallon, and North American plates resulted in the disassociation of a land mass (Baja California Peninsula) from the North American Plate and the creation of a spreading center just east of present–day Isla Angel de la Guardia (Angelier et al., 1981; Gastil et al., 1983). Terrestrial sediments deposited by the Colorado River dominate the shallow, flat sea floor of the upper GOC (Kennett, 1982). South of the Midriff Islands, the sea floor expands in depth and complexity and contains rocky basins, troughs, ridges, cliffs and depths of $\leq$ 3,700 meters (Kennett, 1982). The Gulf's variable depth and habitat characteristics and unique location at a transition zone between temperate and tropical faunal regions account largely for its remarkable species richness (Hastings, 2000; Brusca et al., 2005).

Although terrestrial inputs are minimal and largely aeolian, nutrient levels in the GOC are elevated year–round and show little seasonality (Brusca et al., 2005). This is because upwelling and tidal mixing occur throughout the GOC, bringing colder, nutrient rich deep water to the surface (Álvarez–Borrego, 2003). In general, regions with higher kinetic energy have higher concentrations of planktonic organisms, and therefore higher productivity (Mann and Lazier, 1996). The shallowness of the northern GOC creates large tidal ranges that decrease from $\leq$ 9.6 meters at the head to less than one meter at the mouth (Simpson et al., 1994). Correspondingly, nearly complete tidal mixing in the northern GOC makes this one of the most productive marine regions in the world (Brusca et al., 2005). At the Midriff Islands, tidal currents are also strong and intense mixing (to > 500 m) occurs, creating a situation similar to constant upwelling (Álvarez–Borrego, 2003). Primary productivity is considerable, and this region supports large numbers of marine mammals, seabirds, and fishes (Brusca et al., 2005). Upwelling is also prevalent throughout the GOC, with some of the highest surface nutrient concentrations in the world occurring during winter months (Álvarez–Borrego et al., 1978). Ekman transport creates upwelling along the mainland coast in association with northwesterly winds (December–May) and off the Baja coast with southeasterly winds (July–October). June and November are considered transitional periods (Álvarez–Borrego and Lara–Lara, 1991). The combination of upwelling and tidal flux helps to stir nutrients into the euphotic zone and provides a rich food base for the diverse array of marine organisms inhabiting the GOC (Zeitzschel, 1969; Álvarez–Borrego et al., 1978, Álvarez–Borrego and Lara–Lara, 1991).

The geographic orientation of the GOC limits the influence of major Pacific Ocean circulation; resulting in unique local oceanographic patterns (Maluf, 1983). During winter and summer months, surface and subsurface (to 150 m) flow enters along the mainland side of the GOC, crosses westward below the midriffs and flows out of the GOC along the western margin. This condition reverses during spring and autumn, with inflow along the eastern margin and outflow along the mainland (Marinone, 2003). The general circulation of the southern Gulf is attributable to wind and Pacific Ocean forcing. Circulation in the narrow Midriff Islands is dictated by tidal currents that reach speeds of $\leq$ 3 meters per second, and strong rip currents and large eddies are associated with this region (Maluf, 1983). In the northern GOC, tides play an important role in producing mean residual currents, and both tides and winds oppose Pacific forcing to produce a persistent cyclonic gyre during summer and a more variable anticyclonic gyre during winter (Lavín et al., 1997; Marinone, 2003). This kind of circulation suggests that neutrally buoyant substances and passive organisms may get trapped in the northern GOC for extended periods of time. At the entrance of the GOC, three kinds of surface water interact: cool, low salinity California Current Water (CCW), which flows southward along the west coast of Baja California Sur; Equatorial Surface Water (ESW) of intermediate salinity, which flows into the GOC from the southeast (Costa Rica Current), and warm, highly saline Gulf of California Water (GCW). The influence of these water masses varies both seasonally and annually (Álvarez–Borrego, 2003).

Temperature is greatly spatially and seasonally variable in the GOC. Averaged monthly mean temperature decreases from the mouth towards the interior, reaches a minimum at the Midriff Islands, and then increases slightly towards the head. The variability, in contrast, increases towards the interior, with a minimum at the mouth region and a maximum at the head (Soto–Mardones et al., 1999). The northern GOC exhibits the highest (32.6º C in August) and lowest (8.3 º C in December) recorded temperatures (Álvarez–Borrego, 2003), and ranges of 10–32 º C are typical for this region (Soto–Mardones et al., 1999). The lowest sea surface temperatures, outside of northern extremes during winter, consistently occur at the Midriff Island region because of intense tidal mixing during all seasons. In contrast, the deeper waters of the central and southern region are warmer than those of the Midriff Island and northern GOC during all months except August and September (Soto–Mardones et al., 1999). Maximum summer temperature in the GOC is similar throughout, although highest temperatures are typically recorded during August in the northern GOC (Soto–Mardones et al., 1999). In winter (January and February), the minimum temperatures differ among regions with the southern region typically 3–4 º C warmer than the northern and Midriff Island regions (Soto–Mardones et al., 1999). Waters warm steadily from averages of ~17.3º C at the Midriffs and northern GOC and ~21.0 º C in the southern GOC during March, to ~24.7 º C, ~25.6 º C, and ~27.1 º C, respectively, during June. After August and September highs of ~29.9 º C, ~30.7 º C, and ~30.6 º C, temperatures averaged ~23.5 º C, ~23.5 º C, and ~26.8 º C during November among these three regions, respectively (Soto–Mardones et al., 1999).

The GOC is the only evaporative basin in the Pacific Ocean, because of its location between two arid land masses and the resulting lack of freshwater input to the region (Roden, 1964; Bray and Robles, 1991). Salinity generally decreases on a north to south gradient, with seasonal fluctuations in magnitude evident mainly in the northern GOC. Summer surface salinities of $\leq$ 39.0 parts per thousand (ppt) have been reported in shallow regions of the northern Gulf (Brusca et al., 2005), whereas surface salinities range from 35.3–37.2 ppt in deeper portions of the northern GOC and are closer to oceanic conditions (35.0–35.8 ppt) in the central and southern GOC (Lavín et al., 1998).

Oceanic conditions during the course of this study were greatly influenced by a strong El Niño Southern Oscillation (ENSO) event that occurred during 1997–1998, and by contrasting La Niña conditions during 1999. ENSO events generally suppress primary productivity, especially in the southern GOC, and result in an altered (more tropical, siliceous species) planktonic community structure (Álvarez–Borrego, 2003). They may, however, enhance phytoplankton production in areas of considerable turbulence. For example, the Ballenas Channel, located just west of the Midriff Islands, may serve as an area of refugia for highly mobile animals during ENSO conditions. At the Midriff Islands, however, reproductive failure of sea birds has been observed despite stable phytoplankton resources and production. More data are needed to document the effects of ENSO conditions on associated GOC biota. Greater intrusion of ESW and subtropical subsurface water, and associated higher temperature and salinities, occur during ENSO conditions (Álvarez–Borrego, 2003). The greatest positive sea surface temperature anomalies recorded during this course of this study occurred during January 1998 (17–24 º C), and ranged from ~2º C in the northern GOC, to ~3 and 4º C in the southern and central GOC, respectively (Márquez–Garcia, 2003). Temperature anomalies began to decline steadily during late March (17–22 º C), before fluctuating ±1 º C among all regions during June–December 1998 (Márquez–Garcia, 2003).

During the 1999 La Niña, cooler, highly productive, low–salinity water associated with the California Current infused the GOC (Schwing et al., 2002). In April 1999, temperatures (14–22 º C) declined rapidly, with negative anomalies of ~2.5 º C recorded during May at the southern and central regions and 4 º C in association with the Midriff Islands and northern GOC. By July, anomalies remained slightly negative in all regions but the mouth, which showed a slight (< 0.5 º C) positive anomaly. Between July and November temperature anomalies exhibited a gradual increase, with values of ($\leq$ 1 º C) exhibited during November. Temperature declined sharply at the end of 1999, with anomalies –1º C to –2º C recorded in all regions but the northern GOC (Márquez–Garcia, 2003). Temperatures were generally greater during the summer (27–33 º C) and winter (17–24 º C) of 1998 than 1999 (25–31 º C and 14–21 º C, respectively) (Márquez–Garcia, 2003).

Materials and Methods

Seasonal surveys of artisanal fishing camps located in the Mexican states of Baja California (BC), Baja California Sur (BCS), Sonora (SON), and Sinaloa (SIN) were conducted during 1998–1999 (Figure 1). Survey responsibilities were divided among participating institutions as follows: Moss Landing Marine Laboratories (BC), Universidad Autónoma de Baja California Sur (BCS), Mote Marine Laboratory (SON), and Instituto Nacional de la Pesca (SON, SIN). Surveys were conducted seasonally with primary sampling effort allocated during spring–autumn months. Elasmobranch fishing activities were presumed to be less substantial during winter months, thus winter surveys were conducted opportunistically. Seasons were defined as follows: spring (March–May), summer (June–August), autumn (September–November), and winter (December–February). Because the winter season spanned years, landings were attributable to the year associated with January and February for convenience.

Survey priorities differed slightly between years. During 1998, surveys were principally directed at determining the locations and activities of all active artisanal fishing camps in each state. Primary elasmobranch fishing camps were revisited during 1999 to allow for seasonal comparison of fishing effort and species composition, and additional sampling effort was dedicated to collecting biological information from landed specimens. In addition to state–wide surveys, extended monitoring projects were established in 1999 at El Choyudo (28º 19.12' N, 111º 27.18' W) and Bahía Kino (28º 49.11' N, 111º 56.35' W), Sonora. Elasmobranch landings and effort were consistently greater at these camps than others, and much of the species–specific data collected for this project were derived from these locations.

Locations of fishing camps were determined from maps, local knowledge of fishing activity, and exploration. Once located, the position of each encampment was determined with a handheld Global Positioning System (GPS) unit. At each camp, artisanal fishing vessels ("pangas"), typically 5.5–7.6 m long, open–hulled fiberglass boats with outboard motors of 55–115 hp, were sampled to determine fishery targets and elasmobranch species composition. Interviews were conducted with returning fishermen to ascertain fishing locations, gear types, ex–vessel prices, and markets. All references to mesh size of gillnets indicate stretched mesh size, or the distance between knots when the mesh is pulled taut. Type (A = little to no infrastructure, B = moderate infrastructure, C = significant infrastructure), permanence (1 = permanent, 2 = seasonal), period of activity, and number of active pangas were recorded for each camp. After all active camps were documented, they were numbered from south to north for each state.

Elasmobranch and chimaera (Class: Holocephali) landings were identified to lowest possible taxonomic level, enumerated, sexed, measured, and weighed whenever possible. All gymnurid rays (i.e., *Gymnura crebripunctata*, *G. marmorata*) and triakid sharks (i.e., *Mustelus. albipinnis, M. californicus*, *M. dorsalis*, *M. lunulatus, M. henlei*) were grouped into species complexes (i.e., *Gymnura* spp., *Mustelus* spp.) because of taxonomic confusion within these genera during the time of surveys (Castro–Aguirre et al. 2005; Smith et al., in press a). Co–occurring vertebrate and invertebrate landings were occasionally documented. Taxonomy follows Compagno (2005) for chondrichthyans, Nelson et al., (2004) for teleosts, and Fischer et al. (1995) for other vertebrates and invertebrates. Common names of elasmobranchs follow Nelson et al. (2004). Standard measurements (e.g., total length, disc width) were consistently recorded to the nearest 1.0 cm for sampled chondrichthyans. Additional external measurements (e.g., body length, clasper length) were sometimes taken and alternative measurements (e.g., dorsal to dorsal length) were made on processed ("dressed") specimens. Disc width was recorded for skates (Rajidae), but converted to total length using the relationships estimated by Castillo–Géniz (2007). Weight was recorded to the nearest 0.1 kg with a spring scale.

The maturity status of specimens landed in GOC artisanal elasmobranch fisheries was assessed opportunistically. When time allowed, maturity status was determined based on visual inspection of the reproductive organs and individuals were classified to one of four categories: neonate, juvenile, mature, or gravid. Newborn specimens (neonates) of placentally viviparous species could be identified based on the presence of an umbilical scar. A qualitative comparison of observed size to known size at birth was used to distinguish neonates of oviparous or aplacentally viviparous species. Males were considered to be mature if the claspers were elongate, calcified, could be easily rotated, and the testes were enlarged and lobed (Pratt, 1979). Juvenile males were differentiated by a lack of calcification of the claspers and limited development of the testes. Female maturity status was determined by inspection of the ovaries, uterus, and oviducal gland (Martin and Cailliet, 1988; Snelson et al., 1988). Females were considered to be mature if vitellogenic ova >1 cm diameter were present, uteri/oviducal glands were well developed, and/or trophonemata were present. Juvenile females lacked differentiation of the ovaries and mature oocytes and possessed uteri that were typically narrow and constricted. When embryos or egg cases were present in the uterus, their number, sex and size (disc width, DW, or stretched total length, STL) were recorded. Because of restrictions concerning handling time and specimen access, maturity information was obtained for only a small subset of the specimens examined.

Chondrichthyan (Class: Elasmobranchii and Holocephali) landings were summed by season and year to determine state–specific species composition. Only landings from vessels targeting chondrichthyans were used. Catch per unit effort (CPUE), defined as the mean number of individuals/vessel/trip, was calculated seasonally.

All measured specimens were utilized to determine state–specific size composition and sex ratio of landings. For all species with $\geq$ 50 measured individuals, potential differences in the size composition of landed females and males were examined using parametric and non–parametric approaches, as appropriate. Raw size data were first evaluated for normality and equality of variances using Shapiro–Wilk and two–tailed variance ratio (F) tests, respectively (Zar, 1996). When data were determined to be normally distributed and of equal variance, two–tailed t–tests were applied to test the hypothesis that mean sizes of females and males did not significantly differ (α = 0.05) among landings. Size data that did not meet the assumptions of normality or homoscedasticity were transformed (log, square root) in an attempt to correct for deviations from these assumptions and re–examined with Shapiro Wilk and two–tailed *F*–tests. If transformations were unsuccessful, size data were evaluated using two–tailed non–parametric Mann–Whitney U tests (Zar, 1996). Additionally, the assumption of equal sex ratios (1:1) within the landings was tested using chi–square analysis with Yates correction for continuity (Zar, 1996).

Similarity of seasonal species composition from 1998–1999 was compared among states using cluster analysis. This multivariate technique reduces data redundancy and identifies distinct groupings within data sets (McGarigal et al., 2000). To maintain consistency in the level of identification among regions, higher taxonomic categories were used to group triakid sharks, gymnurid rays, and narcinid rays. Clustering was performed using the unweighted pair group method with arithmetic mean (UPGMA) and Schoener's index (also known as the Percent Similarity Index; Krebs, 1999) as a measure of similarity. Prior to analysis, sample–size sufficiency was quantitatively evaluated using cumulative species curves (Bizzarro et al., 2007b). If an insufficient number of vessels was sampled for adequate estimates of seasonal species composition, those data were not used. Similarity values among clusters that were $\geq$ 50% of the maximum overall similarity distance were considered to indicate major divisions and used to distinguish species assemblages (i.e., species guilds; Yoklavich et al., 2000).

THE ARTISANAL ELASMOBRANCH FISHERY OF BAJA CALIFORNIA

Introduction

Baja California is bordered by the United States to the north, Baja California Sur to the south, and shares its northeastern border with Sonora just east of the Colorado River. The total area of this state is 71,446 km^2 (INEGI, 2007a). Baja California contains an almost uninterrupted chain of mountains that are primarily volcanic in origin and reach heights of 3,100 m (Gastil et al., 1983). The eastern faces of these mountains present a steep, cliff–like escarpment to the GOC, and a much more gradual slope toward the Pacific Ocean (Wiggins, 1980). The climate of Baja California is generally hot and dry, especially in the northeast, where the Sierra de Juárez and Sierra San Pedro Mártir mountains create a barrier to Pacific winds (Encyclopedia Britannica, 2007).

Situated between the Pacific Ocean and the GOC, mainland Baja California contains 1,555 km of coastline (INEGI, 2007b). Eight major offshore islands occur along the GOC coast (Lindsay, 1983). Most were formed during the Baja Peninsula's separation from the mainland and are located off the southern part of the state (Gastil et al., 1983). The largest of these islands, Isla Angel de la Guardia, encompasses 936 km^2 (Carreño and Helenes, 2002). Coastal and insular shelves and terraces are conspicuously absent or diminished in Baja California. In the southern portion of the state, the shelf is generally rocky and narrow (~5–10 km), with a sharp shelf break at ~200 m. Two large, geologically active basins, Delfin and Salsipuedes, extend from northwest of Isla Angel de la Guardia to the southern border region and reach depths of ~900 m and ~1400 m, respectively (Maluf, 1983). The northern part of coastal Baja California consists of sandy beaches, transitioning to muddy deltaic sediments near the head of the GOC. Waters off northern Baja California are generally shallow (< 100 m) (Dauphin and Ness, 1991).

More than 68% of Baja California's estimated 2,844,469 inhabitants live in the border cities of Tijuana and Mexicali, and almost 80% are from the expanded metropolitan regions associated with these cities (INEGI, 2007a). Human population growth in Baja California has increased considerably (14.4%) since 2000. Migration to the large border cities from other Mexican states and Central American countries has accounted for a significant part of this population growth. Recent immigration has been fostered by the development of export–oriented assembly plants and their proximity of U.S. markets and, to a lesser extent, by agricultural opportunities (Encyclopedia Britannica, 2007). Although Tijuana and Mexicali are major urban centers, the great majority of the state is sparsely populated and only 15 towns have populations > 10,000 (INEGI, 2007a). The absence of consistent sources of fresh water and the characteristically rugged, desolate terrain have historically hampered attempts to colonize rural portions of Baja California.

Baja California is one of Mexico's most important states in terms of fishery production, accounting for 7.4% of landings and 8.5% of revenues during 2003 (CONAPESCA, 2003). These totals ranked fifth and third, respectively, among Mexican states. The most important fishery resources in Baja California were, in order of decreasing landings during 1998–2003: sardines, sargassum algas, and tunas (CONAPESCA, 2003). In addition, Baja California is the main source of sea urchin production. The primary fishery port in Baja California is Ensenada, and San Felipe is the only major industrial port along the Gulf of California.

Elasmobranchs landings averaged 2.9% of total fishery production in Baja California during 1998–2003. Total landings during this period ranged from 3278–4852 t (CONAPESCA, 2003). Elasmobranch landings from Baja California comprised 14.1% of national production during 2003 and averaged 12.7% of national production during 1998–2003. Sharks, especially "tiburón" (sharks > 1.5 m total length), comprised the great majority of reported landings, with rays contributing an average of 14.9% by weight during 1998–2003 (CONAPESCA, 2003).

Materials and Methods

Baja California was surveyed during spring, summer, and autumn of 1998 and 1999. Data were collected specifically during March 26–April 9, June 18–July 9, October 25–November 3, 1998, and April 8–20, July 6–26, October 26–November 4, 1999. The majority of documented camps were revisited seasonally (Appendix 1). The entire catch (i.e., all chondrichthyan, teleost, invertebrate, and vertebrate landings) of each sampled vessel that targeted elasmobranchs in BC was identified to lowest possible taxon and enumerated. Because *M. henlei* could be reliably distinguished from other local triakids based on dentition, it was consistently identified to species. Therefore, the *Mustelus* species complex in this region (*Mustelus* spp.) may have included *M. albipinnis, M. californicus*, *M. dorsalis,* and/or *M. lunulatus*.

Results

Camp characteristics

A total of 17 artisanal fishing sites, broadly termed "camps," was documented in Baja California over 70 survey days during 1998–1999 (Table 1, Figure 2). Elasmobranchs were directly targeted at 70.6% (n = 12) of the camps. Fishing effort was exclusively focused on bivalves (especially scallops, Pectinidae) at BC–07 and on teleosts and shrimps at BC–15 and

BC–17 (Appendix 1). Signs of fishing activity were evident at two additional locations (BC–11, BC–12), but the extent of effort directed toward elasmobranchs could not be documented because no one was present at the time of the surveys. Most fishing camps were active throughout the year (58.8%, n = 10). However, five camps were found to be occupied seasonally (29.4%) and the period of use could not be determined for two additional camps (11.8%). The majority of camps contained moderate infrastructure (64.7%, n = 11).

In contrast to the other, largely isolated camps, artisanal fishery landing sites associated with the city of San Felipe (BC–14, BC–15, BC–16) were well developed and supported considerably more fishing vessels. The number of pangas actively involved in fishing operations (not necessarily targeting elasmobranchs) at the time of the surveys ranged from 1 at BC–05, BC–08, and BC–12 to approximately 200 operating out of BC–14. An influx of fishermen from the southern state of Chiapas who specifically targeted large sharks during the summer and autumn contributed notably to the variability in the number of pangas and elasmobranch fishing effort at BC–02. Fishermen also traveled north from Baja California Sur to target large sharks from BC–03 during the summer and early autumn. Elasmobranch fishing effort was more extensive in the southern region of the state. Although directed effort for elasmobranchs was generally low in San Felipe (BC–14, BC–15, BC–16), indirect take of elasmobranchs was common in both artisanal and industrial teleost fisheries.

Processing methods and typical market prices differed markedly for teleosts (iced, \$15–\$25(MX)/kg) and most elasmobranchs (salted and dried, \$3–\$8(MX)/kg). Rays, small sharks, and large sharks with white flesh (e.g., *Sphyrna* spp. *C. falciformis*) were processed into fillets, salted, and sold domestically. However, large sharks with red flesh (e.g., *A.*

pelagicus, *I. oxyrinchus*) were iced and transported to the United States from BC–02 and BC–03 by truck.

Fishery characteristics

All sampled artisanal vessels targeting elasmobranchs during spring months used bottom set gillnets exclusively. Among the 23 pangas directly sampled, gillnets were commonly constructed of 12.7 cm monofilament line, but a range of mesh sizes from 10.2 cm to 20.3 cm was observed. Lengths of bottom set gillnets were highly variable and were estimated to range between 420–1500 m. More than one gillnet was usually deployed, with 3–5 nets often recorded among sampled vessels. Gear was typically soaked for 24 hours before retrieval. Depths at which gillnets were set varied among camps and by target species. Bottom depths of 3–100 m were reported by fishermen. Secondary gear, such as handlines, was often onboard sampled vessels and allowed fishermen to opportunistically target teleost species during their trips.

A greater diversity of fishing gear was observed during the summer in Baja California than during other seasons. Among the 72 sampled pangas for which the gear type was known, the following were used: surface, or drift, gillnets (47.2%), bottom set gillnets (50.0%), and bottom set longlines (2.8%). Although vessels frequently deployed more than one net, they were typically of the same type. Surface set gillnets were usually tended by fishermen during a 12–24 hour period and were used to target larger–sized shark species (i.e. *Carcharhinus falciformis*, *Sphyrna zygaena*). Mesh sizes were 25.4 cm or 30.5 cm for surface gillnets, in contrast to bottom set gillnets which ranged in mesh size from 7.6–20.3 cm. Net lengths of ~180–1050 m were reported by fishermen.

Of the 45 pangas sampled during autumn for which gear type was identified, surface gillnets (64.4%) were most commonly observed. Bottom set gillnets were used by 35.6% of the vessels surveyed and no longline gear was reported. Mesh sizes from 25.4–38.1 cm were used in surface gillnets. The majority of bottom set gillnets consisted of 12.7 cm and 20.3 cm stretch mesh. Net lengths of 400–600 m were typical of both net types. Soak times of 8–11 hours were most commonly reported for surface gillnets, whereas bottom set gillnets were usually retrieved after 24 hours of deployment.

Artisanal fisheries identified in Baja California were diverse and highly opportunistic. Activities, targets, and gear use changed seasonally within fishing camps. Elasmobranchs landed in more remote camps (e.g. BC–04, BC–05) were typically filleted, salted and dried as a method of preservation and sold for local (BC) consumption (Appendix 1). Elasmobranchs were also directly consumed within fishing camps and were partially relied upon as a component of subsistence fisheries. Buyers of meat and fins of several larger shark species (e.g., *A. pelagicus*, *I. oxyrinchus*) traveled to select camps to purchase dressed sharks for export primarily to US and Asian markets. Fins from *R. productus* were also frequently retained for sale at BC–02. Skins and jaws of some sharks (e.g., *C. falciformis*, *C. obscurus*) were excised and sold at some camps (e.g., BC–02, BC–03). At sites with more infrastructure, sharks and rays were typically dressed and sold fresh to local buyers or cooperatives. Prices for elasmobranchs varied among seasons, by species, size, and buyers, but typically ranged between $3.00–$8.00 (MX)/kg.

Sharks and rays contributed similarly to elasmobranch landings in Baja California, comprising 50.9% and 48.3%, respectively, of the overall recorded catch (Table 2). Skates (0.8%) represented an insignificant portion of overall landings and chimaeras were not documented. At least 17 species of shark, 13 species of ray, and 2 species of skate were identified among the 4495 specimens observed. The shovelnose guitarfish, *Rhinobatos productus*, dominated landings (26.0%). No other single species constituted more than 6.5% of the combined 1998–1999 catch. Members of the family Triakidae (i.e., *Mustelus henlei*, *Mustelus* spp., and *Triakis semifasciata*) comprised 23.6% of total landings, with the great majority represented by a complex of smoothound shark species (*Mustelus* spp., 21.1%). Other prominent species within overall landings included the: Mexican hornshark (*Heterodontus mexicanus*, 6.5%), bat ray (*Myliobatis californica*, 5.6%), and pygmy devil ray (*Mobula munkiana*, 5.5%).

Spring landings were dominated by shark species, and included a notable percentage of specimens that could not be accurately identified because they were processed (heads and fins removed) at sea (Table 2). *Mustelus* spp. represented the largest proportion of landings sampled in 1999 (46.1%, n = 639), but were absent from sampled landings in 1998. *Heterodontus mexicanus* (19.1%) and *R. productus* (11.9%) were also commonly observed in the spring 1999 fishery, but were not recorded during spring 1998. Conversely, the Pacific angelshark, *Squatina californica*, was the primary species observed in 1998 landings (41.5%), but was a minor component of the catch in 1999 (5.7%). Swell sharks, *Cephaloscyllium ventriosum*, were observed only among spring 1999 landings in which they constituted a small proportion of the catch (1.9%). Although spring ray landings were dominated by *R. productus* during 1999, *M. californica* (4.9%), banded guitarfish (*Zapteryx exasperata*, 2.5%), and butterfly rays (*Gymnura* spp., 3.8%) were also relatively common. Enough vessels were sampled from spring 1999 ($t \geq 4.082$, $P \geq 0.05$), but not spring 1998 ($t < 4.082$, $P < 0.05$), to adequately characterize species composition of landings.

The most specimens (48.9%) and greatest species diversity were encountered during summer surveys (Table 2). Rays dominated sampled landings in each year, comprising 75.6% of the catch in 1998 and 79.4% of the catch in 1999. During both 1998 (40.1%) and 1999 (55.8%), *R. productus* was the most commonly recorded species in landings. The longnose eagle ray (*Myliobatis longirostris*, 1.1%) was only documented in summer landings during 1998, whereas longtail stingrays (*Dasyatis longa*, 1.1%) were identified only from summer 1999 landings. Sharks constituted 23.4% of combined summer landings, with only three species accounting for more than 5.0% of the catch in either year. The most commonly observed shark species during 1998, the Pacific sharpnose shark, *Rhizoprionodon longurio* (6.4%), was encountered less frequently during 1999 (1.1%). Silky sharks, *C. falciformis*, constituted 3.4% of summer elasmobranch landings in 1998, but were relatively more abundant during 1999 (9.1%). The only blue (*Prionace glauca*) and dusky (*C. obscurus*) sharks identified from Baja California were reported from summer 1999 and 1998 surveys, respectively. Shortfin mako sharks, *Isurus oxyrinchus*, were observed in summer landings during 1999 (n = 3), but not during 1998. Although minor components of the summer fishery, scalloped (*S. lewini*) and smooth (*S. zygaena*) hammerhead sharks were observed most frequently during this season. Enough vessels were sampled from summer 1998 and 1999 to adequately characterize species composition of landings ($t \geq 4.082$, $P \geq 0.05$).

Shark species were more frequently observed among autumn landings than were rays, comprising 78.4% and 94.9% of the sampled catch in 1998 and 1999, respectively (Table 2). Autumn 1998 landings were dominated by pelagic thresher sharks, *Alopias pelagicus* (25.6%) and *Mustelus* spp. (36.1%). Common thresher sharks, *A. vulpinus* (0.3%), represented a minor proportion of autumn 1998 landings and were only observed at this time.

Autumn 1999 catches consisted primarily of the brown smoothound, *M. henlei* (41.0%), and *S. californica* (28.7%). The most commonly landed ray species during autumn 1998 were *M. californica* (9.4%) and *R. productus* (6.1%), but neither species was recorded from landings during autumn 1999. The mobulid rays *M. japanica* and *M. munkiana* were not observed in autumn 1998 landings but represented minor constituents of autumn 1999 catches. The only round stingray (*Urobatis halleri*) recorded from Baja California landings was documented in the autumn of 1999. Enough vessels were sampled during autumn 1998 ($t \geq 4.082$, $P \geq 0.05$), but not autumn 1999 ($t < 4.082$, $P < 0.05$), to adequately characterize species composition of landings.

Fishing effort was often opportunistic and directed toward multiple species or groups. Teleosts and invertebrates were frequently targeted in addition to elasmobranchs or retained as bycatch. In total, non–elasmobranchs comprised almost half (46.1%) of numerical landings from vessels targeting elasmobranchs. Invertebrates comprised a small component of the overall recorded landings and were represented primarily by crabs and molluscs (Table 3). Among 3,610 individual teleosts examined from vessels targeting elasmobranchs, 19 species and 32 additional higher order taxonomic categories (e.g. genus, family) were identified. Another 185 specimens could only be categorized as “unidentified” teleosts. Croakers (Sciaenidae) were the group most commonly retained in association with the Baja California elasmobranch fishery, constituting 22.0% of the total number of specimens recorded. Sciaenids were encountered predominantly during the spring 1998 survey. A large number of commercial and artisanal vessels in northern Baja California exclusively targeted croakers. Sierras (*Scomberomorus* spp.) were similarly prevalent in summer catches during 1998, and represented nearly 10% of the individual specimens recorded from all seasons combined. Flatfishes (e.g., *Paralichthys californicus*, Pleuronectidae) contributed a relatively consistent proportion of the overall landings in each season, representing 3.0% of the total individuals enumerated. Two green sea turtles, *Chelonia mydas*, taken during spring and summer 1999, were documented among artisanal fishery landings.

Overall seasonal and taxon–specific CPUE (mean $\pm$ SE) were greatest during the spring, largely because of the frequency of *Mustelus* spp. (27.8 ± 7.7) and *H. mexicanus* (11.5 ± 5.9) among these landings (Table 4). CPUE of *S. californica* was also elevated (5.3 ± 2.0) in comparison to other taxa during spring months.   In contrast to the spring and autumn seasons, summer CPUE was greatest for rays. CPUE was, however, dominated by a single species; *R. productus* (13.2 ± 3.6). The summer catch rate of *R. productus* represented the highest CPUE for a single species in Baja California. Summer CPUE among sharks was $\leq$ 1.5 for all taxa; however individual CPUE of four ray species (*M. munkiana*, *M. californica*, *R. productus*, and *Rhinoptera steindachneri*) and the butterfly ray group (*Gymnura* spp.) exceeded this amount. Shark species overwhelmingly dominated autumn CPUE, with *Mustelus* spp. (4.9 ± 1.8), *A. pelagicus* (3.7 ± 0.9), and *M. henlei* (2.4 ± 0.8) exhibiting the greatest catch rates. CPUE of sharks and rays differed markedly among seasons. Skate catch rates were considerably less than those of sharks and rays during all seasons, with the greatest observed values occurring during the spring (1.3 $\pm$ 0.5).

Species–specific size and sex composition were available for a portion of the elasmobranchs recorded in the Baja California artisanal fishery. Specimens were often dressed prior to a vessel's arrival at camp and overall sampling time was limited to minimize interference with general fishing operations. Therefore, alternative measurements such as inter–dorsal distance (DD) or pre–caudal length (PCL) were often necessary. Broad size ranges were reflected among individual *H. mexicanus*, *R. longurio*, *S. lewini*, *S. zygaena*, *M. californica*, and *R. productus* (Table 5). Measured *A. pelagicus*, *C. falciformis*, and *S. californica* were primarily represented by relatively large individuals.

The mean size of female (134.3 ± 8.3 cm PCL) and male (130.4 ± 8.6 cm PCL) *A. pelagicus* differed significantly (Table 5; Figure 3a; $t = 2.47$, $P = 0.015$). Females comprised nearly 73% of the total 143 *A. pelagicus* examined, resulting in a sex ratio that differed significantly from the expected ratio of 1:1 ($\chi^2_{0.05,1} = 28.643$, $P < 0.001$).

Of the 82 *C. falciformis* measured from Baja California landings, 54 were female (Table 5; Figure 3b). Specimens ranged from 155–245 cm stretched total length, STL, with females occupying the largest size classes (≥ 220 cm STL) and exhibiting significantly greater mean sizes (198.2 ± 17.1 cm STL) than males (183.5 ± 16.6 cm STL; $t = 1.99$, P < 0.001). The proportion of sexes differed significantly from a 1:1 ratio ($\chi^2_{0.05,1} = 7.622$, $P = 0.006$).

Female and male *H. mexicanus* averaged 70.6 ± 6.7 cm STL and 60.1 ± 9.9 cm STL, respectively (Table 5; Figure 3c). A total of 83 individuals ranging from 43–90 cm STL were documented in Baja California. Although few males > 70 cm STL were observed, the two largest *H. mexicanus* were males. A significant difference was detected in the size composition of females and males within the sampled landings ($U = 1421.50$, $P < 0.001$). However, the number of females (n = 49) and males (n = 34) did not differ significantly from a predicted sex ratio of 1:1 ($\chi^2_{0.05,1} = 2.361$, $P = 0.137$).

Female *R. longurio* comprised the largest and smallest individuals recorded for this species, ranging from 30–120 cm STL among a total of 96 specimens (Table 5; Figure 3d). However, the average sizes of females (89.7 ± 19.9 cm STL) and males (86.9 ± 19.0 cm STL) were similar within the landings ($t = 0.773$, $P = 0.441$). The proportion of females and males within the landings was also similar and did not deviate significantly from a 1:1 ratio ($\chi^2_{0.05,1}$= 0.510, P = 0.484).

With the exception of a single male *S. zygaena* that measured 248 cm STL, the size composition of the 38 females (108.8 $\pm$ 40.2 cm STL) and 34 males (112.6 $\pm$ 42.1 cm STL) measured from Baja California was similar (Table 5; Figure 3e). The observed size distribution was bimodal with peaks occurring from 60–70 cm and 120–140 cm STL. Mean STLs of females and males were similar within landings (t = –0.397, P = 0.693). The smallest specimen measured was a 46 cm STL female. The observed sex ratio did not differ significantly from 1:1 ($\chi^2_{0.05,1}$= 0.125, P = 0.734).

The size composition of female (88.4 $\pm$ 5.5 cm STL) and male (87.8 $\pm$ 6.9 cm STL) *S. californica* did not differ significantly (Table 5; Figure 3f; t = 0.33, P = 0.744). Specimens ranged from 55–97 cm STL, with males representing the smallest and largest specimens. Males (n = 38) were also more commonly observed than females, resulting in a sex ratio that differed significantly from the expected ratio of 1:1 ($\chi^2_{0.05,1}$ = 4.983, P = 0.026).

Female and male *M. munkiana* observed among fishery landings were of similar sizes, averaging 67.6 $\pm$ 3.9 cm DW and 67.8 $\pm$ 4.3 cm DW, respectively (Table 5; Figure 4a). Of the 81 specimens examined, DW ranged from 54–77 cm with the majority of specimens occupying size classes > 59 cm DW. Mean DWs and observed proportion of sexes did not differ significantly between females and males (t = –0.239, P = 0.811; $\chi^2_{0.05,1}$= 0.049, P = 0.842).

A total of 101 *M. californica* was directly examined from Baja California artisanal fishery landings, measuring 45–102 cm DW (Table 5; Figure 4b). Females comprised the largest size classes and were of larger mean sizes (69.7 $\pm$ 13.2 cm DW) than males (61.7 $\pm$ 6.5 cm DW). Size composition of females and males differed significantly within the landings (U = 1479.00, P = 0.001). Males were recorded more frequently in catches and the total number of females (n =

29) and males (n = 72) varied significantly from a predicted 1:1 sex ratio ($\chi^2_{0.05,1}$= 17.465, P < 0.001).

The size composition of the most common species in the fishery, *R. productus*, ranged from 44–99 cm STL (Table 5; Figure 4c). Females averaged 76.3 ± 7.7 cm STL and males 63.7 ± 5.7 cm STL. The majority of specimens exceeded 70 cm STL. A significant difference was found between mean the STL of females and males within the landings (t = 15.13, P < 0.001). Landings were dominated by female *R. productus*, as indicated by a sex ratio that differed significantly from 1:1 ($\chi^2_{0.05,1}$= 164.917, P < 0.001).

Female and male *R. steindachneri* ranged between 57–90 cm DW (Table 5, Figure 4d). Mean DW of females (78.5 ± 6.5 cm) was greater than that of males (73.9 ± 4.0 cm). Female and male size composition differed significantly within the sampled landings (U = 1449.50, P < 0.001). However, males were more prevalent, representing 57 of the 91 specimens measured. The observed sex ratio differed significantly from 1:1 ($\chi^2_{0.05,1}$= 5.319, P = 0.022).

Discussion

Artisanal elasmobranch fisheries for small demersal sharks and rays and directed fisheries for large coastal and pelagic sharks were active in Baja California during 1998–1999, especially in the southern part of the state. Although Baja California contained fewer camps than any of the four surveyed states, most camps targeted elasmobranchs, especially during summer months. Small sharks and rays were fished with bottom set gillnets during all surveyed seasons (spring–autumn) and large sharks were directly targeted with drift gillnets during summer and autumn. Sharks and rays contributed similarly to overall elasmobranch landings, with catch rates of sharks greatest during spring and those of rays greatest during summer. At these times, landings were dominated by triakid sharks (*M. henlei*, *Mustelus* spp.) and the shovelnose guitarfish (*R. productus*), respectively. Catch rates of elasmobranchs were lowest during autumn months in Baja California. Pronounced differences in seasonal catches were evident between survey years, probably as a result of highly variable interannual oceanic conditions (Schwing et al., 2002). For instance, in association with extensive warming during autumn 1998, *A. pelagicus*, a primarily tropical species, was one of the principal elasmobranchs landed. During autumn 1999, however, landings were dominated by sharks (e.g., *M. henlei*, *S. californica*) with temperate and subtropical distributions (Love et al., 2005), and *A. pelagicus* was rarely taken.

Geographic factors and a general lack of infrastructure limited the overall number and activities of fishing camps along the GOC coast of Baja California. Steep, desolate topography largely precluded the establishment of camps along major portions of the central and southern Baja California coast, and extensive shallow, intertidal sand and mudflats in the extreme north were largely unpopulated and unfished. Of the seventeen established camps, only four were associated with urban (San Felipe) or suburban (Bahía de los Angeles) centers. The remote nature and associated lack of infrastructure of most encampments restricted the potential range of targets and the marketability of catches. At rural sites, running water and electricity were not available and encampments largely consisted of corrugated tin dwellings with little or no common use facilities. One camp (BC–01) that was seasonally active and targeted large sharks (May–August) and small demersal elasmobranchs (Jan–Feb), was only accessible by boat. The long–term permanence of some smaller camps was probably variable, and coincident with localized areas of high fisheries productivity. For example, during July 1999, a group of fishermen from SIN–13 (Playa Destiny) established a temporary camp ("Campo Speedy's") nearby to exploit locally abundant sciaenids and batoids.

Artisanal fishermen in Baja California were highly opportunistic and temporal fluctuations in targets and fishing locations were common. Because ice was unavailable or inconsistently available in most rural encampments, and elasmobranchs could be reliably landed and processed for sale, most camps directly targeted elasmobranchs or targeted both demersal elasmobranchs and teleosts in mixed species fisheries. In areas with more infrastructure, teleosts (*Scomberomorus* spp., sciaenids, pleuronectids) and/or invertebrates (e.g., *Octopus* spp., penaeid shrimps) were primary targets during all seasons. Most fishermen targeted whatever locally abundant fauna could be landed with their gear (primarily gillnets) in shallow, shelf waters. Some fishermen, however, emigrated to southern Baja California from either Chiapas or Baja California Sur to fish large sharks at the Midriff Islands during summer and autumn. Targets differed seasonally, but generally remained similar between years with the following exceptions: 1) teleosts (e.g., serranids, gerreids, pleuronectids) were the primary targets in southern Baja California during 1998, whereas demersal elasmobranchs were primary targets during spring 1999, and 2) large sharks were fished until November of 1998, whereas only a summer fishery was active during 1999.

Among the primary state–wide fisheries in Baja California during the course of this study, the harvesting of *Sargassum* spp. was noted at BC–05 (Las Animas), but artisanal fisheries for sardines or tunas were not observed (CONAPESCA, 2003). Landings of mackerels ("macarela") in 1998 were the highest recorded during 1993–2003 (CONAPESCA, 2003), possibly corresponding to ENSO warming. Anecdotal evidence from this study suggested that artisanal landings of *Scomberomorus* spp. were more abundant and extensive during 1998, supporting the overall fishery trend. In addition to directed landings, elasmobranch bycatch was considerable by the artisanal fleet associated with San Felipe, specifically during sciaenid (spring), *Scomberomorus* spp. (summer), and shrimp (autumn) fisheries.

In addition to coastal artisanal fisheries, elasmobranchs are caught as bycatch in industrial trawl fisheries off the Gulf coast of Baja California. Deep water (30–281 m) trawl fisheries for hake (*Merluccius* spp.) incidentally capture and land substantial numbers of triakid sharks (*Mustelus* spp.) and rajids (*Raja* spp.) and probably represent a considerable source of mortality for these taxa (Pérez–Jiménez et al., 2005b; Castillo–Géniz et al., 2007). Similarly, small demersal sharks and rays are common bycatch in industrial shrimp and sciaenid trawl fisheries in the northern Gulf of California. Rays, especially, have long been taken as bycatch by shrimp trawlers throughout the GOC (Fitch and Schultz, 1978; Flores et al., 1995; Garcia–Caudillo et al., 2000), with mortality levels estimated to exceed those from directed fisheries (Márquez–Farías, 2002). Although not targeted by fishermen, whale sharks aggregate seasonally (May–December) in Bahía de los Angeles, where they support a developing ecotourism industry (Cárdenas–Torres et al., 2007; Rodríguez–Dowdell et al., 2007).

Field efforts were conducted during spring–autumn of both survey years, and results were largely representative of the amount and allocation of elasmobranch fishing effort at the time of surveys. Sufficient sample sizes were available to substantiate species composition of spring (1999), summer (1998, 1999), and autumn (1998) landings. Winter surveys, however, were not conducted because of financial and logistical limitations. Based on anecdotal evidence, artisanal fishermen in the northern part of the state generally fished sciaenids during winter months, but also targeted triakids in relatively deep (> 50 m) water. Small, demersal elasmobranchs were also targeted in southern Baja California camps during the winter, but the extent and activities of fishing operations were not determined.

The greatest numbers of active pangas observed in Baja California were reported from camps associated with the San Felipe sciaenid fishery during autumn months. Artisanal elasmobranch fishery efforts were, however, minimal during this fishery. The total number of pangas targeting elasmobranchs could not be reliably obtained for Baja California because only a subset of active camps were visited each season, camps were only visited for a brief period of time, and the total number of vessels targeting elasmobranchs was not consistently recorded at each camp. However, elasmobranch effort was notably greatest during summer when $\geq$ 50 vessels directly targeting elasmobranchs were observed among sampled locales, and considerably less during spring and autumn (~20–30 boats).

Detailed aspects of direct and indirect fisheries for elasmobranchs in Baja California are lacking, but some published information is available for comparison. Mariano–Mélendez and Villavicencio–Garayzar (1998) reported on the catch of an adult silvertip shark (*Carcharhinus albimarginatus*) at BC–03 (San Francisquito), but did not provide fishery details from this site. Artisanal elasmobranch fishing camps on the Gulf coast of Baja California have been generally referenced in recent literature (e.g., Pérez–Jiménez et al., 2005b; Bizzarro et al., 2007a), but specific camp names and locations were not provided. Artisanal fishing camps for teleosts along the Pacific coast of Baja California, however, have been documented (Rosales–Casián and Gonzalez–Camacho, 2003). In addition, a group of researchers from Scripps Institution of Oceanography and the Monterey Bay Aquarium are currently working with personnel at the Centro de Investigacion Cientifica y de Educacion

Superior de Ensenada (CICESE) to determine the locations and activities of artisanal elasmobranch camps in the same region. An artisanal blue shark fishery, active since the early 1990s, has already been documented on the Pacific coast of Baja California (Sosa–Nishizaki et al., 2002). Another group from the University of Arizona is currently documenting artisanal fisheries in the northern GOC and collecting biological information from landings as part of a Packard Foundation funded project ("PANGAS"). The historic information presented here should be useful for comparison with these contemporary studies.

The most common elasmobranchs in the Baja California fishery changed seasonally and, because fishermen were highly opportunistic, species composition of landings probably generally reflected actual local relative abundance. During the spring, a mixture of temperate and subtropical fauna (e.g, *H. mexicanus*, *Mustelus* spp., *M. californica*, *R. productus*) was prevalent among landings. The capture of female *R. productus* as they began their immigration to shallow coastal and insular waters was noted at this time and is a common practice among Mexican artisanal fishermen (Salazar–Hermoso and Villavicencio–Garayzar, 1999; Márquez–Farías, 2007). The relatively high catch rate of the most abundant group in spring landings, *Mustelus* spp., was also likely related to the targeting of schooling aggregations (Ebert, 2003). *Heterodontus mexicanus* was a common fishery target in the southern part of Baja California during the spring of 1999, but was rarely observed among other seasons. The effect of different oceanic conditions on interannual landings composition during summer and autumn was notable. Several tropically distributed species (e.g., *A. pelagicus*, *R. longurio*, *M. munkiana*) that were important fishery targets in summer and/or autumn 1998 were scarce during those seasons in 1999. During the summer, reproductive aggregations of *R. productus* typically reach their peak (Márquez–Farías, 2007) and catch rates of this species were the greatest of any elasmobranch taxon. Although published elasmobranch fishery information from the Gulf coast of Baja California is not available for comparison, Brusca et al. (2005) reported the occurrence of 58 elasmobranch species in the northern GOC, with no endemics. Of these, at least 32 were recorded from Baja California artisanal fishery landings during this study. It has been suggested that *A. vulpinus* does not occur in the GOC (Robertson and Allen, 2002); however, two individuals of this species were noted among autumn landings.

Although relatively small juvenile life stages of many species were common in Baja California landings, size records were documented for some species. Landings of most shark species, with the notable exception of the hammerheads, *S. lewini* and *S. zygaena*, consisted of size classes corresponding to adults or subadults (PSRC, 2004). Landings of the most abundant ray species in the Baja California fishery, *R. productus*, were primarily comprised of gravid adult females. Conversely, landings of two other common species (e.g., *M. californica*, *M. munkiana*) consisted largely of immature specimens (PSRC, 2004). New maximum sizes were documented for *M. longirostris* (97 cm DW) and *M. thurstoni* (215 cm DW) (Love et al., 2005). However, the *M. thurstoni* specimen greatly exceeded the largest previously known specimen (180 cm DW) and may have been misidentified. In addition, *R. velezi* exceeding the maximum reported size of 83 cm TL (Robertson and Allen, 2002) were probably observed. However, disc width (maximum = 70 cm), not total length, was measured for this species.

THE ARTISANAL ELASMOBRANCH FISHERY OF BAJA CALIFORNIA SUR

Introduction

Baja California Sur encompasses the lower portion of the Baja California Peninsula and is bordered to the north by Baja California. The total area of this state is 73,922 km^2 (INEGI, 2007a). Dormant or extinct volcanic mountains span the extent of Baja California Sur along the eastern margin of the state and are also located in central and southern regions (Gastil et al., 1983). The eastern faces of these mountains present a steep, cliff–like escarpment to the GOC, and a much more gradual slope westward (Wiggins, 1980). The climate of Baja California Sur is generally hot and arid; however, tropical storms originating in the Gulf of Tehuantepec occasionally reach southern Baja California Sur during summer and early autumn months, resulting in periodic heavy rains (Lankford, 1977).

Bordered by the Pacific Ocean to the west and south and the GOC to the east, mainland Baja California Sur contains 2,705 km^2 of coastline, the most of any Mexican state (INEGI, 2007b). Thirteen major offshore islands occur along the GOC coast, most of which were formed during the Baja Peninsula's separation from the mainland and are located off the central and southern portions of Baja California Sur (Lindsay, 1983). The largest of these islands are, from south to north, Espíritu Santo–Partida Sur (88 km^2), San José (187 km^2), and Carmen (143 km^2) (Carreño and Helenes, 2002). Coastal and insular shelves and terraces are absent or diminished in most regions of coastal Baja California Sur, with the notable exception of Bahía Concepción and Bahía La Paz. Outside these regions, the shelf is generally rocky and narrow (~ 5–10 km), with a sharp shelf break at approximately 200 m (Maluf, 1983). Within and adjacent to these embayments, the coastal regions are composed primarily of sandy substrates. Extremely deep water (> 1000 m) occurs within 20 km off the southeastern part of the state (Dauphin and Ness, 1991). The only river on the Baja

California Peninsula, the Rio Santa Rosalía, flows into the GOC at the town of Mulege, creating estuarine conditions.

Baja California Sur is sparsely populated, with an estimated 512,170 inhabitants, and includes many isolated regions (INEGI, 2007a). Human population growth in this state has been rapid, however, and the population increased 20.8% between 2000 and 2005. Most of the citizens of Baja California Sur live in the regions of La Paz (219,596) or Los Cabos (164,162) (INEGI, 2007a). Tourism is the primary industry in Baja California Sur, and these regions are the primary vacation spots for foreigners. The absence of consistent sources of fresh water and the characteristically rugged, desolate terrain has historically hampered attempts to colonize rural parts of Baja California Sur.

Baja California Sur is one of Mexico's most important states in terms of fishery production, accounting for 10.9% of landings and 5.4% of revenues during 2003 (CONAPESCA, 2003). These totals ranked third and seventh, respectively, among Mexican states. The most important fishery resources in Baja California Sur were, in order of descending landings during 1998–2003: sardines, squids, and tunas (CONAPESCA, 2003). In addition, Baja California Sur is the main source of abalone, clam, and lobster production. The primary fishery ports in Baja California Sur are Puerto San Carlos, on the Pacific coast, and La Paz, Loreto, and Santa Rosalía on the GOC coast.

Elasmobranchs landings averaged 2.9% of total fishery production in Baja California Sur during 1998–2003. Total landings during this period ranged from 3628–5459 t (CONAPESCA, 2003). Elasmobranch landings from Baja California Sur comprised 12.1% of national production during 2003 and averaged 12.8% of national production during 1998–2003. Sharks, especially "tiburón" (sharks > 1.5 m total length), comprised the majority of reported landings, with rays contributing an average of 26.3% by weight during 1998–2003 (CONAPESCA, 2003).

Materials and Methods

Baja California Sur was surveyed during spring, autumn, and winter of 1998 and during each season of 1999. Data were collected specifically from January 9–February 21, March 23–May 16, September 9–November 15, 1998, and January 15–February 25, March 3–May 15, June 2–29, September 11– November 13, 1999. Time spent at each camp was typically less than one day and most camps in Baja California Sur were visited sporadically within and among seasons (Appendix 2).

Results

Camp characteristics

A total of 83 artisanal fishing sites, broadly termed "camps," was documented in Baja California Sur during 85 survey days in 1998–99 (Table 6, Figure 5). However, directed elasmobranch fishing effort was observed at only 48.2% of these locations (n = 40). The remaining sites either did not target elasmobranchs (n = 9) or directed elasmobranch fishing efforts could not be determined (n = 34) at the time of the survey. Most fishing camps were active throughout the year (66.3%, n = 55). However, 15 camps were found to be occupied seasonally (18.1%) and the period of use could not be determined for 13 additional camps (15.7%). Fishing camps with little to no infrastructure were common in BCS (45.8%, n = 38). Lacking electricity or sources for water, fishermen from nearby towns or cities (e.g. La Paz, Loreto) lived at and fished from these camps for extended periods (e.g., BCS–34, BCS–

35, BCS–36, BCS–79, BCS–80). Fishing camps were typically established in remote locations, including islands (e.g., BCS–45, BCS–46). Thirty (36.1%) of the surveyed sites contained moderate infrastructure. Artisanal fishing activities were also observed in association with cities or larger towns (e.g., BCS–20, BCS–71, BCS–77). The number of active pangas ranged from one at several camps to approximately 450 at BCS–77, and varied seasonally. Artisanal fisheries identified in Baja California Sur were diverse and highly opportunistic. Camps or landing sites that exclusively targeted elasmobranchs were rarely identified (e.g., BCS–35).

Fishery characteristics

Among the 96 sampled vessels for which gear type and set (e.g., bottom, surface) details were available, bottom set gillnets were found to be the most common fishing method (38.5%) with surface set longlines observed only slightly less frequently (31.3%). Gear was typically soaked for 24 hours before retrieval. Details regarding gear length and depth of deployment were largely unavailable. Vessels often set two or more nets and occasionally used different gear types, such as traps and handlines, during the same fishing trip. Crews usually consisted of two individuals, but groups of 3 and 4 were also observed.

A diverse array of gear types was noted during the spring artisanal elasmobranch fishery. Among those vessels for which gear type and set was reported (n = 48), usage was as follows: 37.5% longlines set in the water column, 29.2% surface set longlines, 27.1% bottom set gillnets, 4.2% surface set gillnets, and 2.1% gillnets set in the water column. Mesh sizes ranged from 10.1–25.4 cm, with gillnets of approximately 20.3 cm observed most frequently. Fishing depths of bottom set gear ranged from 9–130 m, whereas surface and water column set gear was typically used over depths > 100 m.

Among the eight vessels surveyed during the summer fishery, surface set gillnets (37.5%) were most frequently recorded. Also noted were water column set longlines (31.3%), bottom set longlines (18.8%), and bottom set gillnets (12.5%). Surface set gillnets were constructed with mesh sizes of 25.4 cm.

During autumn surveys, bottom set gillnets (63.2%) were most commonly employed among vessels for which gear type and set were reported (n = 19). Mesh sizes of 10.2 cm, 12.7 cm, 20.3 cm, and 25.4 cm were noted. Surface (10.5%) and water column set (5.3%) gillnets were comprised of 30.5 cm mesh. Surface (15.8%) and bottom set (5.3%) longlines also were used.

Bottom set gillnets (52.4%) and surface set longlines (47.6%) were the only gear types observed among 21 pangas sampled during winter in Baja California Sur. A varied range of mesh sizes was recorded among gillnets, with 20.3 cm being most common. Two to four nets were reported from each panga. At BCS–15, longlines were set to target larger shark species over deep water (>100 m) near Isla Cerralvo.

Artisanal fisheries identified in Baja California were diverse and highly opportunistic. Activities, targets, and gear use changed seasonally within fishing camps and a diverse variety of organisms including teleosts, squids, and shrimps were often targeted from vessels in the same camp. An influx of fishermen, particularly from Chiapas, immigrated to some camps in Baja California Sur to target large sharks and pelagic rays during summer and autumn. Elasmobranchs landed in remote locations were typically filleted, salted, and dried as a method of preservation and sold for local (Baja California Sur) consumption (Appendix 2). Elasmobranchs were also directly consumed within fishing camps and were partially relied upon as a component of subsistence fisheries. Buyers often traveled to select camps to purchase salted or fresh elasmobranchs directly from the fishermen. Overall, markets for elasmobranchs were primarily associated with Baja California and Baja California Sur cities (e.g., Ensenada, La Paz, Loreto, Los Cabos), but also included Mexico City and the US. Skins and jaws of some sharks (e.g., *C. falciformis*) were occasionally retained and sold. At sites with more infrastructure, sharks and rays were typically dressed and sold fresh to local buyers or cooperatives. Typical ex–vessel prices were similar for teleosts and large sharks (\$10–\$20(MX)/kg). However, small sharks and rays were sold for considerably lower prices (≤ \$5(MX)/kg).

During 1998–1999, 972 specimens were recorded from directed elasmobranch fishery landings in Baja California Sur (Table 7). The majority of the documented specimens were sharks (71.3%), which dominated the landings of each season. The scalloped hammerhead, *Sphyrna lewini*, was the most frequently observed species (15.2%). However, three other species were similarly represented within the overall catch composition, the: blue shark, *Prionace glauca* (11.4%), Pacific sharpnose shark, *Rhizoprionodon longurio* (11.3%), and Pacific angelshark, *Squatina californica* (11.6%). Rays contributed 28.1% of the sampled landings and skates (i.e., *Raja velezi*) represented a minor component of the overall catch (0.2%). The pygmy devilray, *Mobula munkiana*, was the most commonly recorded batoid, comprising 8.6% of the total landings. No chimaeras were noted among Baja California Sur landings.

The shortfin mako shark (*Isurus oxyrinchus*), *P. glauca*, and *M. munkiana* were the most consistently observed species during the spring of 1998 and 1999 (Table 7). *Prionace* *glauca* comprised 48.0% of recorded landings in 1998. The spinetail devilray (*M. japanica*) also contributed notably (21.6%) to spring landings in 1998, but was absent from catches recorded during 1999. The most frequently observed species in the spring of 1999 were *R. longurio* and *M. munkiana*, which accounted for 31.7% and 17.2% of the sampled catch, respectively. Spring landings were diverse, consisting of at least 25 species, including the bigeye thresher shark (*Alopias superciliosus*), silky shark (*Carcharhinus falciformis*), oceanic whitetip shark (*C. longimanus*), dusky shark (*C. obscurus*), prickly shark (*Echinorhinus cookei*), *S. californica*, giant manta (*Manta birostris*), longtail stingray (*Dasyatis longa*), and Cortez stingray (*Urobatis maculatus*). The majority of sampling was conducted within two camps, BCS–15 and BCS–71. A sufficient number of vessels was sampled during spring 1999 ($t \geq 4.082$, $P \geq 0.05$), but not spring 1998 ($t < 4.082$, $P < 0.05$), to adequately characterize species composition of landings.

Summer catch composition was assessed only during 1999 from a total of eight pangas (Table 7). The whitesnout shark (*Nasolamia velox*) was the most abundant (54.3%) species among landings. Pelagic thresher (*A. pelagicus*) and blacktip (*C. limbatus*) sharks comprised 6.7% and 7.6% of observed summer landings, respectively. The shovelnose guitarfish, *Rhinobatos productus*, was the most commonly observed ray species (15.2% of landings). An insufficient number of vessels was sampled to adequately characterize species composition of summer 1999 landings ($t < 4.082$, $P < 0.05$).

A total of 198 specimens was identified from artisanal landings during autumn of 1998 and 1999 (Table 7). Catch composition was dominated by *S. lewini* (39.4%) and *S. californica* (28.2%) in 1998 and *C. falciformis* (44.6%) and *S. californica* (42.9%) in 1999. Autumn landings also included the only Galapagos (*C. galapagensis*), smalltail (*C. porosus*), and tiger (*Galeocerdo cuvier*) sharks that were recorded from Baja California Sur during the course of this study. Rays were more frequently recorded in 1998, when they comprised 22.5% of the overall sampled catch. Unidentified guitarfishes (*Rhinobatos* spp., 6.3%), the speckled guitarfish (*R. glaucostigma*, 4.9%), and the golden cownose ray (*Rhinoptera steindachneri*, 4.9%) were the most commonly represented ray taxa. An insufficient number of vessels was sampled to adequately characterize species composition of landings during autumn 1998 and 1999 ($t < 4.082$, $P < 0.05$).

Although sharks comprised the majority of sampled winter landings during 1998 (66.0%), the proportions of sharks (51.2%) and rays (46.9%) were more similar in 1999 (Table 7). The only skate species (*R. velezi*) observed among Baja California Sur artisanal catches was recorded from winter landings. The dominant species among 1998 landings was *S. lewini* (45.8%); however, it was recorded much less frequently during 1999 (5.1 %). Butterfly rays (*Gymnura* spp.) were also a substantial component of winter 1998 landings, comprising 22.9% of the total elasmobranch catch. The most commonly observed species in 1999 landings were *P. glauca* (24.5%), *M. munkiana* (15.3%), and *I. oxyrinchus* (13.3%). An insufficient number of vessels was sampled to adequately characterize species composition of landings during winter 1998 and 1999 ($t < 4.082$, $P < 0.05$).

Fishing effort was often opportunistic and directed toward multiple teleost and/or elasmobranch taxa. Fourteen species and 16 higher taxa of teleosts were recorded opportunistically from artisanal elasmobranch landings (e.g., *Makaira* spp., Gerreidae) (Table 8). Scombridae and Serranidae were the most commonly represented teleost families. Finescale triggerfish (*Balistes polylepis*) were frequently taken in association with demersal ray species and *S. californica* during all seasons, and were occasionally targeted using handlines after gillnets were set or retrieved. Billfishes (Istiophoridae) and dolphinfish (*Coryphaena hippurus*) were noted among landings from pelagic gillnet and longline fisheries.

CPUEs (mean ± SE) of sharks and rays were greatest during the summer fishery (Table 9). However, the lowest sampling effort was associated with this season (eight vessels) and the elevated catch rate of sharks was driven largely by the frequency of a schooling species, *N. velox* (7.1 ± 7.1), sampled from a single vessel. Spring surveys yielded the greatest number of vessels sampled. CPUE exceeded 1.0 for only two species, *R. longurio* and *P. glauca*, during spring months. Overall CPUE of rays was 1.6 ± 0.6 during spring. The highest individual catch rate during autumn was estimated for *S. californica* (3.0 ± 1.1). CPUE for rays did not exceed 0.5 for any species in this season. Winter catch rates were greatest for *S. lewini* (2.5 ± 1.3) and *Gymnura* spp. (1.2 ± 1.1). Total CPUE of rays from the winter (3.4 ± 1.5) was similar to the estimated summer maximum.

Species–specific size and sex composition were available for a subset of the total elasmobranchs recorded in the artisanal fishery. Specimens were often dressed prior to a vessel's arrival at camp and overall sampling time was limited to minimize interference with general fishing operations. Processing of specimens prior to examination occasionally required the use of alternative measurements such as pre–caudal length (PCL). Relatively broad size ranges were reflected among *I. oxyrinchus* and *R. longurio* (Table 10). Recorded landings of *S. zygaena* and *M. japanica* were primarily represented by relatively large individuals of these species.

A total of 56 *N. velox* was directly examined from artisanal fishery landings (Table 10, Figure 6a). The smallest and largest specimens were females, ranging from 66–121 cm stretched total length (STL). Average male size (82.1 ± 9.6 cm STL) was significantly less than that of females (92.4 ± 13.4 cm STL) (t = 3.292, P = 0.002). The number of females (n = 29) and males (n = 27) recorded from the landings did not depart significantly from a predicted sex ratio of 1:1 ($\chi^2_{0.05,1}$= 0.018, P = 0.897).

Sampled landings of *P. glauca* were dominated by males, representing 73.9% of the total (Table 10, Figure 6b). The observed sex ratio indicated a significant departure from a 1:1 relationship ($\chi^2_{0.05,1}$= 20.098, P < 0.001). Specimens ranged from 133–275 cm STL, and average size of males (199.1 ± 22.5 cm STL) and females (201.7 ± 23.0 cm STL) was similar within the landings (t = 0.4901, P = 0.625).

A limited size range of *S. lewini* was recorded among fishery landings, with catches consisting primarily of relatively small individuals (Table 10, Figure 6c). The 84 examined specimens ranged from 77–114 cm STL. The majority of sampled specimens were < 95 cm STL. Mean female and male sizes were similar, 88.1 ± 5.4 cm STL and 88.8 ± 5.6 cm STL, respectively (t = 1.66, P = 0.671). Likewise, the proportion of sexes was not significantly different from a 1:1 ratio ($\chi^2_{0.05,1}$= 0.964, P = 0.353).

The 36 female and 31 male *S. californica* examined from Baja California Sur artisanal fishery landings ranged from 62–93 cm STL, with females representing the largest and smallest specimens (Table 10, Figure 6d). Mean sizes of female and male were similar, however, and averaged 77.2 ± 5.9 cm STL and 77.5 ± 5.5 cm STL, respectively (t = –0.199, P = 0.843). No significant difference was detected in the proportion of females to males ($\chi^2_{0.05,1}$= 0.239, P = 0.653).

A broad size range of *M. munkiana* was observed among fishery landings (Table 10, Figure 7). Individuals ranged from 62–108 cm DW. The average size of males (91.9 ± 14.1

cm DW) was larger but did not significantly differ from that of females (86.5 ± 16.6 cm DW) (t = –1.305, P = 0.197). Males of 100–105 cm DW comprised the most common size class. The ratio of females (n = 20) to males (n = 37) differed significantly from a predicted sex ratio of 1:1 ($\chi^2_{0.05,1}$= 4.491, P = 0.036).

Discussion

More than half (56.5%) of all documented artisanal fishing sites in the Gulf of California were located in Baja California Sur. Directed elasmobranch fishing activities were extensive, but artisanal fisheries were diverse and highly opportunistic. Therefore, sites in Baja California Sur that exclusively targeted elasmobranchs were scarce. In addition, survey efforts were insufficient to adequately document the activities of many artisanal fishing sites and the species composition of most seasonal landings. Sharks numerically dominated sampled landings during all seasons, and were primarily represented by similar proportions of large (e.g, *P. glauca*; *I. oxyrinchus*) and small (*R. longurio*, *S. californica*) species. *Mobula munkiana* was the most abundant ray in overall Baja California Sur landings. Large sharks were fished using drift gillnets and, to a lesser extent, longline and handline gear, whereas small demersal sharks and rays were typically fished with bottom set gillnets.

Although the arid, mountainous landscape and a general lack of infrastructure resulted in the establishment of many remote fishing sites, they did not seem to restrict fishing effort in Baja California Sur. Encampments were located throughout the GOC coast, often concentrated near cities (e.g., Lorteo, La Paz) and/or regions of high fishery productivity. Teleosts (e.g., Lutjanidae, Serranidae) were the primary targets at most camps, with invertebrates (e.g., Teuthoidea) also commonly targeted. Both teleosts and squids were typically fished with handlines. In addition, many fishermen switched from artisanal fishing to sportfishing periodically, especially in tourist areas. Elasmobranch fishing efforts were greatest for large sharks during summer and autumn among surveyed camps. Rays and small sharks (especially *S. californica*) were fished throughout the year in a relatively small proportion of surveyed camps, with rays targeted more often during summer and small sharks more often during autumn–spring. The capture of squids (especially *Dosidicus gigas*), a primary commercial fishery in Baja California Sur during the course of this study, was widely noted using handlines during summer and autumn 1999. Artisanal fisheries for sardines or tunas, however, were not observed (CONAPESCA, 2003). Because relatively few camps were visited during each season and time spent at each camp was typically less than one day, the extent and activities of artisanal fishing operations in Baja California Sur may not be entirely representative of the actual conditions at the time of survey.

In addition to being artisanal fishery targets, elasmobranchs are common bycatch in the industrial drift net fishery for swordfish (*Xiphias gladius*) and purse seine fishery for yellowfin tuna (*Thunnus albacares*) (Mendizábel y Oriza et al., 2000). Both of these pelagic fisheries are substantial in Baja California Sur (CONAPESCA, 2003). Rays have also been reported as common bycatch in industrial shrimp fisheries off the Gulf of California coast of Baja California Sur (Fitch and Schultz, 1978). Sportfishing is a major industry in Baja California Sur and also represents a considerable source of mortality for large sharks in this region (Castillo–Géniz, 1992).

Field efforts were conducted during winter, spring, and autumn of 1998 and during all seasons of 1999. However, sufficient sample sizes were only available to substantiate species composition during spring 1999. The total number of pangas targeting elasmobranchs could not be reliably obtained for Baja California Sur because only a small subset of active camps were visited each season, camps were only visited for a brief period of time, and the total number of vessels targeting elasmobranchs was not consistently recorded at each camp. It is also likely that, because directed elasmobranch fisheries were documented at 82% of adequately surveyed sites, elasmobranch fishing effort may also be extensive among the 34 insufficiently surveyed sites.

Based on available data, the greatest elasmobranch effort (n = 23 vessels) was recorded during winter from a large shark fishery (e.g., *I. oxyrinchus*) at Punta Arenas (BCS–15). The greatest artisanal fishing effort witnessed in Baja California Sur during this study was directed at squid (*D. gigas*) during September 1999, with 570 vessels participating in the fishery from BCS–76 (n = 120) and BCS–77 (n = 450).

Detailed aspects of some elasmobranch fisheries in Baja California Sur are available for comparison with the results of this study. The artisanal shark fishery in Baja California Sur was described by Villavicencio–Garayzar (1996a), but specific camp locations were not provided. Several fishing sites targeting mobulids in the region of Bahía de La Paz, however, have been documented (BCS–14 to BCS–17, BCS–21, BCS–36, BCS–37) (Notarbartolo–di–Sciara, 1987, 1988; Villavicencio–Garayzar, 1991). Mobulid fisheries were noted at BCS–15 during spring, BCS–35 during spring and summer, and BCS–36 during winter of this survey. Additionally, on June 21, 2001, 12 pangas were observed targeting mobulids (especially *M. munkiana*) with 10–12” drift gillnets or harpoons at Punta Arenas (BCS–15) (Bizzarro, unpub.). An active fishery at San Ignacio lagoon was mentioned, but not described (Villavicencio–Garayzar and Abitia–Cárdenas, 1994; Villavicencio–Garayzar, 1996b). An angel shark (*S. californica*) fishery was previously documented at Aqua Verde (BCS–44) and remained active, at least during winter months (Villavicencio–Garayzar, 1996b). Other elasmobranch fishing sites were previously reported from the mainland or islands associated with Bahía de La Paz, most of which were inactive or not documented during this study (Klimley and Nelson, 1981; Mariano–Meléndez and Villavicencio–Garayzar, 1998). Artisanal fisheries for elasmobranchs also have been reported from the Pacific coast of Baja California Sur, with large sharks (e.g., *C. falciformis*, *P. glauca*, *I. oxyrinchus*) targeted at Las Barranchas, Punta Belcher, and Punta Lobos (Hoyos–Padilla, 2003; Ribot–Carballal et al., 2005) and rays targeted at Puerto Viejo and other camps in Bahía Almejas (Villavicencio–Garayzar, 1995; Bizzarro et al., 2007a; Smith et al., 2007).

Because relatively few specimens were sampled in Baja California Sur and the seasonal species composition of landings was not adequately represented, reliable inferences regarding the fauna of this region are limited. Overall, species richness was similar between groups. However, sharks were far more important to the fishery than rays. This observation was supported by official fishery statistics, as sharks constituted 74.9% of reported landings during 1998–2003 (CONAPESCA, 2003). Seasonal migrations of large pelagic sharks to the waters off southern Baja California Sur have historically supported substantial fisheries and may be one of the primary reasons for this trend (Villavicencio–Garayzar, 1996a). The coastal geography of Baja California Sur may also not be ideal for the establishment of ray fisheries. Fisheries for rays are typically centered in embayments and other insular waters, where rays tend to aggregate for breeding or feeding purposes (Bizzarro, 2005). These habitats are relatively sparse, however, along the mountainous Gulf coast of Baja California Sur. The two primary embayments on the Pacific coast of Baja California Sur, Bahía Almejas and Bahía Sebastian Vizcaino, have historically supported active ray fisheries (Villavicencio–Garayzar, 1995; Bizzarro, 2005; L. Castillo–Géniz, pers. obs.). Fisheries for rays were documented in Bahía La Paz and Bahía Concepción during this study, but were not extensively sampled. Conversely, large shark fisheries near La Paz were sampled with greater relative frequency, which may have biased overall catch composition estimates. Some large shark species that were previously noted in Baja California Sur shark landings (e.g., *C. brachyurus*, *S. mokkaran*, *Ginglymostoma cirratum*) were not observed during this study (Villavicencio–Garayzar, 1996a).

Among species with ≥ 50 sampled specimens in Baja California Sur, a mixture of adults and juveniles was observed. No size at maturity has been determined for *N. velox*, but maximum reported size is 150 cm total length (Compagno et al., 1995). The great majority of *N. velox* specimens landed in Baja California Sur were juveniles. However, mature males of 91 cm STL and 105 cm STL were noted. Blue shark (*P. glauca*) landings were primarily comprised of adult males, but several gravid females were also observed, especially during spring 1999. Similarly, most landed *M. munkiana* were adults. *Squatina californica* landings included a combination of subadult and adult sizes, whereas those of *S. lewini* were represented exclusively by juveniles. No size records were documented in Baja California Sur, but *M. japanica* (306 cm DW) and *M. munkiana* (108 cm DW) individuals approached maximum reported sizes of 310 cm DW and 110 cm DW, respectively (Notarbartolo–di–Sciara, 1988; McEachran and Notarbartolo–di–Sciara, 1995).

THE ARTISANAL ELASMOBRANCH FISHERY OF SONORA

Introduction

Sonora is bordered by the United States to the north, Chihuahua to the east, Sinaloa to the south, and shares its northwestern border with Baja California. Sonora is the second largest Mexican state, with a total area of 179,503 km^2 (INEGI, 2007a). Eastern Sonora encompasses the northwestern edge of the Sierra Madre Occidental mountains and has a mixed semiarid and subhumid climate. The arid but biologically diverse Sonoran Desert dominates the western part of the state. Low, scattered mountains and wide plains characterize this region (Encyclopedia Britannica, 2007).

Bordered by the GOC to the west, mainland Sonora contains 1208 km^2 of coastline (INEGI, 2007b). Three major islands occur off the central coast of Sonora (Lindsay, 1983), all of which were formed primarily by faulting. The largest island in the GOC, Isla Tiburón (1224 km^2) is situated < 2 km from the coast, whereas the other islands are much smaller (Isla Dátil, 1 km^2; Isla San Pedro Nolasco, 3 km^2), and occur considerably farther offshore (Carreño and Helenes, 2002). The continental shelf off Sonora is generally narrow and irregular and varies in width from ~5–70 km, with the widest regions present in the northern portion of the state and the narrowest found off Guaymas (Dauphin and Ness, 1991). Deep water occurs off Guaymas, where the expansive Guaymas basin reaches depths of ~ 2000 m. Coastal regions are composed primarily of sandy substrates, with extensive tidal sand and mudflats present in the extreme northern portion of the state. Coastal lagoons commonly occur in this region and the presence some large rivers (e.g., Rio Concepción, Rio Yaqui, Rio Mayo) creates punctuated estuarine conditions.

According to the 2005 census, Sonora has an estimated population of 2,394,861. Human population growth in this state has increased by 8.0% since 2000 (INEGI, 2007a).

The largest cities include Hermosillo (317,846), Ciudad Obregón (132,663), and the border region of Heroica Nogales (189,759). Eight Sonoran cities have populations > 50,000, but the great majority of the population lives in rural regions (INEGI, 2007a). An extensive irrigation system, established in the 1940s, has resulted in the widespread cultivation of agricultural resources in Sonora and has contributed to the development of most major urban centers (Encyclopedia Britannica, 2007).

Sonora is one of Mexico's most important states in terms of fishery production, accounting for 32.6% of landings and 19.2% of revenues during 2003 (CONAPESCA, 2003). These totals ranked first and second, respectively, among Mexican states. Sardines are the most important fishery resource in Sonora and landings from this state have accounted for 61.0% of national production since 1998. Shrimp and squid landings were of secondary and tertiary importance, respectively, during the same time period (CONAPESCA, 2003). Sonora was also the primary source of Mexican crab production during 1998–2003. Guaymas is the primary fishery port.

Elasmobranch landings averaged 1.0% of total fishery production in Sonora during 1998–2003. Total landings during this period ranged from 3051–5339 t (CONAPESCA, 2003). Elasmobranch landings from Sonora comprised 9.5% of national production during 2003 and averaged 12.1% of national production during 1998–2003. Sharks and rays contributed similarly to landings, with rays accounting for 51.3% by weight during 1998–2003 (CONAPESCA, 2003).

Materials and Methods

Sonora was surveyed during each season of 1998 and 1999. Data were collected specifically during March 9–14, June 13–August 28, September 1–November 18, December 14–17, 1998, and January 1– February 28, March 1–May 31, June 3–August 31, September 1–October 15, 1999. Survey efforts were divided among camps in 1998, with considerable effort focused at La Manga (SON–06) during summer and autumn and El Choyudo (SON–07) during autumn. During 1999, extended monitoring projects were established at El Choyudo and Bahía Kino (SON–09), and comparatively little data were collected from other camps (Appendix 3). Because *M. henlei* could be reliably distinguished from other local triakids, it was typically, but not always, identified to species. Therefore, the *Mustelus* species complex in this region (*Mustelus* spp.) may have included *M. albipinnis, M. californicus*, *M. dorsalis*, *M. henlei*, and/or *M. lunulatus*.

Tagging efforts were initiated during 1999 in waters off Bahía Kino and El Desemboque (SON–14). Fieldwork was directed from these camps because logistical support was readily available and preliminary data indicated a large number of juvenile coastal sharks among landings. All efforts were conducted with the assistance of local artisanal fisherman using 6–7 m fiberglass pangas outfitted with outboard motors. At Bahía Kino, a single fishing event occurred on the night of June 3, 1999. Gear consisted of a 400 m monofilament gillnet with a mesh size of 15.2 cm (6.0–inch standard stretch mesh). A total of 5 bottom sets were conducted with a total soak time of 45 minutes per set. The net was checked every 15 minutes for the presence of sharks. Tagging efforts at El Desemboque were carried out during November 17–21, 1999 using bottom set monofilament gillnets and bottom set longlines. Gillnets (262 m, 15.2 cm mesh size) and were soaked for approximately one hour. Each longline set contained either 400 or 450 hooks (#7 J–type) and was fished for approximately two hours. Longline bait was locally acquired bycatch from a shrimp trawling vessel and consisted primarily of lizardfish (Synodontidae) and croakers (Sciaenidae).

Captured sharks were identified, measured, weighed, and sexed. The following measurements were taken: precaudal length, fork length, total length, and stretched total length. Live sharks were tagged before release with a nylon–head plastic dart tag (Hallprint Pty Ltd, South Australia) inserted just below the first dorsal fin across the body midline, such that the tag head was firmly anchored in the cartilage and connective tissue below the fin. Tag legends were printed in both Spanish and English. The release condition of sharks was rated according to a scale used in previous shark tagging studies (Hueter et al., 2007).

Results

Camp characteristics

Nineteen artisanal fishing sites, broadly termed "camps," were documented in Sonora during 237 survey days in 1998 and 1999 (Table 11, Figure 8). Directed elasmobranch fishing effort was documented at 84.2% (n = 16) of the camps. The occurrence of elasmobranch fishing effort could not be verified at three sites (15.8%) during field surveys; SON–02, SON–11, and SON–18. The majority of the camps (57.9%, n = 11) contained moderate infrastructure and supported some level of fishing activity throughout the year. Only two seasonally active camps were visited (10.5%) and the period of fishing activity could not be determined for one site (SON–18). Three landing sites (15.8%) associated with large towns or cities (SON–04, SON–09, SON–16) contained significant infrastructure. Fifty or more active pangas were reported at 42.1% of the camps (n = 8). The greatest number of active pangas (n = 500) was observed at SON–18 during October 1998. Because elasmobranchs were not targeted at the time of the survey, this camp was not revisited. The number of operational fishing vessels recorded from each camp was highly variable among seasons and during the course of surveys. An influx of fishermen from the southern state of Chiapas who specifically targeted large sharks contributed notably to the observed variability in the number of pangas and elasmobranch fishing effort at several sites, particularly SON–05 and SON–06. Indirect take of elasmobranchs was common in both artisanal and industrial teleost and shrimp fisheries.

Fishery characteristics

Of the 1,789 sampled vessels for which gear type and set (e.g., bottom, surface) details were available, bottom set gillnets were found to be the predominant method employed in the artisanal elasmobranch fishery. Gear was typically soaked for 24 hours before retrieval. Vessels often deployed two or more nets and occasionally used different gear types such as longlines or handlines during the same fishing trip. Crews usually consisted of two individuals, but groups of three and occasionally four were observed.

The great majority of surveyed vessels in the Sonora spring fishery used bottom set gillnets (98.8%). Mesh sizes typically ranged between 8.9–33.0 cm, but those measuring 10.1–20.3 cm were most common. Surface set gillnets of 25.4 cm mesh comprised 0.2% of the gear used, as did gillnets in the water column. Net lengths of 300–2400 m were reported for gillnet gear. Mixed gear use, combining both gillnets and longlines, was observed among

0.8% of the vessels in the spring fishery. Fishing depths in excess of 100 m were reported, but gillnets were most commonly fished at depths of ~9–45 m.

Bottom set gillnets were also the dominant gear type used during the summer in Sonora. Among the 499 sampled pangas for which the fishing method and set were known, the following gear types were documented: bottom set gillnets (91.2%), surface set longlines (5.4%), surface set gillnets (1.6%), and combined gillnet and longline use (1.8%). Mesh sizes of 12.7 cm, 20.3 cm, and 33.0 cm were commonly observed among bottom set gillnets. Surface set gillnets were comprised of 25.4 cm or 33.0 cm stretch mesh. Fishing depths of bottom set gillnets were typically ~8–35 m. Surface set gillnets and longlines were deployed to target large shark species. Fishing for large sharks occurred in relatively deeper waters and often required travel in excess of 100 km. Soak times of 8–48 hours were reported, but gear was typically set for 24 hours.

Of the 385 vessels sampled in the autumn fishery for which gear use was known, 95.3% deployed bottom set gillnets. Several nets of differing mesh sizes (e.g., 7.6 cm, 12.7 cm, 15.2 cm) were often deployed from a single panga. Observed mesh sizes ranged from 8.9–33.0 cm. Bottom set gillnet lengths were typically estimated at 750–1200 m. Fishing depths of ~9–120 m were reported with most effort occurring between ~9–60 m. Surface set longlines (1.6%), surface set gillnets (0.5%), bottom set longlines (0.5%), gillnets set in the water column (0.3%), and combined gillnet and longline use (1.8%) were also noted among surveyed vessels.

During the winter fishery in Sonora, bottom set gillnets (86.2%) were used by most vessels. Bottom set longlines (8.6%), longlines set in the water column (3.5%), and surface set gillnets (1.7%) were also used. Mesh sizes of 8.9 cm and 21.6 cm and gear lengths of

200–1500 m were most frequently observed among bottom set gillnets. Fishing depths > 100 m were most frequently reported among the surveyed vessels, with estimated depths of gear deployment ranging between ~9–180 m.

Artisanal fisheries identified in Sonora were diverse and highly opportunistic. Activities, targets, and gear use changed seasonally within fishing camps and many fishes and invertebrates, including teleosts, bivalves, portunid crabs, and shrimps, were often targeted from vessels in the same camp. Elasmobranchs landed in remote locations were typically filleted, salted, and dried as a method of preservation and sold for local (Sonora) consumption (Appendix 3). Markets for elasmobranchs were primarily cities within mainland Mexico, but also included Tijuana, Mexicali, and the US. Skins and jaws of some sharks (e.g., *Carcharhinus falciformis*, *C. obscurus*) were occasionally retained and sold. At sites with moderate or significant infrastructure, sharks and rays were typically dressed and sold fresh to local buyers or cooperatives. Ex–vessel price of elasmobranchs (~$5–20(MX)/kg) and teleosts (~$6–28(MX)/kg) varied widely among species and seasons. Ex–vessel prices of penaeid shrimps ($60–110(MX)/kg) and bivalves ($100(MX)/kg) were the greatest reported for any taxa in this region.

Artisanal fishermen known as "guateros" acted as middlemen between the shrimp fishery and fish markets by purchasing elasmobranch bycatch from both trawlers and artisanal vessels and selling it to local buyers for a small profit. "Guateros" were notably active at SON–03, SON–07, SON–09, and SON–16 during October–March. The composition and extent of elasmobranch catches acquired in this indirect manner were not assessed, but small sharks and rays were among the most common bycatch observed in this fishery.

Rays dominated artisanal chondricthyan landings in Sonora, representing 63.4% of the total individuals recorded (Table 12). At least 23 species of shark, 18 species of ray, and two skate species were identified among 158,038 observed specimens. Additionally, the spotted ratfish (*Hydrolagus colliei*), a cartilaginous relative of the elasmobranch fishes, was also observed among artisanal landings. Higher order taxonomic categories (e.g., genus, family) were used for six shark, eight ray, and one skate taxa that were not identified to the species level. In contrast to the overall catch composition, sharks were the primary taxon identified from landings during 1998 surveys, totalling 80.9% of the specimens recorded in that year. However, the contribution of ray landings (65.8%) greatly exceeded those of sharks (33.6%) during more extensive fishery surveys in 1999. Although a greater number of species was reported among shark landings, only one species (*M. henlei*) and the broader complex of smoothhound sharks (*Mustelus* spp.) constituted more than 5% of total chondricthyan landings.

Among rays, the shovelnose guitarfish, *Rhinobatos productus*, was the primary species observed, accounting for 29.3% of the total catch (n = 46,331). Landings of the diamond stingray (*Dasyatis dipterura*), butterfly rays (*Gymnura* spp.), and golden cownose ray (*Rhinoptera steindachneri*) each comprised more than 5% of the observed total. In contrast, ratfish (<0.1%) and skates (0.5%) comprised a trivial proportion of overall chondrichthyan landings.

Rays comprised the majority of chondrichthyan landings recorded during spring, with *R. productus* dominating the catch (Table 12). The total proportion of *R. productus* landings (32.7%) exceeded that of the next five most abundant ray taxa (29.2%) during summer 1999: *Gymnura* spp., *R. steindachneri*, *D. dipterura*, speckled guitarfish (*R. glaucostigma*), and giant electric ray (*Narcine entemedor*). The brown smoothhound, *M. henlei*, was the most abundant shark species (28.9%) during spring 1999, with the Pacific angel shark, *Squatina californica*, also contributing notably to catch composition (1.3%). Skates (e.g., *Raja velezi*) and Mexican horn sharks, *Heterodontus mexicanus*, were observed most frequently during spring landings. The only bluntnose sixgill shark (*Hexanchus griseus*), broadnose sevengill shark (*Notorynchus cepidianus*), and California skates (*R. inornata*) documented in landings were observed during spring 1999. Interannual comparisons of spring catch composition were not possible because sample size and sampling duration were extremely limited during 1998. However, the only whitesnout guitarfish, *R. leucorhynchus*, observed in Sonora landings was recorded in spring 1998. A sufficient number of vessels was sampled to adequately characterize species composition of landings during spring 1999 ($t \geq 4.082$, $P \geq 0.05$), but not during spring 1998 ($t < 4.082$, $P < 0.05$).

Summer landings were composed primarily of rays, which totalled 77.9% and 94.2% of all chondricthyans recorded in 1998 and 1999, respectively (Table 12). *Gymnura* spp. (34.0%) and *R. steindachneri* (24.2%) dominated ray landings during the 1998 summer; whereas *R. productus* (52.8%) was the principal ray species observed during the summer of 1999. *Dasyatis dipterura* (15.3%), *R. steindachneri* (11.4%), and *Gymnura* spp. (8.0%) also contributed substantially to summer 1999 landings. Mobulid rays were observed most frequently among summer landings; however, identification of these individuals was frequently complicated by the processing of specimens prior to arrival at landing sites. The greatest proportion of silky (*C. falciformis*, 12.7%) and pelagic thresher (*Alopias pelagicus*, 1.4%) sharks recorded during Sonora surveys were encountered in the summer of 1998. Smooth hammerheads (*Sphyrna zygaena*) represented a relatively substantial component of shark landings during the summer of both survey years (1998 = 12.1%; 1999 = 19.3%). Bull (*C. leucas*), blue (*Prionace glauca*), and shortfin mako (*Isurus oxyrinchus*) sharks were only observed from summer artisanal fishery landings. A sufficient number of vessels was sampled from summer 1998 and 1999 to adequately characterize species composition of landings ($t \geq 4.082$, $P \geq 0.05$).

In contrast to spring and summer, the proportion of sharks was similar to or exceeded that of rays among autumn landings (Table 12). Sharks comprised 88.7% of all autumn 1998 chondrichthyan landings and 49.7% of those sampled in autumn of 1999. The majority of landings during autumn of both years was composed of smoothhound sharks (*Mustelus* spp., *M. henlei*). Pacific sharpnose (*Rhizoprionodon longurio*) and scalloped hammerhead (*S. lewini*) sharks were of secondary importance among shark landings during both survey years. The scalloped hammerhead, *S. lewini*, was also an important constituent of landings during autumn of both survey years. Several relatively large species were reported from a single autumn survey period (e.g. *A. pelagicus*, *C. falciformis*, 1998; *C. porosus*, 1999). Rays comprised only 11.3% of autumn landings in 1998 but contributed much more substantially to landings sampled in 1999 (50.1%). The only batoids comprising > 2% of 1998 landings were *R. productus* (5.0%) and *D. dipterura* (3.0%). Five taxa accounted for the great majority of ray landings during 1999: *D. dipterura* (20.1%), *R. productus* (9.6%), *Gymnura* spp. (7.7%), *R. steindachneri* (6.8%), and the California bat ray (*Myliobatis californica*, 3.0%). Mobulid rays were more commonly taken in autumn 1998 (1.3% of landings) than autumn 1999 (0.3%). A sufficient number of vessels was sampled to adequately characterize species composition of landings in autumn 1998 and 1999 ($t \geq 4.082$, $P \geq 0.05$).

Winter landings consisted primarily of *Mustelus* spp. (67.9%) and *R. longurio* (18.5%) (Table 12). *Mustelus henlei* (3.9%) and *S. californica* (3.3%) were also relatively common in winter landings, with the latter contributing its greatest seasonal proportion during this season. Winter surveys produced the only record of the horn shark (*H. francisci*) in Sonora. Rays were a comparatively minor component of winter landings, with *R. productus* (1.8%) and *Gymnura* spp. (1.1%) most commonly observed. The proportion of skates (0.8%) was similar to that observed in the spring. *Mobula* spp. were not reported from winter catches. A sufficient number of vessels was sampled during winter 1999 to adequately characterize species composition of landings ($t \geq 4.082$, $P \geq 0.05$).

Focused sampling efforts at SON–07 (El Choyudo) during the autumn of 1998 and all seasons of 1999 resulted in 82,075 elasmobranchs sampled from artisanal fishery landings (Table 13). As reflected in the overall catch composition from combined camps, rays comprised the majority (63.0%) of the observed species. Spring and summer catch composition was particularly dominated by rays, which accounted for 70.9% and 87.1%, respectively, of sampled landings. Within spring (37.9%) and summer (34.7%) landings, *R. productus* was the most frequently observed species. A second species of guitarfish, *R. glaucostigma*, and butterfly rays, *Gymnura* spp., were also prevalent within spring and summer landings at SON–07. Sharks were most abundant among autumn landings, accounting for 84.9% and 53.7% of the elasmobranch catch in 1998 and 1999, respectively. Smoothhound sharks (*M. henlei* and *Mustelus* spp.) were the primary component of shark landings in all seasons. During the summer, *R. longurio* also contributed notably to overall catch composition. Autumn 1999 ray landings were comprised primarily of *D. dipterura* (21.8%) and *R. productus* (12.6%). Winter catches were dominated by relatively similar proportions by *R. productus* (39.4%) and *Mustelus* spp. (35.3%); however, rays were more abundant overall and comprised 59.3% of the sampled catch.

Catch records from expanded sampling efforts at SON–09 (Bahía Kino) similarly reflected a preponderance of rays among artisanal fishery landings (70.0% of 63,881 documented chondrichthyans) (Table 14). Proportional differences between shark and ray catches were least disparate in autumn 1998 and spring 1999 landings, but rays exceeded 96 % of the total observed landings during the summer of 1998 and 1999 and autumn of 1999. In contrast, winter 1999 landings at SON–09 consisted primarily of sharks (96.7%). Spring landings were comprised mainly of *M. henlei* (34.4%), *R. productus* (26.7%), and *R. steindachneri* (13.5%). *Gymnura* spp., dominated summer 1998 landings (44.0%), but constituted less than 7.0% of the summer 1999 catch. Similarly, *R. steindachneri* and, to a lesser extent, *M. californica* were common in summer 1998 landings but were observed much less frequently in 1999. Summer 1999 landings were dominated by a single species, *R. productus* (60.4%), which contributed less than 4.0% to overall summer 1998 landings. Four ray taxa comprised > 90% of autumn landings; *D. dipterura* (29.4%), *Gymnura* spp. (25.5%), *M. californica* (19.1%), and *R. steindachneri* (16.5%). Winter catches consisted largely of smoothhound sharks, *Mustelus* spp., which encompassed 86.7% of sampled landings. Most abundant among spring and winter landings, triakid sharks (*M*ustelus spp., *M. henlei*) generated 24.3% of the overall elasmobranch catch at Bahía Kino.

Fishing effort was opportunistic and directed toward multiple species or groups. However, sampling efforts were focused at elasmobranch fishing sites, and other atisanal fisheries were not extensively documented. A total of 15 teleost species and three higher order invertebrate taxa was identified opportunistically from artisanal chondrichthyan landings (Table 15). An additional 12 groupings were assigned to teleost specimens that could not be identified to species. Scombridae was the most commonly represented teleost family among observed landings. Flatfishes (Bothidae, Paralichthyidae, Pleuronectiformes) and finescale triggerfish (*Balistes polylepis*) were frequently taken in association with rays during all seasons. Sierras (*Scomberomorous* spp.) were often identified among catches of rays and small sharks during the spring and autumn.

CPUE (mean $\pm$ SE) of sharks and rays differed considerably among seasons. Overall CPUE was greatest in the winter, primarily because of elevated catch rates of *Mustelus* spp. (70.3 ± 17.6) (Table 16). CPUE also exceeded 50.0 for combined shark species in autumn and combined ray species in spring and summer. The greatest calculated CPUE for a single species was obtained for *R. productus* during the summer (33.3 ± 6.0). Spring catch rates were greatest for *M. henlei* (23.1 ± 2.8) and *R. productus* (26.1 ± 2.0). During summer months, CPUE did not exceed 1.0 for any shark species. Greatest autumn CPUE was associated with *M. henlei* (26.1 ± 5.3). Catch rates of butterfly rays (*Gymnura* spp.) were > 5.0 during all seasons but winter CPUE estimates surpassed 5.0 for few other individual species during any season, including: *R. longurio* (autumn, winter), *S. lewini* (autumn), *D. dipterura* (summer, autumn), and *R. steindachneri* (summer, autumn).

The greatest CPUE rate calculated from the expanded sampling effort at SON–07 was obtained for the autumn fishery (Table 17). Total CPUEs for sharks and rays were 65.4 ± 8.3 and 48.8 ± 5.2, respectively at this time, and catch rates exceeded 10.0 for *M. henlei*, *Mustelus* spp., *R. longurio*, *D. dipterura*, and *R. productus*. Summer CPUE estimates represented the lowest combined seasonal value for sharks (5.9 ± 1.5) and second–lowest value for rays (40.8 ± 3.3). Summer catch rates were greatest for *R. productus* (16.3 ± 2.2) and *D. dipterura* (7.1 ± 1.6). The smallest observed CPUE for rays at SON–07 occurred during winter (32.8 ± 11.7). *R. productus* (21.8 ± 8.6) and *Mustelus* spp. (19.5 ± 18.2) were caught most frequently at this time. The greatest CPUE value for a single species was obtained for *R. productus* from the spring fishery (34.8 ± 2.2). Catch rates of *M. henlei* (24.3 ± 4.3), *Gymnura* spp. (10.8 ± 0.8), and *R. glaucostigma* (7.3 ± 0.6) were also comparatively greater during spring months. CPUE for *R. productus* was > 14.0 during each surveyed season.

Seasonal CPUE at SON–09 was greatest in the winter, primarily because catch rates of *Mustelus* spp. (108.1 ± 25.6) were the greatest reported for any taxon during this study (Table 18). Spring CPUE values of sharks were greatest for *M. henlei* (24.7 ± 4.0). CPUE of non–triakid sharks only exceeded 2.0 for *S. lewini* during the autumn (2.7 ± 1.6) and *S. californica* during the winter (5.3 ± 2.9). CPUE values for sharks were considerably less in the summer (2.9 ± 0.7) and autumn (5.2 ± 2.0). Total ray CPUE was greatest in the summer (92.0 ± 11.8) and lowest in the winter (2.9 ± 1.0). *Rhinobatos productus* generated the greatest CPUE value among rays, 55.8 ± 12.2 during the summer, and also exhibited the greatest catch rates among rays during spring (19.2 ± 3.8) at SON–09. Total autumn CPUE among rays was greatest for *D. dipterura* (20.0 ± 5.4), *Gymnura* spp. (17.4 ± 5.1), *M. californica* (13.1 ± 3.7), and *R. steindachneri* (11.2 ± 2.9). Skate and chimaera CPUE was negligible among seasons, but greatest during winter (1.1 ± 0.5 and 0.1 ± 0.1, respectively).

Species–specific size and sex composition were available for a subset of the elasmobranchs observed in the Sonora artisanal elasmobranch fishery. Specimens were often dressed prior to a vessel's arrival at camp and overall sampling time was limited to minimize interference with general fishing operations. Processing of specimens prior to examination frequently required the use of alternative measurements such as inter–dorsal distance (DD), body length (BL), or pre–caudal length (PCL). Relatively broad size ranges were reflected among individual *R. longurio*, *S. lewini*, *S. zygaena*, *S. californica*, *M. californica*, *R. productus*, and *R. steindachneri* (Table 19). Recorded landings of *A. pelagicus* and *C. falciformis* were primarily represented by relatively large individuals.

Male *C. falciformis* were significantly more common than females among artisanal landings in Sonora ($\chi^2_{0.05,1}$= 8.583; P = 0.004) (Table 19, Figure 9a). Specimens ranged from 90–268 cm stretched total length (STL), with females representing the smallest and largest specimens. Mean sizes of females and males did not differ significantly (U = 2785.5, P = 0.683), measuring 194.3 $\pm$ 27.2 cm STL and 194.7 $\pm$ 16.9 cm STL, respectively. Few specimens less than 160 cm STL were recorded.

Of the 63 *C. limbatus* examined, 31 were female (Table 19, Figure 9b). The observed proportion did not differ significantly from a 1:1 ratio ($\chi^2_{0.05,1}$= 0.000, P = 1.000). Specimens ranged from 62–244 cm STL. Mean sizes were also similar between sexes (t = –0.2823, P = 0.779), and most individuals were < 110 cm STL.

The recorded size composition of *M. henlei* ranged from 35–93 cm STL (Table 19, Figure 9c). Females (59.4 $\pm$ 10.4 cm STL) and males (58.0 $\pm$ 5.4 cm STL) were of similar sizes (U = 63,713.0, P = 0.168). Males, especially individuals of 55–59.9 cm STL, dominated landings. The observed proportion of sexes differed significantly from a ratio of 1:1 ($\chi^2_{0.05,1}$= 60.333, P < 0.001).

A broad and similar size distribution of female and male *R. longurio* was reflected in recorded landings from Sonora (Table 19, Figure 9d). Specimens ranged from 33–122 cm STL and size composition of females (86.4 $\pm$ 19.6 cm STL) and males (87.0 $\pm$ 15.2 cm STL) did not differ (U = 170,815.5, P = 0.329). Two modes were evident within the observed size frequency, the first concentrated at 65–69.9 cm STL and the second at 90–94.9 cm STL. The observed sex ratio did not differ significantly from an expected ratio of 1:1 ($\chi^2_{0.05,1}$= 3.590, P = 0.105).

Although female and male *S. lewini* > 200 cm STL were documented in landings, catches were comprised primarily of individuals < 100 cm STL (Table 19, Figure 9e). Females averaged slightly smaller lengths (82.7 $\pm$ 29.1 cm STL) than males (87.7 $\pm$ 42.5 cm STL). However, size composition did not differ significantly (U = 5609.0, P = 0.630). No significant difference was detected in the proportion of females to males ($\chi^2_{0.05,1}$= 0.236, P = 0.655).

Measured *S. zygaena* specimens ranged from 40–278 cm STL (Table 19, Figure 9f). Mean size of females (99.8 $\pm$ 53.6 cm STL) was greater than that of males (90.8 $\pm$ 46.4 cm STL), but mean length did not differ significantly (t = 1.212, P = 0.227). Most specimens taken in the fishery were < 80 cm STL. The proportion of females and males within the landings did not deviate significantly from a 1:1 ratio ($\chi^2_{0.05,1}$= 1.083, P = 0.319).

Female *S. californica* outnumbered males within sampled catches, which consisted primarily of individuals > 70 cm STL (Table 19, Figure 9g). Females (74.7 $\pm$ 15.3 cm STL) and males (78.7 + 13.4 cm STL) were of comparable sizes (t = 1.218, P = 0.226). The observed sex ratio represented a significant departure from a predicted relationship of 1:1 ($\chi^2_{0.05,1}$= 16.162, P < 0.001).

Dasyatis dipterura individuals measured 20–84 cm DW (Table 19, Figure 10a). Males > 60 cm DW were uncommon, and size composition differed significantly (U =

285,227.0, $P < 0.001$). The sex ratio of females (n = 881) to males (n = 540) also differed significantly from 1:1 ($\chi^2_{0.05,1} = 81.351$, $P < 0.001$).

The size composition of *M. californica* landings ranged from 33–100 cm DW, but consisted largely of specimens between 35–65 cm DW (Table 19, Figure 10b). Size composition of females (57. 6 $\pm$ 14.5 cm DW) was significantly larger than that of males (50.5 $\pm$ 7.1 cm DW; U = 1,104, $P = 0.026$). A total of 52 females and 33 males were examined. Although not statistically significant ($\chi^2_{0.05,1} = 3.812$, $P = 0.056$), the observed sex ratio of females to males (1.6) was considerably greater than 1:1.

The observed size range of *N. entemedor* (n = 414) was 14–82 cm BL (Table 19, Figure 10c). Females were significantly more abundant within the sampled landings, comprising 79.3% of the total number of individuals documented ($\chi^2_{0.05,1} = 140.292$, $P < 0.001$). Females were also significantly larger than males ($U = 9.797$, $P < 0.001$). A bimodal distribution was evident within the observed size range. Most specimens measured 15–25 cm BL or 40–60 cm BL.

Female *R. velezi* (60.7 $\pm$ 11.0 cm DW) were significantly larger than males (57.5 $\pm$ 7.1 cm DW; $U = 472.5$, $P = 0.014$) (Table 19, Figure 10d). A total of 52 individuals ranging from 31–76 cm DW was measured from Sonora landings. An equal number of females and males was recorded $\chi^2_{0.05,1} = 0.019$, $P = 0.894$).

Catches of *R. glaucostigma* ranged in size from 19–88 cm BL, but consisted largely of relatively small individuals (< 30 cm BL) (Table 19, Figure 10e). Mean size of males (39.1 $\pm$ 17.9 cm BL) was slightly, but not significantly larger than that of females (36.5 $\pm$ 17.3 cm BL; $t = 0.951$, $P = 0.343$). However, significantly more females (n = 240) were captured than males (n = 49) ($\chi^2_{0.05,1} = 124.913$, $P < 0.001$).

The size composition of the most commonly recorded ray in the Sonora fishery, *R. productus*, ranged from 16–105 cm BL (Table 19, Figure 10f). Average size of females (50.8 $\pm$ 20.9 cm BL) was significantly greater than that of males (31.8 $\pm$ 15.3 cm BL; U = 102,978.0, $P < 0.001$). The majority of male specimens measured < 25 cm BL. The proportion of females (n = 491) to males (n = 262) differed significantly from 1:1 ($\chi^2_{0.05,1}$= 69.036, $P < 0.001$).

The size and proportion of female and male *R. steindachneri* were similar within fishery landings (Table 19, Figure 10g). Size composition of females (62.7 $\pm$ 14.1 cm DW) and males (60.7 $\pm$ 11.4 cm DW) did not differ significantly (U = 101,219.5, P = 0.081). The number of females (n = 448) and males (n = 423) also did not depart significantly from a predicted sex ratio of 1:1 ($\chi^2_{0.05,1}$= 0.661, P = 0.441).

Landings of *Z. exasperata* were dominated by female specimens, which constituted nearly 70% of the observed total ($\chi^2_{0.05,1}$= 14.297, $P < 0.001$) (Table 19, Figure 10h). Measured individuals ranged from 21–88 cm BL, with the largest and smallest individuals represented by males. Females occurred most frequently in size classes < 35 cm BL. Size composition was marginally different between sexes (U = 1,425.5, P = 0.050)

Shark Tagging

Efforts to tag sharks during two dedicated trips were successful, but did not result in the capture and release of as many specimens as anticipated. At Bahía Kino (SON–09), a total of five gillnet sets resulted in the tagging of one young of the year *S. zygaena* (58 cm STL). At El Desemboque, a total of 15 longline sets resulted in the capture of 41 sharks. No sharks were captured in gillnet sets (n = 3) from this location. Of the 41 captured sharks, 28 were successfully tagged and released. These included: *M. henlei* (n = 24) and *R. longurio* (n = 4). Additionally, two *R. productus* were also tagged and released. No recaptures were documented. These modest results can be partially attributed to high winds at the time of sampling that prevented fishing activities during several days.

Discussion

By far the greatest fishing effort directed at rays and small sharks was documented in Sonora. Landings and effort were consistently elevated throughout the year not only at the monitored camps (SON–07, El Choyudo; SON–09, Bahía Kino), but also at several other fishing sites. Overall, relatively few camps were reported in Sonora, and large sharks were of comparably minor importance, with a limited summer fishery operating in the southern part of the state. Rays numerically dominated landings, and catch rates exceeded those of sharks during spring and summer months. *Rhinobatos productus* was the primary fishery target during these seasons. During autumn, small sharks, especially triakids (*Mustelus* spp., *Mustelus henlei*) were numerically dominant, but rays (especially *D. dipterura*) were also caught in large numbers. Winter landings in Sonora were principally composed of triakid sharks (*M. henlei*, *Mustelus* spp.), which exhibited the greatest seasonal catch rates of any elasmobranch taxa during this study.

Artisanal fishing sites in Sonora typically contained a large, but seasonally variable number of vessels and were active throughout the year. Therefore, although relatively few camps were noted, the overall fishing effort was considerable. Large portions of the south–central and northern coasts of Sonora contained no documented camps and few camps were located in close proximity. General fishery data were somewhat limited because few camps were revisited seasonally except during spring. However, diverse teleost (e.g., Lutjanidae, Pleuronectiformes, *Scomberomorus* spp., Serranidae,), invertebrate (e.g., *Octopus* spp., Penaeidae, Portunidae), and elasmobranch (rays, small sharks, large sharks) fisheries were documented. Among the primary state–wide fisheries in Sonora during the course of this study, the capture of shrimps and, to a lesser extent, squids were noted, but artisanal fisheries for sardines were not observed (CONAPESCA, 2003).

Fishing effort for small demersal sharks and rays in Sonora was the greatest observed for any state. Camps (e.g., SON–04, SON–07, SON–13, SON–16) with $\geq$ 40 vessels targeting these elasmobranch groups were recorded during each season. During summer 1998, an estimated 200 vessels targeted primarily batoids at SON–09, representing the greatest directed elasmobranch effort recorded during this study. Large sharks were primarily targeted by two camps (SON–05, SON–06) in the south–central part of the state during summer.

The importance of the ray fishery in Sonora was verified by the results of this study. However, landings of small sharks were also substantial, especially during periods of relatively cold water. Official landings data may have greatly underestimated actual landings of small sharks during 1998–1999. For example, CONAPESCA data ranks total Sonora "cazón" landings from 1998–1999 below those of Baja California, Baja California Sur, Sinaloa, and ten other states, indicating that only 2.5% of the national "cazón" catch was derived from this state.

The first large–scale shark fishery in Mexico was initiated from Guaymas during 1944 to target large sharks ("tiburón") for vitamin A (McGoodwin, 1976). During the mid 1970s, large sharks were still commonly targeted from this location (Compagno and Welton, 2003). However, fisheries for tiburón were not common during the course of this study and were not extensively sampled. The contribution of large shark landings from artisanal fisheries in Sonora during 1998–1999 is considerably less than would be expected from corresponding CONAPESCA landings and historic records, but data are not available for reliable comparisons.

In addition to being coastal artisanal fishery targets, elasmobranchs are common bycatch in industrial and artisanal shrimp fisheries in Sonora. The shrimp fishery in Sonora is the second largest in the country (CONAPESCA, 2003), and many artisanal and industrial vessels fish in coastal and inshore waters (Meltzer and Chang, 2006). Rays and, to a lesser extent, small sharks are captured incidentally and retained in these fisheries (Flores et al., 1995; García–Caudillo et al., 2000), with mortality levels estimated to exceed those from directed fisheries (Márquez–Farías, 2002). The Sonoran shrimp fishery catches a considerable proportion of non–target species and has recently exhibited a decline in catch rates (Meltzer and Chang, 2006). Shrimp trawling often occurs on nursery areas for rays and sharks, and may therefore represent a considerable source of mortality for typically vulnerable early life stages (Cailliet and Goldman, 2004).

Field efforts were conducted during spring–autumn of 1998 and during all seasons of 1999. Sample size of landings was determined to be sufficient to characterize species composition during summer and autumn of 1998 and during all seasons of 1999. The total number of pangas targeting elasmobranchs could not be reliably obtained for Sonora because only a small subset of active camps were visited during summer–winter, most camps were only visited for a brief period of time, and the total number of vessels targeting elasmobranchs was not consistently recorded at each camp. However, because camps were surveyed extensively during spring, a rough estimate of elasmobranch fishing effort is possible. Based on conservative estimates, > 200 and vessels targeted rays and small demersal sharks among surveyed camps during 1998 (n = 12), and > 250 such vessels were documented in 1999 (n = 10).

Detailed aspects of some direct and indirect fisheries for elasmobranchs in Sonora are available for comparison. The ray fishery, especially, has been recently afforded considerable attention in the scientific literature, primarily by Márquez–Farías. The extent and importance of ray landings from Sonora was first described in 2002 (Márquez–Farías, 2002), and further discussed in a more recent work (Márquez–Farías, 2007). Although the general location of the “main elasmobranch fishing camps” (i.e., SON–07–09) and other important elasmobranch fishing sites in Sonora (i.e., SON–05, SON–13–14) were indicated (Márquez–Farías, 2005; Márquez–Farías, 2007), they were not specifically named and described. SON–09 (Bahía Kino), however, was referenced as a primary collection site for a recent genetics study of *R. productus* (Sandoval–Castillo et al., 2004), and the locations and activities of SON–09 and SON–07 (El Choyudo) were described in a more recent work (Bizzarro et al., 2007a). The great majority of the data used in recent biological and fishery studies of elasmobranchs in Sonora was collected during field surveys for this project. Additionally, personnel from the University of Arizona are currently documenting artisanal fisheries in the northern GOC and collecting biological information from landings as part of a Packard Foundation funded project (“PANGAS”). The historic information presented here should be useful for comparison with these contemporary studies.

The most common elasmobranchs in the Sonora fishery changed seasonally and, because fishermen were highly opportunistic and the primary elasmobranch camps were extensively surveyed, species composition of landings probably reflected actual local relative abundance. As local waters warmed during the spring, fishery targets switched from *M. henlei* to *R. productus*. Catch rates of *M. henlei* were comparable at this time between SON–07 and SON–09, but considerably greater catch rates of *R. productus* were noted at SON–09. Massive vessel–specific CPUEs were documented for these species (*M. henlei* ≤ 1238, *R. productus* ≤ 675). Although *R. productus* overwhelmingly dominated summer landings in Sonora, catch rates were more than three times greater at SON–09 than SON–07, with vessel–specific CPUEs ≤ 1442 reported. Because most of the *R. productus* comprising the spring and summer fishery were gravid females and effort was considerable at SON–07 and SON–09, catch rates and total landings should be monitored at these sites for signs of overfishing.

Catch composition was similar between spring and summer 1999, and species with temperate, subtropical, and tropical distributions were noted during both seasons. However, summer species composition differed greatly between 1998 and 1999, probably as a consequence of highly variable interannual environmental conditions (Schwing et al., 2002, Márquez–Garcia, 2003). Taxa with extensive tropical distributions (e.g., *C. falciformis*, *R. steindachneri*) were relatively more abundant in summer 1998 landings. *Rhinobatos productus* landings were negligible during summer 1998, but comprised more than half of all specimens taken during 1999. A similar trend was noted for *R. productus* during 1998 and 1999 in Bahía Almejas. At this site, the immigration of gravid females and parturition occurred during spring 1998, but during summer in 1999, greatly influencing seasonal landings (Bizzarro, 2005). Variable interannual catch rates of *R. productus* have also been documented in association with previous ENSO conditions (Salazar–Hermoso and Villavicencio–Garayzar, 1999).

Species compositions of autumn and winter landings in Sonora were generally similar and were comprised primarily of triakid sharks. Autumn 1998 and winter 1999 landings were very similar, although the primary triakid target species may have differed between years. Although triakids remained the dominant taxon during autumn 1999, a much greater proportion of rays (e.g., *D. dipterura*, *R. productus*) was landed at this time. Temperature regimes and sampling periods were similar during autumn surveys (Márquez–Garcia, 2003), and catch composition of all autumn and winter surveys was adequately sampled. Differences in landings were probably attributable to variable relative abundance of the main elasmobranch target species in local waters. In fact, autumn catch rates of triakids at SON–07 and SON–09 differed markedly during both years, with relatively few landings reported at SON–09. SON–09 landings comprised a far greater proportion of overall Sonora landings during autumn 1999 then during autumn 1998, resulting in the observed seasonal variability in the relative proportion of triakid landings. The fishery at SON–09 changed dramatically during winter, however, and average CPUE of triakids (108.1) was the greatest recorded for any taxon during this study. Vessel–specific CPUEs of ≤ 551 were documented at this time. Only four vessels were surveyed at SON–07 during winter 1999, and SON–09 landings were primarily responsible for the observed state–wide trend.

Different species–specific life stages of sharks were targeted in Sonora, and a probable size record was noted for *N. velox*. Landings of *C. falciformis*, *M. henlei*, *R. longurio*, and *S. californica* consisted of a range of adult, subadult, and juvenile specimens. Landings of *C. limbatus*, and especially *S. lewini* and *S. zygaena*, were comprised largely of juvenile size classes corresponding to “cazón” (PSRC, 2004). One *C. limbatus* specimen of 250 cm STL, however, approached the maximum size reported for this species (Ebert, 2003). Although *N. velox* was rarely landed in Sonora, one individual probably represented a new size record (156 cm STL). However, different measurements were recorded for this and the largest previously recorded individual (150 cm TL, Compagno and Garrick, 1983), precluding a direct comparison.

Life stages of several ray species were difficult to reliably assess from Sonora landings because typical measurements of total length or STL were not generally recorded for guitarfishes (Rhinobatidae), *N. entemedor*, and *R. velezi*. Landings of *D. dipterura* and *M. californica* were largely comprised of juveniles, whereas landings of *R. steindachneri* contained the entire observed size range of this species in the GOC (Bizzarro et al., 2007a). *Rhinoptera steindachneri* individuals < 38 cm DW consisted of embryos aborted during the capture of gravid females that were landed and filleted for sale. The size composition of all rhinobatid rays and *N. entemedor* were bimodal. Although a considerable proportion of juveniles was evident among *R. glaucostigma* and *Z. exasperata* landings, the proportion of mature and immature *N. entemedor* and *R. productus* could not be reliably assessed. Because STL and total length are essentially equivalent for rhinobatids, an 88 cm STL *R. glaucostigma* specimen represents a size record for this species (85 cm STL; Amezcua–Linares, 1996). Size at maturity has not been established for *R. velezi*, but all males $\geq$ 57 cm DW and females $\geq$ 60 cm DW were mature and gravid specimens with egg cases were observed during mid–March. Size records of two poorly known urobatids were also documented: *U. chilensis*, 33 cm DW (26 cm DW; Robertson and Allen, 2002); *U. rogersi*, 34 cm DW (28 cm DW; Robertson and Allen, 2002).

THE ARTISANAL ELASMOBRANCH FISHERY OF SINALOA

Introduction

Sinaloa is bordered by Sonora to the north, Chihuahua and Durango to the east, and Nayarit to the south. The total area of this state is 57,377 km^2 (INEGI, 2007a). Inland Sinaloa consists largely of barren, coastal plains that abut the Sierra Madre Occidental mountains. Several large rivers (e.g., Rio Culiacán, Rio Fuerte, Rio Sinaloa) emanate from the highlands and flow to the GOC. The northwestern portion of Sinaloa is rather dry, whereas the rest of the coastal plains and foothills are more humid. The rainy season occurs during summer and early autumn, and tropical storm events occur periodically during this time (Encyclopedia Britannica, 2007).

Bordered by the GOC to the east, mainland Sinaloa contains 640 km^2 of coastline (INEGI, 2007b). No large offshore islands occur along the Sinaloa coast (Lindsay, 1983), although several barrier islands (essentially large sandbars) are present in association with embayments and insular waters. The continental shelf off Sonora is relatively wide, with the shelf break typically occurring > 50 km offshore. The shelf is widest off the southern portion of the state, where it may occur > 100 km from shore, and narrowest (~ 20 km) off Isla Altamura (Dauphin and Ness, 1991). Coastal regions are composed largely of sandy substrates. Lagoons, estuaries, and other insular waters occur extensively throughout the coastal region of Sinaloa.

The population size of Sinaloa was estimated at 2,608,442 in 2005. Human population growth in this state has remained relatively stable (2.8% annually) since 2000 (INEGI, 2007a). The many rivers of Sinaloa have carved broad valleys into the foothills of the Sierra Madre Occidental range, creating an expansive region of arable land. Consequently, Sinaloa has historically been the most important Mexican state in terms of agriculture and livestock production, and 34% of this state's land area is dedicated to these practices (Garcia and Falcon, 1993).

Sinaloa is one of Mexico's most important states in terms of fishery production, accounting for 15.5% of landings and 19.7% of revenues during 2003 (CONAPESCA, 2003). These totals ranked second and first, respectively, among Mexican states. The most important fishery resources in Sinaloa were, in order of descending landings during 1998–2003: tunas, sardines, and shrimps. Shrimp production is the greatest source of revenue among Mexican fishery resources, and Sinaloa landed more shrimp than any other Mexican state during 1998–2003 (CONAPESCA, 2003). The principal fishery port in Sinaloa is Mazatlán.

Elasmobranchs landings averaged 1.3% of total fishery production in Sinaloa during 1998–2003. Total landings during this period ranged from 1924–4459 t (CONAPESCA, 2003). Elasmobranch landings from Sinaloa comprised 13.0% of national production during 2003 and averaged 8.6% of national production during 1998–2003. Sharks, especially "tiburón" (sharks > 1.5 m total length), constituted the great majority of reported landings, with rays contributing an average of 11.3% by weight during 1998–2003 (CONAPESCA, 2003).

Materials and Methods

Sinaloa was surveyed during spring and autumn of 1998 and during all seasons of 1999. Data were collected specifically during March 2–8, October 1–7, 1998, and January 10–February 17, March 2–16, June 3–17, November 11–13, 1999. Camp locations and general fisheries information were collected almost exclusively during 1998. A few camps that directly targeted elasmobranchs (e.g., SON–14, SON–28) were revisited seasonally during 1999 (Appendix 4). Because of taxonomic confusion among *Narcine entemedor*, *N. vermiculatus*, *Diplobatis ommata*, and potential undescribed species in this region, all narcinid rays were identified to family (Narcinidae).

Results

Camp characteristics

During 53 survey days in 1998 and 1999, 28 artisanal fishing sites, broadly termed "camps," were identified in Sinaloa (Table 20, Figure 11). Directed fisheries for elasmobranchs were found at 78.6% (n=22) of these locations. Three sites, SIN–02, SIN–10, and SIN–25, were not found to support active fisheries for elasmobranchs and the occurrence of elasmobranch fisheries could not be verified at three additional sites (10.7%). Most fishing camps were active throughout the year (96.4%; n = 27). Fishing camps were typically well–developed, containing either moderate (n = 20) or significant (n = 5) infrastructure. The number of pangas actively involved in fishing operations at the time of the surveys ranged from 10 at SIN–18 and SIN–19 to approximately 500 operating from SIN–15. Seasonal variability in the number of active pangas was notable at several camps (e.g., SIN–01, SIN–12, SIN–28). The onset of the shrimp fishing season in September dramatically altered fishing operations and shifted effort among locations.

Fishery characteristics

Gear use during the spring fishery was diverse and included bottom set gillnets (12.7%), bottom set longlines (85.5%), and longlines that were weighted to fish in the water column (1.8%) among 55 sampled pangas. More than one net or longline was typically deployed from each vessel. Fishing depths ranged from 4–90 m. Soak times of longlines were often brief (< 2 hours), but were occasionally fished for ≤ 24 hours. Gillnets were most often soaked for 12–24 hours before retrieval. Mesh sizes of gillnets ranged from 7.6–20.3 cm.

Among 25 combined vessels for which gear use was known from summer (n = 23) and autumn (n = 2), bottom set gillnets were determined to be most widely used in the summer (87.0%) and longlines set in the water column were exclusively sampled during autumn. Bottom set longlines comprised the remaining 13.0% of the gear recorded during the summer. Bottom set gillnets and longlines were typically fished at ~11–30 m. Gillnet soak times varied from 15–24 hours. Mesh sizes measured 7.6–40.6 cm, with larger mesh sizes (e.g., 21.6 cm, 40.6 cm) most commonly observed.

All of the 96 vessels sampled during the winter used bottom set longlines. Fishing depths were infrequently recorded, but were reported to occur as shallow as 5–6 m and at depths of ≥ 45 m. Soak times and gear lengths were largely undocumented. Fishermen reported traveling 5–30 km to set gear.

Artisanal fisheries identified in Sinaloa were diverse and highly opportunistic. Activities, targets, extent of elasmobranch fishing effort, number of vessels, and gear use changed seasonally within fishing camps (Appendix 4). Markets for elasmobranchs were primarily located in cities within mainland Mexico, including Culiacán, Mazatlán, Mexico City, Acapulco, Los Mochis, and Guadalajara. Ex–vessel price of rays and small demersal sharks (~$10–18(MX)/kg) was rather consistent, whereas that of teleosts (~$3–20(MX)/kg) varied widely among species and seasons. Ex–vessel prices of shrimps were not documented, but prices of the clam, *Megapitaria squalida* (\$250(MX)/kg), and lobsters (Palinuridae, \$65(MX)/kg) were the highest reported for any regional taxa.

Seasonal catch composition in Sinaloa was assessed from 3690 total specimens (Table 21). Sharks comprised the majority of overall landings (65.1%), with rays contributing 34.9%. Skates and chimaeras were not documented from artisanal landings in Sinaloa. The scalloped hammerhead (*Sphyrna lewini*) was the most frequently observed species and was consistently represented in landings during all seasons, comprising 43.1% of the total recorded catch.

Spring landings were dominated by small sharks and, to a lesser extent, rays (Table 21). Few specimens (n = 12) were recorded in 1998, but the most common species among 1999 landings were *S. lewini* (45.4%), the speckled guitarfish, *Rhinobatos glaucostigma* (22.6%), the Pacific sharpnose shark, *Rhizoprionodon longurio* (16.1%), and the diamond stingray, *D. dipterura* (10.1%). The only blue shark (*Prionace glauca*) reported from Sinaloa was observed during spring 1999. A sufficient number of vessels was sampled to adequately characterize species composition of landings during spring 1999 ($t \geq 4.082$, $P \geq 0.05$), but not during spring 1998 ($t < 4.082$, $P < 0.05$).

Based on vessels sampled solely during 1999, summer landings were dominated by rays (87.7%) (Table 21). Six ray species and three taxa were recorded. The most frequently occurring species were the Pacific cownose ray, *Rhinoptera steindachneri* (50.1%) and *R. glaucostigma* (11.6%). Butterfly rays, *Gymnura* spp., accounted for 14.2% of all recorded elasmobranchs during the summer. The pygmy devilray (*Mobula munkiana*) and spotted eagle ray (*Aetobatus narinari*) were observed exclusively during this season. *Sphyrna lewini* was the only shark species to comprise > 5.0% of summer landings (5.4%). The only bull sharks (n = 2), *Carcharhinus leucas*, documented from Sinaloa surveys were reported from summer landings. An insufficient number of vessels was sampled during summer 1999 ($t < 4.082$, $P < 0.05$) to adequately characterize species composition of landings.

Autumn catch composition was described from only 11 specimens sampled during 1999 (Table 21). Most of these individuals were *S. lewini* (72.7%). No rays were reported during this sampling period. An insufficient number of vessels was sampled to adequately characterize species composition of autumn 1999 landings ($t < 4.082$, $P < 0.05$).

The great majority of 1,089 specimens recorded from winter 1999 landings in Sinaloa were sharks (89.1%) (Table 21). Included among these specimens was the only pelagic thresher shark, *Alopias pelagicus*, reported from Sinaloa. Elasmobranch landings were dominated by two species, *S. lewini* (54.4%) and *R. longurio* (27.4%), which accounted for more than 81% of the season's total catch. *Spyrna zygaena* represented an additional 6.4% of winter landings. Catches of rays were primarily composed of *D. dipterura* (8.2%) and *R. glaucostigma* (1.8%). A sufficient number of vessels was sampled during winter 1999 to adequately characterize species composition of landings ($t \geq 4.082$, $P \geq 0.05$).

Artisanal fishing effort was often opportunistic and directed toward multiple species. Groupers and sea basses (Serranidae), as well as snappers (Lutjanidae), were frequently taken in combination with elasmobranchs in Sinaloan longline fisheries (Table 22). Croakers (Sciaenidae) and catfishes (Ariidae) were often captured in association with sharks and rays in the bottom set gillnet fishery. Invertebrates landed incidentally by pangas targeting elasmobranchs included shrimps (Dendrobranchiata, typically Penaeidae) and lobsters (Palinuridae).

Overall CPUE (mean $\pm$ SE) in Sinaloa was greatest during spring (29.9) and at a minimum (5.5) in autumn (Table 23). CPUE estimates for sharks were greater than those of rays during all seasons except summer. The greatest catch rates observed in the spring fishery were associated with *S. lewini* (13.6 ± 2.5). This rate represents the greatest species–specific seasonal CPUE among Sinaloa landings. CPUE values exceeding 1.0 were obtained for three additional species during spring: *R. glaucostigma* (6.7 ± 3.8), *R. longurio* (4.8 ± 1.4), and *D. dipterura* (3.0 ± 1.0). Three taxa, *R. glaucostigma*, *R. steindachneri*, and *Gymnura* spp. largely accounted for the elevated CPUE of rays in the summer. Of these, the catch rate was greatest for *R. steindachneri* (11.1 ± 3.5). CPUE exceeded 1.0 for only one shark species, *R. longurio* (1.2 ± 0.7), during summer months. No rays were observed among catches sampled during autumn and CPUE for *S. lewini* (4.0 ± 4.0) was the greatest observed for a species in this season. CPUE exceeded 1.0 for only two species in the winter, *S. lewini* (6.2 ± 1.0) and *R. longurio* (3.1 ± 0.5).

Species–specific size and sex composition were available for a subset of the total elasmobranchs recorded in the Sinaloa artisanal fishery (Table 24). Specimens were occasionally dressed prior to offload and overall sampling time was limited to minimize interference with general fishing operations. Sampled specimens consisted primarily of relatively small or mid–sized individuals of most species. A full size range of individuals was observed only for *R. longurio*.

More female (n = 324) than male (n = 266) *R. longurio* were examined from fishery landings, indicating a significant difference from an expected sex ratio of 1:1 ($\chi^2_{0.05,1}$= 5.507, P = 0.021). The observed size composition was bimodal, with peaks occurring from 65.0–74.9 cm and 85–99.9 cm stretched total length, STL (Figure 12a). The smallest and largest specimens measured 30 cm and 125 cm STL, respectively (Table 24). Average female size was 91.6 $\pm$ 17.2 cm STL. Mean male length was slightly smaller (89.4 $\pm$ 14.5 cm STL). Observed differences in STL were determined to differ significantly between the sexes (U = 47,452.50, P = 0.034).

With the exception of several large specimens that exceeded 200 cm STL, the great majority of *S. lewini* examined from fishery landings measured < 100 cm (Table 24, Figure 12b). Female *S. lewini* comprised the largest and smallest individuals recorded for this species, ranging from 35–245 cm STL. Females and males averaged 85.9 $\pm$ 12.0 cm STL and 86.8 $\pm$ 12.9 cm STL, respectively. Variances were not found to be equal and non–parametric a Mann–Whitney test indicated that the size of landed females differed from that of males (U = 257,789.00, P = 0.002). The observed proportion of females and males differed significantly from a 1:1 ratio ($\chi^2_{0.05,1}$= 14.458, P < 0.001), with females much more commonly observed among sampled landings.

Female and male *S. zygaena* ranged from 86–155 cm STL (Figure 12c, Table 24). The majority of the 85 specimens sampled, however, measured from 100–120 cm STL. No significant difference was found between mean sizes of females in males (t = 0.484, P = 0.630). The proportion of females and males within landings did not deviate significantly from a 1:1 ratio ($\chi^2_{0.05,1}$= 0.424, P = 0.522).

A total of 178 *D. dipterura* was directly examined from Sinaloa artisanal fishery landings. These specimens ranged from 34–76 cm DW (Table 24, Figure 13a). Females averaged 54.5 $\pm$ 9.1 cm DW, whereas males averaged 48.0 $\pm$ 4.6 cm DW. These differences in size were found to be statistically significant (U = 5909.00, P < 0.001). The number of females (n = 97) and males (n = 81) did not differ significantly from a predicted sex ratio of 1:1 ($\chi^2_{0.05,1}$= 1.264, *P* = 0.267).

Female *R. glaucostigma* were considerably larger than males in artisanal fishery landings (Table 24, Figure 13b). Mean STL of males was 57.4 $\pm$ 7.2 cm, whereas female STL averaged 72.2 $\pm$ 7.3 cm. Females were much more prevalent among the sampled landings, comprising 418 of the 491 specimens measured. A significant difference was detected between the mean STLs of females and males (*t* = 1.965, *P* < 0.001). The observed (5.7:1.0) and expected (1.0:1.0) ratio of females to males differed significantly ($\chi^2_{0.05,1}$= 241.010, *P* < 0.001).

More male (n = 105) than female (n = 26) *R. steindachneri* were reported among specimens from Sinaloa, resulting in a sex ratio that differed significantly from 1:1 ($\chi^2_{0.05,1}$= 46.443, *P* < 0.001) (Table 24, Figure 13c). However, observed mean sizes were similar between the sexes, with females averaging 72.3 $\pm$ 7.6 cm DW and males averaging 72.1 $\pm$ 9.7 cm DW (*t* = 1.978, *P* = 0.896). Individuals of combined sexes ranged from 54–89 cm DW.

Discussion

Several artisanal fishing sites were located in Sinaloa, and most supported elasmobranch fisheries for small demersal sharks and, to a lesser extent, rays. Seasonal variability in effort was considerable, however, and many fishermen switched targets from elasmobranchs to shrimp during early autumn. Landings data from Sinaloa were limited, especially during 1998 and autumn 1999, thus the assessment of elasmobranch fishing activities was incomplete for this state. Small sharks and rays were fished primarily with bottom set gillnets, but longlines were also used. Large sharks were not generally targeted among surveyed camps. Juveniles of large species (e.g., *S. lewini*, *S. zygaena*, *C. limbatus*), however, were commonly reported in landings. Sharks comprised the majority of overall landings and of seasonal landings during autumn, winter, and spring. In each of these seasons, *S. lewini* landings were dominant ($\geq$ 54%), and those of *R. longurio* were of secondary importance. Catch rates of sharks were greatest during spring and lowest during autumn. Ray landings, comprised primarily of *R. steindachneri*, were most abundant in summer.

The great majority of camps in Sinaloa was associated with urban or suburban centers and active throughout the year. Coincidentally, fishing effort was considerable at most sites, especially when compared to camps on the Baja Peninsula. Most fishing sites were concentrated in the northern part of the state, with considerably fewer camps and less effort in southern Sinaloa. General camp–specific fishery data were somewhat limited and the only comprehensive information available was for spring and autumn 1998. Teleosts (e.g., Mugilidae, Sciaenidae, Ariidae) and small sharks (e.g., *S. lewini*, *R. longurio*) were the primary fishery targets during spring 1998. At this time, fishing effort directed at elasmobranchs was considerable, and 12 of 27 surveyed camps targeted primarily small sharks and/or rays. Effort among these camps ranged from 14–80 vessels. Penaeid shrimps were the principal fishery targets at eight of 12 camps surveyed during autumn 1998. Secondary fisheries for small sharks and rays were reported at several sites during autumn 1998, but elasmobranch fishing effort was diminished when compared to spring. A directed fishery for *R. steindachneri* was also documented at SIN–15 during summer months. At this time, *R. steindachneri* was captured with bottom set gillnets for use as bait in a local portunid crab fishery. Among the primary state–wide fisheries in Sinaloa during 1998–1999, an extensive artisanal shrimp fishery was noted during autumn. However, artisanal landings of tunas and sardines were not observed (CONAPESCA, 2003).

In addition to being artisanal fishery targets in Sinaloa, elasmobranchs are commonly caught incidentally and retained for sale in industrial fisheries. Large pelagic sharks are typical bycatch of a substantial pure–seine fishery for yellowfin tuna (*Thunnus albacares*) that operates off Sinaloa (Mendizábel y Oriza et al., 2000, CONAPESCA, 2003). The shrimp fishery in Sinaloa is the largest in the country and is centered in Mazatlán (CONAPESCA, 2003; Meltzer and Chang, 2006). Both industrial and artisanal shrimp fisheries are active. Rays and, to a lesser extent, small sharks are captured incidentally and retained in these fisheries (Flores et al., 1995; Garcia–Caudillo et al., 2000), with mortality levels possibly exceeding those from directed fisheries (Márquez–Farías, 2002). Shrimp trawling often occurs on nursery areas for rays and sharks, and may therefore represent a considerable source of mortality for typically vulnerable early life stages (Cailliet and Goldman, 2004).

Field surveys were conducted during spring 1998 and during all seasons of 1999. Sample size of landings was determined to be insufficient to characterize species composition during all surveys but spring 1999 and winter 1999. The total number of pangas targeting elasmobranchs could not be reliably obtained for Sinaloa because only a small subset of documented camps was visited during summer–winter; most camps were only visited for a brief period of time, and the total number of vessels targeting elasmobranchs was not consistently recorded at each camp. However, because camps were surveyed extensively during spring, an estimate of elasmobranch fishing effort is possible. Based on a conservative estimate from surveyed camps (n = 22), > 250 vessels targeted small demersal sharks and rays during spring 1998.

Published information detailing elasmobranch fisheries in Sinaloa is scarce, but some graduate theses are available for comparison. Most historic elasmobranch research was centered around Mazatlán, especially at SIN–04 (Playa Sur). Biological (Castillo–Géniz, 1990) and fishery (Saucedo–Barron et al., 1982; Rodríguez–Garcia, 1986; Righetty–Rojo and Castro–Morales, 1990) studies were conducted from landings at this site. Landings from Playa Sur were sampled during January–March 1999 of this study, and consisted primarily of small demersal sharks (e.g., *S. lewini*, *R. longurio*). A thesis concerning an industrial fishery for pelagic sharks that reached southern Sinaloa and biological aspects of the primary landings (reported as *A. vulpinus* and *C. limbatus*, actually *A. pelagicus* and *C. falciformis*) was completed by Mendizábal y Oriza (1995) and later published (Mendizábal y Oriza et al., 2000). The summer *R. steindachneri* fishery at SIN–15 was recently detailed by Bizzarro et al. (2007a), using data derived from this study. A master's thesis was also produced from the biological and fishery data collected in Sinaloa during the course of this study (Ocampo–Torres, 2001).

Although catch composition of landings could not be reliably determined for all seasons in Sinaloa, sampling was adequate to formulate reliable inferences about the faunal characteristics of elasmobranchs during spring and winter. Tropically and subtropically distributed species dominated landings of sharks and rays, with no species of primarily temperate distributions reported (Love et al., 2005). Effects of interannually variable oceanic conditions could not be assessed in Sinaloa because only 12 specimens were sampled during 1998. The elasmobranch fishery targeted primarily cazóñ during winter and spring 1999, but triakids although previously reported as a minor component of the Sinaloa cazón fishery (Rodríguez–Garcia, 1986; Righetty–Rojo and Castro–Morales, 1990), were noticeably absent from landings. Instead, *S. lewini* was primarily targeted, with *R. longurio* and, to a lesser extent, *S. zygaena*, also contributing substantially to cazón landings. Although catch rates of *S. lewini* and *R. longurio* were greater during spring than winter, they were considerably lower than spring CPUEs for cazón in the Baja California and Sonora triakid fishery. Cazón comprised a larger proportion of the total catch during winter than spring.

During spring, *R. glaucostigma* was the second most important species in the fishery, whereas landings of the most abundant ray species during the winter (*D. dipterura*) constituted only 8.2% of the catch. Catches during winter and spring were comprised largely of the five previously mentioned species, with little overall diversity evident in landings. In contrast to spring and winter fishery characteristics, summer landing of rays far exceeded those of sharks, with *R. steindachneri* comprising more than half of the total catch, and *Gymnura* spp. and *R. glaucostigma* also contributing substantially. Although the summer trend of increased ray importance was also documented in Baja California Sur and Sonora, low sample size precludes definitive conclusions from Sinaloa.

Landings from SIN–04 (Playa Sur) comprised the majority of the sampled catch during winter and a substantial portion of the catch during spring. An active winter and spring cazón fishery primarily targeting small *S. lewini* and a broad size range of *R. longurio* has been previously documented at Playa Sur (Saucedo–Barron et al., 1982; Rodríguez–Garcia, 1986; Castillo–Géniz, 1990; Righetty–Rojo and Castro–Morales, 1990). The primary targets of this fishery remained consistent, but the targeted size class of *S. lewini* appears to have shifted to smaller specimens (Saucedo–Barron et al., 1982), and a greater proportion of

S. lewini was noted during this study than was generally observed from prior studies. Large sharks (> 2 m) comprised a very small proportion of overall landings from Sinaloa. Although large sharks were never a primary component of the historic fishery, their contribution was reduced during this study, and several previously documented species (e.g., *C. falciformis*, *G. cuvier*, *I. oxyrinchus*, *S. mokarran*) were not observed. In addition, *A. pelagicus* was a common commercial species off Mazatlán during 1986–1987, but only a single specimen was reported among contemporary artisanal landings (Mendizábal y Oriza, 1995). Although the total tiburón catch has steadily increased since the mid–1980s, and reached its greatest total during 2003 (CONAPESCA, 2003), this trend is not supported by artisanal fishery results from this study. It is believed that artisanal fisheries for large sharks have considerably declined in this region (L. Castillo–Géniz, pers. obs.), but a lack of catch data during autumn and summer or interannual replication preclude definitive conclusions.

Elasmobranch landings from the Sinaloa fishery were comprised of adult size classes of most species, and a new maximum size was determined for *R. glaucostigma*. Size composition of *R. longurio* landings indicated a bimodal distribution consisting primarily of adult specimens. In contrast, only juveniles of both hammerhead species, *S. lewini* and *S. zygaena*, were observed in landings. Among rays, *D. dipterura* landings consisted primarily of adults and subadults. Landings of *R. steindachneri* were similarly distributed, but contained a greater proportion of relatively large (≥ 75 cm DW) individuals. Size at maturity is unknown for *R. glaucostigma* and most landed specimens were not inspected for reproductive condition. However, females of 75 cm STL and 76 cm STL with mature ova were reported, and the previously reported maximum size (85 cm total length; Amezcua–Linares, 1996) was exceeded (89 cm STL).

Overall Results and Conclusions

Camp characteristics

Directed elasmobranch fishing effort was observed in 90 of the 147 camps (61.2%) documented in Baja California, Baja California Sur, Sonora, and Sinaloa during 1998–1999 (Figure 14). The activities of 42 (28.6%) camps remain unknown, and it could not be determined during the surveys if elasmobranchs were targeted from these sites. Elasmobranchs were not targeted at 15 (10.2%) of the camps.

Differences among elasmobranch fishing camps along the Baja peninsula and those of the mainland (Sonora and Sinaloa) related primarily to the level of development and number of people occupying the sites. Rugged volcanic terrain and very limited fresh water resources inhibit the expansion and growth of settlements along much of the Baja California and Baja California Sur coastlines. Many of the sites surveyed on the Baja Peninsula lacked running water or electricity, and are best described as fishing camps. Fishing often represented the sole activity that was occurring at those locations. In contrast, most of the sites surveyed in Sonora and Sinaloa had direct access to improved roads, fresh water, and electricity. In these areas, fishing primarily occurred within small villages or towns. Smaller fishing camps were not completely absent in Sinaloa and Sonora, but were restricted to more remote locations, such as islands and northern Sonora. Due in part, to more extensive development in Sonora and Sinaloa, it is likely that the number of artisanal camps identified represents an underestimate of the total camps operating in these regions. Improved infrastructure and larger towns enabled fishermen to commute. In some cases, pangas were secured in sheltered estuaries that served only as launching and landing sites. These catches were immediately received by buyers or transported to local markets upon landing.

Identifying these landing sites during surveys was problematic and beyond the scope of survey efforts in Sinaloa and Sonora, which were focused on describing the primary artisanal fishing camps and collecting biological information from landed specimens.

Among all states, the great majority of artisanal elasmobranch fishing camps were active year–round (73.5%, n = 108). Only 23.1% (n = 34) of the total camps surveyed were limited to seasonal use, and nature and extent of fishing activities could not be verified for five camps. Additionally, surveys were conducted on only a few nearshore islands (e.g., BC–10, BCS–45, BCS–46, SIN–17), but fishermen reported seasonal camps and cleaning stations in use on many islands, particularly during the summer. It is likely that seasonal use of camps may be somewhat more frequent than suggested by our initial surveys.

Mexico's artisanal elasmobranch fishery is extensive, accounting for approximately 40% of total national shark production (Diario Oficial de la Federación, DOF, 2007) and the majority of batoid landings (Márquez–Farías and Blanco–Parra, 2006). Within the surveyed artisanal fishing camps of Baja California, Baja California Sur, Sonora, and Sinaloa, at least 2840 pangas were estimated to be active based on the minimum number of pangas observed in each camp. The majority of these vessels was recorded from Sinaloa (53%) and Sonora (32%), with the fewest active pangas recorded from Baja California (5%). Although it is tempting to make projections of the number of vessels involved in the elasmobranch fishery based on these observations, doing so would represent an unnecessary over–extension of these data and is beyond the design of the survey. The number of vessels estimated to be active within each camp reflected the total number of operational pangas, not those targeting elasmobranchs. For example, although an estimated 500 pangas were observed from SON–18 at the time of the survey, elasmobranchs were not found to be targeted and the site was not revisited. Vessel counts were inconsistently repeated during subsequent surveys and many camps were only visited on a single occasion. Pangas also frequently moved among sites, both within and between states, creating a potential for multiple counts of the same vessels. Some locations, such as those associated with San Felipe or shrimp fisheries in Sonora and Sinaloa, experienced great seasonal fluctuations in effort, which in turn influenced the effort at other camps throughout the GOC. Thus, the maximum number of pangas (at least 5495) no doubt overestimates overall effort among the surveyed camps. Furthermore, because survey efforts were focused on the documentation of artisanal elasmobranch fisheries, vessel counts and records of artisanal fishing camps without directed elasmobranch fishing effort were not necessarily completed. Therefore, any total number of pangas calculated from the survey data would be a poor estimation of the total number of active artisanal vessels. As such, resulting panga counts best represent the number of active pangas within the most consistently surveyed camps (e.g., BC–02, BC–03, BC–04, BC–05, SON–07, SON–09). During the summer and autumn, an influx of fishermen moved northward as water temperatures increased to target large sharks. Fishermen from the southern–most Mexican state of Chiapas, in particular, traveled north to seasonally fish in the central and northern Gulf of California. Camps in Baja California (e.g., BC–02) and Sonora (e.g., SON–05, SON–06) expanded in size and extent of elasmobranch fishing effort at these times. Northward movements of fishermen were most notable during 1998 in coincidence with anomalously high sea surface temperatures in the northern GOC (~3º C) associated with an El Niño year (e.g., Lavín et al., 2003).

Although larger, local cities typically served as the primary markets for most landed elasmobranchs, international export of meat and fins was reported, to a lesser extent, from all states (Appendix 1, Appendix 2, Appendix 3, Appendix 4). Elasmobranchs also provided a component of artisanal subsistence fisheries throughout Baja California and Baja California Sur. In more remote locations, particularly in Baja California and Baja California Sur, shark and ray fillets were commonly salted and dried in the sun as a means of preservation. Although this practice was observed in Sonora and Sinaloa, elasmobranch products were more frequently sold fresh, as ice and markets were more immediately accessible. Ex–vessel prices for elasmobranchs were usually relatively low (~$3–$6/(MX)/kg) in comparison to those for teleost species. However, larger shark species typically earned higher prices (~$12–$20/(MX)/kg).

Artisanal elasmobranch fishery characteristics

Fishing techniques and gear were found to be relatively consistent within the artisanal elasmobranch fisheries of Baja California, Baja California Sur, Sonora, and Sinaloa. The use of bottom set gillnets was widespread and represented the most common gear type observed in the GOC fishery. Surface set gillnets and longlines were most frequently recorded from the summer and autumn fisheries. The use of longlines set vertically within the water column and gillnets set within the water column was exclusively reported from fishing camps in Sinaloa and Baja California Sur. Elasmobranchs were also occasionally taken with handlines, although these were frequently deployed as a secondary gear type, often in conjunction with gillnets. The use of beach seines by artisanal fishermen was reported by fishermen in Baja California Sur, Sonora, and Sinaloa but not observed during these surveys.

The artisanal fisheries of the GOC were highly opportunistic. Multiple gear types (e.g., handlines and gillnets) or several gillnets constructed of differing mesh sizes were often used during the same fishing trip to improve the likelihood of success. Seasonal shifts in fishing effort and targets were evident in all surveyed camps. Aggregations of elasmobranchs for feeding or reproductive purposes were common seasonal targets of artisanal fisheries. Increases in the abundance and residence time of large sharks in the Midriff Islands and central and northern GOC as a result of shifting oceanographic conditions during the 1997–1998 El Niño, resulted in greater localized fishing effort directed toward these species. Similarly, increased abundance of jumbo squid, *D. gigas*, the following summer in association with La Niña conditions generated increased fishing effort for this species from many artisanal fishermen who typically targeted sharks (Markaida, 2006). Given that only a small proportion of the artisanal fishermen were itinerant, such as those from Chiapas who attempted to follow the movement patterns of large sharks through the GOC, the strategy of frequently shifting fishing effort in response to changing local oceanographic conditions and species abundance enabled resident fishermen to maximize catches.

The artisanal elasmobranch fishery of the GOC is a multi–species fishery. The wide–spread use of gillnets may result in considerable size–selectivity, but capture within a given size range is largely indiscriminant of species. The fish assemblage of the GOC is extremely diverse (Brusca et al., 2005), as evidenced from artisanal elasmobranch fishery landings. A variety of pelagic teleosts, including billfishes (Istiophoridae), mackerel and bonito (Scombridae), and dolphinfish (*C. hippurus*), were noted from the landings of elasmobranch fishermen using surface set longlines and gillnets, particularly off Baja California Sur and Sinaloa. Within the northern GOC, flatfishes (e.g., Bothidae, Pleuronectidae), croakers (Sciaenidae), tilefishes (*Caulolatilus* spp.), and triggerfish (*B. polylepis*) were commonly landed in bottom set gillnet fisheries targeting elasmobranchs. Discard of bycatch appeared to be uncommon within the artisanal fishery. Embryos of larger species (e.g., *C. falciformis*, *S. lewini*) were often filleted and utilized as part of the overall landings. The elasmobranch species most commonly reported as being discarded were round rays (*Urobatis* spp., *Urotrygon* spp.). The long, sharp tails spines of round rays made it difficult to remove specimens from gillnets. Because of handling danger and their small size (low yield), spines or tails of urobatids were often cut off and individuals were discarded.

Details concerning fishing locations were often unavailable. However, records from the summer and autumn fisheries from Baja California, Baja California Sur, and Sonora suggested that pelagic elasmobranch fishing effort was often associated with bathymetric features (rises and mounts) and islands. Upwelling and strong tidal currents around the Midriff Islands in the central and northern GOC combine to generate conditions that produce levels of primary productivity that are generally elevated in comparison to the rest of the GOC (Álvarez–Borrego, 2003). Circulation patterns aligned with local isobaths serve to concentrate and retain these more productive waters and provide a rich food base for a diverse array of marine organisms (García–Silva and Marinone, 1997; Brusca et al., 2005). Fishing effort for large sharks was concentrated in this region of elevated productivity and included, but was not limited to, locations off of Isla Tiburón, Isla Ángel de la Guarda, Isla Carmen, Isla Tortuga, Isla San Perdo Martir, and Isla San Lorenzo during the summer and autumn. Immigration and emigration of large predatory fishes, including *S. lewini*, have been similarly associated with increases in sea surface temperature and localized upwelling near seamounts in the southern GOC (Klimley and Butler, 1988).

Survey efforts and limitations

The results of this study provide the first species– and camp–specific assessment of the elasmobranch fishery in the GOC. A lack of species–specific catch information has greatly hampered conservation efforts and restricted assessments of shifts in species abundance or community composition. Additionally, the first seasonal, state–specific details on artisanal elasmobranch catch rates for the GOC were produced from these surveys. This information will provide a valuable comparative data set for future research throughout the area.

The majority of sampling efforts during 1998 were expended on locating and describing artisanal fishing sites. Artisanal landings were sampled, but less extensively than was possible the following year. As a result, comparisons among landings data between years are somewhat limited. However, the occurrence of an El Niño during 1997–98 and La Niña conditions in 1999 resulted in different faunal compositions that were evident despite differential interannual sampling efforts.

Surveys in Baja California and Sonora were more extensive and consistent than those in the southern GOC. Unequal seasonal sampling effort in the southern states, in particular, greatly limits intra–annual comparisons of landings within and among states. Whereas catch composition from several survey seasons was adequately sampled in Baja California (n = 4) and Sonora (n = 6), only three seasons were adequately sampled between Baja California Sur (n = 1) and Sinaloa (n = 2). Summer and autumn were sufficiently sampled during both years in the Sonora and during both years and 1998, respectively, in Baja California. However neither season was sufficiently sampled during either year in Baja California Sur and Sinaloa. Fisheries for large sharks were most active during the summer and early autumn in the GOC, and the lack of representative data from the southern GOC is a major limitation of this project. Baja California Sur, especially, has been regarded as a primary location for large shark and mobulid fisheries (Notarbartolo–di–Sciara, 1988; Villavicencio–Garayzar, 1996a); however, the species composition of these fisheries could not be reliably assessed from the results of this study.

Tagging efforts were minimal, as available resources were instead directed towards expanded monitoring projects. Although it was possible to collect and tag specimens with the cooperation of fishermen, the time and logistic considerations associated with establishing and maintaining a successful tag return program proved prohibitive. Fishermen were generally restricted to camps and traveled by sea. Returns could therefore only be collected on site. The financial and temporal considerations associated with contracting and apprising local fishermen of tagging efforts and maintaining a presence among enough camps to regularly collect returned tags were considerable. In addition, elasmobranch bycatch was substantial in industrial trawl and drift gillnet fisheries, and retrieving tags from these sources was not possible within the scope of this project. The unique and extensive data sets obtained through extended monitoring efforts at two of the primary demersal elasmobranch fishing sites in the GOC, SON–07 and SON–09 represents one of the most important accomplishments of this project.

Species composition

At least 27 species of shark, 21 species of ray, two skate species, and one species of chimaera (*H. colliei*) were identified among the 167,195 specimens recorded from artisanal fishery landings in Baja California, Baja California Sur, Sonora, and Sinaloa during 1998–

1999 (Table 25). One species complex of sharks (*Mustelus* spp.) and one species complex of rays (*Gymnura* spp.) were also identified within these landings. The remains of an additional shark species, the ragged–tooth shark (*Odontaspis ferox*), was noted among processed fishery specimens in Baja California Sur.

The greatest species richness of sharks was recorded from Sonora (at least 22 species) and rays were most speciose within Sonora and Baja California Sur landings (at least 18 species). The lowest species richness of sharks (10 species) and rays (at least 8 species) was observed from Sinaloa landings. Marine faunal diversity in the GOC is generally greatest in the south and declines to the north (Brusca et al., 2005). The low diversity of elasmobranchs identified from Sinaloa is likely a sampling artifact. The majority of sampling effort in Sinaloa occurred during the winter. Sampling efforts during the summer, a season associated with high diversity in other states, were extremely limited. Twelve species and one species complex were represented within the landings of all four states: *A. pelagicus*, *C. limbatus*, *C. obscurus*, *P. glauca*, *R. longurio*, *S. lewini*, *S. zygaena*, *D. dipterura*, *D. longa*, *Gymnura* spp., *M. munkiana*, *R. steindachneri*, and *Z. exasperata*. *Rhinobatos productus* was the most abundant species overall within the artisanal fishery landings of the GOC. However, this species was not recorded from Sinaloa where its congener *R. glaucostigma* was instead commonly observed.

Brusca et al. (2005) documented the occurrence of 87 chondrichthyan species in the GOC. Although deep–water species, such as catsharks (e.g., *Apristurus* spp., *Parmaturus xaniurus*), were not anticipated to be encountered within artisanal fishery landings, a number of species that were previously recorded from the GOC were conspicuously absent or uncommon within the sampled landings. These species include the: nurse shark

(*Ginglymostoma cirratum*), spiny dogfish (*Squalus acanthias*), tope (*Galeorhinus galeus*), narrowtooth shark (*C. brachyurus*), scalloped bonnethead (*S. corona*), scoophead (*S. media*), great hammerhead (*S. mokarran*), and bonnethead (*S. tiburo*) (Applegate et al., 1993; Compagno and Welton, 2003; Love et al., 2005). Compagno and Welton (2003) noted that *G. cirratum* and *S. media* were rare and *S. tiburo* were uncommon in Sonora–based surveys conducted in May, 1974. Changing oceanographic conditions may have influenced the distribution and abundance of these species within the GOC, however, it should be noted that surveys in 1998 and 1999 encompassed both El Niño and La Niña conditions. All of the above species were previously reported to occur within Sonora, which was the focus of this study's most extensive sampling efforts. The absence of these species among artisanal fishery landings may therefore indicate marked declines of these populations.

Applegate et al. (1993) documented a total of 30 commercially important shark species from the Pacific coast of Mexico, including the GOC. Although many of these species were commonly recorded within the present survey, several differences were evident (Table 26). *Alopias vulpinus* was uncommon within artisanal landings from the GOC during 1998–1999 and was harvested considerably less frequently than the congener *A. pelagicus*, which was not previously reported as a commercial species. Although possibly restricted to the upper GOC (Walker, 1960), leopard sharks (*T. semifasciata*) were reported as commercial targets by Applegate et al. (1993) but were rarely recorded among landings in Baja California (n = 3) and Sonora (n = 4). Applegate et al. (1993) recognized several "heavily exploited" species, including: *C. obscurus*, *C. leucas*, *C. falciformis*, *C. limbatus*, *G. cuvier*, *Mustelus* spp., *R. longurio*, *S. lewini*, *S. mokarran*, and *S. tiburo*. All, with the exception of *S. mokarran*, and *S. tiburo*, were also observed within landings during 1998–

1999. However, large sharks generally comprised a small, albeit economically important, component of the artisanal fishery. Species such as *C. leucas*, *C. limbatus*, *C. obscurus*, and *G. cuvier* were infrequently encountered in the present surveys of the artisanal elasmobranch fishery. The lack of previous information on the catch composition and abundance or rays restricts a similar comparison.

Differences within elasmobranch catch composition were evident among seasons and along a latitudinal gradient (Figure 15). Limited sample sizes from Baja California Sur and Sinaloa restricted a broad comparison of seasonal catch composition throughout the GOC. However, landings from Baja California Sur (spring 1999) and Sinaloa (spring 1999, winter 1999) were dominated by sharks (particularly, *R. longurio* and *S. lewini*) and clustered separately from those of Baja California and Sonora, which were comprised largely of rays. The species composition from the spring of 1999 in Baja California Sur represented the most disparate of the catch data examined. Dominated by *R. longurio*, these landings also included notable percentages of a diverse assortment of species; *M. munkiana*, *P. glauca*, and *S. californica*. Catches from Sinaloa during the spring and winter of 1999 were the second most similar observed in this study (74.7%) and were primarily composed of *S. lewini* and, to a lesser extent, *R. longurio*, S. *zygaena*, and *D. dipterura*. Catch composition in the northern GOC displayed strong seasonal similarities. Catches from autumn 1998 and winter 1999 in Sonora were characterized by an abundance of smoothhound sharks (*M. henlei* and *Mustelus* spp.) and clustered similarly (79.8%) and distinctly from the composition of other landings in the northern GOC. Summer 1999 landings were found to be highly similar between Baja California and Sonora (70.6%). Rays, particularly *D. dipterura*, *R. productus*, and *R. steindachneri*, were frequently observed among these catches.

Size and sex composition

Landings of sharks were comprised primarily of relatively small species (e.g., *Mustelus* spp., *R. longurio*, *S. californica*) and smaller size classes of larger shark species. Mean sizes of *S. lewini*, for example, did not exceed 89 cm STL in the three states in which it was most often recorded (Baja California Sur, Sonora, Sinaloa). With sizes at birth of approximately 39.5 cm STL (Clarke, 1971), a maximum size of 371 cm STL (Klimley, 1983), and first maturity reported to occur at 223 cm and 170 cm STL for females and males, respectively (Anislado–Tolentino and Robinson–Mendoza, 2001), it is evident that *S. lewini* landings consist primarily of juveniles. Small, immature *S. lewini* were also reported to dominate artisanal fishery landings from the central Mexican Pacific (Pérez–Jiménez et al., 2005a). Catches of *S. zygaena* and *C. limbatus* were also comprised largely of immature specimens, most of which were < 130 cm STL. Mean sizes of *C. falciformis* were greater than those of *Sphyrna* spp. but similarly indicated that most individuals were immature, measuring considerably less than the size at first maturity reported by Branstetter and McEachran (1986) from the Gulf of Mexico (females: 220 cm STL, males: 210 cm STL). The size composition of *A. pelagicus* landed in Baja California and Sonora, however, generally consisted of larger individuals. Mean sizes of *A. pelagicus* observed in these states approached or exceeded the estimated median sizes at maturity of 145–150 cm PCL and 140–145 cm PCL of northwestern Pacific populations (Liu et al., 1999).

Relatively broad size ranges were observed among the most commonly landed ray species. Sizes exceeding the previous recorded GOC maximum of 78 cm DW for *R. steindachneri* were recorded from Baja California (90 cm DW), Sonora (98 cm DW), and Sinaloa (89 cm DW) (McEachran and Notarbartolo–di–Sciara, 1995). However, *R.*

steindachneri from the Pacific coast of the Baja peninsula are known to attain larger sizes ($\leq$ 105 cm DW; Villavicencio–Garayzar, 1995; Bizzarro et al., 2007a). The broad size range observed among many myliobatiform rays, in particular, may be the result of the diminished size selectivity of gillnets for this group. Entanglement of myliobatiform rays in gillnets occurs primarily around the tail spine, anterior tips of the pelvic fins, or cephalic lobes (e.g., *Mobula* spp.) rather than the head and gills. Thus, relatively large individuals may become entangled in a broad range of mesh sizes when they come into contact with netting. As a result, individuals approximating size at birth through large adults were recorded for *D. dipterura*, *M. californica*, *R. steindachneri*, and possibly *M. munkiana*. Inconsistent use of body size measurements among states unfortunately limited a useful comparison of size ranges of elongate rays such as *R. glaucostigma*, *R. productus*, and *N. entemedor*.

Segregation by sex, size, or habitat is a common characteristic of elasmobranch behavior (Springer, 1967; Klimley, 1987; Schmid et al., 1988; Sims, 2005). In Baja California and Sonora, female *R. productus* were significantly more abundant than males within artisanal landings. The same pattern was observed for the congener, *R. glaucostigma*, in Sonora and Sinaloa. In Baja California, female *A. pelagicus* comprised a greater proportion of the sampled catches than males. Similarly, female *S. californica* (Sonora), *S. lewini* (Sinaloa), *D. dipterura* (Sonora), *N. entemedor* (Sonora), and *Z. exasperata* (Sonora) were taken more commonly in artisanal landings than their male counterparts. Female *C. falciformis* were more commonly recorded in Baja California, whereas males were taken in greater frequency across the GOC in Sonora. In contrast, male *R. steindachneri* were more frequently observed in Baja California landings, whereas females were dominant in Sinaloa landings. Male *M. henlei* overwhelmingly dominated the sampled landings from Sonora.

The proportion of males was greater than that of females within landings of *P. glauca* (Baja California Sur), *S. californica* (Baja California), *M. californica* (Baja California), and *M. munkiana* (Baja California Sur).

Although information of the reproductive condition and maturity status of landed specimens was not routinely collected, opportunistic sampling generated useful information on the reproductive condition from a subset of these landings (Table 27). Gravid females were reported most frequently from spring and summer landings. Female *M. henlei*, *Mustelus* spp., *R. productus*, *R. glaucostigma*, *N. entemedor*, and *Gymnura* spp. were noted to possess embryos in some stage of development during all seasons. Gravid *A. pelagicus* were recorded during the summer (Sonora) and autumn (Baja California). The occurrence of neonates was also most prevalent among spring and summer fishery landings. This suggests that mature females of many species, including; *R. longurio*, *S. lewini*, and *S. zygaena*, landed in the late spring and early summer were probably carrying near–term embryos. In Baja California, neonate carcharhinid (e.g., *C. limbatus*, *C. obscurus*) and sphyrnid (e.g., *S. zygaena*) sharks were only observed during summer surveys. More extensive sampling in Sonora revealed a similar pattern, with neonate carcharhinid and sphyrnid sharks present among fishery landings during the late spring and summer months. Neonate *R. productus* were reported from Sonora during spring surveys. *Mustelus* spp. neonates were only observed during the autumn fishery in the northern GOC. The presence of both neonate and gravid females in spring and summer landings indicates that fishing efforts are likely to occur in pupping areas or primary nursery areas (e.g., Simpfendorfer and Milward, 1993; Heupel et al., 2007). The prevalence of juveniles throughout the year and frequency of smaller size classes of several shark species, in particular, within landings further suggests that considerable artisanal fishing effort may be opportunistically directed on primary and/or secondary nursery habitats.

Status of the fishery

Elasmobranchs display a broad range of life history attributes, but may be generally categorized as having low fecundity, slow growth rates, late ages of maturity, and long lives (e.g., Hoenig and Gruber, 1990). These characteristics restrict biological productivity and population resilience (Stevens et al., 2000). Over–exploitation, therefore, often leads to severe and rapid depletion of elasmobranch populations, endangering their resource and ecological value over broad regions. Holden (1973, 1974) cautioned that elasmobranchs offered limited opportunities for long–term exploitation and summarized the rapid rise and collapse of several historic shark fisheries. Successful management and conservation of even well–monitored shark and ray fisheries has proven to be difficult (Musick, 1999; Stevens, 1999). Given the decades of largely unrestricted exploitation of elasmobranchs in Mexican waters, population declines and shifts in size structure have likely occurred among those species with the lowest fecundity, slowest growth, and latest ages at maturity. Elasmobranchs play important roles in marine ecosystems, often occupying the highest trophic levels as apex predators (Compagno, 1990b; Cortés, 1999). Elasmobranchs may affect the distribution, abundance, and behavior of potential prey organisms (Cross and Curran, 2000; Heithaus, 2001, 2004) and rays can additionally alter seafloor environments during foraging and sheltering activities (Orth, 1975; VanBlaricom, 1982; Peterson et al., 2001). Therefore, elasmobranch population declines or collapses in the GOC would be expected to have considerable, unpredictable effects on coastal ecosystem function and structure.

The artisanal elasmobranch fishery in the GOC is substantial and capable of causing localized and perhaps Gulf–wide depletion of elasmobranch stocks. Indeed, artisanal fisheries are capable of producing high levels of fishing mortality. Estimates from a directed fishery for the small coastal shark, *R. terraenovae* in the southern Gulf of Mexico indicated annual fishing mortality rates $\leq$ 0.46 per year (Márquez–Farías and Castillo–Géniz 1998). Given the multi–species nature of artisanal fisheries and the tendency for even closely related elasmobranchs to exhibit variable responses to similar levels of fishing effort, species with lower intrinsic rates of increase have probably been overfished (Stevens, 1999).

The duration and focus of these surveys did not enable a detailed analysis of trends in species and size composition that would allow a broader assessment of elasmobranch population status in the GOC. However, based on the size and species composition of specimens examined from artisanal landings, interviews with fishermen during 1998–1999, and observations during subsequent years, it appears that the populations of large shark species, including *C. leucas*, *C. limbatus*, *C. obscurus*, and *S. mokarran*, have dramatically declined. Reports of fishermen traveling from Chiapas to target large elasmobranchs in the northern GOC during the summer and autumn are now uncommon (W. Smith, pers. obs.). In Guaymas, Sonora, a processor and manufacturer of shark skin products for more than 25 years recently closed business because of a lack of large sharks. Declines in the size, abundance, and mean trophic level of target species has been generally observed among artisanal fisheries in the GOC. Interviews with artisanal fishermen spanning three generations indicated that the older generation ($\geq$ 55 years of age) believed that striking declines of tiger sharks (*G. cuvier*), *C. leucas*, *Sphyrna* spp., and *C. limbatus* as well as large groupers (Serranidae) and snappers (Lutjanidae) had occurred during their life time (Sáenz–Arroyo et al., 2005). Sala et al. (2004) reported rapid growth in fishing effort during the 1980's through the mid–1990's in Baja California Sur and a subsequent decline in the mean trophic level of artisanal fishery landings in the region.

Previous assessments of Mexican elasmobranch fisheries indicated that sharks dominated landings and rays contributed only a small portion (4.2% of mass) of overall catches (Bonfil, 1994; Castillo–Géniz et al., 1998). Results of these surveys, however, revealed that rays represent a substantial portion of elasmobranch landings in this region, particularly in the northern GOC. This apparent contradiction suggests that catch records may be biased against rays, that a significant expansion of batoid fisheries has occurred, or that a combination of the two is responsible for the difference. Indeed, catch records of batoids were not consistently recorded until 1990 (CONAPESCA, 2003), and Mexican ray fisheries have historically received considerably less scientific attention when compared to those of sharks. It is likely that fishing effort for rays has expanded, possibly as a consequence of declines in the abundance of large sharks and upper level teleosts (Sala et al., 2004). Although rays from the GOC are poorly known, expanded fishing effort toward batoids is of particular concern because these populations are not likely to sustain such pressure. Furthermore, an increased emphasis on batoid landings may signify a broader pattern of serial depletion and potential shifts in the ecological function of marine communities.

Mexican catch records lack species–specific designations for elasmobranchs. Small sharks ($\leq$ 1.5 m total length) are termed "cazón," large sharks (> 1.5 m total length) are categorized as “tiburón,” and batoids are collectively designated as “mantarraya.” The combined reported landings of elasmobranchs from Baja California, Baja California Sur, Sonora, and Sinaloa declined steadily from 1993 through 2002 (Figure 16) (CONAPESCA, 2003). During the course of this survey, total elasmobranch landings were greatest for Sonora in 1998 (4613 metric tons) and Baja California Sur in 1999 (5459 metric tons). Sonora produced the greatest tonnage of rays and catches of cazón were consistently highest in Baja California Sur during both survey years. Landings of tiburón were greatest from Baja California in 1998 (3372 metric tons) and Baja California Sur (3491 metric tons) in 1999. The combined elasmobranch landings from Baja California, Baja California Sur, Sonora, and Sinaloa accounted for 70.1% and 73.2% of the elasmobranch landings reported from the Mexican Pacific during 1998 and 1999, respectively. Because of the remote locations of many artisanal fishing camps, sales of salted and dried fillets rather than whole specimens, and itinerant nature of a portion of the artisanal fleet, it is likely that artisanal elasmobranch landings are underestimated, perhaps considerably, by federal landing records. Based on extrapolations from Bahía Almejas, it has been previously suggested that ray landings from Baja California Sur were considerably underestimated during 1998–1999 (Bizzarro, 2005), and this situation is probably more widespread among regions and elasmobranch groups. After years of steady decline, overall elasmobranch landings were 18.0% greater during 2003 than during 2002 among the surveyed states. Production of all elasmobranch groups was elevated during 2003, with proportional interannual increases ranging from 17.4% (tiburón) to 21.6% (cazón) (CONAPESCA, 2003). It is not known if 2003 landings records reflect an actual substantial increase in the elasmobranch catch or are an artifact of a shift in fishery characteristics, increased reporting, an expansion of the industrial fleet, or changes to the way in which catch statistics are collected and reported.

The lack of species–specific information inhibits the identification of trends or long–term changes in the composition of landings. Within aggregate categories, sharks of the same species may be reported as both cazón and tiburón, depending on the size of the individual. In the North Atlantic, the use and analysis of aggregate catch statistics for skates indicated stable landing patterns, however species–specific analyses revealed a shift in species composition and abundance with smaller species increasing and replacing formerly common, larger skate species (Dulvy et al., 2000). These dramatic shifts in biomass and population structure were masked by the use of aggregate catch data that provided the illusion of stability and would have remained undetected without species–specific details. Similarly, natural patterns of fluctuation or dramatic changes of elasmobranch abundance in the GOC could go unrecognized because of the wide–spread use of aggregate landings categories.

In addition to sources of mortality from directed artisanal and industrial elasmobranch fisheries, elasmobranch populations are further impacted by modification or loss of coastal habitats and indirect fishing mortality. Bonfil (1994) estimated that the magnitude of elasmobranch bycatch was likely to be equivalent to their overall reported landings. Although artisanal and industrial shrimp fishing vessels were not sampled in this study, the amount of bycatch associated with shrimp fisheries is considerable. The Mexican shrimp fishery represents the most economically important fishery in the country, and most of this production is derived from the GOC (Meltzer and Chang, 2006). Approximately 9.7 kg of biomass is estimated to be discarded for each kg of landed target species within shrimp trawl operations in the GOC (Alverson et al., 1994). It is likely that soft–bottom demersal species such as *D. dipterura*, *Gymnura* spp., *R. glaucostigma*, and *R. productus* are common components of bycatch within these fisheries. Mortality rates of rays discarded from trawl fisheries is high, ranging between 41–65% (Stobutzki et al., 2002; Laptikhovsky, 2004). Analyses of long–term datasets have revealed sharp reductions in the abundance of demersal batoids as a direct result of bycatch overfishing (Philippart, 1998; Quero, 1998). Large, long–lived batoids have been most impacted by trawl fisheries. The presence of guateros buying elasmobranchs from shrimp fishing vessels in Sonora suggests a relatively consistent and high level of elasmobranch bycatch resulting from this fishery.

The enactment of Mexican Official Standard Rules NOM–029–PESC–2006 in May, 2007 represented a critical, positive advancement for the management and conservation of elasmobranch populations in Mexico (DOF, 2007). Some of the measures implemented with this law include: the accumulation of detailed catch information from industrial and artisanal elasmobranch fisheries, monitoring and tracking of industrial elasmobranch fishing vessels, the establishment of an observer program, area closures, and specific protection for the white shark (*Carcharodon carcharias*), basking shark (*Cetorhinus maximus*), whale shark (*Rhincodon typus*), and mobulid rays (*M. birostris*, *Mobula* spp.). As improved catch and biological information is obtained, these strategies, if enforced, may be further refined to assess and rebuild populations of this historically vulnerable group of fishes.

Recommendations

Species of concern

The vulnerability of elasmobranchs to fishing pressure has been well established (e.g., Holden, 1973; Stevens et al., 2000). Slow growth, long life spans, late ages of maturity, low fecundity, and extended gestation periods are life history traits that are commonly exhibited among elasmobranchs. These combined traits produce low intrinsic rates of increase and severely reduce a population's ability to recover from or compensate for overfishing (Musick, 1999). Increased exploitation of elasmobranchs, therefore, is generally problematic and requires directed management and monitoring of exploited stocks. Given the poor baseline data and limited fisheries information for most elasmobranchs from the GOC, it is difficult to identify and rank conservation priorities without excluding potentially threatened species. Indeed, the species identified and protected under NOM–029–PESC–2006 may not represent those that are in the most urgent need of regulation. Species of concern include those with restricted ranges (e.g., *Z. exasperata*) and those historically reported to be more common in the GOC than suggested by recent surveys (e.g., *G. cirratum*, *G. cuvier*, *C. brachyurus*, *C. leucas*, *S. corona*, *S. mokarran*, *S. tiburo*). The abundance of large shark species in general appears to have declined and further measures to rebuild these stocks should be enacted. It is beyond the scope of this survey to critically evaluate the risk and status of all elasmobranchs recorded within artisanal landings. Instead, we focus on fishery impacts and potential implications for four of the most commonly observed species within the 1998–1999 artisanal fishery landings.

Sphyrna lewini. Scalloped hammerhead sharks are found in warm temperate and tropical seas throughout the world (Compagno, 1984). The use of coastal estuaries as nursery areas has been well documented for this species (e.g., Clarke, 1971; Simpfendorfer and Milward, 1993). Pups tend to stay in coastal zones, near the bottom, occurring at high concentrations during summer in estuaries and bays and have been observed to be highly faithful to particular diurnal core areas (Holland et al., 1993). Based on the size distributions of *S. lewini* within the artisanal landings, fishermen in the GOC frequently targeted these aggregations within coastal nurseries. Small *S. lewini* also form a principal component of artisanal fisheries in Michoacán on the Pacific coast of Mexico (Madrid–Vera et al., 1997). Relatively fecund in relation to other elasmobranchs, *S. lewini* may produce 30–40 pups annually and possesses potential annual population growth rates of 44–81% (Cortés, 2002). These traits indicate that *S. lewini* may be more resilient than other sharks, such *C. limbatus*, *C. obscurus*, and *T. semifasciata* (Cortés, 2002). Among relatively long–lived, late maturing species, juveniles comprise the majority of the population and may be expected to dominate fishery landings. A fishery directed primarily at juveniles is not necessarily a cause for alarm. However, adults that were formerly abundant at seamounts in the southern Gulf of California have largely disappeared as a likely result of overfishing. Adult *S. lewini* are highly migratory and, as a schooling species, may be particularly susceptible to pelagic gillnet fisheries (Stevens and Lyle, 1989). If fishing pressure from industrial elasmobranch fisheries is also substantial on the adult component of the population, the identification and protection of juvenile nursery areas may be essential for ensuring sustainability of the population. Careful monitoring of the spatially segregated adult and juvenile populations is needed.

Dasyatis dipterura. The diamond stingray has been reported from British Columbia, Canada to Chile, including the Galápagos and Hawaiian Islands (Smith, 2005). Exploratory fishery surveys within the GOC indicate that *D. dipterura* constitutes a large proportion of available biomass within soft–bottom, demersal communities, comprising 26% of the total catch weight of fishery–independent trawl surveys (Flores et al., 1995). The limited biological information available for *D. dipterura* is derived primarily from the Bahía Magdalena lagoon complex on the Pacific coast of the Baja peninsula where it is also a primary constituent of artisanal fisheries. Recent research from this region indicates that this stingray is relatively long lived (to at least 28 years) and produces 1–4 offspring annually after attaining maturity at approximately 10 years of age (Smith et al., 2007). Demographic analyses of this population revealed a low productivity and potential resilience for this species, with mean annual population growth of approximately 6% (Smith et al., in press b). Populations with annual intrinsic growth rates less than 10% are considered to be particularly vulnerable to increases in mortality (Musick, 1999). Although the life history characteristics of *D. dipterura* from the GOC may differ from this Pacific coast population, precautionary management of this species is warranted given the likelihood of population declines under moderate levels of exploitation.

Rhinobatos productus. The shovelnose guitarfish ranges San Francisco Bay, California to the southern GOC (Eschmeyer et al., 1983). Genetic differences between *R. productus* from the Pacific coast of the Baja California and upper GOC suggests that these populations are reproductively isolated and should be considered as distinct evolutionarily significant units for conservation purposes (Sandoval–Castillo et al., 2004). The single most common species observed within artisanal fishery landings during these surveys, it is also frequently taken as bycatch in the shrimp trawl fishery (Márquez–Farías, 2005). Seasonal peaks were observed within the artisanal fishery beginning in the late spring through the early summer. The timing of this peak is associated with the movement of gravid females into shallow waters for pupping (Márquez–Farías, 2007). The removal of gravid females prior to reproductive events is particularly detrimental to population growth and stability. Furthermore, fishing effort occurring within pupping areas increases mortality rates on neonate and juvenile segments of the population. This scenario, in conjunction with a marked increase in direct fishery effort, resulted in the recent collapse of a formerly substantial artisanal fishery for *R. productus* in Bahía Almejas (Bizzarro, 2005). Given the further impact of trawl fisheries on GOC populations of *R. productus*, reducing mortality on the reproductively active portion of the population is a critical concern for sustainable management of this species.

Rhinoptera steindachneri. The golden cownose ray is widely distributed throughout shallow inshore waters of the eastern subtropical and tropical Pacific (Love et al, 2005). It is a transient, highly mobile species, and often forms large schools or moves in loose aggregations (Bizzarro et al., 2007a). The extent of movements throughout the eastern Pacific, longevity, growth rates, population structure, and age at maturity are unknown for this species. Recent investigations into the reproductive biology of *R. steindachneri* indicate that both sexes mature at similar sizes that are ~70% of their maximum size, suggesting that the species may have a relatively late age at maturity (Bizzarro et al., 2007a). Following an extended 10–12 month gestation period, a single pup is produced. This conservative reproductive strategy suggests a low productivity and high susceptibility to overexploitation. The same reproductive strategy is observed among the mobulid rays (e.g., *M. munkiana*, *M. japanica*). This group, however, has been afforded special protection under NOM–029–

PESC–2006 because of their low reproductive potential. The same protection should be applied to *R. steindachneri*.

Management and conservation

Conventional methods of stock assessment and tools for evaluating management policies require extensive data on the life history, size, structure, available biomass, and spatial dynamics of exploited populations. Such information is simply unavailable for most elasmobranch populations in Mexico and would require many years of intensive, directed research to obtain. Alternative approaches to population assessment must be developed and broad interim management strategies must be enacted to advance the conservation and sustainable management of this historically vulnerable group of fishes.

Fishermen should not be overlooked as a dynamic component of these fisheries. Management plans directly impact the livelihood of those involved in the fishery and, in turn, fishing activities alter species abundance and the function of the ecosystem on which fishermen rely. After many years of minimal regulation, further measures are critically needed to evaluate and enhance elasmobranch stocks in the GOC. Multi–species interactions and the influence of the physical environment should also be considered to achieve sustainability (Botsford et al., 1997). We recommend that regional consideration be made when further restrictions are placed on fisheries in the GOC. The rugged, remote, and arid nature of much of the Baja peninsula restricts agricultural and employment opportunities in Baja California and Baja California Sur. Subsistence fisheries are important in these states. In contrast, the larger populations and greater infrastructure found in Sonora and Sinaloa present a broad range of opportunities for residents and dampen the socio–economic impacts of fishery regulations on these communities. Differential, interactive approaches to management should therefore be considered between these regions.

Current monitoring and research efforts for elasmobranch fisheries and elasmobranch populations in the GOC are inadequate. A lack of detailed biological and fisheries information about targeted shark and ray species constrains efforts to develop and refine effective management strategies. Catch records typically lack species–specific landing information, precluding an assessment of long–term trends in catch composition and relative abundance. Basic information on the ranges of many elasmobranch species is lacking. Expanded, coordinated efforts should be made to conduct species–specific surveys of elasmobranch catch composition. Details of relative abundance, seasonal occurrence, sex ratios, and reproductive status can readily be obtained through these efforts. Once principal species are recognized from landings, biological studies can be developed and directed toward species of commercial importance to provide additional information necessary for formulating successful management strategies.

A rapid assessment and evaluation of risk should be conducted for elasmobranch species occurring within the GOC. Such an assessment, as presented by Stobutzki et al. (2002), is amenable and adaptable to species for which minimal life history information is available. Using this rapid approach, the relative sustainability of a species can be ranked on the basis of susceptibility and recovery potential based on selected biological and ecological criteria (Stobutzki et al., 2002; Walker, 2004). This approach allows researchers to broadly identify vulnerable species, highlights gaps in life history information, and serves to direct research and management efforts. We recommend that a concerted, coordinated effort be conducted to complete these evaluations in the immediate future.

Sharks and rays aggregating for reproductive purposes (e.g., courtship, pupping) were frequent targets of artisanal fishing efforts. Fishing efforts directed toward pupping areas enhances the probability of removing gravid females before they are able to reproduce and increases mortality rates of neonates and young of the year, dramatically accelerating overexploitation (Kokko et al., 2001). Applegate et al. (1993) highlighted the need to delineate nursery grounds and identify special areas of congregation as an essential step for successful management of elasmobranch populations in Mexico. In the years since this need was reported, very little related work has been completed and details on nursery grounds and special areas of congregation remain largely unknown for Mexican shark populations. This information is equally deficient, but essential for, the sustainable management of expanding batoid fisheries. Indeed, several nursery areas were considered and outlined for protection (seasonal closures) in the recently instituted NOM–029. However, initial attempts to restrict fishing effort during a period of noted reproductive activity in the Bahía Magdalena lagoon complex were forestalled in July, 2007. Increased public education in association with the protection of pupping grounds or seasonally important aggregation sites is essential if nearshore habitats and elasmobranch resources are to be conserved successfully.

Area closures may serve as a hedge against uncertainty, and provide a valuable tool to protect species with low biological productivity, such as elasmobranchs (e.g., Walker, 2004). Nursery grounds and special areas of congregation can be seasonally or permanently closed to fishing in an effort to rebuild stocks. Such closures may support broader aims for the conservation of biodiversity, benefiting multiple species and stakeholders (e.g., Enríquez–Andrade et al., 2005). However, identifying and establishing relevant boundaries will depend upon increased species–specific sampling efforts and systematic attempts to delineate nursery grounds and areas of congregation. Such efforts may be particularly effective for species such as *C. limbatus* that demonstrate high levels of nursery fidelity (philopatry), returning annually to the same areas to give birth (Keeney et al., 2003).

Gear restrictions are common approaches to managing fisheries and may be directed toward limiting use in certain locations or broadly restricting the dimensions of gear (e.g., mesh size, hook size, net length). Gillnets were the most common type of gear used in the artisanal fishery and are typically highly size–selective. Although small sharks are able to swim through gillnets and become increasingly vulnerable to capture until they attain a size of maximum selectivity, dorsal–ventrally flattened species, particularly those with tail spines, are likely to be broadly vulnerable to a wide range of gillnet mesh sizes (e.g., Márquez–Farías, 2005). However, gear restrictions may be particularly useful among pelagic fisheries and should be directed at reducing fishing mortality of adult tiburón species.

Although bycatch of elasmobranchs was not evaluated in this study, the shrimp fishery in the GOC clearly represents a significant source of indirect fishing mortality for many species. *Dasyatis dipterura* and *R. productus*, for example, are known to be common components of bycatch within the shrimp fishery of the GOC (Flores et al., 1995; García–Caudillo et al., 2000). Analyses of shrimp fisheries off Brazil indicated that CPUE of rays is almost three times greater than that of targeted shrimp (Menni and Stehmann, 2000). Bycatch reduction devices (BRDs) may successfully reduce total bycatch by 40% (García–Caudillo et al., 2000). Expanded use of BRDs would benefit elasmobranchs as well as a variety of other demersal teleost species. The shrimp fishery has broad, but poorly understood impacts on populations, biological communities, trophic dynamics, and habitat throughout the GOC. Yet, the scale of the fishery is largely maintained as a result of government subsidies (Meltzer and Chang, 2006). Reduction of these subsidies to industrial vessels would decrease trawling effort, reduce indirect fishing mortality as a result of decreased bycatch, and increase available biomass for artisanal fisheries. Reduction of shrimp fishing effort should be a management priority.

The decline of large sharks from the GOC and expanding fishery for batoids and smaller shark species requires prompt, expanded monitoring and directed research. The institution of NOM–029–PESC–2006 provides a long overdue mechanism by which these goals can begin to be accomplished. However, even with the implementation of the most precautionary management strategies, these newly devised policies and focused conservation efforts will be fruitless without the support of enforcement agencies, which are largely under–staffed and under–supported. Increased education and the broad enforcement of new management strategies are essential if the heavily exploited elasmobranch populations of the GOC are to be sustained or rebuilt.

Acknowledgements

We thank Lázaro Cadena–Cárdenas, David Corro–Espinosa, Erin Jones, Altagracia Landa, Lourdes Patricia Lyle–Fritch, Julie Neer, Arturo Ocampo–Torres, Juan Carlos Perez–Jiménez, Evlin Ramírez–Félix, Phillip Sanchez, and personnel of the Marine Biology Station of the University of Arizona and of the Universidad de Sonora for field and technical assistance. Stori Oates reviewed a draft of this manuscript and provided many helpful comments and suggestions. We greatly appreciate the patience and cooperation of artisanal fishermen throughout the Gulf of California for providing access to their landings and information about their fishing activities. In addition to the generous support of the David and Lucile Packard Foundation, funding for this project was also provided by the: National Fish and Wildlife Foundation, Homeland Foundation, JiJi Foundation, California Sea Grant College System, PADI Project AWARE, World Wildlife Fund, Christensen Fund, Moss Landing Marine Laboratories, Mote Marine Laboratory, Instituto Nacional de la Pesca, Universidad Autonoma de Baja California Sur, and National Oceanic and Atmospheric Administration/National Marine Fisheries Service (to the National Shark Research Consortium.

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Table 1. Descriptive information for all artisanal fishing camps documented in Baja California (BC) during 1998-1999. Type = A (little to no infrastructure), B (moderate infrastructure), and C (significant infrastructure); Perm. (Permanence) = 1 (permanent) and 2 (seasonal); Active = period of fishing activity; #Pangas = number or range of operational artisanal fishing vessels at the time of survey(s); Elasmo. (elasmobranchs targeted) = Yes (elasmobranchs were targeted during the year) and No (there was no directed fishery for elasmobranchs). Zero values listed for #Pangas indicate that the camp was temporarily inactive (because of weather, holidays, etc.) or seasonally abandoned at the time of survey. In all instances, U = unknown.

Camp Code	Camp Name	Latitude	Longitude	Type	Perm.	Active	#Pangas	Elasmo.
BC-01	San Miguel	28.114	-112.816	A	2	Jan-Feb; May-Aug	0	Yes
BC-02	El Barril	28.304	-112.876	B	1	Year-Round	6-26	Yes
BC-03	San Francisquito	28.430	-112.873	B	2	Jun-Nov	0-5	Yes
BC-04	San Rafael	28.583	-113.128	B	2	Mar-Nov	4-13	Yes
BC-05	Bahia las Animas	28.826	-113.355	B	1	Year-Round	1-4	Yes
BC-06	Bahia de los Angeles	28.956	-113.563	C	1	Year-Round	5-30	Yes
BC-07	Calamajue	29.695	-114.166	B	1	Year-Round	10	No
BC-08	Punta Final	29.747	-114.308	B	1	Year-Round	1-4	Yes
BC-09	Alfonsina's	29.819	-114.411	B	2	Dec-Aug	0-5	Yes
BC-10	Isla San Luis Gonzaga	29.823	-114.401	B	2	Mar-Aug	0-6	Yes
BC-11	Los Paredes	30.050	-114.594	A	2	U	0	U
BC-12	El Huerfanito	30.125	-114.622	B	2	U	1	U
BC-13	Playa Destiny	30.388	-114.648	B	1	Year-Round	4-17	Yes
BC-14	San Felipe Harbor	31.000	-114.839	C	1	Year-Round	43-200	Yes
BC-15	San Felipe Malecon	31.030	-114.843	C	1	Year-Round	37-85	No
BC-16	Campo Ruben's	31.034	-114.834	C	1	Year-Round	25-40	Yes
BC-17	Campo Don Abel	31.192	-114.894	B	1	Year-Round	2-4	No

Table 2. Seasonal, annual, and total catch composition of shark, skate, and ray landings sampled from artisanal vessels targeting elasmobranchs in Baja California during 1998-1999. n = number of individuals, % = percentage of elasmobranch landings.

		Spring				Summer				Autumn				1998		1999		Total	
Higher Taxon	Lowest Possible Taxon	1998n	1998%	1999n	1999%	1998n	1998%	1999n	1999%	1998n	1998%	1999n	1999%	n	%	n	%	n	%
Shark	*Alopias pelagicus*							4	0.76	160	25.56	11	6.18	160	6.66	15	0.72	175	3.89
	Alopias superciliosus							1	0.19	2	0.32			2	0.08	1	0.05	3	0.07
	Alopias vulpinus									2	0.32			2	0.08			2	0.04
	Carcharhinidae					97	5.81							97	4.04			97	2.16
	Carcharhinus falciformis					56	3.35	48	9.07					56	2.33	48	2.29	104	2.31
	Carcharhinus limbatus					1	0.06	4	0.76	18	2.88	29	16.29	19	0.79	33	1.58	52	1.16
	Carcharhinus obscurus					1	0.06							1	0.04			1	0.02
	Cephaloscyllium ventriosum			27	1.95					1	0.16			1	0.04	27	1.29	28	0.62
	Heterodontus mexicanus			264	19.05	1	0.06	6	1.13	19	3.04			20	0.83	270	12.90	290	6.45
	Isurus oxyrinchus							3	0.57	1	0.16	1	0.56	1	0.04	4	0.19	5	0.11
	Mustelus henlei									36	5.75	73	41.01	36	1.50	73	3.49	109	2.42
	Mustelus spp.			639	46.10	81	4.85	1	0.19	226	36.10			307	12.78	640	30.58	947	21.07
	Prionace glauca							1	0.19							1	0.05	1	0.02
	Rhizoprionodon longurio					107	6.41	6	1.13	1	0.16			108	4.50	6	0.29	114	2.54
	Sphyrna lewini					2	0.12	11	2.08	8	1.28			10	0.42	11	0.53	21	0.47
	Sphyrna spp.					19	1.14	1	0.19					19	0.79	1	0.05	20	0.44
	Sphyrna zygaena					41	2.46	23	4.35	17	2.72	3	1.69	58	2.41	26	1.24	84	1.87
	Squatina californica	44	41.51	79	5.70							51	28.65	44	1.83	130	6.21	174	3.87
	Triakis semifasciata			2	0.14							1	0.56			3	0.14	3	0.07
	Unidentified	59	55.66											59	2.46			59	1.31
	Subtotal	**103**	**97.17**	**1011**	**72.94**	**406**	**24.31**	**109**	**20.60**	**491**	**78.43**	**169**	**94.94**	**1000**	**41.63**	**1289**	**61.59**	**2289**	**50.92**
Skate	*Raja inornata*			4	0.29					1	0.16			1	0.04	4	0.19	5	0.11
	Raja velezi			26	1.88					4	0.64			4	0.17	26	1.24	30	0.67
	Subtotal	**0**	**0.00**	**30**	**2.16**	**0**	**0.00**	**0**	**0.00**	**5**	**0.80**	**0**	**0.00**	**5**	**0.21**	**30**	**1.43**	**35**	**0.78**
Ray	*Dasyatis dipterura*			17	1.23	9	0.54	10	1.89	1	0.16			10	0.42	27	1.29	37	0.82
	Dasyatis longa							6	1.13							6	0.29	6	0.13
	Dasyatis sp.					1	0.06							1	0.04			1	0.02
	Gymnura spp.	1	0.94	52	3.75	63	3.77	55	10.40	21	3.35			85	3.54	107	5.11	192	4.27
	Mobula japanica					2	0.12	2	0.38			1	0.56	2	0.08	3	0.14	5	0.11
	Mobula munkiana					242	14.49					5	2.81	242	10.07	5	0.24	247	5.49
	Mobula sp.					1	0.06							1	0.04			1	0.02
	Mobula thurstoni					8	0.48	1	0.19					8	0.33	1	0.05	9	0.20
	Myliobatidae					6	0.36							6	0.25			6	0.13
	Myliobatis californica			68	4.91	95	5.69	28	5.29	59	9.42			154	6.41	96	4.59	250	5.56
	Myliobatis longirostris					19	1.14			5	0.80			24	1.00			24	0.53
	Myliobatis sp.	1	0.94											1	0.04			1	0.02
	Narcine entemedor			4	0.29	3	0.18	1	0.19					3	0.12	5	0.24	8	0.18
	Narcine spp.					10	0.60							10	0.42			10	0.22
	Rhinobatidae			4	0.29											4	0.19	4	0.09
	Rhinobatos productus			165	11.90	670	40.12	295	55.77	38	6.07			708	29.48	460	21.98	1168	25.98
	Rhinobatos sp.					1	0.06							1	0.04			1	0.02
	Rhinoptera steindachneri					133	7.96	22	4.16	6	0.96			139	5.79	22	1.05	161	3.58
	Urobatis halleri											1	0.56			1	0.05	1	0.02
	Urobatis sp.			1	0.07											1	0.05	1	0.02
	Zapteryx exasperata			34	2.45							2	1.12			36	1.72	36	0.80
	Subtotal	**2**	**1.89**	**345**	**24.89**	**1263**	**75.63**	**420**	**79.40**	**130**	**20.77**	**9**	**5.06**	**1395**	**58.08**	**774**	**36.98**	**2169**	**48.25**
Batoid	Unidentified	1	0.94			1	0.06							2	0.08			2	0.04
	Subtotal	**1**	**0.94**	**0**	**0.00**	**1**	**0.06**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**2**	**0.08**	**0**	**0.00**	**2**	**0.04**
	Total	**106**	**100.00**	**1386**	**100.00**	**1670**	**100.00**	**529**	**100.00**	**626**	**100.00**	**178**	**100.00**	**2402**	**100.00**	**2093**	**100.00**	**4495**	**100.00**

Table 3. Seasonal, annual, and total catch composition of elasmobranch, teleost, invertebrate, and turtle landings sampled from artisanal vessels in Baja California during 1998-1999. n = number of individuals, % = percentage of total landings.

		Spring				Summer				Autumn				1998		1999		Total	
Higher Taxon	Lowest Possible Taxon	1998n	1998%	1999n	1999%	1998n	1998%	1999n	1999%	1998n	1998%	1999n	1999%	n	%	n	%	n	%
Shark	*Alopias pelagicus*							4	0.46	160	20.89	11	4.70	160	2.89	15	0.51	175	2.06
	Alopias superciliosus							1	0.12	2	0.26			2	0.04	1	0.03	3	0.04
	Alopias vulpinus									2	0.26			2	0.04			2	0.02
	Carcharhinidae					97	3.55							97	1.75			97	1.14
	Carcharhinus falciformis					56	2.05	48.00	5.57					56	1.01	48	1.63	104	1.23
	Carcharhinus limbatus					4	0.15	4.00	0.46	18	2.35	29	12.39	22	0.40	33	1.12	55	0.65
	Carcharhinus obscurus					1	0.04							1	0.02			1	0.01
	Cephaloscyllium ventriosum			27	1.46					1	0.13			1	0.02	27	0.92	28	0.33
	Heterodontus mexicanus			264	14.28	1	0.04	6.00	0.70	19	2.48			20	0.36	270	9.17	290	3.42
	Isurus oxyrinchus							3.00	0.35	1	0.13	1	0.43	1	0.02	4	0.14	5	0.06
	Mustelus henlei									36	4.70	73	31.20	36	0.65	73	2.48	109	1.28
	Mustelus spp.	17	0.83	639	34.56	81	2.96	1	0.12	226	29.50			324	5.85	640	21.74	964	11.36
	Prionace glauca							1	0.12							1	0.03	1	0.01
	Rhizoprionodon longurio					113	4.13	6.00	0.70	1	0.13			114	2.06	6	0.20	120	1.41
	Sphyrna lewini					8	0.29	11.00	1.28	8	1.04			16	0.29	11	0.37	27	0.32
	Sphyrna spp.	2	0.10			25	0.91	1.00	0.12					27	0.49	1	0.03	28	0.33
	Sphyrna zygaena					50	1.83	23.00	2.67	17	2.22	3	1.28	67	1.21	26	0.88	93	1.10
	Squatina californica	45	2.21	79	4.27							51	21.79	45	0.81	130	4.42	175	2.06
	Triakis semifasciata			2	0.11							1	0.43			3	0.10	3	0.04
	Unidentified	59	2.89											59	1.07			59	0.70
	Subtotal	**123**	**6.04**	**1011**	**54.68**	**436**	**15.94**	**109**	**12.66**	**491**	**64.10**	**169**	**72.22**	**1050**	**18.96**	**1289**	**43.78**	**2339**	**27.57**
Skate	*Raja inornata*			4	0.22					1	0.13			1	0.02	4	0.14	5	0.06
	Raja velezi			26	1.41					4	0.52			4	0.07	26	0.88	30	0.35
	Subtotal	**0**	**0.00**	**30**	**1.62**	**0**	**0.00**	**0**	**0.00**	**5**	**0.65**	**0**	**0.00**	**5**	**0.09**	**30**	**1.02**	**35**	**0.41**
Ray	*Dasyatis dipterura*			17	0.92	9	0.33	10	1.16	1	0.13			10	0.18	27	0.92	37	0.44
	Dasyatis longa					1	0.04	6	0.70					1	0.02	6	0.20	7	0.08
	Dasyatis sp.					1	0.04							1	0.02			1	0.01
	Gymnura spp.	1	0.05	52	2.81	63	2.30	55	6.39	21	2.74			85	1.53	107	3.63	192	2.26
	Mobula japanica					2	0.07	2	0.23			1	0.43	2	0.04	3	0.10	5	0.06
	Mobula munkiana					242	8.85					5	2.14	242	4.37	5	0.17	247	2.91
	Mobula sp.					1	0.04							1	0.02			1	0.01
	Mobula thurstoni					8	0.29	1	0.12					8	0.14	1	0.03	9	0.11
	Myliobatidae					6	0.22							6	0.11			6	0.07
	Myliobatis californica			68	3.68	95	3.47	28	3.25	59	7.70			154	2.78	96	3.26	250	2.95
	Myliobatis longirostris					19	0.69			5	0.65			24	0.43			24	0.28
	Myliobatis sp.	1	0.05											1	0.02			1	0.01
	Narcine entemedor			4	0.22	3	0.11	1	0.12					3	0.05	5	0.17	8	0.09
	Narcine spp.					10	0.37							10	0.18			10	0.12
	Rhinobatidae			4	0.22											4	0.14	4	0.05
	Rhinobatos glaucostigma	3	0.15											3	0.05			3	0.04
	Rhinobatos productus	21	1.03	165	8.92	671	24.53	295	34.26	38	4.96			730	13.18	460	15.63	1190	14.03
	Rhinobatos sp.					1	0.04							1	0.02			1	0.01
	Rhinoptera steindachneri					133	4.86	22	2.56	6	0.78			139	2.51	22	0.75	161	1.90
	Urobatis halleri											1	0.43			1	0.03	1	0.01
	Urobatis sp.			1	0.05											1	0.03	1	0.01
	Zapteryx exasperata			34	1.84							2	0.85			36	1.22	36	0.42
	Subtotal	**26**	1.28	**345**	**18.66**	**1265**	**46.25**	**420**	**48.78**	**130**	**16.97**	**9**	**3.85**	**1421**	**25.65**	**774**	**26.29**	**2195**	**25.88**
Batoid	Unidentified	1	0.05			1	0.04							2	0.04			2	0.02
	Subtotal	**1**	**0.05**	**0**	**0.00**	**1**	**0.04**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**2**	**0.04**	**0**	**0.00**	**2**	**0.02**
Invertebrate	Bivalvia							25	2.90							25	0.85	25	0.29
	Brachyura											4	1.71			4	0.14	4	0.05
	Callinectes spp.					7	0.26	14	1.63					7	0.13	14	0.48	21	0.25
	Dosidicus gigas											5	2.14			5	0.17	5	0.06
	Gastropoda			20	1.08											20	0.68	20	0.24
	Octopus spp.							8	0.93							8	0.27	8	0.09
	Panulirus gracilis							2	0.23							2	0.07	2	0.02
	Panulirus spp.			7	0.38											7	0.24	7	0.08

Table 3. continued.

Higher Taxon	Lowest Possible Taxon	Spring 1998n	Spring 1998%	Spring 1999n	Spring 1999%	Summer 1998n	Summer 1998%	Summer 1999n	Summer 1999%	Autumn 1998n	Autumn 1998%	Autumn 1999n	Autumn 1999%	1998 n	1998 %	1999 n	1999 %	Total n	Total %
	Portunidae	1	0.05					17	1.97					1	0.02	17	0.58	18	0.21
	Scyllarides astori			1	0.05			2	0.23							3	0.10	3	0.04
	Teuthoidea					2	0.07							2	0.04	0	0.00	2	0.02
	Subtotal	**1**	**0.05**	**28**	**1.51**	**9**	**0.33**	**68**	**7.90**	**0**	**0.00**	**9**	**3.85**	**10**	**0.18**	**105**	**3.57**	**115**	**1.36**
Teleost	*Abudefduf* sp.							1	0.12							1	0.03	1	0.01
	Anchoa sp.							1	0.12							1	0.03	1	0.01
	Atractoscion nobilis	14	0.69	1	0.05	8	0.29							22	0.40	1	0.03	23	0.27
	Balistes polylepis	2	0.10	5	0.27	7	0.26	20	2.32	4	0.52	1	0.43	13	0.23	26	0.88	39	0.46
	Balistidae					33	1.21	1	0.12	2	0.26			35	0.63	1	0.03	36	0.42
	Bothidae			11	0.59	1	0.04			3	0.39			4	0.07	11	0.37	15	0.18
	Carangidae							2	0.23							2	0.07	2	0.02
	Caulolatilus princeps			1	0.05					6	0.78			6	0.11	1	0.03	7	0.08
	Caulolatilus spp.	1	0.05	2	0.11							4	1.71	1	0.02	6	0.20	7	0.08
	Citharichthys sp.			1	0.05											1	0.03	1	0.01
	Coryphaena hippurus					1	0.04	2	0.23					1	0.02	2	0.07	3	0.04
	Cynoscion spp.							2	0.23							2	0.07	2	0.02
	Euthynnus lineatus							1	0.12	51	6.66			51	0.92	1	0.03	52	0.61
	Gerreidae	30	1.47	12	0.65	31	1.13	35	4.07	43	5.61	8	3.42	104	1.88	55	1.87	159	1.87
	Girella spp.			3	0.16											3	0.10	3	0.04
	Haemulidae							1	0.12							1	0.03	1	0.01
	Haemulon sexfasciatum							9	1.05							9	0.31	9	0.11
	Istiophorus platypterus							3	0.35	1	0.13			1	0.02	3	0.10	4	0.05
	Kathetostoma averruncus							1	0.12							1	0.03	1	0.01
	Lutjanidae			5	0.27	5	0.18	7	0.81			3	1.28	5	0.09	15	0.51	20	0.24
	Merluccius sp.			1	0.05											1	0.03	1	0.01
	Mugilidae					1	0.04							1	0.02			1	0.01
	Mycteroperca rosacea					2	0.07	1	0.12					2	0.04	1	0.03	3	0.04
	Paralabrax maculatofasciatus	1	0.05			6	0.22	33	3.83					7	0.13	33	1.12	40	0.47
	Paralabrax spp.	1	0.05	30	1.62	5	0.18			1	0.13	1	0.43	7	0.13	31	1.05	38	0.45
	Paralichthys californicus			10	0.54											10	0.34	10	0.12
	Paralichthys spp.			92	4.98			37	4.30			10	4.27			139	4.72	139	1.64
	Pleuronectidae			59	3.19					2	0.26			2	0.04	59	2.00	61	0.72
	Pleuronectiformes	21	1.03			9	0.33							30	0.54			30	0.35
	Pleuronichthys sp.							1	0.12							1	0.03	1	0.01
	Sarda chiliensis									5	0.65			5	0.09			5	0.06
	Scaridae							3	0.35							3	0.10	3	0.04
	Sciaenidae	1815	89.06	2	0.11	33	1.21	15	1.74					1848	33.36	17	0.58	1865	21.99
	Scomber japonicus							62	7.20							62	2.11	62	0.73
	Scomber spp.					40	1.46							40	0.72			40	0.47
	Scomberomorus spp.					832	30.42							832	15.02			832	9.81
	Scombridae									2	0.26	5	2.14	2	0.04	5	0.17	7	0.08
	Scorpaena mystes			5	0.27											5	0.17	5	0.06
	Scorpaena spp.			7	0.38			1	0.12							8	0.27	8	0.09
	Scorpaenidae	1	0.05	2	0.11	1	0.04	1	0.12	18	2.35			20	0.36	3	0.10	23	0.27
	Scorpaenodes xyris							6	0.70	1	0.13			1	0.02	6	0.20	7	0.08
	Semicossyphus pulcher	1	0.05							1	0.13			2	0.04			2	0.02
	Seriola spp.											15	6.41			15	0.51	15	0.18
	Serranidae					2	0.07	2	0.23					2	0.04	2	0.07	4	0.05
	Sphoeroides annulatus							1	0.12							1	0.03	1	0.01
	Sphyraena argentea							3	0.35							3	0.10	3	0.04
	Synodus spp.							5	0.58							5	0.17	5	0.06
	Tetraodontidae					1	0.04							1	0.02			1	0.01
	Trachinotus paitensis							5	0.58							5	0.17	5	0.06
	Trachinotus spp.					5	0.18	1	0.12					5	0.09	1	0.03	6	0.07
	Unidentified			184	9.95	1	0.04							1	0.02	184	6.25	185	2.18
	Uranoscopidae			1	0.05											1	0.03	1	0.01
	Subtotal	**1887**	**92.59**	**434**	**23.47**	**1024**	**37.44**	**263**	**30.55**	**140**	**18.28**	**47**	**20.09**	**3051**	**55.08**	**744**	**25.27**	**3795**	**44.74**
Turtle	*Chelonia mydas*			1	0.05			1	0.12							2	0.07	2	0.02
	Subtotal	**0**	**0.00**	**1**	**0.05**	**0**	**0.00**	**1**	**0.12**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**2**	**0.07**	**2**	**0.02**
	Total	**2038**	**100.00**	**1849**	**100.00**	**2735**	**100.00**	**861**	**100.00**	**766**	**100.00**	**234**	**100.00**	**5539**	**100.00**	**2944**	**100.00**	**8483**	**100.00**

Table 4. Seasonal catch per unit effort (CPUE = #individuals/vessel/trip) and standard error (SE) of shark, skate, and ray landings sampled in Baja California during 1998-1999. Sample size (number of vessels examined) is indicated for each season in parentheses.

		Spring (n = 23)		Summer (n = 73)		Autumn (n = 46)	
Higher Taxon	Lowest Possible Taxon	CPUE	SE	CPUE	SE	CPUE	SE
Shark	*Alopias pelagicus*			0.05	0.03	3.72	0.90
	Alopias superciliosus			0.01	0.01	0.04	0.03
	Alopias vulpinus					0.04	0.03
	Carcharhinidae			1.33	0.73		
	Carcharhinus falciformis			1.42	0.42		
	Carcharhinus limbatus			0.07	0.06	1.02	0.27
	Carcharhinus obscurus			0.01	0.01		
	Cephaloscyllium ventriosum	1.17	0.75			0.02	0.02
	Heterodontus mexicanus	11.48	5.86	0.10	0.07	0.41	0.21
	Isurus oxyrinchus			0.04	0.03	0.04	0.03
	Mustelus henlei					2.37	0.77
	Mustelus spp.	27.78	7.73	1.12	0.88	4.91	1.79
	Prionace glauca			0.01	0.01		
	Rhizoprionodon longurio			1.55	0.79	0.02	0.02
	Sphyrna lewini			0.18	0.07	0.17	0.13
	Sphyrna spp.			0.27	0.14		
	Sphyrna zygaena			0.88	0.30	0.43	0.15
	Squatina californica	5.35	1.96			1.11	0.79
	Triakis semifasciata	0.09	0.06			0.02	0.02
	Unidentified	2.57	2.57				
	Subtotal	**48.43**	**9.64**	**7.05**	**1.72**	**14.35**	**2.64**
Skate	*Raja inornata*	0.17	0.14			0.02	0.02
	Raja velezi	1.13	0.45			0.09	0.05
	Subtotal	**1.30**	**0.48**	**0.00**	**0.00**	**0.07**	**0.06**
Ray	*Dasyatis dipterura*	0.74	0.45	0.26	0.09	0.02	0.02
	Dasyatis longa			0.08	0.08		
	Dasyatis sp.			0.01	0.01		
	Gymnura spp.	2.30	0.74	1.62	0.35	0.46	0.25
	Mobula japanica			0.05	0.03	0.02	0.02
	Mobula munkiana			3.32	1.55	0.11	0.11
	Mobula sp.			0.01	0.01		
	Mobula thurstoni			0.12	0.07		
	Myliobatidae			0.08	0.08		
	Myliobatis californica	2.96	1.27	1.68	1.13	1.28	0.74
	Myliobatis longirostris			0.26	0.23	0.11	0.06
	Myliobatis sp.	0.04	0.04				
	Narcine entemedor	0.17	0.14	0.05	0.03		
	Narcine spp.			0.14	0.10		
	Rhinobatidae	0.17	0.17				
	Rhinobatos productus	7.17	2.79	13.22	3.60	0.83	0.36
	Rhinobatos sp.			0.01	0.01		
	Rhinoptera steindachneri			2.12	0.79	0.13	0.13
	Urobatis halleri					0.02	0.02
	Urobatis sp.	0.04	0.04				
	Zapteryx exasperata	1.48	0.56			0.04	0.03
	Subtotal	**15.09**	**3.89**	**23.05**	**5.64**	**3.02**	**1.18**
Batoid	Unidentified	0.04	0.04	0.01	0.01		
	Subtotal	**0.04**	**0.04**	**0.01**	**0.01**	**0.00**	**0.00**

Table 5. Size composition of elasmobranchs sampled from artisanal fishery landings in Baja California during 1998-1999. Only specimens identified to species are included. DD = inter-dorsal distance; DW = disc width; PCL = precaudal length; STL = stretched total length; TL* = estimated total length (based on conversion equations in Castillo-Géniz, 2007).

Chondrichthyan Group	Species	Sex	n	Measurement (cm)	Minimum	Maximum	Mean	±1 SD
Shark	*Alopias pelagicus*	F	104	PCL	114	162	134.3	8.3
		M	39	PCL	109	150	130.4	8.6
	Alopias superciliosus	F	1	DD	153	153		
		M	2	DD	54	56	55	1.4
	Alopias vulpinus	F	1	PCL	211	211		
		M	1	PCL	168	168		
	Carcharhinus falciformis	F	54	STL	163	245	198.2	17.1
		M	28	STL	155	215	183.5	16.6
	Carcharhinus limbatus	F	10	STL	76	208	138.3	46.6
		M	35	STL	64	230	176.8	47.8
	Carcharhinus obscurus	F	1	STL	98	98		
	Cephaloscyllium ventriosum	F	8	STL	67	84	76.4	6.3
		M	1	STL	68	68		
	Heterodontus mexicanus	F	49	STL	51	82	70.6	6.7
		M	34	STL	43	90	60.1	9.9
	Isurus oxyrinchus	F	1	STL	128	128		
		M	3	STL	140	234	177.7	49.7
	Mustelus henlei	F	16	STL	63	93	79.4	12.3
		M	17	STL	63	93	80.8	12.3
	Rhizoprionodon longurio	F	44	STL	30	120	89.7	19.9
		M	52	STL	31	113	86.9	19.0
	Sphyrna lewini	F	14	STL	47	232	110.3	69.4
		M	7	STL	49	201	95.2	65.7
	Sphyrna zygaena	F	38	STL	46	176	108.8	40.2
		M	34	STL	56	248	112.6	42.1
	Squatina californica	F	20	STL	72	94	88.4	5.5
		M	38	STL	55	97	87.8	6.9
	Triakis semifasciata	F	1	STL	63	63		
Batoid	*Dasyatis dipterura*	F	12	DW	34	73	54.3	13.1
		M	7	DW	37	49	43.9	4.0
	Dasyatis longa	M	3	DW	36	75	50.7	21.2
	Mobula japanica	F	2	DW	68	203	135.5	95.5
		M	3	DW	105	223	181.3	66.3
	Mobula munkiana	F	39	DW	58	77	67.6	3.9
		M	42	DW	54	74	67.8	4.3
	Mobula thurstoni	F	3	DW	141	176	162.8	19.0
		M	6	DW	156	215	169.0	22.9
	Myliobatis californica	F	29	DW	45	102	69.7	13.2
		M	72	DW	49	83	61.7	6.5
	Myliobatis longirostris	F	2	DW	64	97	69.7	13.2
		M	8	DW	51	63	61.7	6.5
	Narcine entemedor	F	6	STL	49	86	63.3	13.1
	Raja inornata	F	1	DW	40	40		
	Raja inornata	F	1	TL*	40	40		
	Raja velezi	F	4	DW	41	73	61.8	14.9
		M	13	DW	57	70	64.8	4.1
	Raja velezi	F	4	TL*	57	93	80.3	16.6
		M	13	TL*	75	88	83.2	4.2
	Rhinobatos productus	F	376	STL	44	99	76.3	7.7
		M	96	STL	46	83	63.7	5.7
	Rhinoptera steindachneri	F	34	DW	61	90	78.5	6.5
		M	57	DW	57	81	73.9	4.0
	Urobatis halleri	M	1	DW	21	21		
	Zapteryx exasperata	F	5	STL	69	84	76.2	6.1
		M	11	STL	64	75	69.3	3.2

Table 6. Descriptive information for all artisanal fishing camps documented in Baja California Sur (BCS) during 1998-1999. Type = A (little to no infrastructure), B (moderate infrastructure), and C (significant infrastructure); Perm. (Permanence) = 1 (permanent) and 2 (seasonal); Active = period of fishing activity; #Pangas = number or range of operational artisanal fishing vessels at the time of survey(s); Elasmo. (elasmobranchs targeted) = Yes (elasmobranchs were targeted during the year) and No (there was no directed fishery for elasmobranchs). Zero values listed for #Pangas indicate that the camp was temporarily inactive (because of weather, holidays, etc.) or seasonally abandoned at the time of survey. In all instances, U = unknown.

Camp Code	Camp Name	Latitude	Longitude	Type	Perm.	Active	#Pangas	Elasmo.
BCS-01	La Playa	23.054	-109.671	C	1	Year-Round	11-171	No
BCS-02	La Playa II	23.247	-109.437	A	2	Oct-Feb	2	U
BCS-03	Los Frailes	23.389	-109.439	A	2	Sep-Apr	17-80	Yes
BCS-04	La Ribera	23.454	-109.433	B	1	Year-Round	13-50	No
BCS-05	Los Barriles	23.675	-109.707	C	1	Year-Round	0-80	No
BCS-06	Las Pilitas	23.771	-109.710	A	2	Nov-Jun	1	Yes
BCS-07	Punta Pescadero	23.791	-109.708	A	1	Year-Round	4-5	U
BCS-08	La Tina	23.817	-109.730	B	1	Year-Round	1-4	U
BCS-09	San Javier (Los Algodones)	23.832	-109.736	B	1	Year-Round	1-2	Yes
BCS-10	El Cardonal	23.843	-109.743	B	2	6 Months	3-5	Yes
BCS-11	La Linea	23.866	-109.766	B	1	Year-Round	1	U
BCS-12	San Isidro	23.894	-109.789	B	1	Year-Round	1-4	Yes
BCS-13	Boca del Alamo	23.901	-109.805	B	1	Year-Round	6-12	Yes
BCS-14	Ensenada de Los Muertos	23.997	-109.831	B	1	Year-Round	3	Yes
BCS-15	Punta Arenas	24.051	-109.834	B	1	Year-Round	3-40	Yes
BCS-16	La Ventana	24.051	-109.992	B	1	Year-Round	7-8	Yes
BCS-17	El Sargento	24.079	-109.992	U	1	Year-Round	11-150	U
BCS-18	Canechica	24.149	-109.864	A	2	Nov-Jun	3	Yes
BCS-19	La Loberita	24.197	-109.815	A	1	Year-Round	2	Yes
BCS-20	La Paz	24.152	-110.317	C	1	Year-Round	8-20	Yes
BCS-21	El Quelele	24.203	-110.508	A	1	Year-Round	1	U
BCS-22	Los Rodriguez	24.205	-110.536	B	1	Year-Round	3	U
BCS-23	Punta Leon	24.218	-110.566	A	1	Year-Round	1-2	Yes
BCS-24	Las Pacas	24.228	-110.577	B	1	Year-Round	4-6	U
BCS-25	Pichilingue	24.267	-110.317	B	2	U	11	U
BCS-26	El Sauzoso	24.311	-110.641	U	1	Year-Round	3	No
BCS-27	San Juan de la Costa	24.381	-110.683	A	1	Year-Round	2-4	Yes
BCS-28	La Cueva de San Gabriel	24.427	-110.370	A	1	Year-Round	1	U
BCS-29	El Saladito	24.443	-110.688	U	U	U	0-2	Yes
BCS-30	El Empachado	24.446	-110.374	A	1	Year-Round	1	U
BCS-31	La Cueva Cropola	24.447	-110.367	B	1	Year-Round	2	Yes
BCS-32	La Partida	24.531	-110.368	B	1	Year-Round	10	U
BCS-33	La Cueva (La Partidae)	24.532	-110.383	B	1	Year-Round	U	U
BCS-34	Punta Coyote	24.710	-110.700	A	2	8 Months	2	No
BCS-35	El Portugues	24.757	-110.690	A	2	Sep-Apr	2-3	Yes
BCS-36	El Pardito	24.858	-110.586	A	1	Year-Round	4-5	Yes
BCS-37	San Evaristo	24.915	-110.714	B	1	Year-Round	9-20	Yes
BCS-38	La Palma Sola	24.933	-110.633	B	2	6 Months	6	U
BCS-39	Nopolo	24.995	-110.758	A	1	Year-Round	7	U
BCS-40	La Curva de Punta Alta	25.009	-110.759	A	1	Year-Round	3	U
BCS-41	Punta Alta	25.012	-110.759	U	1	Year-Round	5-6	No
BCS-42	Los Burros	25.049	-110.825	A	1	Year-Round	2	U

Table 6. continued.

Camp Code	Camp Name	Latitude	Longitude	Type	Perm.	Active	#Pangas	Elasmo.
BCS-43	Timbabichi	25.264	-110.947	A	1	Year-Round	5	No
BCS-44	Agua Verde	25.522	-111.068	B	1	Year-Round	4-10	Yes
BCS-45	Isla Catalina, Punta Sur	25.613	-110.788	A	2	Jul-Apr	0	U
BCS-46	Isla Monserrat	25.707	-111.044	A	U	U	U	U
BCS-47	Ensenada Blanca	25.732	-111.255	B	1	Year-Round	5-13	Yes
BCS-48	Ligui	25.749	-111.266	B	1	Year-Round	0-9	No
BCS-49	Puerto Escondido	25.818	-111.312	C	2	U	0	U
BCS-50	Juncalito	25.843	-111.341	B	1	Year-Round	2-15	Yes
BCS-51	Ensenada Amarilla-Rincon	25.867	-111.183	A	2	5 Months	2	U
BCS-52	Col. Zaragoza	25.883	-111.347	C	1	Year-Round	9	U
BCS-53	Nopolo II	25.939	-111.358	C	1	Year-Round	0	U
BCS-54	Loreto	26.024	-111.343	C	1	Year-Round	25-200	Yes
BCS-55	Puerto Balandra	26.022	-111.164	A	2	11 Months	0-5	Yes
BCS-56	Ensenadita	26.121	-111.290	A	2	U	2	Yes
BCS-57	San Bruno	26.226	-111.386	B	1	Year-Round	0-125	U
BCS-58	San Juanico	26.414	-111.450	B	2	3 Months	8	Yes
BCS-59	Palo San Juan	26.457	-111.472	U	U	U	3	U
BCS-60	El Manglito	26.553	-111.764	A	2	4-6 Months	2-6	Yes
BCS-61	San Nicolas	26.559	-111.557	B	1	Year-Round	2-14	Yes
BCS-62	El Sauce	26.558	-111.567	A	1	Year-Round	2-3	Yes
BCS-63	El Cardancito	26.566	-111.577	A	1	Year-Round	7	Yes
BCS-64	La Huertita	26.589	-111.786	U	1	Year-Round	1-5	Yes
BCS-65	La Ramadita	26.586	-111.573	B	1	Year-Round	7-16	Yes
BCS-66	Requeson	26.635	-111.826	A	2	U	2-5	U
BCS-67	El Frijol	26.650	-111.831	A	2	3 Months	5	U
BCS-68	Santa Rosa	26.783	-111.667	A	1	Year-Round	2	U
BCS-69	Guadalupe	26.843	-111.844	A	2	U	2	Yes
BCS-70	Los Hornitos	26.874	-111.851	A	1	Year-Round	U	U
BCS-71	Mulege	26.903	-111.959	C	1	Year-Round	4-80	Yes
BCS-72	Cooperativa de los Del Real	27.033	-112.017	A	2	6 Months	5	U
BCS-73	Punta Colaradito	27.060	-111.986	A	1	Year-Round	3	No
BCS-74	San Rafaelito	27.149	-112.123	A	2	U	0-6	U
BCS-75	San Bruno (2)	27.173	-112.169	B	1	Year-Round	10-50	Yes
BCS-76	San Lucas	27.223	-112.220	B	1	Year-Round	4-120	Yes
BCS-77	Santa Rosalia	27.328	-112.259	C	1	Year-Round	8-450	Yes
BCS-78	Santa Maria	27.429	-112.326	B	1	Year-Round	0-15	Yes
BCS-79	Punta la Reforma	27.583	-112.414	A	U	U	0	U
BCS-80	La Reforma	27.595	-112.444	A	U	U	0	U
BCS-81	Santana	27.673	-112.608	B	1	Year-Round	4-8	Yes
BCS-82	La Trinidad	27.829	-112.729	A	2	U	0	U
BCS-83	Mojon	27.905	-112.775	A	2	U	0	Yes

Table 7. Seasonal, annual, and total catch composition of shark, skate, and ray landings sampled from artisanal vessels targeting elasmobranchs in Baja California Sur during 1998-1999. n = number of individuals, % = percentage of elasmobranch landings. No surveys were conducted during summer 1998.

		Spring				Summer		Autumn				Winter				1998		1999		Total	
Higher Taxon	Lowest Possible Taxon	1998n	1998%	1999n	1999%	1999n	1999%	1998n	1998%	1999n	1999%	1998n	1998%	1999n	1999%	n	%	n	%	n	%
Shark	*Alopias pelagicus*	0	0.00	4	1.23	7	6.67	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	11	1.88	11	1.13
	Alopias superciliosus	0	0.00	2	0.62	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.34	2	0.21
	Carcharhinidae	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.69	0	0.00	1	0.26	0	0.00	1	0.10
	Carcharhinus falciformis	8	7.84	1	0.31	0	0.00	0	0.00	25	44.64	1	0.69	1	1.02	9	2.32	27	4.62	36	3.70
	Carcharhinus galapagensis	0	0.00	0	0.00	0	0.00	0	0.00	1	1.79	0	0.00	0	0.00	0	0.00	1	0.17	1	0.10
	Carcharhinus limbatus	0	0.00	6	1.85	8	7.62	0	0.00	0	0.00	0	0.00	4	4.08	0	0.00	18	3.08	18	1.85
	Carcharhinus longimanus	2	1.96	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.52	0	0.00	2	0.21
	Carcharhinus obscurus	0	0.00	2	0.62	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.34	2	0.21
	Carcharhinus porosus	0	0.00	0	0.00	0	0.00	1	0.70	0	0.00	0	0.00	0	0.00	1	0.26	0	0.00	1	0.10
	Echinorhinus cookei	0	0.00	1	0.31	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	1	0.10
	Galeocerdo cuvier	1	0.98	0	0.00	0	0.00	1	0.70	0	0.00	0	0.00	0	0.00	2	0.52	0	0.00	2	0.21
	Isurus oxyrinchus	6	5.88	19	5.85	0	0.00	0	0.00	0	0.00	0	0.00	13	13.27	6	1.55	32	5.48	38	3.91
	Mustelus spp.	0	0.00	14	4.31	0	0.00	1	0.70	4	7.14	4	2.78	1	1.02	5	1.29	19	3.25	24	2.47
	Nasolamia velox	0	0.00	0	0.00	57	54.29	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	57	9.76	57	5.86
	Negaprion brevirostris	0	0.00	0	0.00	0	0.00	3	2.11	0	0.00	0	0.00	0	0.00	3	0.77	0	0.00	3	0.31
	Prionace glauca	49	48.04	34	10.46	3	2.86	0	0.00	1	1.79	0	0.00	24	24.49	49	12.63	62	10.62	111	11.42
	Rhizoprionodon longurio	0	0.00	103	31.69	0	0.00	6	4.23	0	0.00	1	0.69	0	0.00	7	1.80	103	17.64	110	11.32
	Sphyrna lewini	0	0.00	21	6.46	0	0.00	56	39.44	0	0.00	66	45.83	5	5.10	122	31.44	26	4.45	148	15.23
	Sphyrna zygaena	3	2.94	7	2.15	0	0.00	2	1.41	0	0.00	0	0.00	0	0.00	5	1.29	7	1.20	12	1.23
	Squatina californica	0	0.00	25	7.69	0	0.00	40	28.17	24	42.86	22	15.28	2	2.04	62	15.98	51	8.73	113	11.63
	Subtotal	**69**	**67.65**	**239**	**73.54**	**75**	**71.43**	**110**	**77.46**	**55**	**98.21**	**95**	**65.97**	**50**	**51.02**	**274**	**70.62**	**419**	**71.75**	**693**	**71.30**
Skate	*Raja velezi*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	2.04	0	0.00	2	0.34	2	0.21
	Subtotal	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**2**	**2.04**	**0**	**0.00**	**2**	**0.34**	**2**	**0.21**
Ray																					
	Dasyatis dipterura	0	0.00	8	2.46	2	1.90	2	1.41	0	0.00	2	1.39	19	19.39	4	1.03	29	4.97	33	3.40
	Dasyatis longa	0	0.00	14	4.31	1	0.95	1	0.70	0	0.00	0	0.00	4	4.08	1	0.26	19	3.25	20	2.06
	Gymnura spp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	33	22.92	0	0.00	33	8.51	0	0.00	33	3.40
	Manta birostris	1	0.98	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.26	0	0.00	1	0.10
	Mobula japanica	22	21.57	0	0.00	4	3.81	0	0.00	0	0.00	2	1.39	1	1.02	24	6.19	5	0.86	29	2.98
	Mobula munkiana	9	8.82	56	17.23	3	2.86	0	0.00	0	0.00	1	0.69	15	15.31	10	2.58	74	12.67	84	8.64
	Mobula spp.	0	0.00	1	0.31	0	0.00	2	1.41	0	0.00	0	0.00	0	0.00	2	0.52	1	0.17	3	0.31
	Mobula thurstoni	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	2.08	3	3.06	3	0.77	3	0.51	6	0.62
	Myliobatis californica	0	0.00	0	0.00	0	0.00	2	1.41	0	0.00	0	0.00	1	1.02	2	0.52	1	0.17	3	0.31
	Myliobatis longirostris	0	0.00	1	0.31	0	0.00	0	0.00	0	0.00	4	2.78	2	2.04	4	1.03	3	0.51	7	0.72
	Narcine entemedor	1	0.98	1	0.31	0	0.00	0	0.00	0	0.00	1	0.69	0	0.00	2	0.52	1	0.17	3	0.31
	Pteroplatytrygon violacea	0	0.00	0	0.00	0	0.00	1	0.70	0	0.00	0	0.00	0	0.00	1	0.26	0	0.00	1	0.10
	Rhinobatos glaucostigma	0	0.00	0	0.00	0	0.00	7	4.93	0	0.00	0	0.00	0	0.00	7	1.80	0	0.00	7	0.72
	Rhinobatos leucorhynchus	0	0.00	0	0.00	0	0.00	1	0.70	0	0.00	0	0.00	0	0.00	1	0.26	0	0.00	1	0.10
	Rhinobatos productus	0	0.00	2	0.62	16	15.24	0	0.00	1	1.79	0	0.00	0	0.00	0	0.00	19	3.25	19	1.95
	Rhinobatos spp.	0	0.00	0	0.00	0	0.00	9	6.34	0	0.00	0	0.00	0	0.00	9	2.32	0	0.00	9	0.93
	Rhinoptera steindachneri	0	0.00	0	0.00	0	0.00	7	4.93	0	0.00	0	0.00	1	1.02	7	1.80	1	0.17	8	0.82
	Urobatis halleri	0	0.00	1	0.31	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	1	0.10
	Urobatis maculatus	0	0.00	2	0.62	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.34	2	0.21
	Zapteryx exasperata	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	2.08	0	0.00	3	0.77	0	0.00	3	0.31
	Subtotal	**33**	**32.35**	**86**	**26.46**	**26**	**24.76**	**32**	**22.54**	**1**	**1.79**	**49**	**34.03**	**46**	**46.94**	**114**	**29.38**	**159**	**27.23**	**273**	**28.09**
Batoid	Unidentified	0	0.00	0	0.00	4	3.81	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	0.68	4	0.41
	Subtotal	**0**	**0.00**	**0**	**0.00**	**4**	**3.81**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**4**	**0.68**	**4**	**0.41**
	Total	**102**	**100.00**	**325**	**100.00**	**105**	**100.00**	**142**	**100.00**	**56**	**100.00**	**144**	**100.00**	**98**	**100.00**	**388**	**100.00**	**584**	**100.00**	**972**	**100.00**

Table 8. Non-elasmobranch taxa sampled from artisanal fishery landings in Baja California Sur during 1998-1999.

Higher Taxon	Family	Genus & Species
Teleost	Balistidae	*Balistes polylepis*
	Bothidae	
	Carangidae	
	Coryphaenidae	*Coryphaena hippurus*
	Gerreidae	
	Haemulidae	
	Istiophoridae	*Istiophorus platypterus*
	Istiophoridae	*Makaira* spp.
	Labridae	
	Lutjanidae	*Hoplopagrus guntheri*
	Lutjanidae	*Lutjanus argentiventris*
	Lutjanidae	*Lutjanus* spp.
	Malacanthidae	*Caulolatilus princeps*
	Malacanthidae	*Caulolatilus* sp.
	Mullidae	*Mulloidichthys dentatus*
	Nemastistiidae	*Nematistius pectoralis*
	Pleuronectiformes	
	Pomacentridae	*Abudefduf troschelii*
	Sciaenidae	*Cynoscion* spp.
	Scomberesocidae	
	Scombridae	*Euthynnus* sp.
	Scombridae	*Katsuwonus pelamis*
	Scombridae	*Scomber japonica*
	Scombridae	*Scomberomorus* spp.
	Scorpaenidae	*Scorpaena* sp.
	Serranidae	*Mycteroperca* spp.
	Serranidae	*Paralabrax auroguttatus*
	Serranidae	*Paralabrax maculatofasciatus*
	Serranidae	*Paralabrax* spp.
	Sphyraenidae	*Sphyraena argentea*

Table 9. Seasonal catch per unit effort (CPUE = #individuals/vessel/trip) and standard error (SE) of shark, skate, and ray landings sampled in Baja California Sur during 1998-1999. Sample size (number of vessels examined) is indicated for each season in parentheses.

		Spring (n = 74)		Summer (n = 8)		Autumn (n = 21)		Winter (n = 28)	
Higher Taxon	Lowest Possible Taxon	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Shark	*Alopias pelagicus*	0.05	0.05	0.88	0.48				
	Alopias superciliosus	0.03	0.03						
	Carcharhinidae							0.04	0.04
	Carcharhinus falciformis	0.12	0.05			1.19	0.49	0.07	0.05
	Carcharhinus galapagensis					0.05	0.05		
	Carcharhinus limbatus	0.08	0.04	1.00	1.00			0.14	0.11
	Carcharhinus longimanus	0.03	0.03						
	Carcharhinus obscurus	0.03	0.03						
	Carcharhinus porosus					0.05	0.05		
	Echinorhinus cookei	0.01	0.01						
	Galeocerdo cuvier	0.01	0.01			0.05	0.05		
	Isurus oxyrinchus	0.34	0.09					0.46	0.14
	Mustelus spp.	0.19	0.12			0.24	0.19	0.18	0.15
	Nasolamia velox			7.13	7.13				
	Negaprion brevirostris			0.38	0.38	0.14	0.14		
	Prionace glauca	1.12	0.17			0.05	0.05	0.86	0.26
	Rhizoprionidon longurio	1.39	0.75			0.29	0.24	0.04	0.04
	Sphyrna lewini	0.28	0.14			2.67	1.10	2.54	1.29
	Sphyrna zygaena	0.14	0.06			0.10	0.07		
	Squatina californica	0.34	0.32			3.05	1.13	0.86	0.39
	Subtotal	**4.16**	**0.61**	**9.38**	**6.86**	**7.86**	**1.68**	**5.18**	**1.55**
Skate	*Raja velezi*							0.07	0.07
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.07**	**0.07**
Ray	*Dasyatis dipterura*	0.11	0.10	0.25	0.25	0.10	0.07	0.75	0.68
	Dasyatis longa	0.19	0.13	0.13	0.13	0.05	0.05	0.14	
	Gymnura spp.							1.18	1.07
	Manta birostris	0.01	0.01						
	Mobula japanica	0.30	0.14	0.50	0.50			0.11	0.06
	Mobula munkiana	0.88	0.52	0.38	0.38			0.57	0.50
	Mobula spp.	0.01	0.01			0.10	0.07		
	Mobula thurstoni							0.21	0.13
	Myliobatis californica					0.10	0.10	0.04	0.04
	Myliobatis longirostris	0.01	0.01					0.21	0.09
	Narcine entemedor	0.03	0.02					0.04	0.04
	Pteroplatytrygon violacea					0.05	0.05		
	Rhinobatos glaucostigma					0.33	0.33		
	Rhinobatos leucorhynchus					0.05	0.05		
	Rhinobatos productus	0.03	0.03	2.00	2.00	0.05	0.05		
	Rhinobatos spp.					0.43	0.30		
	Rhinoptera steindachneri					0.33	0.33	0.04	0.04
	Urobatis halleri	0.01	0.01						
	Urobatis maculatus	0.03	0.03						
	Zapteryx exasperata							0.11	0.11
	Subtotal	**1.61**	**0.61**	**3.25**	**2.02**	**1.57**	**0.51**	**3.39**	**1.51**
Batoid	Unidentified			0.50	0.50				
	Subtotal	**0.00**	**0.00**	**0.50**	**0.50**	**0.00**	**0.00**	**0.00**	**0.00**

Table 10. Size composition of chondrichtyans sampled from artisanal fishery landings in Baja California Sur during 1998-1999. Only specimens identified to species are included. DW = disc width; PCL = precaudal length; STL = stretched total length; TL* = estimated total length (based on conversion equations in Castillo-Géniz, 2007).

Chondrichthyan Group	Species	Sex	n	Measurement (cm)	Minimum	Maximum	Mean	±1 SD
Shark	*Carcharhinus falciformis*	F	19	PCL	122	162	144.2	11.3
		M	16	PCL	95	189	140.5	20.8
	Isurus oxyrinchus	F	17	STL	110	268	166.4	40.1
		M	17	STL	92	253	178.6	44.0
	Nasolamia velox	F	29	STL	66	121	92.4	13.4
		M	27	STL	69	105	82.1	9.6
	Negaprion brevirostris	F	3	STL	119	128	122.3	4.9
	Prionace glauca	F	24	STL	141	230	201.7	23.0
		M	68	STL	133	275	199.1	22.5
	Rhizoprionodon longurio	F	26	STL	69	118	105.2	14.7
		M	19	STL	65	110	95.0	13.8
	Sphyrna lewini	F	37	STL	77	97	88.1	5.4
		M	47	STL	81	114	88.8	5.6
	Sphyrna zygaena	F	4	STL	204	262	242.8	18.5
		M	1	STL	224	224		
	Squatina californica	F	36	STL	62	93	77.2	5.9
		M	31	STL	68	89	77.5	5.5
Batoid	*Dasyatis dipterura*	F	7	DW	41	94	57.3	21.2
		M	6	DW	46	58	49.7	4.4
	Dasyatis longa	F	6	DW	50	118	76.8	31.2
		M	9	DW	57	96	77.0	12.2
	Dasyatis violacea	F	1	DW	67	67		
	Mobula japanica	F	13	DW	132	233	189.8	35.3
		M	8	DW	132	306	209.0	47.9
	Mobula munkiana	F	20	DW	62	107	86.5	16.6
		M	37	DW	64	108	91.9	14.1
	Mobula thurstoni	F	4	DW	93	170	122.8	34.7
		M	2	DW	102	156	129.0	38.2
	Narcine entemedor	F	4	STL	56	74	63.5	8.2
	Raja velezi	F	2	DW	62	66	64.0	2.8
	Raja velezi	F	2	TL*	80	84	82.7	3.1

Table 11. Descriptive information for all artisanal fishing camps documented in Sonora (SON) during 1998-1999. Type = A (little to no infrastructure), B (moderate infrastructure), and C (significant infrastructure); Perm. (Permanence) = 1 (permanent) and 2 (seasonal); Active = period of fishing activity; #Pangas = number or range of operational artisanal fishing vessels at the time of survey(s); Elasmo. (elasmobranchs targeted) = Yes (elasmobranchs were targeted during the year) and No (there was no directed fishery for elasmobranchs). Zero values listed for #Pangas indicate that the camp was temporarily inactive (because of weather, holidays, etc.) or seasonally abandoned at the time of survey. In all instances, U = unknown.

Camp Code	Camp Name	Latitude	Longitude	Type	Perm.	Active	#Pangas	Elasmo.
SON-01	Aguiabampo	26.368	-109.155	B	1	Year-Round	35	Yes
SON-02	Las Bocas	26.589	-109.340	B	1	Year-Round	20	U
SON-03	Santa Barbara	26.702	-109.652	B	2	8-12 Months	0-55	Yes
SON-04	Yavaros	26.711	-109.519	C	1	Year-Round	80	Yes
SON-05	Los Melagos	27.158	-110.305	A	1	Year-Round	9-35	Yes
SON-06	La Manga	27.988	-111.128	B	1	Year-Round	2-20	Yes
SON-07	El Choyudo	28.320	-111.450	B	1	Year-Round	2-49	Yes
SON-08	El Sahuimaro	28.554	-111.760	B	1	Year-Round	13-64	Yes
SON-09	Bahia Kino	28.820	-111.943	C	1	Year-Round	30-200	Yes
SON-10	Punta Chueca	29.023	-112.171	B	1	Year-Round	6-27	Yes
SON-11	Igipto	29.188	-112.208	A	2	8 Months	10	U
SON-12	El Sargento	29.333	-112.343	A	1	Year-Round	17	Yes
SON-13	Puerto Libertad	29.906	-112.692	B	1	Year-Round	120	Yes
SON-14	El Desemboque	30.568	-113.015	B	1	Year-Round	20-65	Yes
SON-15	La Pinta	31.255	-113.219	A	1	Year-Round	8-25	Yes
SON-16	Puerto Penasco	31.309	-113.558	C	1	Year-Round	8-60	Yes
SON-17	La Cholla	31.353	-113.468	B	1	Year-Round	0-40	Yes
SON-18	Golfo de Santa Clara	31.676	-114.505	B	1	Year-Round	500	U
SON-19	Santo Tomas	31.749	-114.579	A	2	U	17	Yes

Table 12. Seasonal, annual, and total catch composition of chimaera, shark, skate, and ray landings sampled from artisanal vessels targeting elasmobranchs in Sonora during 1998-1999. n = number of individuals, % = percentage of elasmobranch landings.

		Spring				Summer				Autumn				Winter		1998		1999		Total	
Higher Taxon	Lowest Possible Taxon	1998n	1998%	1999n	1999%	1998n	1998%	1999n	1999%	1998n	1998%	1999n	1999%	1999n	1999%	n	%	n	%	n	%
Chimaera	*Hydrolagus colliei*			1	0.00									4	0.07	0	0.00	5	0.00	5	0.00
	Subtotal	**0**	**0.00**	**1**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**4**	**0.07**	**0**	**0.00**	**5**	**0.00**	**5**	**0.00**
Shark	*Alopias pelagicus*			1	0.00	14	1.44	2	0.01	1	0.01					15	0.18	3	0.00	18	0.01
	Alopias vulpinus			9	0.01													9	0.01	9	0.01
	Carcharhinidae			1	0.00													1	0.00	1	0.00
	Carcharhinus falciformis			4	0.01	124	12.74	7	0.02	49	0.66					173	2.07	11	0.01	184	0.12
	Carcharhinus leucas							1	0.00									1	0.00	1	0.00
	Carcharhinus limbatus			45	0.06	2	0.21	35	0.11	2	0.03	283	0.85	10	0.17	4	0.05	373	0.25	377	0.24
	Carcharhinus obscurus			2	0.00	1	0.10									1	0.01	2	0.00	3	0.00
	Carcharhinus porosus											1	0.00					1	0.00	1	0.00
	Carcharhinus spp.					3	0.31			9	0.12					12	0.14			12	0.01
	Cephaloscyllium ventriosum			20	0.03									4	0.07			24	0.02	24	0.02
	Galeocerdo cuvier											49	0.15					49	0.03	49	0.03
	Heterodontus francisci													9	0.15			9	0.01	9	0.01
	Heterodontus mexicanus			781	1.00			3	0.01	15	0.20	11	0.03	13	0.22	15	0.18	808	0.54	823	0.52
	Heterondontus spp.			2	0.00							1	0.00					3	0.00	3	0.00
	Hexanchidae													2	0.03			2	0.00	2	0.00
	Hexanchus griseus			1	0.00													1	0.00	1	0.00
	Isurus oxyrinchus					3	0.31									3	0.04			3	0.00
	Mustelus henlei			22455	28.85			505	1.55			10181	30.52	237	3.95			33378	22.30	33378	21.12
	Mustelus spp.	2	14.29	947	1.22	2	0.21	184	0.57	5775	78.32	707	2.12	4076	67.85	5779	69.12	5914	3.95	11693	7.40
	Nasolamia velox											74	0.22					74	0.05	74	0.05
	Notorynchus cepedianus			1	0.00													1	0.00	1	0.00
	Prionace glauca							1	0.00									1	0.00	1	0.00
	Rhizoprionodon longurio			486	0.62	6	0.62	351	1.08	279	3.78	2740	8.21	1110	18.48	285	3.41	4687	3.13	4972	3.15
	Sphyrna lewini			24	0.03	12	1.23	238	0.73	250	3.39	2284	6.85	2	0.03	262	3.13	2548	1.70	2810	1.78
	Sphyrna spp.			3	0.00	16	1.64	7	0.02					4	0.07	16	0.19	14	0.01	30	0.02
	Sphyrna zygaena			372	0.48	26	2.67	357	1.10	124	1.68	35	0.10	15	0.25	150	1.79	779	0.52	929	0.59
	Squatina californica	3	21.43	1045	1.34	6	0.62	155	0.48	37	0.50	208	0.62	198	3.30	46	0.55	1606	1.07	1652	1.05
	Triakis semifasciata			2	0.00			2	0.01									4	0.00	4	0.00
	Subtotal	**5**	**35.71**	**26201**	**33.67**	**215**	**22.10**	**1848**	**5.69**	**6541**	**88.70**	**16574**	**49.68**	**5684**	**94.62**	**6761**	**80.86**	**50307**	**33.61**	**57064**	**36.11**
Skate	*Raja inornata*			2	0.00													2	0.00	2	0.00
	Raja spp.	2	14.29	1	0.00							4	0.01	1	0.02	2	0.02	6	0.00	8	0.01
	Raja velezi			683	0.88			36	0.11	1	0.01	56	0.17	46	0.77	1	0.01	821	0.55	822	0.52
	Subtotal	**2**	**14.29**	**686**	**0.88**	**0**	**0.00**	**36**	**0.11**	**1**	**0.01**	**60**	**0.18**	**47**	**0.78**	**3**	**0.04**	**829**	**0.55**	**832**	**0.53**
Ray	*Dasyatis dipterura*	1	7.14	3762	4.83	60	6.17	4977	15.32	218	2.96	6711	20.12	18	0.30	279	3.34	15468	10.33	15747	9.96
	Dasyatis longa			29	0.04			44	0.14	1	0.01	24	0.07			1	0.01	97	0.06	98	0.06
	Dasyatis spp.			151	0.19	1	0.10	39	0.12	4	0.05					5	0.06	190	0.13	195	0.12
	Gymnura spp.			7339	9.43	331	34.02	2588	7.97	44	0.60	2553	7.65	64	1.07	375	4.49	12544	8.38	12919	8.17
	Mobula japanica			27	0.03			11	0.03	51	0.69	1	0.00			51	0.61	39	0.03	90	0.06
	Mobula munkiana					10	1.03	3	0.01	8	0.11	1	0.00			18	0.22	4	0.00	22	0.01
	Mobula spp.			3	0.00	2	0.21	92	0.28	4	0.05					6	0.07	95	0.06	101	0.06
	Mobula thurstoni					1	0.10			1	0.01					2	0.02			2	0.00
	Myliobatis californica	1	7.14	850	1.09	40	4.11	29	0.09			1015	3.04	9	0.15	41	0.49	1903	1.27	1944	1.23
	Myliobatis longirostris			12	0.02	6	0.62	6	0.02			5	0.01			6	0.07	23	0.02	29	0.02
	Myliobatis spp.			3	0.00	13	1.34							1	0.02	13	0.16	4	0.00	17	0.01
	Narcine entemedor	3	21.43	3337	4.29	17	1.75	786	2.42	22	0.30	636	1.91	30	0.50	42	0.50	4789	3.20	4831	3.06
	Narcine spp.			51	0.07													51	0.03	51	0.03
	Rhinobatos glaucostigma			3570	4.59			790	2.43			217	0.65	12	0.20			4589	3.07	4589	2.90
	Rhinobatos leucorhynchus	1	7.14													1	0.01			1	0.00
	Rhinobatos productus	1	7.14	25443	32.69	40	4.11	17156	52.81	370	5.02	3210	9.62	111	1.85	411	4.92	45920	30.68	46331	29.32
	Rhinobatos spp.			2	0.00					4	0.05					4	0.05	2	0.00	6	0.00
	Rhinoptera steindachneri			4700	6.04	235	24.15	3692	11.37	102	1.38	2263	6.78	8	0.13	337	4.03	10663	7.12	11000	6.96

Table 12. continued.

Higher Taxon	Lowest Possible Taxon	Spring 1998n	Spring 1998%	Spring 1999n	Spring 1999%	Summer 1998n	Summer 1998%	Summer 1999n	Summer 1999%	Autumn 1998n	Autumn 1998%	Autumn 1999n	Autumn 1999%	Winter 1999n	Winter 1999%	1998 n	1998 %	1999 n	1999 %	Total n	Total %
	Urobatis halleri			17	0.02			22	0.07			2	0.01	1	0.02			42	0.03	42	0.03
	Urobatis maculatus			216	0.28			118	0.36			48	0.14					382	0.26	382	0.24
	Urobatis spp.			34	0.04							7	0.02					41	0.03	41	0.03
	Urotrygon chilensis			50	0.06			17	0.05			2	0.01					69	0.05	69	0.04
	Urotrygon rogersi			17	0.02													17	0.01	17	0.01
	Urotrygon sp.							1	0.00									1	0.00	1	0.00
	Zapteryx exasperata			1324	1.70	2	0.21	229	0.70	3	0.04	32	0.10	21	0.35	5	0.06	1606	1.07	1611	1.02
	Subtotal	**7**	**50.00**	**50937**	**65.45**	**758**	**77.90**	**30600**	**94.20**	**832**	**11.28**	**16727**	**50.14**	**275**	**4.58**	**1597**	**19.10**	**98539**	**65.83**	**100136**	**63.36**
Batoid	Unidentified													1	0.02			1	0.02	1	0
	Subtotal	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**1**	**0.02**	**0**	**0.00**	**1**	**0.00**	**1**	**0.00**
	Total	**14**	**100.00**	**77825**	**100.00**	**973**	**100.00**	**32484**	**100.00**	**7374**	**100.00**	**33361**	**100.00**	**6011**	**100.07**	**8361**	**100.00**	**149681**	**100.00**	**158038**	**100.00**

Table 13. Seasonal, annual, and total catch composition of shark, skate, and ray landings sampled from artisanal vessels targeting elasmobranchs at SON-07 (El Choyudo) during 1998-1999. n = number of individuals, % = percentage of elasmobranch landings.

		Spring		Summer		Autumn				Winter		1998		1999		Total	
Higher Taxon	Lowest Possible Taxon	1999n	1999%	1999n	1999%	1998n	1998%	1999n	1999%	1999n	1999%	n	%	n	%	n	%
Shark	*Carcharhinus falciformis*	1	0.00											1	0.00	1	0.00
	Carcharhinus leucas			1	0.01									1	0.00	1	0.00
	Carcharhinus limbatus	9	0.02	6	0.07			156	0.63	1	0.45			172	0.22	172	0.21
	Carcharhinus porosus							1	0.00					1	0.00	1	0.00
	Galeocerdo cuvier							48	0.19					48	0.06	48	0.06
	Heterodontus mexicanus	127	0.28	3	0.03			10	0.04					140	0.18	140	0.17
	Mustelus henlei	11855	26.47	504	5.55			7313	29.51					19672	24.94	19672	23.97
	Mustelus spp.	193	0.43	48	0.53	2300	72.01	673	2.72	78	35.29	2300	72.01	992	1.26	3292	4.01
	Nasolamia velox							70	0.28					70	0.09	70	0.09
	Rhizoprionodon longurio	52	0.12	290	3.19	266	8.33	2707	10.92			266	8.33	3049	3.87	3315	4.04
	Sphyrna lewini	10	0.02	5	0.06	89	2.79	2173	8.77			89	2.79	2188	2.77	2277	2.77
	Sphyrna zygaena	299	0.67	149	1.64	54	1.69	15	0.06	1	0.45	54	1.69	464	0.59	518	0.63
	Squatina californica	216	0.48	132	1.45	2	0.06	134	0.54	2	0.90	2	0.06	484	0.61	486	0.59
	Subtotal	**12762**	**28.49**	**1138**	**12.52**	**2711**	**84.88**	**13300**	**53.67**	**82**	**37.10**	**2711**	**84.88**	**27282**	**34.59**	**29993**	**36.54**
Skate	*Raja* spp.							4	0.02					4	0.01	4	0.00
	Raja velezi	281	0.63	36	0.40	1	0.03	10	0.04	7	3.17	1	0.03	334	0.42	335	0.41
	Subtotal	**281**	**0.63**	**36**	**0.40**	**1**	**0.03**	**14**	**0.06**	**7**	**3.17**	**1**	**0.03**	**338**	**0.43**	**339**	**0.41**
Ray	*Dasyatis dipterura*	1821	4.07	1369	15.07	16	0.50	5404	21.81	2	0.90	16	0.50	8596	10.90	8612	10.49
	Dasyatis longa	15	0.03	31	0.34			11	0.04					57	0.07	57	0.07
	Dasyatis spp.			7	0.08									7	0.01	7	0.01
	Gymnura spp.	5276	11.78	851	9.37	19	0.59	722	2.91	19	8.60	19	0.59	6868	8.71	6887	8.39
	Mobula japanica	13	0.03	4	0.04	51	1.60					51	1.60	17	0.02	68	0.08
	Mobula munkiana			3	0.03	8	0.25	1	0.00			8	0.25	4	0.01	12	0.01
	Mobula spp.			40	0.44	4	0.13					4	0.13	40	0.05	44	0.05
	Myliobatis californica	88	0.20	7	0.08			56	0.23	2	0.90			153	0.19	153	0.19
	Myliobatis longirostris	2	0.00					4	0.02					6	0.01	6	0.01
	Narcine entemedor	2473	5.52	600	6.60	7	0.22	585	2.36	5	2.26	7	0.22	3663	4.64	3670	4.47
	Narcine spp.	51	0.11											51	0.06	51	0.06
	Rhinobatos glaucostigma	3545	7.91	788	8.67			217	0.88	12	5.43			4562	5.78	4562	5.56
	Rhinobatos productus	16964	37.87	3156	34.73	359	11.24	3135	12.65	87	39.37	359	11.24	23342	29.59	23701	28.88
	Rhinoptera steindachneri	486	1.09	737	8.11	15	0.47	1273	5.14	2	0.90	15	0.47	2498	3.17	2513	3.06
	Urobatis halleri	17	0.04	22	0.24									39	0.05	39	0.05
	Urobatis maculatus	216	0.48	118	1.30			48	0.19					382	0.48	382	0.47
	Urobatis spp.	1	0.00					7	0.03					8	0.01	8	0.01
	Urotrygon chilensis	50	0.11	17	0.19			2	0.01					69	0.09	69	0.08
	Urotrygon rogersi	17	0.04											17	0.02	17	0.02
	Zapteryx exasperata	713	1.59	162	1.78	3	0.09	4	0.02	2	0.90	3	0.09	881	1.12	884	1.08
	Subtotal	**31748**	**70.88**	**7912**	**87.08**	**482**	**15.09**	**11469**	**46.28**	**131**	**59.28**	**482**	**15.09**	**51260**	**64.98**	**51742**	**63.04**
Batoid	Unidentified									1	0.45			1	0.00	1	0
	Subtotal	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**1**	**0.45**	**0**	**0.00**	**1**	**0.00**	**1**	**0.00**
	Total	**44791**	**100.00**	**9086**	**100.00**	**3194**	**100.00**	**24783**	**100.00**	**221**	**100.00**	**3194**	**100.00**	**78881**	**100.00**	**82075**	**100.00**

Table 14. Seasonal, annual, and total catch composition of chimaera, shark, skate, and ray landings sampled from artisanal vessels targeting elasmobranchs at SON-09 (Bahía Kino) during 1998-1999. n = number of individuals, % = percentage of elasmobranch landings.

		Spring		Summer				Autumn				Winter		1998		1999		Total	
Higher Taxon	Lowest Possible Taxon	1999n	1999%	1998n	1998%	1999n	1999%	1998n	1998%	1999n	1999%	1999n	1999%	n	%	n	%	n	%
Chimaera	*Hydrolagus colliei*	1	0.00									4	0.09			5	0.01	5	0.01
	Subtotal	**1**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**4**	**0.09**	**0**	**0.00**	**5**	**0.01**	**5**	**0.01**
Shark	*Alopias vulpinus*	9	0.03													9	0.01	9	0.01
	Carcharhinus falciformis	2	0.01													2	0.00	2	0.00
	Carcharhinus limbatus	31	0.10			29	0.13	2	0.42	5	0.12			2	0.17	65	0.10	67	0.10
	Carcharhinus obscurus	2	0.01													2	0.00	2	0.00
	Carcharhinus spp.			1	0.15			1	0.21					2	0.17			2	0.00
	Cephaloscyllium ventriosum	20	0.06									4	0.09			24	0.04	24	0.04
	Heterodontus francisci											8	0.17			8	0.01	8	0.01
	Heterodontus mexicanus	651	2.11									13	0.28			664	1.06	664	1.04
	Hexanchidae											2	0.04			2	0.00	2	0.00
	Hexanchus griseus	1	0.00													1	0.00	1	0.00
	Mustelus henlei	10599	34.40			1	0.00					237	5.14			10837	17.28	10837	16.96
	Mustelus spp.	546	1.77	2	0.30	136	0.59			31	0.74	3998	86.71	2	0.17	4711	7.51	4713	7.38
	Notorynchus cepedianus	1	0.00													1	0.00	1	0.00
	Prionace glauca					1	0.00									1	0.00	1	0.00
	Rhizoprionodon longurio	429	1.39	6	0.89	61	0.26	13	2.74					19	1.65	490	0.78	509	0.80
	Sphyrna lewini	12	0.04	5	0.74	232	1.00	160	33.68	23	0.55			165	14.32	267	0.43	432	0.68
	Sphyrna spp.					6	0.03									6	0.01	6	0.01
	Sphyrna zygaena	73	0.24	6	0.89	207	0.89	57	12.00	4	0.10			63	5.47	284	0.45	347	0.54
	Squatina californica	772	2.51	6	0.89	23	0.10			59	1.42	196	4.25	6	0.52	1050	1.67	1056	1.65
	Triakis semifasciata	2	0.01			2	0.01									4	0.01	4	0.01
	Subtotal	**13150**	**42.68**	**26**	**3.84**	**698**	**3.02**	**233**	**49.05**	**122**	**2.93**	**4458**	**96.68**	**259**	**22.48**	**18428**	**29.38**	**18687**	**29.25**
Skate	*Raja inornata*	2	0.01													2	0.00	2	0.00
	Raja spp.	1	0.00									1	0.02			2	0.00	2	0.00
	Raja velezi	402	1.30							25	0.60	39	0.85			466	0.74	466	0.73
	Subtotal	**405**	**1.31**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**25**	**0.60**	**40**	**0.87**	**0**	**0.00**	**470**	**0.75**	**470**	**0.73**
Ray	*Dasyatis dipterura*	1659	5.38	55	8.12	3551	15.34	181	38.11	1182	28.36	15	0.33	236	20.49	6407	10.21	6643	10.40
	Dasyatis longa	14	0.05			17	0.07	1	0.21	13	0.31			1	0.09	44	0.07	45	0.07
	Dasyatis spp.	76	0.25	1	0.15	7	0.03							1	0.09	83	0.13	84	0.13
	Gymnura spp.	1312	4.26	298	44.02	1608	6.95	24	5.05	1159	27.81	24	0.52	322	27.95	4103	6.54	4425	6.93
	Mobula japanica	14	0.05			5	0.02									19	0.03	19	0.03
	Mobula munkiana			5	0.74									5	0.43			5	0.01
	Mobula spp.	3	0.01	1	0.15	52	0.22							1	0.09	55	0.09	56	0.09
	Myliobatis californica	755	2.45	40	5.91	22	0.10			888	21.31	4	0.09	40	3.47	1669	2.66	1709	2.68
	Myliobatis longirostris	10	0.03	6	0.89	5	0.02							6	0.52	15	0.02	21	0.03
	Myliobatis sp.											1	0.02			1	0.00	1	0.00
	Narcine entemedor	538	1.75	6	0.89	175	0.76	10	2.11	4	0.10	25	0.54	16	1.39	742	1.18	758	1.19
	Rhinobatos glaucostigma	3	0.01			2	0.01									5	0.01	5	0.01
	Rhinobatos productus	8226	26.70	24	3.55	13983	60.42	4	0.84	11	0.26	20	0.43	28	2.43	22240	35.45	22268	34.86
	Rhinobatos spp.	2	0.01													2	0.00	2	0.00
	Rhinoptera steindachneri	4162	13.51	213	31.46	2950	12.75	22	4.63	742	17.80	1	0.02	235	20.40	7855	12.52	8090	12.66
	Urobatis halleri											1	0.02			1	0.00	1	0.00
	Urobatis spp.	33	0.11													33	0.05	33	0.05
	Urotrygon sp.					1	0.00									1	0.00	1	0.00
	Zapteryx exasperata	445	1.44	2	0.30	66	0.29			22	0.53	18	0.39	2	0.17	551	0.88	553	0.87
	Subtotal	**17252**	**56.00**	**651**	**96.16**	**22444**	**96.98**	**242**	**50.95**	**4021**	**96.47**	**109**	**2.36**	**893**	**77.52**	**43826**	**69.87**	**44719**	**70.00**
	Total	**30808**	**100.00**	**677**	**100.00**	**23142**	**100.00**	**475**	**100.00**	**4168**	**100.00**	**4611**	**100.00**	**1152**	**100.00**	**62729**	**100.00**	**63881**	**100.00**

Table 15. Non-elasmobranch taxa sampled from artisanal fishery landings in Sonora during 1998-1999.

Higher Taxon	Family	Genus & Species
Invertebrate	Gastropoda	
	Portunidae	
	Teuthoidea	
Teleost	Ariidae	*Bagre panamensis*
	Balistidae	*Balistes polylepis*
	Bothidae	
	Carangidae	*Seriola* spp.
	Carangidae	*Trachinotus* sp.
	Clupeidae	*Sardinops sagax*
	Coryphaenidae	*Coryphaena hippurus*
	Elopiidae	*Elops affinis*
	Gerreidae	
	Haemulidae	*Anisostremus davidsonii*
	Haemulidae	*Orthopristis reddingi*
	Istiophoridae	*Istiophorus platypterus*
	Lutjanidae	*Hoplopagrus guntherii*
	Malacanthidae	*Caulolatilus affinis*
	Malacanthidae	*Caulolatilus princeps*
	Malacanthidae	*Caulolatilus* spp.
	Paralichtyidae	
	Pleuronectiformes	
	Sciaenidae	*Cynoscion* spp.
	Sciaenidae	*Micropogonis* spp.
	Scombridae	*Euthynnus lineatus*
	Scombridae	*Euthynnus* spp.
	Scombridae	*Katsuwonus pelamis*
	Scombridae	*Scomber japonicus*
	Scombridae	*Scomberomorous* spp.
	Serranidae	*Epinephelus cifuentesi*
	Stromateidae	*Peprilus* spp.

Table 16. Seasonal catch per unit effort (CPUE = #individuals/vessel/trip) and standard error (SE) of chimaera, shark, skate, and ray landings sampled in Sonora during 1998-1999. Sample size (number of vessels examined) is indicated for each season in parentheses.

		Spring (n = 974)		Summer (n = 517)		Autumn (n = 390)		Winter (n = 58)	
Higher Taxon	Lowest Possible Taxon	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Chimaera	*Hydrolagus colliei*	0.00	0.00					0.07	0.07
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.07**	**0.07**
Shark	*Alopias pelagicus*	0.00	0.00	0.03	0.01	0.00	0.00		
	Alopias vulpinus	0.01	0.00						
	Carcharhinidae	0.00	0.00						
	Carcharhinus falciformis	0.00	0.00	0.25	0.04	0.13	0.04		
	Carcharhinus leucas			0.00	0.00				
	Carcharhinus limbatus	0.05	0.01	0.07	0.02	0.73	0.19	0.17	0.07
	Carcharhinus obscurus	0.00	0.00	0.00	0.00				
	Carcharhinus porosus					0.00	0.00		
	Carcharhinus spp.			0.01	0.01	0.02	0.02		
	Cephaloscyllium ventriosum	0.02	0.02					0.07	0.04
	Galeocerdo cuvier					0.13	0.04		
	Heterodontus francisci							0.16	0.06
	Heterodontus mexicanus	0.80	0.20	0.01	0.00	0.07	0.03	0.22	0.11
	Heterodontus spp.	0.00	0.00			0.00	0.00		
	Hexanchidae							0.03	0.03
	Hexanchus griseus	0.00	0.00						
	Isurus oxyrinchus			0.01	0.00				
	Mustelus henlei	23.05	2.78	0.98	0.53	26.11	5.27	4.09	2.83
	Mustelus spp.	0.97	0.24	0.36	0.25	16.62	4.43	70.28	17.63
	Nasolamia velox					0.19	0.05		
	Notorynchus cepedianus	0.00	0.00						
	Prionace glauca			0.00	0.00				
	Rhizoprionodon longurio	0.50	0.14	0.69	0.13	7.74	1.34	19.14	7.98
	Sphyrna lewini	0.02	0.01	0.48	0.12	6.50	0.92	0.03	0.02
	Sphyrna spp.	0.00	0.00	0.04	0.03			0.07	0.05
	Sphyrna zygaena	0.38	0.04	0.74	0.11	0.41	0.10	0.26	0.11
	Squatina californica	1.08	0.19	0.31	0.09	0.63	0.21	3.41	1.87
	Triakis semifasciata	0.00	0.00	0.00	0.00				
	Subtotal	**26.91**	**2.81**	**3.99**	**0.65**	**59.27**	**6.89**	**97.93**	**17.79**
Skate	*Raja inornata*	0.00	0.00						
	Raja spp.	0.00	0.00			0.01	0.01	0.02	0.02
	Raja velezi	0.70	0.08	0.07	0.05	0.15	0.05	0.79	0.31
	Subtotal	**0.71**	**0.08**	**0.07**	**0.05**	**0.16**	**0.05**	**0.81**	**0.33**
Ray	*Dasyatis dipterura*	3.86	0.39	9.74	0.88	17.77	2.76	0.31	0.14
	Dasyatis longa	0.03	0.01	0.09	0.03	0.06	0.02		
	Dasyatis spp.	0.16	0.09	0.08	0.05	0.01	0.01		
	Gymnura spp.	7.53	0.47	5.65	0.65	6.66	1.04	1.10	0.38
	Mobula japanica	0.03	0.01	0.02	0.01	0.13	0.12		
	Mobula munkiana			0.03	0.01	0.02	0.02		
	Mobula spp.	0.00	0.00	0.18	0.05	0.01	0.01		
	Mobula thurstoni			0.00	0.00	0.00	0.00		
	Myliobatis californica	0.87	0.17	0.13	0.06	2.60	0.68	0.16	0.06
	Myliobatis longirostris	0.01	0.00	0.02	0.01	0.01	0.01		
	Myliobatis spp.	0.00	0.00	0.03	0.03			0.02	0.02
	Narcine entemedor	3.43	0.24	1.55	0.15	1.69	0.28	0.52	0.40
	Narcine spp.	0.05	0.03						
	Rhinobatos glaucostigma	3.67	0.30	1.53	0.27	0.56	0.13	0.21	0.12
	Rhinobatos leucorhynchus	0.00	0.00						
	Rhinobatos productus	26.12	1.99	33.26	6.03	9.18	1.70	1.91	0.89
	Rhinobatos spp.	0.00	0.00			0.01	0.01		
	Rhinoptera steindachneri	4.83	0.55	7.60	1.02	6.06	0.74	0.14	0.08

Table 16. continued.

Higher Taxon	Lowest Possible Taxon	Spring (n = 974) CPUE	SE	Summer (n = 517) CPUE	SE	Autumn (n = 390) CPUE	SE	Winter (n = 58) CPUE	SE
	Urobatis halleri	0.02	0.01	0.04	0.04	0.01	0.00	0.02	0.02
	Urobatis maculatus	0.22	0.07	0.23	0.08	0.12	0.12		
	Urobatis spp.	0.03	0.03			0.02	0.02		
	Urotrygon chilensis	0.05	0.02	0.03	0.02	0.01	0.00		
	Urotrygon rogersi	0.02	0.01						
	Urotrygon sp.			0.00	0.00				
	Zapteryx exasperata	1.36	0.11	0.45	0.07	0.09	0.02	0.36	0.11
	Subtotal	**52.30**	**2.36**	**60.65**	**6.04**	**45.02**	**3.75**	**4.74**	**1.42**
Batoid	Unidentified							0.02	0.02
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.02**

Table 17. Seasonal catch per unit effort (CPUE = #individuals/vessel/trip) and standard error (SE) of shark, skate, and ray landings sampled at SON-07 (El Choyudo) during 1998-1999. Sample size (number of vessels examined) is indicated for each season in parentheses.

		Spring (n = 487)		Summer (n = 194)		Autumn (n = 245)		Winter (n = 4)	
Higher Taxon	Lowest Possible Taxon	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Shark	*Carcharhinus falciformis*	0.00	0.00						
	Carcharhinus leucas			0.01	0.01				
	Carcharhinus limbatus	0.02	0.01	0.03	0.01	0.64	0.21	0.25	0.25
	Carcharhinus porosus					0.00	0.00		
	Galeocerdo cuvier					0.20	0.06		
	Heterodontus mexicanus	0.26	0.11	0.02	0.01	0.04	0.02		
	Mustelus henlei	24.34	4.33	2.60	1.39	29.85	6.23		
	Mustelus spp.	0.40	0.07	0.25	0.06	12.13	5.21	19.50	18.19
	Nasolamia velox					0.29	0.07		
	Rhizoprionodon longurio	0.11	0.06	1.49	0.31	12.13	2.08		
	Sphyrna lewini	0.02	0.01	0.03	0.01	9.23	1.37		
	Sphyrna zygaena	0.61	0.07	0.77	0.24	0.28	0.10	0.25	0.25
	Squatina californica	0.44	0.08	0.68	0.20	0.56	0.28	0.50	0.50
	Subtotal	**26.21**	**4.32**	**5.87**	**1.50**	**65.35**	**8.30**	**20.50**	**17.93**
Skate	*Raja* spp.					0.02	0.02		
	Raja velezi	0.58	0.11	0.19	0.14	0.04	0.02	1.75	1.44
	Subtotal	**0.58**	**0.11**	**0.19**	**0.14**	**0.06**	**0.02**	**1.75**	**1.44**
Ray	*Dasyatis dipterura*	3.74	0.61	7.06	1.59	22.12	4.08	0.50	0.50
	Dasyatis longa	0.03	0.01	0.16	0.07	0.04	0.02		
	Dasyatis spp.			0.04	0.04				
	Gymnura spp.	10.83	0.77	4.39	0.46	3.02	0.40	4.75	3.47
	Mobula japanica	0.03	0.01	0.02	0.01	0.21	0.19		
	Mobula munkiana			0.02	0.01	0.04	0.03		
	Mobula spp.			0.21	0.05	0.02	0.02		
	Myliobatis californica	0.18	0.05	0.04	0.02	0.23	0.10	0.50	0.50
	Myliobatis longirostris	0.00	0.00			0.02	0.01		
	Narcine entemedor	5.08	0.37	3.09	0.32	2.42	0.44	1.25	0.75
	Narcine spp.	0.10	0.05						
	Rhinobatos glaucostigma	7.28	0.56	4.06	0.68	0.89	0.20	3.00	1.22
	Rhinobatos productus	34.83	2.15	16.27	2.20	14.26	2.65	21.75	8.56
	Rhinoptera steindachneri	1.00	0.29	3.80	0.72	5.26	0.76	0.50	0.50
	Urobatis halleri	0.03	0.01	0.11	0.09				
	Urobatis maculatus	0.44	0.14	0.61	0.21	0.20	0.19		
	Urobatis spp.	0.00	0.00			0.03	0.02		
	Urotrygon chilensis	0.10	0.04	0.09	0.04	0.01	0.01		
	Urotrygon rogersi	0.03	0.01						
	Zapteryx exasperata	1.46	0.14	0.84	0.14	0.03	0.02	0.50	0.50
	Subtotal	**65.19**	**2.97**	**40.78**	**3.29**	**48.78**	**5.20**	**32.75**	**11.69**
Batoid	Unidentified							0.25	0.25
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.25**	**0.25**

Table 18. Seasonal catch per unit effort (CPUE = #individuals/vessel/trip) and standard error (SE) of chimaera, shark, skate, and ray landings sampled at SON-09 (Bahía Kino) during 1998-1999. Sample size (number of vessels examined) is indicated for each season in parentheses.

		Spring (n = 429)		Summer (n = 251)		Autumn (n = 68)		Winter (n = 37)	
Higher Taxon	Lowest Possible Taxon	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Chimaera	*Hydrolagus colliei*	0.00	0.00					0.11	0.11
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.11**	**0.11**
Shark	*Alopias vulpinus*	0.02	0.01						
	Carcharhinus falciformis	0.00	0.00						
	Carcharhinus limbatus	0.07	0.02	0.12	0.04	0.10	0.05		
	Carcharhinus obscurus	0.00	0.00						
	Carcharhinus sp.					0.01	0.01		
	Cephaloscyllium ventriosum	0.05	0.03					0.11	0.06
	Heterodontus francisci							0.22	0.10
	Heterodontus mexicanus	1.52	0.44					0.35	0.17
	Hexanchidae							0.05	0.05
	Hexanchus griseus	0.00	0.00						
	Mustelus henlei	24.71	3.95	0.00	0.00			6.41	4.42
	Mustelus spp.	1.27	0.33	0.55	0.51	0.46	0.19	108.05	25.64
	Notorynchus cepedianus	0.00	0.00						
	Prionace glauca			0.00	0.00				
	Rhizoprionodon longurio	1.00	0.31	0.27	0.06	0.19	0.11		
	Sphyrna lewini	0.03	0.01	0.94	0.25	2.69	1.56		
	Sphyrna spp.			0.02	0.02				
	Sphyrna zygaena	0.17	0.05	0.85	0.13				
	Squatina californica	1.80	0.41	0.12	0.09	0.90	0.39	5.30	2.90
	Triakis semifasciata	0.00	0.00	0.01	0.01	0.87	0.31		
	Subtotal	**30.65**	**4.05**	**2.88**	**0.68**	**5.22**	**2.01**	**120.49**	**24.83**
Skate	*Raja inornata*	0.00	0.00						
	Raja spp.	0.00	0.00					0.03	0.03
	Raja velezi	0.94	0.14			0.37	0.18	1.05	0.46
	Subtotal	**0.94**	**0.14**	**0.00**	**0.00**	**0.37**	**0.18**	**1.08**	**0.48**
Ray	*Dasyatis dipterura*	3.87	0.52	14.37	1.25	20.04	5.41	0.41	0.21
	Dasyatis longa	0.03	0.01	0.07	0.02	0.21	0.06		
	Dasyatis spp.	0.18	0.12	0.03	0.02				
	Gymnura spp.	3.06	0.34	7.59	1.26	17.40	5.06	0.65	0.20
	Mobula japanica	0.03	0.01	0.02	0.01				
	Mobula munkiana			0.02	0.01				
	Mobula spp.	0.01	0.00	0.21	0.09				
	Myliobatis californica	1.76	0.37	0.25	0.11	13.06	3.67	0.11	0.06
	Myliobatis longirostris	0.02	0.01	0.04	0.02				
	Myliobatis spp.							0.03	0.03
	Narcine entemedor	1.25	0.29	0.72	0.14	0.21	0.07	0.68	0.62
	Rhinobatos glaucostigma	0.01	0.01	0.01	0.01				
	Rhinobatos productus	19.17	3.75	55.80	12.15	0.22	0.10	0.54	0.15
	Rhinobatos spp.	0.00	0.00						
	Rhinoptera steindachneri	9.70	1.17	12.60	1.97	11.24	2.88	0.03	0.03
	Urobatis halleri							0.03	0.03
	Urobatis spp.	0.08	0.07						
	Urotrygon sp.			0.00	0.00				
	Zapteryx exasperata	1.04	0.15	0.27	0.10	0.32	0.12	0.49	0.17
	Subtotal	**40.21**	**4.01**	**92.01**	**11.82**	**62.69**	**8.93**	**2.95**	**0.98**

Table 19. Size composition of chondrichtyans sampled from artisanal fishery landings in Sonora during 1998-1999. Only specimens identified to species were included. BL = body length; DD = inter-dorsal distance; DW = disc width; PCL = precaudal length; TL = total length; STL = stretched total length; TL* = estimated total length (based on conversion equations in Castillo-Géniz, 2007).

Elasmobranch Group	Species	Sex	n	Measurement (cm)	Minimum	Maximum	Mean	±1 SD
Shark	*Alopias pelagicus*	F	8	PCL	135	164	151.6	11.1
		M	9	PCL	92	155	140.1	18.9
	Alopias vulpinus	M	1	STL	190	190		
	Carcharhinus falciformis	F	57	STL	90	268	194.3	27.2
		M	94	STL	149	260	194.7	16.9
	Carcharhinus limbatus	F	31	STL	62	244	123.3	56.2
		M	32	STL	65	227	127.1	50.7
	Carcharhinus obscurus	M	1	PCL	173	173		
	Carcharhinus porosus	M	1	STL	82	82		
	Cephaloscyllium ventriosum	F	6	STL	37	64	46.3	9.3
		M	11	STL	40	69	45.8	7.9
	Galeocerdo cuvier	F	8	STL	114	148	128.0	11.9
		M	7	STL	122	152	139.7	11.1
	Heterodontus francisci	F	3	STL	62	75	69.7	6.8
		M	2	STL	58	63	60.5	3.5
	Heterodontus mexicanus	F	26	STL	36	74	58.9	10.5
		M	19	STL	42	74	54.7	8.7
	Hexanchus griseus	F	1	STL	95	95		
	Isurus oxyrinchus	F	1	PCL	141	141		
		M	2	PCL	141	188	164.5	33.2
	Mustelus henlei	F	257	STL	35	93	59.4	10.4
		M	467	STL	39	78	58.0	5.4
	Nasolamia velox	F	8	STL	69	93	84.5	8.7
		M	11	STL	67	156	90.7	24.1
	Rhizoprionodon longurio	F	199	STL	33	122	86.4	19.6
		M	161	STL	40	112	87.0	15.2
	Sphyrna lewini	F	108	STL	49	259	82.7	29.1
		M	100	STL	46	263	87.7	42.5
	Sphyrna zygaena	F	83	STL	40	273	99.8	53.6
		M	98	STL	50	278	90.8	46.4
	Squatina californica	F	90	STL	30	100	73.5	15.5
		M	39	STL	27	96	81.2	12.6
	Triakis semifasciata	F	1	DD	42	42		
Batoid	*Dasyatis dipterura*	F	881	DW	20	84	47.6	12.3
		M	540	DW	21	71	42.2	5.8
	Dasyatis longa	F	36	DW	27	164	60.8	33.1
		M	12	DW	35	106	62.6	27.8
	Mobula japanica	F	17	DW	57	283	124.4	66.1
		M	10	DW	101	222	179.6	51.1
	Mobula munkiana	F	6	DW	49	97	67.3	17.2
		M	13	DW	47	102	62.8	14.6
	Mobula thurstoni	M	1	DW	145	145		
	Myliobatis californica	F	52	DW	33	100	57.6	14.5
		M	33	DW	38	64	50.5	7.1
	Myliobatis longirostris	F	2	DW	48	71	59.5	16.3
		M	5	DW	55	66	58.2	4.4
	Narcine entemedor	F	279	STL	22	82	54.2	6.9
		M	55	STL	18	72	45.4	7.7
	Raja velezi	F	26	DW	31	76	60.7	11.0
		M	26	DW	41	67	57.5	7.1
	Raja velezi	F	26	TL*	48	98	80.9	12.1
		M	26	TL*	59	88	77.4	7.8
	Rhinobatos glaucostigma	F	54	STL	48	88	69.5	6.0
		M	29	STL	48	77	56.7	5.2
	Rhinobatos leucorhynchus	F	1	BL	40	40		
	Rhinobatos productus	F	504	STL	21	105	64.2	11.1
		M	276	STL	20	79	56.2	5.3
	Rhinoptera steindachneri	F	448	DW	32	98	62.7	14.1
		M	423	DW	31	89	60.7	11.4
	Urobatis halleri	F	1	DW	30	30		
		M	2	DW	14	25	19.5	7.8
	Urobatis maculatus	F	28	DW	19	31	23.3	2.4
	Urotrygon chilensis	F	9	DW	22	33	26	4.6
	Urotrygon rogersi	F	2	DW	33	33	33.0	0.0
		M	1	DW	29	29		
	Zapteryx exasperata	F	23	STL	49	83	70.0	8.7
		M	38	STL	56	88	67.8	6.2

Table 20. Descriptive information for all artisanal fishing camps documented in Sinaloa (SIN) during 1998-1999. Type = A (little to no infrastructure), B (moderate infrastructure), and C (significant infrastructure); Perm. (Permanence) = 1 (permanent) and 2 (seasonal); Active = period of fishing activity; #Pangas = number or range of operational artisanal fishing vessels at the time of survey(s); Elasmo. (elasmobranchs targeted) = Yes (elasmobranchs were targeted during the year) and No (there was no directed fishery for elasmobranchs). Zero values listed for #Pangas indicate that the camp was temporarily inactive (because of weather, holidays, etc.) or seasonally abandoned at the time of survey. In all instances, U = unknown.

Camp Code	Camp Name	Latitude	Longitude	Type	Perm.	Active	#Pangas	Elasmo.
SIN-01	Teacapan	22.536	-105.747	C	1	Year-Round	42-80	Yes
SIN-02	La Brecha	22.551	-105.741	B	1	Year-Round	27	No
SIN-03	Majahual	22.841	-106.033	B	1	Year-Round	22	Yes
SIN-04	Playa Sur	23.204	-106.444	C	1	Year-Round	29	Yes
SIN-05	Barras de Piaxtla	23.667	-106.804	B	1	Year-Round	18-49	Yes
SIN-06	Cospita	24.104	-107.140	B	1	Year-Round	22-35	Yes
SIN-07	El Conchal	24.247	-107.338	B	1	Year-Round	14	Yes
SIN-08	Las Arenitas	24.376	-107.541	B	1	Year-Round	U	U
SIN-09	Las Puentes	24.539	-107.546	B	1	Year-Round	50	U
SIN-10	El Castillo	24.550	-107.710	B	1	Year-Round	U	No
SIN-11	Las Aguamitas	24.577	-107.795	B	1	Year-Round	50	Yes
SIN-12	Altata	24.643	-107.941	C	1	Year-Round	90-200	Yes
SIN-13	Dautillos	24.721	-107.978	B	1	Year-Round	250	Yes
SIN-14	Yameto	24.788	-108.042	A	1	Year-Round	U	Yes
SIN-15	La Reforma	25.077	-108.064	C	1	Year-Round	500	Yes
SIN-16	Costa Azul	25.101	-108.137	B	1	Year-Round	50	Yes
SIN-17	La Riscion - Isla de Altamura	25.103	-108.302	A	2	Dec-Apr	0-15	Yes
SIN-18	Playa Colorada	25.297	-108.332	B	1	Year-Round	10	Yes
SIN-19	Boca del Rio	25.292	-108.504	B	1	Year-Round	10	Yes
SIN-20	El Tortugo	25.412	-108.660	B	1	Year-Round	30	Yes
SIN-21	El Coloradito	25.503	-108.725	B	1	Year-Round	20	U
SIN-22	El Caracol	25.498	-108.749	B	1	Year-Round	50	Yes
SIN-23	Huitussi	25.511	-108.787	B	1	Year-Round	50	Yes
SIN-24	Cerro el Cabezon	25.572	-108.858	B	1	Year-Round	50-60	Yes
SIN-25	Topolobampo	25.610	-109.063	C	1	Year-Round	20	No
SIN-26	El Colorado	25.756	-109.330	B	1	Year-Round	15	Yes
SIN-27	Las Grullas Margen Izquierdo	25.848	-109.345	A	1	Year-Round	23-51	Yes
SIN-28	Las Lajitas	26.107	-109.381	B	1	Year-Round	50-100	Yes

Table 21. Seasonal, annual, and total catch composition of shark, skate, and ray landings sampled from artisanal vessels targeting elasmobranchs in Sinaloa during 1998-1999. n = number of individuals, % = percentage of elasmobranch landings. No sampling was conducted in summer, fall, or winter 1998.

		Spring				Summer		Autumn		Winter		1998		1999		Total	
Higher Taxon	Lowest Possible Taxon	1998n	1998%	1999n	1999%	1999n	1999%	1999n	1999%	1999n	1999%	n	%	n	%	n	%
Sharks	*Alopias pelagicus*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.09	0	0.00	1	0.03	1	0.03
	Carcharhinus altimus	0	0.00	0	0.00	0	0.00	0	0.00	1	0.09	0	0.00	1	0.03	1	0.03
	Carcharhinus leucas	0	0.00	0	0.00	2	0.43	0	0.00	0	0.00	0	0.00	2	0.05	2	0.05
	Carcharhinus limbatus	0	0.00	10	0.47	19	4.09	0	0.00	4	0.37	0	0.00	33	0.90	33	0.89
	Carcharhinus obscurus	0	0.00	0	0.00	0	0.00	2	18.18	0	0.00	0	0.00	2	0.05	2	0.05
	Carcharhinus spp.	0	0.00	0	0.00	2	0.43	0	0.00	0	0.00	0	0.00	2	0.05	2	0.05
	Nasolamia velox	0	0.00	4	0.19	0	0.00	0	0.00	4	0.37	0	0.00	8	0.22	8	0.22
	Prionace glauca	0	0.00	1	0.05	0	0.00	0	0.00	0	0.00	0	0.00	1	0.03	1	0.03
	Rhizoprionodon longurio	0	0.00	339	16.05	7	1.51	1	9.09	298	27.36	0	0.00	645	17.54	645	17.48
	Sphyrna lewini	7	58.33	959	45.41	25	5.38	8	72.73	592	54.36	7	58.33	1584	43.08	1591	43.12
	Sphyrna zygaena	3	25.00	40	1.89	2	0.43	0	0.00	70	6.43	3	25.00	112	3.05	115	3.12
	Subtotal	**10**	**83.33**	**1353**	**64.06**	**57**	**12.26**	**11**	**100.00**	**970**	**89.07**	**10**	**83.33**	**2391**	**65.03**	**2401**	**65.07**
Rays	*Aetobatus narinari*	0	0.00	0	0.00	3	0.65	0	0.00	0	0.00	0	0.00	3	0.08	3	0.08
	Dasyatis dipterura	1	8.33	214	10.13	26	5.59	0	0.00	89	8.17	1	8.33	329	8.95	330	8.94
	Dasyatis longa	0	0.00	15	0.71	1	0.22	0	0.00	4	0.37	0	0.00	20	0.54	20	0.54
	Dasyatis spp.	0	0.00	8	0.38	0	0.00	0	0.00	0	0.00	0	0.00	8	0.22	8	0.22
	Gymnura spp.	1	8.33	8	0.38	66	14.19	0	0.00	3	0.28	1	8.33	77	2.09	78	2.11
	Mobula munkiana	0	0.00	0	0.00	5	1.08	0	0.00	0	0.00	0	0.00	5	0.14	5	0.14
	Mobula sp.	0	0.00	0	0.00	1	0.22	0	0.00	0	0.00	0	0.00	1	0.03	1	0.03
	Narcinidae	0	0.00	1	0.05	19	4.09	0	0.00	0	0.00	0	0.00	20	0.54	20	0.54
	Rhinobatos glaucostigma	0	0.00	477	22.59	54	11.61	0	0.00	20	1.84	0	0.00	551	14.99	551	14.93
	Rhinobatos spp.	0	0.00	32	1.52	0	0.00	0	0.00	0	0.00	0	0.00	32	0.87	32	0.87
	Rhinoptera steindachneri	0	0.00	3	0.14	233	50.11	0	0.00	3	0.28	0	0.00	239	6.50	239	6.48
	Zapteryx exasperata	0	0.00	1	0.05	0	0.00	0	0.00	0	0.00	0	0.00	1	0.03	1	0.05
	Subtotal	**2**	**16.67**	**759**	**35.94**	**408**	**87.74**	**0**	**0.00**	**119**	**10.93**	**2**	**16.67**	**1286**	**34.97**	**1288**	**34.93**
	Total	**12**	**100.00**	**2112**	**100.00**	**465**	**100.00**	**11**	**100.00**	**1089**	**100.00**	**12**	**100.00**	**3677**	**100.00**	**3689**	**100.00**

Table 22. Non-elasmobranch taxa sampled from artisanal fishery landings in Sinaloa during 1998-1999.

Higher Taxon	Family	Genus & Species
Invertebrate	Dendrobranchiata	
	Palinuridae	
Teleost	Ariidae	*Bagre panamensis*
	Ariidae	*Bagre* spp.
	Balistidae	*Balistes polylepis*
	Carangidae	
	Coryphaenidae	*Coryphaena hippurus*
	Cynoglossidae	
	Gerreidiae	
	Haemulidae	*Anisotremus* spp.
	Lobotidae	*Lobotes pacificus*
	Lutjanidae	
	Pleuronectiformes	
	Pristigasteridae	*Pliosteostoma lutipinnis*
	Sciaenidae	*Cynoscion macdonaldi*
	Sciaenidae	*Cynoscion reticulatus*
	Sciaenidae	*Cynoscion* spp.
	Sciaenidae	*Menticirrhus undulatus*
	Sciaenidae	*Menticirrhus* spp.
	Sciaenidae	*Micropogonias altipinnis*
	Scombridae	
	Serranidae	*Diplectrum eumelum*
	Serranidae	*Epinephelus acanthistius*
	Serranidae	*Epinephelus nigritus*
	Serranidae	*Epinephelus* spp.
	Tetraodontidae	

Table 23. Seasonal catch per unit effort (CPUE = #individuals/vessel/trip) and standard error (SE) of shark, skate, and ray landings sampled in Sinaloa during 1998-1999. Sample size (number of vessels examined) is indicated for each season in parentheses.

		Spring (n = 71)		Summer (n = 21)		Autumn (n = 2)		Winter (n = 96)	
Higher Taxon	Lowest Possible Taxon	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Shark	*Alopias pelagicus*							0.01	0.01
	Carcharhinus altimus							0.01	0.01
	Carcharhinus leucas			0.10	0.07				
	Carcharhinus limbatus	0.14	0.05	0.90	0.71			0.04	0.02
	Carcharhinus obscurus					1.00	1.00		
	Carcharhinus spp.			0.10	0.10				
	Nasolamia velox	0.06	0.03					0.04	0.02
	Prionace glauca	0.01	0.01						
	Rhizoprionodon longurio	4.77	1.35	0.33	0.16	0.50	0.50	3.10	0.51
	Sphyrna lewini	13.61	2.49	1.19	0.67	4.00	4.00	6.19	0.99
	Sphyrna zygaena	0.61	0.26	0.10	0.10			0.73	0.12
	Subtotal	**19.20**	**3.18**	**2.71**	**1.31**	**5.50**	**2.50**	**10.10**	**1.08**
Ray	*Aetobatus narinari*			0.14	0.10				
	Dasyatis dipterura	3.03	0.96	1.24	0.49			0.93	0.50
	Dasyatis longa	0.21	0.08	0.05	0.05			0.04	0.03
	Dasyatis spp.	0.11	0.11						
	Gymnura spp.	0.13	0.07	3.14	1.51			0.03	0.02
	Mobula munkiana			0.24	0.19				
	Mobula sp.			0.05	0.05				
	Narcinidae	0.01	0.01	0.90	0.47				
	Rhinobatos glaucostigma	6.72	3.83	2.57	1.74			0.21	0.10
	Rhinobatos spp.	0.45	0.45						
	Rhinoptera steindachneri	0.04	0.04	11.10	3.48			0.03	0.01
	Zapteryx exasperata	0.01	0.01						
	Subtotal	**10.72**	**3.96**	**19.43**	**4.41**	**0.00**	**0.00**	**1.24**	**0.55**

Table 24. Size composition of elasmobranchs sampled from artisanal fishery landings in Sinaloa during 1998-1999. Only specimens identified to species are included. DW = disc width; PCL = precaudal length; STL = stretched total length.

Chondrichthyan Group	Species	Sex	n	Measurement (cm)	Minimum	Maximum	Mean	±1 SD
Shark	*Carcharhinus altimus*	F	1	STL	119	119		
	Carcharhinus leucas	F	1	STL	123	123		
		M	1	STL	182	182		
	Carcharhinus limbatus	F	12	STL	67	146	90.2	29.2
		M	23	STL	57	233	114.1	66.0
	Carcharhinus obscurus	M	2	STL	248	268	258.0	14.1
	Mustelus henlei	M	3	STL	57	67	62.7	5.1
	Nasolamia velox	F	6	STL	97	100	99.2	1.3
		M	2	STL	93	94	93.3	0.4
	Prionace glauca	F	1	PCL	69	69		
	Rhizoprionodon longurio	F	324	STL	30	125	91.6	17.2
		M	266	STL	32	124	89.4	14.5
	Sphyrna lewini	F	832	STL	35	245	85.9	12.0
		M	683	STL	36	242	86.8	12.9
	Sphyrna zygaena	F	46	STL	86	143	115.7	12.3
		M	39	STL	100	155	114.3	13.6
	Squatina californica	F	1	STL	77	77		
		M	5	STL	70	79	75.4	3.5
Batoid	*Aetobatus narinari*	M	1	DW	80	80		
	Dasyatis dipterura	F	97	DW	34	76	54.5	9.1
		M	81	DW	37	63	48.0	4.6
	Dasyatis longa	F	13	DW	39	124	61.5	22.1
		M	3	DW	49	81	60.1	17.7
	Mobula munkiana	F	12	DW	66	89	75.2	7.3
		M	3	DW	107	108	107.7	0.6
	Rhinobatos glaucostigma	F	418	STL	47	89	72.2	7.3
		M	73	STL	48	88	57.4	7.2
	Rhinoptera steindachneri	F	26	DW	58	85	72.3	7.6
		M	105	DW	54	89	72.1	9.7
	Zapteryx exasperata	F	1	STL	59	59		

Table 25. Checklist of chondrichthyan (chimaera, shark, skate, and ray) species observed in artisanal elasmobranch fishery landings sampled in Baja California (BC), Baja California Sur (BCS), Sonora (SON), and Sinaloa (SIN) during 1998-1999. Because of local taxonomic confusion within the genera, all mustelid sharks (*Mustelus* spp.) and gymnurid rays (*Gymnura* spp.) were grouped into species complexes.

Higher Taxon	Genus & Species	BC	BCS	SON	SIN
Chimaera	*Hydrolagus colliei*			X	
Shark	*Alopias pelagicus*	X	X	X	X
	Alopias superciliosus	X	X		
	Alopias vulpinus	X		X	
	Carcharhinus altimus				X
	Carcharhinus falciformis	X	X	X	
	Carcharhinus galapagensis		X		
	Carcharhinus leucas			X	X
	Carcharhinus limbatus	X	X	X	X
	Carcharhinus longimanus		X		
	Carcharhinus obscurus	X	X	X	X
	Carcharhinus porosus		X	X	
	Cephaloscyllium ventriosum	X		X	
	Echinorhinus cookei		X		
	Galeocerdo cuvier		X	X	
	Heterodontus francisci			X	
	Heterodontus mexicanus	X		X	
	Hexanchus griseus			X	
	Isurus oxyrinchus	X	X	X	
	Mustelus spp.	X	X	X	
	Nasolamia velox		X	X	X
	Negaprion brevirostris		X		
	Notorynchus cepedianus			X	
	Prionace glauca	X	X	X	X
	Rhizoprionodon longurio	X	X	X	X
	Sphyrna lewini	X	X	X	X
	Sphyrna zygaena	X	X	X	X
	Squatina californica	X	X	X	
	Triakis semifasciata	X		X	
Skate	*Raja inornata*	X		X	
	Raja velezi	X	X	X	

Table 25. continued.

Higher Taxon	Genus & Species	BC	BCS	SON	SIN
Ray	*Aetobatus narinari*				X
	Dasyatis dipterura	X	X	X	X
	Dasyatis longa	X	X	X	X
	Gymnura spp.	X	X	X	X
	Manta birostris		X		
	Mobula japanica	X	X	X	
	Mobula munkiana	X	X	X	X
	Mobula thurstoni	X	X	X	
	Myliobatis californica	X	X	X	
	Myliobatis longirostris	X	X	X	
	Narcine entemedor	X	X	X	
	Pteroplatytrygon violacea		X		
	Rhinobatos glaucostigma		X	X	X
	Rhinobatos leucorhynchus		X	X	
	Rhinobatos productus	X	X	X	
	Rhinoptera steindachneri	X	X	X	X
	Urobatis halleri	X	X	X	
	Urobatis maculatus		X	X	
	Urotrygon chilensis			X	
	Urotryogon rogersi			X	
	Zapteryx exasperata	X	X	X	X

Table 26. Relative frequency of elasmobranch species documented in artisanal elasmobranch landings from Baja California, Baja California Sur, Sonora, and Sinaloa during 1998-1999. Elasmobranchs were identified to the lowest possible taxon and arranged systematically by family following Compagno (2005). Relative frequencies are based on the overall number of individuals recorded and coded as: * low, ** intermediate, and *** high. Because of local taxonomic confusion within the genera or family, all mustelid sharks (*Mustelus* spp.) and gymnurid rays (*Gymnura* spp.) were grouped into species complexes

Sharks	Frequency	Batoids	Frequency
Hexanchidae		Rhinobatidae	
Hexanchus griseus	*	*Rhinobatos glaucostigma*	**
Notorynchidae		*Rhinobatos leucorhynchus*	*
Notorynchus cepedianus	*	*Rhinobatos productus*	***
Echinorhinidae		*Zapteryx exasperata*	**
Echinorhinus cookei	*	Narcinidae	
Squatinidae		*Narcine entemedor*	**
Squatina californica	**	Rajidae	
Heterodontidae		*Raja inornata*	*
Heterodontus francisci	*	*Raja velezi*	**
Heterodontus mexicanus	**	Urolophidae	
Alopiidae		*Urobatis halleri*	*
Alopias pelagicus	**	*Urobatis maculatus*	*
Alopias superciliosus	*	*Urotrygon chilensis*	*
Alopias vulpinus	*	*Urotryogon rogersi*	*
Lamnidae		Dasyatidae	
Isurus oxyrinchus	*	*Dasyatis dipterura*	***
Scyliorhinidae		*Dasyatis longa*	**
Cephaloscyllium ventriosum	*	*Pteroplatytrygon violacea*	*
Triakidae		Gymnuridae	
Mustelus henlei	***	*Gymnura* spp.	***
Mustelus spp.	***	Myliobatidae	
Triakis semifasciata	*	*Aetobatus narinari*	*
Carcharhinidae		*Myliobatis californica*	***
Carcharhinus altimus	*	*Myliobatis longirostris*	**
Carcharhinus falciformis	**	Rhinopteridae	
Carcharhinus galapagensis	*	*Rhinoptera steindachneri*	***
Carcharhinus leucas	*	Mobulidae	
Carcharhinus limbatus	**	*Manta birostris*	*
Carcharhinus longimanus	*	*Mobula japanica*	**
Carcharhinus obscurus	*	*Mobula munkiana*	**
Carcharhinus porosus	*	*Mobula thurstoni*	*
Galeocerdo cuvier	*		
Nasolamia velox	**		
Negaprion brevirostris	*		
Prionace glauca	*		
Rhizoprionodon longurio	***		
Sphyrnidae			
Sphyrna lewini	***		
Sphyrna zygaena	***		

Table 27. Elasmobranch species documented as neonates, juveniles, or gravid females in the artisanal fisery landings of Baja California (BC), Baja California Sur (BCS), Sonora, and Sinaloa by season. Spring = Spr, Sum = Summer, Aut= Autumn, and Win = Winter.

		BC												BCS												Sonora												Sinaloa											
		Neonate				Juvenile				Gravid				Neonate				Juvenile				Gravid				Neonate				Juvenile				Gravid				Neonate				Juvenile				Gravid			
Family	Lowest Possible Taxon	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win
Hexanchidae	*Hexanchus griseus*																													X																			
Squatinidae	*Squatina californica*					X		X		X		X						X		X	X				X					X	X	X	X	X	X	X													
Heterodontidae	*Heterodontus francisci*																																X						X										
	Heterodontus mexicanus					X	X	X																						X		X	X	X															
Alopiidae	*Alopias pelagicus*							X				X							X												X				X														
	Alopias superciliosus																					X																											
	Alopias vulpinus																													X																			
Lamnidae	*Isurus oxyrinchus*						X	X										X			X				X						X																		
Scyliorhinidae	*Cephaloscyllium ventriosum*					X																								X			X																
Triakidae	*Mustelus* spp.			X		X	X	X		X												X								X		X	X	X	X	X	X												
	Mustelus henlei							X																						X	X	X		X	X	X	X		X										
	Triakis semifasciata							X																																									
Carcharhinidae	*Carcharhinus altimus*																																																
	Carcharhinus falciformis						X				X							X		X				X	X					X	X	X			X	X					X								
	Carcharhinus galapagensis																			X																													
	Carcharhinus leucas																																																
	Carcharhinus limbatus		X				X	X							X			X	X			X			X		X			X	X	X	X	X	X				X										
	Carcharhinus longimanus																	X																				X	X	X	X		X						
	Carcharhinus obscurus		X				X																								X																		
	Galeocerdo cuvier																	X		X												X																	
	Nasolamia velox																		X																														
	Negaprion brevirostris																			X																		X			X								
	Prionace glauca																	X			X	X			X																								
	Rhizoprionodon longurio		X				X	X										X				X			X		X			X	X	X	X	X		X	X	X											
Sphyrnidae	*Sphyrna lewini*		X				X	X										X		X	X					X	X			X	X	X	X		X			X	X	X	X		X			X			X
	Sphyrna zygaena		X				X	X														X								X	X	X	X	X	X			X	X	X	X	X	X				X		
Rhinobatidae	*Rhinobatos glaucostigma*																													X	X	X		X	X	X	X	X	X	X	X								
	Rhinobatos productus					X	X	X			X											X								X	X	X	X	X	X	X	X	X		X	X						X		
	Zapteryx exasperata					X																								X	X	X	X	X	X														
Narcinidae	*Narcine entemedor*																													X	X	X	X	X	X	X	X										X		
Rajidae	*Raja* spp.																															X																	
	Raja velezi					X																			X					X	X	X	X			X													
Urolophidae	*Urobatis halleri*																																X	X															
	Urobatis maculatus																															X			X	X													
	Urotrygon chilensis																														X	X		X		X													
Dasyatidae	*Dasyatis dipterura*					X												X												X	X	X			X	X													
	Dasyatis longa																			X		X								X	X	X		X	X			X	X	X	X								X
Gymnuridae	*Gymnura crebripunctata*																													X	X	X	X	X				X	X	X	X								
	Gymnura marmorata					X																								X	X	X	X	X	X	X	X												
Myliobatidae	*Myliobatis californica*					X	X	X																						X	X	X							X		X					X	X		
	Myliobatis longirostris																	X																															
Rhinopteridae	*Rhinoptera steindachneri*						X																							X	X	X	X	X	X	X													
Mobulidae	*Mobula* spp.																														X				X														
	Mobula japanica						X												X		X									X	X	X																	
	Mobula munkiana						X	X													X										X	X																	
	Mobula thurstoni																				X				X														X										

Figure Captions

Figure 1. Study region encompassing the four Mexican states bordering on the Gulf of California.

Figure 2. Location of artisanal fishing camps (n = 17) documented in Baja California during 1998–1999. Designations are as follows: black dots = elasmobranchs targeted, white dots = elasmobranchs not targeted, gray dots = fishery targets unknown.

Figure 3. Size compositions of sharks sampled from artisanal fishery landings in Baja California during 1998–1999. Only species with $\geq$ 50 specimens measured were included: (**a**) female (n = 104) and male (n = 39) pelagic thresher sharks, *Alopias pelagicus*, (**b**) female (n = 54) and (n = 28) male silky sharks, *Carcharhinus falciformis*, (**c**) female (n = 49) and male (n = 34) Mexican horn sharks, *Heterodontus mexicanus*, (**d**) female (n = 44) and male (n = 52) Pacific sharpnose sharks, *Rhizoprionodon longurio*, (**e**) female (n = 38) and male (n = 34) smooth hammerheads, *Sphyrna zygaena*, and (**f**) female (n = 20) and male (n = 38) Pacific angel sharks, *Squatina californica*.

Figure 4. Size compositions of rays sampled from artisanal fishery landings in Baja California during 1998–1999. Only species with $\geq$ 50 specimens measured were included: (**a**) female (n = 39) and male (n = 42) pygmy devil rays, *Mobula munkiana*, (**b**) female (n = 29) and male (n = 72) bat rays, *Myliobatis californica*, (**c**) female (n = 376) and male (n = 96) shovelnose guitarfish, *Rhinobatos productus*, (**d**) female (n = 34) and male (n = 57) golden cownose rays, *Rhinoptera steindachneri*.

Figure 5. Location of artisanal fishing camps (n = 83) documented in Baja California Sur during 1998–1999. Designations are as follows: black dots = elasmobranchs targeted, white dots = elasmobranchs not targeted, gray dots = fishery targets unknown.

Figure 6. Size compositions of sharks sampled from artisanal fishery landings in Baja California Sur during 1998–1999. Only species with $\geq$ 50 specimens measured were included: (**a**) female (n = 29) and male (n = 27) whitesnout sharks, *Nasolamia velox*, (**b**) female (n = 24) and male (n = 68) blue sharks, *Prionace glauca*, (**c**) female (n = 37) and male (n = 47) scalloped hammerheads, *Sphyrna lewini*, and (**d**) female (n = 36) and male (n = 31) Pacific angel sharks, *Squatina californica*.

Figure 7. Size composition of female (n = 20) and male (n = 37) pygmy devil rays, *Mobula munkiana*, sampled from artisanal fishery landings in Baja California Sur during 1998–1999. Measurements were available for < 50 individuals of all other rays encountered in this state's fishery.

Figure 8. Location of artisanal fishing camps (n = 19) documented in Sonora during 1998–1999. Designations are as follows: black dots = elasmobranchs targeted, gray dots = fishery targets unknown.

Figure 9. Size compositions of sharks sampled from artisanal fishery landings in Sonora 1998–1999. Only species with ≥ 50 specimens measured were included: (**a**) female (n = 57) and male (n = 94) silky sharks, *Carcharhinus falciformis*, (**b**) female (n = 31) and male (n = 32) blacktip sharks, *C. limbatus*, (**c**) female (n = 257) and male (n = 467) brown smoothhounds, *Mustelus henlei*, (**d**) female (n = 199) and male (n = 162) Pacific sharpnose sharks, *Rhizoprionodon longurio*, (**e**) female (n = 108) and male (n = 100) scalloped hammerheads, *Sphyrna lewini*, (**f**) female (n = 83) and male (n = 98) smooth hammerheads, *S. zygaena*, and (**g**) female (n = 70) and male (n = 29) Pacific angel sharks, *Squatina californica*.

Figure 10. Size compositions of rays sampled from artisanal fishery landings in Sonora during 1998–1999. Only species with ≥ 50 specimens measured were included: (**a**) female (n = 881) and male (n = 540) diamond stingrays, *Dasyatis dipterura*, (**b**) female (n = 52) and male (n = 33) bat rays, *Myliobatis californica*, (**c**) female (n = 328) and male (n = 86) giant electric rays, *Narcine entemedor*, (**d**) female (n = 26) and male (n = 26) rasptail skates, *Raja velezi*, (**e**) female (n = 240) and male (n = 49) speckled guitarfish, *Rhinobatos glaucostigma*, (**f**) female (n = 491) and male (n = 262) shovelnose guitarfish, *R. productus*, (**g**) female (n = 448) and male (n = 423) male golden cownose rays, *Rhinoptera steindachneri*, and (**h**) female (n = 70) and male (n = 31) banded guitarfish, *Zapteryx exasperata*.

Figure 11. Location of artisanal fishing camps (n = 28) documented in Sinaloa during 1998–1999. Designations are as follows: black dots = elasmobranchs targeted, white dots = elasmobranchs not targeted, gray dots = fishery targets unknown.

Figure 12. Size compositions of sharks sampled from artisanal fishery landings in Sinaloa during 1998–1999. Only species with ≥ 50 specimens measured were included: (**a**) female (n = 324) and (n = 266) male Pacific sharpnose sharks, *Rhizoprionodon longurio*, (**b**) female (n = 832) and male (n = 683) scalloped hammerheads, *Sphyrna lewini*, and (**c**) female (n = 46) and male (n = 39) smooth hammerheads, *S. zygaena*.

Figure 13. Size compositions of rays sampled from artisanal fishery landings in Sinaloa during 1998–1999. Only species with ≥ 50 specimens measured were included: (**a**) female (n = 97) and male (n = 81) diamond stingrays, *Dasyatis dipterura*, (**b**) female (n = 418) and male (n = 73) speckled guitarfish, *Rhinobatos glaucostigma*, and (**c**) female (n = 26) and male (n = 105) male golden cownose rays, *Rhinoptera steindachneri*.

Figure 14. Location of artisanal fishing camps (n = 147) documented throughout the Gulf of California during 1998–1999. Designations are as follows: black dots = elasmobranchs targeted, white dots = elasmobranchs not targeted, gray dots = fishery targets unknown.

Figure 15. Cluster analysis of species composition of chondrichthyan landings using proportional data from seasonal surveys of all states with sufficient sample size. Hierarchical clustering was performed using average linkage with the Percent Similarity Index as a measure of similarity. Dashed line indicates major clades (≥ 56.8% similar).

Figure 16. Reported elasmobranch landings from Baja California (BC), Baja California Sur (BCS), Sonora, and Sinaloa from 1986–2003 based on three general categories: (**a**) batoids, (**b**) cazón (small sharks, ≤ 1.5 m total length), and (**c**) tiburón (sharks > 1.5 m total length). Landings are based on data from CONAPESCA (2003) and CONAPESCA (unpub.).

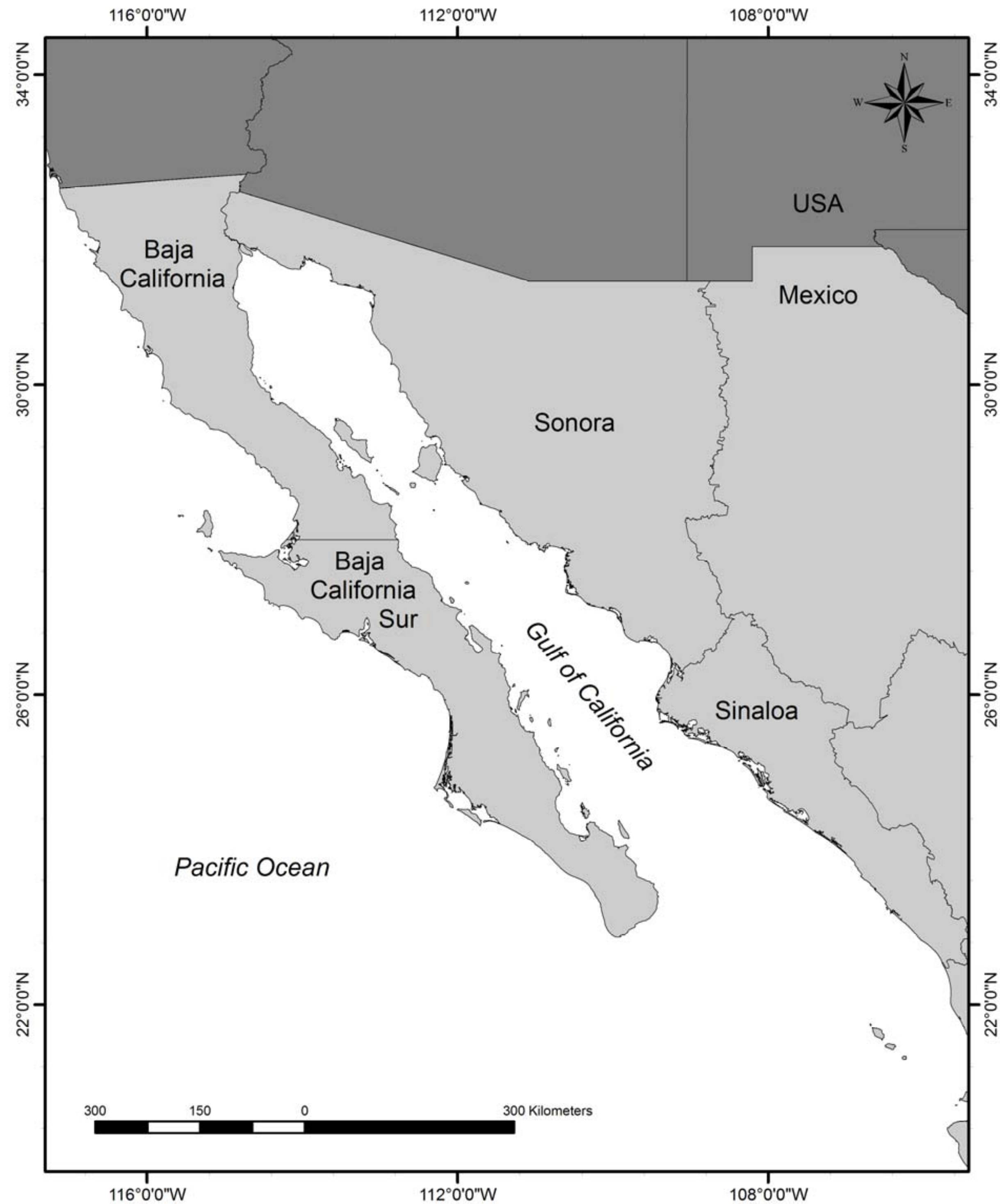

116°0'0"W
112°0'0"W
108°0'0"W
34°0'0"N
30°0'0"N
26°0'0"N
22°0'0"N
N
S
E
W
USA
Mexico
Baja California
Sonora
Baja California Sur
Gulf of California
Sinaloa
Pacific Ocean
300
150
0
300 Kilometers

Figure 1.

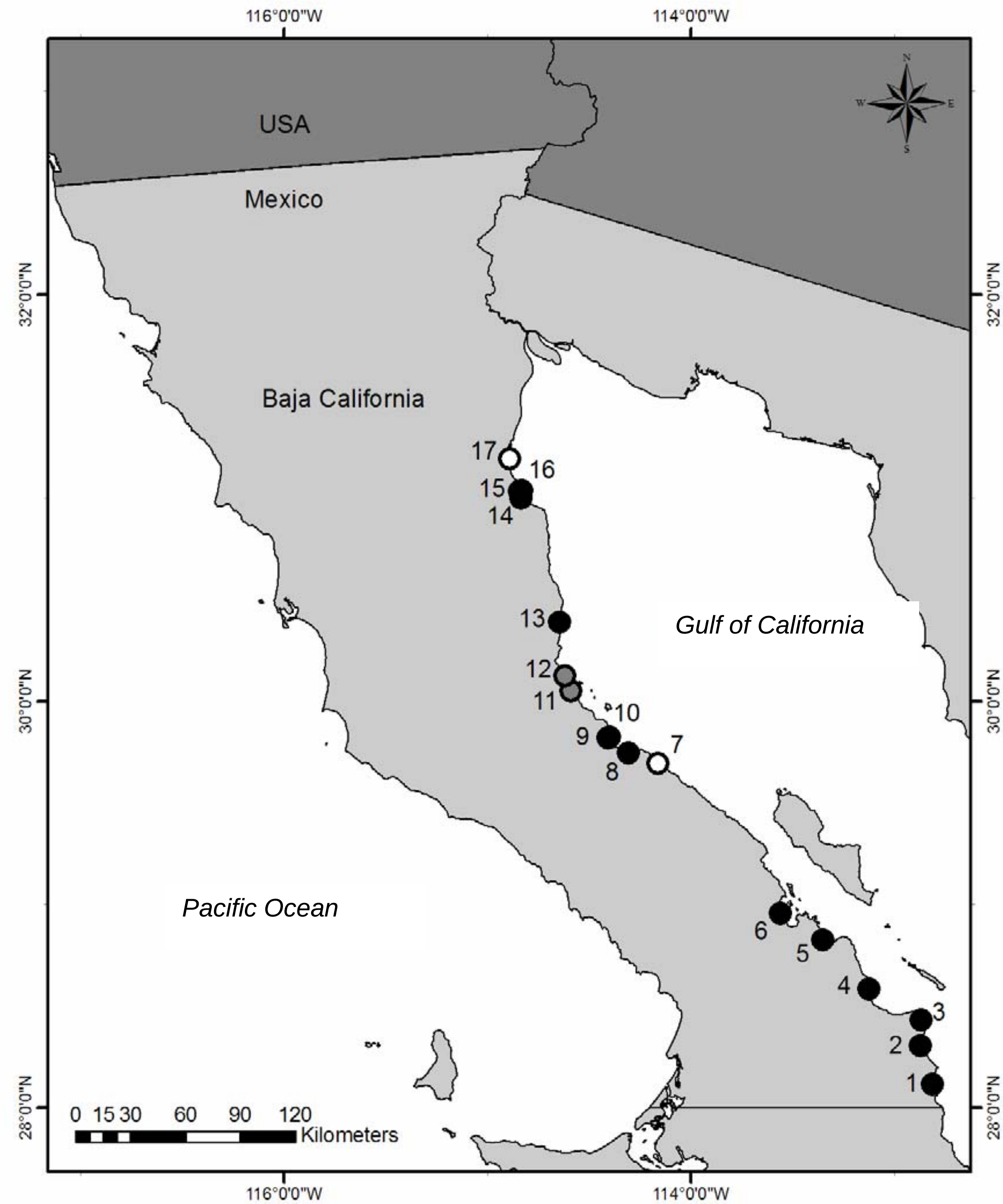

116°0'0"W
114°0'0"W
32°0'0"N
30°0'0"N
28°0'0"N
USA
Mexico
Baja California
Gulf of California
Pacific Ocean
N
S
E
W
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
0 15 30 60 90 120
Kilometers

Figure 2.

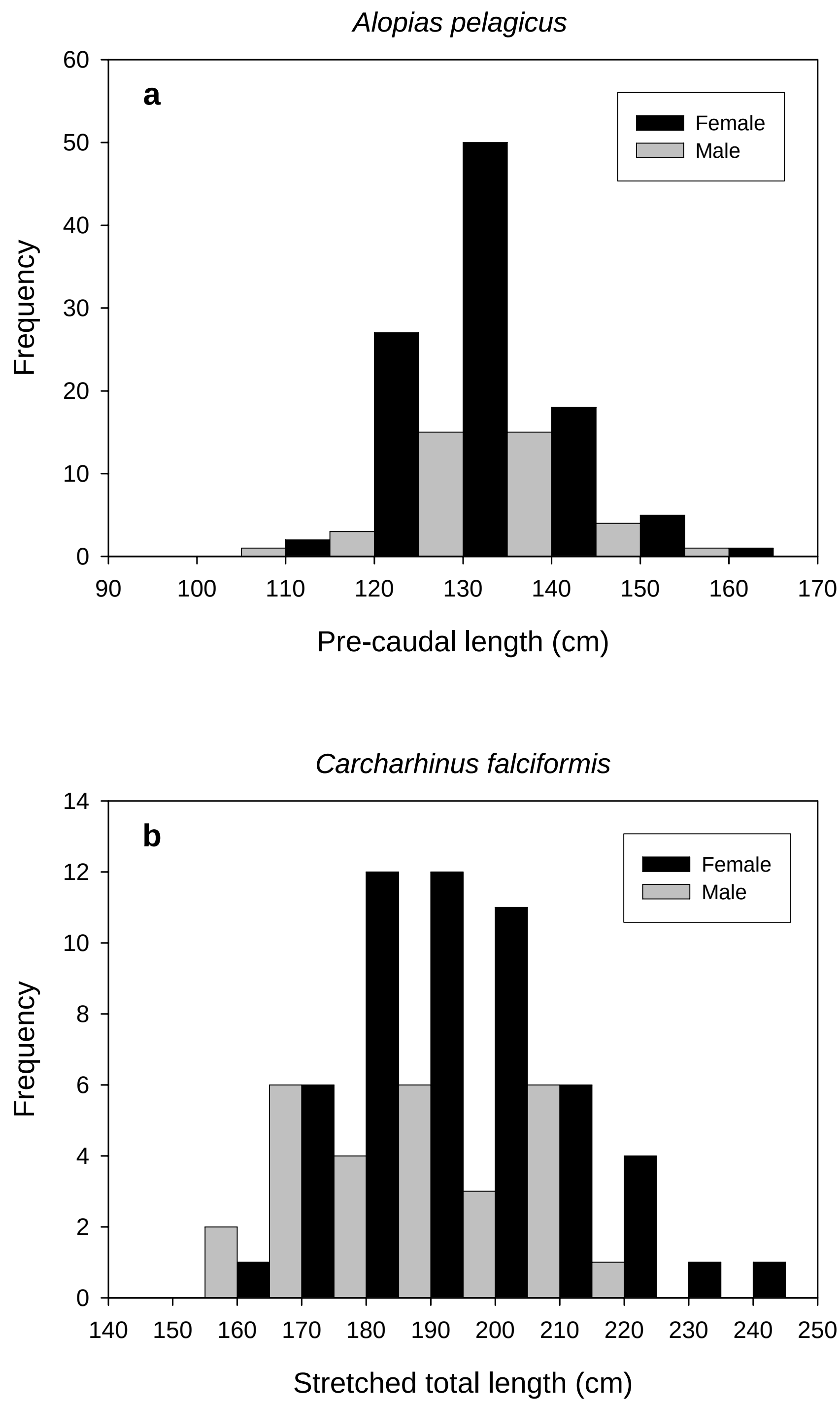

Alopias pelagicus
a
Female
Male
Frequency
0
10
20
30
40
50
60
90
100
110
120
130
140
150
160
170
Pre-caudal length (cm)
Carcharhinus falciformis
b
Female
Male
Frequency
0
2
4
6
8
10
12
14
140
150
160
170
180
190
200
210
220
230
240
250
Stretched total length (cm)

Figure 3.

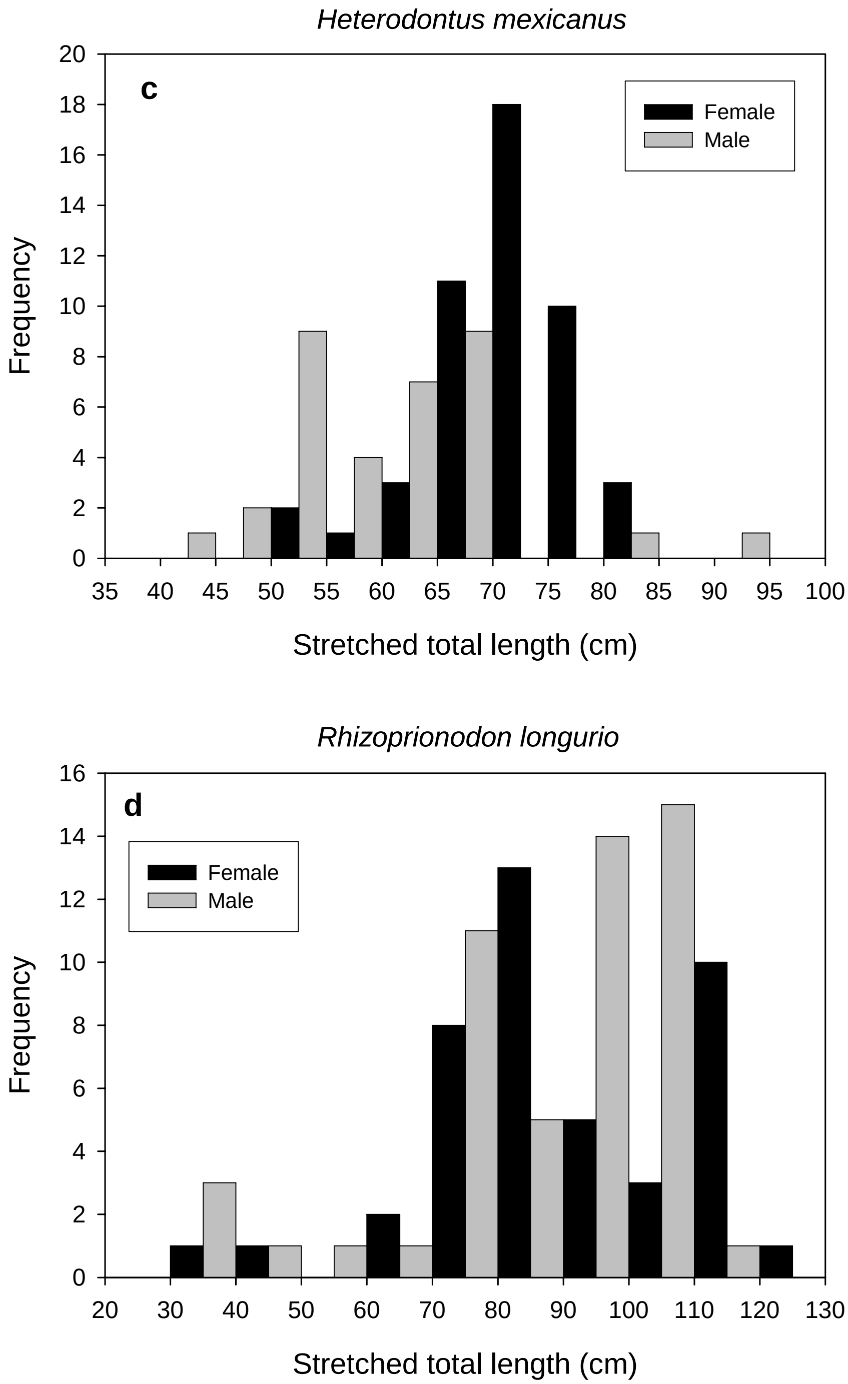
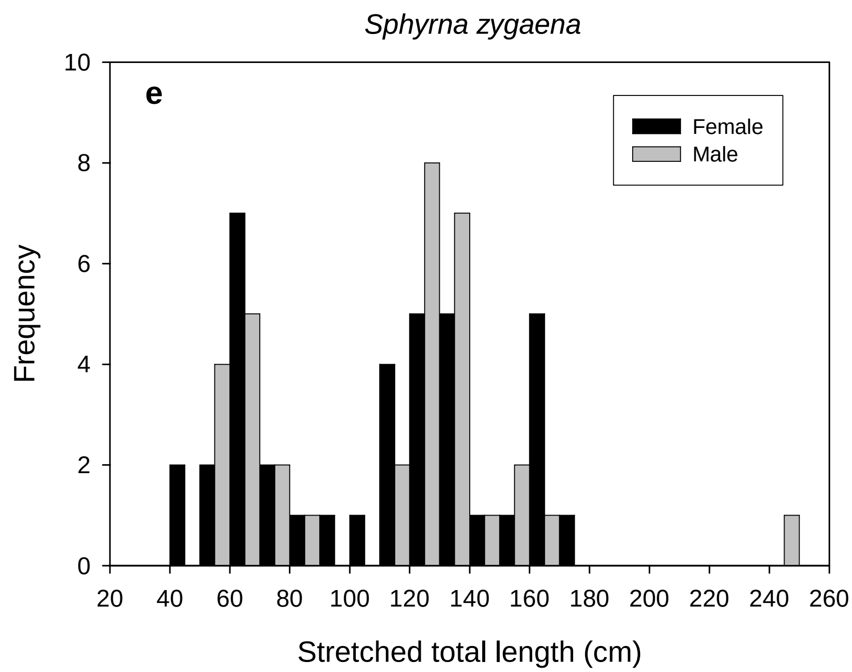


Figure 3. continued.



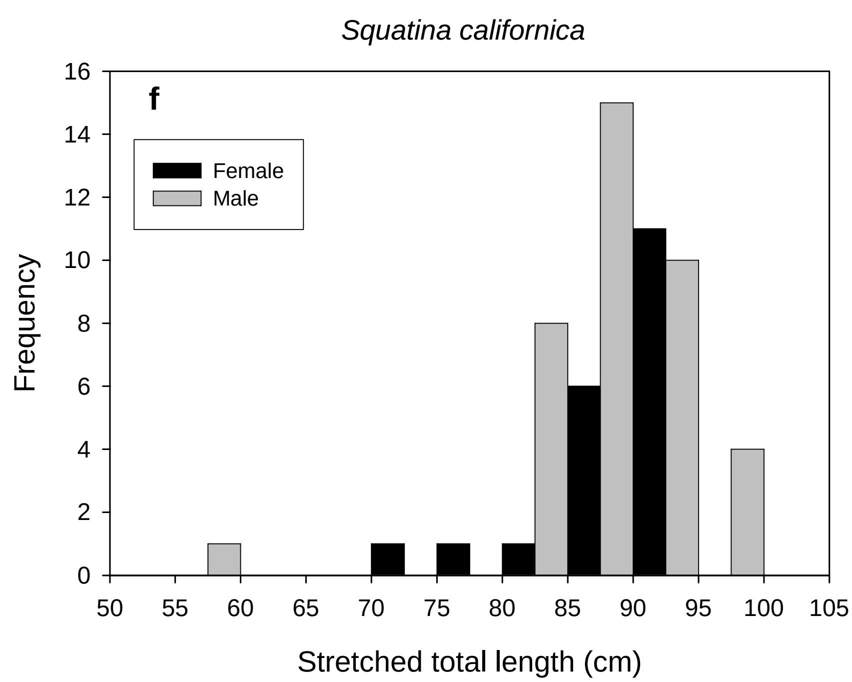


Figure 3. continued.

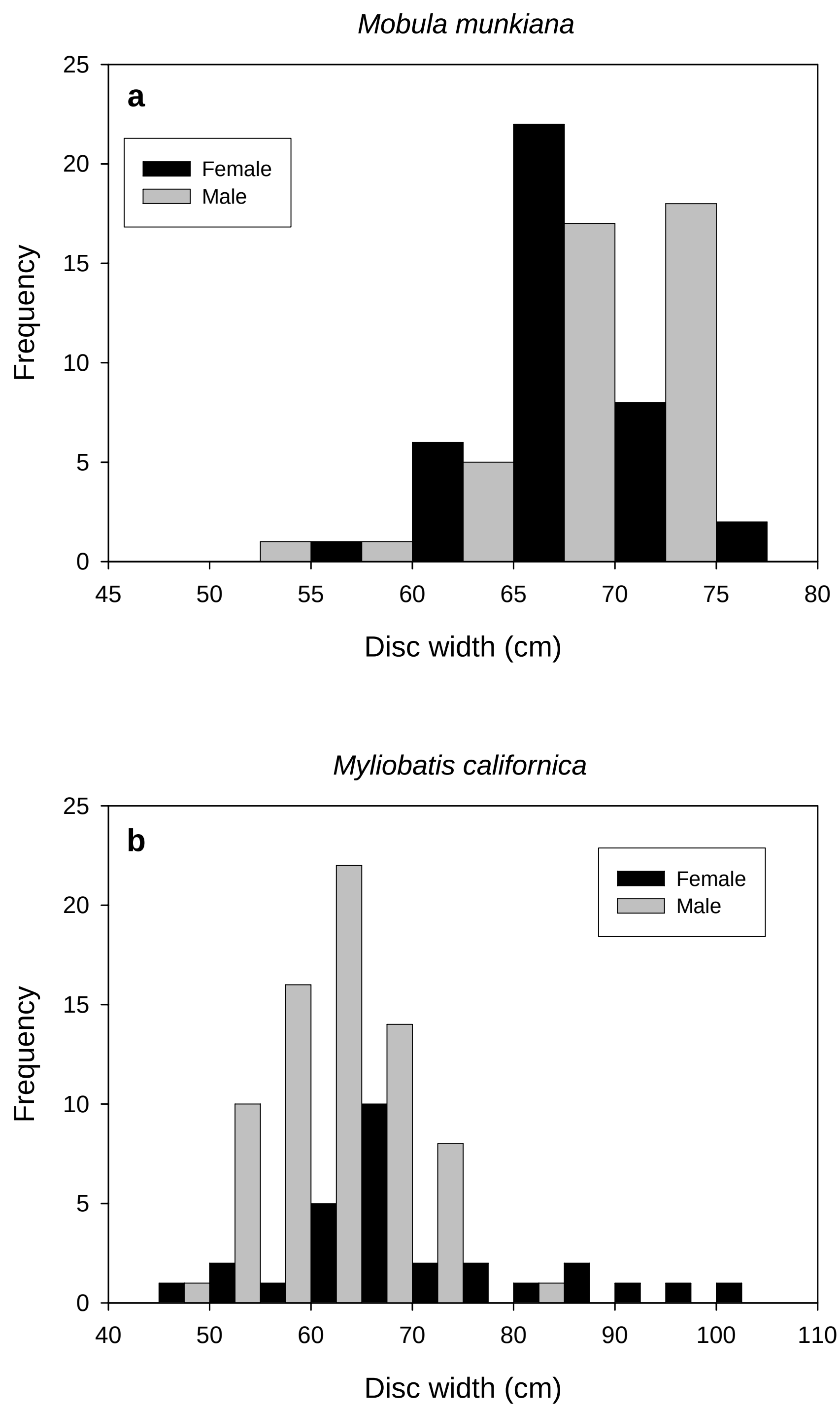
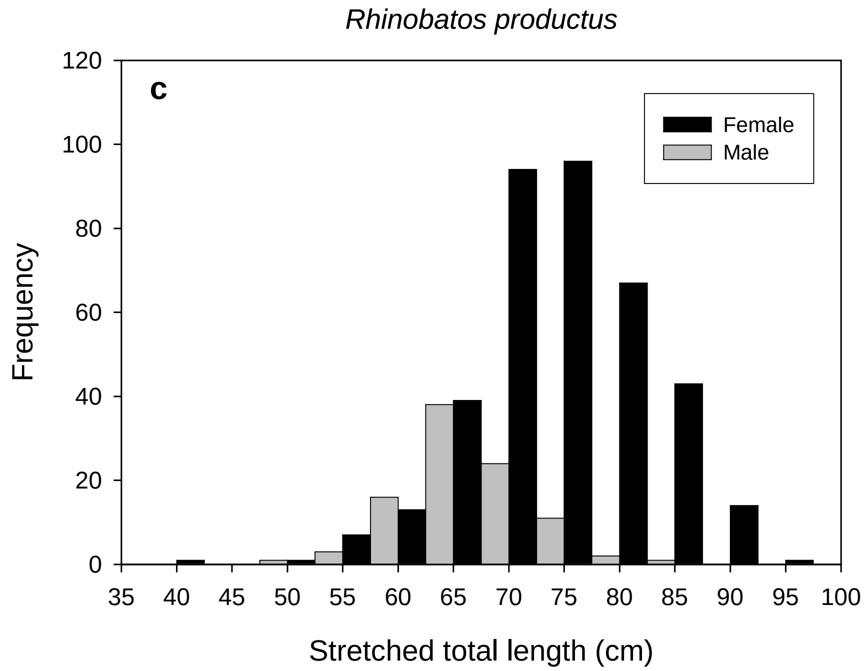

Mobula munkiana
a
Female
Male
Frequency
0
5
10
15
20
25
45
50
55
60
65
70
75
80
Disc width (cm)
Myliobatis californica
b
Female
Male
Frequency
0
5
10
15
20
25
40
50
60
70
80
90
100
110
Disc width (cm)

Figure 4.



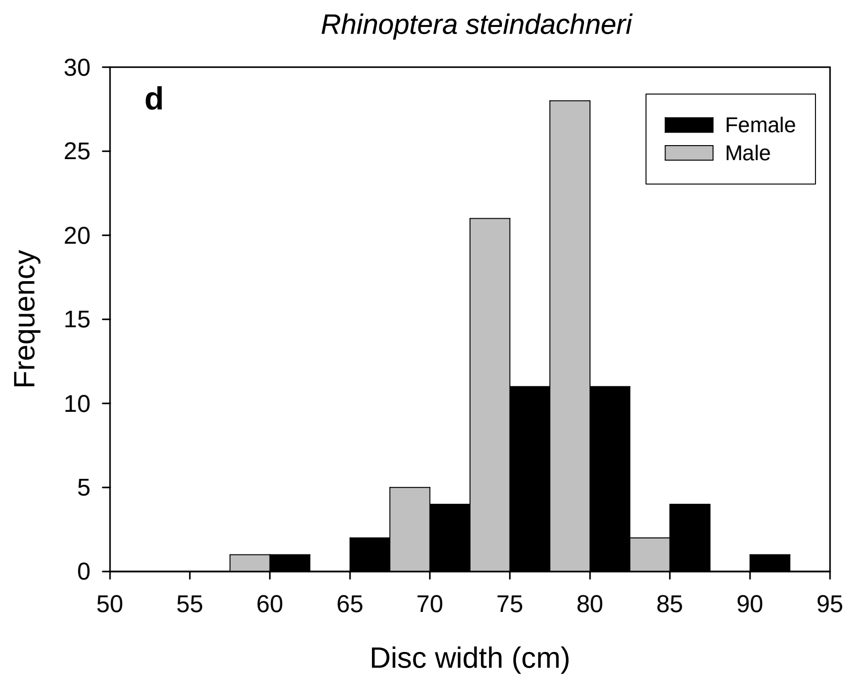
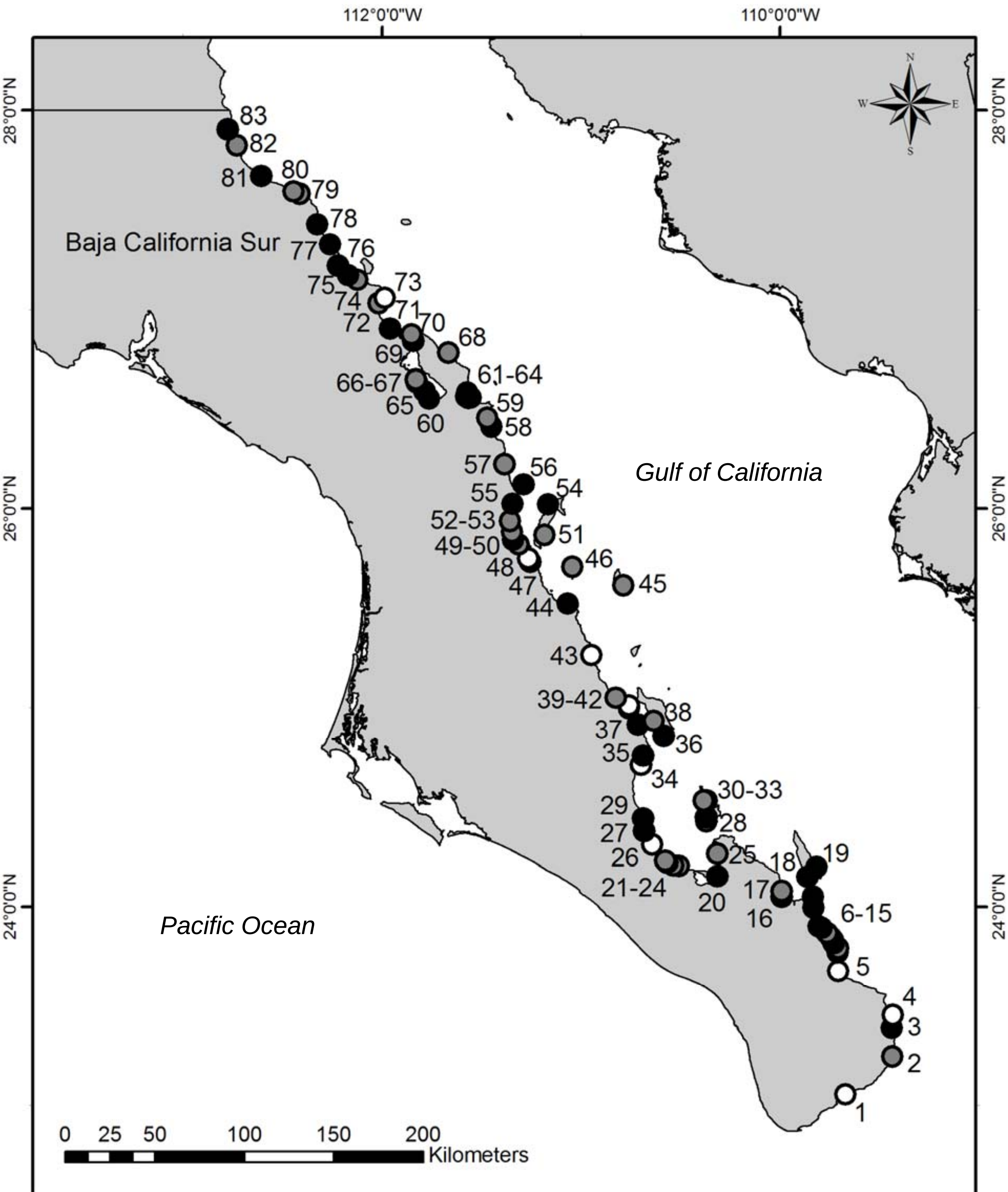


Figure 4. continued.


112°0'0"W
110°0'0"W
28°0'0"N
26°0'0"N
24°0'0"N
N
S
E
W
Baja California Sur
Gulf of California
Pacific Ocean
83
82
81
80
79
78
77
76
75
74
73
72
71
70
69
68
66-67
65
61-64
60
59
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57
56
55
54
52-53
51
49-50
48
47
46
45
44
43
39-42
38
37
36
35
34
30-33
29
28
27
26
25
21-24
20
19
18
17
16
6-15
5
4
3
2
1
0 25 50 100 150 200
Kilometers

Figure 5.

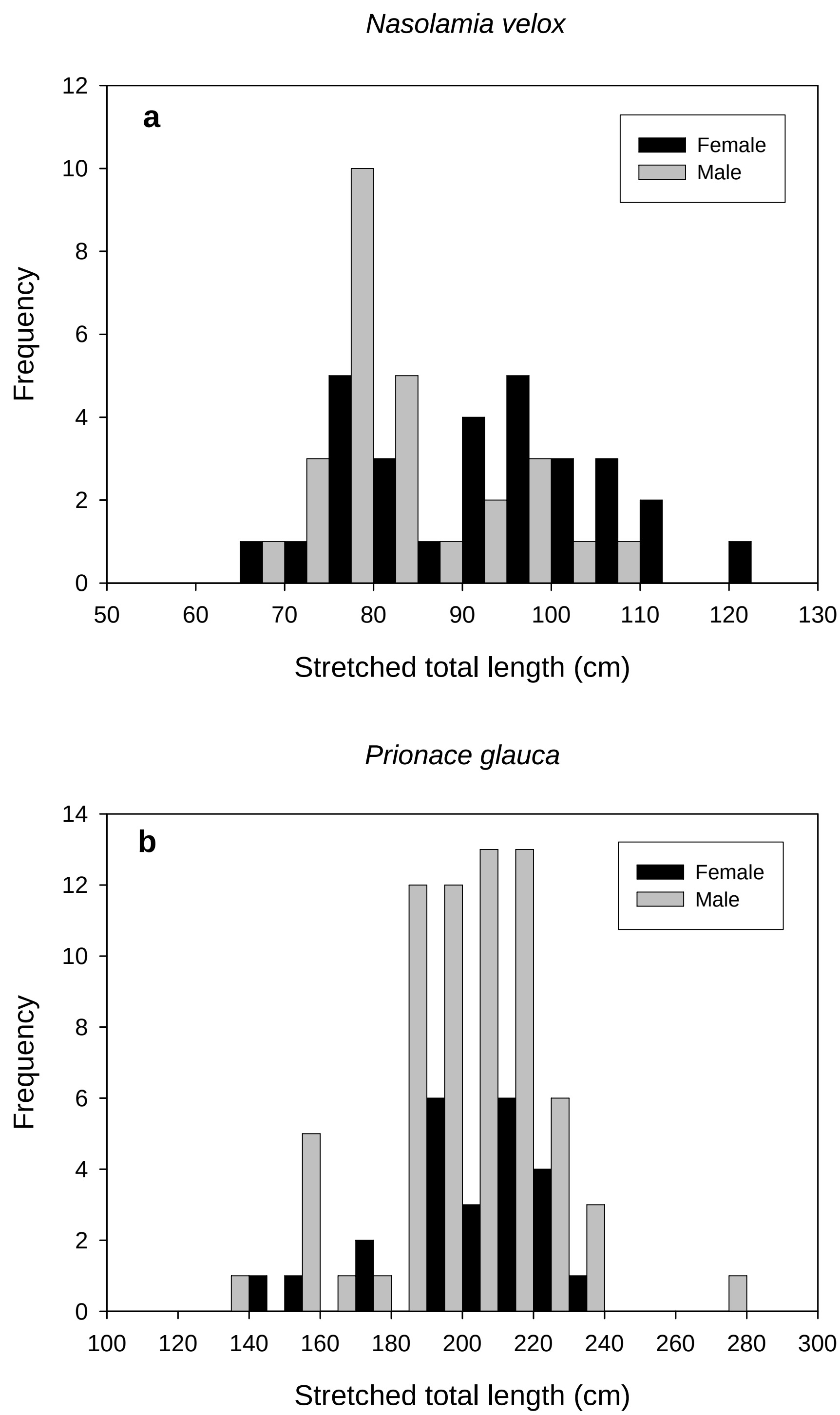

Nasolamia velox
a
Female
Male
Frequency
0
2
4
6
8
10
12
50
60
70
80
90
100
110
120
130
Stretched total length (cm)
Prionace glauca
b
Female
Male
Frequency
0
2
4
6
8
10
12
14
100
120
140
160
180
200
220
240
260
280
300
Stretched total length (cm)

Figure 6.

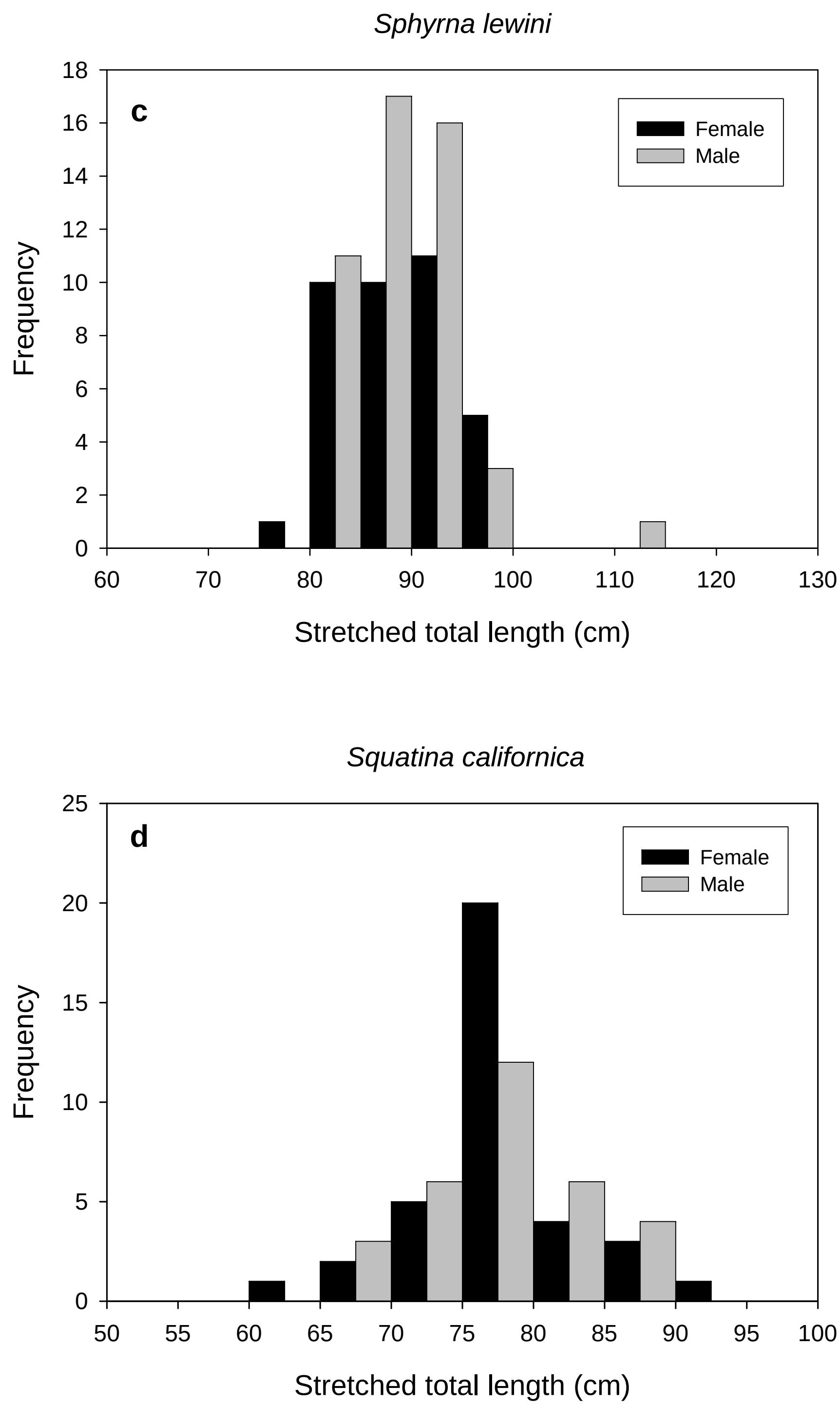
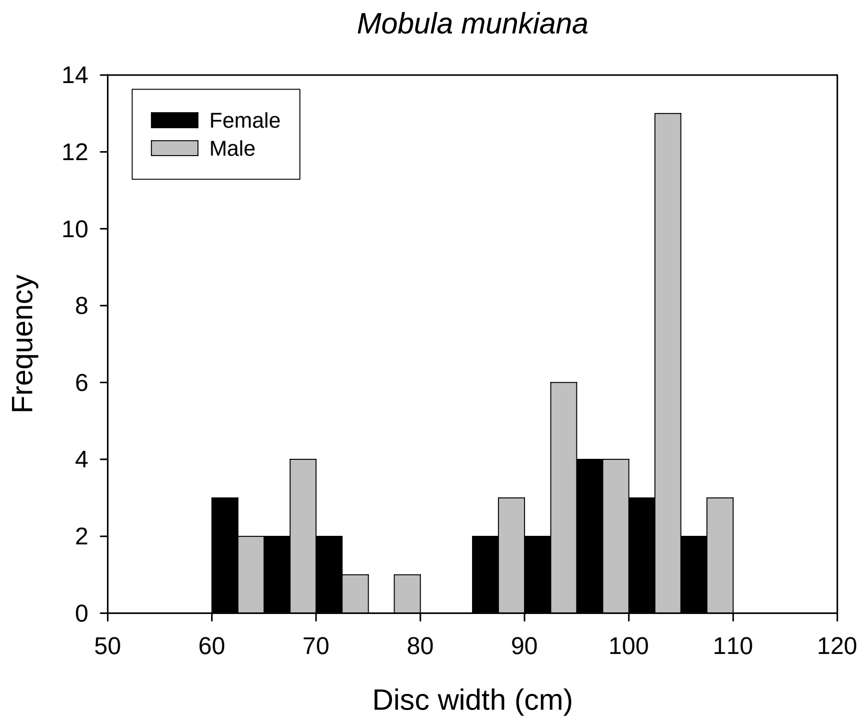
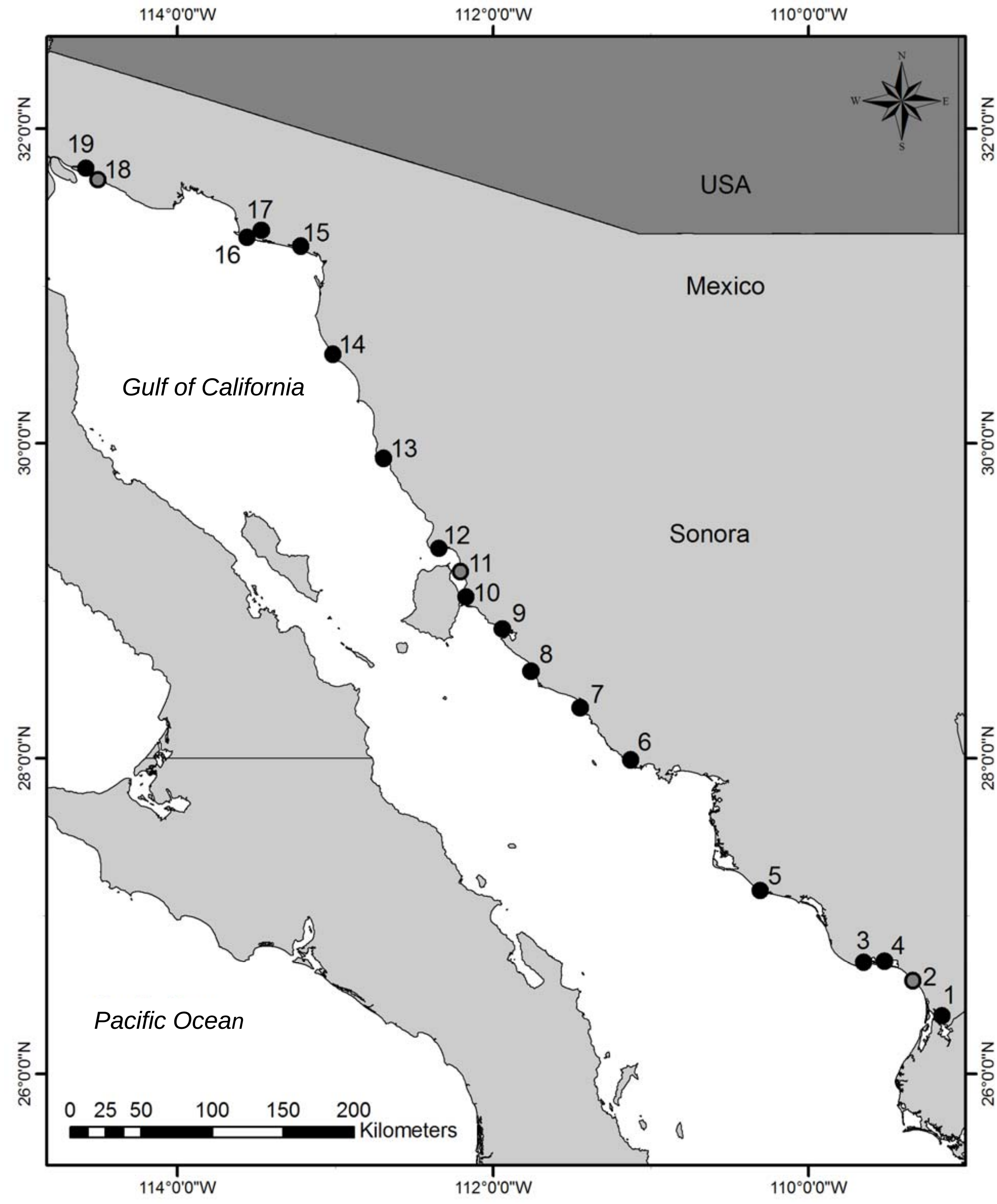


Figure 6. continued.



Mobula munkiana
Female
Male
Frequency
Disc width (cm)
0
2
4
6
8
10
12
14
50
60
70
80
90
100
110
120

Figure 7.



114°0'0"W
112°0'0"W
110°0'0"W
32°0'0"N
30°0'0"N
28°0'0"N
26°0'0"N
USA
Mexico
Sonora
Gulf of California
Pacific Ocean
N
S
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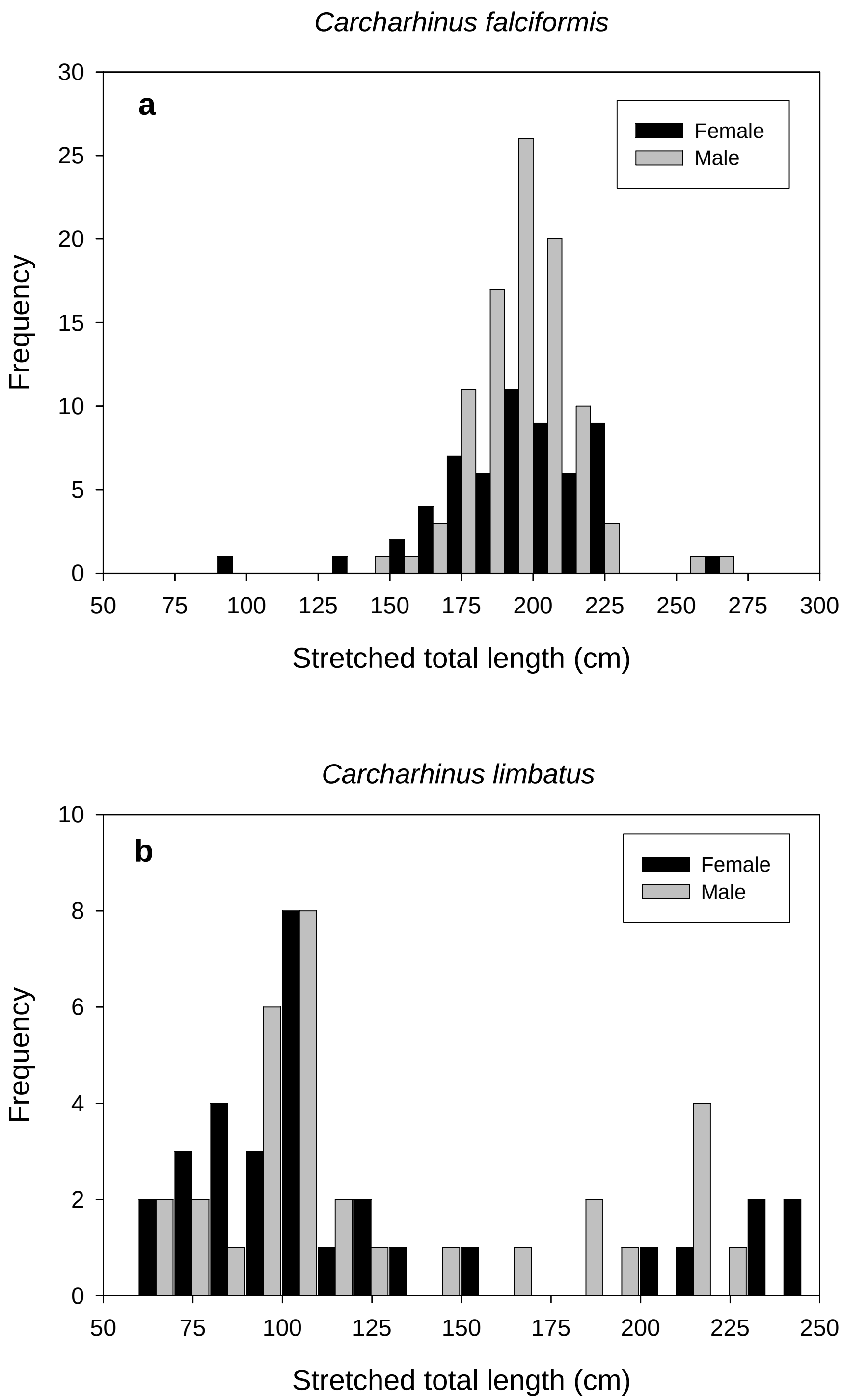
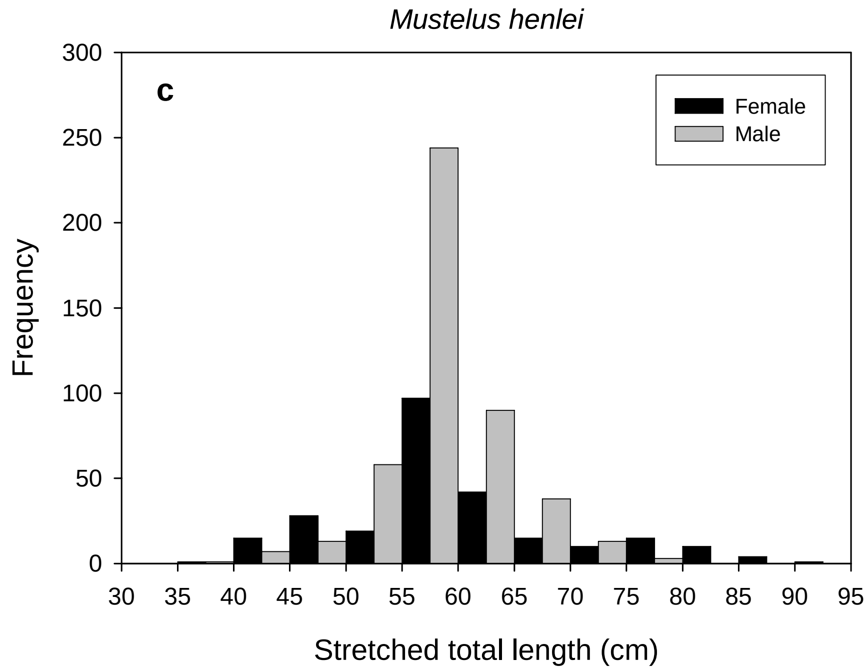
18
19
0 25 50 100 150 200
Kilometers

Figure 8.



Carcharhinus falciformis
a
Female
Male
Frequency
30
25
20
15
10
5
0
50
75
100
125
150
175
200
225
250
275
300
Stretched total length (cm)
Carcharhinus limbatus
b
Female
Male
Frequency
10
8
6
4
2
0
50
75
100
125
150
175
200
225
250
Stretched total length (cm)

Figure 9.



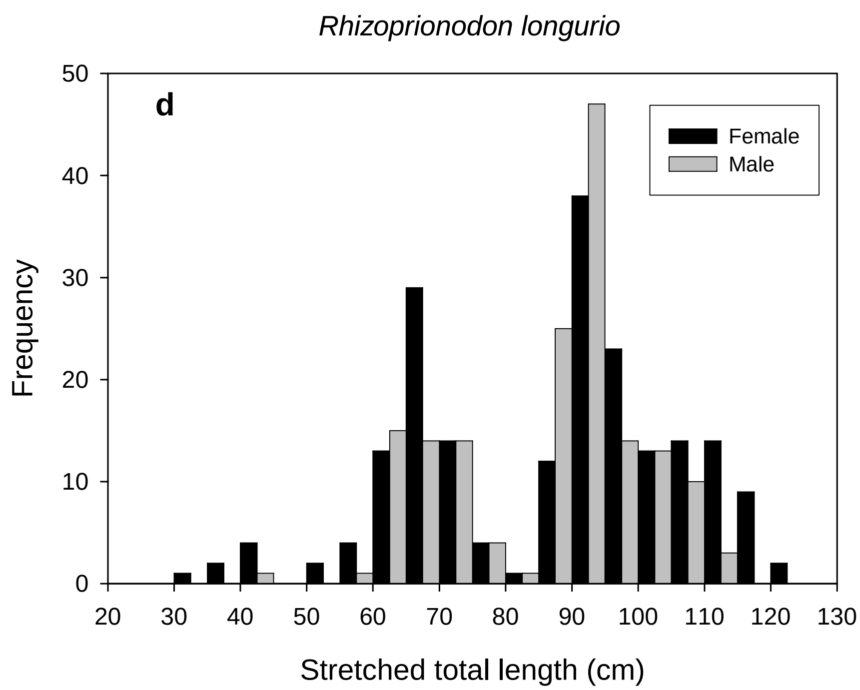
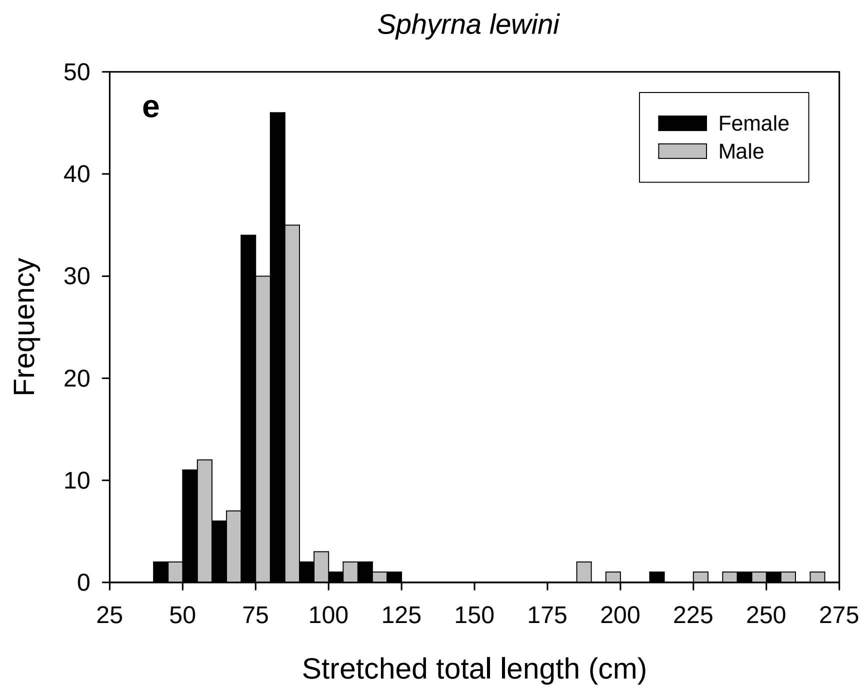


Figure 9. continued.



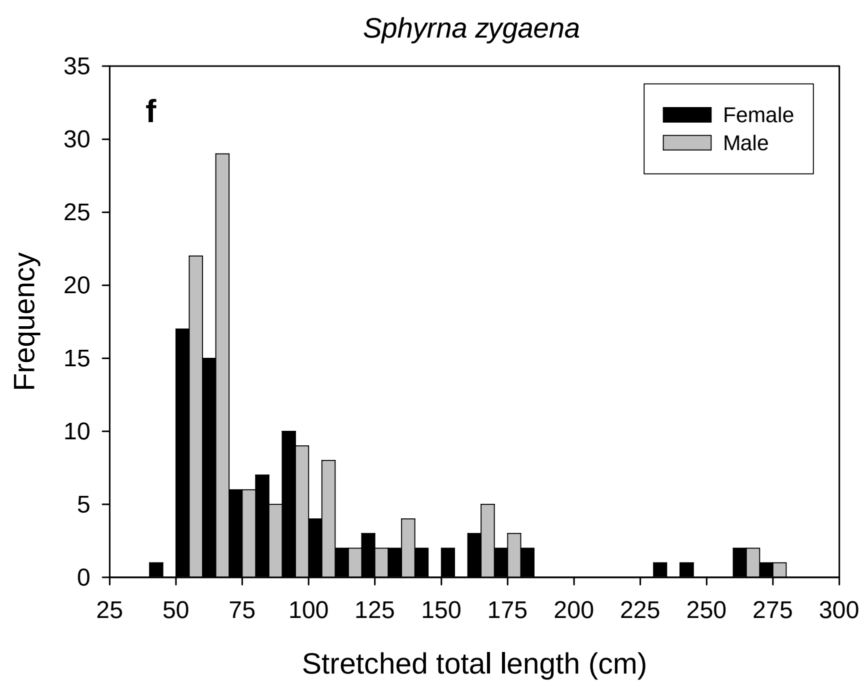


Figure 9. continued.

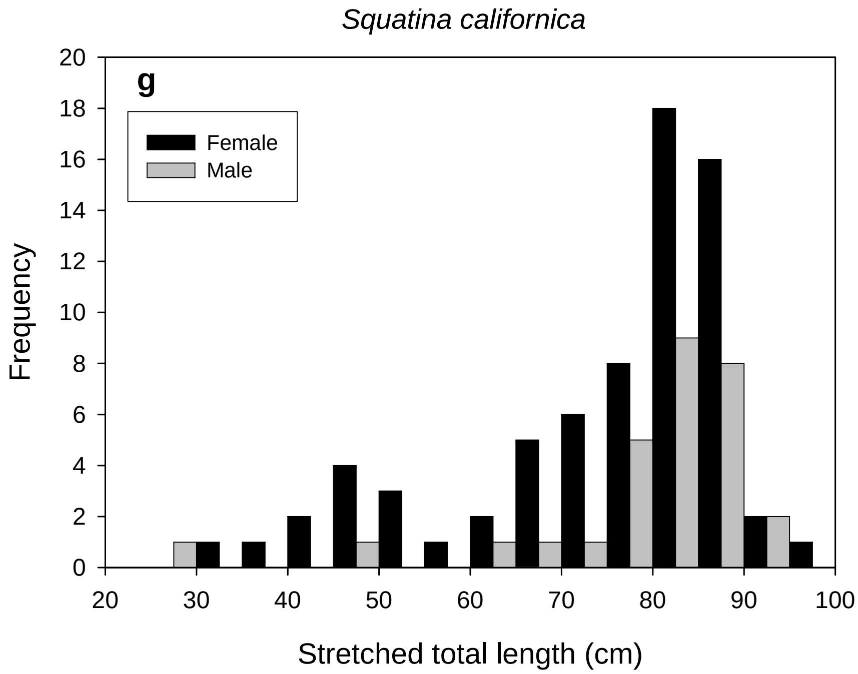


Figure 9. continued.

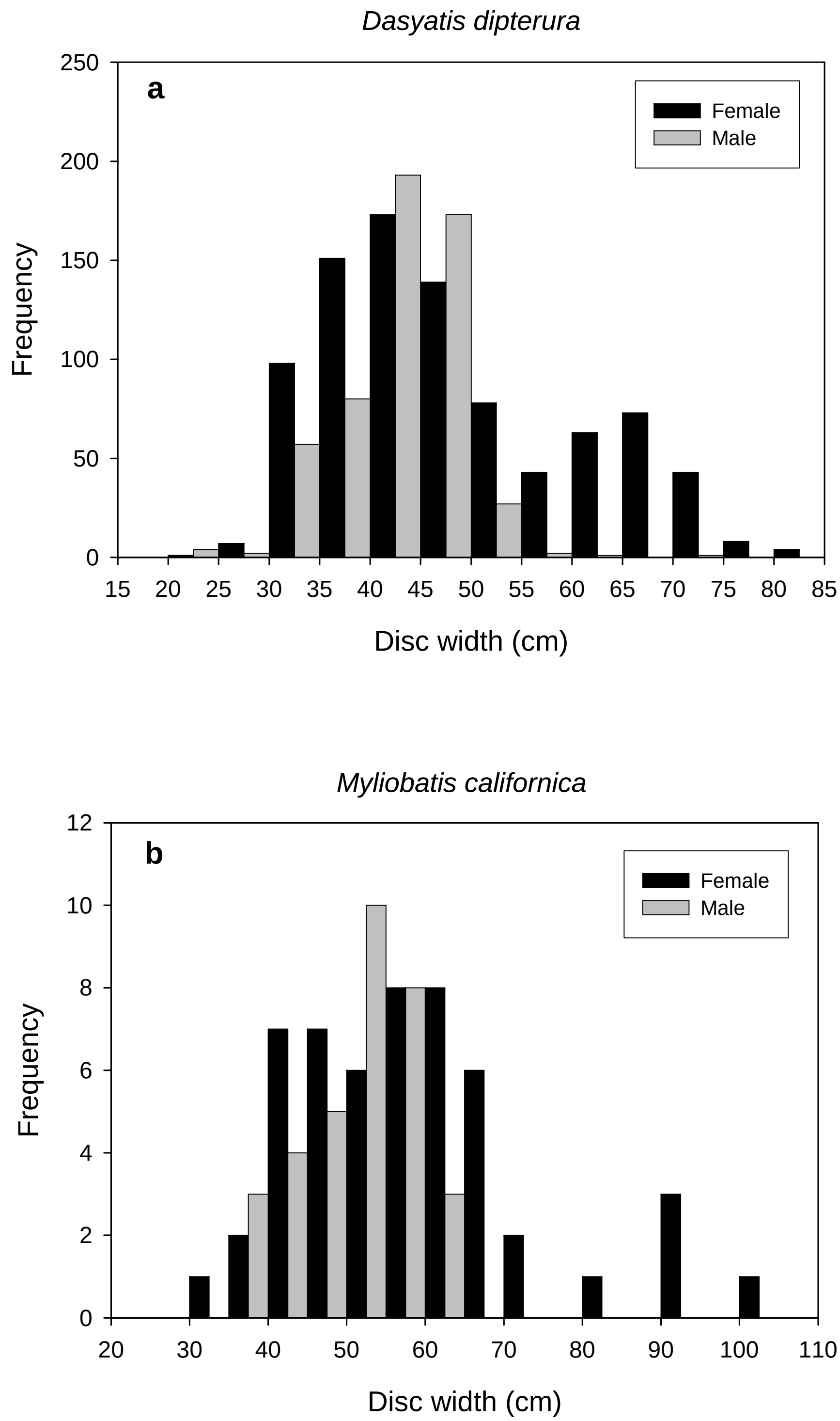
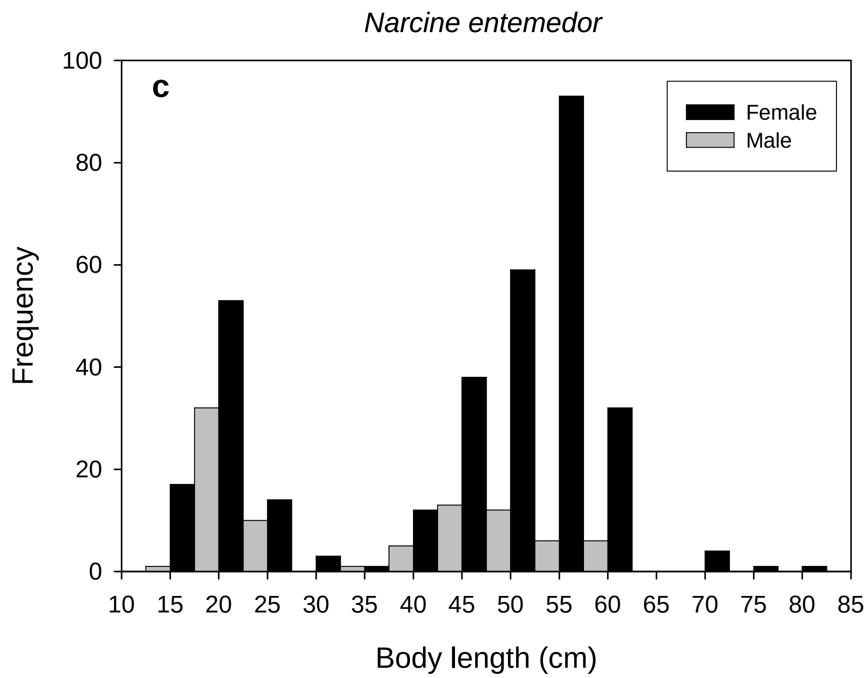

Dasyatis dipterura
a
Female
Male
Frequency
250
200
150
100
50
0
15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Disc width (cm)
Myliobatis californica
b
Female
Male
Frequency
12
10
8
6
4
2
0
20 30 40 50 60 70 80 90 100 110
Disc width (cm)

Figure 10.



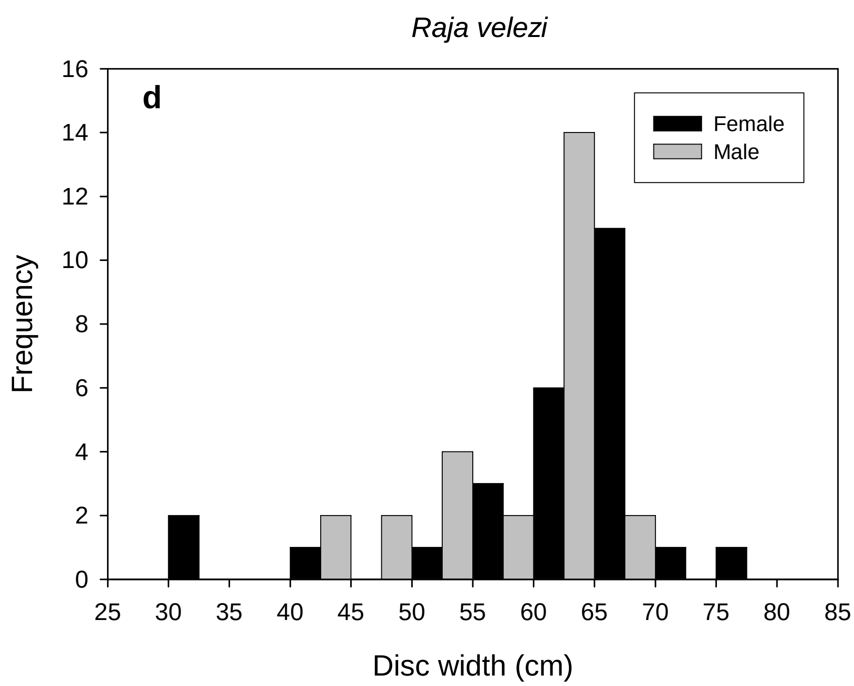
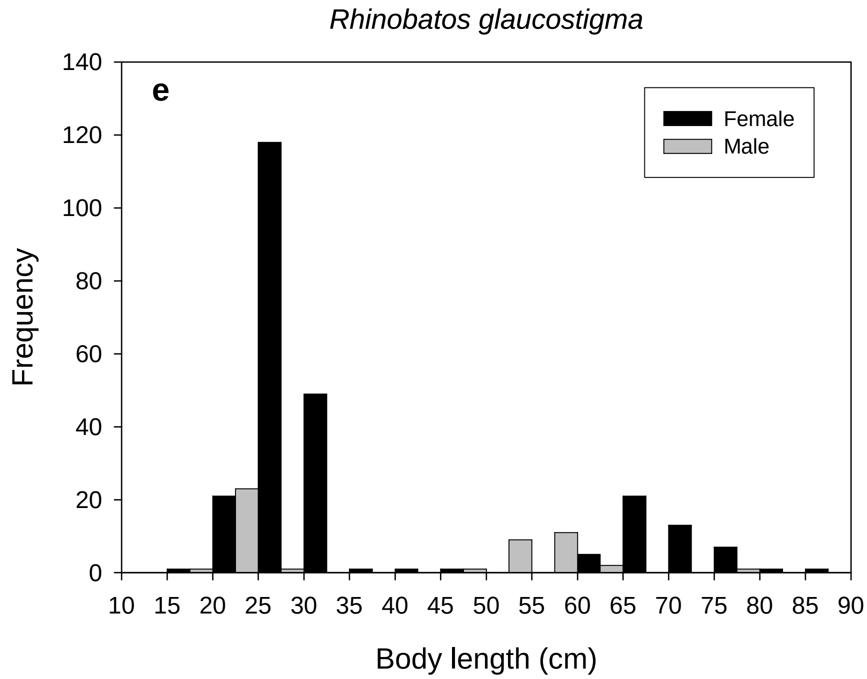


Figure 10. continued.



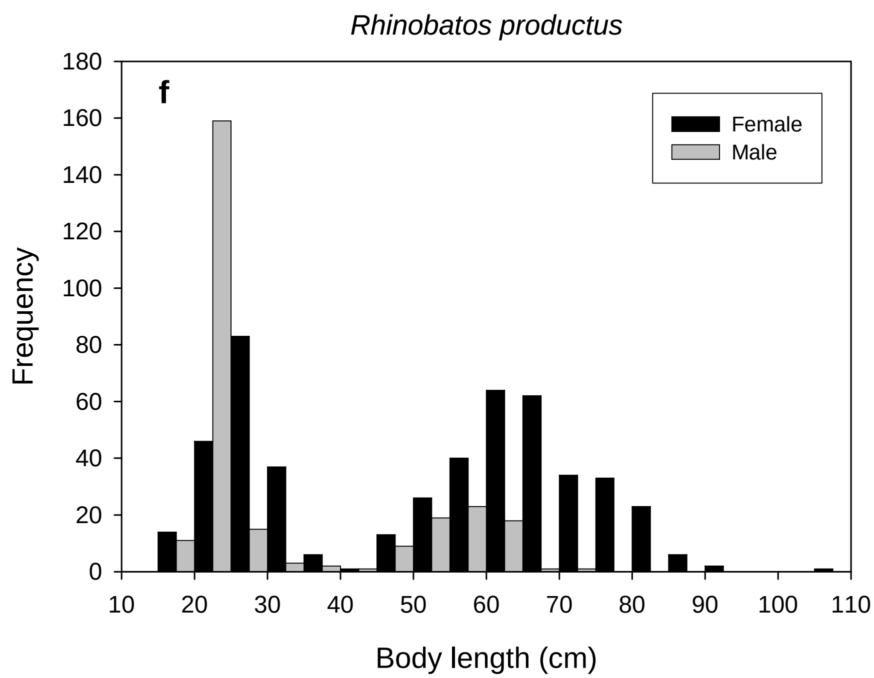


Figure 10. continued.

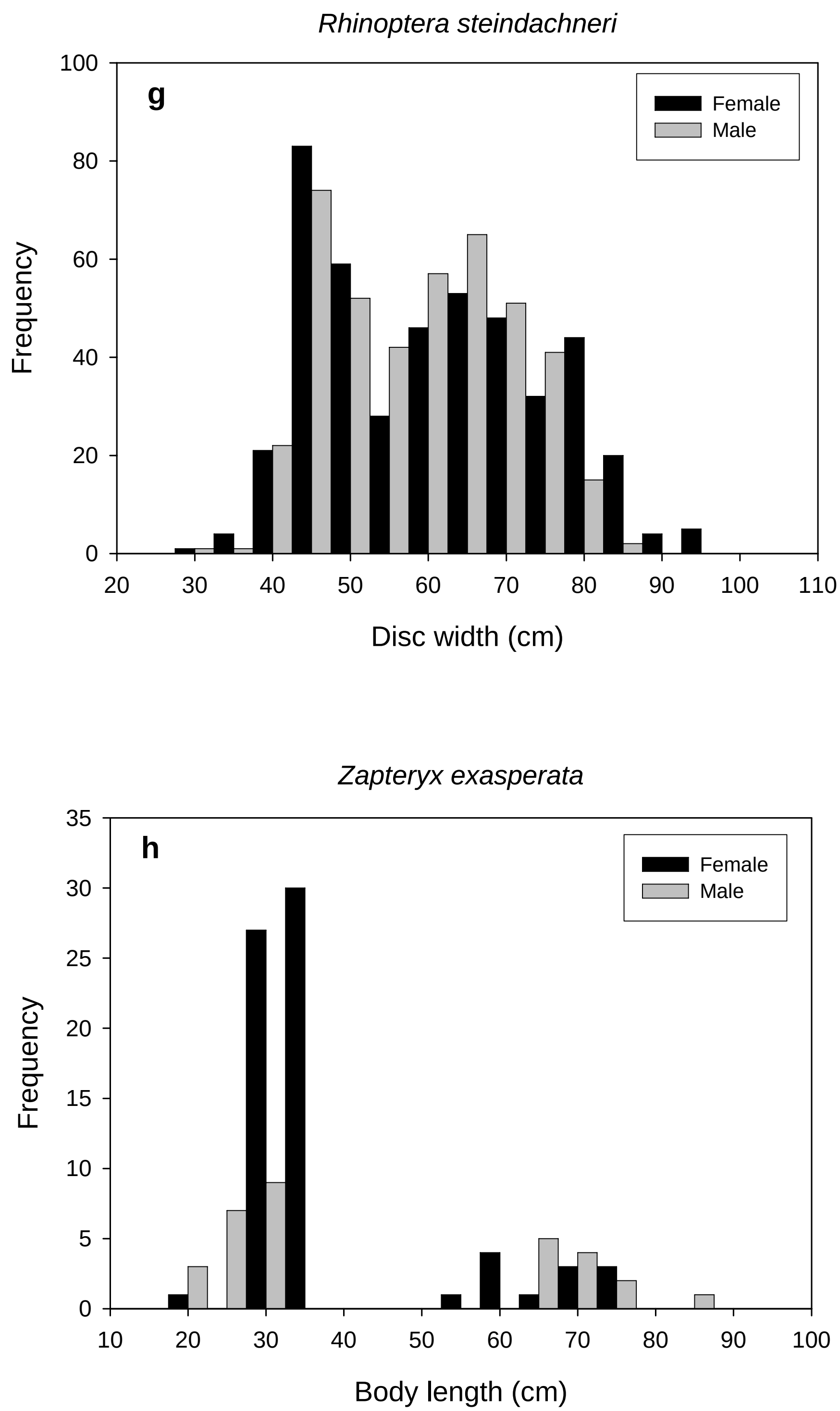


Figure 10. continued.

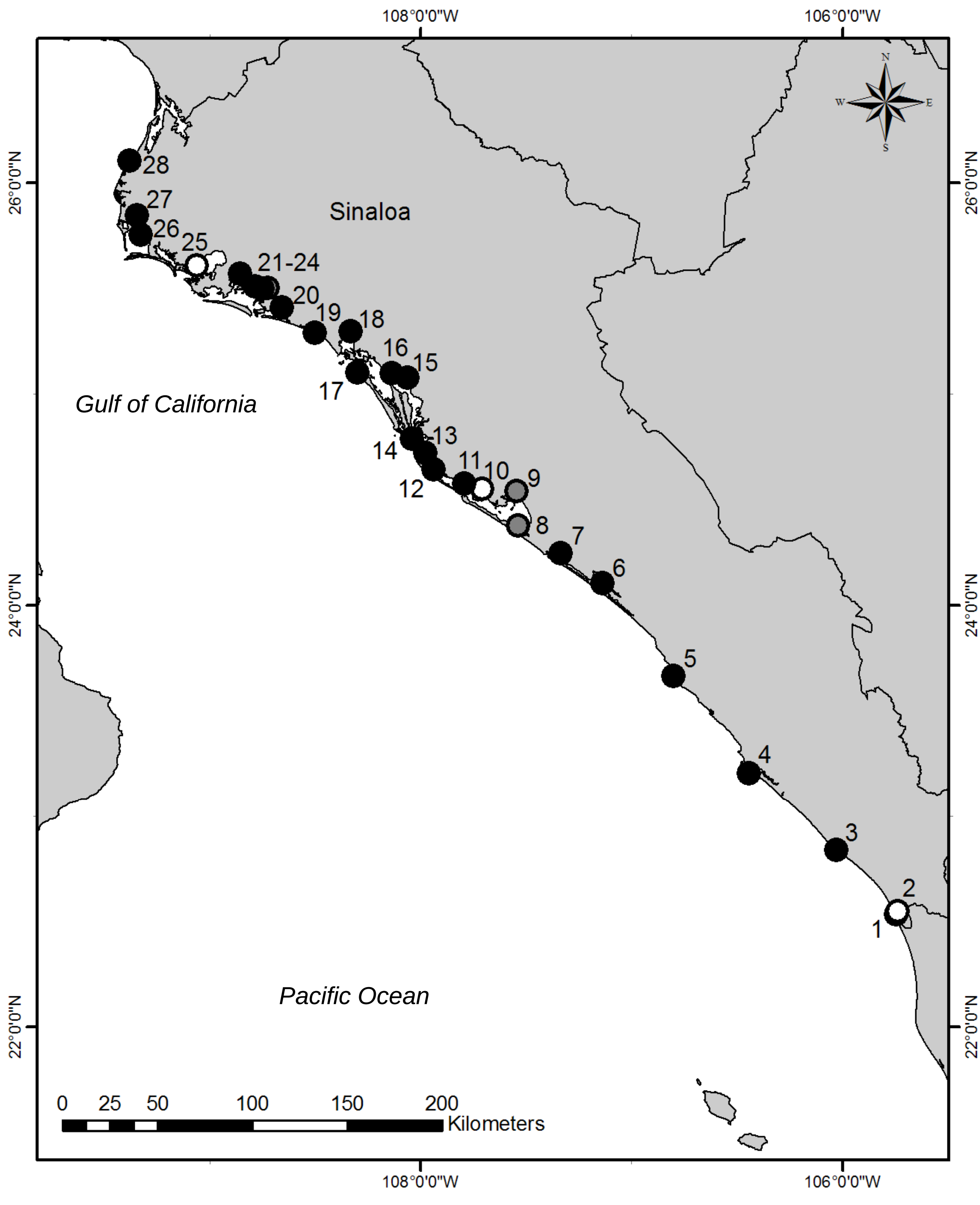
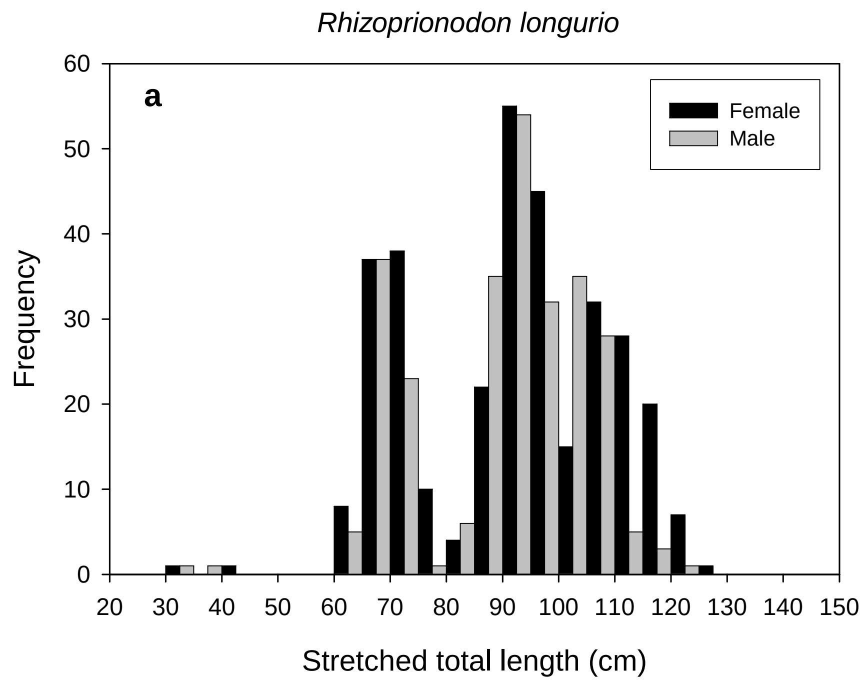

108°0'0"W
106°0'0"W
26°0'0"N
24°0'0"N
22°0'0"N
N
S
E
W
Sinaloa
Gulf of California
Pacific Ocean
28
27
26
25
21-24
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0 25 50 100 150 200
Kilometers

Figure 11.


Rhizoprionodon longurio
a
Female
Male
Frequency
0
10
20
30
40
50
60
20 30 40 50 60 70 80 90 100 110 120 130 140 150
Stretched total length (cm)

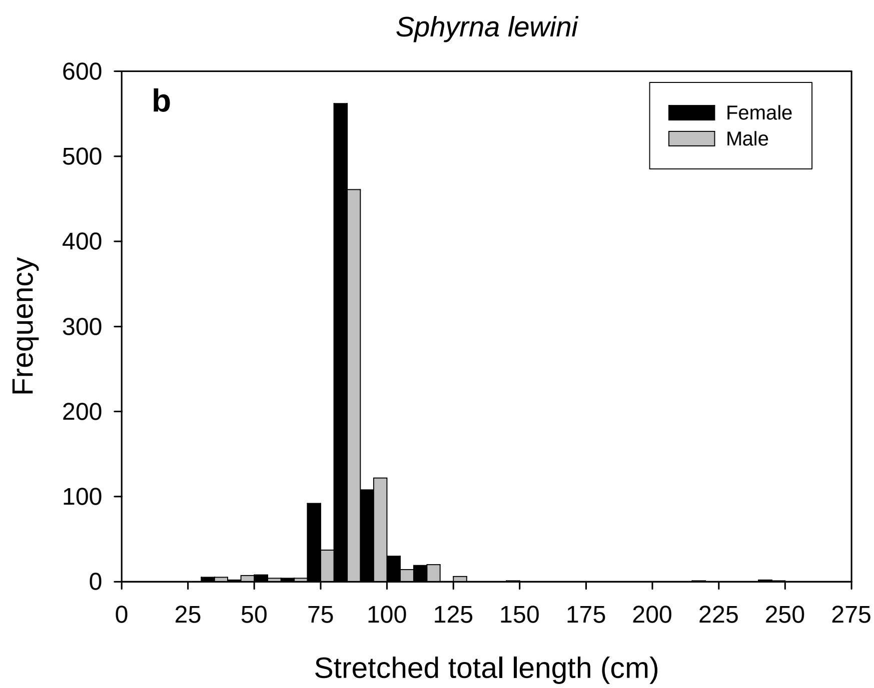

Sphyrna lewini
b
Female
Male
Frequency
0
100
200
300
400
500
600
0 25 50 75 100 125 150 175 200 225 250 275
Stretched total length (cm)

Figure 12.

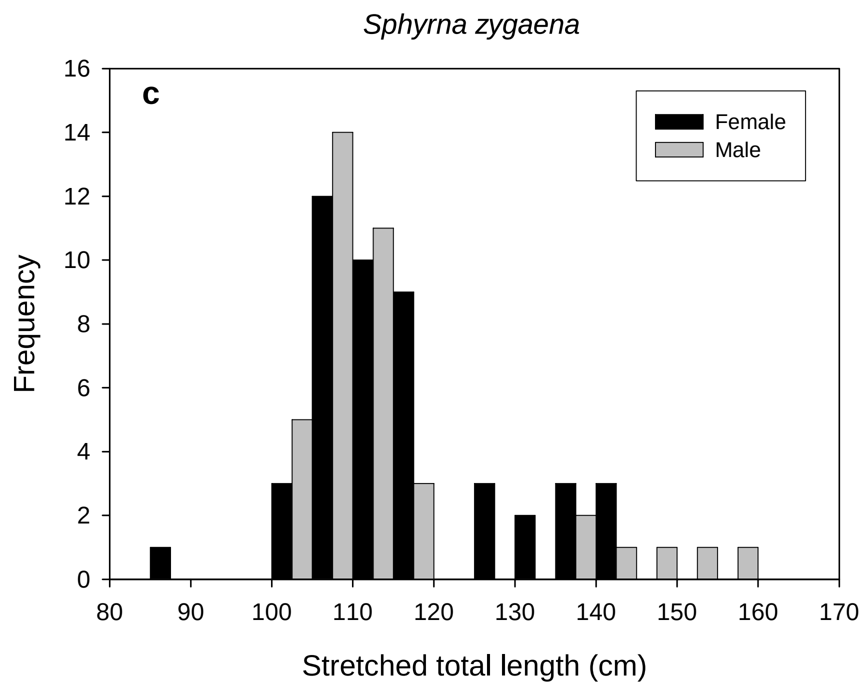
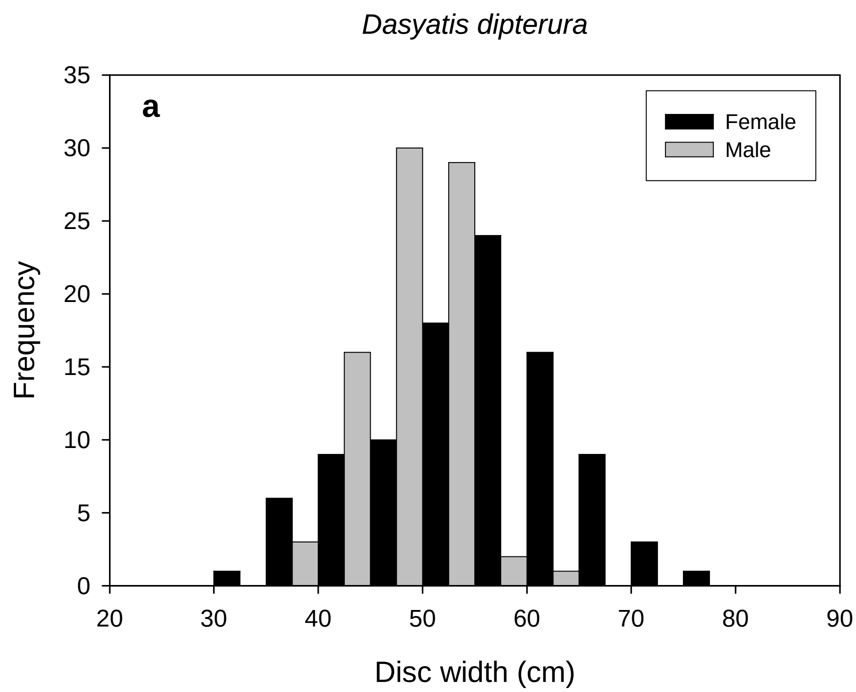
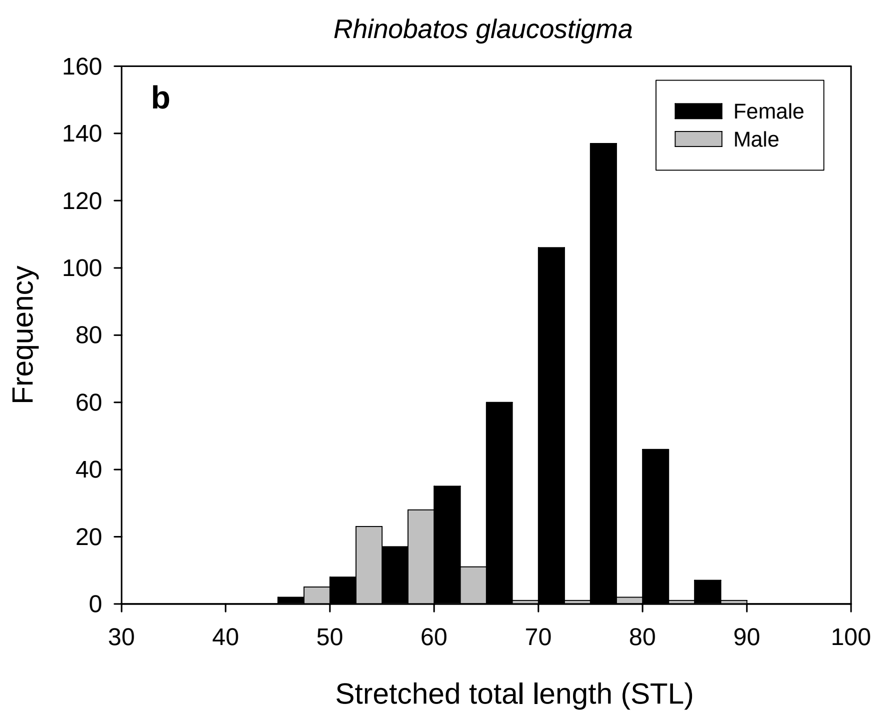


Figure 12. continued.



Dasyatis dipterura
a
Female
Male
Frequency
0
5
10
15
20
25
30
35
20
30
40
50
60
70
80
90
Disc width (cm)



Rhinobatos glaucostigma
b
Female
Male
Frequency
0
20
40
60
80
100
120
140
160
30
40
50
60
70
80
90
100
Stretched total length (STL)

Figure 13.

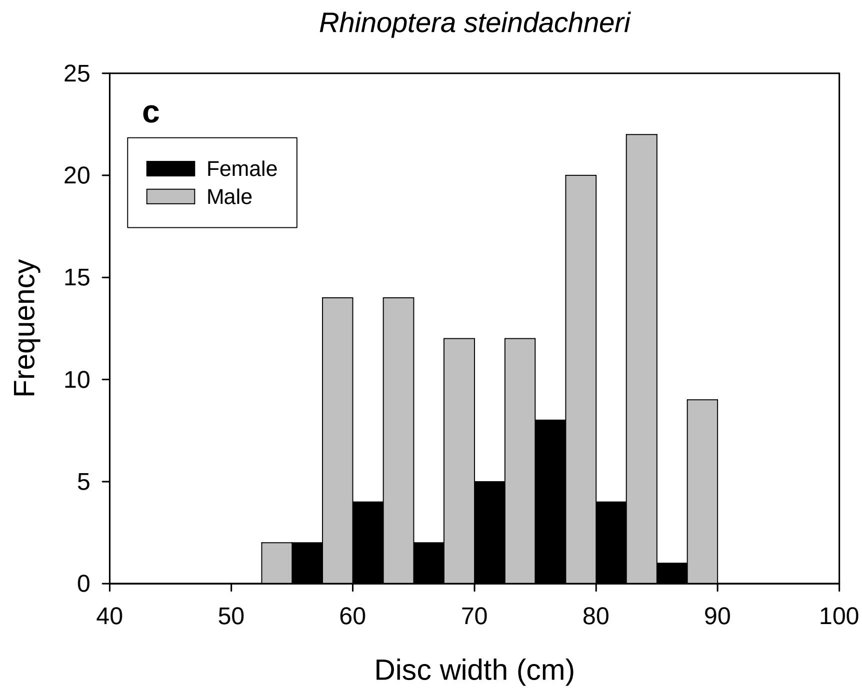


Figure 13. continued.

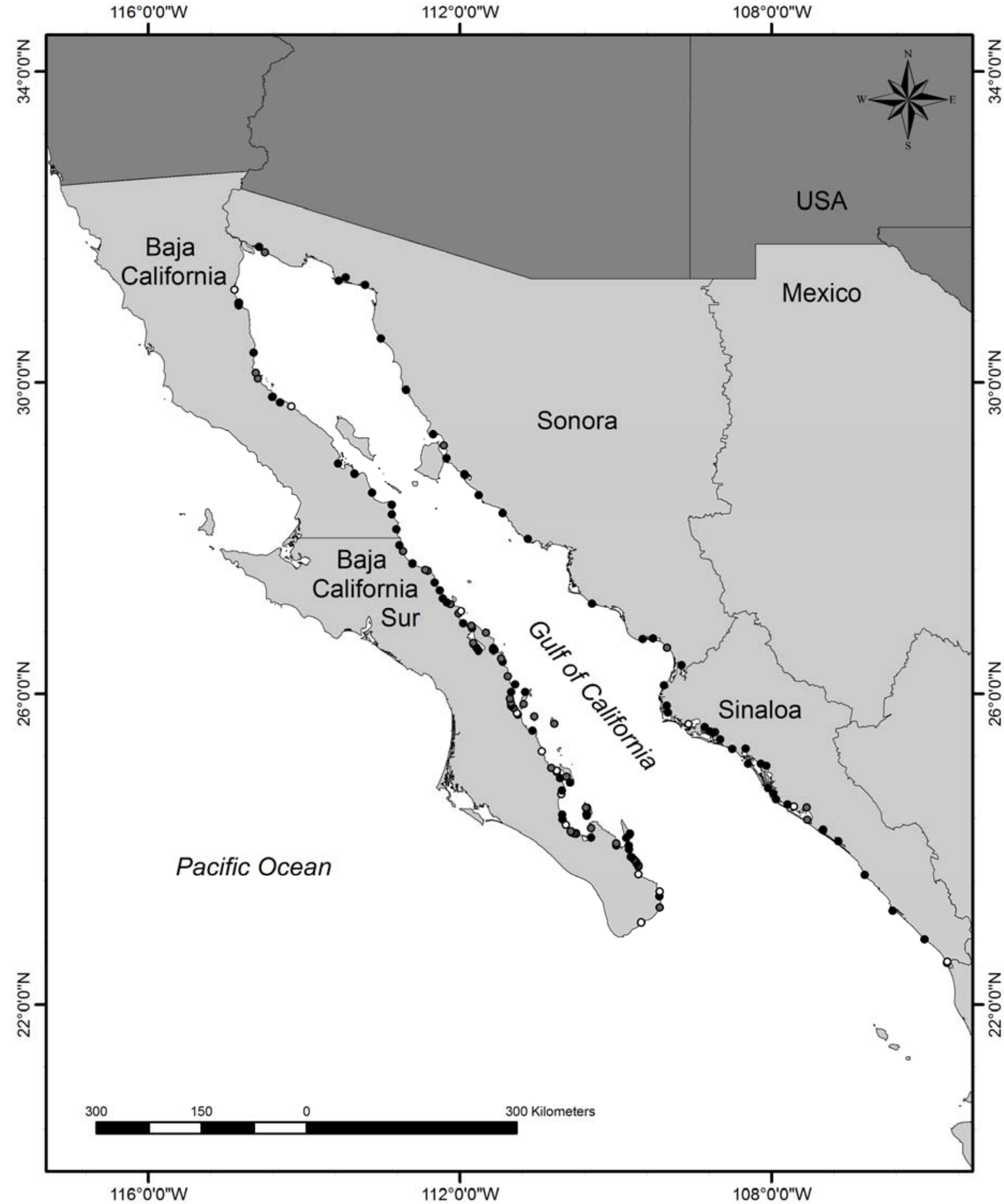
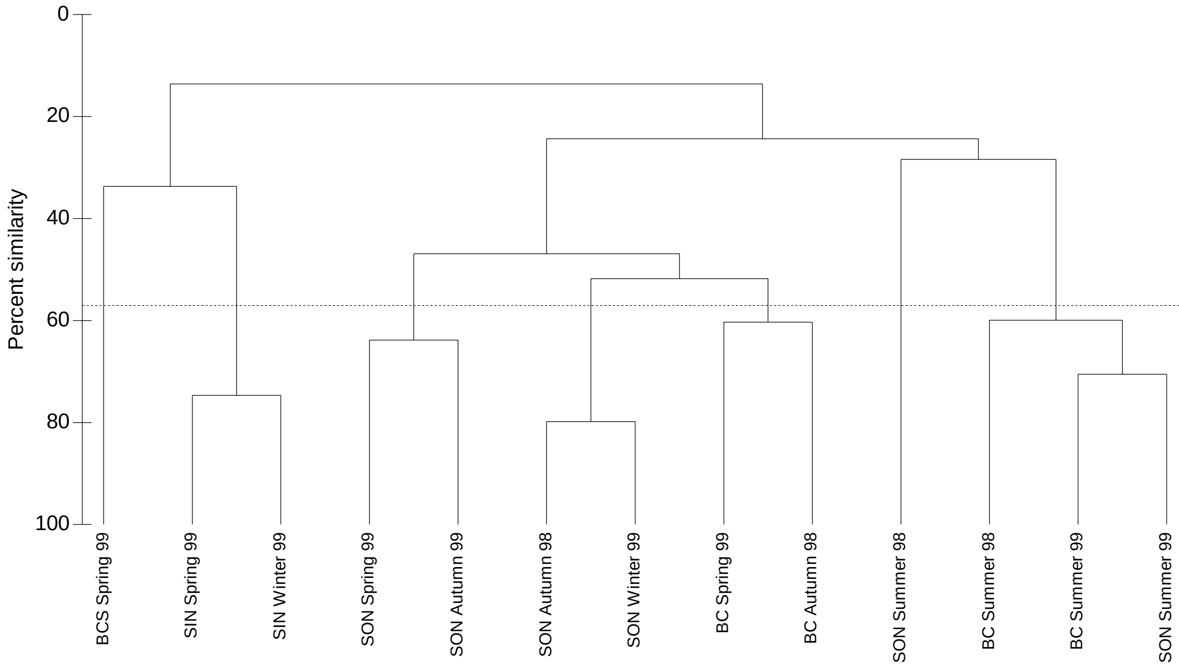

116°0'0"W
112°0'0"W
108°0'0"W
34°0'0"N
30°0'0"N
26°0'0"N
22°0'0"N
N
W
E
S
USA
Mexico
Baja
California
Sonora
Baja
California
Sur
Gulf of California
Sinaloa
Pacific Ocean
300
150
0
300 Kilometers

Figure 14.



Percent similarity
0
20
40
60
80
100
BCS Spring 99
SIN Spring 99
SIN Winter 99
SON Spring 99
SON Autumn 99
SON Autumn 98
SON Winter 99
BC Spring 99
BC Autumn 98
SON Summer 98
BC Summer 98
BC Summer 99
SON Summer 99

Figure 15.

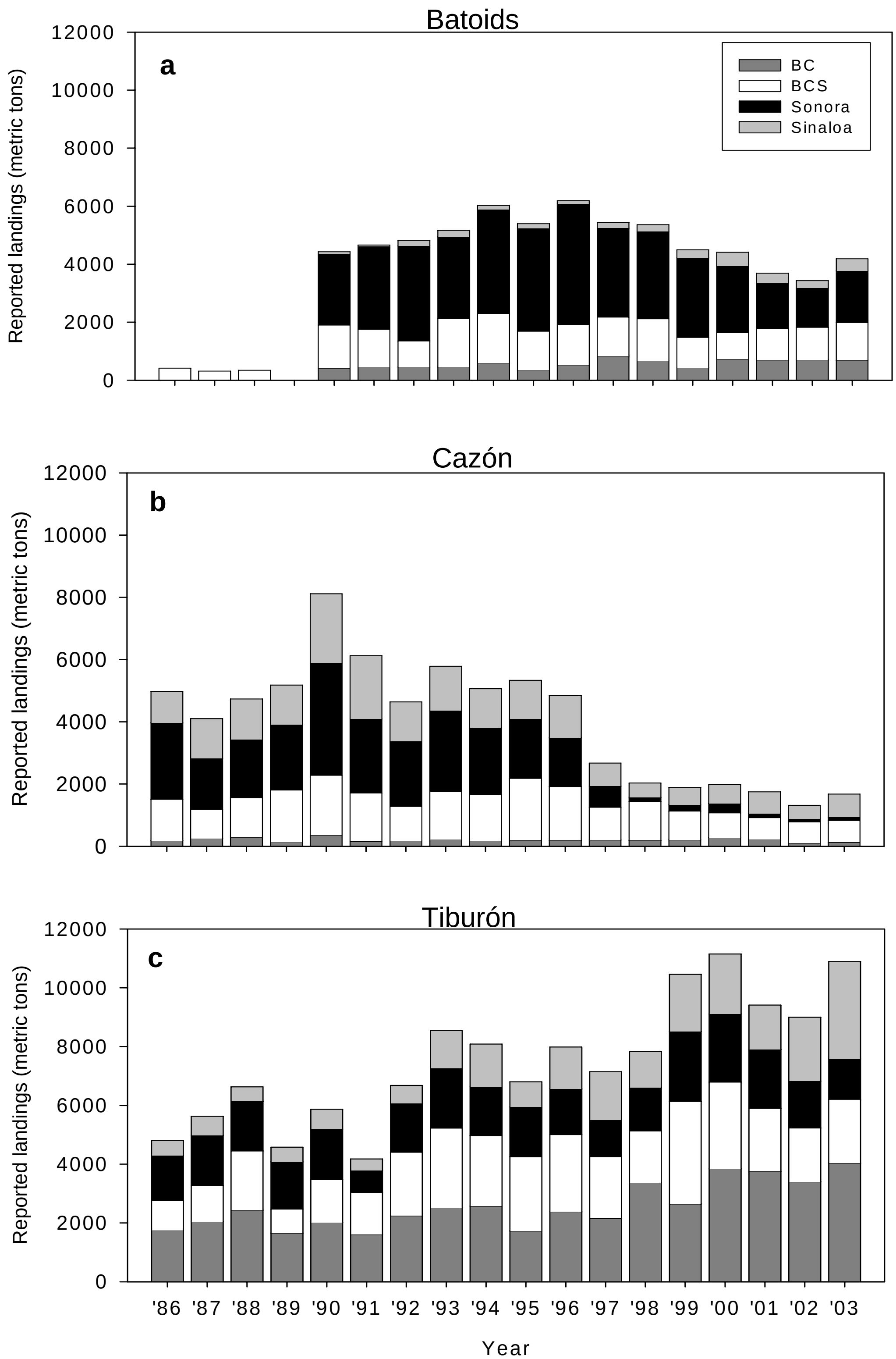

Batoids
a
BC
BCS
Sonora
Sinaloa
Cazón
b
Tiburón
c
Reported landings (metric tons)
0
2000
4000
6000
8000
10000
12000
'86 '87 '88 '89 '90 '91 '92 '93 '94 '95 '96 '97 '98 '99 '00 '01 '02 '03
Year

Figure 16.

Appendix 1. General fishery information by season and year for artisanal camps in Baja California (BC). Targets were identified to lowest possible taxon. Abbreviations are as follows: D (dressed), GN (gillnet), H (hookah diving), HL (handline), LL (longline), N (none or camp not active), NS (camp not surveyed during this period), N$/kg (pesos per kilogram), T (traps), U (unknown, data not collected), and W (whole). Gear and target categories do not necessarily correspond. Note: Winter surveys were not conducted in Baja California.

Spring 1998

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BC-01	NS													
BC-02	3 Apr	GN	HL	N	Batoidea	3	D	*Squatina californica*	6	D	Small sharks	6	D	Guerrero Negro
BC-03	NS													
BC-04	3 Apr	GN	HL	N	Holothuriidae, Serranidae	U, 7	W, W	Gerreidae	6	W	N	N	N	Ensenada, Mexicali, Tijuana
BC-05	3 Apr	GN	HL	N	Pleuronectidae, Serranidae	12, 12	U, U	Batoidea, Small sharks	6, U	U, U	Scorpaenidae	U	U	Ensenada
BC-06	2, 7, 8 Apr	GN	N	N	Gerreidae, Pleuronectiformes	5, 14	D, D	Batoidea	3.5	D	Small sharks, *Squatina californica*	6, 6	D, D	Ensenada
BC-07	1 Apr	H	N	N	Bivalvia, Pectinidae	35, U	U, U	N	N	N	N	N	N	Tijuana
BC-08	1 Apr	GN	U	N	*Scomberomorus* spp.	6	U	Batoidea, Small sharks	5, 5	U, U	N	N	N	Tijuana
BC-09	31 Mar	LL	GN	N	Batoidea, Serranidae, Small sharks	2, 5, 2	D, D, D	N	N	N	N	N	N	San Felipe
BC-10	31 Mar	LL	GN	N	Serranidae	5	D	Batoidea, Small sharks, *Paralabrax* spp.	2, 2, 2	D, D, D	N	N	N	San Felipe
BC-11	NS													
BC-12	NS													
BC-13	30 Mar	LL	N	N	Serranidae	10	U	Batoidea, Small sharks	U, U	U, U	*Paralabrax* spp.	10	U	Puertocitos, San Felipe
BC-14	26, 27 Mar; 9 Apr	GN	N	N	Sciaenidae	6	W	N	N	N	N	N	N	San Felipe
BC-15	26 Mar	GN	N	N	Sciaenidae	U	W	N	N	N	N	N	N	San Felipe
BC-16	NS													
BC-17	26 Mar	GN	N	N	Sciaenidae	U	W	N	N	N	N	N	N	San Felipe

Spring 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BC-01	12 Apr	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-02	8-10 Apr	GN	H	N	Small sharks	7	W	*Squatina californica*	6.5	W	Batoidea, *Octopus* spp., Pleuronectiformes	4.5, 20, 16	D, W, W	Guerrero Negro, Mexicali
BC-03	10 Apr	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-04	11, 13 Apr	GN	T	N	Batoidea, Small sharks	4, 8	D, W	Pleuronectiformes, Serranidae	13, 6	W/D, W	Rhinobatidae, Teleostei	5, 5	D, W	Ensenada, Tijuana
BC-05	14, 15 Apr	GN	T	N	Batoidea, Small sharks	U, U	U, U	*Caulolatilus* spp., Serranidae	6, 7	W, W	N	N	N	Bahia de los Angeles, Ensenada
BC-06	16 Apr	GN	H	N	Pleuronectiformes	12-18	W	*Rhinobatos* spp., Small sharks, *Squatina californica*	5, 7, 6	U, U, U	*Octopus* spp.	U	U	Ensenada
BC-07	NS													
BC-08	16 Apr	GN	GN	LL	Pleuronectiformes, *Scomberomorus* spp., Serranidae	20, 5-7, 20	W, W, W	Batoidea	4-5	D	N	N	N	Ensenada, San Quintin, Tijuana
BC-09	16 Apr	LL	GN	N	Serranidae	7	W	*Scomberomorus* spp.	8.5	W	Batoidea	3	D	Ensenada, Tijuana
BC-10	16 Apr	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-11	16 Apr	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-12	NS													
BC-13	NS													
BC-14	19 Apr	GN	N	N	Sciaenidae	4.5-6	W	N	N	N	N	N	N	China, Ensenada, Korea, Japan, San Felipe
BC-15	19 Apr	GN	N	N	Sciaenidae	6	W	N	N	N	N	N	N	Ensenada, Japan, Mexico, San
BC-16	19 Apr	GN	N	N	Sciaenidae	4.5	W	N	N	N	N	N	N	China, Ensenada, Japan, Korea
BC-17	20 Apr	GN	N	N	Sciaenidae	5	W	N	N	N	N	N	N	Ensenada, Korea, San Felipe

Appendix 1. continued.

Summer 1998

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BC-01	NS													
BC-02	3, 8 Jul	GN	GN	N	Large sharks	3.5	W	N	N	N	N	N	N	(Fins): China, Hong Kong, Thailand; (Meat, skin): Mexico (mainland)
BC-03	4, 6, 7 Jul	GN	N	N	Large sharks	7	W	N	N	N	N	N	N	El Barril
BC-04	1, 2 Jul	GN, H	N	N	Batoidea, *Octopus* spp.	3, U	D, U	Small sharks	7	D	*Balistes polylepis* , Gerreidae, Sciaenidae	5, 5, 10	W, W, W	Bahia de los Angeles, Ensenada
BC-05	27, 29, 30 Jun	GN	LL	N	Batoidea	3	D	*Rhinobatos productus*	6	D	*Paralabrax* spp.	6	W	Bahia de los Angeles, Ensenada
BC-06	26, 27 Jun	H	GN, LL	N	*Octopus* spp.	U	U	Batoidea, *Rhinobatos productus* , Teleostei	3, 5, U	D, D, U	N	N	N	Bahia de los Angeles
BC-07	26 Jun	H	N	N	Bivalvia	U	U	N	N	N	N	N	N	U
BC-08	24, 25 Jun	GN	LL	N	Small sharks	8	D	Batoidea	5	D	Pleuronectiformes, *Scomberomorus* spp.	U, U	U, U	Ensenada, Tijuana
BC-09	9 Jul	GN	LL	N	Small sharks	8	D	Serranidae	26	W	*Paralabrax* spp.	7	W	Ensenada, Japan, Mexicali, Tijuana
BC-10	9 Jul	GN	LL	N	Small sharks	8	D	Serranidae	26	W	*Paralabrax* spp.	7	W	Ensenada, Japan, Mexicali, Tijuana
BC-11	NS													
BC-12	NS													
BC-13	22, 23 Jun	GN	N	N	Small sharks	10	D	*Scomberomorus* spp.	8	W	Sciaenidae	8	W	San Felipe
BC-14	18, 19 Jun	GN	GN	U	*Scomberomorus* spp.	2	W	Dendrobranchiata	170	W	Sciaenidae	4-5	W	Ensenada, San Felipe, Tijuana
BC-15	19, 20 Jun	GN	N	N	*Scomberomorus* spp.	8	W	Small sharks	7	D	N	N	N	San Felipe
BC-16	19 Jun	GN	LL	N	Serranidae	20	U	Small sharks	7	D	N	N	N	San Felipe
BC-17	20 Jun	GN	N	N	Sciaenidae	5-7	W	*Balistes polylepis, Scomberomorus* spp.	5-7, 5-7	W, W	Small sharks	U	U	San Felipe

Summer 1999

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BC-01	NS													
BC-02	18, 25-26 Jul	GN	GN	N	Large sharks	3	W	Batoidea	5	D	N	N	N	(Fins): China; (Meat, skin): Mexico (mainland)
BC-03	18-21 Jul	GN	N	N	Large sharks	5 (red meat) 8 (white meat)	U	N	N	N	N	N	N	(Fins): China; (Meat, skin): Mexico (mainland)
BC-04	17 Jul	GN	GN	N	*Rhinobatos productus*	6	D	Batoidea	5	D	N	N	N	Bahia de los Angeles, Ensenada
BC-05	15, 16 Jul	GN	T	N	*Caulolatilus* spp., *Rhinobatos productus* , Serranidae	6, 6, 7	D, W, W	Batoidea	4	D	*Octopus* spp., Teleostei	U, 4	W, W	Bahia de los Angeles, Ensenada
BC-06	12 Jul	GN	H, GN	N	*Mugil* spp., *Seriola lalandi*	4, 4 (small) 6 (large)	W, W	*Octopus* spp., *Rhinobatos productus*	U, 5	W, D	N	N	N	San Felipe
BC-07	NS													
BC-08	9, 10 Jul	GN	HL	T	Batoidea, *Rhinobatos productus*	5, 5	D, D	*Cynoscion* spp.	5 (small) 12 (large)	W	Lutjanidae, Serranidae	5-12, 5-12	W, W	Ensenada, Mexicali
BC-09	8, 10 Jul	GN	N	N	*Cynoscion* spp.	7.5	D	Small sharks	7.5	D	N	N	N	Mexicali
BC-10	8 Jul	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-11	8 Jul	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-12	8 Jul	H	N	N	U	U	U	N	N	N	N	N	N	U
BC-13	7, 8 Jul	GN	N	N	Batoidea	U	U	*Cynoscion* spp.	U	U	N	N	N	U
BC-14	6 Jul	GN	GN	T	*Scomberomorus* spp.	U	U	*Mustelus* spp.	U	U	Portunidae	8.5	W	San Felipe
BC-15	6 Jul	GN	N	N	*Scomberomorus* spp.	8	W	*Cynoscion* spp.	8 (small) 15 (large)	W	*Trachinotus* spp.	5	W	San Felipe
BC-16	6 Jul	GN	N	N	U	U	U	N	N	N	N	N	N	U
BC-17	6 Jul	N	N	N	N	N	N	N	N	N	N	N	N	N

Appendix 1. continued.

Autumn 1998

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BC-01	NS													
BC-02	29-31 Oct	GN	GN	N	Large sharks	5.5 (red flesh) 8.5 (white flesh)	W	Small sharks	6	D	N	N	N	Baja, Mexico (mainland), US
BC-03	27 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-04	25-28 Oct	GN	GN	N	Large sharks	6	D	Small sharks	10-14	D	N	N	N	Bahia de los Angeles, Ensenada, La Paz, Tijuana
BC-05	1 Nov	GN	N	N	Batoidea, Serranidae	4, U	D, U	N	N	N	N	N	N	Bahia de los Angeles
BC-06	NS													
BC-07	NS													
BC-08	2 Nov	GN	GN	N	Batoidea	3	D	Small sharks	5	D	N	N	N	San Quintin
BC-09	2 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-10	2 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-11	NS													
BC-12	NS													
BC-13	2 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-14	3 Nov	GN	N	N	Dendrobranchiata	50	W	N	N	N	N	N	N	Baja, Mexico (mainland)
BC-15	3 Nov	GN	GN	N	Dendrobranchiata	130	W	Sciaenidae, *Scomberomorus* spp.	10, 10	W, W	N	N	N	Baja, Mexico (mainland)
BC-16	2 Nov	GN	N	N	Dendrobranchiata	U	W	N	N	N	N	N	N	Baja, Mexico (mainland)
BC-17	3 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N

Autumn 1999

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BC-01	26 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-02	30, 31 Oct; 1 Nov	HL	GN	N	Teleostei	5-6	W	Batoidea, Small sharks, *Squatina californica*	U, 7.5, 6	D, D, D	N	N	N	Ensenada, Guerrero Negro
BC-03	27 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-04	1 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BC-05	26 Oct; 2-4 Nov	H, HL	GN	T	*Octopus* spp., Teuthoidea	20, 25	W, D	Batoidea	5-7	D	*Balistes polylepis* , Teleostei	U, U	U, U	Bahia de los Angeles
BC-06	NS													
BC-07	NS													
BC-08	NS													
BC-09	NS													
BC-10	NS													
BC-11	NS													
BC-12	NS													
BC-13	NS													
BC-14	NS													
BC-15	NS													
BC-16	NS													
BC-17	NS													

Appendix 2. General fishery information by season and year for artisanal camps in Baja California Sur (BCS). Targets were identified to lowest possible taxon. Abbreviations are as follows: D (dressed), GN (gillnet), H (hookah diving), HL (handline), LL (longline), N (none or camp not active), NS (camp not surveyed during this period), N$/kg (#pesos per kilogram), P (purse seine), T (traps), U (unknown, data not collected), and W (whole). Gear and target categories do not necessarily correspond. Note: No survey was not conducted during summer 1998.

Spring 1998

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-01	NS													
BCS-02	NS													
BCS-03	NS													
BCS-04	NS													
BCS-05	NS													
BCS-06	NS													
BCS-07	NS													
BCS-08	NS													
BCS-09	NS													
BCS-10	NS													
BCS-11	NS													
BCS-12	NS													
BCS-13	NS													
BCS-14	NS													
BCS-15	18, 25, 28-30 Apr; 16 May	HL, LL	LL	N	Lutjanidae, Serranidae	20, 20	U, U	Large sharks	15	U	N	N	N	U
BCS-16	NS													
BCS-17	NS													
BCS-18	NS													
BCS-19	NS													
BCS-20	19 Apr	GN, HL	N	N	Teleostei	U	U	Batoidea, Elasmobranchii	U, U	U, U	N	N	N	U
BCS-21	NS													
BCS-22	NS													
BCS-23	NS													
BCS-24	NS													
BCS-25	20 Apr	U	U	U	U	U	U	U	U	U	U	U	U	U
BCS-26	NS													
BCS-27	30 Apr	GN, HL	N	N	Teleostei	U	U	N	N	N	N	N	N	U
BCS-28	NS													
BCS-29	30 Apr	GN	H	N	Teleostei	U	U	Elasmobranchii	U	U	N	N	N	U
BCS-30	NS													
BCS-31	NS													
BCS-32	NS													
BCS-33	NS													
BCS-34	30 Apr	GN	N	N	Teleostei	U	U	N	N	N	N	N	N	U
BCS-35	29 Apr	GN	N	N	Elasmobranchii	U	U	N	N	N	N	N	N	U
BCS-36	NS													
BCS-37	29 Apr	HL	N	N	Lutjanidae, Serranidae	U, U	U, U	N	N	N	N	N	N	U
BCS-38	NS													
BCS-39	NS													
BCS-40	NS													
BCS-41	NS													
BCS-42	NS													
BCS-43	NS													
BCS-44	26 Apr	HL	GN	N	*Lutjanus* spp., *Paralabrax* spp.	20, 20	U, U	*Squatina californica*	6	U	N	N	N	Loreto, USA

Appendix 2. continued.

Spring 1998. continued.

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-45	NS													
BCS-46	NS													
BCS-47	25 Mar; 4 May	GN	HL	N	*Squatina californica* , Teleostei	5.5, U	U, U	Lutjanidae, *Paralabrax* spp.	10, 16	U, U	N	N	N	USA
BCS-48	5 May	HL	N	N	*Paralabrax* spp.	20	U	*Lutjanus* spp.	10	U	*Mobula* spp.	4	U	Ciudad Insurgentes
BCS-49	25, 29 Mar	U	U	U	U	U	U	U	U	U	U	U	U	La Paz, Loreto, USA
BCS-54	1 May	U	U	U	U	U	U	U	U	U	U	U	U	Loreto
BCS-55	23 Mar	U	U	U	U	U	U	U	U	U	U	U	U	Loreto
BCS-56	NS													
BCS-57	30 Apr	HL	N	N	*Seriola* spp.	7	W	N	N	N	N	N	N	Loreto
BCS-58	25 Mar	GN, HL	N	N	Lutjanidae, *Seriola* spp., Serranidae	U, U, U	U, U, U	*Squatina californica*	U	U	N	N	N	U
BCS-59	29 Apr	HL	N	N	*Seriola* spp.	U	W	*Lutjanus* spp.	U	W	N	N	N	Loreto
BCS-60	NS													
BCS-61	25, 28 Mar	H, HL	HL	N	Balistidae, Holothuroidea, *Lutjanus* spp., *Paralabrax* spp., *Seriola* spp.	5, U, 12, 22, 9	U, U, U, U, U	*Seriola* spp.	U	U	N	N	N	U
BCS-62	28 Apr	HL	N	N	*Seriola* spp.	6	U	*Paralabrax* spp.	19	U	N	N	N	Mexicali
BCS-63	28 Apr	GN	N	N	*Squatina californica*	10	U	N	N	N	N	N	N	Guadalajara, Tijuana
BCS-64	NS													
BCS-65	28 Apr	HL	GN	N	*Carnax* spp., *Paralabrax* spp.	6, 20	U, U	*Mugil cephalus*	12	U	N	N	N	Mexicali
BCS-66	NS													
BCS-67	NS													
BCS-68	26 Apr	P	N	N	*Mugil cephalus*	7	U	N	N	N	N	N	N	Guadalajara, Mulege, Tijuana
BCS-69	25 Apr	GN	HL	N	Gerreidae	3	U	Lutjanidae	7	U	*Octopus* spp.	22	U	Mulege
BCS-70	26 Apr	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-71	NS													
BCS-72	NS													
BCS-73	NS													
BCS-74	NS													
BCS-75	NS													
BCS-76	NS													
BCS-77	NS													
BCS-78	NS													
BCS-79	NS													
BCS-80	NS													
BCS-81	NS													
BCS-82	NS													
BCS-83	NS													

Appendix 2. continued.

Spring 1999

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-01	NS													
BCS-02	NS													
BCS-03	NS													
BCS-04	NS													
BCS-05	NS													
BCS-06	NS													
BCS-07	NS													
BCS-08	NS													
BCS-09	NS													
BCS-10	NS													
BCS-11	NS													
BCS-12	NS													
BCS-13	NS													
BCS-14	NS													
BCS-15	3, 5, 6, 20 Mar; 20 Apr; 1, 14, 15 May	U	N	N	Elasmobranchii	12	D	Lutjanidae, Serranidae, Xiphiidae	U, U, U	U, U, U	N	N	N	U
BCS-16	NS													
BCS-17	15 May	U	U	U	U	U	U	U	U	U	U	U	U	U
BCS-18	NS													
BCS-19	NS													
BCS-20	NS													
BCS-21	21 Apr	GN	N	N	Teleostei	7	D	N	N	N	N	N	N	La Paz
BCS-22	21 Apr	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-23	21 Apr	U	N	N	Large sharks, Small sharks, Teleostei	6, 6, 4	D, D, D	N	N	N	N	N	N	La Paz
BCS-24	21 Apr	GN	N	N	Teleostei	6	D	N	N	N	N	N	N	La Paz
BCS-25	NS													
BCS-26	NS													
BCS-27	NS													
BCS-28	NS													
BCS-29	NS													
BCS-30	NS													
BCS-31	23 Apr	LL	GN	N	Teleostei	20	D	Batoidea	7	U	N	N	N	La Paz, San Evaristo
BCS-32	NS													
BCS-33	NS													
BCS-34	NS													
BCS-35	21, 22 Apr	GN	N	N	*Dasyatis* spp.	12	D	N	N	N	N	N	N	La Paz
BCS-36	22-24 Apr	U	GN	N	*Seriola* spp.	25	D	*Squatina californica*	25	D	N	N	N	U
BCS-37	NS													
BCS-38	NS													
BCS-39	NS													
BCS-40	NS													
BCS-41	NS													
BCS-42	NS													
BCS-43	NS													
BCS-44	NS													

Appendix 2. continued.

Spring 1999. continued.

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-45	NS													
BCS-46	NS													
BCS-47	NS													
BCS-48	17 Mar	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-49	NS													
BCS-50	NS													
BCS-51	NS													
BCS-52	NS													
BCS-53	NS													
BCS-54	NS													
BCS-55	NS													
BCS-56	NS													
BCS-57	NS													
BCS-58	NS													
BCS-59	NS													
BCS-60	NS													
BCS-61	NS													
BCS-62	NS													
BCS-63	NS													
BCS-64	NS													
BCS-65	NS													
BCS-66	NS													
BCS-67	NS													
BCS-68	NS													
BCS-69	NS													
BCS-70	NS													
BCS-71	17-20 Mar	GN	GN	N	Teleostei	U	U	Small sharks	10	U	N	N	N	Mexico City, Tijuana
BCS-72	NS													
BCS-73	NS													
BCS-74	NS													
BCS-75	NS													
BCS-76	NS													
BCS-77	19 Mar	HL	N	N	*Seriola* spp.	8	U	N	N	N	N	N	N	U
BCS-78	12, 19 Mar	HL	N	N	Sciaenidae, Serranidae, Teleostei	U, 20, U	W, W, U	N	N	N	N	N	N	Conchania
BCS-79	12 Mar	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-80	12 Mar	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-81	12 Mar	GN	N	N	Batoidea, Small sharks	6, 6	D, D	N	N	N	N	N	N	Ensenada, Santa Rosalia
BCS-82	12 Mar	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-83	12 Mar	N	N	N	N	N	N	N	N	N	N	N	N	N

Appendix 2. continued.

Summer 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-01	2 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-02	NS													
BCS-03	2 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-04	3 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-05	3 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-06	3 Jun	GN	N	N	Batoidea	15	U	N	N	N	N	N	N	La Paz, Los Cabos
BCS-07	NS													
BCS-08	4 Jun	LL	N	N	Lutjanidae	20	U	*Balistes polylepis*	5	U	N	N	N	La Paz
BCS-09	NS													
BCS-10	3 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-11	4 Jun	U	U	U	U	U	U	U	U	U	U	U	U	U
BCS-12	4 Jun	LL	N	N	Large sharks	18	U	N	N	N	N	N	N	La Paz
BCS-13	NS													
BCS-14	NS													
BCS-15	NS													
BCS-16	NS													
BCS-17	NS													
BCS-18	5 Jun	GN	N	N	Large sharks	20	U	Xiphiidae	15	U	N	N	N	La Paz
BCS-19	5 Jun	GN	N	N	Large sharks	20	D	N	N	N	N	N	N	La Paz
BCS-20	NS													
BCS-21	NS													
BCS-22	NS													
BCS-23	NS													
BCS-24	2 Jun	GN	N	N	Lutjanidae	6	D	N	N	N	N	N	N	La Paz
BCS-25	NS													
BCS-26	7 Jun	GN	N	N	Pleuronectiformes	U	U	N	N	N	N	N	N	La Paz
BCS-27	NS													
BCS-28	3 Jun	HL	GN	N	Lutjanidae	14	D	Scaridae	10	D	N	N	N	La Paz
BCS-29	NS													
BCS-30	3 Jun	HL	N	N	Lutjanidae	14	U	*Balistes polylepis*	7	U	N	N	N	La Paz
BCS-31	NS													
BCS-32	3 Jun	U	N	N	Lutjanidae	18	D	N	N	N	N	N	N	U
BCS-33	3 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-34	NS													
BCS-35	NS													
BCS-36	2 Jun	HL	GN	N	*Balistes polylepis*	8	D	Batoidea, *Squatina californica*	3, U	D, D	N	N	N	La Paz
BCS-37	29 Jun	HL	GN	N	Serranidae	14	U	N	N	N	N	N	N	U
BCS-38	2 Jun	HL	N	N	Lutjanidae	14-20	D	*Balistes polylepis*	4	D	N	N	N	La Paz, San Evaristo
BCS-39	29 Jun	HL	GN	N	Lutjanidae, Serranidae	16, 16	U, U	N	N	N	N	N	N	U
BCS-40	29 Jun	HL	GN	N	U	U	U	N	N	N	N	N	N	U
BCS-41	29 Jun	HL	N	N	U	U	U	N	N	N	N	N	N	U
BCS-42	28 Jun	HL	GN	N	U	U	U	N	N	N	N	N	N	La Paz
BCS-43	28 Jun	GN	HL	N	Teleostei	U	U	N	N	N	N	N	N	U
BCS-44	27 Jun	HL	GN	N	Lutjanidae, Serranidae	16, U	U, U	*Seriola* spp.	6	U	N	N	N	La Paz

Appendix 2. continued.

Summer 1999. continued.

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-45	26 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-46	NS													
BCS-47	NS													
BCS-48	25 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-49	25 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-50	25 Jun	LL	N	N	Batoidea	U	U	Large sharks	U	U	N	N	N	Loreto
BCS-51	NS													
BCS-52	24 Jun	HL	N	N	Teuthoidea	3.5	U	N	N	N	N	N	N	Ensenada
BCS-53	NS													
BCS-54	24 Jun	HL	N	N	Teuthoidea	3.5	U	N	N	N	N	N	N	Ensenada
BCS-55	24 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-56	NS													
BCS-57	24 Jun	U	U	U	U	U	U	U	U	U	U	U	U	U
BCS-58	NS													
BCS-59	NS													
BCS-60	NS													
BCS-61	23 Jun	HL	N	N	Teuthoidea	3.5	U	N	N	N	N	N	N	La Paz
BCS-62	23 Jun	GN	N	N	Scaridae	8	U	N	N	N	N	N	N	Loreto
BCS-63	NS													
BCS-64	NS													
BCS-65	NS													
BCS-66	22 Jun	N	N	N	Bivalvia	N	N	N	N	N	N	N	N	N
BCS-67	NS													
BCS-68	NS													
BCS-69	23 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-70	23 Jun	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-71	16, 22 Jun	GN	N	N	Teleostei	10-20	W	Small sharks	U	U	N	N	N	Ensenada
BCS-72	NS													
BCS-73	NS													
BCS-74	NS													
BCS-75	NS													
BCS-76	16 Jun	HL	N	N	Teuthoidea	3.5	U	N	N	N	N	N	N	Ensenada
BCS-77	16 Jun	HL	GN	N	Teuthoidea	3.5	U	Large sharks	20	D	N	N	N	Ensenada, La Paz
BCS-78	NS													
BCS-79	NS													
BCS-80	NS													
BCS-81	NS													
BCS-82	NS													
BCS-83	NS													

Appendix 2. continued.

Autumn 1998

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-01	28 Oct	HL	N	N	Lutjanidae	18	U	Serranidae	20-24	U	Large sharks	8 (<12 kg) 10 (>12 kg)	U	La Paz, San Jose Viejo
BCS-02	NS													
BCS-03	28 Oct	HL	N	N	Lutjanidae	N	U	N	N	N	N	N	N	La Paz
BCS-04	18, 29 Oct	HL	N	N	*Lutjanus peru* , Teuthoidea	U, U	U, U	N	N	N	N	N	N	La Paz
BCS-05	29 Oct	HL	N	N	Lutjanidae	18	U	Balistidae	4-5	U	N	N	N	La Paz
BCS-06	NS													
BCS-07	NS													
BCS-08	29 Oct	HL	N	N	Lutjanidae	18	U	Balistidae	5	U	Serranidae	20	U	La Paz
BCS-09	17 Sep	GN, HL	N	N	Teleostei, Large sharks	U, U	U, U	N	N	N	N	N	N	U
BCS-10	29 Oct	HL	N	N	Lutjanidae	18	U	Serranidae	20-22	U	N	N	N	La Paz
BCS-11	29 Oct	LL	N	N	Lutjanidae	18	U	Balistidae	5	U	Large sharks	17	U	La Paz
BCS-12	9 Sep, 29 Oct	GN, LL, HL	N	N	Large sharks, Teleostei	18, U	U, U	N	N	N	N	N	N	La Paz
BCS-13	17 Sep	GN, HL	N	N	Teleostei	U	U	Elasmobranchii	U	U	N	N	N	U
BCS-14	NS													
BCS-15	11 Sep	HL	N	N	*Lutjanus peru*	20	U	N	N	N	N	N	N	U
BCS-16	29 Oct	GN	N	N	*Mobula* spp.	19	U	N	N	N	N	N	N	La Paz
BCS-17	11 Sep	HL	N	N	Teuthoidea	3	U	N	N	N	N	N	N	Asia
BCS-18	NS													
BCS-19	NS													
BCS-20	31 Oct	HL	GN	N	Haemulidae	5	D	Balistidae	6	D	N	N	N	La Paz
BCS-21	NS													
BCS-22	NS													
BCS-23	NS													
BCS-24	NS													
BCS-25	NS													
BCS-26	NS													
BCS-27	12 Oct	GN	LL	N	Lutjanidae	18	U	Gerreidae	10	U	Large sharks	20	D	La Paz
BCS-28	NS													
BCS-29	12 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-30	NS													
BCS-31	NS													
BCS-32	NS													
BCS-33	NS													
BCS-34	12 Oct	GN, LL	N	N	*Caulolatilus* spp.	8	U	Lutjanidae	15	U	Elasmobranchii	U	U	La Paz
BCS-35	12 Oct	GN	N	N	*Squatina californica*	15	U	Large sharks	15	U	Batoidea	15	U	La Paz
BCS-36	NS													
BCS-37	12 Oct	HL	N	N	Lutjanidae	10-16	U	*Seriola* spp.	7	U	*Caulolatilus* spp.	6	U	La Paz
BCS-38	NS													
BCS-39	NS													
BCS-40	NS													
BCS-41	NS													
BCS-42	NS													
BCS-43	NS													
BCS-44	NS													

Appendix 2. continued.

Autumn 1998. continued.

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-45	NS													
BCS-46	NS													
BCS-47	12 Nov	GN	HL	N	*Squatina californica*	7	U	Small sharks	10	U	Balistidae	3	U	La Paz
BCS-48	NS													
BCS-49	12 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-50	12 Nov	GN	LL	N	Large sharks	8	U	Pleuronectiformes	9	U	N	N	N	Loreto
BCS-51	NS													
BCS-52	NS													
BCS-53	12 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-54	15 Nov	U	U	U	U	U	U	U	U	U	U	U	U	U
BCS-55	NS													
BCS-56	NS													
BCS-57	15 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-58	NS													
BCS-59	NS													
BCS-60	15 Nov	GN	T	N	Large sharks	10	U	Batoidea	6	U	Gastropoda	12	U	Mulege
BCS-61	15 Nov	GN	HL	N	Large sharks	10	U	Batoidea	4	U	Balistidae	4	U	Loreto
BCS-62	NS													
BCS-63	NS													
BCS-64	15 Nov	GN	N	N	Small sharks	U	U	N	N	N	N	N	N	Mulege
BCS-65	15 Nov	HL	N	N	Serranidae	19	U	Lutjanidae	5	U	Small sharks	7	U	Loreto
BCS-66	14 Nov	LL	N	N	N	N	N	N	N	N	N	N	N	U
BCS-67	NS													
BCS-68	NS													
BCS-69	NS													
BCS-70	NS													
BCS-71	14 Nov	GN	LL	N	Large sharks	10	U	*Squatina californica*	8	U	Teleostei	3-5	W	Mexico City, Tijuana
BCS-72	NS													
BCS-73	13 Nov	H	HL	N	*Octopus* spp.	U	U	Serranidae	U	U	N	N	N	Mulege
BCS-74	13 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-75	13 Nov	HL	N	N	Balistidae	4	U	N	N	N	N	N	N	Santa Rosalia
BCS-76	13 Nov	GN	LL	N	*Squatina californica*	8	U	Large sharks	5	U	N	N	N	Ensenada
BCS-77	13 Nov	GN	N	N	*Alopias* spp.	7	U	*Carcharhinus falciformis*, *Carcharhinus limbatus*, *Sphyrna lewini*	5, 5, 5	U, U, U	N	N	N	Mexico City, Tijuana
BCS-78	13 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-79	NS													
BCS-80	NS													
BCS-81	NS													
BCS-82	NS													
BCS-83	NS													

Appendix 2. continued.

Autumn 1999

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-01	28 Oct	HL	N	N	Lutjanidae	22	D	N	N	N	N	N	N	U
BCS-02	28 Oct	HL	N	N	Teleostei	U	U	N	N	N	N	N	N	U
BCS-03	28 Oct	HL	N	N	Lutjanidae	28	D	N	N	N	N	N	N	La Paz
BCS-04	27 Oct	H	U	U	U	U	U	U	U	U	U	U	U	U
BCS-05	27 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-06	NS													
BCS-07	28 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-08	NS													
BCS-09	NS													
BCS-10	27 Oct	U	N	N	Lutjanidae	24	D	N	N	N	N	N	N	U
BCS-11	NS													
BCS-12	26, 27 Oct; 3 Nov	LL	N	N	U	U	U	U	U	U	N	N	N	La Paz
BCS-13	26, 27 Oct	HL	LL	N	U	U	U	Large sharks	35	U	N	N	N	La Paz
BCS-14	NS													
BCS-15	NS													
BCS-16	NS													
BCS-17	NS													
BCS-18	NS													
BCS-19	NS													
BCS-20	NS													
BCS-21	6 Oct	GN	N	N	*Nematistius pectoralis*	U	U	N	N	N	N	N	N	La Paz
BCS-22	6 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-23	6 Oct	H	N	N	U	U	U	U	U	U	U	U	U	U
BCS-24	6 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-25	NS													
BCS-26	7 Oct	HL	N	N	Lutjanidae, Serranidae	23, 23	D, D	N	N	N	N	N	N	La Paz
BCS-27	7 Oct	LL	N	N	*Carcharhinus limbatus*, *Lutjanus* spp.	U, U	U, U	N	N	N	N	N	N	La Paz
BCS-28	NS													
BCS-29	7 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-30	NS													
BCS-31	NS													
BCS-32	NS													
BCS-33	NS													
BCS-34	NS													
BCS-35	7 Oct	GN	N	N	*Squatina californica*	U	U	N	N	N	N	N	N	La Paz
BCS-36	7 Oct	U	U	U	U	U	U	U	U	U	U	U	U	La Paz
BCS-37	8 Oct	HL	N	N	Carangidae, Lutjanidae, Scombridae, Serranidae	U, U, U, U	U, U, U, U	N	N	N	N	N	N	La Paz
BCS-38	NS													
BCS-39	8 Oct	HL	N	N	Lutjanidae	U	U	N	N	N	N	N	N	San Evaristo
BCS-40	NS													
BCS-41	8 Oct	HL	N	N	Lutjanidae	25	D	N	N	N	N	N	N	La Paz, San Evaristo
BCS-42	8 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-43	7 Oct	U	N	U	U	U	U	U	U	U	U	U	U	U
BCS-44	8 Oct	HL	N	N	Lutjanidae, Malacanthidae	25, 18	D, D	N	N	N	N	N	N	Loreto

Appendix 2. continued.

Autumn 1999. continued.

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-45	NS													
BCS-46	18 Sep	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-47	NS													
BCS-48	10 Nov	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-49	NS													
BCS-50	NS													
BCS-51	NS													
BCS-52	NS													
BCS-53	NS													
BCS-54	NS													
BCS-55	17 Sep	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-56	NS													
BCS-57	19 Sep	U	N	N	Teuthoidea	4	D	N	N	N	N	N	N	Santa Rosalia
BCS-58	NS													
BCS-59	NS													
BCS-60	NS													
BCS-61	NS													
BCS-62	NS													
BCS-63	NS													
BCS-64	NS													
BCS-65	NS													
BCS-66	NS													
BCS-67	NS													
BCS-68	NS													
BCS-69	NS													
BCS-70	NS													
BCS-71	11 Sep	GN	HL	N	*Scomberomorus* spp.	4	W	Lutjanidae	U	U	N	N	N	Guadalajara, Mexico City
BCS-72	11 Sep	U	N	N	Teuthoidea	U	U	N	N	N	N	N	N	U
BCS-73	NS													
BCS-74	NS													
BCS-75	13 Nov	HL	N	N	Teuthoidea	2.5-3	U	N	N	N	N	N	N	Korea
BCS-76	18 Sep	U	N	N	Teuthoidea	4	D	N	N	N	N	N	N	Loreto
BCS-77	18 Sep; 13 Nov	HL	GN	N	Teuthoidea	2.5-4	D	N	N	N	N	N	N	Guadalajara, Korea, Los Angeles (USA), Mexico City, Tijuana
BCS-78	18 Sep; 28, 29 Oct	HL	GN	N	Teuthoidea	4	D	Large sharks	25	D	N	N	N	Santa Rosalia
BCS-79	28 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-80	28 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-81	28, 29 Oct	HL	GN	N	Teleostei	25	W	Batoidea, Small sharks	10-20, 10-20	U, U	Teuthoidea	2.5	D	Ensenada
BCS-82	28 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-83	28 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N

Appendix 2. continued.

Winter 1998

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-01	NS													
BCS-02	NS													
BCS-03	NS													
BCS-04	NS													
BCS-05	NS													
BCS-06	NS													
BCS-07	NS													
BCS-08	NS													
BCS-09	NS													
BCS-10	NS													
BCS-11	NS													
BCS-12	NS													
BCS-13	NS													
BCS-14	10 Jan	LL	GN	N	*Coryphaena hippurus* , Lutjanidae	U, U	U, U	Batoidea	U	U	N	N	N	La Paz, Local
BCS-15	10 Jan	H	N	N	*Megapitaria aurantiaca*	3	W	Gastropoda	U	D	N	N	N	La Paz
BCS-16	10 Jan	GN	HL	N	*Squatina californica* , Batoidea	5, 5	D, D	Teleostei	U	U	Small sharks	9	D	La Paz
BCS-17	NS													
BCS-18	NS													
BCS-19	NS													
BCS-20	NS													
BCS-21	NS													
BCS-22	NS													
BCS-23	NS													
BCS-24	NS													
BCS-25	NS													
BCS-26	NS													
BCS-27	NS													
BCS-28	NS													
BCS-29	NS													
BCS-30	NS													
BCS-31	NS													
BCS-32	NS													
BCS-33	NS													
BCS-34	9 Jan	GN	N	N	Teleostei	3.5	W	N	N	N	N	N	N	La Paz
BCS-35	9 Jan	GN	N	N	*Squatina californica*	U	U	*Sphyrna* spp.	U	U	N	N	N	La Paz
BCS-36	NS													
BCS-37	9 Jan	GN	LL	N	Lutjanidae	8-10	W	*Squatina californica*	17	D	*Sphyrna* spp.	U	U	La Paz
BCS-38	NS													
BCS-39	NS													
BCS-40	NS													
BCS-41	NS													
BCS-42	NS													
BCS-43	NS													
BCS-44	12 Jan	GN	HL	N	*Sphyrna lewini* , *Squatina californica*	U, U	U, U	N	N	N	N	N	N	Ciudad Constitucion

Appendix 2. continued.

Winter 1998. continued.

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-45	NS													
BCS-46	NS													
BCS-47	12 Jan	GN	N	N	*Sphyrna* spp.	8	D	*Squatina californica*	U	U	*Mustelus* spp.	U	U	Ciudad Constitucion
BCS-48	NS													
BCS-49	NS													
BCS-50	NS													
BCS-51	NS													
BCS-52	NS													
BCS-53	NS													
BCS-54	14 Jan	GN	N	N	Small sharks	U	D	*Squatina californica*	5	U	N	N	N	Loreto
BCS-55	NS													
BCS-56	14 Jan	GN	GN	N	Small sharks	8	U	Teleostei	U	U	N	N	N	Loreto
BCS-57	NS													
BCS-58	NS													
BCS-59	NS													
BCS-60	16 Feb	GN	T	H	Elasmobranchii	U	U	Mollusca	U	U	Teleostei	U	U	U
BCS-61	13 Jan	U	U	U	U	U	U	U	U	U	U	U	U	Mexicali
BCS-62	NS													
BCS-63	NS													
BCS-64	16 Feb	GN, T	N	N	Gastropoda	U	U	Batoidea	U	U	N	N	N	U
BCS-65	13 Jan	HL	GN	N	Lutjanidae, Carangidae	15, 15	W	Small sharks	8	D	N	N	N	Ciudad Constitucion, Ensenada
BCS-66	NS													
BCS-67	16 Feb	T	N	N	Gastropoda	U	U	N	N	N	N	N	N	U
BCS-68	NS													
BCS-69	NS													
BCS-70	NS													
BCS-71	17 Feb	GN, HL	H	N	Elasmobranchii	U	U	Lutjanidae, Serranidae	U, U	U, U	N	N	N	U
BCS-72	NS													
BCS-73	18 Feb	HL	GN	H	Teleostei	U	U	Gastropoda	U	U	Holothuroidea	U	U	U
BCS-74	19 Feb	H	HL	GN	Gastropoda, Holothuroidea, Octopoda	U, U, U	U, U, U	Lutjanidae, *Seriola* spp., Serranidae	U, U, U	U, U, U	Batoidea	U	U	U
BCS-75	19 Feb	HL	H	N	Bivalvia, Octopoda	U, U	U, U	Teleostei	U	U	N	N	N	U
BCS-76	21 Feb	GN, HL	N	N	Teleostei	U	U	N	N	N	N	N	N	U
BCS-77	21 Feb	HL	GN	N	Teleostei	U	U	*Squatina californica*	U	U	N	N	N	U
BCS-78	21 Feb	HL	GN	GN	Teleostei	U	U	Elasmobranchii	U	U	N	N	N	U
BCS-79	NS													
BCS-80	NS													
BCS-81	NS													
BCS-82	NS													
BCS-83	NS													

Appendix 2. continued.

Winter 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-01	15 Jan	HL	LL	GN	*Sphyrna lewini*	10	U	Lutjanidae	20	U	Serranidae	25	U	San Jose del Cabo
BCS-02	NS													
BCS-03	15 Jan	HL	LL	N	Lutjanidae	10-20	U	*Caulolatilus* spp.	5	U	*Scomberomorus* spp.	U	U	La Paz, Tijuana
BCS-04	15 Jan	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-05	15 Jan	N	N	N	N	N	N	N	N	N	N	N	N	N
BCS-06	NS													
BCS-07	15 Jan	HL	GN	N	U	U	U	U	U	U	U	U	U	U
BCS-08	NS													
BCS-09	16 Jan	HL	GN	N	Large sharks	8	U	N	N	N	N	N	N	La Paz
BCS-10	15 Jan	HL	N	N	Balistidae	5	U	Lutjanidae	5-15	U	Large sharks	8	U	La Paz
BCS-11	NS													
BCS-12	16 Jan	LL	GN	N	U	U	U	U	U	U	U	U	U	Los Barriles
BCS-13	16 Jan	LL	N	N	U	U	U	U	U	U	U	U	U	U
BCS-14	NS													
BCS-15	16 Jan; 17, 23, 25 Feb	HL, LL	GN, LL	N	*Isurus oxyrinchus* , *Prionace glauca,* Scombridae	16, 16, 6	D, D, U	N	N	N	N	N	N	La Paz, USA
BCS-16	NS													
BCS-17	16 Jan	HL	N	N	U	U	U	U	U	U	U	U	U	U
BCS-18	NS													
BCS-19	NS													
BCS-20	26 Jan	GN	HL	N	Batoidea	16-17	U	U	U	U	N	N	N	La Paz
BCS-21	NS													
BCS-22	NS													
BCS-23	NS													
BCS-24	NS													
BCS-25	NS													
BCS-26	NS													
BCS-27	27 Feb	GN	N	N	Teleostei	8	D	N	N	N	N	N	N	U
BCS-28	NS													
BCS-29	NS													
BCS-30	NS													
BCS-31	NS													
BCS-32	NS													
BCS-33	NS													
BCS-34	NS													
BCS-35	28 Feb	GN	N	N	*Mobula* spp.	8	D	*Squatina californica*	U	D	N	N	N	La Paz
BCS-36	NS													
BCS-37	27 Feb	HL	N	N	Balistidae	6	D	N	N	N	N	N	N	La Paz
BCS-38	NS													
BCS-39	NS													
BCS-40	NS													
BCS-41	NS													
BCS-42	NS													
BCS-43	NS													
BCS-44	NS													

Appendix 2. continued.

Winter 1999. continued.

Camp Code	Survey Dates	1° Gear	2° Gear	3° Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
BCS-45	NS													
BCS-46	NS													
BCS-47	NS													
BCS-48	NS													
BCS-49	NS													
BCS-50	NS													
BCS-51	NS													
BCS-52	NS													
BCS-53	NS													
BCS-54	NS													
BCS-55	NS													
BCS-56	NS													
BCS-57	NS													
BCS-58	NS													
BCS-59	NS													
BCS-60	NS													
BCS-61	NS													
BCS-62	NS													
BCS-63	NS													
BCS-64	NS													
BCS-65	NS													
BCS-66	NS													
BCS-67	NS													
BCS-68	NS													
BCS-69	NS													
BCS-70	NS													
BCS-71	NS													
BCS-72	NS													
BCS-73	NS													
BCS-74	NS													
BCS-75	NS													
BCS-76	NS													
BCS-77	NS													
BCS-78	NS													
BCS-79	NS													
BCS-80	NS													
BCS-81	NS													
BCS-82	NS													
BCS-83	NS													

Appendix 3. General fishery information by season and year for artisanal camps in Sonora. Targets were identified to lowest possible taxon. Abbreviations are as follows: D (dressed), GN (gillnet), H (hookah), HL (handline), LL (longline), N (none), NS (camp not surveyed during this period), $N/kg (pesos per kilogram), T (traps), U (unknown), and W (whole). Gear and target categories do not necessarily correspond.

Spring 1998

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SON-01	9 Mar	U	U	U	Bivalvia	100	U	Portunidae	U	U	Batoidea	U	U	Mazatlan, Mexico
SON-02	9 Mar	GN	T	GN	Dendrobranchiata	60	W	Gastropoda	13	U	Portunidae	U	W	Sonora
SON-03	9 Mar	N	N	N	N	N	N	N	N	N	N	N	N	Guadalajara, Mexico City
SON-04	9 Mar	LL	GN	N	Small sharks, Teleostei	10, U	U, U	N	N	N	N	N	N	Guadalajara
SON-05	NS													
SON-06	10 Mar	GN	LL	N	Batoidea	18	U	Lutjanidae	18	U	N	N	N	Guadalajara, Mexico City, San Carlos
SON-07	NS													
SON-08	NS													
SON-09	11 Mar	GN	GN	N	*Scomberomorus* spp.	5	U	Batoidea, Small sharks	8, 15	U, U	N	N	N	Ciudad Juarez, Hermosillo, Mexico City, Tijuana
SON-10	11 Mar	T	GN	N	Portunidae	7.5	W	Small sharks	12	U	N	N	N	Bahia Kino, Hermosillo
SON-11	11 Mar	T	N	N	Portunidae	U	W	N	N	N	N	N	N	Hermosillo
SON-12	11 Mar	T	GN	N	Portunidae	U	W	Batoidea, Small sharks	U	U, U	Bivalvia	U	U	Bahia Kino, Hermosillo
SON-13	12 Mar	GN	LL	N	Batoidea, Small sharks	4, 9	D, D	Serranidae	23	U	Tetraodontidae	U	U	Mexico City
SON-14	14 Mar	LL	GN	N	Pleuronectidae, Serranidae	24, 24	U, U	Batoidea, Small sharks	8, 8	U, U	N	N	N	Caborca, Hermosillo, Torreon
SON-15	NS													
SON-16	13 Mar	GN	LL	N	Batoidea, *Rhinobatos* spp., Small sharks	8, 8, 20	U, U, U	Pleuronectidae, Serranidae	10, 20	U, U	N	N	N	Hermosillo, Mexico City, Tijuana
SON-17	NS													
SON-18	NS													
SON-19	NS													

Appendix 3. continued.

Spring 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SON-01	NS													
SON-02	NS													
SON-03	27 Mar, 21 May	GN, HL	GN	GN, T	Lutjanidae, *Scomberomorus* spp.	21, 7	U, U	Sciaenidae	22	U	Batoidea, Gastropoda, Small sharks	6, 18, 6	U, D, U	Obregon, Hulabampo
SON-04	NS													
SON-05	22, 23 May	HL	GN, LL	N	Teuthoidea	6	D	Large sharks	4	D	N	N	N	Hermosillo, Mexico City
SON-06	NS													
SON-07	13, 14, 19-25, 27, 28, 30, 31 Mar; 6-11, 13-21, 23-30 Apr; 1, 2, 4-9, 15-20, 22, 30, 31 May	GN	GN	T	Batoidea, Pleuronectiformes	6, 17	U, U	Small sharks	9	U	Gastropoda	18-20	U	U
SON-08	18-20 Mar; 26 Apr	GN	GN	T	Batoidea	6	D	Pleuronectiformes, *Scomberomorus* spp.	16, 6	U	Portunidae	U	U	Kino Viejo
SON-09	1, 3-6, 8-12, 14, 16, 17, 23, 25, 26 Mar; 6, 7, 9-14 Apr; 4-9, 11-14, 16-18, 24, 25, 29 May	GN	GN	N	Batoidea, Small sharks	6, 12	U, U	*Scomberomorus spp., Small sharks*	U, 11	U, U	*Octopus* spp., *Scomberomorus* spp.	U, 6.5	U, U	Bahia Kino, Hermosillo
SON-10	NS													
SON-11	23 Mar	N	N	N	N	N	N	N	N	N	N	N	N	N
SON-12	NS													
SON-13	NS													
SON-14	21, 22 Mar	GN, LL	GN	N	Batoidea, Serranidae	6, 20-27	U, W	*Mustelus* spp., Pleuronectiformes	9, 15	U, U	Balistidae, Batoidea	7, 9	U, U	Caborca, Guadalajara, Hermosillo, Torreon, USA
SON-15	23 Mar; 31 May	GN, T	GN	N	Batoidea, Portunidae	5-6, 11	D, W	Batoidea, Small sharks	7, 8-10	U, D	U	12	U	Mexicali, San Luis Rio Colorado, Tijuana
SON-16	23 Mar; 31 May	GN, LL	GN	N	Batoidea, Serranidae	5.5-6, 28	D, W	Small sharks	8-10	D	Batoidea	6	U	Mexico City, Puerto Penasco
SON-17	23 Mar; 31 May	GN	N	N	Batoidea, *Rhinobatos* spp.	6, 5.5	U, U	N	N	N	N	N	N	Tijuana
SON-18	NS													
SON-19	24 Mar	LL	N	N	Serranidae	27	U	Small sharks	10	U	Batoidea	8	U	USA, Others Unknown

Appendix 3. continued.

Summer 1998

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SON-01	NS													
SON-02	NS													
SON-03	NS													
SON-04	NS													
SON-05	NS													
SON-06	13, 20 Jun; 2, 7, 8, 13-15, 21-23, 25, 30 Jul; 26-28 Aug	GN	N	N	Large Sharks	17	D	N	N	N	N	N	N	Mexico City
SON-07	NS													
SON-08	NS													
SON-09	9, 10 Jul	GN	GN	N	Batoidea	16	D	*Octopus* spp.	35	U	Large Sharks, Small Sharks	5, 5	U	U
SON-10	NS													
SON-11	NS													
SON-12	NS													
SON-13	NS													
SON-14	NS													
SON-15	NS													
SON-16	12, 13 Jul	GN	LL	N	Batoidea	6-8	U	Large Sharks, Small Sharks	8, 8	U	Scopaenidae, *Squatina californica*	8, 8	U, U	Hermosillo, Mexico City, Tijuana
SON-17	NS													
SON-18	NS													
SON-19	NS													

Appendix 3. continued.

Summer 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SON-01	NS													
SON-02	NS													
SON-03	19 Aug	HL	T	N	Lutjanidae	22	U	Portunidae	4	W	N	N	N	Guadalajara, Mexico City, Tijuana, USA
SON-04	NS													
SON-05	29 Jun; 17, 18 Aug	GN, LL	GN	N	Large Sharks	4	U	Batoidea	3	U	N	0	N	Mexico City
SON-06	NS													
SON-07	1-21, 23, 24, 26, 28-30 Jun	U	U	U	U	U	U	U	U	U	U	U	U	U
SON-08	NS													
SON-09	3-5, 8-10, 13-18, 20-15 Jun; 2, 4, 5, 24-26, 29-31 Jul; 1-3, 5-7, 9, 11-13, 21-23, 31 Aug	U	U	U	U	U	U	U	U	U	U	U	U	U
SON-10	NS													
SON-11	NS													
SON-12	NS													
SON-13	NS													
SON-14	NS													
SON-15	NS													
SON-16	1 Jun	U	U	U	U	U	U	U	U	U	U	U	U	U
SON-17	NS													
SON-18	NS													
SON-19	NS													

Appendix 3. continued.

Autumn 1998

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SON-01	NS													
SON-02	NS													
SON-03	NS													
SON-04	NS													
SON-05	NS													
SON-06	1, 7, 12, 13, 30 Sep; 1, 15 Oct	U	U	U	U	U	U	U	U	U	U	U	U	U
SON-07	7, 27 Oct; 6, 17, 18 Nov	GN	LL	N	Small Sharks	25	D	Batoidea	15	D	*Scomberomorus* spp.	7	D	Hermosillo
SON-08	NS													
SON-09	9, 10, 15 Oct	GN	T	N	Batoidea	6	D	Balistidae	6	D	Portunidae	5.5-6	W	Mexico (mainland)
SON-10	9 Oct	T	GN	N	Portunidae	U	W	Batoidea	6	U	N	N	N	Bahia Kino
SON-11	NS													
SON-12	NS													
SON-13	NS													
SON-14	13, 14 Oct	GN	LL	N	*Mustelus* spp.	6	D	Batoidea, *Rhinobatos* spp.	6, 6	D, D	Serranidae	20	U	Foreign, Local
SON-15	11 Oct	T	N	N	Portunidae	8.5-10.5	W	N	N	N	N	N	N	N
SON-16	11 Oct	GN	GN	N	Sciaenidae	10	U	Dendrobranchiata	U	W	Batoidea	4.5-10	U	Local, USA
SON-17	11 Oct	T	GN	N	Portunidae	9	W	Batoidea	8	U	N	N	N	Mexicali, Nogalis, Tijuana
SON-18	12 Oct	GN	GN	N	Dendrobranchiata	110	W	Sciaenidae	5	U	N	N	N	Local
SON-19	NS													

Appendix 3. continued.

Autumn 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SON-01	NS													
SON-02	NS													
SON-03	5-7 Nov	GN	HL	GN	Dendrobranchiata	110	D	Teuthoidea	2.5	U	Small Sharks	6-10	U	Guaymas, Hermosillo, Obregon
SON-04	NS													
SON-05	NS	GN	HL	GN	Dendrobranchiata	110	U	Teuthoidea	2.5	U	Small Sharks	10	U	Guaymas, Obregon
SON-06	NS													
SON-07	20-30 Sep; 1-7; 12, 13, 20-31 Oct; 1-4	GN	GN	N	Batoidea	10-13	U	*Scomberomorus* spp.	5	U	N	0	N	Guaymas, Hermosillo
SON-08	13-15 Oct	GN	GN	GN	Batoidea	6	U	Plueronectiformes	16	U	Small Sharks	10-15	U	Bahia Kino
SON-09	1-3, 13-17, 20, 23, 29 Sep; 1-4, 14, 16, 31 Oct; 2, 4, 5, 11, 12,	GN	GN	T	Batoidea, Small Sharks	6, 13	U, U	*Scomberomorus* spp.	6	U	Portunidae	6	U	Canada, Ensenada, Hermosillo, Guadalajara, Japan, Mexico City, Monterrey, USA
SON-10	15 Oct	T	GN	N	Portunidae	8	U	*Mugil* spp.	5-6	U	N	N	N	Bahia Kino, Hermosillo, Punta Chueca
SON-11	NS													
SON-12	NS													
SON-13	NS													
SON-14	20-22 Oct	GN	T	N	Batoidea	6.5	U	Small Sharks	12	U	Balistidae, Serranidae	28, 6	U, U	Caborca, Hermosillo, Mexico City
SON-15	19 Oct	T	N	N	Portunidae	7.5	U	N	N	N	N	N	N	U
SON-16	NS													
SON-17	NS													
SON-18	NS													
SON-19	NS													

Appendix 3. continued.

Winter 1998

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SON-01	NS													
SON-02	NS													
SON-03	NS													
SON-04	NS													
SON-05	NS													
SON-06	NS													
SON-07	14 Dec	GN	GN	N	*Scomberomorus* spp.	6	U	Batoidea	6	U	Pleuronectiformes	16	U	U
SON-08	NS													
SON-09	14 Dec	GN	GN	N	*Scomberomorus* spp.	6	U	Batoidea	6	U	N	N	N	Hermosillo
SON-10	NS													
SON-11	NS													
SON-12	NS													
SON-13	NS													
SON-14	15, 16 Dec	GN, LL	N	N	Small Sharks	U	U	N	N	N	N	N	N	U
SON-15	NS													
SON-16	17 Dec	U	U	U	U	U	U	U	U	U	U	U	U	U
SON-17	17 Dec	T	N	N	Portunidae	4	U	N	N	N	N	N	N	U
SON-18	NS													
SON-19	NS													

Appendix 3. continued.

Winter 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SON-01	NS													
SON-02	NS													
SON-03	NS													
SON-04	NS													
SON-05	NS													
SON-06	NS													
SON-07	23 Jan; 27 Feb	GN	GN	N	Batoidea	6-7	U	*Scomberomorus* spp.	6	U	N	N	N	Obregon
SON-08	NS													
SON-09	21, 22 Jan; 27, 28 Feb	GN	GN	N	Batoidea	6	U	*Scomberomorus* spp.	U	U	Pleuronectiformes	16	U	Bahia Kino, Hermosillo
SON-10	NS													
SON-11	NS													
SON-12	NS													
SON-13	NS													
SON-14	NS													
SON-15	NS													
SON-16	NS													
SON-17	NS													
SON-18	NS													
SON-19	NS													

Appendix 4. General fishery information by season for artisanal camps in Sinaloa. Targets were identified to lowest possible taxon. Abbreviations are as follows: D (dressed), GN (gillnet), H (hookah), HL (handline), LL (longline), N (none), NS (camp not surveyed during this period), $N/kg (pesos per kilogram), T (traps), TN (throw net), U (unknown), and W (whole). Gear and target categories do not necessarily correspond. Note: No surveys were conducted in summer or winter 1998.

Spring 1998

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SIN-01	3 Mar	GN	GN	N	*Rhizoprionodon longurio*, *Sphyrna* spp.	U, U	U, U	*Bagre panamensis*, Serranidae	2.5, 22	U, U	Sciaenidae, *Scomberomorus* spp.	3.5, 3.5	U, U	Guadalajara, Mexico City
SIN-02	3 Mar	GN	N	N	*Mugil setosus*	3	U	*Bagre panamensis*	3.5	U	Clupeidae, Mugilidae	2.5, 2.5	U, U	Culiacan, Local, Mazatlan
SIN-03	3 Mar	GN	N	N	*Scomberomorus* spp., *Bagre panamensis*	3, 3	U, U	*Rhizoprionodon longurio*, Small sharks	4, 7	U, U	Sciaenidae, Serranidae	3, 8	U, U	Guadalajara, Mexico City, Puebla
SIN-04	2 Mar	LL	N	N	Small sharks	18	U	Serranidae	20	U	Lutjanidae	20	U	Mazatlan
SIN-05	4 Mar	GN, T	N	N	Batoidea, *Centropomus* spp., Lutjanidae, Palinuridae, Sciaenidae, Small sharks	U, 20, 20, 65, 20, 12	U, U, U, U, U, U	N	N	N	N	N	N	Guadalajara, Mexico City
SIN-06	4 Mar	GN	LL	N	Sciaenidae, Small sharks	18, 13	U, U	Lutjanidae	18	U	N	N	N	Culiacan
SIN-07	4 Mar	GN	N	N	Small sharks	10	U	Serranidae, Ariidae	17, 17	U, U	N	N	N	U
SIN-08	4 Mar	GN	N	N	Balistidae, Carangidae, Sciaenidae	4, 12, 12	U, U, U	N	N	N	N	N	N	Guadalajara
SIN-09	5 Mar	TN	N	N	Mugilidae	4	U	Bivalvia	U	W	N	N	N	USA
SIN-10	5 Mar	GN	N	N	Ariidae, Mugilidae	4, 4	U, U	Tetraodontidae	20	U	N	N	N	Culiacan
SIN-11	5 Mar	GN	LL	N	Lutjanidae, Sciaenidae	20, 20	U, U	Small sharks	15	U	Tetraodontidae	18	U	Culiacan, Guadalajara, Mexico
SIN-12	5 Mar	GN	LL	N	Sciaenidae, Teleostei	6, 6	U, U	Bivalvia	1	W	N	N	N	Guadalajara
SIN-13	5 Mar	GN	LL	N	Small sharks	16	U	Serranidae	20	U	Pleuronectiformes	16	U	Guadalajara
SIN-14	NS													
SIN-15	6 Mar	GN	LL	N	Mugilidae	7	U	Balistidae	7	U	N	N	N	Guadalajara, Mexico (mainland)
SIN-16	6 Mar	GN	LL	N	Small sharks	15-17	U	Batoidea	10	U	*Megapitaria aurantiaca*, *Megapitaria squalida*	20, 250	W, W	Guadalajara
SIN-17	6 Mar	GN	LL	N	Batoidea, Small sharks	10, 13	U, U	Serranidae	18	U	Mugilidae, Pleuronectiformes	10, 10	U, U	U
SIN-18	6 Mar	TN	HL	N	Mugilidae	3	U	Teleostei	U	U	N	N	N	Guadalajara, Local
SIN-19	7 Mar	TN	GN	N	Mugilidae	3	U	Small sharks, Teleostei	U, U	U, U	N	N	N	Guadalajara
SIN-20	7 Mar	TN	HL	N	Mugilidae	3	U	Lutjanidae	20	U	N	N	N	Guadalajara, Los Mochis,
SIN-21	7 Mar	TN	GN	LL	Mugilidae	3	U	Lutjanidae	12	U	Tetraodontidae	U	U	Local
SIN-22	7 Mar	GN	LL	N	Mugilidae	3.5	U	Batoidea, Small sharks	14, 16	U, U	Lutjanidae	20	U	Guadalajara, Huitussi
SIN-23	7 Mar	LL	GN	TN	Batoidea, Small sharks	13, 13	U, U	*Scomberomorus* spp., Tetraodontidae	5, 5	U, U	Mugilidae	3	U	Guadalajara, Guasave
SIN-24	7 Mar	GN	N	N	Batoidea, Small sharks	13, 13	U, U	Mugilidae	3	U	N	N	N	Guadalajara, Mexico City
SIN-25	7 Mar	GN	U	N	Mugilidae	3.5	U	*Scomberomorus* spp.	U	U	N	N	N	Guadalajara, Los Mochis,
SIN-26	8 Mar	GN	GN	N	Mugilidae, Small sharks	3, 14	U, U	Lutjanidae	20	U	Sciaenidae, Serranidae	U, U	U, U	Culiacan, Los Mochis
SIN-27	8 Mar	LL	GN	N	Small sharks	U	U	N	N	N	N	N	N	U
SIN-28	8 Mar	GN	LL	N	Small sharks	13	U	Pleuronectiformes, Serranidae	13, 17	U, U	*Scomberomorus* spp.	7	U	Los Mochis, Mexico City

Appendix 4. continued.

Spring 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SIN-01	2-4, 6, 8-10 Mar	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-02	NS													
SIN-03	NS													
SIN-04	3, 5, 6 Mar	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-05	5 Mar	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-06	NS													
SIN-07	NS													
SIN-08	NS													
SIN-09	NS													
SIN-10	NS													
SIN-11	8 Mar	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-12	NS													
SIN-13	NS													
SIN-14	9, 10, 16 Mar	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-15	NS													
SIN-16	NS													
SIN-17	NS													
SIN-18	NS													
SIN-19	NS													
SIN-20	NS													
SIN-21	NS													
SIN-22	NS													
SIN-23	NS													
SIN-24	NS													
SIN-25	NS													
SIN-26	NS													
SIN-27	NS													
SIN-28	15 Mar	U	U	U	U	U	U	U	U	U	U	U	U	U

Appendix 4. continued.

Summer 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SIN-01	NS													
SIN-02	NS													
SIN-03	NS													
SIN-04	NS													
SIN-05	3, 4 Jun	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-06	NS													
SIN-07	NS													
SIN-08	NS													
SIN-09	NS													
SIN-10	NS													
SIN-11	8, 10 Jun	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-12	NS													
SIN-13	NS													
SIN-14	5 Jun	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-15	11, 12 Jun	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-16	NS													
SIN-17	NS													
SIN-18	NS													
SIN-19	NS													
SIN-20	NS													
SIN-21	NS													
SIN-22	NS													
SIN-23	16, 17 Jun	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-24	NS													
SIN-25	NS													
SIN-26	NS													
SIN-27	NS													
SIN-28	NS													

Appendix 4. continued.

Autumn 1998

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertiary Target	N$/kg	Market Condition	Market
SIN-01	1 Oct	GN	LL	N	Teleostei	U	U	Small sharks	U	U	N	N	N	Acapulco, Guadalajara
SIN-02	NS													
SIN-03	NS													
SIN-04	NS													
SIN-05	2 Oct	GN	LL	N	*Scomberomorus* spp.	3	U	Lutjanidae	20	U	Small sharks	12	U	Mazatlan
SIN-06	2 Oct	GN	LL	N	*Bagre panamensis*, Gerreidae, Mugilidae	3, 3, 3	U, U, U	Small sharks	12	U	Sciaenidae	18	U	Culiacan
SIN-07	NS													
SIN-08	NS													
SIN-09	NS													
SIN-10	NS													
SIN-11	3 Oct	TN	GN	LL	Dendrobranchiata	U	W	Teleostei	U	U	Lutjanidae, Small sharks	17-20, U	U, U	Culiacan, Guadalajara
SIN-12	3 Oct	GN	LL	N	Dendrobranchiata	U	W	Small sharks	12	U	Large sharks	10	U	Guadalajara, Mexico (mainland)
SIN-13	3 Oct	GN	GN	N	Dendrobranchiata	U	W	Lutjanidae, Sciaenidae, Small sharks	U, U, U	U, U, U	N	N	N	Guadalajara
SIN-14	NS													
SIN-15	4 Oct	GN	N	N	Dendrobranchiata	U	W	N	N	N	N	N	N	Culiacan, Mexico City
SIN-16	4 Oct	GN	N	N	Dendrobranchiata	U	W	N	N	N	N	N	N	U
SIN-17	4 Oct	N	N	N	N	N	N	N	N	N	N	N	N	N
SIN-18	NS													
SIN-19	NS													
SIN-20	NS													
SIN-21	NS													
SIN-22	NS													
SIN-23	NS													
SIN-24	6 Oct	GN	N	N	Dendrobranchiata	U	W	N	N	N	N	N	N	Culiacan
SIN-25	NS													
SIN-26	NS													
SIN-27	7 Oct	GN	LL	N	Dendrobranchiata	U	W	Lutjanidae, Small sharks	20, U	U, U	N	N	N	Guadalajara
SIN-28	NS	GN	GN	N	Dendrobranchiata	U	W	Small sharks, Teleostei	U, U	U, U	N	N	N	Guadalajara, Mexico City

Appendix 4. continued.

Autumn 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertitiary Target	N$/kg	Market Condition	Market
SIN-01	NS													
SIN-02	NS													
SIN-03	NS													
SIN-04	NS													
SIN-05	NS													
SIN-06	NS													
SIN-07	NS													
SIN-08	NS													
SIN-09	NS													
SIN-10	NS													
SIN-11	NS													
SIN-12	NS													
SIN-13	NS													
SIN-14	11 Nov	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-15	NS													
SIN-16	NS													
SIN-17	NS													
SIN-18	NS													
SIN-19	NS													
SIN-20	NS													
SIN-21	NS													
SIN-22	NS													
SIN-23	NS													
SIN-24	NS													
SIN-25	NS													
SIN-26	NS													
SIN-27	NS													
SIN-28	13 Nov	U	U	U	U	U	U	U	U	U	U	U	U	U

Appendix 4. continued.

Winter 1999

Camp Code	Survey Dates	1º Gear	2º Gear	3º Gear	Primary Target	N$/kg	Market Condition	Secondary Target	N$/kg	Market Condition	Tertitiary Target	N$/kg	Market Condition	Market
SIN-01	NS													
SIN-02	NS													
SIN-03	NS													
SIN-04	14-16, 19 Jan; 5, 6, 9-13, 18-20, 24, 26, 27 Feb	U	U	U	U	U	U	U	U	U	U	U	U	U
SIN-05	NS													
SIN-06	NS													
SIN-07	NS													
SIN-08	NS													
SIN-09	NS													
SIN-10	NS													
SIN-11	NS													
SIN-12	NS													
SIN-13	NS													
SIN-14	NS													
SIN-15	NS													
SIN-16	NS													
SIN-17	NS													
SIN-18	NS													
SIN-19	NS													
SIN-20	NS													
SIN-21	NS													
SIN-22	NS													
SIN-23	NS													
SIN-24	NS													
SIN-25	NS													
SIN-26	NS													
SIN-27	NS													
SIN-28	10 Jan; 17 Feb	U	U	U	U	U	U	U	U	U	U	U	U	U